JOURNAL

OF THE

ROYAL MICROSCOPICAL SOCIETY;

CONTAINING ITS TRANSACTIONS AND PROCEEDINGS,

AND A SUMMARY OF CURRENT RESEARCHES RELATING TO

ZOOLOGY AND BOTANY

(principally Invertebrata and Cryptogamia),

MICROSCOPY, &c.

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FELLOWS OF THE SOCIETY.

FOR THE YEAR

1893.

LONDON:

TO BE OBTAINED AT THE SOCIETY'S ROOMS,

20 HANOVER SQUARE, W.;

OF MESSRS. WILLIAMS & NORGATE; AND OF MESSRS. DULAU & CO.

MICROSCOPY.

a. Instruments, Accessories, &c.*

(1.) Stands.

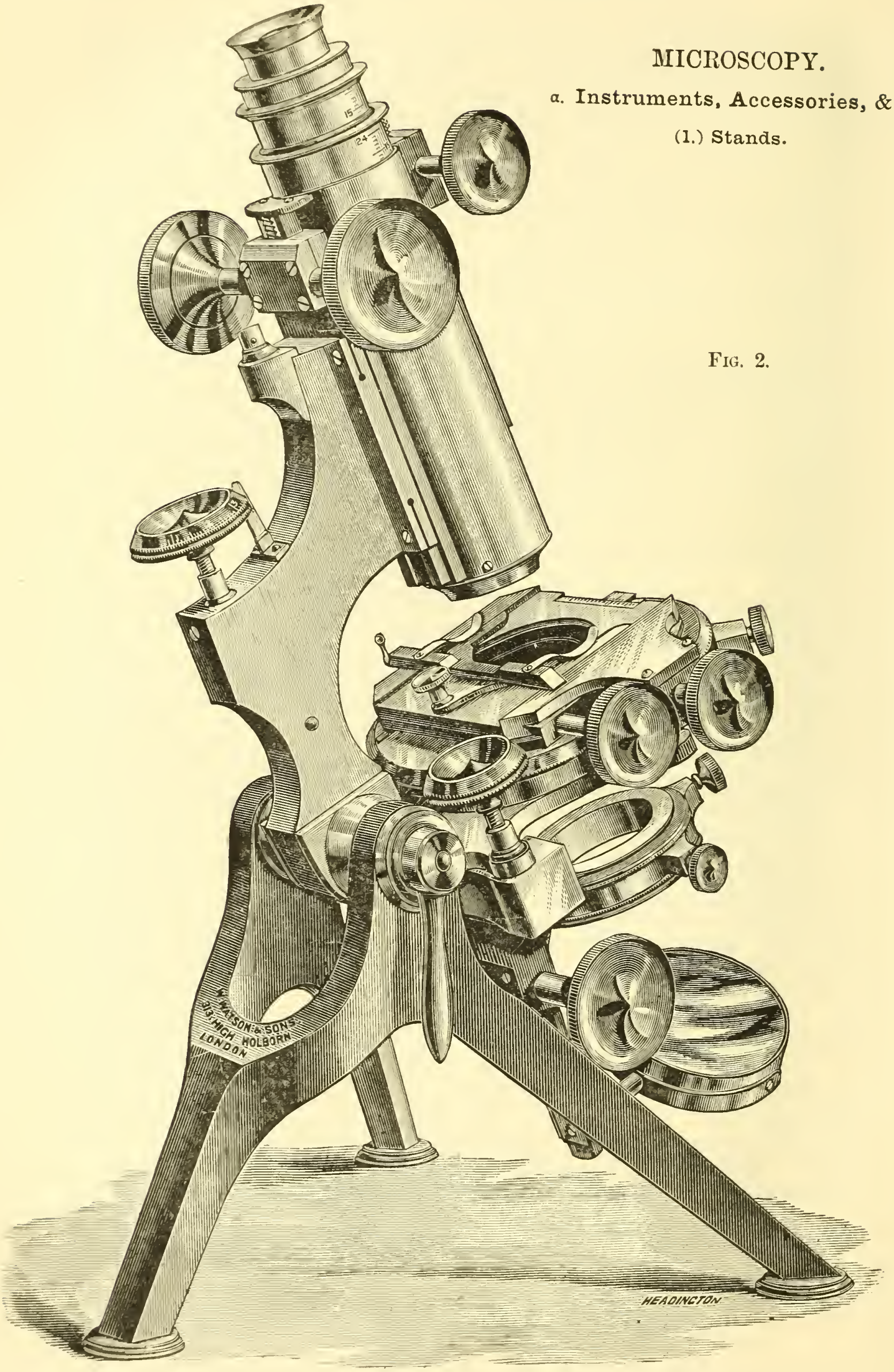
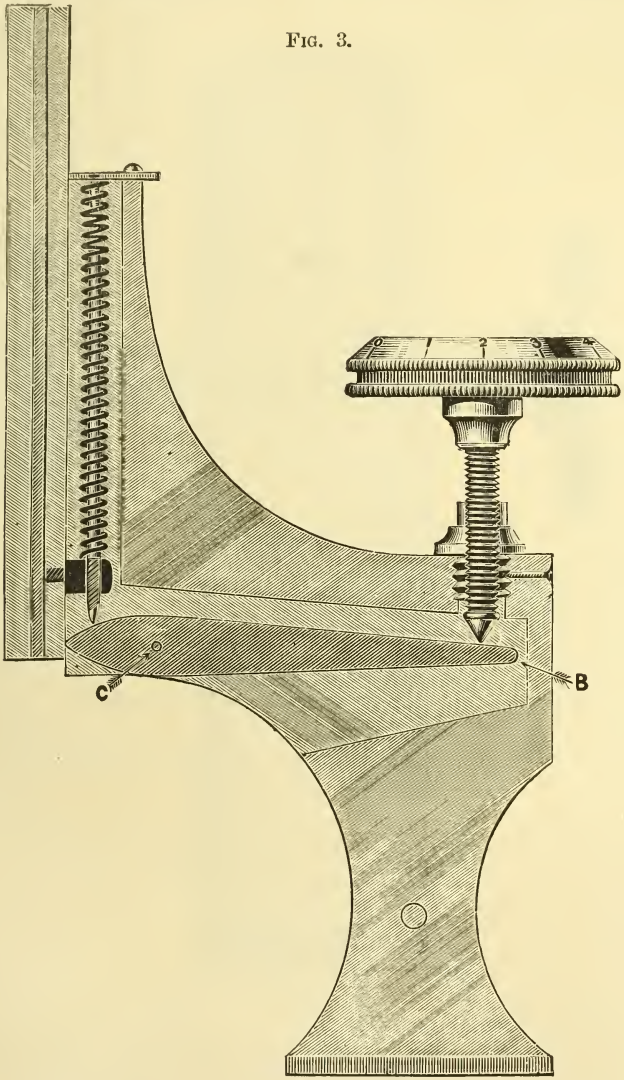


Fig. 2.

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

Messrs. W. Watson and Sons' No. 4 Van Heurck Microscope (B) (fig. 2).—Mounted on plain tripod foot, showing centering screws to stage. Height, when placed vertically and racked down, $13\frac{1}{8}$ in. The instrument is identical in all respects with the A and B forms, but is mounted on a different foot.

Fig. 3.

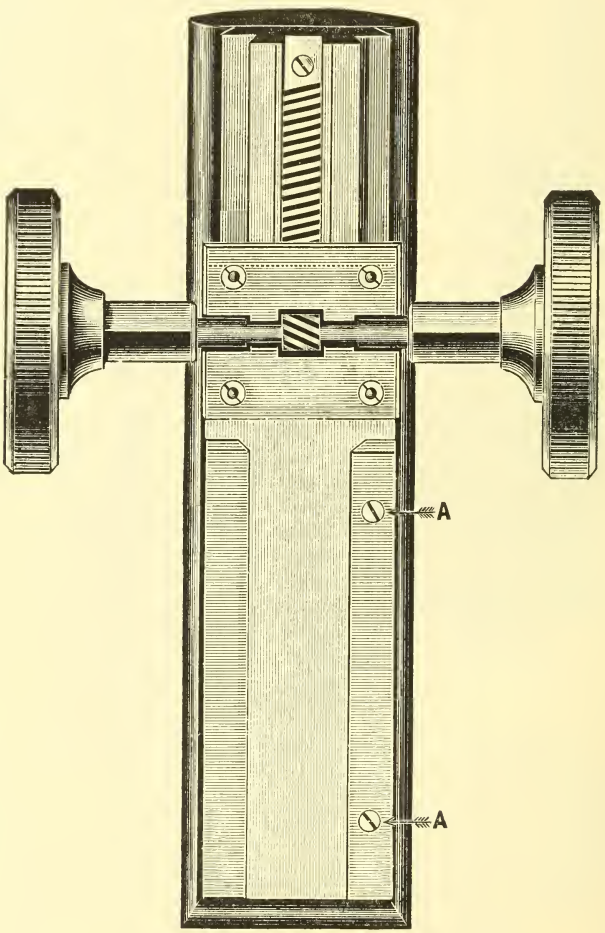


Messrs. W. Watson's Fine-Adjustment.—In calling attention to their system of fine-adjustment, Messrs. Watson write as follows:—"The entire body [of the instrument] is raised or lowered by means of

a milled head fixed to a screw having a hardened steel point, acting on a lever, in a perfect fitting dove-tail slide, about 2½ in. long. The principle of it is shown in the accompanying figure (fig. 3).

At first sight it would appear that the screw controlling this important movement has to bear the entire weight of the body of the instrument,

Fig. 4.



as in the Continental models. This is a common error, but not in accordance with fact. The turning of the milled-head screw actuates a hardened steel lever B, varying in length according to the size of the instrument, the fulcrum C of which is placed as closely as possible to the sliding fitting in which the movement of the body takes place, which reduces the weight carried by the milled head to considerably less than

in any other form. For instance, in our Edinburgh Student's Microscope—a section of a limb of which is shown in fig. 3—the total length of the lever arms is $2\frac{1}{16}$ in., the arm on the one side being 3/8 in. long, and on the other $1\frac{1}{16}$ in. The weight of the body, fittings, &c., is 17 oz. The resistance at the end of the lever is therefore $3\frac{3}{4}$ oz. We have not included the reactionary spring in these figures, as this is employed in all forms of fine-adjustment, but the resistance of this is minimized at the point of force, in the same ratio as the weight. Also by means of the long lever an extremely slow motion is obtained, the movement being lessened in the same proportion as the weight.

All fine-adjustments must wear in course of time as the result of friction, and in the majority of cases it is irremediable, except in the maker's or a skilled mechanic's hands. In our form the fitting is sprung and has two screws (shown in fig. 4, A), by means of which any wear as the result of friction can be at once taken up by the user. This is of the greatest importance to residents abroad, the necessity of returning an instrument to be adjusted being obviated.

The coarse-adjustment fitted to our instruments is as shown in fig. 4, and is effected by means of a diagonal rack and spiral pinion, which ensures the smoothest possible motion and an entire absence of backlash, the teeth of the pinion never leaving the rack. High powers can be exactly focused by its means without the aid of the fine-adjustment. This adjustment and all the frictional parts of the instruments are fitted with screws, as in the fine-adjustment, which by being very slightly turned compensate for wear and tear."

Note on Watson's Edinburgh Student's Microscope.—Mr. E. M. Nelson read the following note at the November meeting:—"It will be remembered that a certain amount of controversy was raised with regard to a Microscope exhibited here by Messrs. Watson and Sons last year.* I am now alluding not to the general design of that instrument, but solely to the fine-adjustment. Whatever the general design of an instrument, or however simple or complex its movements may be, its real value for work entirely stands or falls with the quality of its fine-adjustment. It is well to remember the axiom propounded by the late T. Powell, 'that a Microscope without a fine-adjustment, but with a good coarse-adjustment, is to be preferred to one, however elaborate, with a bad fine-adjustment.'

The question in dispute, therefore, is of supreme importance. At that time my opinion with regard to the fine-adjustment was asked, but, never having seen it, it was impossible for me to express any opinion on the subject. Since then Messrs. Watson and Sons wrote to me, saying that they were confident of the soundness of the principle of their fine-adjustment, and that if I would examine one, they would submit an instrument for my prolonged investigation. To this I agreed, and I am now in a position to answer the question asked last year regarding this fine-adjustment.

The adverse critics said that this fine-adjustment was on the Zentmayer plan, and as the Zentmayer fine-adjustment was a miserable failure, this one must be a failure also. This might have been very

* This Journal, 1891, p. 434.

true had their premises been correct, but the fallacy of the criticism lay in the fact that this fine-adjustment is not the same as Zentmayer's.

The reason why Zentmayer's fine-adjustment broke down was because it had no sprung grooves; the slides worked in solid V-shaped grooves, so that in more or less time the effect of wear made itself apparent, the fitting became loose, and as there was no means of tightening it up again, the Microscope in the end became only fit for the proverbial dust-bin.

The essential point of a Microscope is the springing of the dovetail grooves, and, so far as I am aware, it is to Messrs. Powell and Lealand that 'microscopy' is indebted for this valuable invention or adaptation. Whether springing of dovetail grooves was previously used in instruments other than the Microscope I am unable to say, but my impression is that Messrs. Powell and Lealand were the first to use it in the Microscope. Now, in Watson's Microscope we have two sprung slides, one for the coarse-adjustment, and one for the fine. The moment either movement exhibits the slightest sign of wear the slack can be immediately taken up by tightening the screws. There is no reason, therefore, why in years to come this instrument should not work as well as it does to-day. There is one point, however, which must be mentioned, and that is the weight of the body and of the coarse-adjustment slide is thrown on the fine-adjustment lever. It differs, therefore, from Powell's, inasmuch as the fine-adjustment in this instrument moves the whole body, whereas in Powell's it only moves the nose-piece. Strictly speaking, in this instrument there is no nose-piece at all. In general, a Microscope which has much weight on its fine-adjustment is to be regarded with suspicion. All who have had much to do with the Microscope know painfully well how soon the fine-adjustments of the Continental Microscopes, which have a considerable weight of brasswork thrown on a delicate screw, become useless. Here the Campbell differential screw with its strong threads has come to the rescue. In Watson's instrument we have a somewhat similar compensation: the arms of the lever being $1 : 4\frac{1}{2}$, the weight which ultimately falls on the fine-adjustment screw is reduced in that proportion. It must be remembered, too, that we are not now dealing with such large or heavy tubes as in the Powell instrument, but with far smaller and lighter tubing. The actual weight on the screw is, I am told, a trifle under a quarter of a pound,* which is, of course, not excessive. This instrument may be said to be identical with what may appropriately be called Swift's No. 2, with this difference: in Swift's the lever is parallel to the body, and in this it is at right angles to it. In Swift's side-lever No. 1 the instrument had a nose-piece, which only was moved as in the Powell; in his No. 2, however, both the body and the coarse-adjustment slide were moved; but in his No. 3 or present form only the body is moved. A lever at right angles to the body has two advantages over a side-lever, the first being that the screw-head is as conveniently placed for use with one hand as with the other; and the second is, that for photomicrography, the gearing to the focusing rod is more simple and direct.

There is one very ingenious and novel adaptation in this instrument which I would like to bring to your notice; the fine-adjustment screw is

* When the tubes and coarse-adjustment pinion-heads are made of aluminium this will be further reduced.

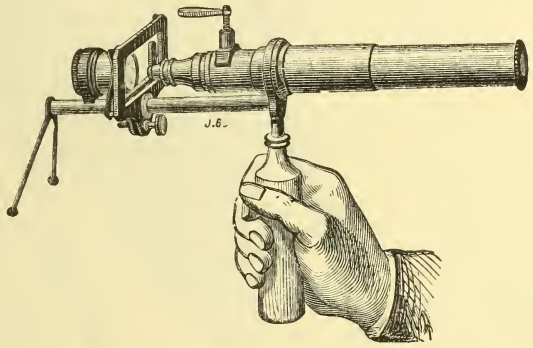
a left-handed one, therefore the movement of the nose-piece follows the *apparent* movement of the screw. In other words, when you think you are turning the screw downwards you are in reality raising it, and by doing so you are lowering the nose-piece.

This plan removes the single objection to the Powell plan of fine-adjustment, viz. the reversal of the movement, which is confusing until the idea is overcome by practice.

I have brought this to the notice of the Society, as I feel sure they have no wish to disparage any instrument which may be brought before them by an erroneous criticism founded on a misconception of its construction."

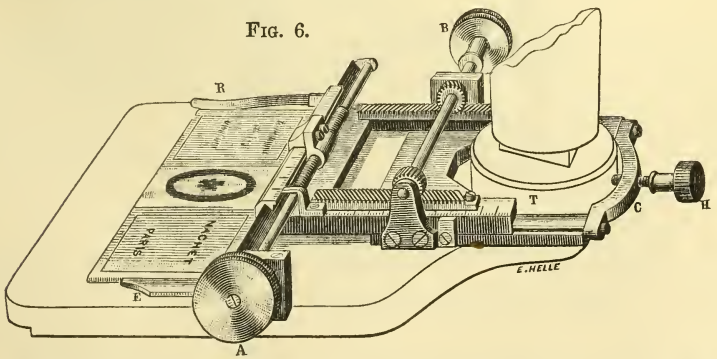
Nachet's Hand-Microscope.—This instrument, shown in fig. 5, is intended for circulation amongst an audience. Contrary to the usual arrangement in Microscopes, the preparation is held on its upper surface

Fig. 5.



by the stage in such a way that the different preparations are at once brought into focus when this has been regulated once for all. For finding the point of the object which it is required to demonstrate, the instrument can be adjusted on a base-plate, and can be separated again for circulation amongst the audience.

Fig. 6.



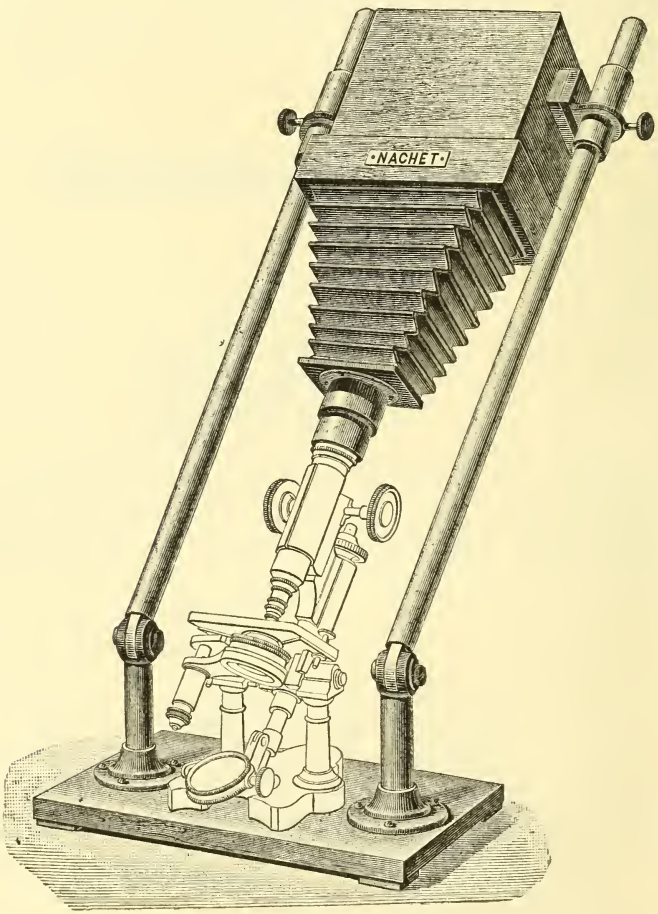
Nachet's Movable Stage.—In this stage, represented in fig. 6, two carriers, perpendicular to one another, move the preparation in all

directions. The latter is simply placed upon the stage and is held firm by the pressure of the spring on the right against the stop on the left. The forward movement is effected by the rack and pinion, and the lateral by the transversal screw. As seen in the figure the apparatus is attached to the ordinary stage by a screw pressing against the column of the slow motion.

(3) Illuminating and other Apparatus.

Nachet's Camera.—The new camera, shown in fig. 7, is mounted on two columns of nickelled copper on which it can be raised to different

Fig. 7.

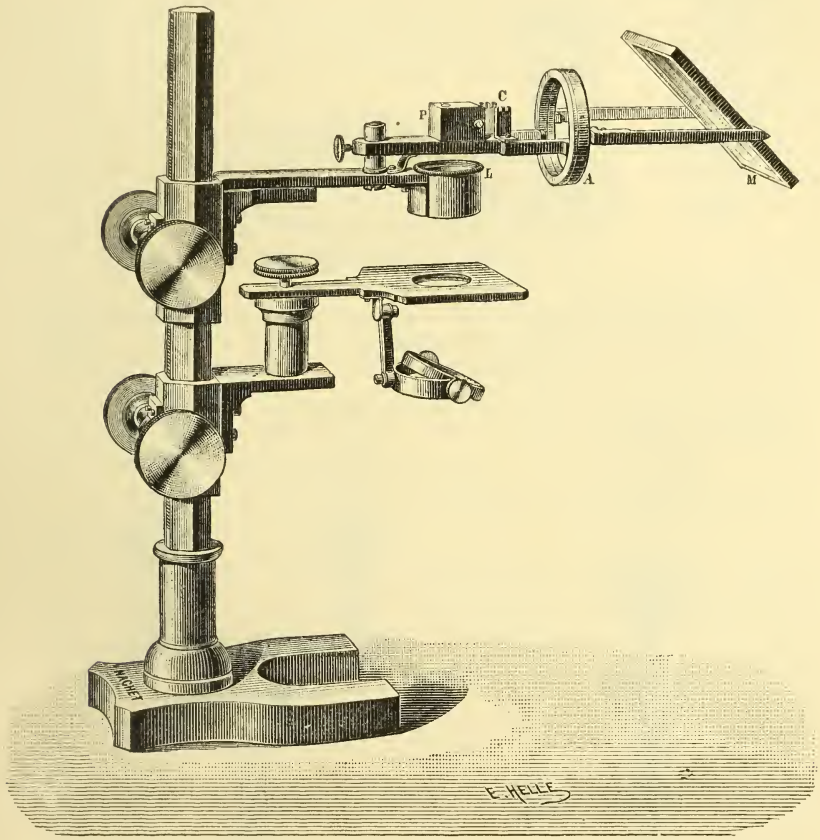


heights above the Microscope. The columns are hinged so that the camera can be inclined at any angle.

The bellows carries a union formed of two pieces, one fixed on the camera and the other screwed on the body-tube of the Microscope. These two pieces are free, one in the other, so that the movements given to the Microscope are independent of the camera.

Nachet's Camera Lucida.—The instrument seen in fig. 8 is a modified form of the camera lucida described in this Journal, 1887, p. 619. It carries two racks, one for adjusting the camera lucida, the other for

Fig. 8.



adjusting the stage beneath the lens P. The modifications in this model consist:—

(1) In the addition of a stage adjustable in height so as to bring the object into the focus of the lens, while the camera lucida is kept at the same distance from the table on which the drawing is to be made.

(2) In the possibility of drawing beneath a very weak lens, objects placed on the table beneath the mirror. For this purpose the stage is

removed and replaced by a small table provided with supports for the hands.

(3) By turning the ring, the mirror passes from the horizontal to the vertical plane, and it is possible thus to reproduce beneath the same weak lens any object placed vertically in front and to reduce it to any extent required. The small frame in front of the prism is for the reception of convex or concave glasses for the correction of parallax, or for tinted glasses intended to equalize the illumination of the object and the paper.

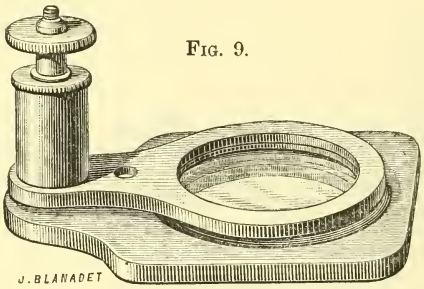


Fig. 9.

Nachet's Compressor.—The advantage of the model shown in fig. 9 is that all the points of the object are compressed equally owing to the two surfaces of glass being parallel to one another.

Fig. 10.

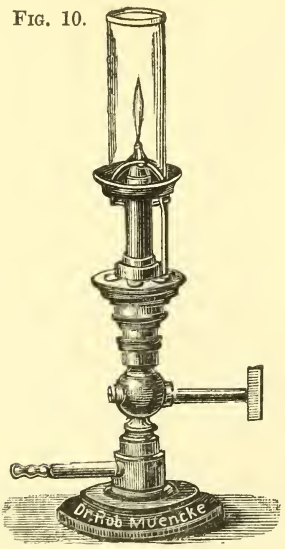
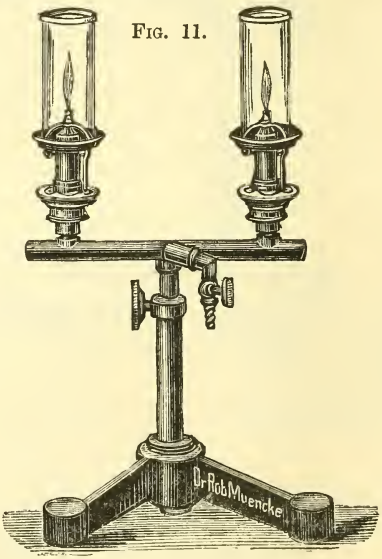


Fig. 11.

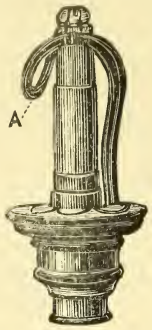


New Microscope-Lamp as Safety Burner.*—Herr P. Altmann describes a new lamp for heating drying ovens, &c., which in point of

* Centralbl. f. Bakteriol. u. Parasitenk., xii. (1892) pp. 786-7.

safety possesses some advantages over those in ordinary use. The automatic arrangement for cutting off the gas when the flame, by accident or otherwise, has been extinguished is novel and ingenious. Fig. 10 shows a single burner as used for small thermostat, and fig. 11 a double burner for heating ordinary cultivating ovens. To light the burner, a match is applied for some seconds to the lower part of the loop at A (fig. 12). The vapour tension, resulting from the heating of the bent tube, acts upon a metal membrane which opens the gas valve, and keeps it open as long as the flame is burning. Should, however, the flame by any accident be extinguished, the temperature of the tube falls, the hydraulic pressure is diminished and the gas-valve is again closed.

Fig. 12.



An Improved Form of Dr. Edinger's Apparatus* for Drawing Objects under Low Powers.—Mr. E. M. Nelson writes to us:—"The following is a description of the instrument made and exhibited for me by Mr. Curties, at the special exhibition on November 30th. My improvement consists in securing a far larger angle from the source of illumination and then condensing it so that it may all pass through the front lens of the objective, which on that occasion was a Zeiss *aa*. This increased illumination will, I think, be found to be an improvement on Dr. Edinger's method.

On referring to fig. 13 it will be seen that the magnified image of the object is projected on the paper so that there is no troublesome camera or other apparatus to look through, and no previous knowledge or practice in drawing is necessary.

The outline of the image is directly traced on the paper on which it is projected, in the same way that a magic lantern view might be traced on the sheet on which it was cast.

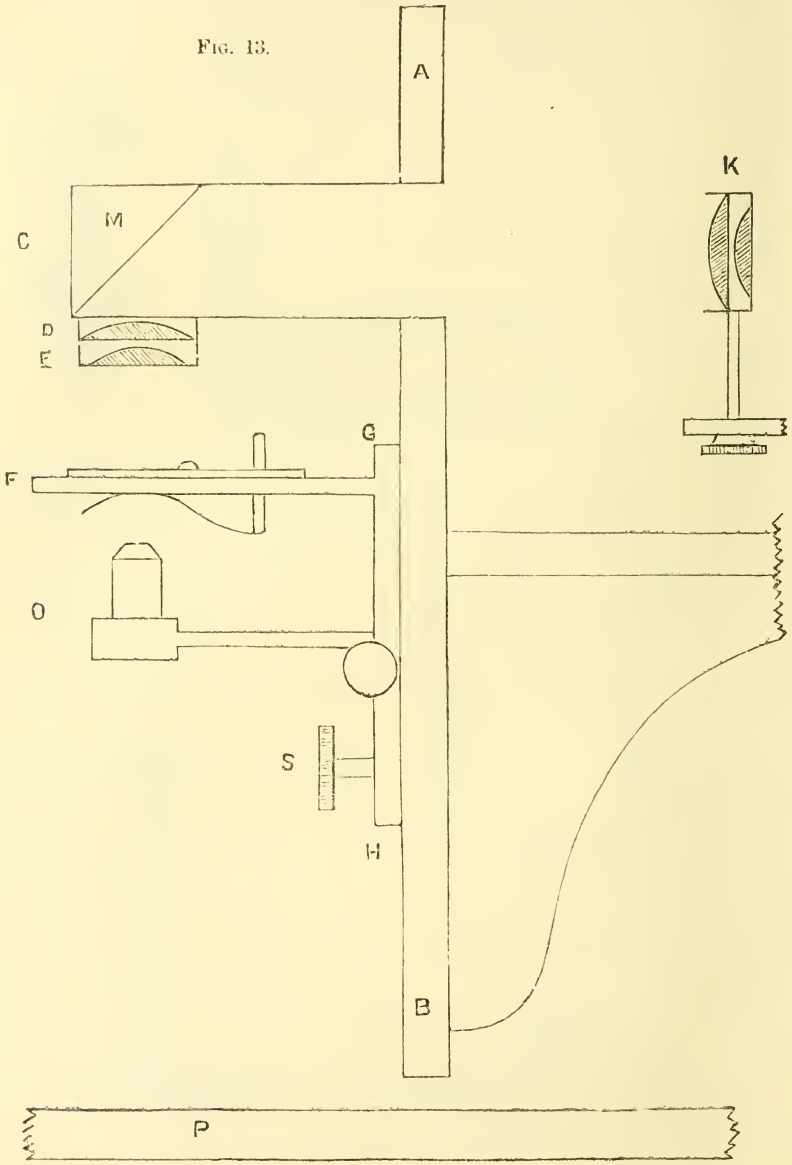
The instrument consists of a vertical board A B, with a tube C fitted at right angles to it; this tube has a mirror M of common looking-glass fixed at an angle of 45°. Below this there is a specially constructed condenser D E, consisting of two lenses D and E such that either of them can be used independently or they may be used together as in the figure. For very low powers the large lens D is alone used, for higher powers the small one E, while for still higher both D and E are used together. T is a simple stage, the slide being held against the lower side of it by spring clips. On the upper side there is a wheel of diaphragms; the use of this wheel of diaphragms is totally distinct from that in an ordinary Microscope, where its office is to regulate the angle of the cone of illumination, because here it merely limits the size of the field. O is the objective (for a medium power a Zeiss *a a* will be found very suitable). Both the objective-holder O and the stage F are fixed to a separate block GH which slides in grooves on the board AB, and is clamped by the screw S.

This arrangement allows the stage and the objective to be placed at a proper distance from the condenser. The illumination of an object in projection, especially in low power projection, differs essentially from

* See this Journal, 1891, p. 812.

that in ordinary microscopical work; in the latter a critical image is obtained by focusing the light on the object, but here the light should

Fig. 13.



be focused on the *front lens* of the objective. O is fitted with rack-and-pinion focusing adjustment. At the back of the board A B there is a

bracket to hold an ordinary Microscope lamp with an attached bull's-eye. Only the bull's-eye K (one of my doublets) is shown.

Finally the board A B slides in uprights on the base P (not shown); this is to allow the magnification to be altered by increasing or decreasing the distance between the objective and the paper on the base-board P on which the drawing is to be made. To use the instrument, in the first instance the bull's-eye K is focused to the edge of the lamp flame and parallel rays are sent on the mirror M. The condenser suited to the power is arranged at D. The distance between K and D should not be less than 12 in. Having placed the object in the clips on the stage, and having roughly focused the objective, the screw S must be loosened and the whole block G H moved up or down so that the rays from the condenser are focused on the objective. The field is then limited by the wheel of diaphragms. The illumination from an ordinary Microscope lamp with a 1/2 in. wick will be found sufficient when the apparatus is used in a darkened room, but if scattered light interferes with the image, cloth curtains may be provided to shield it off. This instrument was shown on the evening of the special exhibition with oxy-hydrogen illumination, a miniature jet and zirconium disc being employed, by which means sufficient light was obtained although the room was lighted by electricity.

The instrument gives an inverted and transposed image, the drawing is therefore precisely as it is in nature, which is not the case in some cameras which correct the inversion but leave the transposition."

(4) Photomicrography.

Nachet's large Photomicrographic Apparatus.—In this apparatus, represented in fig. 14, the two slide-ways superposed allow of a separation of 2 m. between the objective of the Microscope and the sensitive plate. The camera, measuring 18 by 24 cm., is divided into two parts connected by bellows of equal length. The front portion carries a special chamber with which the body-tube of the Microscope makes a light-proof connection. In the upper part of this chamber, at O, there is a lid which allows of the adjustment of the projection eye-pieces.

Exact focusing is effected by means of the rod CT in connection with an endless screw R, which engages in the wheel H, placed in front of the screw-head of the slow motion, and connected with it by a spiral spring of such resistance that the motion may be communicated to it instantaneously and without vibration. The connection between the rod and tangent screw is of the same kind. The extremity of the upper slide is provided with a levelling screw V to keep it in contact with the table on which the apparatus is placed. On this table are placed the different illuminating apparatus: heliostat, oxy-hydrogen lamp, ordinary lamp, &c.

Bousfield's Photomicrography.*—The second edition of this guide to the science of photomicrography has just appeared. It has been entirely rewritten and much enlarged. It is extremely well got up, and the illustrations, including specimens of photomicrography, are frequent. For those more interested in photographing histological and bacterio-

* J. and A. Churchill, London, 1892, pp. 174, 34 figs. and 1 pl.

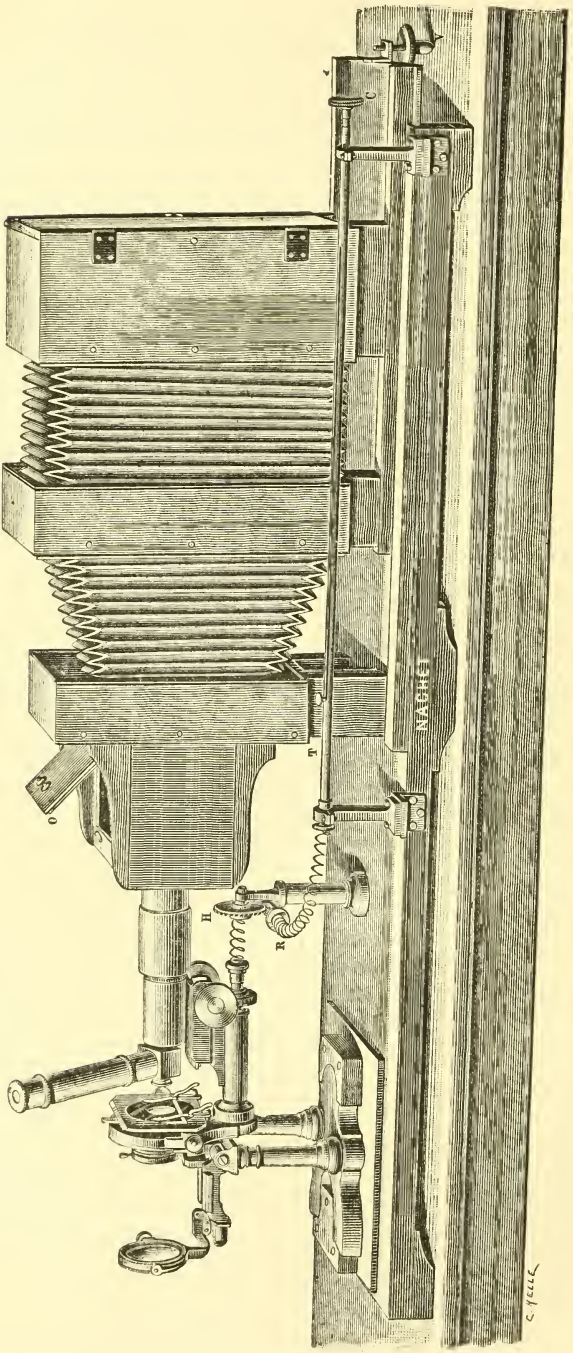


FIG. 14.

NACHET'S LARGE PHOTOMICROGRAPHIC APPARATUS.

logical specimens this work will be very useful, as most of the space is devoted to such preparations, the photographing of diatoms being only mentioned.

At the end of the work is an appendix, showing how to prepare objects to be photographed.

Podura Scale.—The following is the text of the remarks made by Mr. T. F. Smith at the Society's meeting last November (see this Journal, 1892, p. 908), which were illustrated by several photomicrographs:—

In the papers read 16th December last and March 16th by the Hon. J. G. P. Vereker and Dr. A. Clifford Mercer on the subject of the structure of the Podura scale there is a direct conflict of evidence, in so much that while Mr. Vereker describes the structure as consisting of a hyaline beaded membrane having minute featherlets inserted in it, such featherlets being forked at the end, Dr. Mercer has seen nothing in the shape of spines or featherlets projecting from torn or folded scales, and doubts their existence. At the last meeting of this Society Mr. H. L. A. Wright throws his weight on the side of featherlets, but the evidence offered in support of this seems to have been of such an inconclusive character as to leave the question exactly as it stood before. It was my good (or bad) fortune some two or three years ago—when perhaps I was a little more sanguine of being able to solve the mystery of the scale than I am now—to devote a great deal of attention to this subject, and gained a little positive knowledge which I beg to offer to-night in hope the evidence produced may be able to carry the matter one step further.

In estimating the value of the evidence already given us, it is necessary to consider the circumstances under which the images were produced; and here I cannot help thinking that both observers have failed to take due advantage of the modern methods of illumination, or to get the best performance out of the objectives in their hands. Mr. Nelson's remark when discussing Mr. Vereker's paper, that the method of illumination used reduced the performance of an oil-immersion to rather less than a dry objective is so forcible and so true, that it would be an impertinence for me to add to it; but from internal evidence offered by the reproduction of the prints referring to the Podura, I should say that Dr. Mercer has also been governed too much by the conventional appearance of the scale, and produced only the ordinary "exclamation marks" with the light streak on them, with which we have been so familiar for the last forty years.

Now there are only two conditions under which you can produce these appearances with an oil-immersion. First, if the scale is on the cover you must throw the objective so much out of adjustment that the resulting image is valueless; or, secondly, if the scale is on the slip, there is an air-space between it and the cover, and the lens performs, as Mr. Nelson says, rather worse than a dry objective.

I submit two prints * here in support of my remarks—Nos. 1 and 2: No. 1 taken with a dry 1/6-in., and showing the usual "markings," and No. 2 taken with Zeiss's 2-mm. apo. of 1·40 N.A., and in a fixed setting for a 160-mm. tube. In No. 2 you see the conventional "markings" have disappeared altogether, and in their place appears a series of

* Copies of these prints are in the Society's Library.

white pin-like forms with secondary structure between. Now I offer no opinion as to the truth of the whole of the appearances, but only produce it as an example of what an oil-immersion objective of large aperture shows when working at its best.

Print No. 3 shows a scale folded over, and two of the same pin-like bodies projecting nearly their whole length from the line of the fold. No. 4 also shows a scale folded over, and there the projections, although less pronounced, are still visible. On No. 5 I show three or four of the "pins" separated from the scale altogether, and I think there is sufficient evidence in the last three prints to prove that they are real, and not ghosts.

But this is not the whole of the structure, and what that whole is it is not at present for me to say, nor do I early expect to, but I am still collecting evidence, and hope to carry the matter still a little further at an early date.

(6) Miscellaneous.

The late Sir Richard Owen, K.C.B., F.R.S.—Although the Fellows will have read numerous obituary notices of this distinguished naturalist, they will expect to have, in their own Journal, some account of the man who was the first President of the Society. Although he does not appear to have been among the most constant of those friends of Dr. Bowerbank who met at the latter's and at one another's homes to discuss microscopical problems, his abilities and his position marked him out as the first President of the Society which grew around that nucleus, so that he occupied the chair in 1840 and 1841, and delivered the first two Presidential addresses. He retained throughout life a warm interest in the affairs of the Society, and none expressed more warmly than he his satisfaction at the improvement in the prospects and activity of the Society, which has been so remarkable during the last fifteen years. His own most important contribution to the microscopical side of his science is to be found in his large work on 'Odontography,' illustrated by 168 beautiful plates, many of which are devoted to the details of the minute structure of the teeth of Vertebrates.

Born in 1804, on July 20th, originally of Huguenot extraction, and endowed with the constitution, both physical and mental, of a giant, Owen probably produced, single-handed, a larger amount of descriptive work than any other naturalist. Although, in recent years, he was regarded as a conservative, if not an obstructive, he was full to the brim of a philosophical desire to generalize and to speculate. If we say that he generalized about things different to those on which, say Prof. Haeckel or Mr. Romanes speculate, we are, after all, only saying that men and times change. His acuteness in solving palæontological problems has almost become a proverb. Of his speculations some have been shown by later discoveries to have been justified, some have had to be modified, others to be decisively rejected; but, it is to be remembered that Owen was a philosophical as well as a descriptive naturalist. As was well said by Prof. Huxley, he was not only the continuator of Cuvier, he belonged also to the philosophical school of Geoffroy Saint-Hilaire and Oken.

With regard to the branches of Zoology which he studied, his range

extended from the Sponge *Euplectella* to the manlike Gorilla and to Man himself; in every division of the Animal Kingdom he made researches of prime importance to the student of Comparative Anatomy; some divisions thereof, such as the Fossil Reptiles, the Dinornis, the Fossil Mammals of Australia, the Marsupials, were for years almost his especial property. His generalizations extended from the wide difference between analogy or functional, and homology or structural resemblance, to the morphology of the digits of odd- and even-toed Ungulates. Even those philosophical speculations which have been universally rejected are still recognized as the cause of investigations in himself and others.

Though a man of the most pronounced individuality of character, his affection and esteem for those who preceded him, and especially for Georges Cuvier and John Hunter, was intense, and was a distinct note of his personality.

When the history of sanitary science in this country is written the name of Owen will be found associated with that of Edwin Chadwick and John Simon. To the lovers of Natural History he will, for generations to come, be remembered as the prime mover in the erection of the splendid edifice at South Kensington, which is now the "National Museum of Natural History."

To those who had the benefit of his personal acquaintance, his loss is one that it is difficult to express in words; those who did not know him at home had no idea of the lovable and affectionate nature of one who will, perhaps, be for all time the greatest zoologist our country has produced.

Bacteriological Department of King's College.—Most of the Fellows will remember one of the last of our Conversazioni held at King's College, when Prof. Crookshank opened his Bacteriological Laboratory for our inspection, and they will read, therefore, with interest the report lately made to the Council of the College by the Principal and the Dean of the Medical School.

"The rapid development of bacteriology has been one of the most remarkable events in the history of medical progress during recent years. Ten years ago bacteriology was only represented by researches which excited scientific interest when published, but the subject did not form a part of the training of a medical student, nor was any knowledge of it regarded as essential to the general medical practitioner. The discoveries which rapidly followed in Germany and France, and the establishment of classes of instruction for medical practitioners and scientists in Germany, created a demand for similar instruction in this country. During the past five years that demand has increased, until bacteriology has come to be recognized and taught as a distinct branch of medical science; and in London and the provinces opportunities for carrying on original research have been provided at public health institutions and in the medical schools.

From the report which follows of the work of the Bacteriological Laboratory of King's College, for the six years since its foundation, it will be seen that not only was King's College the pioneer in providing a laboratory devoted to this special branch of medical education, but the laboratory continues to maintain a unique position in giving systematic teaching on this subject in England. In 1886 the Council resolved to

meet the great demand, which existed at that time and has since increased, for courses of lectures and practical instruction in bacteriology. Mr. Crookshank, a former pupil of King's College, accepted the Lectureship, the first appointment of its kind in this country, and accommodation for practical instruction was provided in one of the class-rooms of the physiological laboratory. The success of these classes was so great that the Council resolved to provide special and permanent accommodation for the courses of instruction, and to grant facilities also for original research. For this purpose the Council created a department distinct from that of physiology, and one of the largest lecture-rooms in the College, admirably adapted for microscopical work, was converted into a teaching and research laboratory and lecture-room, and additional rooms were built for the Professor and to complete the necessary accommodation. The laboratory was duly licensed for research, and Mr. Crookshank was promoted to the newly created professorial chair; and with the aid of a contribution from him of 1000*l.* towards the expenses of the laboratory, the Council were able, without any loss of time, to completely equip the laboratory with all the fittings, instruments, and material necessary for the investigation of the diseases of man and the lower animals, and for the study of bacteriology in all its applications.

To enter as a pupil, or for the purpose of undertaking original investigation, it is not necessary to have had any previous connection with King's College. The laboratory has been opened to all, and, as set forth in the original syllabus, special inducements were offered from the very first to medical men in practice, medical officers of health, analysts, medical and veterinary officers of the services, and any others whose duties might prevent a daily attendance.

It will be a source of satisfaction and gratification to the Council to learn that, from the foundation six years ago up to the date of this report, the number of students qualified and unqualified who have entered the laboratory for instruction or for research amounts to 419. This number comprises general practitioners, army and navy surgeons, medical officers of health, analysts, biologists, veterinary surgeons, and veterinary and medical students. A few have previously been connected with the College or Hospital; a great number have been qualified medical men from the United States; others have come from New South Wales, Queensland, Tasmania, China, India, Ceylon, Chili, Cape of Good Hope, and Trinidad; and if the medical officers of the army and navy on leave from foreign service are added to this list, they will serve to illustrate how widely the laboratory is known, and the Council will realize still more fully how great a want existed, and that it has been met by their action.

It will be still more gratifying to refer somewhat in detail to the work done in the laboratory as regards original research and work on behalf of the State. Among the first to make use of the laboratory in connection with work for the Government may be mentioned Prof. Brown, C.B., of the Board of Agriculture. The Hon. H. N. MacLaurin, M.D., President of the Board of Health, New South Wales, passed through a course of instruction, and paid special attention to actinomycosis. On his return he continued his observations, and published them in the Official Reports of the Board. Mr. Park, Government Veterinary Surgeon, Tasmania,

came over to study bacteriology, particularly actinomycosis and tuberculosis, and was thus enabled to make valuable reports and suggestions at the Australasian Stock Conference. Prof. Anderson Stuart, of Sydney, passed through a special course of instruction, and investigated the tubercle bacillus, preparatory to proceeding to Berlin to study Koch's treatment of phthisis. His researches were published in an exhaustive report to the Government, and the assistance which he received in this laboratory was acknowledged in the preface to his report. [Others follow for which we have no space.]

Important researches have been carried out on behalf of the Agricultural Department of the Privy Council—now the Board of Agriculture—and Prof. Crookshank, who undertook these researches, received in 1890 the thanks of the Privy Council. The results were published in the following reports:—(1) Report on the so-called Hendon Cow Disease and its relation to Scarlet Fever in Man. (2) Report on a Micro-organism alleged to be the contagium of Scarlet Fever. (3) Report on Anthrax in Swine. (4) Report on Tubercular Mammitis in Cows and the Infectivity of the Milk. (5) Report on Actinomycosis in Cattle in Great Britain. (6) Report on Actinomycosis in Man in Great Britain. (7) Report on Actinomycosis in Cattle in Foreign Countries. (8) Report on Actinomycosis in Man in Foreign Countries. (9) Report on Cowpox and Horsepox.

The Council will see from this Report that original investigation has been a very important part of the work conducted in the Laboratory of King's College since its foundation; but as a department of King's College, it is especially necessary at the present time to lay stress upon the fact that it has occupied and still retains a unique position in this country as a teaching institution. It was not only the first laboratory established, but it always has been, and still is, in marked contrast to the bacteriological laboratories attached to the pathological department of some of the medical schools, in that systematic courses of instruction are regularly given throughout the whole academical year, and are open to any one. It is a public laboratory, and as such has already attracted a large number of workers, not only from London and the provinces, but from our colonies and other countries.

It will not be out of place in this report to add that Prof. Watson Cheyne, previous to the creation of a surgical pathological laboratory, made use of the bacteriological laboratory for a part of his work on tubercular disease of bones, and Prof. Ferrier also, pending the equipment of a neurological laboratory, performed there some of the experiments which were published in his most recent work on Cerebral Localization."

β. Technique.*

Behrens' Introduction to Botanical Microscopy.† — This work differs considerably in its scope from the standard work for the botanical laboratory, Strasburger's 'Botanisches Praktikum.' The latter is chiefly

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

† 'Leitfaden der botanischen Mikroskopie,' Braunschweig, 1892, 208 pp. and 150 figs.

concerned with the best modes of treatment of a great variety of botanical preparations and tissues, and with the demonstration of processes of botanical physiology, which it takes up in succession and in considerable detail. The work under review is rather a guide to the use of the Microscope by botanists, applicable to the whole scope of his investigations, and may be regarded as a supplement or companion to Strasburger's work. The first section is concerned with the Microscope as an instrument, and with microscopical appliances, and contains nothing that will not be found in ordinary English text-books. The second and larger portion is a guide to the preparation of botanical objects for the Microscope, and treats the subject more in detail than do English treatises, including the most recent methods recommended by the best workers. Here will be found directions for hardening, fixing, clarifying, and softening, the preparation of botanical sections, the use of staining materials, the preservation of the sections when made, and similar daily needs of the microscopical botanist. For the fixing of algæ, and of the protoplasmic contents of the higher plants, Ripart's fluid is recommended, consisting of 0·3 grm. cupric acetate, 0·3 grm. cupric chloride, 1 ccm. glacial acetic acid, 75 ccm. camphor-water, and 75 ccm. distilled water; for studies of the cell-nucleus a very dilute solution of gentian-violet, 0·3 grm. dissolved in 100 ccm. of absolute alcohol, and this again diluted with 1000 times its volume of distilled water.

(1) Collecting Objects, including Culture Processes.

Preparing Nutrient Bouillon for Bacteriological Purposes.*—Herren Petri and Massen give the following for preparing bouillon:—Fresh chopped meat containing little fat is soaked for one hour in the necessary quantity of distilled water. It is next heated for three hours at about 60° C., after which it is boiled for half an hour and filtered. When cold the degree of acidity of the fluid is tested from samples of 10–20 ccm. As a rule 10 ccm. require by the litmus reaction 1·8 ccm.; by the phenolphtalein reaction, 3 ccm. of 1/10 normal caustic soda solution. The broth obtained from the meat of different animals did not present any striking differences. After the addition of alkali pepton and salt it is boiled for some time, best over the open fire for a quarter of an hour, and then filtered hot. Too long and too frequent boiling are to be avoided. The bouillon and the medium prepared from it are to be kept in the dark.

Degree of Alkalinity of Media for Cultivating Cholera Bacilli.†—Dr. M. Dahmen made a series of experiments to determine the most suitable degree of alkalinity for the cultivation media of cholera bacilli. From them he concludes that for the examination of fæces for cholera bacilli a gelatin with 1 per cent. of soda is the most suitable, and that a faintly alkaline medium is not only not sufficient, but absolutely unsuitable.

Method for Sowing Bacteria on Gelatin Plates and other Surface Media.‡—Dr. P. Troppau practises the following device for sowing

* Arbeiten aus d. Kaiserl. Gesundheitsamte, viii. No. 2. See Centralbl. f. Bakteriol. u. Parasitenk., xii. (1892) p. 484.

† Centralbl. f. Bakteriol. u. Parasitenk., xii. (1892) p. 620.

‡ Tom. cit., pp. 653–4.

germs on nutritive media. The bacteria to be cultivated are first disseminated in a small quantity of sterilized water, and some of this is then run over the plate, made of gelatin, serum, vegetable albumen, and the like. The capsule and plate are then placed under the bell of a powerful air-pump. If this work well the water is soon evaporated, leaving the germs behind scattered all over a smooth surface. Care must be taken not to make the surface too dry. This procedure is said to offer the advantage of allowing the inspection of the characteristic shape of superficial colonies at very early stages. Inoculations are easily made from any particular colony, and counting the colonies is much facilitated.

Culture of Diatoms.*—Dr. P. Miquel states that a very favourable medium for the artificial culture of freshwater diatoms is ordinary fresh water in which have been thrown stems of grasses, the cortical substance of grains of wheat, barley, or oats, fragments of Muscineæ, &c.; soluble carbohydrates, albuminoids, &c., have an injurious rather than a favourable influence. The presence of a very small proportion—from 1 to 5 per mil.— of certain salts, such as those of soda, potash, or lime, in the condition of chlorides, bromides, iodides, phosphates, and sulphates, has a marked favourable effect on the multiplication of diatoms; but they appear to prefer to obtain their silica from that set at liberty by the decomposition of plants rather than from soluble silicates. The marine kinds are easily cultivated in artificial sea-water, especially if containing fragments of *Fucus* or other sea-weeds.

In another paper on the same subject, the same author † gives full instructions as to the best mode of cultivating diatoms, both freshwater and marine, the best media for their growth, the most favourable temperature, light, &c. The most destructive enemies to diatoms are bacteria. An apparatus is described for their culture free of bacteria.

Cultivation of Diatoms.‡—Dr. L. Macchiati, in a preliminary communication, points out that diatoms are easily cultivable in the nutritive solutions used in vegetable physiology, provided that a few drops of silicate of potash be added to the medium. Or the very water which the diatoms inhabit may be used. This, when filtered, and with the addition of a few drops of strong silicate of potash solution, forms an excellent fluid. The medium, placed in a watch-glass, is then inoculated with a loopful of the water inhabited by the diatoms, and the two fluids having been thoroughly mixed together by stirring, a loopful of the mixture is placed on the surface of a cover-glass, the exact thickness of which is previously ascertained. To the margin of the cavity of a hollow-ground slide is then applied some vaselin, and this is carefully placed over the cover-glass. The slide, now containing a hanging drop cultivation, is turned over.

In such a drop the diatoms are in an almost natural state, and their development and mode of life may be watched under a power as high as 1/18, though the lens commonly employed by the author is a dry apochromatic with focal distance of 4 mm. and N.A. 0·95. In combination

* Comptes Rendus, cxiv. (1892) pp. 780–2.
† Le Diatomiste, 1892, pp. 73–5, 94–9, 121–8, 149–56 (3 figs.).
‡ Journ. de Micrographie, xvi. (1892) pp. 116–20.

with eye-pieces 6, 12, 18, magnifications of 372, 750, and 1125 were obtained.

The best part for observing the diatoms is the edge of the drop, and this should be first centered under a low power.

Preparing Litmus Tincture for Testing Reaction of Gelatin.*—According to Dr. M. Dahmen, a very sensitive litmus solution may be prepared from Mohr's formula. The litmus is to be thoroughly worked up with hot distilled water; the filtered solution is then evaporated, and having been treated with acetic acid to saturation, is again evaporated down to the consistence of a thick extract. This mass is then placed in a flask, and a large quantity of 90 per cent. alcohol added. The blue pigment then precipitates a red dye and acetate of potash remains in solution. The litmus is next filtered off, and having been washed with alcohol, is dissolved in warm water and again filtered. The solution must be kept in vessels stopped with cotton-wool, as in tightly-closed bottles it soon loses its colour.

Sterilizing Incoagulable Albumen.†—M. E. Marchal suggests that the action of certain salts may be utilized to prevent the coagulation of egg albumen when heated to 100°. These salts are borate of soda, sulphate of iron, and nitrate of urea. The following are the quantities of these substances to be used for the purpose:—Solutions of 2 to 5 per cent.:—Borate of soda, 0·05 grm. per litre; sulphate of iron, 0·001–0·006 grm. per litre. Solutions of 10 per cent.:—Nitrate of urea, 4 to 5 grm. per litre. Thus prepared, the liquids may be sterilized at 100° in cultivation flasks.

It is hardly necessary to point out that nitrate of urea should not be used to prevent the coagulation of albumen if the experiments relate to nutrition or fermentation of matter containing albumen.

Sterilization of Water by Pressure.‡—MM. Rouart, Geneste, and Herscher have constructed an apparatus for sterilizing water effectually and economically by a combination of heat and pressure. It consists of four distinct parts—a boiler, primary and secondary converter (or cooler), and a clarifier. The water to be sterilized is introduced into the primary converter—a cylindrical metal vessel surrounded by a worm in which water heated to 120°–130°, and just coming from the boiler, is circulating. From the converter, and having there been raised to 100°, the water is conducted along a pipe to a worm running round the boiler, where it is heated up to 120°–130°. From this worm the water then passes through the worm in the primary converter, thence through the secondary converter, and finally, having passed through the clarifier, completes its circuit. The secondary converter is also a worm surrounded by cold water, and might be termed the cooler. The clarifier is filled with powdered silica, apparently between layers of canvas, and is not intended for a filter, but to impart a clearness or limpidity to the water which has been removed from it by the heating it has gone through. The water having passed through the clarifier, is delivered bright and clear, and fit for all the purposes of life.

* Centralbl. f. Bakteriol. u. Parasitenk., xii. (1892) p. 622.
† Bull. Acad. Roy. Sci. de Belgique, xxiv. (1892) pp. 323–7.
‡ Journ. de Microgr., xvi. (1892) pp. 145–52 (2 figs.).

Thermo-Regulator for Petroleum Heating.*—Dr. P. Altmann describes an apparatus by which a thermostat can be maintained at a constant temperature where the source of heat is not gas. It consists of a contact thermometer, the tube of which is immersed in the water space of the incubator. At the top of the tube is a box with dial and two hands, one of these is fixed at any desired temperature. As the temperature of the incubator rises, the free hand moves until it touches the fixed hand. This makes an electric contact, and a current passes to the other part of the apparatus. Here by means of an electromagnet and a lever two mica plates are made to close over the lamp in such a way that the heat is directed away. As the temperature of the thermostat falls, so does the free hand of the contact thermometer fall away from the fixed hand, and then the contact is broken, whereupon the mica plates fall back, and the heat reaches the thermostat again. The apparatus works quite automatically, and is said to maintain a constant temperature.

Apparatus for Obtaining Samples of Deep Sea Water and from the Sea Bottom.†—Mr. H. L. Russell describes an apparatus which he has used with very satisfactory results, for collecting samples of deep sea water. It consists of a large-sized test-tube, tightly fitted with a rubber cork, having a single hole. The opening in the cork is closed by a glass tube, which projects about 3/4 in. below the lower end of the stopper. The upper part of this small tube is bent at right angles to the long axis of the collecting tube, and drawn out to a fine calibre. The various parts having been carefully sterilized, are fitted together, and a partial vacuum produced either by means of an air-pump, or by just heating the tube. The end of the tube is then sealed. To prevent the ingress of air, the cork should be coated with a mixture of beeswax and resin.

Samples of water are obtained by clamping the tubes to a holder in such a way that the drawn-out end lies close to the connecting line. When sunk to the desired depth, a lead messenger is sent down the connecting line. This catches the end of the fine tube, breaks it off, and destroys the vacuum. The tube then fills with water. There is no danger of the sample getting mixed with water from other depths, as the tube is effectually stoppered by means of imprisoned air.

The apparatus used for obtaining material from the sea bottom consists of an iron tube (gas-pipe) pointed at one end. The other end is fitted by means of a screw with a removable "sleeve," the upper end of which is closed by a valve. As the weighted instrument descends, the water passes through the pipe, and when the bottom is struck, the pipe is forced into the soil, and so fills with a compact mass of material. When withdrawn, the water-pressure closes the valve, and prevents the contents from being washed out. Though the apparatus is theoretically imperfect, it practically delivers samples of the sea bottom quite uncontaminated.

Puritas Water Filter.‡—Dr. M. Jolles, from experiments with *Micrococcus prodigiosus*, finds that the Puritas Water Filter is only

* Centralbl. f. Bakteriol. u. Parasitenk., xii. (1892) pp. 654–5 (2 figs.).
† Bot. Gazette, xvii. (1892) pp. 312–21.
‡ Centralbl. f. Bakteriol. u. Parasitenk., xii. (1892) pp. 596–605.

suitable for the filtration of waters which have not undergone sufficient natural filtration, and that it does not deliver a germ-free water.

Testing the Pasteur-Chamberland Filter.* — Drs. T. Smith and V. A. Moore show how, by a very simple contrivance, it can be demonstrated that the pores in the porcelain bougie are bigger than most bacteria. A bougie of the usual shape is put inside a long, pretty narrow test-tube, and the latter plugged at the top with cotton-wool. The combination is then dry-sterilized.

To show how the bacteria pass through, a flask of bouillon is inoculated with a pure cultivation of a species of bacterium, and having been incubated for some hours, is run into the filter by means of a sterilized pipette. The flask is then connected with an air-pump, and some of the fluid drawn through the filter until the latter is surrounded up to a certain height with a layer of fluid. The whole apparatus is then incubated. In a few days the bouillon becomes turbid.

The experiment may be reversed; that is, the fluid may be sucked up into the filter from without, but the details of the process are more complicated, and much less satisfactory.

Method for Differentiating between Bacilli of Typhoid Fever and Water Bacteria closely resembling them.†—Dr. J. Weyland examined some drinking water suspected of giving rise to enteric fever, and isolated therefrom a species of bacterium the morphological and cultivation characteristics of which were not to be certainly distinguished from those of true typhoid bacilli. The negative indol reaction served to increase the suspicion of their identity.

The author first set about comparing the vitality of these bacilli with those of real typhoid, but no notable differences were shown, and recourse was had to chemistry. As the bouillon cultivation of both kinds had an acid reaction, the amount of acid formed in 10 ccm. of milk serum was first ascertained. For this Petruschsky's method was adopted, but phenolphtalein was substituted for litmus as indicator. After having been incubated for three days, it was found that the serum inoculated with the real typhoid required 8–9·1 ccm. of 1/100 alkali solution to neutralize it, while the pseudo-typhoid took 12·9–15·4 ccm. The amount of carbonic acid formed by the two kinds of bacteria was then determined by Pettenkofer's method; this consists in forcing the carbonic acid formed by the bacteria into tubes filled with baryta water, and estimating the diminution of alkalinity by titration with oxalic acid.

The only caution to be observed is that the fermentation bulbs must be kept at similar temperatures, as the slightest difference in heat has an important influence on the production of carbonic acid. This part of the experiment lasted 10 days, and the result of it was that the pseudo-typhoid bacilli were found to have produced about five times as much carbonic acid as the true typhoid bacilli. A repetition of the experiment gave a similar result. It was accordingly determined that the water bacteria in question were not typhoid bacilli.

* Centralbl. f. Bakteriol. u. Parasitenk., pp. 628–9 (1 fig.).

† Archiv f. Hygiene, xiv. p. 374. See Centralbl. f. Bakteriol. u. Parasitenk., xii. (1892) pp. 338–9.

New Biological Test for Cholera Bacteria.* — Herr O. Bujwid finds that iodoform exerts considerable influence on the growth of cholera bacilli, and little or none on that of bacteria resembling cholera vibrios. If cholera bacilli be mixed with gelatin and placed in a test-tube, and then exposed to the vapour of iodoform the gelatin will remain unliquefied for 10 to 15 days, while in control tubes the superficial layers begin to be liquefied on the second day.

It is noteworthy that the quantity of iodoform in the vapour is so small, that even after 18 days no diminution in weight can be detected by most sensitive scales.

In 10 to 15 days liquefaction begins and proceeds, the iodoform notwithstanding. No like effect was produced by the following substances:—Camphor, naphthalin, hypochlorite of calcium, turpentine, thymol, phenol. Iodine has some, but much weaker, effect.

On the cholcroid bacteria, e. g. *B. Finkler-Prior*, *Vibrio Metschnikovi*, *B. Milleri*, *B. Denecki*, the effect is much weaker, and liquefaction is perceptible on the third day. The difference is little dependent on external conditions, and holds good for low and high temperatures, even for such at which the gelatin begins to liquefy; for the liquefied gelatin remained quite clear under the iodoform action, while the control gelatin is quite cloudy.

Old and new cultivations give the same reaction, and the author thinks that the action of iodoform should be added to the methods for distinguishing cholera bacilli from other bacteria, and that this might be known as the iodoform test.

Bacteriological Diagnosis of Cholera.†—According to Dr. Pfeiffer the only certain procedure for diagnosing cholera is by cultivating on the gelatin plate. Colonies of cholera bacilli can be certainly recognized in 24–36 hours, and more especially if the cultivations be made with dejecta in which liquefying bacteria are rare.

Bujwid's reaction with mineral acids is regarded as very uncertain and the presence of comma bacilli in microscopical preparations from suspected material should only be regarded as presumptive evidence. On the other hand, the method of Schottelius may be adopted in many cases, though if there be time it should be controlled by the plate method. Schottelius' method consists in mixing the material to be examined with a thick layer of bouillon, and as the cholera bacilli are strongly aerobic they grow on the surface, forming a delicate scum which is almost a pure cultivation.

Coplin, W. M. L., and D. Bevan—**A Test Reaction for the Culture of the Micrococcus pyogenes aureus.** *Med. Record*, II. (1892) p. 70.

Dei Santi, L. — **Note sur la stérilisation de l'eau par précipitation.** (Note on the Sterilization of Water by Precipitation.) *Compt. Rend. Soc. Biol.*, 1892, pp. 711-3.

Merke, H.—**Ein Apparat zur Herstellung keimfreien Wassers für chirurgische und bakteriologische Zwecke.** (Apparatus for producing Germ-free Water for Surgical and Bacteriological Purposes.) *Berl. Klin. Wochenschr.*, 1892, pp. 663–5.

* Centralbl. f. Bakteriol. u. Parasitenk., xii. (1892) pp. 595–6.

† Deutsch. Med. Wochenschr., 1892, No. 36. See Centralbl. f. Bakteriol. u. Parasitenk., xii. (1892) pp. 483–4.

Petri, R. J., u. A. Maassen—**Ueber die Bereitung der Nährbouillon für bakteriologische Zwecke.** (On the Preparation of Nutrient Bouillon for Bacteriological Purposes.) *Arb. a. d. k. Gesundheits-A.*, VIII. (1892) pp. 311–4.

Petri, R. J.—**Eine Flasche zur Sterilisation und zur keimfreien Entnahme von Flüssigkeiten.** (A Sterilization Flask, and means for obtaining Parts of Fluids free of Germs.) *Arb. a. d. k. Gesundheits-A.*, VIII. (1892) pp. 316–7.

(2) Preparing Objects.

Examination of Blood of Amphibia.*—Herr M. C. Dekhuyzen makes use of test-tubes with not too thin walls, holding 8 ccm., and having a diameter of 14 mm.; they are placed in a simple wooden stand, and filled with the fixation fluid or with simple salt solution. In the latter cases the tubes are filled first with water and boiled, and the slides are treated in the same way; the cover-glasses are cleaned with acetic acid, and water, and, after drying, with ether. The two fluids used were (*a*) (1) a 2 per cent. solution of osmic acid, (2) 6 per cent. acetic acid containing 24 per cent. of a watery solution of methylen-blue and a little (0·014 per cent.) acid fuchsin; (*b*) the other fluid contained 20 volumes of acetic acid mixed with 80 volumes of methylen-blue solution; 6 volumes of this fluid mixed with 14 volumes of a 1/5 per cent. solution of acid fuchsin gave the required concentration.

Before every fixation 2 ccm. of the last deep-blue mixture was well mixed with 6 ccm. of 2 per cent. osmic acid and placed in small tubes which were filled up to the top.

It is important to be very careful in allowing the blood when it comes from the blood-vessels to come into the most intimate contact with the fixing mixture. The blood-cells sink to the bottom. After thirty minutes a drop of the fluid should be placed on a stick, and then some of the bottom be drawn up and added to it; the cover-glass should be run round with xylol balsam. The preparations must be kept from the light.

Examination of Land Nemertines.†—Dr. A. Dendy, after various trials, finds that the best way of killing *Geonemertes australiensis* is first to hold the worm in vapour of chloroform for about half a minute, when the animal will contract to its normal resting condition and be rapidly stupefied. Then quickly plunge the worm into strong spirit. The creature is thus killed and hardened while under the influence of chloroform, and the proboscis is not ejected at all, nor does the body break up. If it is desired to kill specimens with the proboscis ejected they may be suddenly immersed in strong methylated spirit or in a cold saturated alcoholic solution of corrosive sublimate. The sections of the worm were stained with borax-carmine or Kleinenberg's hæmatoxylin; both methods should be employed, for the latter reagent brings out with wonderful distinctness the network of excretory tubules, which were not to be recognized in specimens treated with borax-carmine.

Killing Nematodes for the Microtome.‡—Mr. C. W. Stiles recommends the following method:—Only one worm can be killed at a time; place it on a large slide with a few drops of water, place a second slide

* Verhandl. Anat. Gesell., 1892, pp. 90–3.
† Proc. Roy. Soc. Victoria, 1891 (1892) pp. 89 and 90.
‡ Amer. Natural., xxvi. (1892) p. 972.

over the worm and move it slowly to and fro. This movement causes the worm to straighten. As soon as the Nematode assumes the desired position pipette in the fixing solution between the slides, continuing the motion of the upper slide till the worm is dead. By this method a specimen can be obtained which is perfectly straight and sound. Pressure on a delicate worm may be avoided by pasting a piece of paper on the upper surface of the second slide, and using that as a handle. As a killing liquid Mr. Stiles generally uses a solution of corrosive sublimate + 70 per cent. alcohol + a few drops of acetic acid heated to 50°; this passes through the cuticle very rapidly.

Methods of Studying Development of Amphiura squamata.*—Mr. E. W. MacBride fixed his specimens with corrosive sublimate in distilled or in sea water; with a mixture of three parts sublimate and one part acetic acid; with chromic, picric, and glacial acetic acid; with Flemming's solution, alcohol of 30 per cent., or alcohol (hot) at 70 per cent., with a few drops of corrosive; with one-fifth to 1 per cent. osmic acid; or with osmic acid followed by Müller's fluid for 18 to 20 hours. He found that the only liquid which gives reliable results is osmic acid, though there are certain disadvantages in its use, for it renders the animals very brittle and has little penetrating power. The shrinkage which follows its use is entirely prevented, and the brittleness is diminished if the osmic acid is followed by Müller's fluid. All liquids which decalcified as well as fixed were of no use as they gave rise to cavities by the evolution of gas in the still soft tissues. The method finally adopted by the author was to kill the animals in a solution of about half per cent. osmic acid allowed to act for ten minutes or so; after mixing with water they were transferred to Müller's fluid for 18 to 20 hours, then put at once into alcohol of 30 per cent. and brought slowly up into alcohol of 90 per cent. In this last they were hardened for a night; two or three drops of nitric acid were then added to some fresh alcohol of 90 per cent., and the animals were immersed in this till decalcification was complete, a process which occupied not more than twenty hours.

Double staining was used in order to be certain about the boundaries of sinuses, since the ordinary plasma of Echinoderms stains with great difficulty. Mayer's paracarmine was used as a nuclear stain; this has the great advantages that it acts rapidly, and that all superfluous stains can be extracted by 70 per cent. of alcohol, which can be allowed to act for an indefinite time. The plasma stained was applied on the slide; two were found to give good results—solution of picric acid in turpentine, and Mayer's oxidized hæmoglobin or "hæmatein." The advantage of the former is that it can be used with the shellac method of mounting without any danger of staining the mounting agent. For embryos preserved in glacial acetic acid Mayer's hæmalaun was used; this gives a blue nuclear stain and colours much of the plasma a faint yellow.

The embryos were imbedded in paraffin and cut into series of sections in a plane parallel to the line joining the madreporite with the mouth, and at the same time perpendicular to the plane of the disk. The specimens were always carefully oriented before being cut, a point

* Quart. Journ. Micr. Sci., xxxiv. (1892) pp. 131–4.

to which, in Mr. MacBride's opinion, Cuénot has not paid sufficient attention. Very thin sections—$3\frac{1}{4}$ μ, $4\frac{1}{2}$ μ, and for adults and oldest stages 7 μ—were made. The author states that he obtained perfect series of sections with finely differentiated stain, and clear, sharp outlines; the sections are said to be clearer and more diagrammatic than the figures he has been able to make of them.

Preparation of Larvæ of Asterias vulgaris.*—Mr. G. W. Field found that Kleinenberg's picric salt gave the most satisfactory results for killing these larvæ. Flemming's, followed by Merkel's fluid, gave excellent results, as did also Perenyi's fluid. Oil of cedar or of origanum proved most satisfactory for clearing.

Preserving Cunina.†—Dr. O. Maas killed the *Cunina*-stock and its buds with Flemming's chrom-osmic-acetic acid (5–20 minutes), gradually washed them with water, and passed them through a series of dilutions of alcohol up to 90 per cent. Thence some were replaced in water and stained with borax-carmine, but the unstained forms gave best results. Methyl-blue was also used to demonstrate the nervous system. The most important point is to see that the medusæ are properly placed before they are cut.

Preparing and Staining Yeast.‡—Dr. H. Moeller used for fixing yeast preparations a 1 per cent. solution of iodide of potassium saturated with iodine, this fluid ten times diluted, and also iodine-water. The material and the fixative may be mixed together at once or upon the cover-glass, which merely requires a smear. When fixed and dried the preparation must be thoroughly hardened. This may be done by leaving the preparations in the iodine solution for a day, and then after washing in water and weak spirit keeping them in absolute alcohol for one or two days. The time required for hardening may be diminished by repeatedly boiling the alcohol, and the preparations are more clearly stained if they are then immersed in chloroform for a day. It is always useful to pass the cover-glasses once or twice through the flame.

The preparations are best stained by means of hæmatein and picric acid, the latter acting as a mordant. But it is essential that the preparations should be thoroughly fixed and hardened; they may then be treated with a saturated aqueous solution of picric acid for 1/2–3 hours; the preparation is then passed through water so as to wash off some, but not all of the picric acid. For staining, an alkaline solution of hæmatoxylin is used. It would not appear, however, that the foregoing staining was more advantageous than that with anilins, of which the following were successfully employed:—phenolfuchsin, alkaline methylen-blue, Gram's method, and also gentian-violet in carbolic acid, water, glycerin, 1 per cent. acetic acid, and 1 per cent. iodide of potash.

If the anilin dyes are used the preparation should be over-stained and then differentiated by some decolorant; if Gram's method be adopted alcohol must be used; but for other stains a mixture of equal volumes of glycerin and water was found to give the best result. As soon as the desired degree of decolorization is attained the preparation

* Quart. Journ. Micr. Sci., xxxiv. (1892) p. 106.

† Zool. Jahrb., v. (1892) pp. 271–300 (2 pls.).

‡ Centralbl. f. Bakteriol. u. Parasitenk., xii. (1892) pp. 537–50 (1 pl.).

is washed in water, dried in the air, and mounted in balsam, styrax, or dammar.

The grana or microsomes were best brought out by staining with some anilin dye and then differentiating with 2 per cent. acetic acid.

Spores are very easily stained by treating the preparation with boiling phenolfuchsin and then washing out in 4 per cent. sulphuric acid.

The yeasts used for these observations were natural cultivations of ordinary bottom yeasts. The yeast was shaken up with distilled water and then, after settling, the fluid decanted off. The sediment, after having been thus treated several times, was kept for the observations.

Method for Discovering Tubercle Bacilli in Milk with the Centrifuge.*—Herr Ilkewitsch says that he has successfully employed the following method for detecting tubercle bacilli in milk after these organisms had been precipitated by the centrifuge. The author was led to this procedure by finding that the intraperitoneal inoculation of guinea-pigs and rabbits was ofttimes unsuccessful. After the cream has been separated 20 ccm. of the milk are coagulated with citric acid. The residue separated from the whey by filtration is dissolved in an aqueous solution of sodic phosphate, treated with 6 ccm. of sulphuric ether, and then shaken up for 10 to 15 minutes.

The solution below the fat layer is drawn off by opening a tap at the bottom of the collecting vessel and then placed in the centrifuge. The sediment is separated from the fluid by means of a copper ball dropped into the separation-tube. This allows the fluid to be poured off and the sediment left behind. The sediment is then spread out on cover-glasses and obtained in the usual way.

(4) Staining and Injecting.

Method for Staining Tubercle Bacilli.†—Dr. B. A. van Ketel has devised the following procedure for detecting tubercle bacilli in sputum, &c. In a wide-mouthed flask capable of holding about 100 ccm., 10 ccm. of water and 6 ccm. of acid. carbolic. liquefactum are mixed. About 10–15 ccm. of the fluid to be examined are then added and the flask having been closed with a caoutchouc stopper is vigorously shaken for about a minute. With milk or very thin sputum the water may be omitted. After the shaking the fluid becomes milky; the flask is then filled up with water and again shaken. The fluid is then poured into a conical glass and allowed to subside. In from 12 to 24 hours some of the deepest lying sediment is removed with a pipette and spread on a cover-glass. The dried and heated cover-glass preparation is then washed in ether or chloroform and afterwards in alcohol, or the preparation may be treated with ether-alcohol. This is specially necessary if the preparation turn out rather thick. The cover-glass is then stained by the Ziehl-Neelsen method. The foregoing procedure is extremely simple, easily carried out, and produces a bright distinct microscopical picture.

* München. Med. Wochenschr., 1892, No. 5. See Centralbl. f. Bakteriol. u. Parasitenk., xii. (1892) pp. 441–2.

† Arch. f. Hygiene, xv. pp. 109–24. See Centralbl. f. Bakteriol. u. Parasitenk., xii. (1892) pp. 689–90.

Staining Solutions made with Carmine, Cochineal, and Hæmatin.* —Dr. P. Mayer, who has been at some pains to investigate the origin of cochineal and the composition of carmine, finds that carminic acid is not the sole staining principle, but that this acid must be considered in conjunction with alumina and also with calcium.

The practical outcome of his investigations and experiments are formulæ for staining solutions having a fixed composition and giving a definite result. Of these we may mention the following :—

Carmalum.—Carminic acid, 1 grm. ; alum, 10 grm. ; distilled water, 200 ccm. The solution is made with the aid of heat and the clear supernatant fluid or the filtrate used. The solution will keep if a few crystals of thymol be added, or if 1 per cent. salicylic acid or 5 per cent. salicylate of soda be used.

Paracarmin.—Carminic acid, 1 grm. ; chloride of aluminium, 1/2 grm. ; chloride of calcium, 4 grm. ; 70 per cent. alcohol, 100 ccm. The solution is made cold or by the aid of heat, and after having stood is filtered. There is no necessity to differentiate the stain with acidulated alcohol, although this may be done.

A staining solution made with cochineal, and having similar but less efficient properties to the foregoing:—Cochineal, 5 grm. ; chloride of calcium, 5 grm. ; chloride of aluminium, 0·5 grm. ; nitric acid (sp. gr. 1·20), 8 drops ; 50 per cent. alcohol, 100 ccm. The cochineal is to be finely powdered and mixed with the salts in a mortar. The spirit and acid are then added, and the mixture heated to boiling. It is allowed to stand for some days and filtered.

The author concludes by referring to hæmacalcium, a solution devised by him some time back.† He finds that it tends to throw down a deposit and decompose after a time, but this may be prevented by preparing the solution in two flasks, one containing the spirit, the acid, and the calcium chloride ; the other the hæmatin and the aluminium chloride. The two solutions are mixed when required for use.

Demonstrating Cholera Vibrio.‡—Dr. L. Heim gives the following as a very practicable procedure for demonstrating the presence of the cholera vibrio. From the evacuation or from the intestinal contents a flakelet of mucus should be taken, and having been spread out on a cover-glass, stained with fuchsin and examined with an oil-immersion for vibrios. At the same time another little flake of mucus is to be placed on a cover-glass, and a drop of bouillon added thereto. The cover is then fitted over a hollow-ground slide, and the margins vaselined to make a hanging drop cultivation. Two other particles are to be distributed, one in a test-tube filled with bouillon, the other in a test-tube containing gelatin. From the latter plate cultivations, after some attenuations, may be obtained. Even if the usual indispensable apparatus be wanting, the suspected material may be inoculated on bouillon or a 2 per cent. pepton solution, and a plate culture made from the gelatin solution, the latter serving for further inoculations. This procedure is to be repeated during the next 24 hours, during which the

* Mittheil. Zool. Station zu Neapel, x. (1892) pp. 480–504.

† See this Journal, 1891, p. 831.

‡ Centralbl. f. Bakteriol. u. Parasitenk., xii. (1892) p. 353.

bouillon tubes, together with the hanging drops intended for microscopical examination, are to be left. The latter should be protected from the light and kept in a warm place, best in an incubator. If the cholera germs have been in the excreta, they may be detected with a low power on the plates in 24–48 hours, and may then be inoculated in gelatin or pepton bouillon. In these the cholera-red reaction with sulphuric acid may be obtained the next day.

In default of the double capsule, a couple of dinner plates or saucers, the undermost being covered with blotting-paper, will serve the purpose of making a moist chamber. The incubator may be replaced by a pot or saucepan partly filled with water at 30°–27°. In this the test-tube, &c., may be incubated by fixing them in beakers laden with sand to keep them steady. The saucepan is covered with its lid, and a temperature approximate to that of the body is maintained by means of a night-light placed under the pot.

Staining Flagella of the Tetanus Bacillus.*—As a rule, says Dr. R. Schwarz, the tetanus bacillus has a flagellum at one of its rounded ends, and this is usually somewhat, occasionally considerably, larger than the bacillus itself. In sporogenous bacilli the flagella cannot be perceived. The flagella were best stained by Loeffler's method on bacilli taken from bouillon cultivations developed under hydrogen, and 48 hours old. Two drops of 1 per cent. soda solution were added to the mordant. Trenkmann's method was not successful.

Staining Flagella of Bacteria.†—Herr L. Luksch finds that by substituting ferric acetate for the sulphate of iron in the mordant devised by Loeffler for staining bacterial flagella, the disagreeable deposit on the surface of the preparation is obviated. It is certainly true that this deposit renders the original procedure ‡ less effective in practice than the promise held out, and it is noted by the author that Loeffler's solution should be made with the ferric, and not with the ferrous salt, but if the acetate gets rid of the surface deposit the distinction may be neglected.

The author's solution is made from freshly prepared cold saturated ferric acetate; in other respects the formula is the same as Loeffler's, except that to the 16 ccm. of the mordant, 5–10 drops of acetic acid are added.

When the preparation has been slightly warmed for one minute it is washed in water and then in 20 per cent. acetic acid to give greater clearness. It is again washed in water several times, after which it is warm-stained with anilin-water-fuchsin or anilin-water-gentian-violet.

Examining Sputum in Sections.§ — When examining sputum in cover-glass preparations many of the delicate and fragile cells, says Dr. Gabritschewsky, are destroyed, but this may be avoided by making sections of sputum which has been fixed and hardened. For this purpose alcohol, Flemming's fluid, chromacetic acid, picric acid and saturated sub-

* Lo Sperimentale, 1891, p. 373. See Centralbl. f. Bakteriol. u. Parasitenk., xii. (1892) p. 391. † Centralbl. f. Bakteriol. u. Parasitenk., xii. (1892) p. 430.

‡ See this Journal, 1890, p. 678.

§ Deutsch. Med. Wochenschr., 1891, No. 43. See Centralbl. f. Bakteriol. u. Parasitenk., xii. (1892) p. 395.

limate solution are well suited. Müller's fluid cannot be used as it softens and disintegrates the masses of expectoration.

The staining solutions employed by the author were alum-carmine, safranin, and hæmatoxylin-eosin. By this method in three cases out of four examined, giant cells were demonstrated.

Rapid Staining of Tubercle Bacilli in Tissue preserved in Müller's Fluid.*—M. Letulle gives the following procedure for staining tubercle bacilli in tissues which have been hardened in Müller's fluid. According to this, and indeed other writers, Müller's fluid is unsuitable as a hardening agent when these micro-organisms are to be sought for.

After hardening in Müller's fluid the material is treated with spirit and then imbedded in celloidin. The sections are then stained with hæmatoxylin and next with a rubin solution (2 per cent. carbolic acid water with rubin to saturation). The sections, after having been washed with water and alcohol, are further stained with iodine-green (iodine-green 1 grm., 2 per cent. carbolic acid water 100 grm). The preparations are then mounted in the usual way.

The nuclei are stained violet, hyaline bodies rose, and the bacilli dark red, the rest remaining white. The whole procedure lasts barely half an hour.

Hofmeister, F.—**Ein Apparat für Massenfärbung von Deckglastrockenpräparaten.** (Apparatus for Staining dry Cover-glass Preparations.)
Fortschr. d. Med., 1892, pp. 531–6.

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

Preserving Fluid and Fixing Material.†—Dr. F. Krasser recommends as a preserving fluid for vegetable substances a mixture of 1 vol. acetic acid, 3 vols. glycerin, and 10 vols. of a 50 per cent. solution of sodium chloride. In this solution sections of beet and of etiolated potato-shoots retained their structure and their colour for nearly a year.

Salicyl-aldehyde is a good fixing material for chromatophores, as e.g. the pigment of *Solanum Lycopersicum*. For this purpose Dr. Krasser uses a 1 per cent. alcoholic solution.

Glycerin Mounting.‡—Dr. C. E. McClung recommends the use of glycerin in the following:—"The use of glycerin as a mounting medium is not as universal as its qualities merit it should be. The convenience with which a balsam mount is made proves a temptation which many microscopists cannot resist, and as a result, numerous mounts are entirely spoiled by consigning the object to a medium not adapted for its reception. There is a fitness in all things, and the saying is as applicable to microscopy as to other departments of work. Balsam has its use and glycerin its application, and the two should be confined to their respective provinces. Frey says, 'What balsam is to dry tissues, glycerin is to moist ones,' and the saying might be made even more emphatic.

Glycerin has the advantage of being non-volatile, colourless, slightly

* Gazette Hebd., 1892, No. 22. See Centralbl. f. Bakteriol. u. Parasitenk., xii. (1892) p. 441.

† SB. K. K. Zool.-Bot. Gesell. Wien, May 20, 1892.

‡ The Microscope, xii. (1892) pp. 201–3.

affected by changes of temperature and of having a high refractive index. An advantage of special importance is that it remains perfectly colourless for any length of time, while balsam, in a few years at most, becomes yellow, and finally so opaque that the preparation is worthless. The soft, natural appearance which objects mounted in glycerin have renders any extra labour incurred in their preparation a matter of little moment to the artistic manipulator.

The difficulty experienced in the manipulation of glycerin deters many from its more frequent employment. If attention is paid to details, however, it will be found but little more difficult to use than balsamic mediums. In order to bring out the points of importance, a brief description of the preparation of an ideal mount will be expedient. Attention is first directed to the material and apparatus used.

The glycerin should be pure, and free from dust and air-bubbles. To keep it free from these contaminations, devices such as are recommended by Carpenter and Prof. James are excellent. These are bottles containing the glycerin, and provided with glass tubes, whereby the glycerin is forced out by air-pressure.

The cements may be of a balsamic nature, but preferably zinc oxide or asphalt. Any cement not affected by the medium may be employed, but experience has proven that the two above named are the best.

The other essential parts of the completed mount are the slip and cover-glass. No special mention is required concerning these except that they should be perfectly clean. To ensure this, the practice of leaving them until ready for use in a bath of ordinary battery fluid is recommended.

In preparing a mount, the operations naturally divide themselves into four divisions, coming under the heads—(1) preparing the cell; (2) preparing the section; (3) placing section in the cell; and (4) securing the cover-glass to the cell.

Under the first head attention is called to three points, viz. thickness of the cement, depth of cell, and age of the cell. Upon the consistency of the cement depends in a great measure the formation of a good cell. It should not be thin enough to spread, yet should flow readily and smoothly from the brush. The depth of the cell should be such that a complete support shall be provided for the cover-glass without causing it to bear upon the object when cemented down, and yet should not be of such a depth as to interpose an unnecessary stratum of glycerin between the section and cover-glass.

Of more importance, perhaps, than any other point, is the direction regarding the age of the cell. It is a common practice to ring a cell and use it while fresh, the manipulator arguing that a more perfect union of cell-wall and cover-glass is secured in this manner. Perhaps this is true, but it is at the expense of the slide's usefulness. An author already quoted is authority for the statement that an ordinary balsam cell will, in drying, shrink 30 per cent.

Under these conditions and in view of the fact that glycerin is non-compressible, something must give way when the cell contracts; and this is either the cover-glass or cell-wall. Whichever it is, the final result is the destruction of the mount and loss of all the work involved in its preparation. This leads us then to make the following statement:

—Never use a 'green' cell. The older the cell the better, and, at ordinary temperatures, two weeks is the shortest space of time in which a cell of medium depth will become seasoned.

Assuming the mount to be a section of vegetable tissue, the steps involved in its preparation would be the cutting, staining, washing, and dehydrating. The length of this article will not permit any reference to cutting, so the process of staining is next noticed. Any stain insoluble in the glycerin may be used. It is best applied immediately after the cutting of the section. After the section has acquired the proper depth of colour, it should be thoroughly washed, and then placed in glycerin. From here it goes through the next process—placing in the cell. In placing the section care should be exercised to have it exactly in the centre of the cell. With the section thus situated a drop of glycerin is allowed to fall upon it from the dropping-bottle. Take the clean cover-glass between the left thumb and forefinger, and place the left side in contact with the drop of glycerin; draw it over until supported on the left edge of the cell-wall; loose the hold of the left hand and allow the cover-glass to fall gradually by supporting the right edge with a needle. Having thus placed the cover-glass and centered it, place a clip upon it. The superfluous glycerin thus forced out is washed away by means of a jet of water from the wash-bottle so directed as not to strike under the cover-glass. Some water does get under, but this does no harm, as it supplies moisture which the glycerin otherwise would have by 'creeping' from the cell.

When thoroughly dried by means of strips of bibulous paper the slide is ready for the last step—securing the union of cover-glass and cell-wall. This result is best obtained by ringing once around the cover-glass and allowing this coat to dry before applying cement enough to hide the junction of the cover-glass and cell-wall. When this latter step is accomplished the mount is essentially complete, but no one who has a pride in his work will leave the slide unstriped. There is no more beautiful slide than one formed of white cement and ringed with black. Properly labelled and cleaned, the slide is ready for the cabinet; and if the due amount of care has been exercised in its preparation, it will always be a source of pride and pleasure to its owner."

An Aqueous Solution of Hæmatoxylin which does not readily deteriorate.*—Prof. S. H. Gage writes as follows:—"For most of the purposes of histology there is no more satisfactory and generally applicable stain than hæmatoxylin; and experience has shown that aqueous solutions are on the whole preferable to those containing a considerable quantity of alcohol. Every microscopist knows, however, that aqueous solutions of hæmatoxylin soon begin to deposit a dark precipitate on the bottle and become filled with granules, and frequently with threads or fungus mycelium.

As so many chemical changes are due to living ferments, bacteria, fungi, &c., it occurred to the writer that the deterioration of the hæmatoxylin might be due to some living ferment or ferments, and if these could be eliminated the solution would retain its excellence. Experiment proved the correctness of this supposition, for an aqueous hæma-

* Microscopical Bulletin and Sci. News, ix. (1892) pp. 36 and 7.

toxylin, prepared as directed below, made in February of the present year, is at present writing, after eight months, as good as when first made. During the eight months it has remained in the laboratory, and has been subjected to all the vicissitudes of heat, dust, &c., that an ordinary histological reagent must endure. The bottle has no deposit upon it, and the solution is entirely devoid of the spores or mycelium of fungi, and is in fact as good as when first made. Formula :—Distilled water, 300 ccm.; potash alum, 10 grm.; chloral hydrate, 6 grm.; hæmatoxylin crystals, 1/10 grm.

To prepare the solution, place the water in an agate or porcelain dish and add the alum either in powder or small pieces. Boil the water and alum for five minutes. When cool add the chloral hydrate and the hæmatoxylin. It is advantageous to dissolve the hæmatoxylin in 5 to 10 ccm. of absolute or 95 per cent. alcohol before adding to the alum solution.

The colour will be quite light at first, but in a week or two it will be of a dark purple. The boiling is to destroy all living objects in the water or alum, and the chloral hydrate is to prevent the development of germs that accidentally reach the solution after its preparation. The solution may be made more concentrated by adding hæmatoxylin. For slight dilution, distilled water will answer, but the mixture of alum, chloral, and water is the best diluent."

MICROSCOPY.

a. Instruments, Accessories, &c.*

(1.) Stands.

New Student's Microscope.—Mr. E. M. Nelson made the following remarks when exhibiting one of Messrs. Watson's Edinburgh Student's Microscopes with a tripod foot, having an equilateral base whose side is 6½ in. :—"Without dwelling on the ordinary movements, which have been described before, merely mentioning that they are sprung throughout, I will pass on to what may be called the novelties. The first is in the rotating nose-piece. This I have had considerably lightened by doing away with the loose adapting screw, and making it a part of the fixed nose-piece of the Microscope. It will be seen that it now forms a part of the body, which can only be removed by taking out the three screws which usually fasten the ordinary nose-piece on the body. A rotating nose-piece is not one of those pieces of apparatus you sometimes use and at other times dispense with, therefore there can be no objection to fixing it permanently to the Microscope.

The second novelty is in truth an old friend. It is what on a former occasion I called a semi-mechanical stage; in other words, it is a stage with a mechanical movement only in a vertical direction (fig. 15). This you will find an important movement in an advanced student's Microscope. But before proceeding allow me to again state that whatever appliance you may put to a student's Microscope it must leave the stage perfectly plain. Our Continental neighbours sometimes spoil a stage by screwing pieces of watch-spring to it.

This stage is to all appearances one of my plain horse-shoe stages, fitted with a sliding bar, which can be entirely removed. On closer inspection you will see that the edges of the stage are connected with the mechanical movement underneath the stage (fig. 17).

These edges have 3/4 in. of movement by spiral rackwork, the movement being sprung, and the pinion which is carried through has a head on either side of the stage.

The sliding bar slides on these mechanically moving edges, and, consequently, it can be moved either by the rackwork or by the hand. There is an important point which was omitted in my first drawing of this movement; this I soon rectified by making the ledges bear downwards, instead of upwards; if this were not done, a manipulator who rested his hand against the edge of the stage would bend down the guiding lugs, and so injure the whole movement; but by making the ledges bear downwards no injury can happen by pressure from above (fig. 16).

A semi-mechanical stage will be found a great convenience. Every one who has worked with the Microscope knows what an immense advantage a sliding bar is. It holds your slip and enables you to run

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

along a parallel of latitude, by pushing the slide with your finger. To really appreciate the value of a sliding bar, after having used one for some time, go back to a Microscope without one, say a spring clip stage.

Fig. 15.

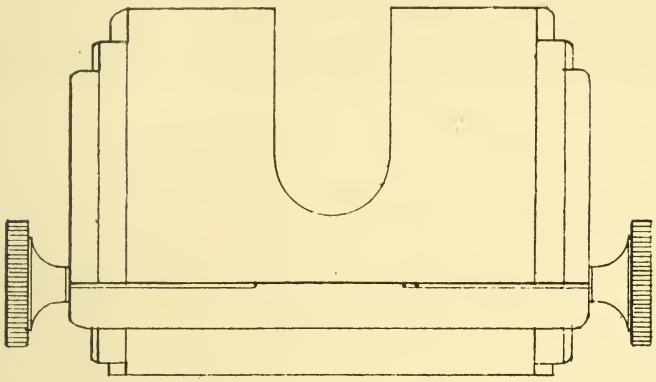


Fig. 16.

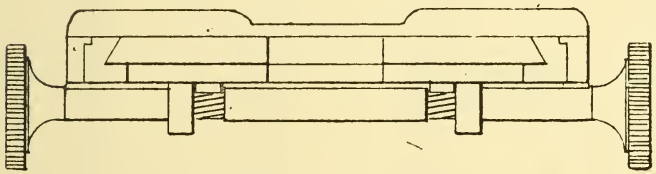
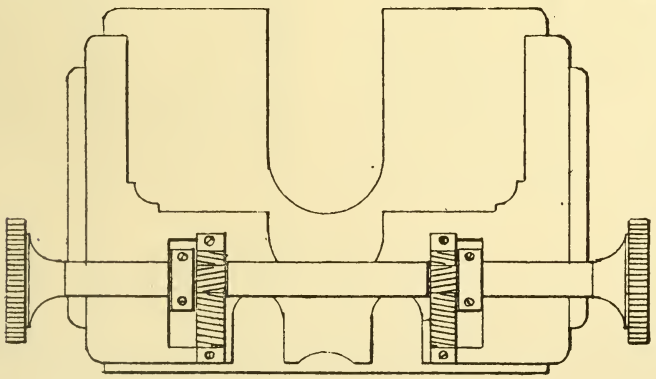


Fig. 17.



This instrument has a stage with a sliding bar, only more so. The main stage is made of 1/4 in. brass plate, and is of ample strength. The whole stage measures $5\frac{1}{4}$ in. wide by 4 in. deep, and the workmanship is excellent, but of that you can judge for yourselves as it is passed round.

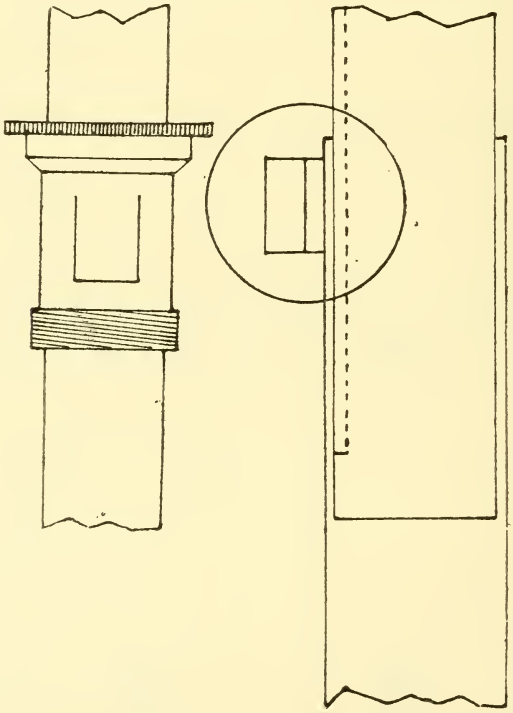
There is one point with regard to the draw-tube, and that is the way

I have had the collar, in which the draw-tube slides, screwed to the main body-tube (fig. 18). The screw is placed below, while a shoulder is placed above, where the screw usually is. This is an important point, because it makes a sound and strong slide, which will not become shaky as is often the case. This kind of fitting is used in the best telescopes.

In connection with this I have an ingenious adaptation of Messrs. Watson to show you for a mechanical draw-tube.

There are two kinds of mechanical draw-tubes at present in use. The first fitted to a Microscope was that by Powell, who cut the inside

Fig. 18. Fig. 19.



tube and placed the rack in the cut (fig. 19). This plan is quite feasible in his Microscope on account of the large size of the tubing; but when we come to small tubing such as this, it is hardly practicable. For this reason No. 2 was invented. It has the inner tube intact, and the outer tube cut, and a box placed over the cut in the outer tube (fig. 20). This is expensive to make. Messrs. Watsons' plan consists in cutting neither tube, but in making the outside tube large enough to take the rack, which projects from the inner tube, and then cutting the collar to allow it to pass (fig. 21). This is the cheapest of the three, and at the same

time quite a sound fitting. In brief the three forms are—1st, the rack let into the inner tube; 2nd, the rack boxed in the outer tube; 3rd, the rack passing through the collar."

Fig. 20.

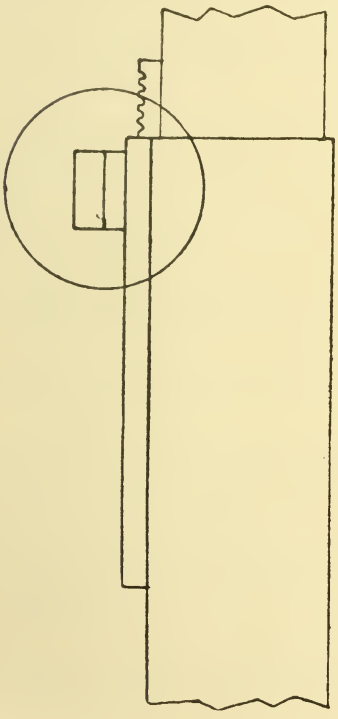
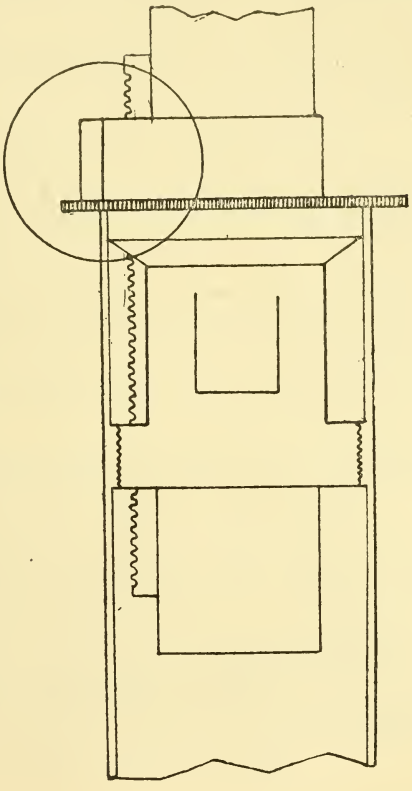


Fig. 21.



(2) Eye-pieces and Objectives.

Use of the Microscope with High-power Objectives.* — M. H. Peragallo points out, without entering into superfluous theoretical considerations, the method of using high-power objectives so as to obtain from them all possible advantages. He first gives a brief *resumé* of the theoretical considerations concerning the formation of images in the Microscope. The classical theory of the formation of images in the Microscope, founded on the emission theory, has long been known to be incapable of furnishing a complete explanation of optic phenomena. Abbe was the first to apply to the formation of images an exact mathe-

* Ann. de Microgr., iv. (1892) pp. 585-616.

matical analysis based on the properties of luminous waves, and from his work there resulted the following principles :—

(1) When the fineness of a structure, i. e. the interval between two elements to be distinguished, is not less than $0 \cdot 10\ \mu$, everything results according to the laws of geometrical optics, and the image is the exact representation of the object. If, after having focused in central light, the eye-piece be removed, a white circle representing the luminous pencil emerging from the objective will be seen on looking into the tube of the Microscope. The diameter of this circle varies according to the focus and aperture of the objective, and also to the aperture of the illuminating pencil.

(2) If the structure is finer, it produces on the illuminating pencil phenomena of diffraction, and on looking into the tube, beside the white dioptric pencil a certain number of coloured diffraction pencils will be seen, of which the number and the arrangement depend upon the nature of the structure examined. These spectra are so much more widely separated as the structure which produces them is finer. Thus, in the case of *Pleurosigma angulatum*, with a high-power immersion objective a central white pencil will be seen with six coloured ones arranged regularly round it, and if the latter are blocked out all traces of structure disappear from the image. Consequently:

(3) The diffraction pencils united in the image, alone give the image of the structure, and:

(4) To a given structure corresponds a certain number of diffraction pencils, and reciprocally to a given number of these pencils corresponds the image of a given structure. But the reciprocity is not absolute, for:

(5) The admission in the image of all the spectra given by a structure is not absolutely necessary for the formation of an exact image of the structure; but it is possible by the non-admission of a certain number of these spectra to either change nothing in the result or to modify it altogether, i. e. in other words to give either the image of the structure or a different image.

Thus consider a series of parallel lines at distances apart ϵ. Beside the pencil of refraction there will be a double series of spectra to the right and left.

(1) S'_4 S'_3 S'_2 S'_1 O S_1 S_2 S_3 S_4 . . .

A structure twice as fine will produce spectra twice as wide apart.

(2) S'_4 S'_2 O S_2 S_4 . . .

In all symmetrical structures the admission of one series alone, right or left, reproduces the image of the structure. In the case of (1), the admission of one only of the uneven spectra reproduces the image; but if by a suitable diaphragm all the uneven spectra are eliminated, and only the even or only one of these retained, then an image corresponding to structure (2) will be produced. Consequently, by eliminating part of the light which reproduces the image of a structure, the image of a structure twice as fine and which does not really exist is obtained.

Accordingly, although the admission of all the spectra is not abso-

lutely essential to the production of a correct image, the only way to ensure such an image is to collect all the spectra produced. But as the structures examined are generally unknown, and since we know *a priori* neither the number nor the arrangement of the spectra produced, we can never know if we collect them all, and consequently we can never know if the image which we observe represents exactly the structure, or even if we do not see the image of a structure which does not actually exist.

From this follows the theoretical conclusion that we can draw from the examination of a microscopical image no mathematically correct deduction as to the real structure of the object which has produced it, if the dimensions of the details of the structure are less than $0{\cdot}10\ \mu$. As an example we have in the case of *Pleurosigma angulatum* six spectra, and only six, whatever may be the obliquity of the illumination. But it is known that a grating composed of two series of lines cutting at 60° gives in the Microscope, beside the central pencil, two concentric series of spectra, the first of six, the second of twelve. By varying the number and arrangement of the spectra admitted, different images can be obtained, but by eliminating the second series altogether an arrangement of spectra similar to that of *Pleurosigma angulatum* is obtained, and an image is produced similar to the structure of that diatom, which, however, does not correspond to the real structure of the grating. Since, then, in the case of *Pleurosigma angulatum* we do not know whether there may not exist a second series of spectra sufficiently separated to escape our present objectives, we cannot affirm that the structure of this diatom is really that of which we observe the image. From these facts two conclusions can be drawn:

(6) It is important to collect the greatest number of diffraction pencils, and as these pencils diverge from the point where they are produced, it is necessary to employ objectives of the greatest possible aperture.

(7) The power of an objective is a direct function of its aperture.

The brightness of the image depends upon two factors,—the aperture of the illuminating pencil and the magnification. Calling ω the aperture of the objective and f the focal length, the brightness of the image will be proportional to

$$f^2\ \omega^2$$

so that in order to obtain the same degree of brightness, as f diminishes ω must be increased.

The maximum aperture which can be practically attained corresponds to an angle in air of 135°–140°.

This angular aperture can be easily applied to an immersion homogeneous objective of 1/8 in. focus, and gives a numerical aperture of about $1{\cdot}40$; but the maximum will be reached if the magnification be pushed much farther, and, instead of augmenting it will be necessary to reduce the aperture. Thus in the catalogues of opticians, e. g. Powell & Lealand, we find the aperture $1{\cdot}50$ applied to objectives of 1/6, 1/8, 1/12, and 1/20 focal length; but to 1/25 only $1{\cdot}38$ aperture and to 1/50 only $1{\cdot}33$ can be given. Beyond a certain limit, then, there is no advantage in augmenting the magnification of the objective. The author

considers that a focal length of 1/12 for the English tube, and 1/18 for the short tube ought not to be exceeded. With these combined with strong eye-pieces, magnifications of 3000 times can be attained. As good examples of such objectives, he cites the No. 9 of Nachet, No. 10 of Verick, the 1/12 and 1/16 homogeneous immersion of Zeiss, and the 1/12 1·30 homogeneous of Leitz.

The power of an objective, then, depends only upon its aperture, which is measured by the product

$$n \sin u,$$

where n is the index of refraction and $2\ u$ the angle under which the extreme rays from the object penetrate into the objective. The power of the objective is represented by the square of its numerical aperture. In a good objective it ought to be possible to utilize 1/3 of the total aperture. This condition is fulfilled when the central luminous circle seen on looking into the body-tube, has a diameter equal to 1/3 of the total diameter of the aperture. Now the ordinary mirror applied to Microscopes throws upon the object a luminous cone of about 30° angular aperture, which corresponds to a numerical aperture of 0·25. With such a mirror therefore an objective having an aperture three times as great, viz. 0·75, can be used. Beyond this, it is necessary to have recourse to special condensing apparatus, furnishing wider illuminating cones.

Taking into account the nature of the light employed, the more correct expression for the power of an objective is

$$p = \frac{n \sin u}{\lambda},$$

where λ is the wave-length.

Thus p can be augmented by diminishing λ, as well as by increasing n and u. The power of an objective expressed as 1 in white light will be 1·08 in blue and 1·32 for the extra-violet rays. It is not surprising therefore that photographs may be obtained of details with objectives which do not resolve them to the eye.

The author gives the following practical directions for the use of high-power objectives:—

(1) To always give to the body-tube of the Microscope the length for which the objectives are corrected, 0·160 m. for the short tube, and 0·250 m. for the English tube.

(2) To employ dry and immersion objectives which are mounted for correction, starting with a numerical aperture 0·75 (about 100° in air). If the graduation of the correction is not given in thickness of cover-glass, to find out the relation between them from the maker.

(3) With homogeneous objectives, whenever it is required to utilize marginal pencils, to optically unite the upper lens of the condenser to the preparation by means of a liquid with index of refraction at least equal to that of the immersion medium, and to only use preparations mounted in a medium of this index.

(4) With these objectives to always use a condenser.

The subject of the illumination of the Microscope receives very complete treatment at the hands of the author.

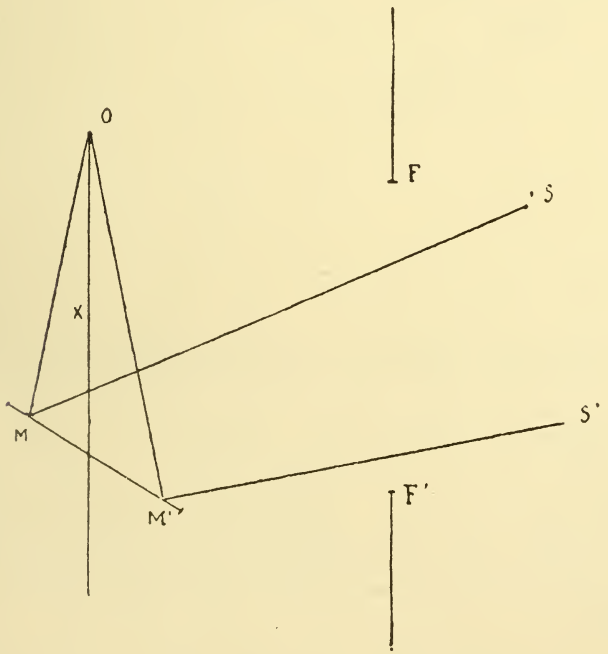
The general problem of illumination is how to cause the luminous rays emitted by a source of light to converge upon the object under a certain angle; but since in every optical apparatus the path of the luminous rays can be considered as reciprocal, it is more convenient to transform this and consider that the problem to be solved is to find the conditions in which all the rays of a pencil emanating from the object under a given angle shall meet a source of light.

As regards the achromatism of the illumination, if all the coloured rays emanating from a point of the object meet the source of light, the illumination of that part will be achromatic; but if this is not the case, it will be coloured by a colour complementary to that of the rays which do not meet the source of light.

Two cases of illumination are considered.

(1) The luminous source has dimensions relatively indefinite. Suppose that the rays of the pencil from the object have an angular aperture sufficiently small not to extend beyond the limits of the mirror MM′ and that their prolongations SS′ passing freely across the window FF′ lose themselves in a clear blue sky (fig. 22). In this case it is evident

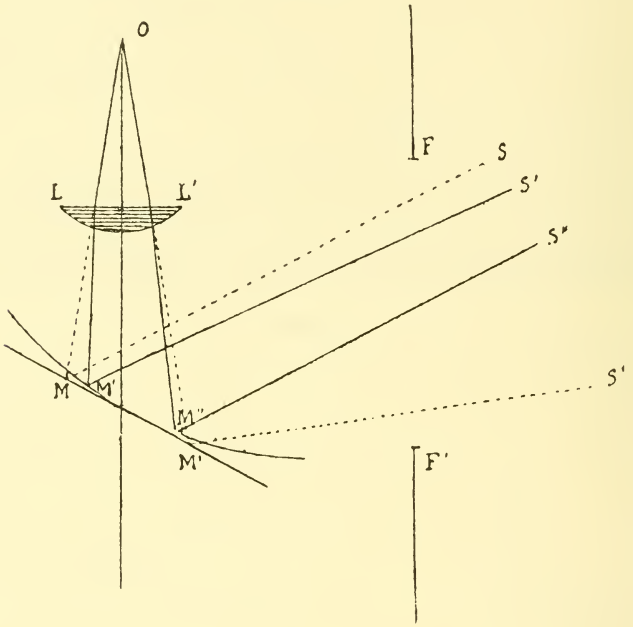
FIG. 22.



that if the rays O M and O M′ always start from the object in the same directions, whatever modifications these directions may afterwards undergo, the effect produced will be the same. Thus, as seen in fig. 23, the interposition of the lens LL′ and the curved mirror MM′ in place of

the plane mirror, in no way affects the final result. Accordingly, whenever the source of light can be regarded as limitless for a given amplitude of illumination, no apparatus, concave mirror or condenser, will produce a different effect to that obtained by the use of the plane mirror alone.

Fig. 23.



This will always be the case when objectives with total angle of aperture less than 30° (No. 1 of Nachet, A of Zeiss, and lower numbers) are used with the Microscope placed before a window widely open on a horizon sufficiently vast, and with the sky free from clouds.

(2) The source of light is limited. This is usually the case, and is caused either by the source being really limited in itself, or by the plane mirror which transmits it being too small to receive all the rays proceeding from the object A condenser is therefore necessary in order to cause all the rays emanating from the object to meet the source of light. The concave mirror is a simple but imperfect condenser, which suffices for low-power objectives. Its angular aperture is about 30°.

For high-power objectives a condenser is required. This forms at a given point a real and reduced image of the source, and the position of the object must be on this image. Here the intensity of the light is at a maximum, and since the object coincides with a source of light, all phenomena of diffraction are eliminated.

As regards the achromatism of the illumination, it is sufficient that

the object coincide with the colourless part of the image of the source. The achromatism of the condenser is therefore so far useful that it augments the extent of the image which can be utilized. The illumination will also be so much more perfect as the image of the source is better defined, so that the result will be more satisfactory if the condenser is aplanatic, if it is well centered, and if it functions in conditions for which the curvature of the lenses are calculated.

The author gives the following practical rules for the regulation of the light:—

(1) Furnish the instrument with a low objective, and, after having centered the condenser, illuminate with the plane mirror and focus the object.

(2) Raise or lower the condenser until the image of the luminous source is seen somewhere in the field.

(3) Make the image coincide with the object by displacing the source of light, or, where this is impracticable, by displacing the mirror.

(4) Exchange the low- for the high-power objective which is to be used, and again focus. Centre if necessary, and displace the image of the source as before.

(5) Remove the eye-piece and look into the body-tube at the image of the aperture; then by means of a diaphragm cause the image of the luminous pencil to occupy about a third of the total aperture.

When a lamp is used, the flame should be turned sideways to the Microscope. When the sky is the source of light, the condenser is focused by bringing into the field the image of some distant object, and then slightly turning the mirror to make it disappear.

If the object is too large to be superposed on the image of the flame, or if it is desired to have a large field uniformly illuminated, the condenser must be either raised or lowered. But in many cases, as e. g. when the condenser is united to the preparation by an immersion-liquid, it is impossible to move the condenser. In these cases a lens known as the *illuminating lens* is interposed between the lamp and mirror. The adjustment of this lens usually offers some difficulty. The mode of operation is as follows:—

(1) With the lamp about 0·25 to 0·30 m. from the mirror, the flame is centered and focused.

(2) The illuminating lens is then placed nearly in the focus of the flame, and centered by making use of the image furnished by its mounting.

(3) A uniform illumination of the field is then effected by slight movements of the lens in its mounting.

These conditions are very difficult to fulfil when the lens is independent of the lamp; but the regulation of the light becomes comparatively easy when the lens is united to the lamp by a special mounting provided with articulations, by which the lens can be moved in two rectangular directions. The most convenient lamp in this connection is that of Beck.

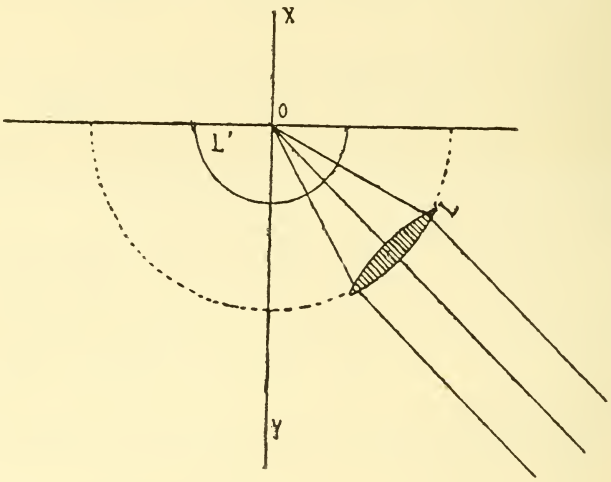
Glasses coloured more or less blue are the best means to employ in order to modify the intensity of the illumination.

For oblique illumination the above rules are no longer applicable. It is necessary to proceed by trial. After having correctly regulated the

central light the diaphragm is shifted little by little out of the centre, and after each movement its aperture is again illuminated by slightly displacing the mirror, or, better, the lamp.

In English and American instruments the oblique illumination is easily regulated by rotating the condenser L about the object itself O as centre. A hemispherical lens L′ placed beneath the object and optically united to the slide by an immersion-liquid, collects, without sensible deviation, the convergent rays from the condenser L, whatever may be the inclination of the latter to the axis $x\,y$ of the Microscope (fig. 24). As a rule the aperture of the illuminating pencil ought not to exceed the third of the aperture of the objective, but cases may occur in which the employment of pencils of large amplitude may be of service, as e. g. when very small coloured particles, dispersed in a feebly transparent but colourless medium, have to be distinguished; for in this case, although when using a very wide pencil the images disappear, yet the opposition of the colour will remain.

Fig. 24.



By employing an illuminating pencil so oblique that it does not enter into the aperture of the objective, the field will be dark, but any particles or objects in the field can so modify the direction of the rays that they penetrate into the objective, and a bright image will be obtained on a dark ground. This method of illumination gives very beautiful effects, but it is only employed with objectives of low or moderate power.

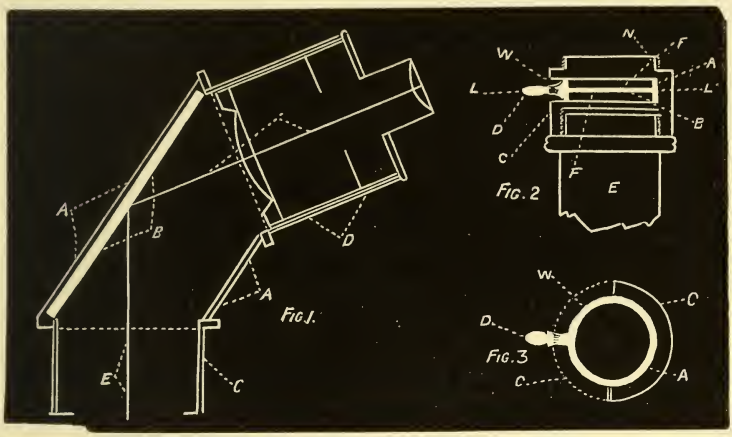
The Analysing Eye-piece.*—Mr. W. Lighton remarks:—"At the first meeting of the American Society of Microscopists, held at Indianapolis, I presented a paper upon an analysing eye-piece, and exhibited one that I had been using for several years. I sent, at a later date, a drawing and description of it to the San Francisco Microscopical Society.

* Amer. Mon Micr. Journ., xiii. (1892) pp. 260–2.

I have had many letters from microscopists since that time asking about the appliance, and I have been strongly urged lately to present the matter through the 'American Monthly Microscopical Journal.'

This apparatus consists of a box A, of the form shown in the side view, fig. 25, 1, made of either metal or wood, and containing a plate of

Fig 25.



polished black glass B. At the lower part of this box is a short tube C, which fits into the draw-tube of the Microscope, and at the opposite angle of the box is another short tube D, which receives the eye-piece. The glass plate is used for the purpose of reflecting the beams of polarized light at the best analysing angle. It will be necessary, of course, to use some form of polarizer below the object upon the stage of the Microscope, and the best is the Nicol's prism.

The line E represents a ray of light which has been reflected by the concave mirror through the Nicol's prism and objective, and is reflected by the polished surface of the glass B through the axis of the eye-piece, as shown by the line F. C represents the eye-piece.

The exact angle of inclination of the polished surface of the glass to the line E, which represents the axis of the Microscope, is very important. This angle should be 146°, which will cause the reflected beam F to form an angle of 112° with the line E, which is the correct angle for a reflector of polished German plate glass, now to be described.

If a piece of black glass cannot be obtained, procure a piece of perfectly polished German plate looking-glass $2\frac{1}{8}$ in. long and $1\frac{1}{4}$ in. wide. Scrape off the silver surface and thoroughly clean. Paint the cleaned surface quite heavily with black paint. Plate glass of a dark-green colour when examined edgeways is best.

A diaphragm with opening about the diameter of the field-lens of the eye-piece should be placed at the lower end of tube C. It is hardly necessary to state that this piece of apparatus is used as an analysing arrangement instead of the Nicol's prism analyser placed above the

objective. The following are some of the valuable features of this arrangement:—

It allows the entire angular aperture of all objectives to be used, which is not the case when using the Nicol's analyser and large-angle low-power objectives. The stage can be kept in a horizontal position in chemical experiments and in the examination of fluids, and the line of vision for the worker is the very convenient one shown at F. The image of very delicate objects is free from distortions, which is rarely the case when using a Nicol's analyser.

The analysing eye-piece can be revolved in the draw-tube of the Microscope by means of the tube C, giving the usual effects of a revolving analyser.

It is well to use a hemispherical lens of about $\frac{5}{8}$ in. diameter above the selenite film and polarizing prism, with the convex side of the lens toward the object upon the stage, and the upper part of this convex surface about $\frac{1}{4}$ in. from the object.

A modification of the revolving mica film, which I described in 'The Omaha Clinic,' to be used with the Nicol's analyser, is of especial value with the above described eye-piece arrangement, and it is represented in figs. 2 and 3. The apparatus consists of a plate of mica placed between the analysing plate and the object upon the stage of the Microscope in such a manner that rotation can be given to it, and it can be instantly removed if desired.

Let fig. 2 represent a side sectional view of the apparatus. C is an adapter carrying the rotating mica plate. E is the objective screwed into the lower part of the adapter. N is the screw for the body-tube of the Microscope. The mica film B is to be cemented between two plates of perfectly polished glass F of sufficient thickness to prevent distortion of image. This disc is to be fitted in the ring A, to one side of which is screwed a small handle D, to be used in giving rotation to the plates B F. A slit W is cut in the side of the adapter C to allow of the necessary motion to the handle D. The amount of this motion is governed by the length of the slit.

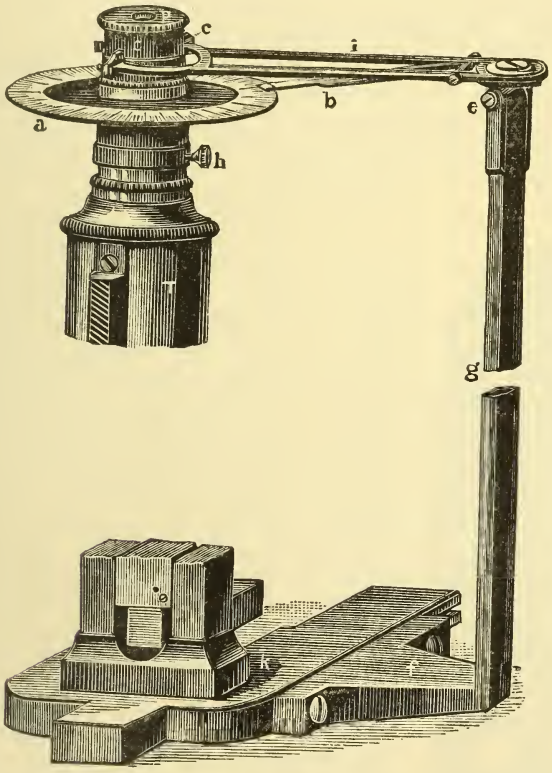
Fig 3 is a top sectional view, as indicated by the dotted lines L L in fig. 2. The letters in figs. 2 and 3 refer to the same parts. It will be seen in fig. 3 that the slit for the rotation of the mica film allows 180 degrees of motion, which is equal in its optical effects to an entire revolution. In selecting mica films great care must be taken to use only those which are free from bubbles, lines, and other optical defects, and are perfectly clear; and the richest effects are obtained when used in connection with a red and green selenite film placed in its position over the polarizing prism, and the mica plate so placed in its plane of rotation to the polariscope that it gives a deep, rich violet colour to the field of the Microscope. This will be the case if the proper thickness of mica film has been selected.

As before mentioned, it will be noticed that the mica film is placed between the analyser and the object upon the stage, and in this position it will be found to give new and beautiful effects, in many cases giving great boldness to delicate structure."

(3) Illuminating and other Apparatus.

Fromme's Arrangement of the Polarization Apparatus for Histological Purposes.*—Prof. V. v. Ebner remarks that the arrangement of the polarization apparatus in the ordinary Microscope is not very convenient for histological work. Means for measuring the angle of rotation of the polarizer, necessary in the case of circularly polarizing substances, is not required for histological work. An indispensable requisite, however, for such work is an arrangement which allows the preparation to be turned through all azimuths between the fixed nicols. The rotating

Fig. 26.



stage-plate with which many polarizing Microscopes are provided is not suited for work with high powers, owing to want of proper centering. A Microscope, however, of which the upper portion together with the stage can be rotated about the vertical axis, allows of the rotation of the preparation between fixed nicols if the polarizer is attached to the lower fixed portion of the stand, and the analyser to a special holder which does not share in the movement of the Microscope.

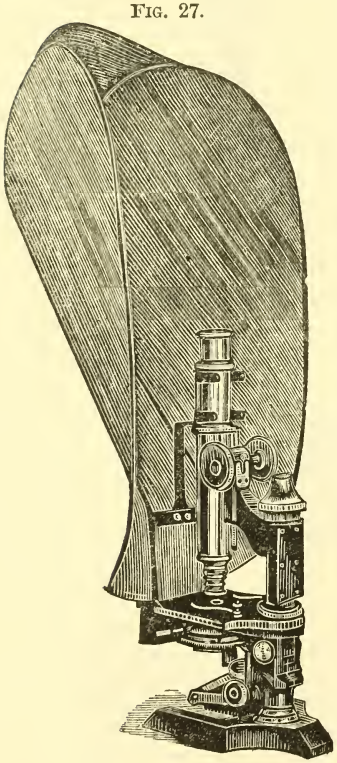
An instrument, answering to these requirements, which was made for

* Zeitschr. f. wiss. Mikr., ix. (1892) pp. 161–8.

the author by A. Fromme, of Vienna, is represented in half its natural size in fig. 26. The metal upright *g* is at its lower end *f* bent at a right angle, and attached to the horse-shoe foot of the Microscope *k* by a slide arrangement so that it can be easily removed or replaced at will. The horizontal arm *i*, at the upper end of the rod *g*, carries two vertical projecting pieces *c*, which fit into corresponding slots made in the fastening of the analyser. The latter, which is simply placed above the eye-piece, therefore remains fixed when the body-tube of the Microscope is rotated. The upright *g* is so far from the stage that the upper part of the Microscope never comes in contact with it during a complete rotation.

If an analysing eye-piece is used instead of the simple analyser, its fastening must be provided with slots in which the projecting edges *c* fit as before. The length of the rod *g* is chosen to correspond to a tube-length of 16 cm. The draw-tube of the Microscope must be used in order to effect the exact adjustment of the arm *i*. The latter can, however, be rotated about the horizontal axis *e* so as to give play for the slow motion. A rotation of this arm about a vertical axis is also possible.

Fig. 27.



For most histological purposes observation of the behaviour of the preparation between crossed nicols is all that is required; but, where necessary, an arrangement can be easily added to the apparatus by which angles of extinction, &c., can be measured. For this purpose cross-wires are fitted in the compensating eye-piece and a circle *a* divided in degrees and half degrees is clamped to the body-tube of the Microscope by the screw *h*. The scale thus turns with the body-tube while the eye-piece and analyser remain fixed. A projecting pointer *b* on the arm *i* serves as index for reading the angle of rotation. It is movable about a horizontal axis near the screw-head of the rod *g* so as to accommodate itself to the movement of the micrometer screw and remain constantly in contact with the divided circle.

In conclusion, the author gives some of his experiences with doubly refracting objectives and condensers. Of a series of new objectives few were found which were quite free from double refraction; but in most cases it was so slight that it could only be recognized by special means. Apochromatics were found to have this fault more than ordinary achromatic objectives.

New Microscope-Shade.*—Herr P. Schieferdecker has devised a new shade for the Microscope for which he claims many advantages. It has the form represented in fig. 27, and

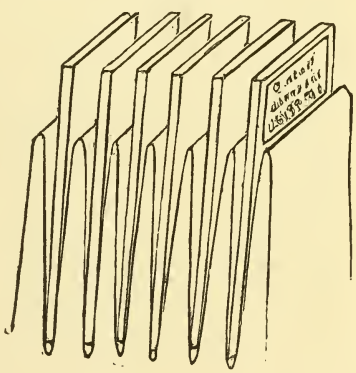
* Zeitschr f. wiss. Mikr., ix. (1892) pp. 180-1.

consists of a light wire frame on which is stretched some light black material. The latter extends a little below the lower edge of the rectangular plate which supports the shade, so that no interval is left on raising the body-tube. The shade serves to protect the eyes from the light, while it is so large that no heating of the head or deposition of moisture by the breath is likely to occur. It is very light and does not in any way encroach upon the working space. Finally, it can be very easily attached and taken off again.

Cheap Form of Box for Microscope Slides.—Mr. G. P. Merrill* describes the following arrangement:—"Presumably no one ever started out with making a collection of slides for the Microscope but has wrestled long with the problem as to how they may best be taken care of. In the administrative work of this department the problem early became a serious one. For its satisfactory solution I am indebted to my brother, L. H. Merrill, then assisting me.

As it happened, we had in stock a number of pasteboard boxes some 93 mm. wide, 143 mm. long, and 48 mm. deep, all inside measurements. The dimensions of our standard slide are 48 by 28 mm. By means of two wooden partitions, some 3 mm. thick, running lengthwise, each box was divided into three equal compartments, the partitions being held in place by glue reinforced by two small tacks at each end. Heavy manilla wrapping paper, such as we also had in stock, was then cut into strips 25 mm. wide and as long as the sheet of paper would allow, in this case about 7 ft. These strips were then bent into a series of folds, as shown in the accompanying illustration, the apices being rounded, not pinched flat. If carefully done, the folds when crowded gently together act as a spring. Two of these folded strips were then placed lengthwise in each compartment, and the slides introduced, standing on end, between the folds at the top. A box as thus prepared readily holds three rows of 50 slides in a row, or 150 altogether.

Fig. 28.



Each slide is separated from its neighbour in the same row by a double thickness of manilla paper, which, owing to its manner of folding, acts as a spring, and avoids all possible danger of breakage. When all the compartments are filled, the space between the tops of the slides in any row is but about 2 mm.; but there is, nevertheless, no difficulty in removing a slide or in getting at it to read the label without removal, since, owing to the yielding nature of the paper, the tops may be readily drawn apart. In this respect the box offers a great advantage over those with rigid wooden compartments, such as are commonly in use. The first box was made merely as an experiment. It proved so satisfactory

* Dept. of Geology, U.S. Nat. Mus. Washington D.C. See Science, xx. (1892) pp. 298-9.

that, for the time being at least, it is the form adopted for storing the several thousand slides forming the Museum collections.

I have attempted to show the arrangement as above described in the accompanying drawing. In reality the slides are held much more firmly than indicated, since the paper bulges and comes against both the front and back of the slides, the full length of the fold, instead of merely at the bottom. It will very likely strike the reader that a better material than paper might be found. I can only state that after considerable experimenting the paper was, all things considered, found most satisfactory."

(4) Photomicrography.

Photomicrography and direct positive Enlargements.*—M. Fabre-Domergue points out the limits to the use of photomicrography as a help to the Microscopist, and shows what advantages a careful drawing made by means of the camera lucida possesses over a photomicrogram; for while the artist in drawing superposes all the planes which he observes by means of successive focusing, the photomicrogram on the contrary only reproduces one of these, viz. that one which was in focus before the exposure of the plate. At present he considers that the questions whether the employment of photography considered as an auxiliary is really useful, and whether time and precision are gained by replacing the camera lucida by the photographic objective, would generally be answered in the negative. He ascribes the discredit into which photomicrography has fallen partly to the reason above stated and partly to the complicated apparatus required. Photomicrography can only be considered as a good method of work if it surpasses that of the camera lucida in rapidity, precision, and convenience, and these qualities he has not met with when he wished to make use of the complicated combination of apparatus now in vogue.

For this reason he has returned to Moitessier's original system and has made use of a small camera adapted directly to the Microscope, which gives small but perfectly clear images. The small proofs thus obtained are then enlarged by some of the new processes which have been lately considerably simplified.

The process which the author advocates therefore consists in the application of new and improved photographic processes to an old method of operation which had fallen into disuse, and of which the only fault consisted in giving proofs too small to be directly used.

He first describes the mode of operation for obtaining the small negative, and secondly the method of enlargement to a positive proof.

(1) *Taking the small negative.*—The camera, which is entirely of wood, consists of a small box pierced below by an aperture, into which fits the body-tube of the Microscope, and closed above by a velvet cover. A shutter of cardboard, containing either a sensitive plate 4 in. by 4 in. or a ground glass, slides in a groove in the base of the box. The ground glass, on which two diagonal lines are scratched, is provided at its centre with a small disc of thin glass cemented to the plate by Canada balsam. Since the refractive index of the balsam is nearly the same as that of the glass, a transparent window is thus formed, by means

* Ann. de Microgr., iv. (1892) pp. 288-99, 569-75.

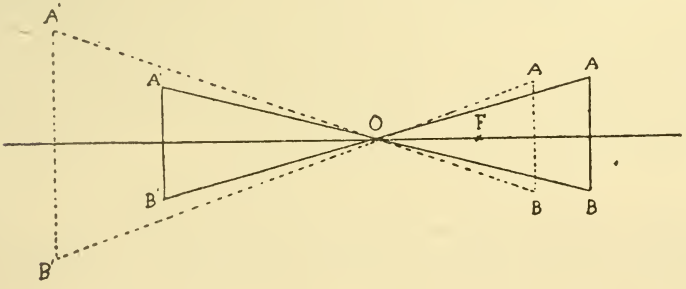
of which the focusing is much facilitated. The method of illumination is either by a petroleum or albo-carbon gas lamp. The amount of illumination is determined by Abbe's method, which consists in looking into the body-tube of the Microscope after removal of the eye-piece, and making the ratio of the bright and darker luminous field thus observed as 1 : 3.

With respect to the choice of preparations, sections should be as thin as possible. The most suitable are those which have been embedded in paraffin and stained with safranin, eosin, hæmatoxylin, &c., and then mounted in balsam. For coloured sections the author prefers balsam to glycerin for mounting.

Two methods of focusing may be employed. The first consists in repeating the operation before each photograph, the second in calculating once for all what displacement the optic system ought to undergo in changing from the eye-piece to the ground glass of the camera. The method of procedure in the first case is as follows:—After removal of the eye-piece and the insertion into the body-tube of the Microscope of a cardboard cylinder coated with black velvet for the prevention of internal reflections, the camera is adjusted on the Microscope. The image is then approximately focused on the ground glass by the micrometer screw. For more exact focusing a lens is employed. The lines traced upon the glass are brought into focus with the lens, and then, looking at the transparent portion of the plate, the micrometer-screw is turned until the image of the preparation is seen with the same clearness as the lines. The second method of focusing consists in determining once for all the lengthening of the body-tube necessary in order to readjust the focus when the eye-piece is substituted for the camera; but for high powers it is scarcely to be relied upon.

As regards the choice of sensitive surfaces, the albumen plates furnish layers absolutely without granulation, but unfortunately they are too slow in action. The author uses Lumière gelatin-bromide plates, of which the fineness is sufficient to allow of enlargements of three diameters without appreciable loss of clearness.

Fig. 29.



(2) *Enlargement of the small negative.*—The principle of all enlarging apparatus is represented in fig. 29, in which A B denotes the surface to be magnified, O the objective, and A′ B′ the sensitive surface intended to

receive the magnified image of A B. If the distance of A B from the objective is double the focal length, the image A′ B′ will be formed at an equal distance on the other side of O, and there will be no magnification. The nearer A B approaches O, the farther from O will the image A′ B′ be formed and the greater will be the magnification. Thus the proper choice of the focal length of the photographic objective is an important point. The author recommends either a very small aplanatic of 8 cm. focal length, or a simple objective of short focus. This is fitted into the middle compartment of a universal camera, the front and back portions of which receive respectively the small negative and the ground glass and slides. Instead of a universal camera an ordinary camera with long draw-tube can be used, though not so conveniently. In this case a cone of cardboard, fitted to the holder of the objective, and provided at the other end with a draw-tube containing the small negative, replaces the front part of the universal camera.

For the production of proofs with the same magnification, an apparatus of constant focus can be very simply constructed on the principle of the enlarging slide of M. Carpentier. This consists of a light-proof wooden box, the bottom of which receives a sensitive gelatin bromide paper while the top carries a draw-tube, in the base of which is inserted a lens which serves as objective. The proof to be enlarged is contained in a box attached to the other end of this draw-tube.

In all these enlarging apparatus the focusing is effected in precisely the same way as in the ordinary apparatus. Daylight is the best means of illumination.

The best way of arranging the sensitive paper in the slide is to place it between two glass plates. In this case the focusing must not be made on the ground glass, but upon a second plate placed against the small transparent window made by the layer of balsam.

When only low magnifications (1 to 5 diameters) of microscopic preparations are required, as e. g. of sections of embryos, brain, &c., which may measure several centimetres in diameter, direct enlargement of the preparation can be made by means of the photographic objective, without the aid of a Microscope. For this purpose the preparation takes the place of the small negative in the enlarging apparatus. It is fixed by two bands of gummed paper to a card pierced by a suitable aperture. Preparations which lend themselves best to this kind of reproduction are those which are a little thick and rather strongly coloured. The author obtained the best results with those which had been treated with hæmatoxylin, decolorized with acid alcohol, washed in alcohol and mounted in balsam. Preparations that are too thin or too feebly coloured should be illuminated by yellow light.

(5) Microscopical Optics and Manipulation.

Index of Refraction.*—Mr. A. B. Aubert describes some of the simpler methods for determining indices of refraction. An instrument for this purpose which he has found to work very satisfactorily is Bertrand's Refractometer, described in this Journal, 1887, p. 469. A simple method, proposed by Mr. Gordon Thompson as sufficiently accu-

* Amer. Microsc. Journ., xiii. (1892) pp. 225–9.

rate for the ordinary purposes of the microscopist, consists in making a fine mark with a diamond on an ordinary glass slide and cementing on each side of it the two halves of a large cover-glass, leaving a space of about 1/8 in. between their edges. The rectangular cell thus formed serves to hold the liquid under examination, and is covered with a very thin cover-glass. The fine mark is viewed with the highest power available, and the difference in focal adjustment for any two liquids examined is a measure of the difference of their refractive indices.

Another simple device for testing the refractive index, due to Prof. H. L. Smith, is also described. The necessary apparatus consists of an adapter about 3/4 in. long, into each side of which a horizontal slot is cut. Through these slots slide two slips of crown glass (2 in. by 1/2 in.) having approximately the refractive index of ordinary cover-glass. A hollow is ground in one of these slips, and serves to hold the liquid to be examined. The instrument is graduated by using different liquids of known refractive index and focusing upon an object through a 1 in. objective, a mark being made on the rack-bar in each case when the focus is perfect. This apparatus was originally devised to test homogeneous immersion media and has been called Prof. Smith's Homotester.

Optical Glass.*—Mr. J. R. Gotz discusses the properties and advantages to be gained by the use of the new glasses for optical purposes. Up to 1885 or 1886, in spite of the experiments of Harcourt and others, the manufacture of optical glass left much to be desired. Up to that time no means had been discovered by which certain errors of achromatism could be eliminated. It was in 1881 that Abbe and Schott first commenced their experiments with a view to the production of new kinds of glass which would allow of the removal of the so-called secondary spectrum.

The success which attended their efforts was attained by the production of improved crown and flint glass, mostly with mixtures of boracic and phosphoric acids, together with the addition of baryta, magnesia, and zinc oxide to obtain greater variations in refractive and dispersive power. Up to the present about eighty different kinds of glass have been put upon the market. These include several series of quite new glasses, such as the phosphate crowns, barium phosphate crowns, boro-silicate crowns, barium silicate crown, borate flint, boro-silicate flint, a special silicate flint, and a light baryta flint.

The catalogue of these glasses indicates for each the refractive index for D, the mean dispersion from C to F, and the proportional or relative dispersion. The variety of these glasses is so great that for almost any special purpose a suitable glass can be found. Some of them are identical with glasses formerly made by Chance Brothers, of Birmingham. For photographic purposes the silicate crowns or flints, and also some of the baryta flints are especially serviceable, but the borate flints are unsuitable owing to the fact that they are injuriously affected by the atmosphere. In this connection the baryta light flints have proved of great value, for on account of the high refraction, lenses of this material can be ground with much flatter curves.

* Anthony's Photographic Bulletin, xxiii. (1892), pp. 624-8.

The author concludes with a brief description of the method of manufacture and mode of testing these new glasses. The making of silicate glass takes close upon three weeks. The crucible is heated during four or five days until it attains a red heat; the inside is then well glazed out with molten glass of the kind to be made. The mixture of substances of which the glass is to be made is then placed in the crucible, thoroughly melted and worked into a homogeneous mass. The glass is then tested, and if in good condition is taken out of the oven and allowed to cool down a little, when it is transferred to another oven where it is left about three days to cool. The crucible is then broken up, and the clear transparent pieces of glass are next subjected to the "setting" process, which consists in heating them in moulds to about the melting point, in a special oven, to which a cooling oven is attached. The cooling takes ten to twelve days. The usable glass amounts to about 20 per cent. of the quantity melted. For special glass a process of fine annealing is used in which the glass is allowed to cool very slowly in a vessel the temperature of which can be accurately measured.

Plane of Polarization and Direction of Vibration of the Light in Doubly Refracting Crystals.*—Prof. V. v. Ebner examines the vexed question of the direction of vibration of plane polarized light. He states as the fundamental data of Fresnel's theory the two following propositions:—

(1) That in plane polarized light the oscillations take place at right angles to the direction of propagation in one plane, which is either the plane of polarization or one at right angles to it.

(2) That the velocity of propagation of the polarized light in a crystal depends only on the direction in the crystal in which the vibration takes place, and not on the direction of propagation.

The first proposition is now undisputed; but not so the second. We know, however, that longitudinal vibrations of the light-waves, at least in the interior of a crystal, do not come into account, for otherwise a rectangular crossing of the planes of polarization could not produce darkness. Further, along one and the same direction in a doubly refracting crystal the faster and slower waves can propagate themselves. Thus the direction of vibration is of essential importance for the velocity of propagation.

Taking the case of an optically uniaxial doubly refracting crystal, the ordinary ray, according to the conventional expression, is polarized in the principal section, the extraordinary in the plane at right angles. In a sphere formed out of such a crystal every diameter will be a possible direction along which the light movement in the crystal can take place. One of these diameters must coincide with the optic axis, and planes through this diameter are principal sections. All these meridional planes are polarization planes of the ordinary ray, and tangents to the meridians cutting the surface of the sphere represent all possible directions of vibration which belong to one of the two polarized light-waves (it is yet undecided to which).

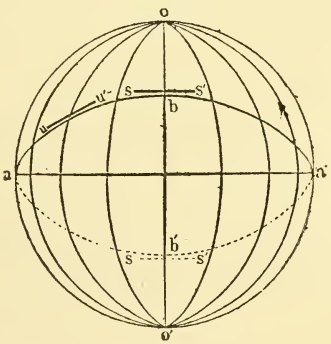
Of the planes of the great circles which are at right angles to principal sections, the equatorial plane is distinguished as cutting all the

* Zeitschr. f. wiss. Mikr., ix. (1893) pp. 289-97.

possible principal sections at right angles. It is at right angles to the optic axis and is the polarization plane of the extraordinary wave when the light is propagated at right angles to the axis. Thus tangents to the equator are all possible directions of vibration of the one wave—whether of the ordinary or extraordinary remains still undetermined. Now, possible polarization planes for the extraordinary wave are all planes at right angles to the principal sections, and of these there can be drawn an infinite number as great circles through a determined diameter of the equator of the sphere. If a diameter to the equator be drawn at right angles to a chosen meridional principal section, and a plane containing it be supposed to be turned through all possible angles about it, the plane in all positions during the rotation remains at right angles to the principal section, and therefore represents in all these positions a possible polarization plane of the extraordinary wave.

Matters are simplified if, instead of the possible polarization planes of the extraordinary wave, we consider the possible directions of vibration in these planes. These directions must, under all circumstances, be at right angles to a principal section, and must therefore be at right angles to the line of intersection of the plane of polarization of the extraordinary wave with a principal section. On the surface of the sphere, therefore, the tangents of the great circles which belong to possible polarization planes of the extraordinary wave, do not all correspond to the directions of vibration in these polarization planes, but only such tangents as stand at right angles to a principal section. In fig. 30 $o\,o'$ denotes the optic axis with principal sections drawn through it which cut the sphere in meridians; $a\,a'$ is the diameter of the equatorial plane; $a\,b\,a'\,b'$ any possible polarization plane of the extraordinary wave; $s\,s'$ the only possible directions of vibration in this plane; $u\,u'$ a direction in this plane, which cannot be a direction of vibration.

Fig. 30.



Now consider the case of a plate of a uniaxial crystal cut at right angles to the optic axis. When this is traversed by a plane light-wave in the direction of the optic axis there is no double refraction, and the light propagates itself with the velocity of the ordinary wave. Since the vibrations are at right angles to the optic axis, their direction lies in that plane of the crystal which exhibits the highest possible symmetry, viz. in the so-called basal plane of the rhombohedral, hexagonal, and tetragonal systems. All directions, then, in such a plane must be regarded as optically similar, since light propagates itself at right angles to planes of this symmetry as ordinary light. In the case of a plate cut parallel or oblique to the optic axis, the ordinary wave polarized in the principal section behaves so far like ordinary light, that it always exhibits the same velocity as light propagated in the direction of the optic axis; while the wave polarized at right angles to the principal section has a

velocity dependent on the inclination of the section to the optic axis; which is greatest (negative crystal) or least (positive crystal) when the light propagates itself at right angles to the optic axis, and is equal to the constant velocity of the ordinary wave when the light proceeds in the direction of the optic axis.

If we accept Fresnel's fundamental data, the constant velocity of propagation of the ordinary wave must correspond to a constant property of the substance in the direction in which the vibration takes place. In the basal plane, however, the vibrations must take place in all directions in the same way, because—as stated above, a plane wave propagated at right angles to this plane behaves like ordinary light, which proceeds in the crystal with the velocity of the ordinary wave.

The only supposition possible is, then, that the vibrations of the ordinary wave take place in the basal plane, and that consequently the direction of vibration of plane polarized light is at right angles to the plane of polarization.

(6) Miscellaneous.

Fifteenth Annual Meeting of American Microscopical Society.—This meeting was held in August last, at Rochester, N.Y., under the presidency of Prof. M. D. Ewell, whose address dealt with some relations of the Microscope and Jurisprudence. Twenty-seven papers were communicated, and six prizes, varying in value from 50 to 15 dollars, have been put at the disposal of the Society. The President for the ensuing year is Prof. Jacob D. Cox.

Scottish Microscopical Society.—This young society has published in a separate form some of its Proceedings, reprinted from the 'Journal of Anatomy and Physiology' (vol. xxv.). The pamphlet is mostly occupied with an interesting address, by Prof. Rutherford, its second President, on the Tercentenary of the Compound Microscope. Prof. Sir W. Turner was the first President, and Dr. Rutherford has been succeeded by Prof. Struthers.

β. Technique.*

(1) Collecting Objects, including Culture Processes.

Coco-nut-Water as a Cultivation Medium.†—Dr. J. N. Daválos opens the nuts in the usual way, pouring the fluid into a vessel, and then distributes it into flasks or test-tubes, which are afterwards discontinuously steam sterilized. If the nut be unripe the reaction of the coco-milk is neutral, but later it becomes acid. If the fluid be made alkaline with soda, potash, or ammonia, a coagulum, which must be filtered off, forms. When the fluid, alkalized and filtered, is steamed under a pressure of $1\frac{1}{2}$ atmospheres it remains clear, but takes on a mahogany colour. This is probably the effect of heat on the glucose.

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

† Crónica Médico-quirúrgica de la Habana, 1892, No. 11. See Centralbl. f. Bacteriol. u. Parasitenk., xii. (1892) pp. 766–9.

The attempt to make agar media with coco-milk instead of meat-broth failed.

The cultivation of micro-organisms shows that on the whole this fluid was a favourable nutritive medium. There was no success with *B. choleræ asiat.*, *B. anthracis*, or gonococci. Most other organisms bred with facility, and the medium seems to afford, in the quantity and form of the sediment, a criterion for distinguishing between *B. entericus* and *B. coli commune*.

Besides these two organisms, *B. mallei*, *B. diphtheriæ*, *B. pyocyaneus*, *St. pyogenes*, *St. pyogenes aureus*, *albus*, and *cereus*, *Diplococcus choleræ gallinarum*, *B. choleræ suum*, and *Vibrio Metsch.* were cultivated with success.

Alkalinity and Liquefaction of Gelatin.*—Dr. Eug. Fränkel has observed that the rapidity of the occurrence of liquefaction, other things being equal, was subject to a considerable amount of variation owing to different methods of preparing gelatin, and that the variable amount of alkali must be considered responsible for these fluctuations in the liquefaction period. The author found that by increasing the alkalinity of the nutrient gelatin the occurrence of liquefaction could be considerably hastened without the characteristic kind of liquefaction being in any way interfered with. It would appear that the optimum amount of alkali to produce the optimum growth varies from 0·5–1·5 per cent. soda, the mean being 1 per cent.

The varying absence or presence of the scum on bouillon and liquefied gelatin cultures is, the author thinks, to be ascribed to peculiarities in the composition of the gelatin, and he states that the different degrees of alkalinity can be produced by using a saturated solution of sodium carbonate.

Chamberland Filter.†—On account of the bad quality of the drinking water in Havana, many families make use of the Chamberland filter in order to purify it. Drs. E. Acosta and F. Grande Rossi have found from an examination of these filters as supplied by the trade that they are quite untrustworthy and are therefore dangerous on account of their supposed safety. For domestic purposes Chamberland filters should be first submitted to an examination; if not, the proper course is to boil the water first.

Beach, B. S.—**Histology, Pathology, and Bacteriology. A Manual.**
Philadelphia, 1892, 165 pp.

Houston, A. C.—**Note on Von Esmarch's Gelatin Roll Cultures.**
Edinburgh Med. Journ., 1892, pp. 552–4.

Schutz, J. L.—**A Rapid Method of making Nutrient Agar-agar.**
Bull. Johns Hopkins Hosp., 1892, p. 92.

(2) Preparing Objects.

Demonstrating Continuity of Protoplasm.‡—Mr. S. Le M. Moore states that a convenient way of demonstrating the continuity of proto-

* Deutsch. Med. Wochenschr., 1892, No. 46. See Centralbl. f. Bacteriol. u. Parasitenk., xii. (1892) pp. 827–8.

† Crónica Médico-quirúrgico de la Habana, 1892, No. 18. See Centralbl. f. Bacteriol. u. Parasitenk, xii. (1892) p. 883.

‡ Journ. of Bot., xxxi. (1893) pp. 51–2.

plasm through cell-walls is by the careful boiling of sections mounted in Millon's fluid. Preparations of endosperm made in this way may, after thorough washing and mounting in glycerin, be kept for years. The application of heat is necessary for only a few seconds.

Demonstration of Intergranular Network.*—Prof. Altmann uses a 2½ per cent. solution of molybdic acid ammonia, plus a small quantity (about 1/4 per cent.) of free chromic acid. In this mixture the fresh organs are left for about 24 hours, then placed in alcohol, and thence into pure paraffin. The sections were stained as usual with hæmatoxylin, gentian, &c.

Blood.†—Dr. A. Spuler investigated the mesenteries of young mice and rabbits, which were spread out on cork plates, and fixed with picro-acetic-osmic acid (1000 ccm. picric, 6 ccm. acetic, 1/2 grm. osmic). After gradations of alcohol, they were stained with hæmatoxylin, Ehrlich-Biondi's mixture, and eosin, and cleared in clove oil.

Bone-cutting Machine.‡—Prof. J. Csokor and Herr A. Csokor have devised a machine which cuts sections of bone thin enough (·12 mm.) to be at once examined microscopically. A circular saw rotates very rapidly; a self-steering arrangement draws the object slowly but persistently against the cutting edge; and there are devices perfecting what is in principle very simple.

Preserving Larvæ of Ascidians.§—Mr. A. Willey finds that the best results are to be obtained by using Davidoff's mixture of 3 parts concentrated corrosive sublimate, and 1 part glacial acetic; the shrinking tendency of the former is neutralized by the swelling power of the latter ingredient.

Examination of Eyes of Arthropods.‖—M. H. Viallanes fixed the eyes of the Crustacea he studied very satisfactorily by means of absolute alcohol; but he prefers a watery solution of sublimate acidified by acetic acid; the proportions he used were distilled water 100 parts, bichloride of mercury 5 parts, and acetic acid 5 parts. After maceration for some hours in this liquid the object was plunged into 70 per cent. alcohol, in which it was left for three or four hours. Perfect depigmentation is very difficult, as all the reagents used are very apt to alter the tissues. The method he recommends is this; take a test-tube closed with a guttapercha cork, pass through this a tube with a ball, twice curved and provided with a mercury valve. At the bottom of the vessel place crystals of chlorate of potash and some drops of hydrochloric acid; this mixture will give off a large amount of chlorine; the test-tube is then placed in a larger tube half filled with a mixture of equal parts of absolute alcohol, glycerin, and water; the cork is then put in. The chlorine is gradually dissolved in the glycerin mixture, and acts on the pigment; this will, in a few hours, disappear completely without affecting the tissues in any way. When the removal of the pigment is complete the piece of eye is placed in 90 per cent. alcohol, renewed as often as is necessary to get rid of the last traces of chlorine.

* Verh. Anat. Ges., vi. (1892) pp. 220–24.
† Archiv f. Mikr. Anat., xl. (1892) pp. 530–52 (1 pl.).
‡ Ver. Anat. Ges., vi. (1892) pp. 270–1.
§ Quart. Journ. Micr. Sci., xxxiv. (1893) p. 319.
‖ Ann. Sci. Nat., xiii. (1892) pp. 354–7.

Staining is advantageously effected by Ranvier's picrocarmine. To study the mode of termination of the nerves in the ommatidium the author recommends a process which consists in forming within the nervous elements a coppery layer of hæmatoxylin. On removal from the alcohol the depigmented piece is put for twelve hours into a solution of 1 per cent. sulphate of copper. This is then washed for five or six hours in distilled water, which is frequently renewed. It is then immersed in a solution which is not prepared till the moment of using it; this consists of 75 ccm. of perfectly distilled water, 25 ccm. of absolute alcohol, and 0·25 grm. of crystallized hæmatoxylin. After immersion for twelve hours the piece is withdrawn, care being taken to avoid the use of any metallic instrument, and it is put at once into a 1 per cent. solution of sulphate of copper; after twelve hours it gives its proper tint. The piece is then washed very carefully for several hours so as to get completely rid of the copper, and it is then dehydrated in baths of alcohol of increasing strength, always kept neutral. The piece is then treated successively with chloroform and paraffin. Sections fixed by the aid of albuminous water are mounted in dried Canada balsam, dissolved in chloroform. Tissues treated in this way have a splendid deep Prussian blue colour, which is almost exclusively confined to the cylinder-axes, the protoplasm, and the nuclei of the nerve-cells; the connective tissue takes such a slight tinge that one can scarcely recognize the nuclei. Unfortunately preparations thus obtained do not last long, even if kept in darkness.

Examination of Sub-cuticular Layer of Ascarids.*—M. Jammes has been able to make some interesting observations on fresh specimens of Ascaris without any other preparation than staining in a watery solution of methylene-green. The best way to fix the cells is to hold a living worm between two pairs of scissors pretty close together, and to plunge the scissors and the piece of the worm between them into a solution of osmic acid, and then with both hands at once to cut through the specimen. Teasing may be effected in a solution containing one-third of alcohol. Besides methylene-green, borax-carmine, acid carmine, Delafield's hæmatoxylin, and others may be used. It is often well to use more than one reagent. On the whole, hæmatoxylin gives the most marked and permanent results. Chloride of gold was also found to be useful.

Method of obtaining Embryos of Balanoglossus.†—Mr. T. H. Morgan finds that Bateson's method, somewhat modified, is the most satisfactory means for obtaining embryos of *Balanoglossus*. Collect the sand around the adults carefully, and allow it to settle in tall glasses filled with water; keep the water in rapid rotatory motion. Siphon off sand and débris. If the young are required in a living state they can be picked out with a pipette. The embryos can be collected much more rapidly by pouring Kleinenberg's picrosulphuric acid, mixed with glacial acetic acid, in 2 to 10 parts per cent. of the whole solution over the sand collected through the siphon. The embryos are quickly coloured dark yellow, and so may be easily and rapidly collected.

* Ann. Sci. Nat., xiii. (1892) pp. 325–7.
† Zool. Anzeig., xv. (1892) p. 457.

Investigation of Freshwater Dendrocœla.*—M. G. D. Chichkoff finds that the best fluid for killing these worms is one containing 2 per cent. bichloride of mercury, 6 parts; 15 per cent. acetic acid, 4 parts; pure nitric acid, 2 parts; 14 per cent. chloride of sodium, 8 parts; and 2 per cent. alum, 1 part. Put some of the fluid in a watch-glass or porcelain dish, take a worm on a spatula in a drop of water, and when it begins to move tip it into the fluid. The animal will die at once, without any contraction. After the worm has been in the fluid for one or two hours put it into 70 per cent. iodized alcohol to remove every trace of the bichloride of mercury; after passing through 80 per cent., 90 per cent., and absolute alcohol, the worm will be ready to be stained. For this purpose boracic carmine was successfully used. Chloroform for ten minutes was used to clear the tissues. The author has observed that if specimens are left for more than twenty minutes in paraffin they cannot be used for sections, as they become brittle, and their histological elements are seriously displaced.

By means of Schanze's microtome sections 1/100 to 2/100 mm. thick were obtained, and were fixed to the slide by Schaellibaum's collodion.

The author claims many advantages for the above method; cilia are perfectly preserved, and epithelial cells are in no way disarranged. In preparations which were to be teased Müller's fluid was used, and was followed by 3 per cent. acetic acid mixed with a few drops of 10 per cent. nitric acid. Teasing is effected in slightly acid glycerin. The isolated parts may be stained by hæmatoxylin or Beale's mixture of carmine and glycerin.

The cellular structure of the epithelium of the pharynx was demonstrated by treatment with a 1/400 solution of nitrate of silver, into which the isolated pharynx was plunged.

Killing and Preserving Rotatoria.†—Mr. C. Rousselet has worked out a successful method of killing and preserving Rotifers in their natural extended state. It consists in narcotizing the animals by adding a small quantity of a 2 per cent. solution of hydrochlorate of cocain to the water in a trough, and when the Rotifers are sufficiently weakened, they are rapidly killed and fixed by adding Flemming's chromo-aceto-osmic acid solution; then, in half an hour, washed in distilled water and put up in an aqueous preservative fluid. The action of cocain is not the same with different species of Rotifers, and therefore the length of time the animals have to remain under the influence of the anæsthetic varies greatly in different species. Distilled water, with only a trace of the fixing solution added, is recommended as the best preservative fluid. Single animals as well as large numbers can be treated at the same time. Rotifers prepared in this way are fully extended, nearly as transparent as in life, with the cilia, muscles, nerve-threads, and all minute anatomical details fully preserved.

Demonstration of Parasitic Protozoa in Cancerous Tumours.‡—Dr. M. Armand Ruffer and Mr. J. H. Walker fixed their material with absolute alcohol, concentrated sublimate solution, or (small pieces)

* Arch. de Biol., xii. (1892) pp. 438-41.
† Journ. Quekett Micr. Club, v. (1893) pp. 205-9.
‡ Journ. of Pathol. and Bacteriol., 1892.

Flemming's solution or osmic acid, washed in water for at least twenty-four hours afterwards, and then hardened in the usual way with alcohol. The pieces were imbedded in paraffin, after the Naples method, before cutting. Biondi's reagent, as prepared by Grübler of Leipzig, proved by far the most valuable stain for cancers hardened in alcohol; one gramme of the powder is dissolved in 80 ccm. of water, and 15 ccm. of a 5 per cent. solution of acid fuchsin is added to it. In a footnote the authors add that Grübler now advises a ·4 per cent. solution of the powder with the addition of 7 ccm. of a ·5 per cent. solution of acid fuchsin to 100 ccm. of the first solution. The sections, after remaining in this solution for an hour at least, are washed in water (30 seconds), and passed through 95 per cent. alcohol (1 minute), absolute alcohol (2–5 minutes), xylol (2–15 minutes), and finally mounted in Canada balsam dissolved in xylol.

The only drawback to such preparations is that the colour has a tendency to fade; they are, however, very beautiful and instructive. The nucleus of the cell is green, the nucleolus reddish-brown or red, and the protoplasm orange-red. On the other hand, the nucleus of the parasite is red, and the protoplasm a light Cambridge blue colour. After using Flemming's solution, Biondi's reagent may also be used.

Solutions of hæmatoxylin and Gerrard's logwood-stain give very fair results, after fixing with osmic acid or Flemming's solution; better preparations are obtained by combining Gerrard's logwood stain with a solution of eosin, or with a ·5 per cent. of rose-bengale in 80 parts of water and 20 parts of absolute alcohol.

Use of Centrifugal Machines in Analytical and Microscopical Work.*—Herr W. Thörner recommends the use of a centrifugal machine for the separation of solid or fluid bodies suspended in liquids which only settle very slowly under ordinary conditions. The apparatus is set in rapid rotation either by a crank, toothed wheels, or a small turbine. The vessel containing the liquids is attached to the upper part of the apparatus in such a way that during the rotation it takes the horizontal position, and at the end returns by steady oscillations to the vertical. The liquids to be separated can also be brought into small glass receptacles fitted into a metal holder which is attached to the plate of the machine. According as the material to be estimated sinks or floats, these receptacles are narrowed in their lower or upper part, and there provided with a scale.

The author has modified the Victoria centrifugal machine, which he has used in his experiments, by the addition of an iron jacket provided with a cover. By this means the enclosed air shares in the rotation and the air resistance is avoided.

Aid to Microscopical Examination of Fæces.†—Dr. Herz uses the centrifuge for separating the different constituents of the fæces. The stools are diluted with water, and after centrifuging, separate into layers, the uppermost consisting of bacteria, thin masses of undigested cellulose, striated muscle, thin layers of round cells, clostridium, starch, &c.

* Zeitschr. f. Instrumentenk., xii. (1892) pp. 390–1. See Chem. Ztg., xvi. p. 1101.

† Centralbl. f. Klin. Med., 1892, No. 92. See Centralbl. f. Bakteriol. u. Parasitenk., xii. (1892) p. 769.

Separation of Micro-organisms by Centrifugal Force.* — Micro-organisms being composed, says M. R. Lezé, of proteids, cellulose, and minerals, are heavier than water, hence if they float in liquids such as wine, cider, milk, this is probably due to the presence of gas; the force necessary to move them up or down in a liquid of specific gravity hardly differing from that of their own protoplasmic body, must be extremely feeble. But this force may be augmented by setting the liquid in motion by means of a centrifuge. The apparatus used by the author were a handworked lactocrite with radius of 9 cm., giving 3600 turns, and a steam turbine (Burmeister's) having a radius of 20 cm. and doing 4000 turns.

In the former the receivers are little tubes drawn out to a conical shape, with the pointed end sealed up. In the second apparatus the action is continuous, so that an indefinite quantity of the liquid can be centrifuged.

In the hand-machine the organisms are chiefly deposited in the pointed ends of the receiver, in the turbine all over the sides, as a sticky gelatinous deposit.

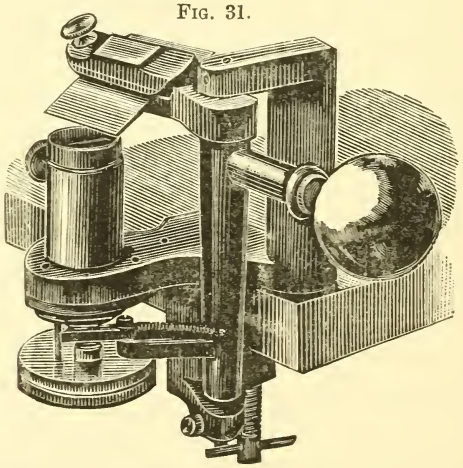
By this method liquids undergoing change of fermentation, &c., may be "separated," and the larger the organisms, the more easily is this effected; thus moulds and yeasts are more easily separated than bacteria.

By diminishing the density of the fluid centrifuging is rendered more easy. This may be done by heating the liquid or adding water, ammonia, alcohol.

(3) Cutting, including Imbedding and Microtomes.

Jung's Microtomes.†—Herr P. Schiefferdecker describes two microtomes constructed by R. Jung. The first instrument is a modification

Fig. 31.



of the English "Cathcart improved microtome." It is made entirely of cast iron, and has the form shown in fig. 31. A strong vertical bar can

* Comptes Rendus, cxv. (1892) pp. 1317–8.
† Zeitschr. f. Wiss. Mikr., ix. (1892) pp. 168–75.

be rotated by the projecting handle on the right between two screw points in the ends of a powerful clamp fastened to the projecting edge of the table. From the upper end of the bar projects a horizontal arm carrying a clamp in which the short knife is held by two screws. In front of the knife and supported by a plate projecting from the base-clamp is a metal cylinder, in which a second cylinder, holding the preparation, is raised by means of the micrometer screw. Jung offers two instruments, differing only in the method of raising the cylinder: in the one the screw is simply adjusted by touch as in the English original, while in the other, represented in the figure, there is an automatic adjustment of the micrometer screw which, though simple in construction, works satisfactorily. The displacement is effected by a pall engaging in a toothed wheel, and its amount, ranging from 10 to 100 μ, is regulated by an adjustable plate provided with a division. The knife is set square and is on the radius of a circle having the axis of rotation as centre. Thus the different parts of the knife will move with different velocities, and as a result there is a displacement of the object towards the parts nearest to the axis of rotation; but this effect is so slight as to be scarcely appreciable. The movement of the knife is very smooth and regular. The lower of the two screws about which the guiding bar rotates can be adjusted when, after prolonged use, the points of the screws have penetrated deeper and deeper into the bar. The instrument is not intended for very delicate work, but for ordinary useful sections of paraffin and frozen preparations.

The second microtome described is a slightly modified form of the "Cambridge rocking microtome," which was described and figured in this Journal, 1885, p. 550. The instrument produces sections which are not simply plane surfaces, but portions of a cylinder with radius equal to the distance of the knife-edge from the axis, and therefore cannot be used for most embryological investigations. Its chief use is for paraffin preparations of histological objects. The author remarks that the instrument can be used with advantage by the pathological anatomist in nearly all cases, but by the normal anatomist only in a restricted degree.

Minot's Microtome.*—Herr P. Schiefferdecker describes a new and improved form of Minot's microtome.† On a metal plate supported by short feet rises a strong upright A (figs. 32 and 33), which carries a slide-way provided with a swallowtail groove. In the figure this is raised so high that it reaches the end of the upright; it carries a second horizontal slide-way in a swallowtail groove, which is moved by a micrometer-screw having at its end the large toothed wheel B. This slide carries on the end turned towards the knife a disc, to which the paraffin preparation is attached. This disc can be turned in different directions by the hand and fixed in any desired position by screws. In the large toothed-wheel B engages a pall which is attached to a movable metal plate fastened to the vertical slide-way. This metal plate projects beyond the pall, and the free end, by the vertical movement of the slide presses against one of the six rays of the star at the side. The pall is thus drawn down and consequently rotates the toothed wheel, by means of which the preparation is displaced. The different rays of the star

* Zeitschr. f. wiss. Mikr., ix. (1892) pp. 176–9. † See this Journal, 1889, p. 143.

allow of displacements of 1/300, 1/150, 1/100, 1/75, 1/60, 1/50 mm. For smaller displacements use is made of the second small toothed wheel C (fig. 33), which by a slight displacement is made to engage in the

Fig. 32.

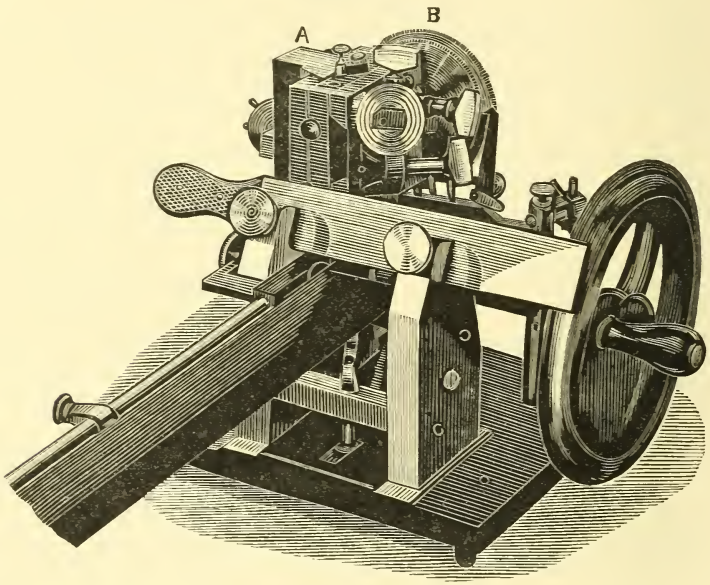
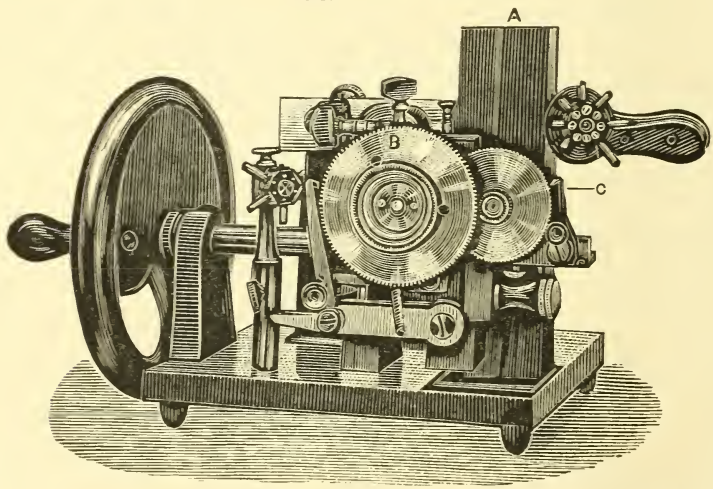


Fig. 33.



large one. By means of the star belonging to this wheel displacements of 1 to 6 μ can be obtained. The knife rests in clefts in two strong uprights, and is clamped and adjusted by two screws.

This instrument has the advantage over the rocking microtome, that

it produces sections all parts of which are in one plane. The sections can also be obtained at a greater rate of speed, and the inclination of the knife can be changed at will. One disadvantage of the instruments lies in the swallowtail grooves of the slide-ways which are not so accurate as those of the rocking microtome. The instrument can be used for all kinds of paraffin sections for normal, pathological histology, and series of embryonic sections. For moist and frozen sections it is naturally not adapted.

A Bacteriological Potato Section Cutter.*—Dr. C. F. Dawson describes his apparatus thus:—"Several methods of preparing potatoes for a culture medium are now in vogue, each having more or less efficiency, and a variable amount of labour.

One of the most common methods is the use of a large cork-borer, or apple-corer, to cut a cylinder from the potato. This cylinder of potato is divided diagonally, thus making two preparations. Pieces of glass tubing are inserted into the thick ends of the two pieces of potato, and they are placed into ordinary test-tubes and sterilized. The pieces of glass tubing serve to support the potatoes above the level of the condensation water, which always settles into the bottom of the tube. In some instances, specially made culture-tubes having a constriction near the bottom of the tube, are used. The constriction supports the potato, and the condensation water falls into the reservoir thus formed in the bottom of the culture-tube.

If the potato medium is to be kept for some time, we find that there is a great change in the form of the potato, due to evaporation of water from it. The inoculation surface becomes irregularly concave, the thin end becomes dry and curls, and the preparation presents an unsightly appearance. When the potato cultures are to be used for exhibition purposes it is desirable to have them present a neat appearance. The aim of the writer is to describe an apparatus which he has devised to prevent the changes in form referred to. The apparatus consists of two pieces: a plugger represented by fig. 34, and a curved knife represented by fig. 35. The plugger is made from a metal tube about six inches long, and of a diameter a little less than the culture-tubes to be used. The side of the metal tube is cut out by sawing slantingly through the wall and across the inner diameter of the tube to the opposite wall at such an angle that the distance traversed by the saw will be about two inches and then by sawing vertically across the diameter of the tube to the wall of the opposite side. The end of the tube nearest the side opening is sharpened from the outer surface, and a wooden handle is fitted into the other end.

The curved knife (fig. 35) is used to cut a convex surface on the potato section so as to compensate for the loss by shrinkage from evaporation. After a time this convex surface will become nearly flat, whereas, if the surface were cut flat at the outset, it would now be irregularly concave.

This knife is made by cutting out a segment of a circular tube of about 1½ in. in diameter, the segment having continuous with it a narrow portion of the wall of the same tube, which portion serves as a handle. The segmental portion is sharpened upon its convex surface.

* Amer. Mon. Micr. Journ., xiii. (1892) pp. 243-4.

When it is desired to make a potato preparation, both ends of a large potato are cut off, and the plugger is passed through it by a rotary vertical movement. The potato cylinder, which appears in the plugger, should be long enough to reach a short distance into the hollow handle, so that it will be held firmly. By passing the curved knife into the potato cylinder and across its diameter in contact with the sides of the opening

Fig. 34.

Fig. 35.

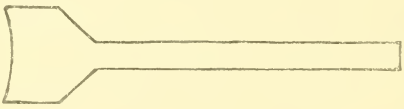


Fig. 36.

in the plugger, the cylinder is divided. The outer piece of the divided cylinder will fall out, and the piece which remains in the plugger now has a levelled surface for inoculation, and it can be removed by pushing it up a short distance into the hollow handle of the plugger.

The thin end of the section should be trimmed off for the distance of about $\frac{1}{2}$ in. to prevent its curling, and a notch should be made in the side of the end of the cylindrical portion of the section to admit the passage of moisture from the water reservoir of the culture-tube to the potato chamber above it. Fig. 36 represents the potato section placed in a reservoir-tube ready for use.

(4) Staining and Injecting.

Staining Bacteria to demonstrate the Flagella.*—Mr. Amos P. Brown writes as follows:—"Among the most difficult objects to demonstrate that the microscopist has to deal with must be ranked the flagella or motile organs of the bacteria. So exceedingly thin and hyaline are they that it requires very skilful manipulation to see them even with the highest angle immersion objectives. Yet by means of staining methods I have been enabled to produce some preparations in which the flagella of *Spirillum undula* may be seen with a 1-in. objective. To see them properly, however, when the forms are as nearly as possible in their natural condition, requires a good 1/5 in. About two years ago I commenced a series of experiments as to the action of various stains on the common putrefactive bacteria, with the especial object of demonstrating the flagella. After trying the methods recommended by Loeffler, Trenckmann, and others for this purpose, I at last developed the following method, which is now published for the first time.

* 'The Observer,' iii. (1892) pp. 298-300.

The process is similar to that used in dying cloth, and consists of two operations, (1) the mordanting, and (2) the staining. The bacteria are placed in a drop of water large enough to nearly cover the cover-glass, when they are allowed to dry spontaneously in the air. Do not use heat to dry the drop, as this deforms the bacteria and often destroys the flagella. The drying process should be watched, and as the last portions of water disappear the cover should be immersed in the mordant and allowed to soak for from two to five hours or more; it may, for instance, be left in the mordant overnight. When culture ovens are available they may be used for drying the drop containing the bacteria, but they are not at all necessary to the success of the operation. After soaking in the mordant for the required time, the cover is transferred to a vessel containing water for about five minutes, to remove excess of the mordant, then it is taken out, drained, and then flooded with the stain. Steam the cover (held in the forceps) for two or three minutes over a lamp, but do not allow it to boil; wash thoroughly in a stream of water, as the jet from a bottle, drain, and set aside to dry spontaneously. Then mount in balsam, preferably that for use with heat, but if using dissolved balsam, put a small drop of oil of cloves, turpentine or xylol in the centre of the cover before lowering the soft balsam. Do not attempt to decolorize in any way, nor to pass through alcohol and oil of cloves to balsam, or the flagella will not remain stained.

The mordant is composed as follows:—tannin 30 grains, anilin oil 12 drops, alcohol 1 fluid oz. This is the normal mordant, but sometimes I find it well to add a little sodic hydrate or hydrochloric acid, one or two drops to the dram, to make it alkaline or acid. A slightly alkaline mordant is best for the large forms *Spirillum undula* and *Bacillus ulna*, which are very common in putrefying water. The alcohol and tannin in the mordant are both fixing agents, and hence the bacteria are fixed without heat, and preserve their shape better than by any other method I have used.

For a stain, any anilin colour, as fuchsin, methyl-violet, dahlia, methyl-green, &c., may be used dissolved in neutral anilin water made by shaking up a few drops of anilin oil in water, adding the stain and then caustic soda until it just begins to precipitate. Then filter and keep well corked. This stain only keeps for a few weeks, so that I recommend the following:—Make a hot saturated solution of fuchsin in water, then add caustic soda until no more red precipitate is formed; filter and save the red precipitate, which is the base rosanilin. A little of this, one or two grains, dissolved in a drop of anilin oil, will make about three or four drams of stain of the proper strength if shaken up with the water. It is often necessary to filter the stain before using. My best preparations are stained with fuchsin; a large series of other mordants, many containing metallic salts, were tried, but after a year and a half's use I still consider this the best.

I would add as a caution to those who may use this method, do not expect perfect results on the first trial; different bacteria require longer or shorter mordanting, and the proper conditions must be determined by experiment in every case."

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

Method for Hermetically closing permanent Cultivations of Bacteria.*—When cultivations of bacteria are intended for exhibition in a museum, the culture-vessels should be hermetically closed. This is usually done with rubber caps or paraffin. The disadvantage of the former is that they become hard and brittle, and the latter may, if the weather become hot, get soft and so sink down.

The method recommended and devised by Dr. C. F. Dawson, which obviates the foregoing inconveniences, is as follows. The cotton-wool plug is cut off flush with the top of the tube with a pair of hot scissors. A circular sterilized cover-glass is then pressed in on the top of the wool so that it just touches the rim of the tube. A thin cake of gelatin which has been lying in perchloride (1–1000) for a short time is then spread firmly over the top and held in position by a rubber band. When the gelatin is nearly dry the superfluous gelatin and with it the rubber band is cut away with a knife. Thus the test-tube is covered in with a circular layer of gelatin, and when this is dry it is further protected with a varnish composed of the following:—alcohol, 200 parts; white shellac, 90 parts; balsam of copaiba, 8 parts.

Medium for Mounting Microscopical Objects which will not mould.†—Dr. A. M. Edwards has devised a medium of high refractive index, and suitable for mounting animal and vegetable objects. It consists of a mixture of saturated solutions of borax, *real* salicylic acid, and oil of cinnamon. The mixture is filtered. The proportions are not given.

Influence of the Composition of the Glass of the Slide and Cover-glass on the Durability of Microscopic Objects.‡—Herr R. Weber, in view of the destruction of microscopic objects through defect or excess of alkalinity in the glass of the object-holder or cover-glass, recommends for delicate preparations a glass especially rich in lime, having a compos tion very similar to that of window-glass.

Mr. G. S. Marryat's Form of Mounting and Dissecting Stand.—The following note by Mr. F. M. Halford was read on Feb. 15th:—"There is nothing new about the simple framework of this stand, which consists of a 3/4 in. pine base-board, 2 ft. 8½ in. by 11 in., on which are raised, in the position shown on plan annexed, two 3/4 in. oak upright supports for the stage and arm-rests. These uprights are grooved at various levels as shown, and the arm-rests are carried down diagonally from the uprights to the base-board.

The stage is 4½ in. by 4¼ in., and of glass, either transparent or opal. When dealing with transparent objects the light is reflected from a small square mirror inclined to the necessary angle and laid on the base-board immediately under the stage. If it is desirable to moderate the light, a square piece of oak with diaphragm of the required diameter is inserted in one of the lower grooves. Four thick elastic

* Centralbl. f. Bakteriol. u. Parasitenk., xii. (1892) pp. 720–1.

† Reprint from 'The Omaha Clinic,' Sept. 1892.

‡ Zeitschr. f. Instrumentenk., xii. (1892) p. 388. See Chem. Ber., xxv. (1892) p. 2374.

bands placed transversely on the glass plate forming the stage, spaced so that the two outer ones rest on top of the uprights and the two inner ones will just take an ordinary 3 in. by 1 in. slip, will be found convenient, as by this means the stage and the slip are prevented from moving when pressure is brought to bear on them.

Fig. 37.

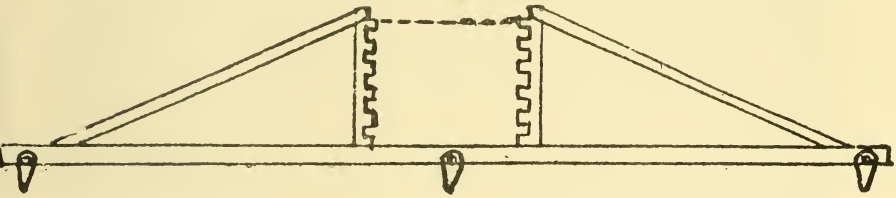
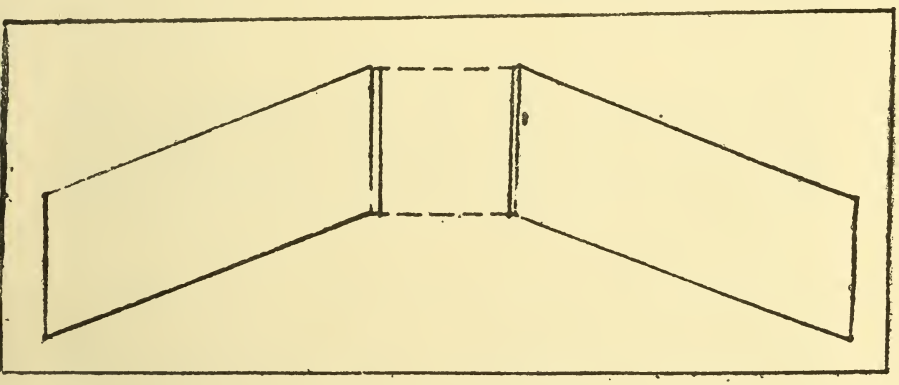


Fig. 38.



For opaque objects the opal glass with elastic bands to take the slip should be used, and the light taken either directly from the lamp or focused by an engraver's globe.

For dissecting under water or other fluid, a square white earthenware trough fitted to one of the grooves should be used; this can be slid in at various heights to suit the object.

When dealing with balsam or other media requiring heat, a brass plate 10 in. long, with a narrow brass tongue 9 in. long, fixed by a nut and screw to the under side of the plate, should be used as a hot stage. The degree of heat can be regulated to a nicety according to the distance from the stage at which the spirit-lamp or Bunsen burner under the brass tongue is placed. The heat is best taken with the tongue at right angles to the plate, as the burner is well out of the way in this position. The tongue folds back under the plate when not in use.

All forms of stages can be fixed securely in the grooves by small oak wedges, and the dissecting trough can also be secured by cork wedges.

Any ordinary lens-holder can be used, but a small rack and pinion,

placed at the back left-hand side of the stage, with jointed brass arm and ring to carry the lens, is the most convenient. For all ordinary work Zeiss's aplanatic lenses × 6 or × 10 are the most useful.

The simple stand can be inexpensively made by an ordinary carpenter or amateur, and many other conveniences and facilities for all kinds of dissecting and mounting work are added in the form exhibited. Such are, small brass tongues on ordinary brass screws turning down and projecting below the front of base-board to prevent the pressure on the stand, when working, from moving it towards the back of the working table. Drawers are fitted below the base-board to hold slips, covers, tools, &c.; small flat boxes with glass lids to hold mounted needles, bristles, brushes, feathers, &c.; spring clips on back to hold pipettes, &c., &c.

The method of fitting and using the hedgehog hairs and bristles, and small pinion feathers of teal, snipe, woodcock, &c., is as follows:—A small cap of quill point is loosely fitted to a pointed handle, the bristle or feather is passed up as far as required and the handle pressed up into the quill; the lower end of the quill may be whipped with waxed silk, to prevent splitting."

(6) Miscellaneous.

Millon's Reagent.*—Mr. S. Le M. Moore recommends, as a better way of making Millon's reagent than the one usually employed, the addition of a saturated solution of mercurous nitrate to an equal quantity of mercuric nitrate as ordinarily sold. No unpleasant smell is caused in the process, and the reagent can be made in any quantity as required.

Forensic Microscopy.†—Dr. L. A. Harding writes:—"Forensic microscopy, like forensic medicine, has a close connection to law; it also deals with cases which are closely interwoven with the administration of justice, and with questions that involve the civil rights and social duties of individuals, the detection of poisons as well as the treatments for the recovery of poison from the poisoned. More and more in the history of the criminal courts is the demand occasioned for the application of the Microscope, and microscopical toxicology . . . If we measure the future by the work and benefits the Microscope has done in the past, it will be seen that a very bright prospect is awaiting us indeed. No instrument yet devised by the ingenuity of man can compare with the Microscope in its universal application to research, and I will endeavour in a brief way to call attention to a few of its special relations to law.

The direct application of the Microscope to law dates back to about 1835, and ever since that time it has made a record for itself in convicting the guilty and protecting the innocent . . . . In the early age of forensic microscopy, its application was simply confined to a few questions of criminal law; but the more it attained perfectness in lenses, the excellent means of determining minute measurements, the adoption of the spectroscope and numerous valuable mechanical appliances, it has claimed so much attention in civil and criminal law that its usefulness cannot be denied. Although the Microscope has played a very important

* Journ. of Bot., xxxi. (1893) p. 51. † Science, xx (1892) pp. 242–3.

part for a number of years in noted criminal and civil cases, its proper relation to law seems to be little understoood. It is true that many underrate its value, and throw aside all testimony attained through its use as worthless, while others again largely overrate its powers . . . . When persons expert in the use of the Microscope are called upon to give testimony, there ought not to be any disagreement as to the result of the examination they may make; as, for instance, if they examine a stain, and blood-corpuscles are found by one, it should be verified by the other; and if measurements of these corpuscles are made, their measures should correspond without a doubt. There should be no difference on such matters of fact, though this is not meant to imply that they should not honestly differ as to how the blood came there. The Microscope will tell with true and unerring certainty whether the adhering substance on a weapon is human or animal hair, or whether what is thought to be hair is not cotton, silk, or wool fibre. It is a well-known fact that portions of brain-substance adhering to weapons which have caused the fracture of the skull and laceration of the brain can only be recognized by the Microscope . . . . In chemistry and toxicology the Microscope is a very important factor for the identification and verification of many ordinary tests, which are made to determine the composition of solids and liquids. Not many years ago, death from poison was surrounded by dread and fear scarcely comprehensible at the present day. Tradition informs us that persons suspected of having committed murder by poisoning were broiled alive in England, and in France burned at the stake, and in the various other countries tortured in the most inhuman manner. It is now, however, generally conceded that, with modern methods introduced for the detection of poison, the fear of discovery has been rendered greater than the dread of punishment. The greatest advance in legal chemistry was through the achievements of Bunsen and others; quantities so minute as to be out of reach of all other known methods of analysis, we are enabled to identify with unerring certainty. Many poisons, such as strychnine, arsenic, morphine, &c., will crystallize with certain reagents into characteristic forms, which are pecular to themselves.

Of late considerable attention has been paid to the microscopical examination of handwritings. While, perhaps, the Microscope cannot be considered an aid in forming an opinion as to the real author of a given specimen, yet its value for the detection of alteration and changes made in the original cannot be underrated. It is impossible to make an erasure of any written or printed lines and hide them from detection by the Microscope; the most skilful forger cannot restore the slighest derangement of the fibres on the finished surface of the paper.

Equipped with the modern improvements and possessing the requisite skill, the progressive microscopist may be said to be a true friend of the curious, in the full meaning of this expression. It is true that sometimes our most exhaustive means of industry and research are only rewarded by negative results; yet it cannot be denied that in the majority of cases we reap the reward of diligence and industry by seeing our work change the whole theory of a plea in civil and criminal actions, becoming a terror to the guilty and joy to the innocent."

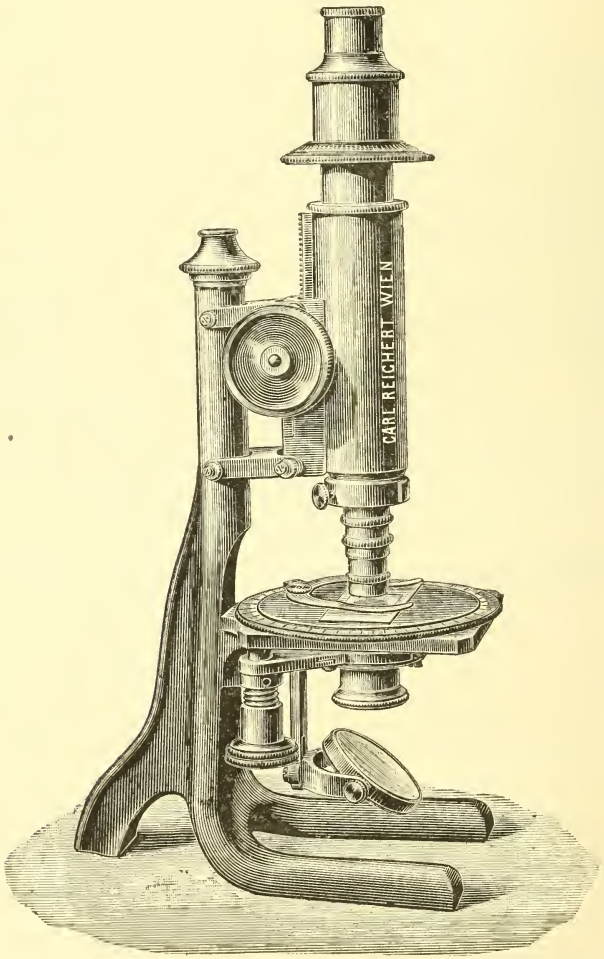
MICROSCOPY.

a. Instruments, Accessories, &c.*

(1) Stands.

Reichert Microscope.—The model No. VII. *b*, shown in fig. 39, is provided with coarse-adjustment by rack and pinion, and fine by micrometer screw. The large circular movable stage is divided into 360°.

Fig. 39.



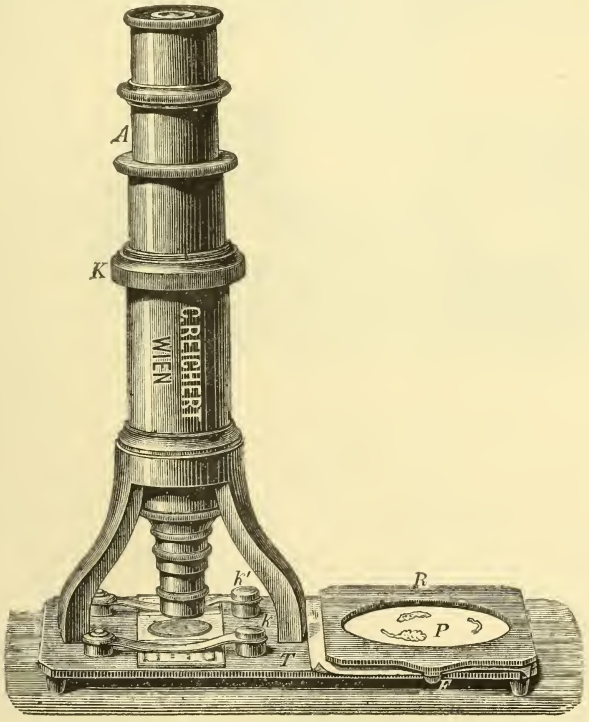
* This subdivision contains (1) Stands; (2) Eye-pieces and Objectives; (3) Illuminating and other Apparatus; (4) Photomicrography; (5) Microscopical Optics and Manipulation; (6) Miscellaneous.

In the polarizing apparatus of large field of view, both nicols can be easily rotated, while the under one is attached to a side arm, so that the conversion from polarized to ordinary light can be rapidly effected.

The instrument is also provided with centering apparatus for the objective, Bertrand's condenser, and mirror, plane and concave, which is adjustable in height and on both sides.

Reichert Hand-Microscope.—This model, represented in half its natural size in fig. 40, is intended for lecture and school work, &c. The focal adjustment is effected by sliding in a socket. The stage projects

Fig 40.



to one side, where it is provided with a frame under which there can be clamped a piece of paper, on which the structures observed in the Microscope can be drawn.

(3) Illuminating and other Apparatus.

Reichert's Illuminating Apparatus.—This apparatus, represented in figs. 41 and 42 as arranged for all modifications of direct and oblique light, consists of:—(1) A condensing system of great intensity with aperture of 1·20 or 1·40; (2) a diaphragm-holder with iris-diaphragm,

together with an arrangement for raising and lowering; (3) a cylinder diaphragm.

Fig. 41.

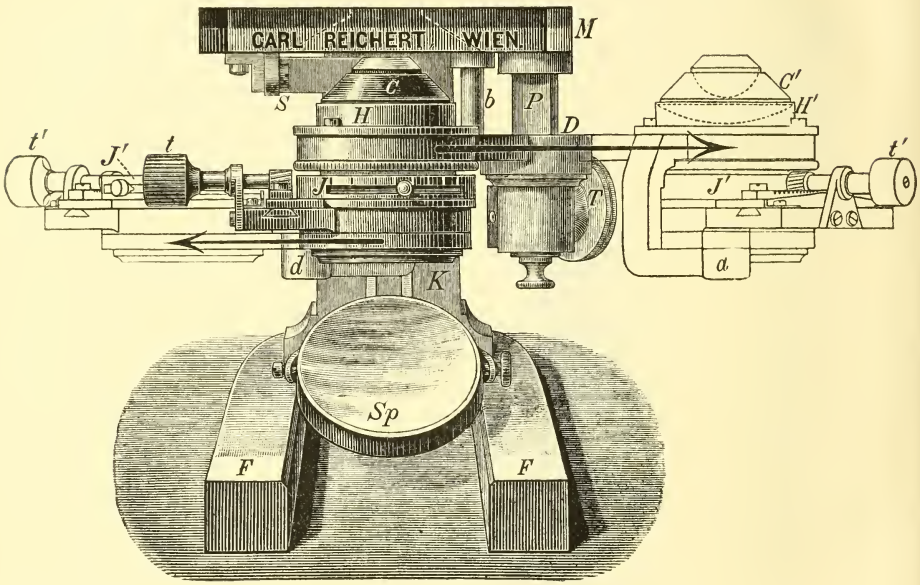
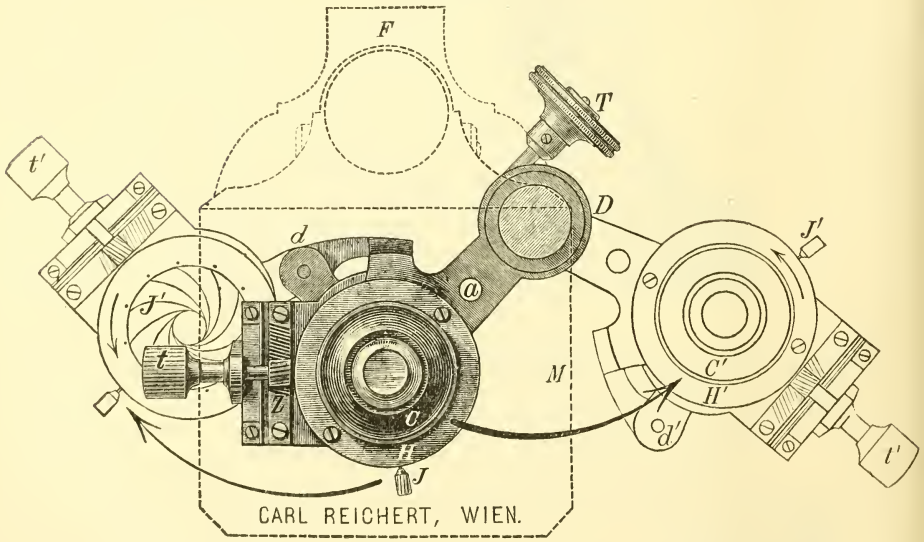


Fig. 42.



To ensure a constant centering of the apparatus, it is made of a single massive piece, in the socket of which fits either the condenser

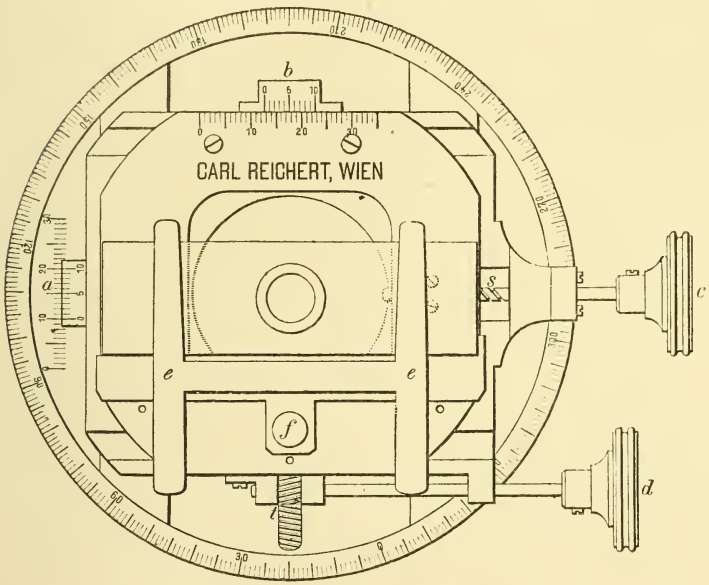
or the cylinder diaphragm. The iris diaphragm which is attached to the same piece gives an aperture of from 1 to 32 mm.

The central illumination is marked by the snapping of a spring. Oblique illumination is effected by turning the screw-head *t'*. The whole illuminating apparatus is attached to the prism P in such a way that it can be easily raised and lowered by means of the screw-head T, while the pin *b* serves as a guide for the exact centering

For the introduction of blue glass, polarizer, &c., the iris diaphragm holder can be separated from the condenser and displaced from its central position to one side in the direction of the arrow *t'*.

Reichert Movable Object-stage.—The latest form of this stage is represented in two-thirds its natural size in fig. 43. The screw-head and pinion by means of which the displacement of the objects in two

Fig. 43.



rectangular directions is effected are placed side by side. Both slides are provided with scales and verniers, and the circumference of the stage with a divided circle.

For the reception of culture-plates the object-holder *e e* can be removed by raising the screw *f*.

This stage is only used on Reichert stands No. 1 *a* and 1 *b*.

Optical Projection.*—Sir David Salomons, in a lecture before the Royal Institution, gave a general survey of the subject of Optical Projection. The apparatus employed was a modified form of that of Mr. Lewis Wright, and was constructed by Messrs. Newton, of Fleet

* Proc. Roy. Inst., xiii. (1893) pp. 534–9.

Street. Instead of the usual lime-light an arc-lamp was the means of illumination, and many difficulties in the use of this light had to be overcome.

Very high magnifications were not attempted, as the projection method is not adapted to give good results under these conditions.

When projecting with an objective alone, this has to be brought very close to the slide, with high powers closer than the cover-glass will allow. In this case special substage condensers are necessary. This difficulty is more especially felt when the arc-light is employed instead of the lime-light. It can be surmounted either by the introduction of plano-concave lenses on the screen side, which have the effect of giving a greater working distance, or preferably by using an eye-piece.

In the eye-piece method adopted by the author almost the exact conditions can be complied with for which the objective was made.

Owing to the field not being flat, all parts of the objects cannot be brought into focus at once, but only successively by slightly shifting the focusing screw. It is only with very considerable depth of focus that for projection work over-correction for flatness can give a sharp picture, since without great care certain forms of distortion will be introduced. By stopping down the objective greater flatness may be secured, but only at the expense of light.

The author exhibited various microscopic objects by projection under different magnifications. The screen distance was 21 ft. The lenses and magnifications employed were as follows:—

First, a 35-mm. Zeiss projection objective, 4-in. substage condenser, Zeiss Huyghens eye-piece 2; 500 diameters = 250,000 times = penny stamp stretched to cover about 147 square yards.

Second, a 1-in. Newton's projection objective, 4-in. substage condenser, Zeiss Huyghens eye-piece 2; 1000 diameters = 1,000,000 times = stamp stretched to about 588 square yards.

Third, 1-in. Newton's projection objective, 4-in. substage condenser, Zeiss Huyghens eye-piece 3; 1300 diameters = 1,690,000 times = stamp stretched to about one-fifth of an acre.

Fourth, 1/4-in. Zeiss's achromatic objective, Abbe's 3-lens substage condenser, with top lens removed, Zeiss Huyghens eye-piece 3; 4500 diameters = 20,250,000 times = stamp extended to nearly $2\frac{1}{2}$ acres.

With the polariscope various objects, such as glass in a condition of strain, Rupert's drops (broken in the field), and mineral sections, were exhibited, both in parallel and convergent light.

With the solidiscope, a new form of apparatus for exhibiting solids, and consisting of two reflecting prisms and suitable projecting lenses, were shown Barton's button, the works of a watch, and a coin.

A spectrum was projected upon the screen by a new method which, by means of a carbon disulphide prism combined with a reflecting prism or with a mirror, gives practically a direct spectrum without the necessity of turning the lantern.

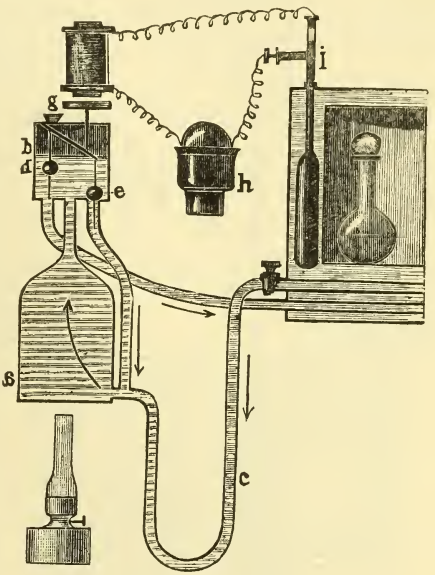
Electrical Thermostat.*—Mr. W. P. Kurtschinski has devised a thermostat with an electric regulator and heated by a mineral oil lamp.

* Wratsch, 1892, p. 744. See Zeitschr. f. wiss. Mikr., ix. (1893) pp. 473-4 (1 fig.)

The apparatus works in the following way:—The water in the reservoir *a* is heated by a mineral oil lamp. The current of hot water rises through the middle pipe to the upper compartment of the reservoir and passes down into the thermostat through the pipe on the left, and returns by the pipe *c*.

On reference to the illustration it will be seen that when the ball *d* sinks the ball *e* rises and the hot current will be diverted into the pipe *c*, and the stream pass in the contrary direction back again into the reservoir *a*. In this way the equilibrium of the water-heat in the thermostat is maintained.

Fig. 44.



The automatic rise and fall of the balls is brought about by the attraction and repulsion of the armature *g* by an electro-magnet while the opening and closing of the electric current (*h* is a Meidinger's element) to the magnet is effected by the rise and fall of the mercury in the regulator *i*. The latter is an ordinary Reichert's regulator without the upper funnel. One end of the conducting wire is connected with the upper end of the regulator, the other with the side branch. When the water gets too hot the mercury rises and touches the upper wire and so closes the circuit. The armature *g* is attracted and the ball *e* drawn up, while *d* sinks down and thus the hot water ceases to pass into the thermostat. When the water cools the mercury sinks and the current is broken, the balls assume their former position and hot water again passes into the thermostat. The author is extremely satisfied with the working of the apparatus.

Heydenreich's Regulator and Remarks on Thermostats.* — Dr. L. Heydenreich describes a modification of Altmann's thermo-regulator † which he has used for some time and has found to be very sensitive.

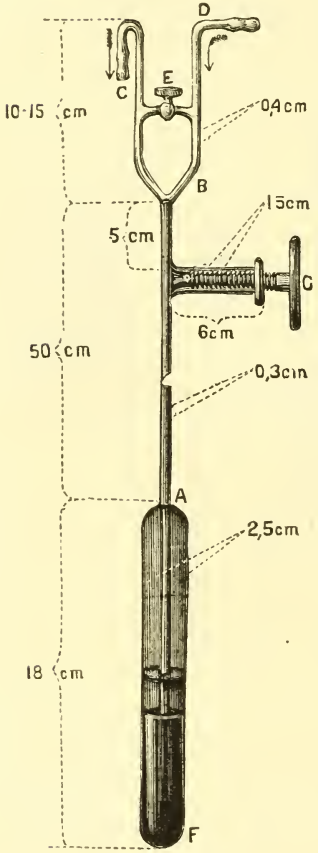
The reservoir A F contains mercury above which is a layer of ether. When the temperature of the water mantle becomes too great the ether vapour presses on the mercury and the latter rises in the tube F A B until it reaches the bifurcation, when it prevents the gas from passing along in the direction D B C, permitting only a small stream to flow through E, a stream just sufficient to keep the burners alight. To ensure more perfect accuracy of regulation the wall of the reservoir should

* Zeitschr. f. wiss. Mikr., ix. (1893) pp. 300–6 (2 figs.).

† This Journal, 1891, p. 651.

be as thin as possible (not too thin as it has to stand the pressure of about 5/6 atmosphere), that of the tube F A B should be thick and the tap E should be nearer D than B. This arrangement aids first of all in preventing the extinction of the flame when the thermostat gets too hot and also saves the apparatus from getting damaged from the action of the mercury on the metal if, as is sometimes the case, it rises above the level of E. Owing to the sensitiveness of the apparatus it is necessary to have the lateral regulating tube G fairly broad, otherwise it would be necessary either to let out or put in mercury for different temperatures.

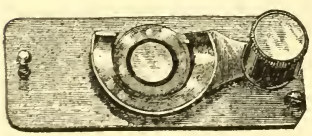
Fig. 45.



The author then goes on to point out that notwithstanding a thermo-regulator may be extremely sensitive yet there are two principal causes which prevent the temperature of a thermostat from being constant. These are the irregular heating of the bottom, and the difference in the heat of the water mantle owing to imperfect mixture of the currents. To obviate these inconveniences as far as possible it is necessary that all the burners should act simultaneously and in concert with the regulator; secondly, that the heating of the bottom should be distributed evenly over the whole surface by the interposition of wire gauze; and thirdly, that the thermostat should be covered over with a protective such as asbestos. The bottom should be somewhat conical as the heat is better distributed by this formation than when flat.

Rousselet's New Compressorium.—This compressor has been devised for the purpose of facilitating the examination of minute living and free-swimming animals, such as rotifers, infusoria, &c. The accompanying woodcut renders a detailed description unnecessary. The advantages claimed for it are the following :—

Fig. 46.



The glass tablet being fixed flush with the lower part of the brass slide, which is slightly countersunk, allows high-angled condensers to be used to the very edge of the tablet for the illumination of the objects.

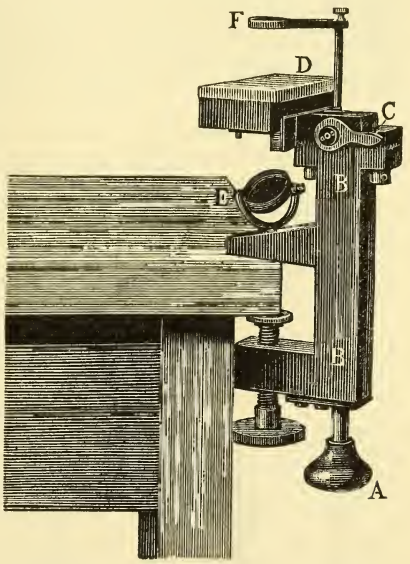
The arm carrying the cover-glass is raised and lowered by screw adjustment, and is held in position by a spring catch, but can easily be

turned aside. The arm moves parallel to the glass tablet, so that very small free-swimming animals can readily be caught and held fast between the two glasses. The thin cover-glass is cut off at the top, thus allowing reagents to be added to the drop of water while the animals are under examination ; it is much larger than the glass tablet and therefore allows the highest powers to be used all over the field and to the very edges of the glass tablet, which is of great importance in practical work. In nearly all other compressors the central part of the field can alone be reached with high powers. Messrs. Baker are the makers.

Air-pump for Microscopical Purposes.*—Dr. A. Koch describes an air-pump which has been used for many years at Göttingen, for removing air from microscopical preparations.

The apparatus consists of a vertical upright B B clamped on to the edge of the table. The upright is drilled out, and through the cylindrical passage runs a piston at the lower end of which is the handle A. The hollow in B B is in communication with the cavity of a rectangular box D, closed by a glass plate, and having cavity only just big enough to admit a slide. The lever C, when placed vertically, closes the communication between D and B B and opens another aperture which places B B in communication with the air. When placed horizontally the air space of D and the hollow of B B are connected. Then by putting down the handle A the air in the space D becomes rarefied and the bubbles are drawn out from underneath the cover-glass, as may be seen by means of the lens F and the mirror E. By alternately placing the lever C in the horizontal and vertical position and pulling down and pushing up the piston the preparation may be completely freed from air.

Fig. 47.



(4) Photomicrography.

Photography of Gratings and Micrometers engraved on Glass.†—M. Izarn, struck with the fineness with which the most delicate details of a plate on glass can be photographically reproduced, has made experiments on the photography of gratings and micrometers engraved on glass, and obtained reproductions so perfect that it is impossible at first sight to distinguish between copy and original. Twenty years ago Lord Rayleigh ‡ made experiments in the same direction, but abandoned

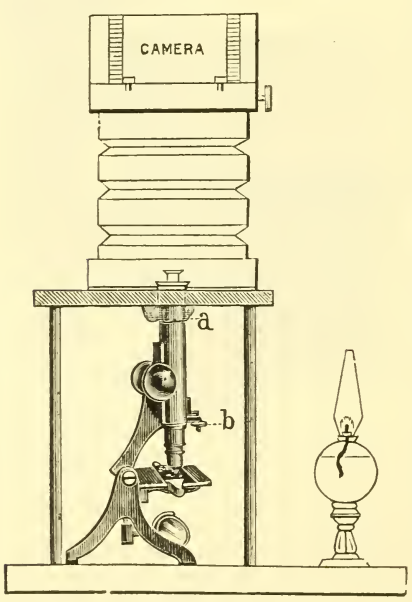
* Zeitschr. f. wiss. Mikr., ix. (1893) pp. 298-9 (1 fig.).
† Comptes Rendus, cxvi. (1893) pp. 506-8. ‡ Phil. Mag., 1872 and 1874.

them owing to the variability of the results obtained. He was also unable to produce a good *copie de copie*. The author, however, has succeeded in obtaining some which could scarcely be distinguished from the original model, and believes that it would be possible to push the reproduction still farther.

These successful results were obtained by means of the gelatin bichromate process. This photocollographic method also allows of successive gratings, placed in any position, being impressed upon the same plate of glass, for each proof can be treated as the original plate, and covered with a new layer of gelatin, and so on.

The technique of the process is simple. Solution of gelatin in the proportion of 1 gr. to 30 grs. of water, with addition of 0·10 gr. to 0·15 gr. of bichromate of ammonia, is liquefied over the water-bath and filtered through cotton-wool on to a plate of glass, which is then set up vertically and allowed to dry in the dark. The shutter in which the plate is exposed should be furnished with a chimney of stout black paper terminated by a cover which only admits the solar rays when the apparatus has been disposed in such a way that they fall perpendicularly upon the grating. With a good sun, the duration of exposure is from six to ten seconds. In diffused light, one to two hours may be required, but in this case the result is less satisfactory. After the exposure the plate is plunged into tepid water, then rinsed with cold distilled water, and, if necessary, brushed very lightly. It is well to protect with black paper all the part of the grating which is not engraved. To obtain a grating by reflection it is only necessary to substitute for the simple glass plate, a plate which has been previously silvered.

Fig. 48.



Camera for Microphotography.*—Mr. D. W. Barker gives the following description of his "home-made" apparatus (fig. 48). A wooden table is made somewhat wider around its top than the front of the camera, and contains near the centre an aperture through which the Microscope tube can project slightly. After removing the lens from the camera, place the latter on the table with its front downward. Place the Microscope underneath and close the aperture to rays of light by means of the small silk sleeve *a*. A good lamp is to be used for illuminating. Focus roughly by hand, and

* Amer. Mon. Micr. Journ., xiii. (1892) p. 39.

then finely on to the ground glass of the camera by means of the fine-adjustment screw *b*. Use a large diaphragm on the Microscope base. Expose in the ordinary way. A little practice will soon show the right exposure to be given, always using the same lamp. A small beading round the top of the table holds the camera firmly.

(5) Microscopical Optics and Manipulation.

Determination of "Optical Tube-length." *—The following paper on this subject was read by Mr. A. Ashe before a recent meeting of the Quekett Microscopical Club:—

"This is one of those practical matters the investigation of which many microscopists postpone indefinitely, and generally end by neglecting entirely, under the mistaken impression that its solution is involved in much difficulty, requiring an advanced knowledge of the laws of optics and a large amount of manipulative dexterity in order to arrive at a satisfactory result, and that even if a correct measurement can be made, the information so obtained is of no real value to the worker. The fallacy, however, of this latter view is so obvious, that it needs no refutation to any one who has taken the trouble to estimate the magnifying power of his own instrument.

To those who are content to accept the figures given in an optician's list as to the amplification of their various lenses, the following quotation from Mr. Crisp's well-known article † may carry some weight:—

'Microscopists have always recognized that the length of the tube of a Microscope is a factor in determining the amplification of the image, that the amplification is generally greater with a 10-in. tube than with one of 6 in., and that we obtain an increase of power by pulling out the draw-tube. Here, however, all exact notions as to the functions of the tube-length have practically stopped, so much so that there has not been any agreement even as to how the length of the tube is to be measured, whether from the front or back lens of the objective to the field-lens, the diaphragm, or the eye-lens of the eye-piece.'

Since these lines were written, now some eight years ago, it has come to be very generally admitted that the optical tube-length must be measured from the posterior principal focal plane of the objective to the anterior principal focal plane of the ocular.

But the question obviously arises, where are these focal planes situated, how are their positions to be located, and the distance between them estimated?

The desire for information on these points will certainly not be rewarded by any light the average microscopical textbook may throw on the subject, for, whilst laying stress upon the relationship existing between tube-length and amplification, they generally leave the reader very much to his own resources as to the methods employed in solving the former part of the problem.

A recent article in the Journal of the Royal Microscopical Society (1892, pp. 545, 546) on this subject is very interesting, but unfortunately the method suggested, whilst perfectly accurate and

* Journ. Quekett Micr. Club, v. (1893) pp. 152-4.

† This Journal, 1883, pp. 816-20.

thoroughly scientific, incontrovertible in its theory and capable of giving most excellent results in the hands of an expert, is yet, from its very nature, far too complicated in the details of its manipulation and abstruse in its mathematical principles to meet the requirements of the average worker, whose possession of apparatus is seldom of such an extent as to warrant his undertaking an optical research of no small magnitude, and who frequently hesitates to trust his conclusions to figures obtained by the exercise of a long-forgotten skill in the solution of algebraic equations.

Under these circumstances I beg to call your attention to a simple method of estimating the tube-length which will not involve the use of difficult formulæ or any apparatus beyond an ordinary stage micrometer.

It is based upon the increase in power obtained by extending the draw-tube through some measured distance, and is carried out thus:—

A careful estimate is made of the power of the Microscope with the draw-tube pushed home as far as it will go, then, having determined this, the eye-piece is withdrawn three or four inches, the exact amount being noted, and the increased power of the instrument remeasured.

We are now in possession of all the data necessary to calculate, not the actual optical tube-length, but its arithmetical equivalent, a distinction to be observed, though the difference is immaterial to the purpose in view.

As it is a rule in optics that the relative sizes of images formed by a lens at different points in its axis are in strict proportion to the distance of those points from the focus of the lens, we may arrange the following formula:—

$$\frac{A\,B}{C} = D$$

Where A = amplification of the instrument with the tube closed, where B = distance the ocular has been withdrawn, where C = increase in power produced by the effect of B. D is, therefore, the equivalent of the distance separating the focus of the objective from the anterior focal plane of the ocular.

To illustrate this simply, suppose an instrument magnifies 100 times, and that on withdrawing the eye-piece 3 in. the power is found to be increased 130 times, the equivalent of the tube-length will be by the above rule 10 in.

That it can be nothing else can be shown by the old Euclidean process of assuming it to be something else, and ascertaining how far this hypothesis agrees with observation, which of course, will end in a *reductio ad absurdum.*

The chief drawback of this proposed method is that it does not enable the worker to place his finger on any point on the tube and say with certainty, "Here lies the posterior focus of the objective and there the anterior focus of the ocular," but it faithfully gives us a figure which is the equivalent of the distance separating these two points, and this, after all, is the only concern of practical import.

In conclusion, I may point out that there is frequently an extraordinary discrepancy between the true optical and the actual mechanical tube lengths; thus in the case of an instrument in my possession a certain combination of lenses gave an optical tube-length of $4\frac{1}{2}$ in., whilst the

substitution of another objective in a much shorter mount increased the tube-length from $4\frac{1}{2}$ to $7\frac{1}{4}$ in., which, if not allowed for, would introduce errors amounting to 60 per cent. in the calculated powers.

Perhaps this may be considered an extreme case, but it serves to emphasize the importance to the microscopist of knowing something more about the optical length of his instrument tube than can be ascertained by comparing its outside dimensions with a foot rule."

(6) Miscellaneous.

Microscopy at the World's Fair.*—Mr. H. L. Tolman chose this subject for an address to the Microscopical Section of the Chicago Academy of Sciences. He said:—

"About eighteen months ago the Illinois State Microscopical Society decided to make a representation at the coming Columbian Exposition, and appointed a committee of three, consisting of Dr. L. D. McIntosh, Mr. C. O. Boring, and myself, to solicit exhibits. On the death of Dr. McIntosh Mr. W. H. Summers was appointed in his place. The design of the Society was to take the requisite space at the World's Fair and then ask all the Microscope makers in Europe and the United States to make a display of their productions, and also, if possible, to get exhibits of mounted slides, &c., from various workers in different departments of science. I spent last summer in Europe, and as chairman of this committee, and also as member of a similar committee appointed by the American Microscopical Society, I visited all the leading European Microscope makers, with one or two exceptions, and was very much pleased to see the interest they took in the matter. Several said they would rather make an exhibit in such a scientific display than in the commercial department, and it is probable that nearly all will be represented. In fact, it is safe to say that the exhibit of modern instruments and accessories will be the most extensive that has ever been made at any world's fair.

In regard to a display of old instruments, unfortunately nothing could be accomplished. There are only three large private collections of Microscopes in Europe. By far the largest and finest, not only in England, but in the world, is that of Mr. Frank Crisp, a prominent and wealthy London solicitor. It contains over 2000 Microscopes, besides a very large number of substage attachments, condensers, micro-spectroscopes, live-cages, mechanical stages, polariscopes, objectives and other accessories, which give an accurate history of the Microscope and its development. An evening spent with Mr. Crisp and his collection is one long to be remembered. Many of these instruments are very fragile and complex, not a few are unique, and it would be impossible, without great time and expense, to box and ship them anywhere. Some, on account of their fragility and complexity, could not be transported at all, and hence Mr. Crisp said he felt compelled to decline even to attempt to send his collection to Chicago.

The next largest collection is that of Mr. Nachet, the well-known Paris Microscope maker, and it also contains some beautiful and rare instruments. Among others he has a unique specimen of the first known

* Amer. Mon. Micr. Journ., xiv. (1893) pp. 15–6.

binocular telescope, and an unexampled collection of simple Microscopes in gold or silver engraved cases. Dr. H. Van Heurck, of Brussels, one of the most able and enthusiastic microscopists living, has also a fine selection of old instruments; but both of them, like Mr. Crisp, were unwilling to allow their treasures to be subjected to the dangers of a long journey. The Society will therefore be compelled to fall back on the collection in the Army Medical Museum at Washington, which, it is hoped, the Government authorities will bring here for exhibition.

The exhibit of the Society ought to be of a good deal of interest, for in some senses it may be said that microscopy has reached its acme. Prof. Abbe says that it is not probable that any glass will be discovered of higher refractive index than that known, and without that it is not possible to construct lenses of much higher power or angle than at present. Our present objectives, then, are nearly perfected, unless future investigations show our theory of light to be erroneous. In regard to Microscope stands, there are a large number of forms for different purposes, many very attractive. Klönne and Müller, of Berlin, manufacture one of the Zeiss form wholly of aluminium, except the foot. Those who will exhibit, so far as they have already consented, are Baker, Swift, Crouch, Beck and Beck, and Powell of London, Klönne and Müller of Berlin, Zeiss of Jena, Hartnack of Potsdam, Reichert of Vienna, and probably Nachet of Paris and Leitz of Wetzlar.

One of the pleasant features of the exhibit will be that, by express permission of the manufacturers, the Committee of the Society will be allowed to show the various stands and objectives at the meeting of the Society or at such times and places as may be agreed on, so that all microscopists will have an opportunity of seeing the best foreign work, and comparing it with that done in this country. The domestic manufacturers will not be behind in their display, and they have already taken the necessary steps to be seen. Dr. E. Cutter, of New York City, has consented to allow his famous Tolles 1/75 to be exhibited. The space assigned to the Society by Prof. Peabody, the chief of the department of Liberal Arts, is in the south gallery of the Liberal Arts Building, next to the astronomical and photographic exhibits, and close to the commercial displays of Bausch and Lomb, Queen and Co., Zeiss and others, and is in a very advantageous part of the building."

β. Technique.*

(1) Collecting Objects, including Culture Processes.

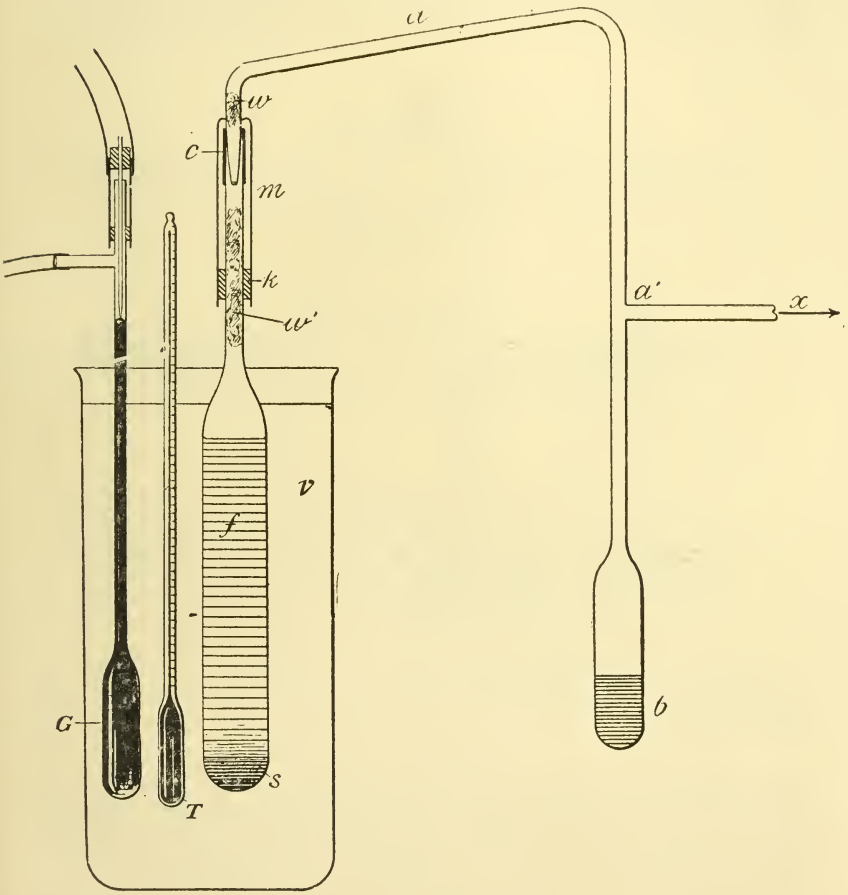
Apparatus for Cultures in Vacuo.†—In the course of his researches on the ginger-beer plant Prof. H. M. Ward found it necessary to cultivate in vacuo, and with the aid of Prof. McLeod devised the following apparatus:—*a a'*, glass tubing attached to mercury pump beyond *x*; *b*, bulb for condensed vapour; *w* and *w'*, cotton-wool plugs, the former in *a*,

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

† Phil. Trans., vol. 183 (1892) pp. 125-97; figs. 49-51 by permission of the Royal Society.

the latter in the neck of the cultivation flask *f* which contains the medium and growing culture *s*; *c*, caoutchouc tubing connecting the tubes *a* and *f*; *k*, cork ring, and *m*, a glass tube filled with mercury so as to make a gas-tight junction over *c*; *v* is a glass beaker containing water; this is placed over a small burner in connection with the gas regulator G; T, thermometer. The various pieces of the apparatus having been carefully

FIG. 49.



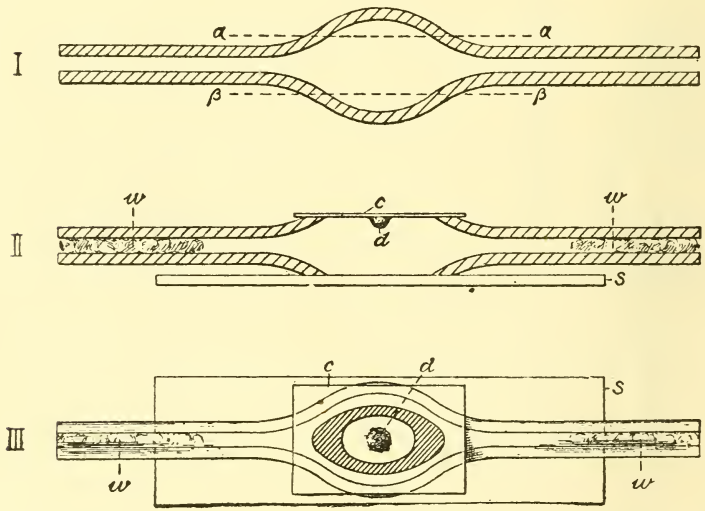
sterilized the tube *f* is filled with the cultivation medium, the neck plugged with cotton-wool and the whole kept at 80–90° C. for several hours on at least three successive days. The medium is then infected and the whole apparatus connected up. The air is exhausted by means of the mercury pump and the gas developed by the culture removed from time to time. This is absorbed at once by potassic hydrate.

The defect of the apparatus appears to be that the medium must alter in composition from the constant and gradual loss of fluid by evaporation, though in other respects its working seems favourable.

Glass Culture-chamber for Hanging Drops.*—In his researches on the ginger-beer plant, Prof. H. M. Ward used the following simple form of apparatus for cultivating organisms in hanging drops and in various gases under the Microscope.

The chamber itself is made out of a piece of stout glass tube about 3 inches long and as thick as possible; this is drawn out carefully at both ends until it looks like fig. 50, I. The narrow tubes must not be

Fig. 50.



I. Tube ready for grinding, the glass being ground down to the levels $\alpha\,\alpha$, $\beta\,\beta$.
II. Side view of chamber ready for use.
III. View of same from above. *c*, cover-slip; *d*, hanging drop; *w*, cotton-wool plug; *s*, glass slide.

drawn thin, but the glass should be softened and allowed to contract the opening. The incomplete instrument now looks like a narrow tube with a bulb at its middle. The upper and lower faces are now ground parallel until the sides are perforated by circular or oval apertures.

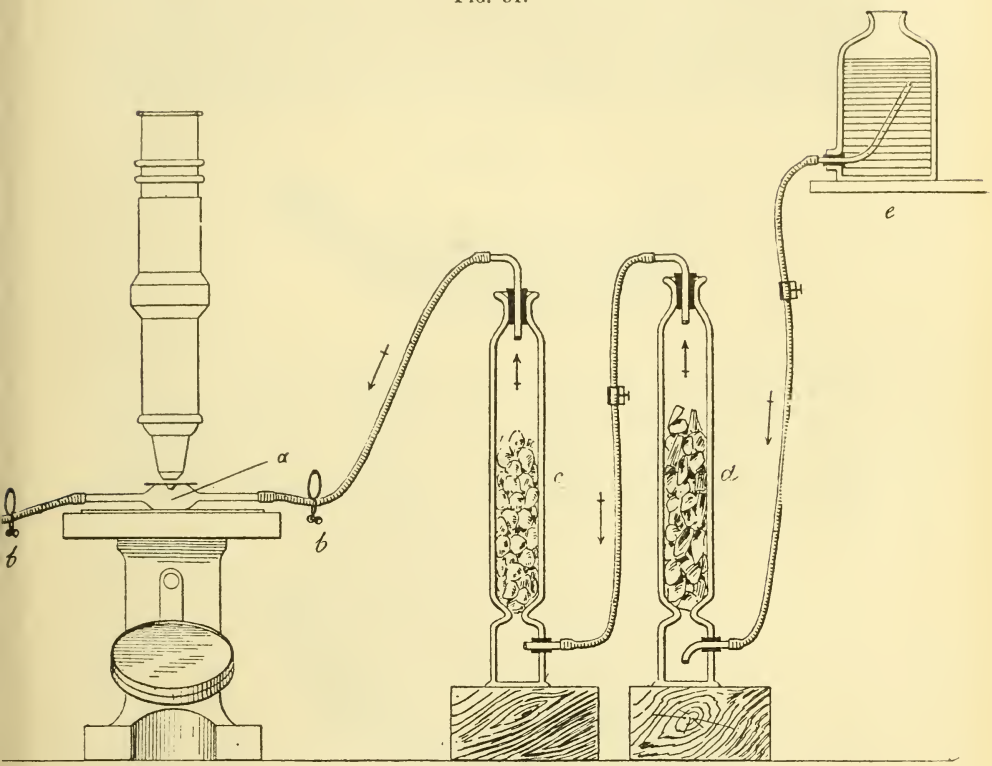
After sterilizing, the lower aperture is closed by fixing its edges with melted paraffin to a sterilized glass slide. The upper aperture is closed with a cover-glass fixed on with freshly boiled oil, and the two end tubes are plugged with sterilized cotton-wool.

The apparatus may be used as it stands for hanging-drop cultivations in air, or, by connecting it with a gas-generator, the cultivation

* Phil. Trans., vol. 183 (1892) pp. 128–97 (5 pls.).

may be carried on in any atmosphere. In fig. 51 is seen the apparatus arranged for cultivations in an atmosphere of CO_2.

Fig. 51.



a, culture chamber, with hanging drop, in position on Microscope stage.

b b, brass clips on caoutchouc tubes attached to plugged tubes of culture chamber.

c, washing apparatus, through which the gas generated in *d* passes before going into culture.

e, vessel containing dilute HCl, for evolving CO_2 from the marble in *d*.

Apparatus for setting Gelatin.*—Dr. L. Heydenreich describes an apparatus which he uses for setting gelatin or agar in flasks or test-tubes just removed from the sterilizer. It consists of a square tin box, 30–40 cm. long, 20 cm. broad, and 20 cm. high. On the broad side are 6 openings, placed one above another, and each with a diameter of about 1 cm. A stream of water is passed into the box, and the water passes out through the lateral openings, any of which may, if necessary, be corked up.

In this way gelatin or agar is rapidly set; large flasks of hot gelatin

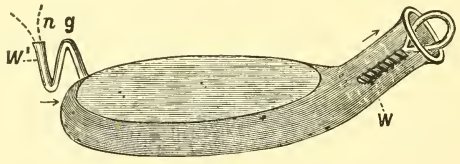
* Zeitschr. f. wiss. Mikr., ix. (1893) pp. 309–11 (1 fig.).

can be consolidated in 15–20 minutes. Care must be taken that the glass is not cracked by using the water too cold at first.

Simple Method for Anaerobic Cultivations.*—Dr. O. Roth has used for some time a glass vessel (fig. 52), having considerable resemblance in shape to a bed-pan, for cultivating micro-organisms anaerobically.

The little tube *g* is N-shaped, and placed laterally, a position which prevents the gelatin from escaping when it is poured in during sterilization. Both openings, W and W′, are plugged with cotton-wool. The

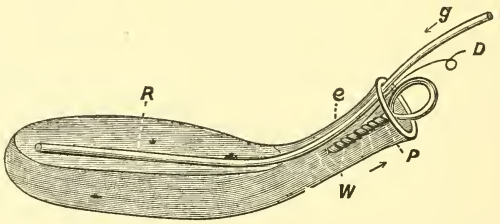
Fig. 52.



former is attached to a wire corkscrew and the latter to a wire loop, so that the plugs can be pushed in or withdrawn with facility.

When the necessary quantity of gelatin (8 cm.) has been poured in, discontinuously sterilized and inoculated, the gas is introduced through the tube *g* and passes out at the neck W. When all the air has been expelled and sufficient gas supplied, the neck is hermetically closed with melted paraffin, and the small tube *g* is similarly treated.

Fig. 53.



For water-examination, the angular entrance-tube *g* is replaced by a curved metal pipe introduced into the flask through the neck (fig. 53). The air is removed after the return to the laboratory. At *e* the pipe is expanded, and just below the swelling is fastened a piece of fine copper wire for the purpose of easily withdrawing the pipe. The gas is introduced through a caoutchouc tube fixed to the free end of R, and when the air has been quite replaced, the neck is plugged with paraffin, the caoutchouc tube being withdrawn while the paraffin is still hot.

For cultivations in fluid media wherein a considerable amount of gas is disengaged, the following plan is suitable.

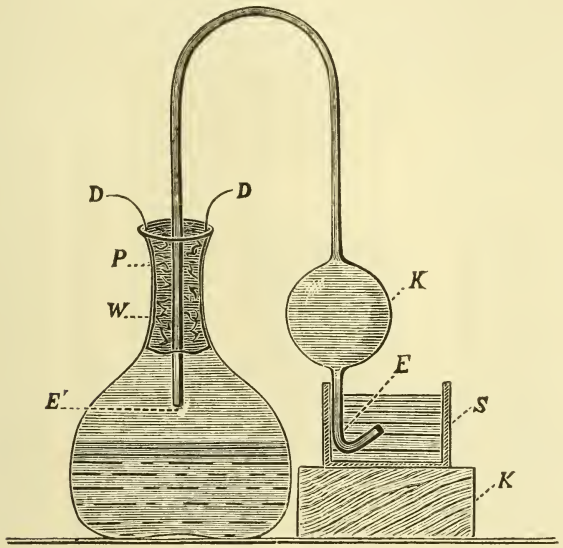
A flask (fig. 54) of any convenient size is stopped with cotton-wool, through the middle of which passes a bent glass tube, near the other end of which is a bulb K, and the extremity is turned up at angle E.

* Centralbl. f. Bakteriol. u. Parasitenk., xiii. (1893) pp. 223–7 (3 figs.).

At present the cotton-wool is only lightly pressed into the neck and now the flask is dry-sterilized. This done, the flask is about half-filled with the liquid medium and then thrice (discontinuously) steam-sterilized.

The medium is next inoculated, and the end E′ of the tube is pushed down until it nearly touches the bottom of the vessel. Hydrogen is then introduced at the E end in the usual manner, and it passes through the medium, to escape through the cotton-wool plug.

Fig. 54.



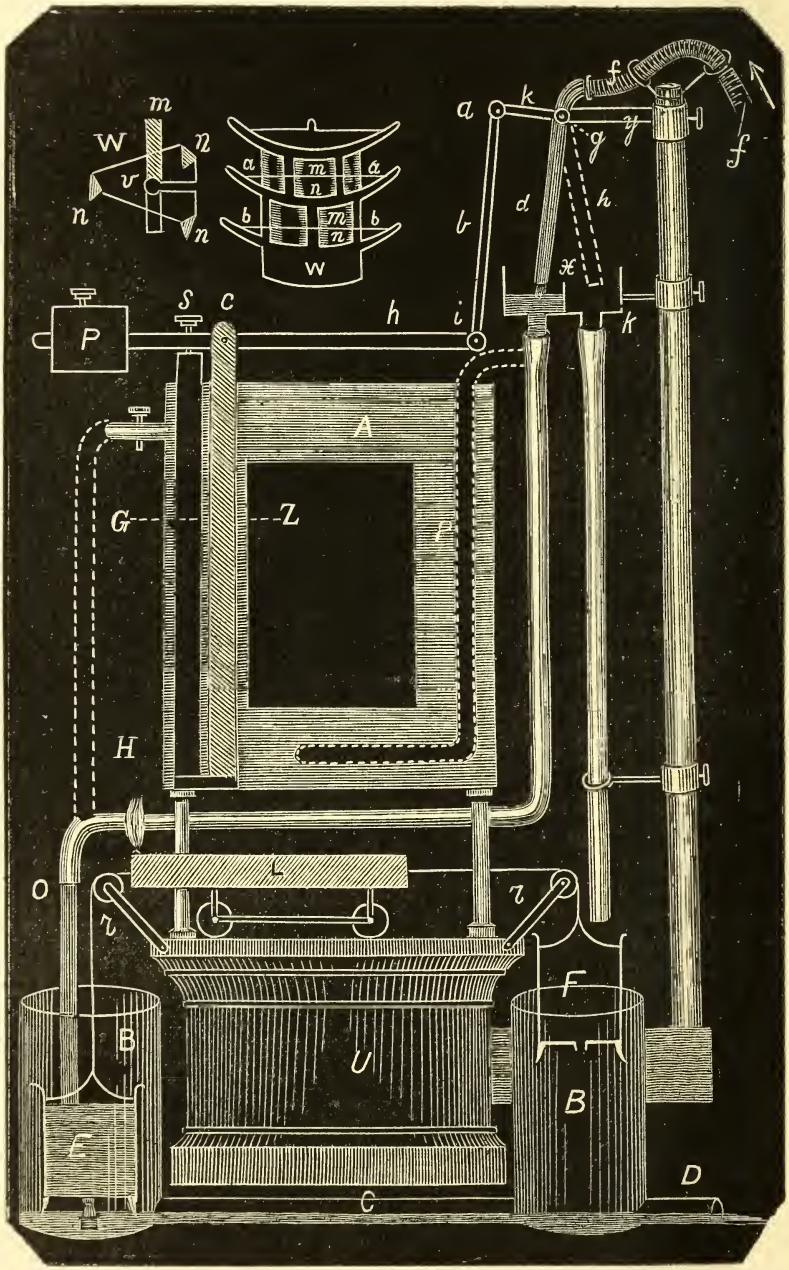
After some time the glass tube E E′ is drawn up to the position indicated in fig. 54, and under the E end is placed a vessel containing glycerin and supported on a wooden block.

When all the air has been driven out of the flask, the neck is filled with paraffin P, and the caoutchouc tube from the gas-generator removed from E. Thus air is prevented from getting into the apparatus by the paraffin at one end and the glycerin at the other. The bulb K is to prevent the glycerin (which is preferable to mercury, as this sometimes damages the copper parts of the incubator) from running up the tube. When necessary, the cotton-wool plug is easily withdrawn by gently heating the neck of the flask.

Self-regulating Constant Incubator.*—Prof. L. Landois describes an incubator, the chief merits of which are that it is quite free from danger, and that it requires for its construction materials such as are to be obtained anywhere. The source of heat is a mineral oil lamp or a specially made stearin candle, so that both gas and electricity are dispensed with (fig. 55).

* Centralbl. f. Bakteriol. u. Parasitenk., xiii. (1893) pp. 256-62 (1 fig.).

FIG. 55.



PROF. LANDOIS' INCUBATOR.

The incubator A is a doubly-walled chest of tin covered with felt, supported on a convenient stand U. The lid, not shown, is also double, and lined with some badly-conducting material. Under the incubator runs a trolly L, which carries the source of heat H. The trolly is made to run to and fro by means of the varying differences in the weight of water in the pails E and F, for when E is full its weight drags the trolly into the position in the illustration, and conversely. Both pails are filled from a stream of water at *o* or *w*, and at the bottom of the pails is a small hole for the water to escape, the outflow stream being, of course, less than the inflow. The result is that as the water cools, the stream ceases to run from *o* and begins to flow in from *w*, the pail F fills and E empties. Hence the trolly is pulled over towards F. The stream of water is regulated in the following manner:—G and Z are two vertical rods—the former of glass, the latter of zinc—joined together at the lower extremity. To the top of Z is connected at *c* the horizontal metal arm *h*, at the end of which is a running counterpoise P. The arm is attached to the glass rod G by the screw *s*, and as the two rods G and Z expand unequally, the zinc rod becoming longer as the heat of the water increases, and *vice versa*, so the metal arm *h* rises or falls. The arm *h* is connected by jointed metal pieces with the water supply, represented in the illustration at *d* and *e*. The position given is where the zinc rod is elongated, the lever has risen, the water stream has been diverted to the pipe *o*, and the heat cut off. When the temperature sinks, the water returns to the position *e*, passing to the pipe *w*. The water stream passes into a box *k* divided by a low partition into two compartments, one of which is in connection with the heating side, the other with the cooling side of the apparatus. B B are receivers connected by a pipe C at the bottom for the overflow to escape at D.

Although the apparatus can be heated with any flat mineral oil lamp placed on the trolly, the author gives the preference to a stearin light, the directions for making which are given, as bought stearin candles are unsatisfactory. The wick fits into a special lighting apparatus made of tin W, and this carries three superimposed pans for catching the melting stearin. The wick is made of reed (*Arundo phragmites*) cut up into pieces 15 cm. long and 1 mm. thick. These pieces, which must be perfectly straight, are boiled in a mixture of equal parts of saturated saltpetre and borax solutions. While still moist they are wound round with three threads of soft, fine, six-strand cotton. Thus prepared, the wicks are again boiled in the solution and afterwards dried in an oven.

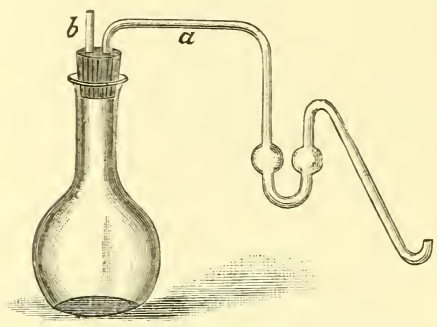
Stoppings and Aerating Arrangements for Pure Cultivations.*—Dr. A. Koch describes an improvement in the arrangements for collecting gases derived from pure cultivations. It consists of a flask (fig. 56), the caoutchouc stopper of which has two perforations. Through one of these passes a U-tube *a*, on which are one or more bulbs. The bulbs are filled with 1 per cent. sublimate or dilute H_2SO_4, &c. The tube *b* is simply a short piece of glass tubing filled with cotton-wool. The caoutchouc stopper is tied firmly on to the neck, the flask filled with the cultivation medium, and the whole sterilized. After sterilization the joints and spaces about the stopper are covered with a mixture of

* Centralbl. f. Bakteriol. u. Parasitenk, xiii. (1893) pp. 252-6 (3 figs.).

2 parts paraffin and 1 part caoutchouc. When the medium is cold it is inoculated by means of a freshly made capillary tube and introduced through the short tube *b*, after which the latter is at once sealed up. In order to collect the gases formed, the end of the tube *a* is immersed in mercury and covered with a eudiometer.

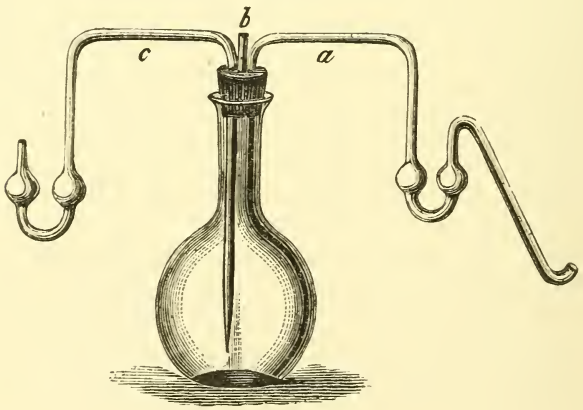
By the foregoing arrangement only a moderate amount of oxygen remains in the flask, and this is soon expelled or replaced by the fermentation gases. If it be desirable to fill the apparatus with hydrogen for anaerobic cultivation, all that is necessary is to connect the *a* end with a hydrogen-forming apparatus directly after sterilization while everything is hot, for as the apparatus cools down it gets filled with hydrogen.

Fig. 56.



It is sometimes necessary to supply air to cultivations, and this may be done by the arrangement shown in fig. 57. In this stopper are three holes, two of which are fitted as in fig. 56, while the third hole is for the passage of a U-tube, one leg of which reaches nearly to the bottom of the flask and is drawn out to a point; on the other end are two bulbs filled with some antiseptic fluid. The air is better forced in at *c* than sucked in at *a*. For this purpose a couple of

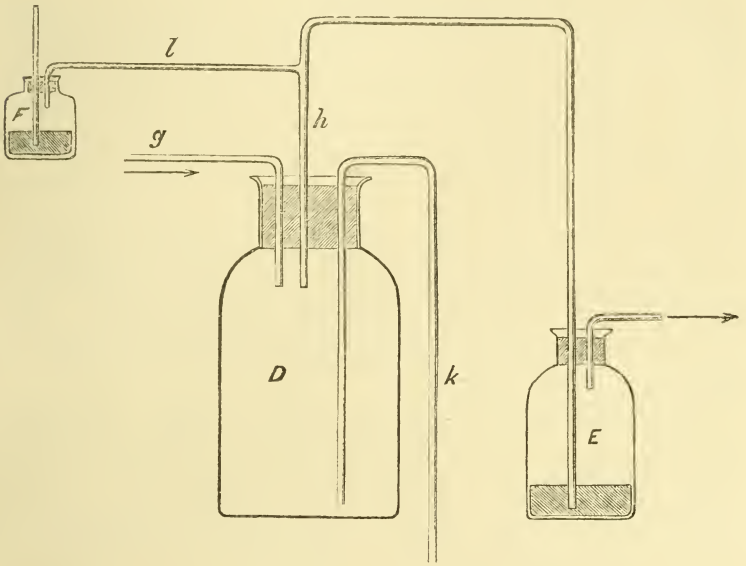
Fig. 57.



large flasks are placed in connection with each other and the tube *c*; one flask, placed higher than the other and containing water, forces by the fall of the water the air from the second flask through the tube *c*. When one flask is empty the positions are reversed.

This arrangement answers very well for a short time, but if the cultivations require to be supplied with air for a long time an automatic arrangement becomes necessary. In fig. 58 such an arrangement is given. It consists of a flask D, closed by a triply-perforated stopper; into this water slowly and continuously runs through the tube *g* and drives

Fig. 58.



through *h* the air in E to the culture through the tube *i*. When, however, the vessel D gets so full that the water rises as far as the level of the letter *h*, then the siphon action of *k'* comes into play and D is emptied in a few minutes. Air is sucked in through *l* to *h*, and when D is empty the water running through *g* goes on driving the air through *h* to E.

As a matter of course, the aerating apparatus is adapted not only for fermentation cultivations, but for any kind of culture.

Plate-making.*—Dr. L. Heydenreich, after pointing out that he was the first to introduce the double capsule, though Petri got the credit of it, says that when several (6–10) have been filled with the necessary quantity of gelatin or agar they are placed on a Koch's levelling tripod, the plate of which is made of metal instead of glass. On the top of this is placed a flat pan filled with ice, a procedure which materially shortens the time required for setting the plates.

The special advantages of a metal plate for the purpose alluded to are obvious, but a perfect plane sheet of brass sufficiently thick not to bend is somewhat costly. A thin sheet of metal backed with wood, however, answers the purpose quite well.

* Zeitschr. f. wiss. Mikr., ix. (1893) pp. 306–9 (1 fig.).

The author then alludes to devices for preventing agar plates made in these double capsules from drying. Into the upper capsule or cover is inserted a semicircle of moistened sterilized filter paper. All the colonies can be seen if the cover be turned round. But gumming up the interspace between the capsules, or putting a layer of paraffin or vaselin along the edge, answers the purpose very well.

Method for Finding the Exciting Cause of Vaccinia.*—Dr. Siegel mixed 1–2 grm. of animal lymph with distilled water and injected the mixture into the peritoneal sac of calves and goats. There were no febrile or other symptoms. The animals were killed in from 4–8 days. The peritoneum, and especially the mesentery, was covered with a fibrinous, easily detached deposit, besides which there were numbers of small nodules on the peritoneum, swelling of the mesenteric lymphatic glands (from inflammation and hæmorrhage) and of the liver, parts of which were softened. Blood-serum tubes inoculated from the glands and liver developed in two or three days colonies of a bacillus, the length of which exceeded the breadth only by a little. Gelatin was not liquefied, and in puncture and stroke cultivations the colonies spread from the inoculation track all over the surface like a transparent veil. Micro- and macroscopical appearances of disease were found in a goat after peritoneal injection, but inoculations of mice, guinea-pigs, rabbits, and pigeons were without result.

Eight adults and three infants were then inoculated. Redness and some swelling resulted, and these passed off by the fourth day. After a lapse of fourteen days all these persons were inoculated with fresh effective lymph. The three children and one adult took. The author concludes that the vaccine bacteria lost virulence from growing on an artificial medium, so that while the lymph was able to protect some who had been previously vaccinated, it was useless to the more sensitive children.

Incoagulable Albumen as Cultivation Medium.†—M. E. Marchal has used with success for the cultivation of pathogenic and saprophytic bacteria, albuminous solutions prepared in the following way. Fresh white of egg is diluted with distilled water; it is then filtered. To the solution sulphate of iron 1-1000 is added in the following proportions:—Solution of white of egg 1–5 per cent., add 1–5 ccm. the litre; solution of white of egg 5–10 per cent., add 5–10 ccm.; solution of white of egg 10–15 per cent., add 10–15 ccm. The ferrous sulphate has the curious property of preventing heat from coagulating the albumen. The solutions may be sterilized at 115° and are perfectly limpid with a slightly alkaline reaction.

New Method for Preparing Gelatin.‡—Drs. E. Acosta and F. Grande Rossi recommend the following procedure for preparing nutritive gelatin on the ground that no filtering apparatus is necessary, that the necessary quantity of gelatin can be quickly prepared, that it is firm, transparent,

* Deutsch. Med. Wochenschr., 1893, p. 29. See Centralbl. f. Bakteriol. u. Parasitenk., xiii. (1893) pp. 291–2.

† Bull. Soc. Belge de Microscopie, xix. (1893) pp. 64–5.

‡ Crónica Médico-quirúrgica, 1892, No. 14. See Centralbl. f. Bakteriol. u. Parasitenk., xiii. (1893) p. 207.

and suitable, and that much time is spared. One kilogramme of meat freed from fat, &c., is cut up into small pieces and immersed in double its weight of water. It is then boiled, skimmed, strained, and replaced on the fire; 0·5 per cent. of pepton and 0·25 per cent. of sodium chloride are added. The original bulk is restored by adding water, and 16–18 per cent. of gelatin is put in. The solution is then placed in a porcelain or glass vessel, twice as high as it is broad, and kept in a Chamberland's autoclave for a quarter of an hour at 105°, and under 1/2 atmospheric pressure. The gas is then turned off and the solution allowed to stand. After the lapse of twenty-four hours the vessel is removed from the stove, and the solidified gelatin, set free with a knife, is placed upside down on filter paper. The top, in which all the impurities have deposited, is then cut off with a thread or wire, and the rest is cut up and the pieces put into a flask and boiled. When liquefied it is distributed into test-tubes, &c., and these are afterwards sterilized discontinuously.

Method for Cultivating Tubercle Bacilli.*—Sigg. Morpurgo and Tirelli made little chambers or boxes of celloidin by moulding the material on blocks of unequal size. The chambers were sterilized by boiling, and then pieces of tuberculous organs placed inside. The little tubes were then filled with cell-free serum by inserting them under the skin, or in the abdominal cavity of a rabbit. After some days small white flecks were seen collected at the bottom of the tube, and these consisted of tubercle bacilli, as was proved by inoculation and cultivation. In tubes similarly prepared, but not placed inside an animal, the bacilli were not found to increase. Some of the boxes placed under the skin excited suppuration, while those placed within the abdominal cavity had no prejudicial effect on the animal's health, even after two months. It seems possible that this method might be useful for cultivating organisms which at present have not been successfully reared on artificial media.

Simplification of Method for Diagnosing Diphtheria.†—Dr. N. Sákharoff proposes as a cultivation medium for diphtheria egg-albumen instead of coagulated blood-serum. Fresh eggs are hard boiled and then shelled. The white is then cut up into longish pieces and these placed in test-tubes in the bottom of which is a little water in order to prevent the albumen from drying. On this medium at 35–40° the diphtheria bacilli appear in twenty-four hours as small round convex colonies.

Simple Apparatus for Collecting and Preserving Pus, Blood, &c., for Microscopical or Bacteriological Work.‡—Dr. von Lagerheim has devised a simple apparatus for the collection, preservation, and transportation in a sterile condition of pus, blood, vaccines, &c. A test-tube is stopped with a doubly perforated cork. Into one hole is inserted a

* Arch. Ital. de Biologie, xviii. p. 187. See Centralbl. f. Bakteriol. u. Parasitenk., xiii. (1893) pp. 74–5.

† Ann. Inst. Pasteur, vi. (1892) No. 6. See Centralbl. f. Bakteriol. u. Parasitenk., xiii. (1893) pp. 143–4.

‡ Annales de la Universidad Central del Ecuador, ser. vii. No. 48, 1893, Quito. See Centralbl. f. Bakteriol. u. Parasitenk., xiii. (1893) pp. 501–2.

tube, the lower end of which is drawn out to capillary size. The upper end is plugged with cotton-wool and can be fixed to the cork by means of paraffin. The second hole, closed with cotton-wool, is merely intended to allow the air to escape when the cork is pushed in, and so prevent it from being forced up the capillary tube.

After sterilizing the test-tube in the flame, the capillary is also sterilized with sublimate, alcohol, and sterile water by sucking these reagents through, and the apparatus is then ready for use.

The material to be collected is obtained by inserting the capillary in the fluid, and then sucking it up, The cork and the tube are then replaced in the test-tube. If it be desired to prevent the germs in the material in the capillary tube from multiplying, small pieces of ice can be placed on the bottom of the large tube and the whole packed in wadding.

New Method for the Culture of Diphtheria-Bacilli in Hard-boiled Eggs.*—Dr. Wyatt Johnson writes :—" All who have had experience in the diagnosis of diphtheria by culture methods agree in praising their accuracy and promptitude. Unfortunately, the general practitioner, who must feel most of all the need of some accurate method for the prompt diagnosis of doubtful cases, does not seem disposed to avail himself of the new process, and the prophecy of Roux and Yersin, that the method would come into general use, appears still to be far from fulfilment.

Thinking that the chief obstacle lay in the difficulty of obtaining serum for the culture medium, M. Sakharoff † recently suggested a simple plan by which slices of hard-boiled eggs, cut with a sterilized knife and placed in sterilized tubes, could be made to replace the serum. Of this method I have no personal experience, but should imagine that the main objection would still exist, as the physician might not have test-tubes about him at the time when they were most needed.

I have, during the past two months, made use of a method which may be regarded as a modification of Sakharoff's, and which does away with the necessity both of test-tubes and the preparation of media before they are actually needed for use.

I employ hard-boiled eggs from which a part of the shell is removed with ordinary forceps, after being tapped so as to break it. In this way shell and shell-membrane can readily be peeled off from one extremity (by selecting the narrow extremity the air-chamber is avoided), leaving a smooth, glistening, moist surface, which offers a most tempting spot for making cultures. These are made, as in case of serum, by touching the diphtheritic exudation with a sterilized needle and drawing the latter lightly from three to six times across the exposed white of the egg. Instead of the regulation platinum needle mounted in a glass rod, I employ either an ordinary needle or a bit of silver suture wire held in an artery forceps. To guard the culture against contamination the egg has only to be placed upside down in a common egg-cup. It can afterwards be wrapped in paper and transported if necessary. The interior of the cup can be sterilized, if desired, by allowing a flame to enter it for a

* Micr. Bull. and Science News, ix. (1892) pp. 42 and 3.
† Ann. Inst. Pasteur, June 1892.

second or two, though I have not found this necessary, as the nutrient surface does not come in contact with the inside of the cup. The egg and shell are, of course, both sterilized by the act of boiling. Five minutes' boiling suffices, and if the operation has to be done 'while you wait,' the egg can be cooled in a still shorter time by placing it in cold water. Strict attention to aseptic details is unnecessary as the diphtheria bacillus outstrips in its growth the contaminating organisms likely to lead to confusion. The appearance of the diphtheria colonies at the expiration of twenty-four hours is the same as when they are grown in serum, but I have found the growth even more rapid, so that a colony is already visible in twelve hours. Confusion with micrococci is, of course, to be guarded against. The reliability of this method seems to be the same as that of the methods of Haffter and E. Roux. I have found one bacillus which attains visible dimensions within the same period, but, as this also grew on in the manner characteristic of the diphtheria bacillus, the great value of the method here described is not invalidated by that fact.

Although this minor modification of a now well-tried procedure might enable it to be employed by those destitute of laboratory outfits, I do not think it likely that this means of diagnosis will be utilized by physicians not habituated to laboratory methods.

It may be of interest to state here that the constant temperature of about 35° C., needful to ensure the rapid and characteristic growths of diphtheria bacillus, can readily be obtained by placing in a cupboard or box with the culture a large jar or pail of warm water, which is renewed from time to time, thus making an impromptu thermostat."

(2) Preparing Objects.

New Method of Preparing Spinal Cord.*—Dr. E. Goodall recommends a new method for preparing the spinal cord for microscopical examination, the chief steps in which are:—Place a portion of a cord taken from a recently killed animal, and 6 to 8 mm. high, on the ether freezing microtome; free and cut; float the section, which should be quite free from wrinkles, on to water; take up the section as soon as possible with a perforated lifter, drain off excess of water, and float the section on pure piridin kept at hand on a watch-glass. One quarter of an hour to one hour will probably suffice. Wash well in water; stain; dehydrate and clear in piridin; mount in balsam suitably thinned with piridin. Anilin blue-black (1/4 per cent. aqueous solution) followed by picrocarmine may be recommended as a staining reagent.

New Method of Preparing Dentine.†—In this method, suggested by Lepkowski, it is stated that sections of bone or dentine may be simultaneously softened and stained. The agent used is a modified form of Ranvier's fluid, and is composed of 6 parts of a 1 per cent. watery solution of gold chloride to 3 parts of pure formic acid. The pieces of teeth, which should be 1/2–3/4 mm. thick, are placed in this fluid for 24 hours; they are then removed, washed with distilled water, and placed in a mixture of gum arabic and glycerin for 24 hours. On

* Brit. Med. Journal, May 1893, pp. 947 and 8.
† Journ. Brit. Dent. Assoc., xiv. (1893) p. 248.

removal from this last reagent they are again washed with distilled water, then alcohol, after which they are imbedded in celloidin or paraffin.

Preserving Larvæ of Crinoids.*—Dr. O. Seeliger found that of the various methods by which he preserved the larvæ of Crinoids, sublimate solutions were the best; not only was the external form truly preserved, but the histological details were in a good state. In the later stages, when calcareous plates begin to be deposited, these solutions could not, of course, be used. For the cleavage stage, 1/50–1/60 part of concentrated acetic acid may with advantage be added to the sublimate; the addition of 1/10 per cent. chromic acid made the embryos rather brittle, and they stained less well than when it was not used. To preserve the calcareous plates, absolute followed by 80 per cent. alcohol should be used.

Almost all the embryos and larvæ were stained slightly before imbedding in borax-carmine; this makes them more easily visible, and notwithstanding their small size they are not so easily lost in paraffin. The sections were most satisfactorily stained with Grenacher's acetic hæmatoxylin solution; if they colour too deeply they should be placed in weak acid alcohol. Some observations were also made on teased preparations.

Demonstration of Living Trichinæ.†—Dr. A. S. Barnes recommends that a piece of trichinized muscle, about the size of a pea, be placed in a small bottle, containing a solution of 3 grains of pepsin, 2 drachms of water and 2 minims of hydrochloric acid. If this be kept at the temperature of the mammalian body, and the fluid be now and again shaken, the meat will, in about three hours, be dissolved, as will also the cysts which contain the Trichinæ. The fluid is next to be poured into a conical glass, so as to allow the Trichinæ to settle at the bottom. They may then be drawn out by a pipette, and the contents placed in a large glass cell. Put the cell under a dissecting Microscope; pipette out the Trichinæ and place them in clear water. Again pick out the worms and place in a drop of pure water in the centre of a glass cell or live-box. Put on a cover and seal with white vaseline. Examine on a hot stage. If a permanent mount of isolated worms be wanted, use a drop of glycerin instead of water.

Observing and Dissecting Infusoria in Gelatin Solution.‡—The procedure adopted by Mr. P. Jensen consists in placing the organisms in a weak solution of gelatin. A 3 per cent. solution is the most satisfactory, and this is made by dissolving 3 grm. gelatin in 100 ccm. of water with gentle heat. At a temperature of 18° to 19° C. this solution sets to a firm jelly. The solution can be kept in a flask stopped with cotton-wool, or, better still, after sterilizing thrice at about 80°. Large infusoria, like *Paramecium aurelia* and *Urostyla grandis*, when immersed in this jelly and placed under a cover-glass, no longer move. If the jelly be thinned down by adding an equal bulk of water, it becomes

* Zool. Jahrb. (Anat. u. Ontog.), vi. (1892) pp. 168–72.

† Amer. Mon. Micr. Journ., xiv. (1893) p. 104.

‡ Biol. Centralbl., xii. (1892) p. 556. See Zeitschr. f. wiss. Mikr., ix. (1893) pp. 483–5.

tremulous and movements are not much impeded. If the Infusoria are to be dissected the gelatin should be thinned down from 0·8 to 1·0 per cent. In order to transfer the animals to the gelatin, the latter is warmed until it is just liquefied. A small quantity of it is poured into a watch-glass, a drop of water containing the animals is added to it, the two stirred quickly together, and a drop of the mixture placed on a slide (which may be ever so slightly warmed), and then the cover-glass at once put on. If it be desired to keep the Infusoria for some time in this gelatin it is well to make the preparation with the water which they inhabit, so that the Bacteria on which they live may be present for their nutriment.

Weaker solutions of gelatin are not at all harmful to the organisms: e.g. the author has found *Paramecium aurelia* and *Euglena viridis* multiply wonderfully in a 0·5 per cent. solution. Stronger solutions set up a gradual granular degeneration, though in these the animals will remain unaltered for 3 hours, quite long enough for observations. *Euglena viridis* has, however, been kept for 24 hours quite motionless in strong jelly, and, after having been dissolved out with warm water, became quite lively again.

Demonstrating Structure of the Embryo-sac.*—Mr. G. W. Martin has found the following process useful for demonstrating the egg-apparatus and antipodal cells in *Solidago* and *Aster*. The material was fixed in 1 per cent. chromic acid for twenty-four hours, and stained with alum-carmine after washing; again washed and dehydrated; it was taken through the xylol-absolute-alcohol process into a saturated solution of xylol and paraffin; it was then infiltrated with paraffin, imbedded, and cut with a microtome; the sections were stained with Bismarck-brown and mounted in xylol-balsam.

Giant Cells and Phagocytosis.† — Dr. Knud Faber devised a method whereby he was able to demonstrate most convincingly that giant cells are intracellular digesting phagocytes; the method consists in introducing into the subcutaneous tissue of rabbits gelatinized agar and then observing the resorption processes. The agar was dissolved in distilled water; usually a 1½ per cent., but occasionally 3 per cent. solutions were injected, and immediately afterwards the injection site was cooled down with an ether spray so that the mass set *in situ*. It was then left for periods varying from 1 to 80 days.

In no case were there any naked eye evidences of inflammation, the agar lying apparently unchanged, imbedded in the connective tissue.

The pieces excised for microscopic investigation were fixed usually in Flemming's fluid or in spirit, but sometimes in sublimate or picric acid. The stains used were safranin, alum-carmine, gentian-violet, and hæmatoxylin. The appearances observed were those of chronic inflammation, the pieces of agar being surrounded by leucocytes, epithelioid and giant cells. The agar pieces were not only surrounded by cells but were found within the cells. By colouring the agar with carmine or Berlin blue the digestive action of the giant cells was best seen. The opinion is strongly expressed that giant cells possess in a special degree the

* Bot. Gazette, xvii. (1892) p. 353.

† Journal of Pathology and Bacteriology, i. (1893) pp. 319–58 (1 pl.).

power of resorption, and the greater number of nuclei is indicative of greater vital activity.

(3) Cutting, including Imbedding and Microtomes.

A Microtome for 50 Cents.*—Dr. Hinz has described his instrument in the 'Omaha Clinic.' The main body is a tin pot 3 in. high by 8 in diameter. A bridge 2 in. wide crosses the top (or open end of the can) and is soldered to the sides of the pot. In its centre is an opening which is the termination of the well, and around the well opening is a glass ring over which the knife is to glide. The space around the well can be filled with ice for freezing. Connected with the well he has a milled screw 4 in. long and with forty threads to the inch. One revolution produces a section 1/40 in. thick; one-half revolution, a section 1/80 in., &c. An amputating knife or razor can be used to cut the sections.

Microtome for Cutting Large Sections.†—Herr O. Schultze describes a new instrument which he has devised for cutting sections of a whole organ or region of the human body. The sections are laid between glass plates and stained so that they can be used for lectures on systematic and topographical anatomy. The instrument is made by Schanze, of Leipzig, and constructed on lines similar to those of other microtomes by this mechanician. The knife-slide is 80 cm. long, and the knife 53 cm. long and 9 cm. broad. The object is fixed to a square iron plate (20 cm. a side) by means of collodion, and the plate clamped to the object-holder, which is moved upwards by means of a micrometer screw. The instrument is capable of making sections of a whole brain 5/100 mm. thick. Before cutting the section, the surface is smeared over with a thin layer of collodion, and each section as it is cut is received on a layer of thin paper.

It requires two persons to work this machine, one to move the knife, the other to manipulate and look after the section.

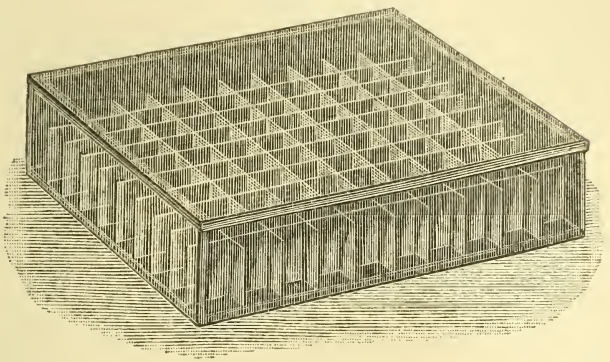
The apparatus is so heavy that it takes two strong men to move it.

Glass Vessel for Serial Sections.‡—Dr. S. A. García describes a convenient form of dish or large capsule subdivided into compartments, which he has devised for the easy manipulation of sections in series. The vessel is rectangular, made of glass and covered with a closely fitting lid, It is obvious that the plan of the apparatus will allow the construction of any number of compartments of any desired size. The subdivisions are made of mica, a substance which, while fitting close enough to the bottom to prevent the sections from escaping from their proper compartment, allows the fluid free passage all over. The author's original apparatus was constructed of nickel, but this does not seem so useful for the purpose as glass. As an example the case of objects imbedded in celloidin is adduced. Here three of these dishes, one filled with alcohol, one with alcohol and ether, and the third with oil of cloves, will greatly facilitate manipulation, as the sections are easily transferred

* The Microscope, xii. (1892) p. 231.
† SB. d. Physik.-Med. Gesell. zu Würzburg, 1892, pp. 116-7.
‡ Zeitschr. f. wiss. Mikr., ix. (1893) pp. 313-5 (1 fig.).

from one vessel to another and deposited in their proper compartment without the trouble of marking.

Fig. 59.



(4) Staining and Injecting.

Staining of Micro-organisms which will not colour by Gram's Method.*—M. Nicolle states that the following method produces very good results for staining micro-organisms which pick up methylen-blue, and especially those of glanders, typhoid, swine fever, pseudo-tuberculosis, fowl cholera, soft chancre:—Stain in Loeffler's or Kühne's blue for one to three minutes; wash in water. Immerse in tannin solution 1–10 (the effect is almost instantaneous); wash in water. Dehydrate in absolute alcohol, oil of cloves or bergamot, xylol, balsam. The micro-organisms are better differentiated if after staining the preparations are treated with weak acetic acid.

Rapid Staining of Nervous Tissue by the Weigert-Pal and Iron Chloride Methods.†— Dr. Kaiser says that nervous tissue, brain or cord, can be stained very expeditiously according to Weigert's method in the following way:—It is most desirable that the pieces should be hardened in a chromic acid solution; four to six weeks in Müller's fluid are quite sufficient, but it is not necessary that the preparations should be placed straight away from the hardening fluid into the alcohol; it is more advantageous to merely wash them out and harden in spirit afterwards, as in this way preparations are more sensitive for other stains.

The sections are taken from 70 per cent. spirit in which they have been kept, and washed in Weigert's hæmatoxylin solution (hæmatoxylin, 1; alcohol, 10; water, 90; saturated solution of lithium carbonate, 1). They are next placed in a fresh quantity of the same fluid in a watch-glass, and then gradually heated until bubbles begin to rise. The sections thus stained are next differentiated by Pal's method:—washing in water, immersion for about half a minute in 0·25 per cent. solution of permanganate of potash, and then in the following solution—oxalic acid, 1; sodium sulphate, 1; water, 200. In the last they remain

* Ann. Inst. Pasteur, 1892, p. 783. See Centralbl. f. Bakteriol. u. Parasitenk., xiii. (1893) p. 501.

† Zeitschr. f. wiss. Mikr., ix. (1893) pp. 468–70.

until the grey substance assumes a brown to yellow hue and the white a dark grey. They are then passed through water, alcohol, and oil to balsam.

Scarcely inferior to the foregoing are the pictures obtained by the following procedure:—The sections are placed for some minutes in a mixture of liq. ferri sesquichlorati 1, H_2O 1, spirit. rectif. 3. They are then immersed in the Weigert hæmatoxylin solution, which must be removed as often as a black precipitate falls. When the sections become black they are washed in water and differentiated in the same way as in the previous method. Should they not clear up at once in the oxalic acid solution, the sections should be returned to the permanganate solution until the desired tone is obtained. After this the sections are washed in ammoniated water and stained with fuchsin 0·1, spirit. rectif. 100·0, or naphthylamin brown 1, spirit. rectif. 100, H_2O 200. The fuchsin solution stains in a half to one minute, the naphthylamin brown in three to five minutes. The subsequent treatment is the same as in the first method. The medullated fibres are blue, the rest red or brown. The medullated fibres become dark blue or black if the hæmatoxylin solution be heated. If the differentiation be exactly hit off, the pigment, nuclear network, and nuclei of the ganglion cells become clearly apparent.

Kolossow's Osmic Acid Method.*—Dr. A. Kolossow says that since the last publication of his method he has made further and numerous trials of it, and finds that the following procedure gives the best results. Small pieces of tissue or organs, or even small embryos are, according to size, immersed for 1/2, 1, 3, 5, 8 hours in 1/2 to 1 per cent. solution of osmic acid, to which nitric acid has been added in the following proportion:—5–10 drops of nitric acid to 100 ccm. of the osmic acid solution. They are next washed with some of the developer (a weak solution of pyrogallic acid) and then placed in a fresh volume of the developer for 10–16 hours, after which they are transferred to 85° spirit. The latter must be changed three or four times before the next step in manipulation (imbedding in paraffin) is attempted.

Staining Fungus of Pinus sylvestris.†—Herr F. Schwarz stained the hyphæ of a fungus infesting pine trees in the following manner:—Sections of the affected twigs were removed from alcohol and placed for 3–6 minutes in an old solution of Delafield's hæmatoxylin. They were next washed in water and then decolorized by immersing them for 1/2–2 minutes in 1 per cent. alcoholic oxalic acid solution. When the sections were reddish to the naked eye they were removed, and the oxalic acid thoroughly washed out in alcohol. The sections were mounted either in balsam or glycerin. The fungi were stained violet or deep-blue, while the cell-tissue of the pine appeared yellow or yellowish-red.

Staining Parasitic Fungi.‡—Mr. H. M. Richards recommends for this purpose the use of methylene-blue. A 1 per cent. solution was used, and the sections were stained on the slide. The sections were first

* Zeitschr. f. wiss. Mikr., ix. (1893) p. 320.

† S.A. a. d. Zeitschr. f. Forst- u. Jagdwesen, 1892, 10 pp. See Centralbl. f. Bakteriol. u. Parasitenk., xiii. (1893) pp. 20–1.

‡ Proc. Amer. Acad. Arts and Sci., 1893, p. 36.

considerably over-stained, and then decolorized to the point desired by acetic acid. After completely washing away the acetic acid, they were mounted in glycerin.

Method for rapid Staining Microbes.*—Dr. J. N. Dávalos recommends as a universal staining fluid for all micro-organisms the following modification of Ziehl's solution:—Fuchsin 0·25, alcohol 10·0, crystallized carbol 5·0, water 100·0. The solution is to be filtered. Coverglasses are floated on for 1–2 minutes, washed and mounted in balsam.

Chromatin of Sympathetic Ganglia.†—Dr. F. Vas followed Nissl's method. The portions of ganglion removed from an animal recently dead were placed in absolute alcohol and imbedded in celloidin. The sections were stained in aqueous solution of magenta-red, washed out in absolute alcohol, cleared in clove oil, and mounted in Canada balsam.

Obregia's Method for Class Purposes.‡—Dr. C. L. Gulland says that he finds Obregia's method, described in the 'Neurologisches Centralblatt' for 1890, is very useful for class purposes. The pieces were imbedded in paraffin and cut with a rocker. The bottom of the boat was intended for the section surface and the pieces were oriented accordingly. The ribbons of sections were transferred to plates coated with the following solution:—Sugar candy solution of consistence of syrup, 30 ccm.; absolute alcohol, 20 ccm.; solution of dextrin of syrupy consistence, 10 ccm. The plates thus coated should be dried in the air, but protected from dust. The plates used were 12 in. by 6 in., in fact as large as would go in the oven. They are then stoved at a temperature a little above melting point of paraffin. In a few minutes the paraffin melts and the sections adhere to the sticky surface. The melted paraffin is then dissolved by running plenty of naphtha over, and this is followed by strong methylated spirit. The sections are then covered with celloidin or photoxylin solution (photoxylin 6 grm., absolute alcohol 100 ccm., ether 100 ccm.), but a thin celloidin solution poured over the surface, and the excess run off, answers well. The plate is dried horizontally, so that the layer is perfectly flat, even, and regular. The drying must be slow, otherwise the celloidin shrinks.

At this point the plates may remain till wanted, as the sugar retains sufficient moisture to prevent the section from getting too dry. When wanted the plates are simply placed in water whereby the sugar is dissolved, and then the ribbons or separate sections can be stained and mounted. The author mentions the Ehrlich hæmatoxylin and aqueous eosin, and these stains were followed by methylated spirit sufficiently strong to dehydrate. When dehydrated the sections are placed in creosote and cleared up. The sections are at this stage handed round the class, and the student then removes the creosote with Weigert's xylol mixture (xylol three parts, phenol one part) and mounts in balsam.

Improved Form of Injection Apparatus.§—Dr. J. Middlemass describes an apparatus for injecting which is easily made and manipu-

* Crónica Médico-quirúrgica de la Habana, 1892, No. 22. See Centralbl. f. Bakteriol. u. Parasitenk., xiii. (1893) p. 291.

† Arch. f. Mikr. Anat., xl. (1892) pp. 375–89 (1 pl.).

‡ Journal of Pathology and Bacteriology, i. (1893) pp. 391–9.

§ Tom. cit., pp. 389–90 (4 figs.).

lated, and by which the pressure can be measured and maintained for any length of time. The essential part is a three-necked Woulff's bottle, and the most convenient size is one of 8 oz. By one of the necks compressed air is introduced by a syringe. By another the pressure is transmitted to a bottle containing the fluid to be injected. Into the third fits a graduated manometer tube, the lower end of which dips into a layer of mercury at the bottom of the vessel, and is so arranged that the zero is flush with the mercurial level, and the mercury inside the manometer is brought to the same level by sucking out some air. The pressure is obtained by injecting air by means of some form of syringe, e. g. a Higginson, an aspirator or injection syringe. In the glass tube which leads into the bottle is placed a three-way stopcock, and this is a necessity for regulating the inflow and the outflow of air, and also for reducing or removing the pressure altogether. Two other stopcocks, one on the tube leading from the bottle and the other on the injecting bottle, are also desirable. The manometer may be graduated in atmospheres or in millimetres, &c., of mercury.

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

Chloral for Mounting Microscopical Preparations.*—M. A. Geoffroy recommends the following process especially for preparations of starch-grains, the lower Fungi, Algæ, &c. Three or four grs. of the purest gelatin are dissolved in 100 ccm. of a 10 per cent. solution of chloral hydrate; or the concentration may be varied according as a greater or less clarifying of the preparation is needed. This is applied in the same way as ordinary glycerin, but it is not necessary to remove the fluid entirely from the edge of the cover-glass. After a short time the gelatin hardens round the cover-glass in such a way that the preparation can be fixed in an alcoholic solution of shellac. Preparations made in this way and stained with carmine or iodine-green retain their colour for a very long time, while other stainings are more evanescent.

Keeping Paraffin Sections Flat.†—After pieces of tissue have been hardened, says Mr. N. Walker, they are to be saturated with toluol, chloroform or the like, and then imbedded in paraffin of about 50° melting-point. The difficulty then arises of keeping the sections spread out flat and smooth on the slide. The preparations flatten out quickly if they are dropped into warm water, the temperature of which is just below the melting point of the paraffin. The slide is then put underneath, the section lifted out of the water and dried in an incubator at 30°. The section will be found to have adhered firmly to the slide. The paraffin is then dissolved out in benzol, and the latter having been washed off with alcohol, the preparation is stained in the usual manner.

Influence of the Composition of the Glass of the Slide and Cover-glass on the Preservation of Microscopic Objects.‡—Herr R. Weber remarks that it is a matter of common observation that objects mounted

* Journ. de Bot. (Morot), vii. (1893) pp. 55-6.

† Monatshefte f. Prakt. Dermatologie, xvi. (1893) p. 113. See Centralbl. f. Bakteriol. u. Parasitenk., xiii. (1893) p. 344.

‡ Ber. Deutsch. Chem. Ges., xxv. (1892) pp. 2374-7.

in the usual way between slide and cover-glass often, after a short time, begin to deteriorate so that the sharpness of outline is lost, and the object is sometimes completely ruined.

The result of the author's observations is to show that this deterioration is due to the effect upon the object of the material of the slide and cover-glass.

The ordinary glasses used in microscopic work vary in their behaviour after long exposure to the air: while some retain their bright surface lustre others of inferior quality gradually lose it and become coated with a moist or dusty deposit. The same phenomena are exhibited by ordinary glass articles (mirrors or window panes) of different qualities.

This deposit has a strong alkaline reaction, and, when formed on cover-glass or slide, has a considerable injurious action upon delicate objects mounted between them.

Now as regards the slides, in their production a soft glass which is almost perfectly colourless is often used. The components of this glass are pure alkalies and calcium carbonate with sand free from iron. The amount of calcium is limited as much as possible on account of the fusibility. Such a glass is known in German commerce as "Salinglas." It is peculiarly liable to the deposit above described, which is sometimes strongly developed even in process of transport.

Analysis of such slides by the author gave the following numbers:—

SiO_2	73·06
Al_2O_3	0·90
CaO	8·47
K_2O	3·87
Na_2O	13·70
	100·00

This gives the molecular ratio

SiO_2	:	CaO	:	$\begin{cases} K_2O \\ Na_2O \end{cases}$
8·2		1		1·74.

According to the author's previous experiments, such a glass is less hard, and therefore less to be recommended than glasses in which the molecular ratios are

$$6 - 7 : 1 : 1 - 1{\cdot}3.$$

Besides these colourless slides, others which have a slightly green tint are used, and these are much less liable to show a deposit. They are made of a window glass, rich in calcium and poor in alkalies, which is much more difficultly fusible.

Cover-glasses exhibit the same differences as slides, some remaining unchanged by exposure while others lose their lustre. Those of English manufacture are the best, are less liable to form a deposit, and are also distinguished by uniformity in the strength, evenness and purity of the material. They are generally of a slightly greenish-blue tint. The cause of the different behaviour of the English and other cover-glasses

depends on the different composition, as shown in the following analyses:—

	English Cover-glass.	Other Cover-glass.
SiO_2 ..	71·00 ..	74·77
Al_2O_3 ..	0·57 ..	0·45
CaO ..	13·76 ..	10·75
MgO ..	0·31 ..	0·33
K_2O ..	0·20 ..	0·20
Na_2O ..	14·16 ..	13·50
	100·00	100·00

In the first case the proportion of lime to alkalies is greater than in the second, and to this is due one of the most important properties of the English glass, viz. its resistance to the effect of moisture and other agents.

For delicate, easily perishable microscopic preparations, then, a highly resisting glass with very high content of lime is absolutely essential, although the production of cover-glasses is thereby rendered very difficult.

The usefulness of a glass for delicate preparations may be tested by observation of its behaviour on keeping for a long time in air free from dust, or more expeditiously by the effect upon it of dilute hydrochloric acid during 24 hours.

Method of Mounting Calcified Microscopic Specimens.*—Mr. J. Mansbridge gives the following description of the method of mounting which he has adopted for certain dry calcified sections where it is advisable to retain air in the structure for purposes of clear definition.

"One great disadvantage in the use of a fluid balsam as a mounting medium for this class of sections, is the liability to run into any spaces, such as lacunæ or tubuli that may exist in the tissue, and thus render the specimen useless. To overcome this difficulty I have used with success desiccated balsam in the following way:—Take a clean slide, place it upon a hot table with a small single lump of balsam upon it; use sufficient heat to slowly melt the balsam, which must not be made too hot. When sufficiently fluid lay the section upon it and cover with a hot cover-glass, which must be pressed down in such a way as to expel all air from beneath it. Remove the slide to a cool surface and continue to keep pressure upon the cover-glass for a few minutes, when the balsam will be found to be quite hard and the specimen ready to be labelled and put away finished.

The advantages of this method are, I think, (1) There is no chance of the mounting medium running in and spoiling the sections, as it becomes perfectly hard a few minutes after removal from the hot table. (2) The specimen is finished at the time and is ready for the cabinet. There is no need to use a clip, and no fear of the cover-glass shifting if the slide is placed upon its side. (3) It is very convenient for teaching purposes, as the ordinary stiff balsam in a bottle furnished with a glass

* Trans. Odont. Soc. Great Britain, xxv. (1893) p. 176.

rod, if used in a class, soon becomes, together with the students, in a most deplorable condition.

(6) Miscellaneous.

The Microscope in the Workshop.*—Prof. W. A. Rogers calls attention to the advantages to be derived from the use of the Microscope in the ordinary operations of machine construction.

The two objections generally urged against its adoption are, that a special and expensive machine, mounted on a foundation separate from the building, would be required for its use, and that without special appliances an adequate illumination of metal surfaces could not be obtained.

The author considers that both these objections may be met.

With regard to the first it is only necessary to have the Microscope firmly clamped to any machine with which it is to be used. The form of mounting used by him has been found to be well adapted to the purpose. It is found that with powers of from 100 to 200 the images in the Microscope are remarkably steady.

The second objection is met by the use of the prism illuminator invented by the late R. B. Tolles. This prism is mounted just at the back of the objective. The light meeting a plane face passes to a facing, making with it an angle of 45°, where it is totally reflected and passes out nearly parallel with the axis of the lens.

The author gives twenty-four examples of operations in which the Microscope may be advantageously employed.

Blood and Blood-stains in Medical Jurisprudence.†—Mr. Clarke Bell gives a summary of the present state of scientific knowledge on the subject of the identification of blood and blood-stains. The red blood-corpuscles afford the best means for discriminating between the blood of man and other animals.

Three methods of investigating blood have been employed, viz. (1) chemistry; (2) the spectroscope; (3) the Microscope and its allies the micrometer and the photomicrogram.

No chemical differences have been discovered between the blood of man and of other animals.

The Microscope, however, has shown that the human corpuscle is larger than those of most of the domestic animals.

The average diameter of the human red blood-corpuscle is 1/3200 in.; that of the sheep 1/5000; the goat 1/6366; so that these can be easily distinguished under the Microscope; as also those of the horse 1/4600, cow 1/4500, cat 1/4004, pig 1/4230, and mouse 1/3814.

There is greater difficulty with animals such as the dog, whose red blood-corpuscles more nearly approximate in size to those of man.

Prof. Formad has, however, recently claimed that by the use of very high magnifications, up to 10,000 times, obtained by rephotographing single corpuscles of different animals, he has obtained the following measurements. The human corpuscle was enlarged to $3\frac{1}{8}$ in. in diameter, guinea-pig to 3 in., dog to $2\frac{4}{5}$ in., ox to $2\frac{1}{8}$ in., sheep 2 in., and goat $1\frac{3}{8}$ in.

* Proc. Amer. Micr. Soc., xiv. (1893) pp. 128-31. † Tom. cit., pp. 91-120.

With these high powers he claims that it would be possible to state that corpuscles were *not* those of the sheep, goat, horse, cow, or ox, and probably the dog, or of any Mammal except the guinea-pig or opossum.

Prof. Wormley, on the other hand, who has made determinations of the apparent size of red corpuscles under a magnification of 1150, came to the general conclusion "that the Microscope may enable us to determine with great certainty that a blood is *not* that of a certain animal, and is *consistent* with the blood of man; but in no instance does it in itself enable us to say that the blood is really human, or indicate from what particular species of animal it was derived."

Prof. Formad's methods of observation of blood-corpuscles are as follows:—

A drop of blood is placed upon a slide and the edge of another slide is quickly drawn across so as to distribute the corpuscles as evenly as possible between them.

Two micrometers, the one a stage-piece, the other an eye-piece micrometer, are used. The stage micrometer, which consists of a glass slide ruled to a scale either in millimetres or fractions of an inch, serves to establish the correct value of the lines ruled upon the micrometer.

The eye-piece micrometer is a slip of glass, with fine lines ruled to a uniform scale, which fits into the eye-piece of the Microscope. By the stage micrometer the number of divisions of the eye-piece micrometer required to fill one of the divisions of the stage micrometer is noted. Thus, if with a 1/12 Zeiss homogeneous-immersion lens the 1/100 in. division of the stage scale covers exactly twenty places in the eye-piece scale, then each division of the eye-piece micrometer will be equal to the 1/20000 in. When the adjustment of the scale has been thus made the slide is brought into focus under the eye-piece micrometer and the number of divisions occupied by a blood-corpuscle is noted. The average of 100 measurements made in this way upon perfectly round biconcave corpuscles only is then taken.

For photographic purposes the blood is mounted directly upon a glass stage micrometer, and both blood and micrometer appear sharply defined in the picture. The measurements are then made directly upon the negative.

Böhm and Oppel's Pocket-book of Microscopical Technique.*—This little manual has now got into its second edition, and it deserves some praise, as it is an excellent compendium of the myriad details necessary for the examination of animal tissues. The first section deals with the Microscope, its accessories and manipulation, and the second section with the preparation of the object. After this follows the special part in which the organs and tissues are separately treated of.

It is certainly one of the most useful compilations we have seen, and it would no doubt command, if in an English dress, a considerable sale, for a little pocket-book on microscopical technique is a desideratum. The get-up of the work is very good.

Mixtures of Antiseptics.†—M. J. de Christmas after alluding to the fact that several observers had laid it down that mixtures of several

* 'Taschenbuch der Mikroskopischen Technik,' A. Böhm u. A. Oppel, 2nd ed., Munich, 1893, 192 pp.

† Ann. Inst. Pasteur, 1892, p. 374. See Centralbl. f. Bakteriol. u. Parasitenk., xiii. (1893) pp. 107–8.

antiseptics possessed greater antibacterial power than any one of the components taken singly, points out that the method of examination had not been free from objection, and the results were without any special practical value, inasmuch as the antiseptics had been used of such strength as would preclude their application to the living organism. Yersin was the first to adopt a satisfactory method, and the author has followed his procedure.

Phenol and salicylic acid formed the basis of the mixture, the presence of the former increasing the solubility of the latter. By the addition of organic acids a still further increase of the bactericidal properties of the mixture was attained, as was shown by its action on *St. pyogenes aureus*.

In one table is shown the superiority of this kind of mixtures over all known antiseptics, with the exception of sublimate, and in a second table are given the different degrees of concentration of "phenosalyl" necessary for destroying different species of bacteria, *St. pyogenes aureus* being the most refractory.

Determination of Pectic Substances in Plants.*—M. L. Mangin recommends for this purpose the action on thin slices of tissue of a mixture of naphthylene-blue and acid green, which gives a double staining reaction, the acid green being fixed by the nitrogenous substances lignin and suberin, while the pectic substances are stained violet by the naphthylene-blue. The preparation should first be neutralized, after washing with 1·5 per cent. acetic acid. The presence of pectic acid can be demonstrated by separating it from its base by the action on very small pieces of tissue of dilute hydrochloric acid or a mixture of 1/4 acid and 3/4 alcohol. Pectic acid is quite insoluble in water; it can be dissolved out by the action of a weak alkali, and then precipitated in gelatinous flakes by a weak acid. The ill-defined substance known as pectose, which remains behind after the action of the alkali, is not readily isolated.

* Journ. de Bot. (Morot), vi. (1892) pp. 363–8.

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

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and Professor of Comparative Anatomy and Zoology in King's College ;

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J. ARTHUR THOMSON, M.A.,
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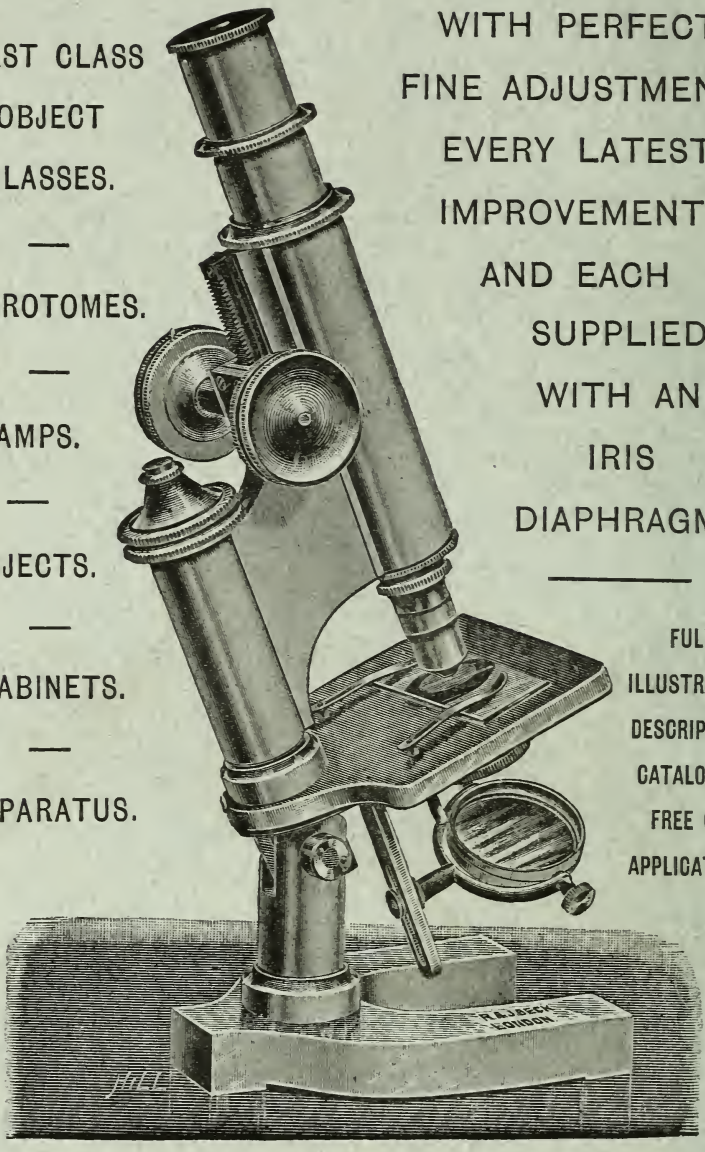

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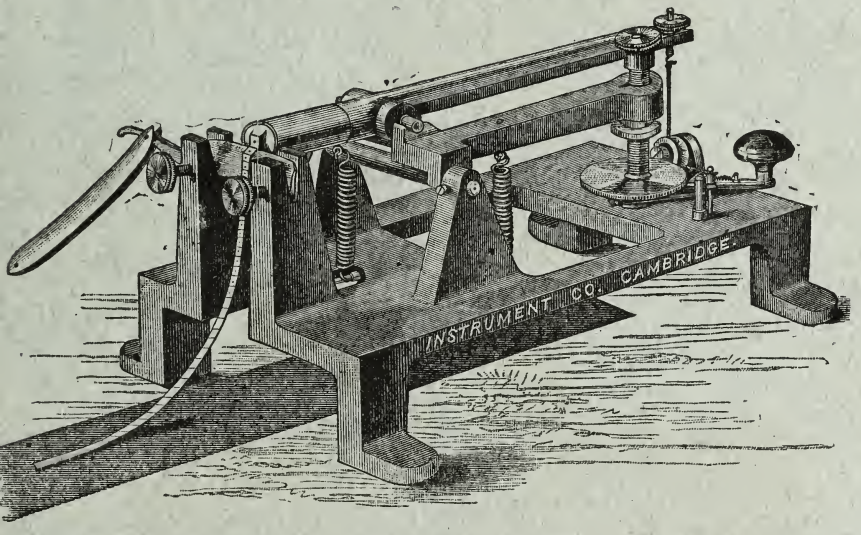

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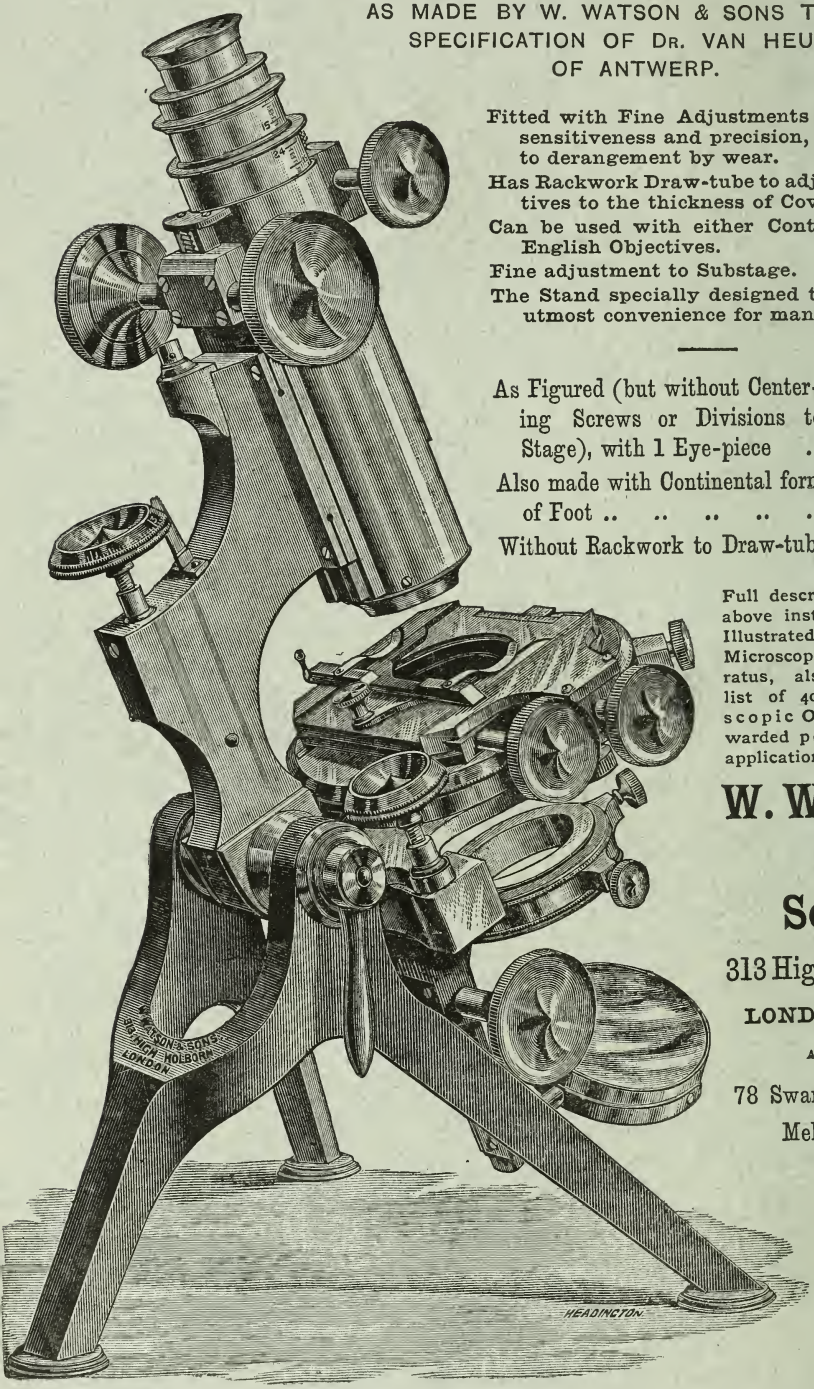

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MICROSCOPY.

Handbook of Microscopy.*—It would be almost impossible to put into a smaller compass the instructions needed by beginners in Microscopy than we find them to be presented in the pages of this book. But efficiency has not been sacrificed to brevity. The field covered is greatly narrowed by the wise omission from so purely elementary a treatise of the history and evolution of the Microscope, and of all attempts to epitomize the optical principles on which the instrument is built. The book introduces the amateur to his Microscope in a simple form, and explains competently, but in few words, the nature and use of apparatus. The plain and at the same time very practical and modern instructions given (pp. 50–6) on centering and illuminating with substage condenser will be welcome to many a tyro, and will prevent much needless waste of time. If the portion of this small volume devoted to the nature and use of the instrument be read with care by any one of ordinary intelligence, the initial work involved in the use of the Microscope will be done with far less trouble and disappointment than is usually the case.

Nor is the feature of absolute utility a whit less lost sight of by Mr. Cole in the second part of the volume. Every line has its value, and he will have but little ingenuity and perseverance who will work honestly with this book before him and not succeed in making fair microscopic preparations and mounts in a short time.

We cannot unconditionally subscribe to all that is laid down in this book; but the divergencies have no great moment in anything appertaining to the work of the beginner; and even when we differ, and our differences are carried over to higher power work, we feel assured that the judgment of the authors is a judgment and not a mere opinion, and is therefore deserving of respect.

This book will have the success it deserves.

a. Instruments, Accessories, &c.†

(1) Stands.

Reichert's Travelling Microscope.‡—In this Microscope, shown in fig. 60, the coarse-adjustment is by sliding in a socket, and the fine by a micrometer screw. It is very solidly built, can be put together very easily and occupies a very small space. It is provided with diaphragm and mirror, plane and concave.

* 'Modern Microscopy. A handbook for beginners, in two parts. 1. The Microscope, with instructions for its use by M. I. Cross. 2. Microscopical Objects: how prepared and mounted, by Martin J. Cole.' Ballière, Tindall, & Cox, London, 1893.

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

‡ Reichert's Catalogue No. 13 (1892).

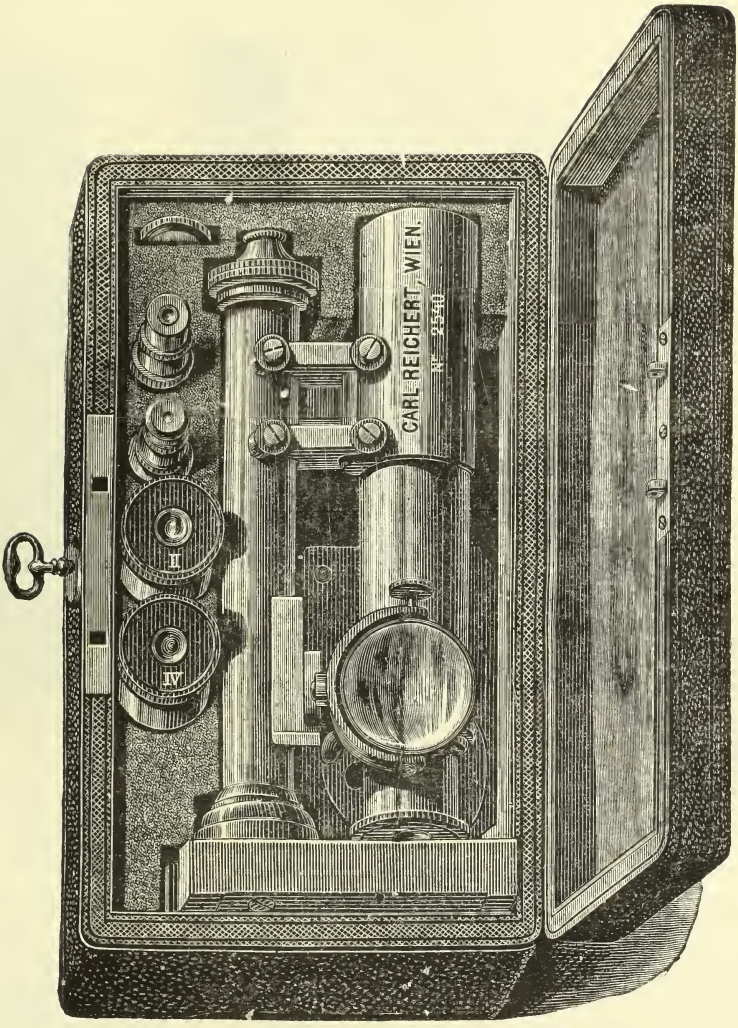


Fig. 60.

Reichert's Preparation Microscope.*—This instrument, fig. 61, is provided with an adjustment by rack and pinion, large brass stage,

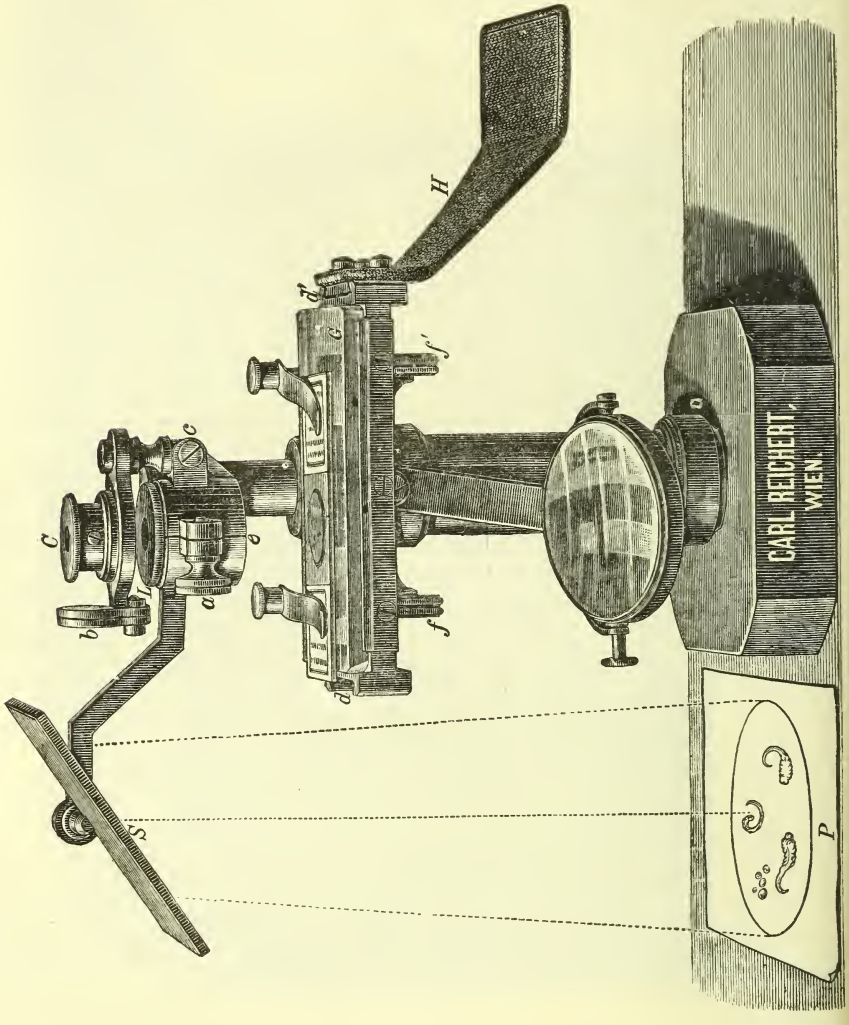


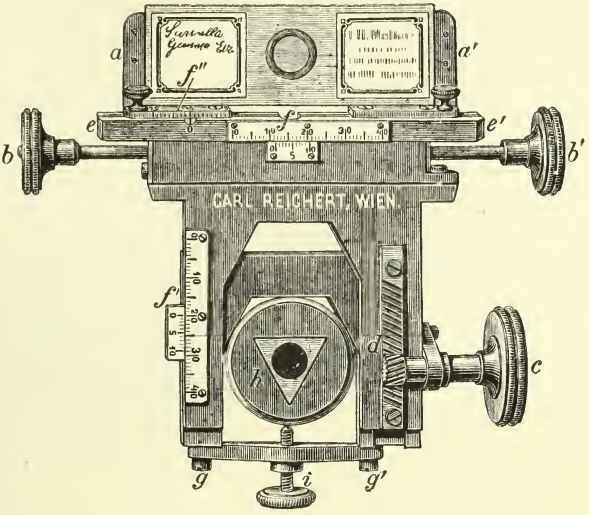
Fig. 61.

plane mirror adjustable on both sides, two leather covered hand-rests, and a doublet which magnifies 10 times.

* Reichert's Catalogue No. 18 (1892).

Reichert's Movable Stage.*—In this stage, represented in fig. 62, the object can be displaced in two rectangular directions by means of the two screw-heads *b* and *c*. It can be readily attached to and removed

FIG. 62.



from the ordinary stage. This stage is intended for the Reichert model No. II., but it can also be fitted by means of the screw *i* to any larger stage of the Continental type.

A Sliding Carriage and Stage for the Microscope†**.**—Mr. G. W. Brown, jun., says, "The following description and drawing of plan and section of an improved sliding carriage and stage for the Microscope may be of interest. If put into actual use it will, I hope, bring as much comfort and satisfaction as it has brought to me.

After considering the qualities useful in a good stage, Dr. Dallinger concludes‡ that an efficient substitute may be found for a mechanical stage in what he terms a 'super-stage,' so arranged that the bearings shall be glass, and friction reduced to a minimum. He says that 'against its employment is the fact, first, that the slide is clipped into a rigid position; and, second, that the aperture is too small to admit of the employment of the finger in moving the slide to assist in rapid focusing.' He adds, 'But these are defects which might certainly be overcome.'

The improved 'super-stage' now described is believed to obviate these objections, and is not only 'an efficient substitute' for a

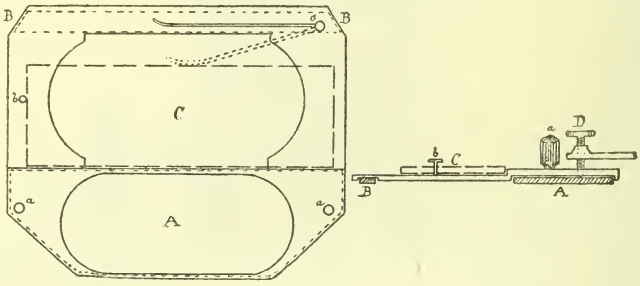
* Reichert's Catalogue No. 18 (1892).

† Amer. Mon. Micr. Journ. xiv. pp. 100–3. ‡ Carpenter, 7th ed., p. 169.

mechanical stage, but a most desirable substitute for usual work with the Microscope; permitting, as it does, absolute freedom of movements about a field for full two inches horizontally and one inch vertically, thus allowing ample room for even serial sections; and possessing, as it does, exquisitely smooth sliding movements, over the stage proper of the Microscope, of almost absolute precision. My carriage and stage, made for me a year ago by Zentmayer of Philadelphia, after my own specifications, is of such excellent workmanship as to give perfectly level and precise movements under a power of 2250 diameters (Zeiss 1/12 homo. immers., 18 compens. ocular).

The drawing shows in fig. 63 a plan of the sliding carriage, and in fig. 64 a cross-section on a vertical central line. The stage should have

Fig. 63. Fig. 64.



two flat rails, one on each side of its aperture, slightly raised above the surrounding surface, on which the carriage slides; and the stage may be square or round in shape, as preferred. The outlines of the carriage are shown by the full lines of the figures. Affixed to the bottom of the carriage are glass rails, A and B, of which the outlines and positions are indicated by dotted lines. These glass rails of the carriage slide on and over the metal rails of the stage. The circles *a a* and *b* show respectively knobs for holdfasts and a centering stop for object slide C, indicated by the broken lines of the figures. A spring clip *c* is provided, which can be swung against the upper side of the slide, as indicated by the dotted lines in fig. 63, to hold it securely in place when the stage is perpendicular or while it is rotated, or swung aside out of the way as shown by full lines. The slide rests with sufficient security against the ledge of the carriage when the stage is level or inclined, free from being clipped in a rigid position, justly criticized as objectionable by Dr. Dallinger. The carriage is kept in contact on the rails of the stage by the spring and ivory-pointed thumb-screw D, and the pressure thereby regulated. It will be observed that there is ample room in the opening of the sliding carriage, above the object-slides, to insert the end of the forefinger in quick focusing as recommended by Dr. Dallinger and practised by many microscopists; and also that the object-slide is not slipped in a rigid position, but can be when desired. This opening also permits the use of wide angle, short focus or immersion substage con-

densers. By placing the forefinger on the holdfast a, the middle finger on the post of the spring clip c, and the thumb against the lowest corner of the sliding carriage, an object can be moved around and about the whole field of view, with the greatest facility and precision, and perfect control, while the other hand is constantly used at the same time in adjusting the focus as desired. Personally, I think such a carriage should be as light as possible, consistent with sufficient rigidity in construction. My own weighs only a little over one ounce; the brass part, supporting the object slides C, being 1/25 in. thick, and that holding the broad glass rail A, double that thickness. The ledge against which the object slides lie, should, I think, be lower than their average thickness, to permit passing under high-power objectives so as to allow examination, even to the extreme edges. The ledge of my own carriage is 1/25 in. high, and I find this ample to securely support ordinary object-slides, and low enough to pass under the highest power objectives.'

The Society of Arts Microscope.*—The following is an account of the discussion on this subject which took place before a meeting of the American Microscopical Society last year.

"Prof. Claypole then read a paper on 'The Society of Arts Microscope as a cheap Microscope.' This instrument was designed and made forty years ago, and is still sold in England for about fifteen dollars.

Mr. G. S. Woolman: What does Prof. Claypole consider cheap?

Prof. Claypole: Twenty to twenty-five dollars.

Mr. C. L. Griffith: What wages are paid by these Microscope-makers?

Prof. Claypole: I do not know; we have no instrument made on the same plan.

Mr. G. S. Woolman: I sold this instrument for many years at 22·50 dollars. It is a miserable instrument. The American makers make much better ones for 30 dollars.

Dr. Blackham: When I first commenced to use a Microscope I used one of these instruments. It is a little better than the Craig Microscope, or a drop of balsam in a pinhole. The lenses are not as good as a 1·50 dollar pocket magnifier—it is beneath contempt. The value of a stand is to hold the tube steady, and I would rather have a Jackson model and sliding-tube than that. The curious system of leverage it possesses magnifies every error of workmanship. The large model known as the Ross, which is similar to it, has been abandoned. The instrument I worked with was so badly made as to be worthless. Such traps are more likely to disgust a student with microscopy than to lead him on.

Prof. Rogers: We have here two opinions—one that of an instructor who has successfully used the instrument in the class-room; the other that of a dealer who formerly sold the instrument. It is only fair that both opinions should have their due weight. In regard to the choice between an instrument simple in form but of good mechanical construction, as compared with a high-priced stand, I prefer the former. I use for most purposes a Bausch and Lomb stand costing about 12 dollars. It is well to keep in mind that nearly all the valuable work—e. g. in

* Proc. Amer. Micr. Soc., xiv. (1892) pp. 32-3.

astronomy—has been done with instruments of comparatively small size. We may go further and say that a large part of the discoveries made in this science have been made with telescopes of moderate power. Dawes made his famous discoveries of double stars with a telescope having an aperture of only 8½ inches. The most of Herschel's discoveries were made with a telescope of small aperture. It often occurs that solidity in mechanical construction more than compensates for increased magnifying power.

Mr. G. S. Woolman: The American makers furnish a better low-priced stand than the European.

President Ewell: All Microscopes are good, but some are better than others. I would not select the Society of Arts instrument, but let us be tolerant. Some English authorities favour that stand. I would buy a model such as Brother Blackham has, but let us encourage every one to get a Microscope of some sort.

Mr. Turner: I look at this matter from the standpoint of the manufacturer. Men will accept, use, and pay for European work of a worse character than they will take from American manufacturers, and then criticize the latter.

President Ewell: I want to say that the best work in the world is made in the United States.

Professor Claypole: I agree with the President, but this instrument was made forty years ago; Dr. Carpenter was the leading man in getting it made, and advocated it. I maintain that it is better the student should get such an instrument as this, and keep up to his work, than to drop it."

(3) Illuminating and other Apparatus.

Three new Accessories for the Microscope.*—Mr. E. H. Griffiths describes three accessories that are easily made by additions to the Griffith focus-indicator, which has already been described to the American Society of Microscopists.

Fig. 65 is a rough sketch of the focus-indicator as now in use.

Fig. 66 represents the same device attached direct to the nose-piece of the Microscope or to an adapter, and figs. 65 and 66 are introduced here simply to show that the indicator is a portion of the new accessories to be described.

Fig. 67 is an object-holder to be used as an excellent substitute for stage-forceps, and for many objects it is much more convenient than the forceps. Near the bottom of the spindle-dropper of the indicator a small hole is drilled for the introduction of a pin, as illustrated in the sketch. The insect or other object for examination may be placed in focus by raising or lowering the dropper, and it may be turned over or placed in any position desired.

This device may be used as a mechanical finger for arranging diatoms, &c. The pin in fig. 67 must be removed, and a cat's whisker or other finger put in its place. It may be thrown into focus and out of focus by means of the Microscope adjustments.

Fig. 68 represents a revolving diaphragm with as many apertures as

* Proc. Amer. Soc. Micr., xiii. (1891) pp. 47–8.

may be desired. It is made of thin metal, and may be quickly attached to the bottom of the indicator-dropper and quickly placed in any position where desired.

Other accessories made by additions to the focus-indicator will be described later.

Fig. 65.

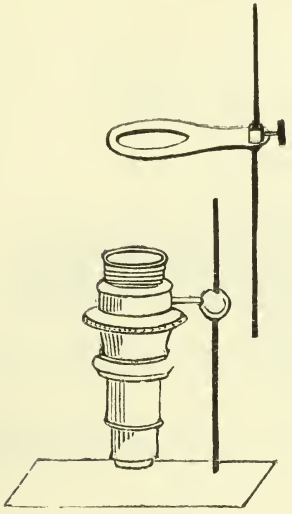


Fig. 66.

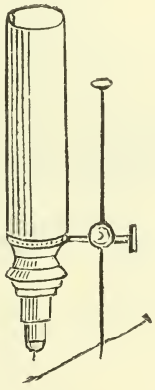


Fig. 67.

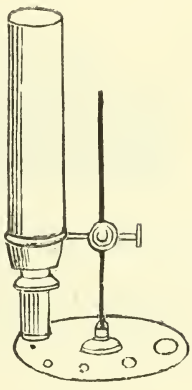


Fig. 68.

Filar Micrometers.*—Prof. W. A. Rogers considers that there are two requirements in the construction of a good filar micrometer to which manufacturers have given too little attention, viz. equality in the diameters of the fixed and movable threads, and ease and uniformity in the movement of the measuring screw.

The author considers that as regards uniformity in diameter, quartz fibres are far superior to spider lines. They appear to be truly circular and any required diameter can be easily obtained.

The second difficulty may be met by the use of a long spring instead of the usual short stiff one for keeping the slide in contact with the end of the screw. For this purpose nearly the whole length of the frame can be utilized by the use of guide-pulleys at one end, thus allowing the spring to lie parallel with the sliding plate.

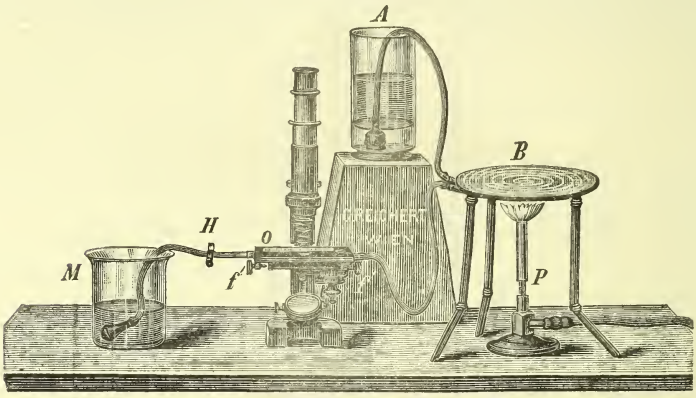
Micrometers made for the author on this plan by Bausch and Lomb have given very satisfactory results.

Reichert's New Heating Apparatus.†—This apparatus, fig. 69, is used for the stage described on p. 383. It was designed by Dr. Spietschka in order to obtain a uniform heating of the hot stage during the course of prolonged investigations. A is a large vessel containing

* Proc. Amer. Soc. Micr., xiv. (1893) p. 132.
† Reichert's Catalogue No. 18 (1892).

water which passes into the spiral B, where it is heated to a given temperature by a Bunsen burner provided with an automatic regulation of the

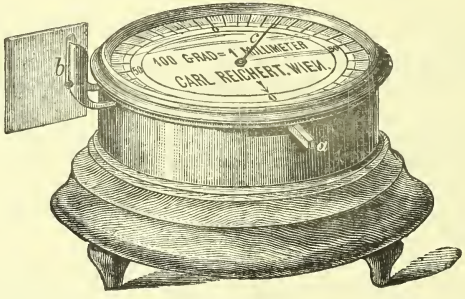
Fig. 69.



gas supply. By means of the stop-cock H the rate of passage of the hot water to the hot stage, and consequently the temperature of the latter, can be conveniently regulated.

Reichert's new Cover-glass Measurer.* — With this instrument, represented of half its natural size in fig. 70, the most exact measure-

Fig. 70.



ments of 0·01 to 8 mm. can be quickly and conveniently made. The clamp *b*, in which the cover-glass to be measured is fixed, is opened by a slight pressure upon the lever *a*.

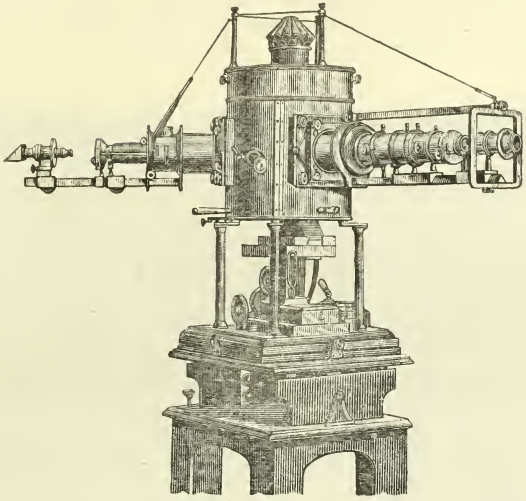
Sir David Salomons' Electric Lantern.—The following figures† represent this lantern as shown by Sir David Salomons at the May Meeting of this Society (see *ante*, pp. 383–4, 424–6). Fig. 71 shows the instrument with the polariscope on the right and the Microscope on the left. Fig. 72 gives another view with the Microscope on the right, and also showing the third front.

* Reichert's Catalogue No. 18 (1892).

† We are indebted to the Camera Club for the use of the clichés.

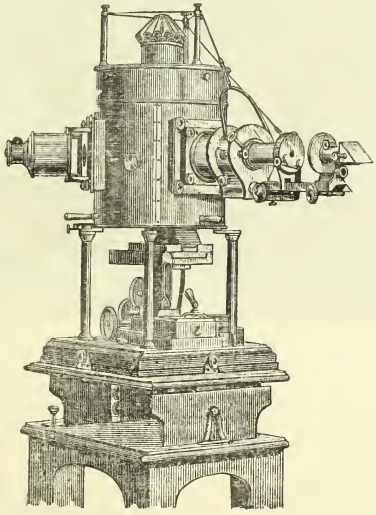
The lantern with its apparatus can be rapidly erected. All parts are interchangeable, and only attached with one screw. No support is

Fig. 71.



required for any apparatus outside the lantern. Support is obtained by straining-rods from portions which project far beyond the lantern case

Fig. 72.

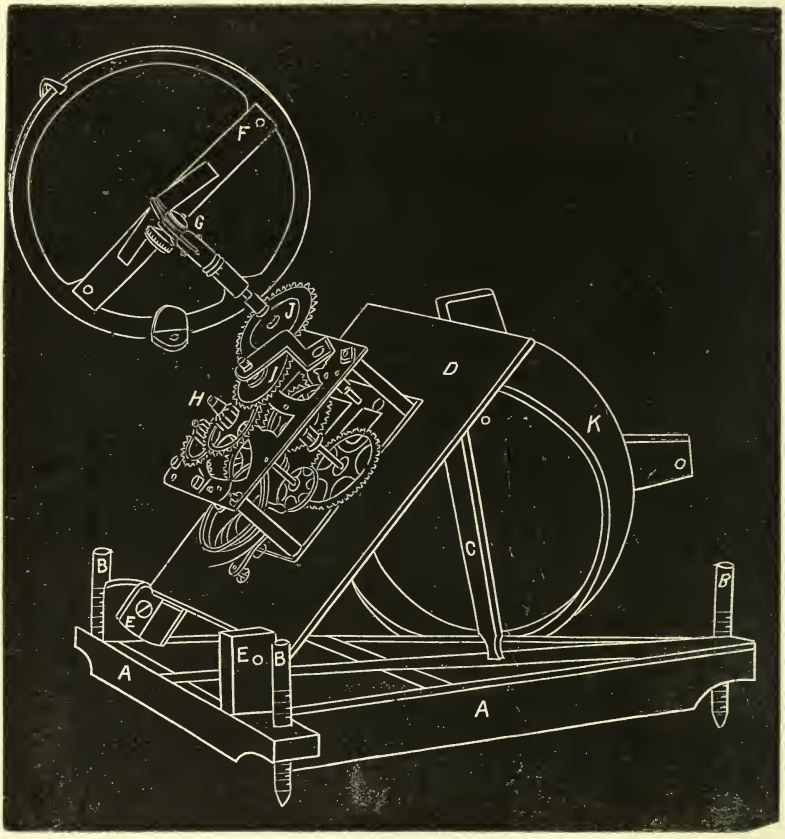


to pillars attached at the top of the lantern. In other words, the same principle is employed which is now so much in vogue with bridges, i. e. the cantilever principle.

(4) Photomicrography.

New Heliostat.*—Dr. Lyman S. Deck writes as follows:—"This simple and inexpensive form of heliostat, some idea of which can be gained from the accompanying illustration, is designed more especially

Fig. 73.



A, Triangular frame on levelling screws B. D, Plate of clock movement. C, Brace for inclining movement at proper angle. E, Posts on which clock-plate turns. F, Mirror frame on joint G. H, Hour spindle carrying wheel with 10 cogs. I, Wheel for reversing the motion of the mirror. J, Wheel having 40 cogs on spindle carrying the mirror. K, Brass case to protect the clockwork from dust.

for use in photomicrography and with projection apparatus. It is constructed on a principle similar to the equatorial telescope, and consists essentially of a mirror revolving on an axis parallel to the axis of the

* Proc. Amer. Soc. Micr., xiii. (1892) pp. 49 and 50.

earth and in an opposite direction to the earth and with one-half its velocity, or making a complete revolution once in 48 hours. It may be made from the works of a common clock, having a balance, in the following manner:—

First remove the striking parts of the clock and procure three cog-wheels,* one having 10 cogs, one 40 cogs, and the third wheel any convenient number. Now fasten the one having 10 cogs to the spindle of the hour-hand and in its place. Next, to carry the mirror, make a spindle about three inches in length and fasten the wheel of 40 cogs to it at such a place that when it is in its place in the framework of the clock it will be on a level with the wheel of 10 cogs, and then drill holes to receive it in the framework of the clock, taking great care to have it sit perpendicular to the frame when in place. Now attach the third wheel to the framework so that its cogs will match with the other two wheels and cause the spindle carrying the mirror to revolve in the same direction as the hands of the clock.

A plane mirror may be attached to the spindle by a ball-and-socket joint or any convenient means.

Now make a flat tripod base of iron with three levelling screws, and attach the clockwork to it by means of a hinge so that it can be elevated to correspond to the latitude of the place.

To use the instrument, set it up with great care exactly north and south and elevate the axis carrying the mirror by means of a protractor and plumb to correspond to the co-latitude of the place, so that the axis points directly to the north star, and then adjust the mirror so as to reflect the light to the desired place.

This simple apparatus, if well made, will answer every purpose of the more expensive heliostats and will practically keep a beam of sunlight in a constant direction for hours at a time.

As reflection from a glass mirror is not perfect, it is better in practice to not reflect the light at an angle too acute to the surface of the mirror."

Photomicrographs by Gas-light.†—Dr. G. M. Sternberg advocates the use of gas-light as a satisfactory artificial light for photomicrographic work. The objections to the use of the oxy-hydrogen lime-light are the considerable expense attending it and the inconvenience resulting from the necessity of frequently renewing the gas-supply when much work has to be done. The electric light is also very expensive unless an electric plant is at hand, and even then it may not be available during the day. Admirable results have been obtained by the use of an oil-lamp; but to photograph bacteria, &c., which have been stained, coloured screens must be used, and then, owing to the loss of light, the time of exposure must be considerably increased.

Under these circumstances the author was induced in 1889, when preparing a report of the investigations which he had made on yellow fever in Cuba, to experiment with gas-light, and obtained very satisfactory results.

The objective used was the 3 mm. oil-immersion apochromatic of

* "Grooved band-wheels may also be used."

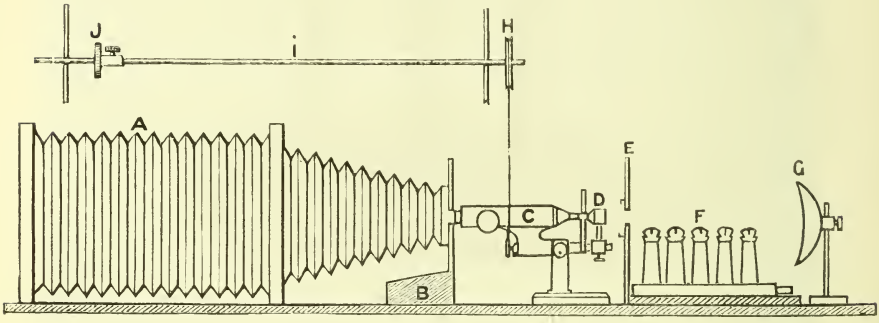
† Proc. Amer. Micr. Soc., xiv. (1893) pp. 85-90.

Zeiss, and the eye-piece his projection No. 3. An amplification of 1000 times was employed.

Most of the photographs were made from preparations stained with a simple aqueous solution of fuchsin. A yellow screen, prepared by coating a plate of glass with a film of negative varnish in which tropæolin had been dissolved, was placed at the back of the achromatic condenser. Orthochromatic plates manufactured by Carbutt of Philadelphia were used.

The arrangement of the apparatus is seen in fig. 74. A is the camera, with pyramidal bellows front supported by the heavy wooden

Fig. 74.



block B, which can be pushed back so as to enable the observer to place his eye at the eye-piece of the Microscope; C is the large Powell and Lealand stand, and D the Abbe condenser supported upon the substage; E is a thick asbestos screen for protecting the Microscope from the heat of the gas-battery F.

The gas-burners are arranged in a series with the flat portion of the flame facing the aperture in the asbestos screen. The light is reflected in the right direction by the concave mirror G. The focusing is effected by means of the rod I, which carries at one extremity a grooved wheel H, connected by a cord with the fine-adjustment screw of the Microscope. The focusing-wheel J may be slipped along the rod I and retained in any required position by a set-screw.

To avoid oscillations, soft rubber cushions were placed under the whole apparatus.

Reichert's New Photomicrographic Apparatus.*—This apparatus can be used with the highest magnifications either in the vertical (figs. 75 and 76) or horizontal (fig. 77) position. For use in the horizontal position with very high magnification, the object is first adjusted in the Microscope as in fig. 76, and then the apparatus is reversed as seen in fig. 77. The light-proof connection between Microscope and camera is effected by the socket V and the adjustable connecting piece F. The final correction of the fine-adjustment is effected by means of the string,

* Reichert's Catalogue No. 18 (1892).

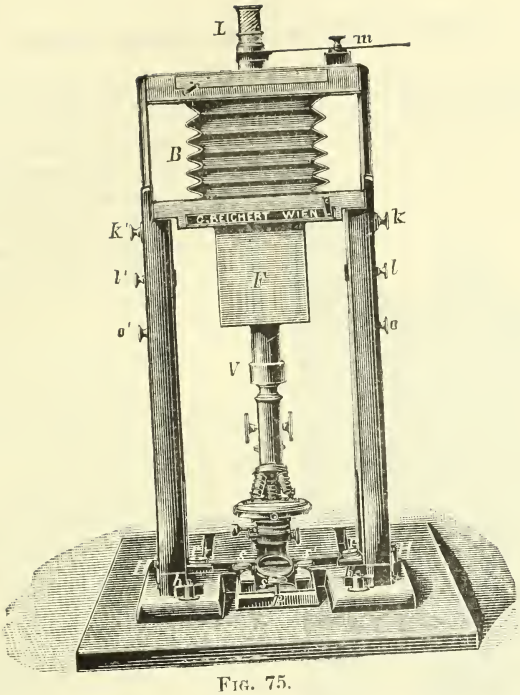

L
m
B
C. REICHERT WIEN
K'
k
l'
l
o'
o
V

Fig. 75.

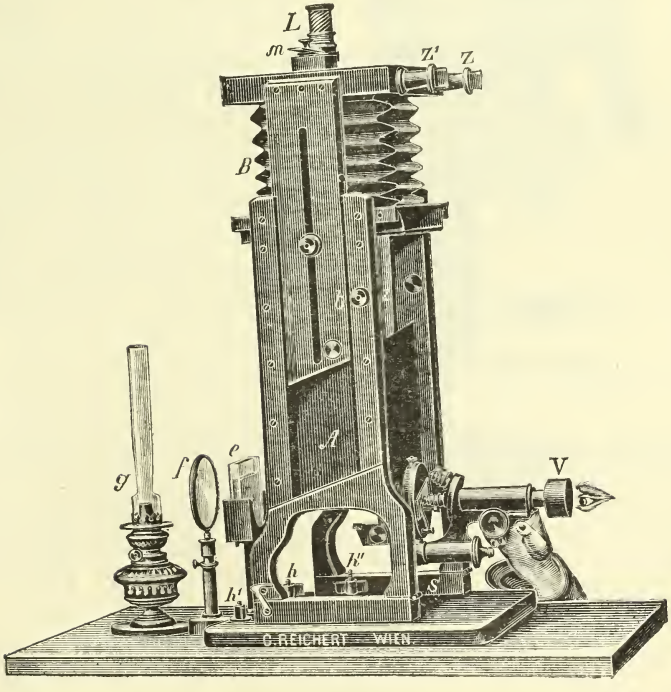

L
m
Z'
Z
B
A
g
f
e
V
h
h''
h'
S
C. REICHERT WIEN

Fig. 76.

seen in fig. 77, which acts upon the lever *a* fitted to the micrometer screw. On the glass plate of the camera four squares are etched, so that it can be simultaneously used as a transparent and as a ground glass plate. The total length of extension of the camera from Microscope stage to glass plate amounts to about 85 cm.

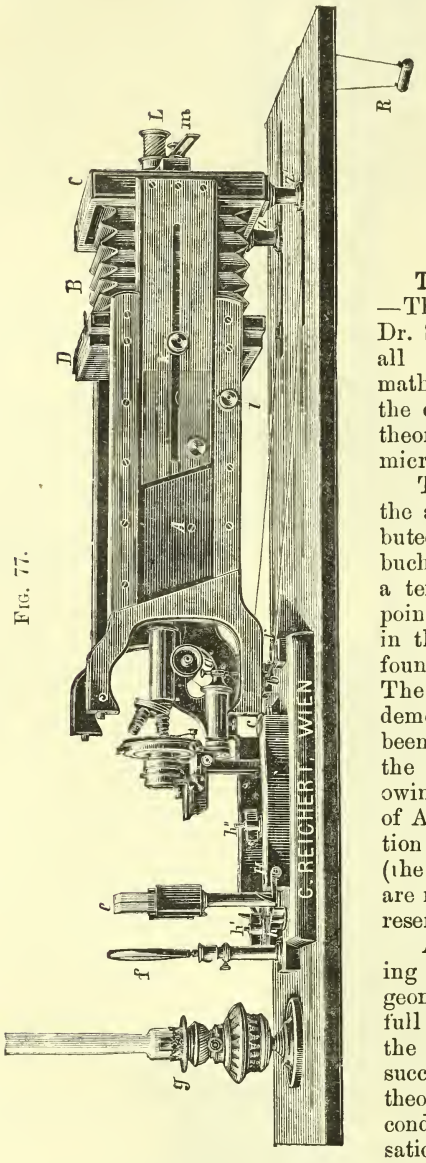


Fig. 77.

(5) Microscopical Optics and Manipulation.

Theory of Optical Instruments.* —The appearance of this book by Dr. S. Czapski will be welcomed by all microscopists who possess the mathematical knowledge necessary for the due appreciation of Prof. Abbe's theories on the formation of the microscopic image.

The book is really an abstract of the articles which the author contributed to Prof. Winkelmann's 'Handbuch der Physik.' It is not, however, a text-book of optics, as only those points are dealt with at length which, in the author's opinion, are not to be found adequately treated elsewhere. The main object of the book is to demonstrate the advances which have been made in our understanding of the behaviour of optical instruments owing to the observations and theories of Abbe. The phenomena of diffraction and the famous diffraction theory (the "Abbe theory" proper), however, are not discussed in this book, but are reserved for a subsequent work.

After a preliminary chapter dealing with the general principles of geometrical optics, there follows a full discussion of the Abbe theory of the formation of images. This is succeeded by a chapter treating of the theory of spherical aberration and the conditions necessary for its compensation (achromatism). Prisms and

* 'Theorie der Optischen Instrumente nach Abbe,' Breslau, 1893, 8vo, 292 pp., 94 figs.

systems of prisms are next considered. Then under the head of limitation of the rays and the properties of optical instruments dependent upon it, the questions of perspective, magnification, penetrating power, brightness of images, the aperture and limits to the resolving power of optical instruments are passed in review.

These general theories form the foundation for the special theory of optical instruments, the most important of which, viz. the eye, projecting systems, lens, Microscope and telescope, are then discussed in detail; for each of them the dioptric effect and the factors on which it depends are determined, and, in the case of the artificial instruments, a critical and historical review is given of the most important types of construction.

The concluding chapter of the book is devoted to a description of the methods employed in the determination of the constants of optical instruments.

At the end of each chapter is a list of the literature bearing upon the subject which has been discussed.

On the Subjective Magnitude of the Monocular and Binocular Images in the Hand-lens.*—Dr. Yves Delage gives an explanation of the increased magnification which results when both eyes instead of one only are used in examining an object through a hand-lens of large diameter.

This increase in magnification must evidently be a subjective phenomenon, since the retinal image of the second eye is equal to that of the first.

In such a question of magnification, then, there are two things to be distinguished: the real magnitude of the retinal image and the subjective sensation of the magnification.

As regards the first point. According to the text-books the lens should be placed so that the image is formed at the minimum distance of distinct vision. This may be an advantage, but is not a necessity, for between eye and object there is a considerable range of distance in which the lens will furnish sharp images; and this is also the case if the eye is displaced with respect to the lens. Similarly for each fixed distance of lens from the eye, there is a series of positions of the object giving sharp images and different magnifications; and finally there is a series of positions of the head giving distinct images. The real magnification, then, depends on the relative positions of three factors: object, lens, and eye.

Now for a given position of the lens L L′ (fig. 78) with its foci F F and of the object O O′, the image I I′ has a position and magnitude fixed and independent of the eye which perceives it.

This image can be considered as a real object seen by the eye without the lens. It is such that any ray I C passing from any one of its points to the eye and meeting the lens in K is real in its part K C which represents the refracted ray corresponding to the incident ray O K. This image I I′ can be seen by the normal eye from an infinite distance up to the punctum proximum.

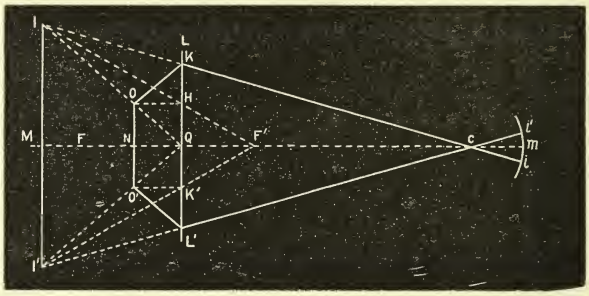
As the distance of the eye increases, the angle beneath which it sees

* Arch. d. Zool. Exp., i. (1893) pp. vi.–xiii.

I I′, i.e. the retinal image, diminishes. Thus in order to obtain images as large as possible, the eye must be placed as close as possible to the lens.

Now let the distance of the lens from the object be varied. The more the lens is separated from the object, the nearer is the latter to the

Fig. 78.



focus and the greater is the image. But the retinal image diminishes as I I′ recedes, and in fact I I′ recedes more rapidly than it increases, for the formula $\frac{I}{O} = \frac{p'}{p}$ put in the form $I = O\frac{p'}{p}$ shows that, O being constant, in order that I may vary uniformly with p', p must be constant. This is not the case, however; p varies much less rapidly than p', but in the same direction as it. In order to obtain the largest retinal image, then, the lens must be approached to the object. But in this direction there is a limit, for as p diminishes, so does p', until it becomes equal to Δ, the minimum distance of distinct vision.

To put this in a more mathematical form, let λ be the distance C Q of the lens to the nodal point of the eye, and consider only the half of the figure situated above or below the optic axis M m. The retinal image is measured by the tangent of the angle α of the extreme rays. But $\tan \alpha = \frac{I}{p' + \lambda}$. The retinal image will therefore be so much greater as λ is smaller; which shows that the eye must be placed as near as possible to the lens.

On the other hand, from the similar triangles F′ Q H, in which H Q = O and Q F′ = f, and F′ M I: we have

$$\frac{I}{O} = \frac{p' + f}{f}.$$

$$\therefore \quad \tan \alpha = \frac{O}{f} \times \frac{p' + f}{p' + \lambda} = \text{constant} \times \frac{p' + f}{p' + \lambda}.$$

Now by varying p', the fraction $\frac{p' + f}{p' + \lambda}$ will vary in the same direction or in the opposite, according as it is less or greater than unity. Thus $\tan \alpha$ will be a maximum when p' is a minimum, so long as λ is less than

f, and this will be the case unless the lens is very thick. It follows from this that the myope can see with the lens more details than the emmetrope, since he is able to make p' less.

On the other hand, however, the magnification defined by $\frac{I}{O}$ is less for him than for the emmetrope, for $\frac{I}{O} = \frac{p'}{p} = \frac{p'(p'+f)}{p'f} = \frac{p'+f}{f}$, which shows that $\frac{I}{O}$ is a maximum when p' is. This is only an apparent contradiction, for the service rendered to the emmetrope by the instrument can be greater than that rendered to the myope, without the latter ceasing to keep the advantage over the former.

Now to consider the second point, viz. the subjective sensation of the magnification of images. Besides the magnitude of the retinal image we have as another element the distance. All objects seen under the same visual angle ought to appear equal, but we *feel* them more or less great because we refer them more or less far in the angle. Thus a doll of 15 cm. seen at 1 metre appears smaller than a woman of 1 m. 50 seen at 10 metres, although they furnish equal retinal images. So inversely a man appears as large at 5 metres as at 10. To what distance then are the images furnished by the lens referred?

In monocular vision the images furnish no direct indication as to their situation on the visual ray. Indirectly we are guided by comparison with other objects in the field of view and also by the effect of accommodation, but this element of judgment is not very precise. In the case of the lens, if it alone influenced us, we should refer the image to its true distance, but other effects intervene which cause us to modify our impression. According to the author's experience we refer the image nearly to the position occupied by the object which furnishes it. Thus in examining with a lens an object on a table, the field of the lens does not appear to be sunk into the table as would be the case if the retinal image was referred to the distance of the virtual image. The feeling of the continuity of the parts seen in the lens with their prolongation beyond the field dominates the less intense impression of the effect of accommodation. The resultant sensation is doubtless a compromise between the organic sensation and the corrected sensation, but much nearer the latter than the former, at least with persons who frequently make use of the lens.

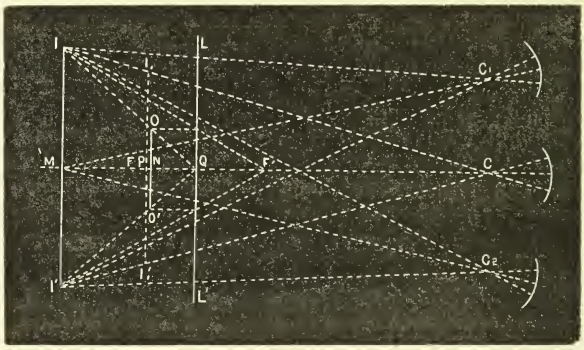
Thus the image seen with the single eye is always estimated below its true dimensions. When, however, both eyes are opened, the convergence of the optic axes furnishes instantly a precise and intense indication which dominates all the preceding vague approximations; the image is referred to its true distance and consequently appears greater. Thus in fig. 79 the rays starting from the point N which, without the lens, would make an angle $C_1 N C_2$, form after refraction the smaller angle $C_1 M C_2$. The eyes have the same direction as if O O′ were at I I′. With a single eye C the image is referred in the angle α to the distance C P, and $I_1 P$ measures its apparent magnitude; while with two eyes C_1 and C_2 it is seen beneath the same angle at a distance C M, and its apparent magnitude is represented by I M.

From fig. 79 we have $\frac{\text{I M}}{\text{I}_1\text{ P}} = \frac{\lambda + p'}{\lambda + p}$, for C P does not differ sensibly from C N.

Replacing p by its value $\frac{p'f}{p' + f}$ drawn from the equation $\frac{\text{I}}{p} - \frac{\text{I}}{p'} = \frac{\text{I}}{f}$

$$\frac{\text{I M}}{\text{I}_1\text{ P}} = \frac{\lambda + p'}{\lambda + \frac{p'f}{p' + f}} = 1 + \frac{p'^2}{\lambda p' + \lambda f + p'f} = 1 + \frac{1}{\frac{\lambda}{p'} + \frac{f}{p'} + \frac{\lambda f}{p'^2}}.$$

Fig. 79.



This shows that the binocular image I I′ appears so much greater with respect to the monocular image $\text{I}_1\,\text{I}_1'$ as λ and f will be smaller and p' greater. To see the phenomenon under the most favourable conditions therefore, it would be necessary to take a lens of short focus, separate the object as far as possible from the lens, and place the eye close to the lens.

For the normal eye, since p' is without limit $\frac{\text{I I}'}{\text{I}_1\,\text{I}_1'}$ can become equal to $+\infty$; but actually the binocular image never appears more than double the monocular, for when the virtual image is very far from the eye, the sentiment of the reality of things is opposed to the idea that the subjective image which represents it is very far from it.

Numerical Aperture.—Dr. M. D. Ewell writes as follows on this subject:*—

"It is not proposed in this paper to enter upon any theoretical discussion, but to give the results of actual measurements of the aperture of such objectives of different makers as I have been able to procure for that purpose. The measurements were made with an Abbe apertometer, which will be found figured and described on p. 24 of Zeiss's English Catalogue, 1891, as 'No. 2.'†

I intended to repeat the measurements on another apertometer of

* Proc. Amer. Micr. Soc., xiv. (1892) pp. 44–7 (2 figs.).

† See also Journ. Roy. Micr. Soc., Jan. 1878, p. 19; 1880, p. 20.

my own construction, and to include the results of this paper, but the pressure of professional duties has prevented the completion of this work in time for this meeting. A description of this piece of apparatus may, however, not be inappropriate. See fig. 80.

Fig. 80.

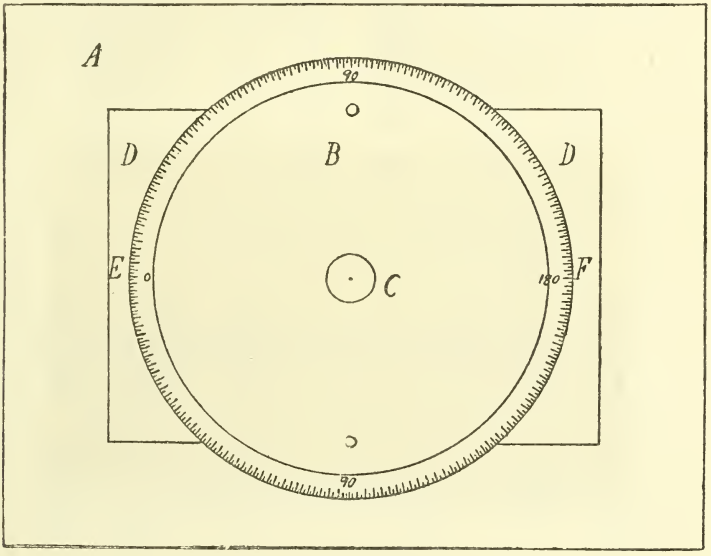
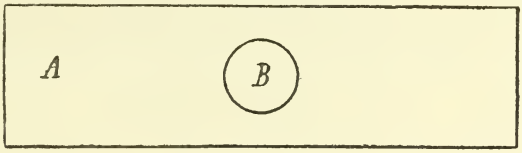


Fig. 81.



A represents an iron plate, 20 in. square and 1/2 in. in thickness, planed as flat as possible on its upper surface; B represents a brass circle 13 in. in diameter, graduated to one-half degrees, and turning around its centre C; D represent two opposite verniers, reading to single minutes of arc.

In practice, however, these are entirely unnecessary, as the unavoidable errors of measurement must exceed the least count of the verniers. The centre is read, therefore, simply to one-half degrees or, if desired, by estimation to three minutes of arc.

In fig. 81, A represents a brass slide with a small hemispherical lens B, burnished into an opening in its centre. The centre of this lens is indicated by a very small circle marked on its plane surface with a diamond while in the chuck on which it was turned up. This portion of the apparatus was made for me by Spencer and Smith, of Buffalo, New York.

Table describing Objectives.

Maker.	No.	Description.	Aperture claimed by Maker.	Aperture as Measured.	No. of Readings.	Owner of Objective.
Bausch & Lomb Optical Co.	None	Professional 1 in.	36°	30°	4	M. D. Ewell, Chicago.
" "	"	1/2 in. opaque illuminator	60°	61°	3	" "
" "	"	2 in. First Class	22°	21°	4	" "
" "	"	1/4 in. Student's Catalogue No. 608	75°	70°	3	Mrs. W. H. Bulloch, Chicago.
" "	"	1/5 in. Student's Catalogue No. 611	110°	95½°	3	" "
" "	"	1/4 in. opaque illuminator	115° *	88°	1	M. D. Ewell, Chicago.
" "	"	First Class 1/6 in.	140°	114°	3	" "
" "	"	First Class 4/10 in.	110°	111°	3	W. H. Summers, Chicago.
" "	"	1/8 in. hom. im.	1·43 N.A.	1·28 N.A.†	3	" "
Beck	"	First Class 1/5 in.	100°	98°	1	" "
Crouch	"	1 in.	25°	24°	1	" "
Grunow	"	1/6 in.	140°	150° closed 147° open	2	Dr. H. M. Farr, Mt. Pleasant, Iowa.
Gundlach	"	1/8 in. hom. im. "E"	136° B.A. = 1·41 N.A.‡	1·39 N.A. = 132° 16	3	Prof. E. S. Bastin, Chicago.
Hartnack	"	1/2 in.	40°	47°	1	W. H. Summers, Chicago.
Leitz	"	No. 3 dry (18 mm.)	N.A. 0·28	N.A. 0·28	4	Richards & Co., Ltd., Chicago.
"	"	No. 7 dry (32 mm.)	N.A. 0·85	N.A. 0·88	3	" "

* So stated by Prof. W. A. Rogers, who purchased it for me.

† Collar at 1°, best point of adjustment.

‡ Approximately.

TABLE DESCRIBING OBJECTIVES—*continued.*

Maker.	No.	Description.	Aperture claimed by Maker.	Aperture as Measured.	No. of Readings.	Owner of Objective.
Leitz	5141	1/12 in. oil im.	N.A. 1·30	N.A. 1·28	3	Richards & Co., Ltd., Chicago.
Spencer & Co.	637	1/4 in. Student's	..	94°	3	M. D. Ewell, Chicago.
„	654	1/10 in. hom. im.	130° B.A.	1·36 N.A.	4	„ „
„	None	1/25 in. hom. im.	125° B.A.	1·32 N.A.	3	„ „
Spencer & Smith	856	New Dry First Class 4/10 in.	130°	126°	4	„ „
„	862	New Dry First Class 1/8 in.	150°	167°	3	„ „
„	884	1/10 in. hom. im. (New formula)	138° B.A.	N.A. 1·41	3	
„	886	1 in.	33°	$33\frac{1}{2}$°	3	
„	893	1/2 in.	70°	71°	3	
„	907	1/12 in. hom. im. New Professional	1·00 N.A.	0·97 N.A.	3	„ „
Tolles	None	1/6 in. hom. im.	B.A. 120° = N.A. 1·32	N.A. 1·31	3	„ „
„	„	2 in. solid	Unknown	$12\frac{1}{2}$°	1	W. H. Summers, Chicago.
„	„	1/12 in. water im.	„	0·99 closed 0·90 open	2	Jno. H. Choate, Salem, Mass.
Wales	„	$1\frac{1}{2}$ in.	20°	20°	1	Preston, Chicago.
„	„	1/2 in.	60°	51°	1	„ „
„	„	1/5 in.	100°	97°	1	„ „
Zeiss	710	A A 3/5 in.	36°	31°	4	M. D. Ewell, Chicago.
„	282	C C 1/4 in.	90°	102°	3	„ „
„	194	1/18 in. hom. im.	N.A. 1·27	1·27 N.A.	3	„ „

To use this instrument, the stand with the slide figured above in position on its stage is placed on the circular disc B, with the centre of the hemispherical lens as nearly over the centre C as possible. The objective whose aperture is to be measured is focused on the centre of the hemispherical lens, the Microscope being in a horizontal position. A light—e. g. a small incandescent lamp—is then placed at a convenient distance in front of the Microscope, and the Microscope and disc revolved, and the angle of aperture in crown glass read off, as with other apertometres. The eccentricity is eliminated by taking the mean of the two readings at E and F.

I should have been glad to include more objectives in this table, but have been unable to procure them, some dealers apparently being unwilling to submit their objectives to the test proposed, since no attention was paid to my letter requesting the loan of objectives for said purpose. The table needs no explanation. No tests of the objectives were made other than to determine their aperture."

(6) Miscellaneous.

Solution of the Dust Problem in Microscopy.*—Mr. A. H. Cole says:—"The statement of the dust problem is this: Given a stock of cleaned micro-slips and cover-glasses, to keep them clean and ready for use at any moment, without the necessity of brushing or wiping them. The following solution is the result of a laboratory study of the problem, and is now announced after having received the approval of leading microscopists.

The objects to be accomplished are:—

(1) To secure a dust-proof magazine for storing the cleaned micro-slips and cover-glasses in separate compartments for the different sizes of squares, circles, and oblongs.

(2) To provide simple mechanical appliances for removing a single slip or cover without exposing those remaining in the case.

(3) To provide an automatic device for warning the operator of the approaching exhaustion of his stock of any of the shapes of covers and of slips, thus avoiding the necessity of opening the case, except to replenish stock.

(4) To provide against the breaking or disarrangement of the covers in case of the accidental overturning of the case.

(5) Incidentally to provide a mounting-table, with guides for centering the objects and cover-glasses, the whole apparatus being so constructed that the glasses are not touched by the fingers, and only once by the forceps until the slide is completed and labelled.

The dust-proof slip and cover-glass case fully meet these requirements. The case is 4½ in. square on the base, and 6 in. high. The slips and mounting-table are contained in the lower half, and the cover-glasses in the upper portion. The mounting-table has concentric lines for guidance in properly centering the objects. Four dust-excluders are hinged to the front of the grooved table to protect the slots through which the cover-glasses pass out upon the grooved table. The milled head of the roller which pushes the cover-glasses out of the slots is at

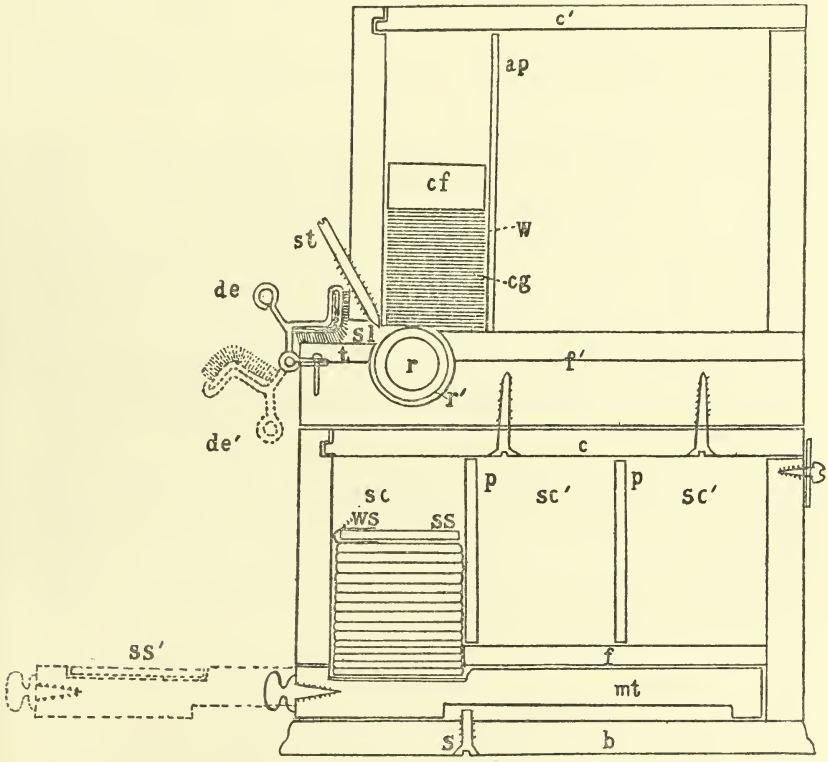
* Amer. Naturalist, xxvii. (1893) pp. 405–7 (3 pls.).

the side of the case. A screw stop is inserted in the front of the case above each slot.

The case is fitted for 3 in. by 1 in. glass slips of any thickness, and has a capacity of six to twelve dozen. It has four compartments for the cover-glasses of the sizes 1/2 in., 3/4 in., 7/8 in, or 12–24 mm., either circles or squares or oblongs of the above widths, and any lengths up to $2\frac{3}{4}$ in. The screw stops regulate the depth of the slots for either No. 1, 2, or 3 thickness of cover-glasses.

Fig. 82 is a vertical section from front to back showing the plan of the case. The section of the lower half is made in the median plane,

Fig. 82.



that of the upper half in the plane of the screw stop. Through the base *b* projects the stop *s* into a narrow groove in the mounting-table *mt*, which slides in and out between the base and the floor *f* of the stock compartments *sc'*. The service compartment *sc* is deepened by a shallow cavity cut into the upper surface of the mounting-table, and in the bottom of this cavity is fitted a sheet of celluloid bearing a series of concentric lines. The slips *ss* are stacked in the service compartment, the lowest slip fitting the shallow cavity in the mounting-table, as shown at *ss'*. A

warning slip of paper *ws* is folded around the front edge of the top slip. The loose partitions *p* running in the grooves in the sides of the case can be removed after sliding back the cover *c*. In the base *f'* of the cover-glass case is the groove *r'* for the roller *r*, which is made of brass and covered with chamois. To the front of the base is hinged the brass dust-excluder *de*, whose lining of silk plush protects the grooved table *t* and the slot *sl* from dust. The dust-excluder also prevents the delivery of a cover-glass by the roller, except when the slot is opened. Into the slot projects the point of the screw-stop *st*, which is so adjusted as to permit the passage into the slot and out upon the grooved table of only one cover-glass at a time. Above the roller are stacked the cover-glasses *cg*. Near the top of the stack is placed a warning disc *w*, and upon the top cover-glass rests the loosely fitting follower *c f*, which prevents displacement and breaking of the covers if the case is accidentally overturned. The adjustable partition *a p* may be moved backward or forward to fit any length of cover-glass from 1/2 in. to $2\frac{3}{4}$ in. The cover *c'* is so constructed as to exclude dust.

Method of operation:—Thoroughly dust the inside of the case, and partly, or completely, fill the compartments with clean slips and cover-glasses of the proper sizes, and place the warnings in position. The apparatus is then ready for immediate use, or at any time during successive weeks or months until the stock of slips and covers is exhausted.

The slips are withdrawn from the case singly by pulling forward the mounting-table, and from this they are removed, either before or after an object is mounted, by inserting a finger into the notches cut into the sides of the table. The warning slip having been withdrawn, the service compartment is again filled by removing the sliding cover which carries with it the cover-glass case, withdrawing a loose partition and sliding the cleaned slips from a stock compartment into a service compartment.

Whenever a cover-glass is needed, the dust-excluder in front of the proper slot is opened by a touch of the finger, the milled wheel is rotated and the chamois-covered roller pushes the bottom cover-glass through the slot and out upon the grooved table, where it is readily grasped by the forceps. This action is positive, because the friction between chamois and glass is greater than between two clean glass surfaces. The table being grooved, only the extreme margins of the cover-glass touch it. A touch of the finger closes the dust-excluder.

It will be noted (*a*) that the slips and covers are doubly protected from atmospheric impurities by the dust-proof case and the constant contact of clean glass surfaces with each other; and (*b*) that in the process of removal for use they do not come in contact with any surface from which they receive dust. They come out as clean as when, weeks or months before, they were put into the case. Thus the dust problem is solved."

Visit to Messrs. Bausch and Lomb's Factory.*—The following is the description of a visit of the members of the American Microscopical Society to the works of the Bausch and Lomb Optical Company. These works "are situated on North St. Paul Street, No. 515, near the Genessee

* Proc. Amer. Micr. Soc., xiv. (1892) pp. 27-9.

river, which, however, does not give them any power, that being furnished by a steam engine.

The establishment was begun in 1859 as a spectacle factory, and has gradually increased until it is now one of the largest in the world devoted to making optical goods. There are at the present time 44,500 square feet of floor space, and about 500 hands are employed, and an addition is in process of construction which will add about 62,000 feet in area, and about 200 hands to the present plant. The new part will contain a Harris-Corliss engine of 500 horse-power that will furnish power for the entire establishment. Spectacle glasses, Microscopes, and photographic goods are the principal lines of work.

Until this year optical glass was all imported, but its manufacture has now begun in this country, and the first exhibit of American made optical glass was opened at this meeting in the hall of the Rochester University. Discs were shown 30 cm. in diameter and 4 cm. thick, free from striæ and perfectly annealed, made by the firm of Geo. A. Macbeth and Co., of Pittsburg, Penn. These discs are first ground on opposite sides so that they can be looked through to see if they are perfect, and are then stored till wanted. For some lenses the glass is pressed into nearly the shape required. A pair of small scales were shown with a piece of flint-glass on one side and a piece of crown three times as large on the other, and yet the scales balanced, that being nearly their relative specific gravities.

The general methods of making lenses are nearly the same for all kinds. It consists of making a pair of metal patterns or shells having the shape of the surface of each side of the lens, and then cementing the rough lens to one with pitch, while the other is rubbed over it with the aid of grinding powders of different degrees of fineness. First coarse emery is used, then fine emery, then rouge. The latter is merely a particular kind of iron oxide, some forms of which are also known as venetian red. Every particle of a coarser powder must be carefully washed off before a finer is applied, or scratches would result.

The finer Microscope lenses have to be made by hand, one by one, the laps or shells being on the end of little handles not larger than lead pencils, and the opposite lap being kept wet with ice-water, and rapidly turned by a spindle in the bench before the workman. Sets of finished glasses lying in the boxes look like gems. The metal-work of Microscope stands is made very largely by milling machines and turret lathes. The first are run with high speed and slow feed, to finish with one cut instead of two, the single cut leaving the work finished. The turret lathes carry all the tools required to finish a given piece, say an adapter, on a revolving tail stock, whereby a slight turn brings each one successively into action.

Arrangements are now being made to cut the racks on the better class of Microscopes with a spiral tooth, similar to that used for some time on the Zeiss instruments.

This brief description is not intended to be complete, but only to touch on those points likely to be of interest to the members of our Society."

B. Technique.*

(1) Collecting Objects, including Culture Processes.

Culture of Diatoms.†—In his concluding paper on this subject, Dr. P. Miquel describes several forms of cells which he has found convenient for preserving diatoms alive, and for propagating, observing, and photographing them. He has succeeded in keeping some species alive for as long as ten months, watching all the various stages of propagation as far as the production of auxospores.

Cultivating Ascospores on Clay Cubes.‡—Dr. H. Elion recommends cubes of clay 2 by 2 by 2 cm. for cultivating ascospores. These cubes are easily sterilized, and the ascospore formation which takes place on them is very satisfactory. The author finds they are superior to the gypsum blocks.

Growing Tubercle Bacilli on Vegetable Nutrient Media.§—Dr. Sander finds that the tubercle bacilli of mammals will grow, not only on potato, as was first pointed out by Pawlowsky, but in various other vegetable media, such as carrot, turnip, radish, and macaroni. On the three first media the growth presented the appearance of chalky white nodules, while on macaroni it was almost invisible. Hence it is possible that baker's bread, &c., may sometimes be the source of infection. The reaction of these media is not so restricted as it is for those of animal origin; indeed a slight degree of acidity appears to be not only beneficial but requisite. Access of air to the cultivation appears to be necessary. The most favourable temperature is rather high, viz. from 38°–39°. At 22°–23° no growth took place. The carrot, turnip, and radish were used as solid cultivation media after the manner of potato cultures in tubes, while the macaroni was soaked and then stuck on slips of glass, which were dropped into the test-tubes. The tubercle bacilli were found to grow also in fluid media made from potato. The juice obtained from mashed potatoes was decanted, and then placed in a water-bath for one hour. From this experiments were made showing that an acid reaction was necessary. One part was neutralized with soda, and after filtration, both were sterilized. Further, to another portion of each was added 4 per cent. of glycerin. The growth was strongest in the acid glycerin potato soup.

The author also states that under some circumstances the tubercle bacillus thrives in sterilized tap-water, and that the presence of mould does not prevent this development. In vegetable media the growth will usually be found to be more luxuriant and more rapid than in animal media, these properties becoming still more marked in the second and third generation.

Certain spheroidal bright bulgings occurring at the end of the bacilli

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

† Diatomiste, i. (1893) pp. 165–72 (3 figs.). Cf. this Journal, *ante*, p. 111.

‡ Centralbl. f. Bakteriol. u. Parasitenk,, xiii. (1893) p. 749.

§ Arch. f. Hygiene, xvi. No. 3. See Centralbl. f. Bakteriol. u. Parasitenk., xiii. (1893) pp. 732–3.

are believed by the author to be an early stage of spore-formation. The author regards potato as being a superior cultivation medium for tubercle bacilli to glycerin agar, and in conclusion expresses the hope that, through vegetable cultivations, an attenuated virus, suitable for vaccination purposes, may eventually be procured. He states that the virulence of the tubercle is altered when cultivated on potato, and that this alteration increases with age.

Impervious Self-acting Self-regulating Stopper for Sterilizing Purposes.*—Dr. Pannwitz says that the rubber caps used for bacteriological purposes may also be used as stoppers for vessels when they are being sterilized. It is suggested that the lip of the tube, &c., should be broad. The rubber cap is perforated with a red-hot platinum wire at some part where it rests against the edge. The wire-made opening is of course under these circumstances quite impassable, but when the tubes or vessels are incubated, the pressure inside rises and causes the rubber cap to bulge outwards and so to open up the aperture. The author states that this device is quite effective, and that he has used it for some time for all kinds of sterilizing purposes. It certainly has the merit of extreme simplicity.

Improvising Bacteriological Apparatus.†—Prof. von Esmarch calls attention to the fact that bacteriological apparatus is often not at hand when most needed for diagnostic purposes, e. g. in an out-of-the-way place where cholera is suspected to have broken out, and under these circumstances makeshifts must be accepted. Yet nothing can supply the place of a Microscope and suitable accessories, and if these be absent almost all is lost. But other orthodox appliances can be done without and their place supplied by some temporary arrangement; for example, an incubator may be made of a saucepan in which is placed one kilo of acetate of soda dissolved in a little water, and then heated up to 60°. If the saucepan be covered up the vessel will retain sufficient heat for incubation purposes for 24 hours. Or if the vessel be filled with water at 37° a night-light placed underneath will maintain the temperature for practical purposes at the proper level.

Rapid Demonstration of Cholera Bacilli in Water and Fæces.‡—Dr. Schill says that old bouillon cultivations of cholera bacilli, which have been sterilized by boiling, form a most suitable basis for starting cholera cultures for diagnostic purposes. If the culture be some months old then 2–3 hours in the incubator after inoculation with fæces or water is quite sufficient for the purpose; if, however, the cholera bouillon be young then it may be necessary to incubate for 24 hours. Plate cultivations are next to be made of meat-pepton-gelatin and agar, the former kept at 20°, the latter incubated at 37°. At the same time it is advisable to make gelatin puncture cultures to see the characteristic liquefaction. A few loopfuls of the first tubes should be transferred to alkaline pepton water (1 per cent. pepton, 0·5 per cent. sodium chloride, 1 per cent. crystallized soda) to test for cholera red reaction which will,

* Centralbl. f. Bakteriol. u. Parasitenk., xiii. (1893) pp. 754–5.

† Hygienische Rundschau, 1892, p. 653. See Centralbl. f. Bakteriol. u. Parasitenk., xiii. (1893) p. 628.

‡ Centralbl. f. Bakteriol. u. Parasitenk., xiii. (1893) pp. 750–2.

if the quantity of the virus inoculated be sufficiently large, be evident in three hours. This reaction is much better obtained if a few loopfuls of a cholera cultivation be placed on a white porcelain dish and then a loopful of sulphuric acid added, than in the usual way of pouring acid over a cultivation.

Present Position of the Bacteriological Diagnosis of Cholera.* — Prof. R. Koch discusses the diagnosis of cholera under several heads, viz. microscopical examination, cultures in pepton solution, on gelatin and agar plates, cholera red reaction, experiments on animals.

The author regards a microscopical examination of the alvine discharge as most important. Some of the mucoid secretion found in the motions or in the intestinal canal after death should be used for making cover-glass preparations, and these stained with dilute Ziehl's fuchsin solution. In cases of cholera such preparations are nearly always successful and frequently show the characteristic arrangement in clusters of the cholera bacilli.

The diagnosis is then to be confirmed by cultivating the organism simultaneously in pepton and gelatin. The tubes are incubated at 22° and 37° respectively. In 8 hours the pepton cultivation will have sufficiently developed to give the cholera red reaction if the cholera vibrio be present. In 20–24 hours the gelatin plates show the cholera colonies. Where there is considerable doubt at the first, agar plates should also be employed, and these inoculated from the pepton cultures after they have incubated for 6 hours, and 10 hours later the diagnosis may be confirmed by the red indol test.

Sometimes the cholera organisms develope slowly and in small numbers, both in pepton and gelatin. If in these there be none, but on agar some suspicious looking colonies, then a completely new set of cultures on all three media must be started and when ready submitted to the sulphuric acid test and experiments made on animals.

Cultures in pepton solutions are made by adding a few drops of the choleraic dejecta or a small quantity of mucus from the stools with a platinum loop to a sterilized 1 per cent. solution of pepton mixed with 0·5-1 per cent. of sodium chloride, and the reaction of the solution must be alkaline. The cultures are incubated at 37°. The pepton cultivations should be confirmed by gelatin plate cultivations. These are made of 10 per cent. gelatin and incubated at 22°. In 15–24 hours characteristic colonies will be apparent. On agar plates the colonies are of medium size and of a brownish-grey colour.

The cholera red reaction is regarded by the author as extremely important since the cholera vibrio is the only comma-shaped organism which gives the reaction. The reaction consists in the formation of a red colour when pure H_2SO_4 is added to a cultivation, and is due to the presence of indol and nitrous acid.

Experiments on animals are of importance since the cholera spirillum is the only one known which when injected into the peritoneal sac produces toxic effects. About 15 decimilligrammes—about as much as can be picked up on a platinum loop—is removed from an agar cultivation, mixed with a cubic centimetre of broth, and injected into the

* Zeitschr. f. Hygiene, xiv. No. 2. See Medical Week, 1893, pp. 265-9.

peritoneal cavity. Toxic symptoms appear soon after the operation, the temperature soon falls, and the animal dies.

Bacteriological Examination of Water for Cholera Bacilli.* — Prof. R. Koch finds that the following method is the most reliable for detecting cholera organisms in water. To 100 ccm. of the water to be examined, 1 per cent. of pepton and 1 per cent. of sodium chloride are added, the mixture being kept at 37°. At the end of 10, 15, or 20 hours a number of pepton tubes and agar plates are inoculated with this culture. The microscopical examination is so far of unimportance as all sorts of comma-shaped organisms are always to be found in water, but the colonies on the agar plate should be carefully examined under the Microscope in order to see if they consist of comma organisms. If so they should be transferred to fresh culture media for the cholera red test and for experiments on animals.

Cultivation of Leprosy Bacillus.†—Dr. A. Ducrey made numerous cultivations from leprous persons and succeeded in obtaining in grape-sugar-agar a growth which became evident to the naked eye six days after inoculation as a thin coating with indented edges. Cultivated *in vacuo* in bouillon the organism showed itself in 48 hours as a thin overlay on the side of the tube. A culture one year old in grape-sugar-agar and kept at 20° would, when transferred to bouillon and cultivated in the absence of air, still develope freely. The cultivations consisted of bacilli, which when stained with anilin-water-fuchsin and afterwards treated with alcohol were quite like leprosy bacilli in tissues. They are thin, straight, or slightly bent rods with rounded ends, of various lengths, but on the average somewhat shorter than leprosy bacilli. They are quite motionless. Many stain quite regularly, others show bright spots in their interior. Very short forms are also present and the chain or rosary form is not infrequent. They also stain well with gentian-violet methyl-violet, methylen-blue, by Gram's and the Koch-Ehrlich methods, but not by those of Ziehl-Neelsen, Gabbet, and Baumgarten. Inoculations on rabbits entirely failed.

The author identified his *in vacuo* cultivation with a cultivation obtained by Campana and de Amicis, and he finally succeeded in obtaining pure cultivations from his eight cases in simple bouillon cultures *in vacuo*.

Cultivating Gonococcus.‡—Dr. C. Gebhard cultivated gonococcus in blood obtained by catching this fluid, as it flowed from the vulva after expulsion of the placenta, in sterilized Erlenmeyer's flasks. The flasks were placed for 24 or 48 hours in a refrigerator, and then 1–3 ccm. of the serum were removed to so many sterilized test-tubes. After this the tubes were sterilized by heating them on 7 consecutive days for 1½ hours at 58°. The absence of germs was then tested by incubating the tubes for several days at 37°. Those tubes which contained the clearest serum were then mixed with 2 parts of meat-pepton-agar and allowed

* Zeitschr. f. Hygiene, xiv. 2. See Medical Week, 1893, pp. 265–9.

† Giorn. Ital. delle Mal. Vener. e della Pelle, xxvii. (1892) p. 76. See Centralbl. f. Bakteriol. u. Parasitenk., xiii. (1893) pp. 627–8.

‡ Berl. Klin. Wochenschr., xxix. No. 14. See Centralbl. f. Bakteriol. u. Parasitenk., xiii. (1893) pp. 565–6.

to set obliquely. In order to avoid entrance of germs when the fluids were mixed, the author mixed them before sterilizing the serum. The serum, which is stained brown from the hæmoglobin, can be used very well for plate cultures, and for this purpose it is recommended to use equal parts of blood-serum and meat-pepton-agar. The plates inoculated with some loopfuls of gonococcus pus show, when kept at the body temperature, in 24 hours, in addition to many other colonies, very small whitish-yellow points, which by the third day after inoculation have become so great that their characteristic irregular form can be descried with the naked eye. Magnified fifteen times, the deep-lying colonies are seen to be sharply defined, of irregular shape, and with many prolongations. The colour of the colonies is brownish and is due to optical causes and not the result of the presence of pigment. The growth of the deep-lying colonies is slow and ceases at the beginning of the second week when they have attained the size of a pin's head. The superficial colonies form pretty regular glassy scums with sharp irregular margins. On oblique media the colonies look like glassy drops 12 hours after inoculation.

Permeability of the Chamberland Filter to Bacteria.*—M. E. de Freudenreich records his observations on the permeability of the Chamberland porcelain bougie filter to bacteria. The same subject has been dealt with by other observers, notably Kitasato, Kübler, Giltay, Aberson, and Miquel. The author's apparatus was very simple, and consisted in placing the bougie inside a vessel filled with the infected fluid and filling the exhaust pipe close to the filter with cotton wool. The experiments were of two classes, those in which the fluid was bouillon infected with enteric fever bacteria, and water. Several experiments with the typhoid cultures showed that no bacilli passed through; cultivations made with the fluid drawn through remained quite sterile. In the second series water was filtered through at 35°, at 22°, and at the ordinary temperature of the room. In the first instance bacteria were cultivated from the filtered water passing through on the sixth day; in the second on the tenth day; while in the third it was sterile on the twenty-first. It is obvious therefore that germs do pass through, and that temperature plays an important part. For practical purposes therefore it is necessary that the filter should be sterilized once a week.

Plate Method for cultivating Micro-organisms in Fluid Media.†—Dr. P. Drossbach has devised a method for obtaining pure cultures. The principle consists in having a number of patches of nutrient material on one plate and infecting each plot with a very dilute solution of the fluid to be examined. The plates are made of stout glass in which are pressed or ground out a number of depressions from 2–3 mm. deep. The plates are about 100 sq. cm. in size and it is convenient to have plates with 3, 5, 9, and 16 depressions to the sq. cm. Plates which are not to be exposed to a high temperature are easily made by pouring paraffin in Petri's capsules to form a layer 3 mm. thick and when the paraffin has become cold making the necessary depression with a cork-borer or other tool.

* Ann. de Microgr., iv. (1892) pp. 559–68 (1 fig.).
† Centralbl. f. Bakteriol. u. Parasitenk., xiii. (1893) pp. 455–7.

The material containing the bacteria is to be diluted with bouillon until 2–3 ccm. of the fluid contains less than 1000 viable germs if each depression is to contain representatives of one species only. Excess of fluid should be removed from the surface with strips of stiff, smooth, sterilized paper. The plates are then incubated at any temperature and in a few days characteristic changes may be observed in the bouillon. If the fluid inoculated has been sufficiently diluted the number of pure cultivations will predominate. Special care is to be taken that the droplets do not run together.

Dr. K. Holten * states that he has used a similar method of cultivation for some time. A number of separate compartments are made in a glass plate by means of asphalt or the like substance. Each square space receives, by means of a fine pipette, a droplet of fluid; the fluid fills but does not exceed the whole space. To prevent contamination each plate should be covered with another, the two being about 2 mm. apart and separated by means of strips of asbestos fixed with some adhesive or by plaster of Paris.

The author uses plates 12 by 9 cm. divided into seventy compartments and finds that the larger the plate the better the result; the breadth, however, should not be too great to prevent every part from being examined under the Microscope. The plates may be dry or steam sterilized.

The material to be examined should be so diluted with the nutrient solution that not more than 1/4 of the drops are infected, and if the approximate number of germs in a definite quantity be unknown then plates of different dilutions must be made. If, however, it be important that the composition of the nutrient fluid should not be altered, then the nutrient medium must be correspondingly concentrated. The plates should be incubated in a moist chamber in order to compensate for evaporation. For a day or two the infected drops begin to get cloudy, and then they may be examined macroscopically and microscopically.

Action of Disinfectants on dry and wet germs.†—MM. Ch. Chamberland and E. Fernbach give the results of numerous experiments with eau de Javelle, chloride of lime, peroxide of hydrogen, and sublimate on *Bacillus subtilis*. This particular organism was selected on account of its great resisting power, and the action of the disinfectants was tested against the germs in the moist and dry condition. In the moist condition a definite quantity of a liquid culture was mixed with a definite quantity of the disinfectant, and the two well shaken up together. From the mixture cultivations were made at various intervals, some of the undisinfected cultivation being kept for control. The experiments on the germs in the dry condition were made in the usual manner, that is to say, they were dried on pieces of glass or silk threads. The authors conclude from their experiments that commercial eau de Javelle (hypochlorite of soda), chloride of lime (a solution of 100 grm. in 1200 grm. of water, diluted with ten times the volume of water), commercial oxygenated water (H_2O_2) are more active than an acid solution of sublimate (1–1000). These disinfectants do not, or only after several

* Centralbl. f. Bakteriol. u. Parasitenk., xiii. (1893) p. 753.

† Ann. Inst. Pasteur, vii. (1893) pp. 433–80.

hours, act on moist germs, if they be used at ordinary temperature, but if they be heated to 40°–50°, or even higher, moist germs are destroyed much more rapidly—a few minutes suffice. Hence it follows that whatever the disinfectant used, it should be made as hot as possible.

Dry germs are more resistant than moist germs ; while the latter are killed in a few minutes, the former may resist for several hours, even at a temperature of 40°–50°. Hence it follows that the germs must be moistened before the disinfectant can act. It was found that when dry germs were damped, especially with warm water, they were attacked after an hour's soaking, just as rapidly as if they had been wet. The necessity of spraying the walls of a room with water before using a disinfectant is therefore of paramount importance. The authors call especial attention to the fact that a saturated solution of calcium chloride is far less active than when this solution is diluted with 10 or even 20 times its volume of water; and that too on moist or dry germs at ordinary temperatures or at 50°.

The disinfectants used on *Bacillus subtilis* destroy very rapidly, in several minutes, and even when used cold, anthrax spores, *Aspergillus niger*, beer yeast, and the microbe of enteric fever.

For practical disinfecting purposes, the authors recommend the chloride of lime solution, as it is effective, economical, and not dangerous.

Method of using Thor Stenbeck's Centrifuge for detecting Tubercle Bacilli.*—Dr. L. Kamen first treats the sputum suspected of containing tubercle bacilli by Biedert's methods, and then with absolute alcohol, until the mixture has the same specific gravity as water. By this means the tubercle bacilli will be found to collect in the sediment, which, as their specific weight is only 1023, they will not do in the much heavier fluid, the gravity of which is never less than 1035.

Method for Testing Filtering Apparatus.†—The opinions as to the value of Chamberland's bougies are, say Dr. E. Giltay and M. J. H. Aberson, extremely divergent, some persons regarding them as indispensable, and others as perfectly useless. It seemed desirable, therefore, to devise some method for accurately testing their value, and the authors have constructed an apparatus, by means of which samples of the water can be tested from time to time during the process of filtration.

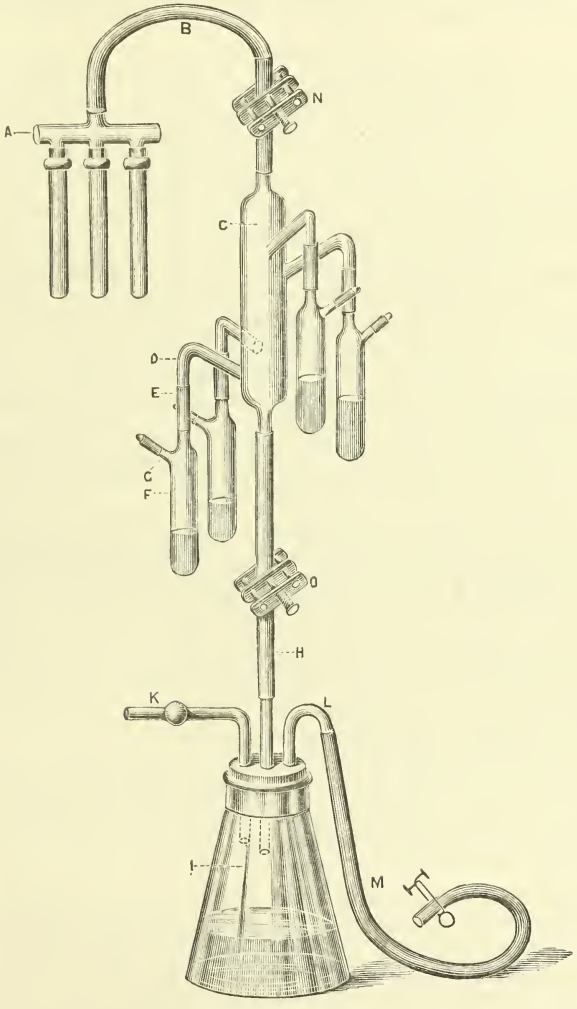
A is a collector to which three bougies are connected on one side, while on the other it is connected by means of a rubber tube with a cylindrical glass vessel C, from which four elbow-pipes D come off. The elbow-pipes are, in their turn, connected with test-tubes containing nutrient gelatin, and the test-tubes, in addition to the inlet opening, have another tube at the side, the opening of which is plugged with cotton-wool. The vessel is connected below by means of a caoutchouc tube H with a receiver I, through the stopper of which three tubes pass, viz. K, L, and M ; K is plugged with cotton, and L-M is for drawing off the water; it is kept closed by a pinch-cock. The bougies are tested

* Intern. Klin. Rundschau, 1892, No. 16. See Centralbl. f. Bakteriol. u. Parasitenk., xiii. (1893) pp. 733–4.

† Centralbl. f. Bakteriol. u. Parasitenk., xii. (1892) pp. 92–5 (1 fig.).

by plunging them in water, and fitting on a suction-pump to the tube K; the water then flows into the receiver I. When the latter is full the tubes B and H are closed by screw-clamps, and air of normal tension allowed to enter at K; the water can run out at M. A sample of water

FIG. 83.



can at any time be obtained by clamping the tube H, and fixing on the air-pump to the side tube G one of the four test-tubes, and when sufficient quantity has flowed into the tube F, the tube B must be clamped, and the suction-pump replaced on K. Of course E must

be clamped before the test-tube is removed for incubation. In a similar way any of the test-tubes may be filled at any time during the filtering process.

The results obtained from filtering impure water by means of the Chamberland bougie were not at all satisfactory, for though the water which flowed through at first was germ-free, it soon showed contamination, and that therefore the porcelain filter is unable to deprive dirty water of its germs.

(2) Preparing Objects.

Eserin in Protistological Technique.*—Sig. P. Longhi finds that a mixture of 1·10 per cent. of eserin sulphate to 10 ccm. of which one drop of a 1 per cent. sublimate solution is added, is of excellent service for all Protista and especially for Rhizopoda. The general form is retained, the separate parts of the organism remain clearly apparent, the pseudopodia and cilia are fixed in their natural position, and there is no interference with hardening or staining.

Preserving Achlorophyllous Phaneragamous Parasites and Saprophytes.†—Prof. E. Heinricher finds that the troublesome blackening of certain plants, e.g. *Lathræa*, which occurs when preserved in spirit, or by pressure, may be avoided by steeping them in boiling water and continuing the boiling for about a quarter of an hour. After this they are transferred to spirit or pressed, when it will be found that there is scarcely any blackening at all.

Nor are these the only advantages offered by this simpler procedure, for it is well known that boiling water acts as a fixative, and hence the method is advantageous for anatomical purposes.

Preparation of Vegetable Objects.‡ — Herr W. Bieliajew recommends the following mode of treatment of microtome-preparations. The fixing is effected by Perenyi's fluid, 3 pts. 0·5 p.c. CrO_3, 4 pts. 10 p.c. HNO_3, 3 pts. alcohol. After fixing and staining, the object is gradually transferred to absolute alcohol and pure xylol, and then placed for a day in a saturated solution of paraffin in xylol at a temperature of 35°; finally warmed to 47°, and then placed in paraffin melting at 45°. The object is simply placed on the slide which has been moistened with distilled water, and the water allowed to evaporate.

Objects which contain no vacuoles, such as spermatozoids and their mother-cells, are first stained on the slide, and some gum arabic added and allowed to dry; and the object becomes then so firmly attached that both the fixing material and the gum can be washed away without disturbing it.

Isolation of Living Protoplasts.§ — Herr J. af Klercker isolates protoplasts by first plasmolysing pieces of leaf or sections of larger organs to such an extent that the protoplasts become detached on all sides from the cell-wall. The sections are next cut to pieces in the plasmolysing solution, when some of the contracted protoplasts escape

* Boll. dei Musei Zool. e Anat. Comp. della R. Univ. Genova, 1892, No. 4. See Zeitschr. f. wiss. Mikr., ix. (1893) p. 483.

† Zeitschr. f. wiss. Mikr., ix. (1893) pp. 321–3.

‡ Scripta Botanica, 1892, 12 pp. See Bot. Centralbl., liv. (1893) pp. 105 and 6.

§ Ofvers. K. Vetensk. Akad. Förh. Stockholm, 1892, pp. 463–74 (8 figs.).

into the fluid. They are then observed either in a capillary space formed by a combination of cover-glasses, or in the culture-apparatus for running water described by the author. The chromoplasts have the appearance of being compressed by an outer elastic layer. The isolated protoplasts were found to be surrounded by a clear margin which is in active motion, and is composed of cilium-like threads. The inner side of the wall of the vacuoles was in places clothed by streams of granular protoplasm. The observations were made chiefly on *Stratiotes aloides*.

Histological Observations on Hydromedusæ.*—Dr. M. Chapeaux, in using the teasing method, fixed the polyps with a mixture of ·1 per cent. osmic acid and ·2 per cent. acetic acid, in which they were left for some time; they were then placed for twenty-four hours in 1 per cent. acetic acid. Maceration being finished, the tissues were teased, and various carmines or hæmatoxylin were used for staining; this was effected with difficulty. If maceration was effected with 1 per cent. osmic acid for from twelve to twenty-four hours, it was impossible to stain the elements, but teasing was easy, and the cells did not really require to be stained.

If it is proposed to make sections, the best method for fixing the polyps in a state of extension is to treat them with 1 per cent. osmic acid for fifteen hours, or 2 per cent. for a less time; the protoplasm of the cells is stained yellowish brown, while the contained granulations are of a dark hue. Flemming's solution may be used, and although concentrated sublimate does not give equally good results, tissues that have been treated with it can be stained.

Graafian Follicle.†—Dr. J. Schottlaender in his study of Graafian follicles used Flemming's chromo-osmic-acetic mixture, Rabl's platinum chloride and chromo-formic acid method, &c. Safranin, gentian-violet, alizarin, &c., were used as stains; celloidin and photoxylin for imbedding.

Methods of Decalcification.‡ — Prof. S. H. Gage discusses the methods of decalcification in which the structural elements are preserved. He points out the necessity of a "restrainer" or chemical substance, which will restrain the decalcifier from injuring the soft parts. In 1888 it was discovered that the gelatinizing and softening action of nitric acid—the great decalcifier—was almost wholly obviated by the use of a saturated aqueous solution of alum to every 100 ccm. of which 2 grm. of chloral hydrate are added. As a satisfactory fixer and hardener, the author recommends a mixture of 500 ccm. water, 500 ccm. 95 per cent. alcohol, and 2 grm. of picric acid. The tissue is left one to three days in the picric alcohol, one to three days in 67 per cent. alcohol, and then put in 82 per cent. alcohol. For decalcification 67 per cent. alcohol and 3 ccm. strong nitric acid may be used, when the alcohol acts on the restrainer; or use is made of a saturated aqueous solution of alum diluted with an equal volume of water, to every 100 ccm. of which 5 ccm.

* Arch. de Biol., xii. (1892) pp. 661 and 665.
† Arch. f. Mikr. Anat., xli. (1893) pp. 219–91 (2 pls.).
‡ Proc. Amer. Micr. Soc., xiv. (1893) pp. 121–4.

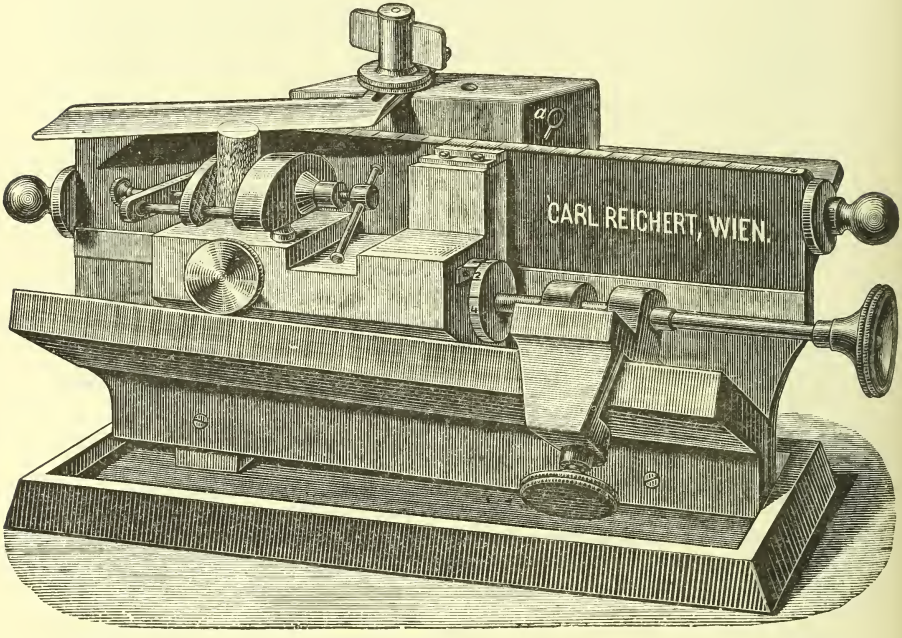
of strong nitric acid is added. After, in either case, remaining in 67 per cent. alcohol for a day, the tissue is kept in 82 per cent. alcohol till it can be cut.

Sections may be made free-hand or the collodion method may be used; details of the method are given. For staining, nothing has been found superior to the author's hæmatoxylin (see p. 564) and eosin or picric acid.

(3) Cutting, including Imbedding and Microtomes.

Reichert's Microtomes with Oblique Planes.*—In the smaller instrument, represented of half its natural size in fig. 84, the object slide is moved forward on the oblique plane either by hand or by means of a micrometer screw which is provided with a snap-arrangement. The knife-slide and also the object-slide rest on fine points. The object-

Fig. 84.

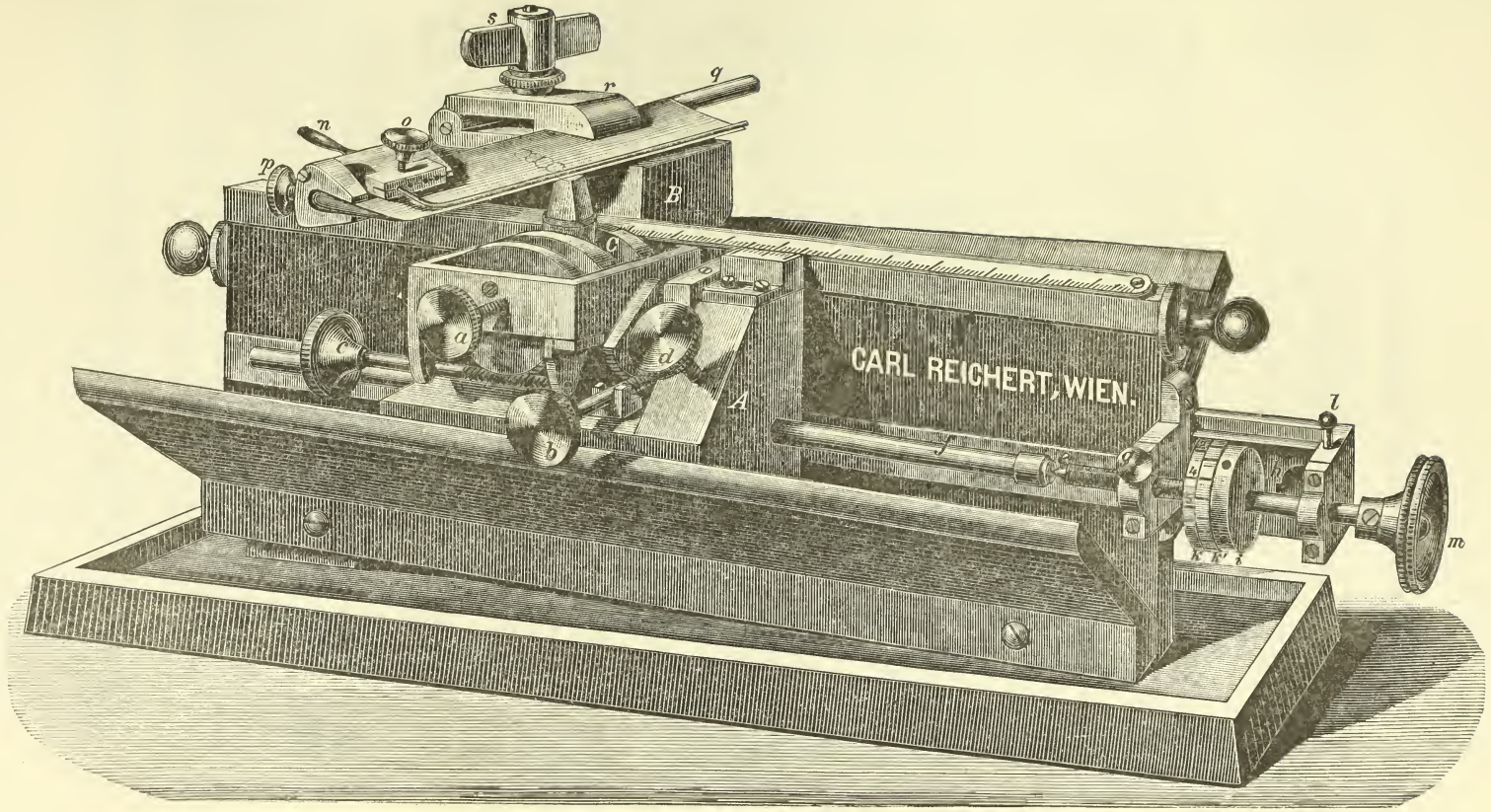


clamp has a ball-and-socket joint to enable the object to be easily brought into any desired position. The length of the slide-way for the knife = 25 cm. The slide-ways and the body of the microtome are made of cast iron, the guiding points of the knife and object-slides of steel or ivory. The apparatus is nickeled to protect from rust.

The second instrument, of larger size, represented in fig. 85, has a length of slide-way of 30 cm. The forward movement of the slide is effected by a micrometer screw which allows the object-slide to be

* Reichert's Catalogue No. 18 (1892).

Fig. 85.



raised by 0·001 mm. and upwards. The instrument is provided with an adjustable snap-arrangement to enable any given thickness of section, within certain limits, to be obtained. It also possesses a clamp by which the knife may be adjusted square for the production of series of sections.

(4) Staining and Injecting.

Double-Staining for Distinguishing Living and Dead Substances after their Preservation.*—Dr. L. Rhumbler recommends a mixture of 50 parts of a 1 per cent. watery solution of methyl-green, 50 parts of a solution of 0·8 grm. eosin in 50 per cent. alcohol, and 50 parts of absolute alcohol. With material preserved in picro-sulphuric acid or alcohol the stain acts, on sections and small pieces, in half an hour. After washing with water the material should be placed in alcohol of increasing strengths. Clearing and imbedding materials may be used as desired.

This mixture has the property of staining brilliant red all the substances which were alive when the material was preserved, while all dead organic or inorganic substances are stained bright green. In other words, the eosin acts on living substances as though there were no methyl-green in the mixture, and methyl-green acts as if there were no eosin.

Organic substances which were beginning to break up at the time of preservation, or which consist of a mixture of organic and inorganic masses, as well as most of the secreted products of protoplasm, such as certain cell-membranes, the fresh secreted cementing substances of Rhizopod shells, and glandular secretions take both stains, and are reddish-violet, violet, blue or blueish-green, according to the proportion of dead or living material. The author recommends the mixture for the study of small organisms, especially Protozoa.

It is particularly useful for finding minute organic bodies in mud or masses of detritus; it is hardly possible to imagine a greater contrast than there is between the small living things and their surroundings. It is good also for distinguishing ingested food particles from other protoplasmic constituents in the bodies of Protozoa. The method is said to afford an absolutely certain means of distinguishing between living and dead substances, and it gives a good clue as to the age of secreted substances.

The author concludes with notes on some of his results, a fuller account of which will be given when he deals separately with the organisms investigated.

Staining of Protoplasts and Cell-wall.†—Herr J. af Klercker recommends the following process for the staining of protoplasts in microtome-material. If the object examined is an aerial part of a plant, the oily substances are first removed by ether or dilute ammonia, and, after washing out the fixing material, the object is allowed somewhat to dry in order to promote the entrance of the staining substance. But if it is only the membrane which is to be stained, the object is brought, directly or after washing out the fixing material, into eau de Javelle or eau de Labarracque, and left there till all the protoplasm is dissolved. After

* Zool. Anzeig., xvi. (1893) pp. 47, 57–62.

† Verhandl. Biol. Ver. Stockholm, iv. (1892) No. 14, 4 pp. See Bot. Centralbl., liv. (1893) p. 41.

careful washing, it is then stained with a moderately concentrated solution of congo-red, and finally, after careful washing, placed in paraffin. A good staining of membranes may also be effected by successive treatment with iron salts and potassium ferrocyanide, or with tannin and ferric chloride.

Metachromatism of Parasitic Sporozoa and Carcinoma Cells.*— Dr. J. Ssudakewitsch states that in 150 cases of cancer the number of sporozoa was very variable, but only in six cases were they absent altogether. Associated with undoubted Sporozoa were forms simulating nuclei, and white blood-corpuscles, and from the appearances it became sometimes difficult to discriminate between the parasite, alterations of the nuclei, invaginated cancer cells and leucocytes. The author here gives the result of observations on the colour assumed by the Protozoa as contrasted with the tissue cells.

(1) The preparations stained with Ranvier's hæmatoxylin were fixed with 1 per cent. osmic acid, and after having been washed in water were placed in Müller's fluid for 3, 4, to 6 days, and afterwards hardened in alcohol increased in strength from 70° or 96°. The preparations had a grey look.

The nuclei of the connective tissue cells, leucocytes, and cancer cells are stained a dirty violet, while all but a few of the Sporozoa were a pure violet (metachromatism).

(2) Objects stained with safranin were fixed in Flemming's fluid, and after soaking in water for 1, 2, 3, or 4 days were immersed in a saturated watery solution of safranin and having been differentiated with alcohol acidulated with HCl or HNO_3, mounted in the usual way. The preparations were brownish, and the resting as well as the mitotic nuclei of the cancer cells were of the usual red colour. The amœboid Sporozoa, the inter- as well as intracellular, had a brownish-yellow hue; while all the capsulated forms were violet (not a pure but a dirty tone).

(3) Methylen-blue preparations were taken from Flemming's fluid or from alcohol and immersed for 24 hours in a saturated anilin-water solution of methylen-blue. Thus prepared the tissue cells were of an olive-green colour and the Sporozoa blue. In one case, by after-staining with eosin, some of the Sporozoa were stained violet, the tissues being of a pale rose tint.

The illustrations given are extremely effective.

Protozooid Appearances in Carcinoma and Paget's Disease.† — Dr. L. Török considers that the appearances observed in carcinoma cells and Paget's disease are those of degeneration affecting the cell-plasma and nucleus, and giving rise to very complicated figures. Only by numerous methods of staining can the deceptive appearances be properly distinguished. The tissue should be fixed in absolute alcohol, 5 per cent. sublimate alcohol, Flemming and Demarbaix's fluid, and stained with different solutions of carmine, hæmatoxylin, and safranin.

* Centralbl. f. Bakteriol. u. Parasitenk., xiii. (1893) pp. 451–5 (1 pl., colrd.).

† Monatsbl. f. Prakt. Dermatol., March 1, 1893. See Centralbl. f. Bakteriol. u. Parasitenk., xiii. (1893) p. 496.

Safranin Nuclear Reaction and its Relation to Carcinoma Coccidia.*—Prof. A. P. Ohlmacher, while disclaiming any intention of disputing the existence of Sporozoa in cancer, or of throwing discredit on safranin as a stain, shows that many of the appearances depicted by some observers, e. g. Podwyssozki, Sawtschenko, are artificial crystalline products, the result of a safranin and iodine reaction. The author's results as summarized by himself are as follows:—A precipitation of deep red material may be produced when solutions of safranin and iodine or safranin and picric acid are mixed, directly. A similar precipitation is produced in tissues and sections when safranin and iodine or safranin and picric acid are used for staining. The precipitate occurs in any of the elements, either of normal or pathological tissue, and may occur either in the nucleus or in the cytoplasm. This artificial product occurs in the cells of sections of carcinoma tissue, prepared as directed by Podwyssozki and Sawtschenko. Therefore, the multiform red particles occurring in the cells of carcinoma tissue prepared by the safranin picric acid method are artificial products; and since Podwyssozki and Sawtschenko base their arguments on the presence of these red formations in their "coccidia," such conclusions must be valueless.

Nerve-endings in Muscle.†—Prof. L. v. Thanhoffer recommends a modification of previous methods. Let the sartorius of frog or lizard be stretched on cork with porcupine spines, split longitudinally, and subjected to a modification of Löwit's gold method. The preparation is placed, till it swells, in a mixture of 1 part formic acid and 2 parts water; it is then transferred to the gold bath, but this is arranged in such a way that osmic acid (in an adjacent vessel) acts along with the gold. After being washed in water, it is left for 24 hours in the original mixture in a dry place. Then it is washed and laid in glycerin. A new treatment recommended is as follows:—The muscle is placed for 10 minutes in 1 per cent. hyperosmic acid, washed, left for 20–30 minutes (in a dark place) in Höllenstein solution, washed, and exposed to sunlight for 10–30 minutes in water with some acetic acid. The author hints at some of the good results he has reached by means of both methods.

Restoration of Osmic Acid Solutions.‡—Mr. C. L. Bristol recommends the addition of 10 to 20 drops of fresh peroxide of hydrogen to 100 ccm. of a 10 per cent. solution of osmium tetroxide, when the latter has been reduced and turned black. The chemical reaction shows there are no injurious changes, for we have OsO_4 + organic substances converted into OsO_2 + oxidized organic substance; and $OsO_2 + 2\ H_2O_2$ converted into $OsO_4 + 2\ H_2O$. Peroxide of hydrogen may also be used to bleach tissue which has been overblackened by osmic acid.

Trustworthy Solution of Hæmatoxylin.§—Prof. S. H. Gage describes an aqueous solution of hæmatoxylin which does not readily deteriorate. As he suspected that the dark precipitate which so soon

* Journ. Amer. Med. Assoc., xx. (1893) pp. 111-7 (1 pl., colrd.).
† Math. Nat. Ber. Ungarn, viii. (1891) pp. 433–40.
‡ Amer. Natural., xxvii. (1893) pp. 175 and 6.
§ Proc. Amer. Micr. Soc., xiv. (1893) pp. 125-7.

appears might be due to the presence of living ferments he prepared a solution of the following composition:—Distilled water 200 ccm.; potash or ammonia alum 7½ grm.; chloral hydrate 4 grm.; hæmatoxylin crystals 1/10 grm. This aqueous solution had, at the time of writing, been treated for nearly a year, and there was not then any deposit, while the action of the stain was as good as at first. In preparing the solution the water and alum should be boiled in an agate or porcelain vessel for from 5 to 20 minutes, to destroy any germs in the water or alum. As hæmatoxylin is almost a pure nuclear dye it is recommended that a counter stain be used with it; eosin is very good, and for many objects picric acid is suitable.

Ruthenium-red as a Staining Reagent.*—M. L. Mangin recommends the use of the ammoniacal oxychloride of ruthenium or ruthenium-red discovered by M. Joly, as a staining reagent for vegetable tissues. It is soluble in water, concentrated calcium chloride, and solution of alum; insoluble in glycerin, alcohol, and essence of cloves. It belongs to the group of basic pigments, inert to cellulose and callose, but taken up eagerly by pectic substances. It is, in fact, the best staining reagent for the analysis of vegetable membranes; the staining resisting powerfully the influence of alcohol and glycerin. It is also permanently fixed by gums and mucilages derived from pectic compounds, but does not stain mucilages derived from cellulose, or from the products of the liquefaction of callose. Illustrations of these reactions are given in the cases of various tissues and organs.

Staining Properties of Oxychloride of Ammoniacal Ruthenium.†—The staining properties of this substance, the formula for which is $Ru_2(OH)_2Cl_4(A_5H_3)7 + 3H_20$ have been examined by MM. M. Nicolle and J. Cantazucène. It exists as brownish crystals, and is soluble in water and glycerin, but not in alcohol. It appears to be easily acted on by acids and alkalies. The authors used an aqueous 1 per thousand solution in which the sections were immersed for one to two minutes, after which they were dehydrated and mounted in balsam. It imparts a beautiful red hue and has special affinity for the nuclear chromatin. It may be used after most fixatives, and while it is stated to give brilliant results after osmic acid, it is inert after Flemming's solution or after osmic acid plus bichromate. Its potentialities are not confined to sections as it stains cover-glass preparations and all micro-organisms, except the tubercle and leprosy bacilli. Its chief merits seem to be that it picks out the nuclear chromatin very well, and that it is insoluble in alcohol.

A new Staining Method for Neuroglia.‡—Prof. N. Kultschitzky has discovered in *Patentsaures Rubin*, prepared by the "Berliner Anilinfarben-Actiengesellschaft," a very successful stain for neuroglia, which renders the cells and the fibres a beautiful red-violet colour.

For fixing and hardening, the following mixture is used:—50 per cent. methylated spirit, plus so much bichromate of potassium and sulphate of copper as will dissolve in the spirit to which 1/2 to 1 per cent.

* Comptes Rendus, cxvi. (1893) pp. 653–6.
† Ann. Inst. Pasteur, vii. (1893) pp. 331–4.
‡ Anat. Anzeig., viii. (1893) pp. 357–61.

acetic acid has been added. The exclusion of light during the fixing is essential. From the mixture the tissue is transferred direct to strong alcohol. The hardening may require to be prolonged for 2 to 3 months.

The staining mixture consists of 2 per cent. acetic acid solution 100 parts, "patentsaures Rubin" 125 parts, and saturated picric acid solution in water 100 parts. In a few seconds the staining is sufficient. Thereafter the preparation is washed in 96 per cent. alcohol. The rubin stain is almost insoluble in alcohol.

Negative Staining Method for Finding Tubercle Bacilli.*—M. Solles' method consists in cutting up the tissue to be examined into small cubes, placing these in absolute alcohol for 12 hours, then in ether for 12 hours, and finally for an equal time in collodion. Sections, when made, are placed in the following fluid composed of two solutions, which are to be mixed just before using. (1) Aq. destill. 100·0; Berlin blue, 1·0; oxalic acid, 0·2. (2) Aq. destill. 100·0; gelatin, 1·0. All the anatomical elements of the tissues pick up the pigment, the micro-organisms remaining unstained. The author applied this method to the study of the morphology of the tubercle bacillus, and thinks he has determined the presence of spores by it. This negative staining method could also be applied to detect the presence of micro-organisms in carcinoma.

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

Mounting Medium for Algæ and Fungi.†—Dr. A. A. Julien recommends the following solution, an indirect outcome of Ripart and Petit's formula, for mounting organisms with endoplasm of ordinary density, e. g. most of the filamentous Algæ:—Copper chloride, 0·1 grm.; copper nitrate, 0·1 grm.; chloral hydrate, 0·5 grm.; distilled water, just boiled, 100·0 ccm. The trace of acidity is removed from the solution in the following manner. Another solution is prepared of a few grams of any soluble copper salt; to this a weak solution of caustic potash is added in slight excess; the hydrated copper oxide is then washed thoroughly, first by decantation and then upon a filter. The purified residue is then thrown into 100 ccm. of the preservative fluid already prepared, and the mixture frequently shaken at intervals until a neutral reaction is shown by test papers, when it is filtered.

Spiral Springs for Manipulating Cover-glass Preparations.‡—Dr. A. A. Julien uses the spiral brass spring suggested by F. L. James,§ for carrying cover-glass impressions. A cork encircled by the spring is wired to the bottom of a small round pasteboard box, and a little tuft of soft tissue paper or cotton wool between the edge of the inserted cover-slips and the side of the box prevents any dislodgment.

The author also applies the spiral spring to staining cover-glass preparations. Here the spring is a straight one and made of brass or platinum wire. Between the coils cover-glasses, which have been

* Le Bulletin Méd., 1892, p. 865. See Centralbl. f. Bakteriol. u Parasitenk., xiii. (1893) p. 670.

† Journ. New York Micr. Soc., ix. (1893) p. 39.

‡ Tom. cit., pp. 24 and 6 (2 figs.).

§ This Journal, 1887, p. 693.

previously prepared, are inserted ; one end of the spring is attached to a cork stopper and then lowered into a broad-necked bottle containing the solution. Of course several bottles with different reagents may be used ; for example, in staining flagella of bacteria, one bottle may hold the mordant, another the stain, and so on.

Mounting large Sections of Vegetable Preparations.*—Dr. H. Schenck mounts large sections in the following simple manner. The sections are placed for 24 hours in a mixture of equal parts of spirit and glycerin. They are then transferred to pure glycerin until they are perfectly saturated therewith. This takes at least some hours, and it is well to let the preparations soak for a whole day. The sections are then removed and carefully dried between folds of blotting-paper, so that all the superfluous glycerin is removed. The next step is to pour some thin flowing xylol-balsam on the slide. In this the preparation is placed and carefully smoothed down with a brush, and any air-bubbles removed with a needle and blotting-paper. The surface of the section is then covered with balsam, after which the cover-glass is put on. The preparation must now be placed on a perfectly flat surface and allowed to dry in this position. When dry the excess of balsam on the slide may be easily removed with a knife or with some solvent.

For lecture purposes the foregoing method gives very satisfactory results as the outlines of the tissues and cells are quite clear, and easily made out with a hand-lens or low powers.

Balsam-paraffin for Cells.†—Dr. A. A. Julien observes that the mixture of balsam and paraffin for making cells deserves to be better known. Balsam-cement is first prepared by slow evaporation of commercial Canada balsam in a shallow tin pan over a low flame until the point is reached of wax-like consistence on cooling, as tested on drops removed and cooled from time to time. About a quarter of a pound of the hardest commercial paraffin, melting point above 45° C., is heated over a low flame to the melting point, a piece of balsam-cement, size of a nut, is then added, and the mass digested with frequent stirring for about an hour until all the paraffin has a slight yellowish tinge. The stock is preserved in a shallow porcelain capsule, so that when required it can be readily warmed up. A cell made with this paraffin-balsam is ready for use directly after it is spun.

Apparatus for Holding Cover-glasses.‡ — Dr. Veranus A. Moore writes as follows :—" When sections of animal tissue are fastened to cover-glasses § in order to transfer them from one bath to another during

* Bot. Centralbl., liv. (1893) pp. 1–4.

† Journ. New York Micr. Soc., ix. (1893) pp. 39–43.

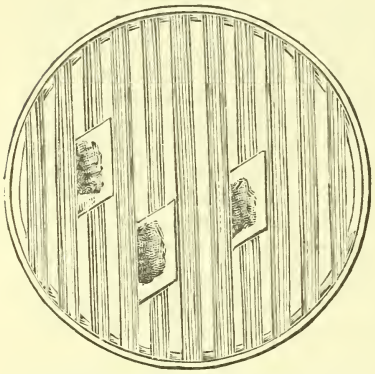
‡ Proc. Amer. Soc. Micr., xiii. (1892) pp. 51–3.

§ " In fastening sections to cover-glasses care must be exercised in the choice of some method of fixation which will not leave a film on the cover that will be tinted to any degree by the stain used. I have had some trouble in this respect with the gelatin, albumen, and collodion processes when certain anilin dyes were subsequently employed.

A method which seems admirably adapted to this process of handling sections is the *paraffin-alcohol method* described by Dr. A. Canini in the Archiv f. Anat. u. Phys., Phys. Abth., 1883, p. 147. It consists simply in placing the section on a cover-glass directly from the section knife and adding a few drops of dilute alcohol

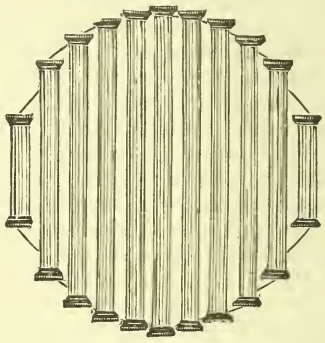
the process of their preparation for mounting, there seems to be no reservoir in the list of histological apparatus that is well suited to their use. The ordinary solid watch-glass, crystallizing dish, &c., is objectionable, as the cover-glass falls at once to the bottom, from which it is removed with difficulty, and, again, when several specimens are being prepared at the same time they almost invariably run together in the form of *rouleaux*, the separation of which is attended with great danger to the

FIG. 86.



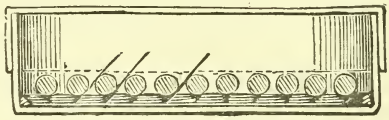
The bottom of the reservoir as seen from above, with cover-glasses in position.

FIG. 88.



A mat of glass rods.

FIG. 87.



Cross-section of reservoir.

sections. These difficulties have rendered this otherwise very convenient method of handling sections, when from their nature a support is necessary, so objectionable that the cover-glass is seldom used by histologists for this purpose. In order to eliminate these difficulties I have devised the following apparatus for holding the cover-glass during the hydration, staining, dehydration, &c., of the sections, which I have found to work admirably.

The apparatus consists simply of a 'double dish' 15 cm. in diameter and 2·5 cm. in depth, in which glass rods are arranged parallel to each

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(60 to 70 per cent.). The cover is then placed in a paraffin oven at a temperature of about 50° C., where it remains until the alcohol is evaporated. This method was also highly recommended by Ogata in his work on the pancreas cell. It is applicable only to sections cut by the paraffin method.

I am indebted to Dr. Theobald Smith, of the Bureau of Animal Industry, Department of Agriculture, and Prof. W. H. Welch, of Johns Hopkins University, for valuable information concerning this method."

other and separated by a distance of about 4 mm. The rods are about 5 mm. in diameter. They are raised about 2 mm. from the bottom of the dish and fastened only at the extremities, thus permitting of a free circulation of the liquids. The cover-glasses are placed on edge between the rods, against which they rest (fig. 86). A reservoir of this size will hold, without crowding, thirty preparations on 3/4-in. covers. It is desirable to have a reservoir for each of the liquids used. The cheapness with which they can be made does not render this objectionable.

The construction consists in procuring the desired number of 'double dishes,' a few feet of glass rod, and an ounce or two of liquid glass (silicate of soda), or a few feet of fine copper wire. The glass rod is easily broken, by the aid of a file, into pieces of the required length, which are fastened in their respective places by means of a few drops of the liquid glass. In order to raise them from the bottom of the dish a ring composed of the liquid glass is built up around the edge, upon which the ends of the rods can rest and upon which they are fastened. As the silicate of soda is soluble in water and dilute alcohol, it is necessary to dehydrate it after the rods are fixed, so as to render it insoluble. This can be done by heating the reservoir in an oven or hot-air chamber at a temperature of about 98° C. If the reservoir is to be used only for turpentine, absolute alcohol, &c., the drying of the silicate of soda in the air is sufficient.

Instead of fastening the rods in the dish they can be bound together by means of fine wire, preferably copper, in the form of mats, which answer every purpose, and which can be removed at will if the dish is desired for other purposes. This is easily accomplished by running the wire around the ends of the rods after they have been cut the desired lengths. A shoulder-like projection can be procured on the ends of the rods by heating them until soft and pressing them against a firm surface. These prevent the wire from slipping off, and also raise the rods from the bottom of the dish (fig. 87).

With a full set of these reservoirs thirty cover-glasses can be carried from the first to the last liquid quite as quickly as a single preparation, for the time necessarily required for the action of the various reagents on a single specimen can be profitably employed in transferring other preparations. The cover-glasses can be handled very quickly, neatly, and with perfect safety with a pair of fine forceps."

(6) Miscellaneous.

Demonstration of Heliotropism.*—Herr F. Noll has constructed a heliotropic chamber for the growth of *Pilobolus crystallinus*. Light is admitted to the chamber only through a round pane of glass on one side. When the fungus was grown on a suitable substratum within the chamber, it was found that the sporanges had all discharged their spores on to the pane of glass, many of them striking it almost in the centre.

Demonstrating the Pigment of the Florideæ.†—Herr F. Noll describes a contrivance for exhibiting in the lecture-room the mode in which the green colour of the chlorophyll is completely masked by the

* Flora, lxxvii. (1893) pp. 32–7 (1 fig.). † Tom. cit., pp. 27–31.

red pigment in the Florideæ. This is effected by filling a flask made of green glass with a solution of potassium permanganate, when the green colour is completely absorbed, and the glass appears as if colourless.

Detection of "Masked Iron" in Plants.*—Dr. H. Molisch withdraws his previous statement as to the invariable presence of "masked iron" in plants, on the ground that the reagent employed, potassium hydrate, invariably contains traces of iron. Even when the amount of iron employed is so small as not to be detected by the most delicate chemical tests, vegetable tissues have the remarkable property of withdrawing it entirely from solution.

* Ber. Deutsch. Bot. Gesell., xi. (1893) pp. 73–5. Cf. this Journal, 1892, p. 632.

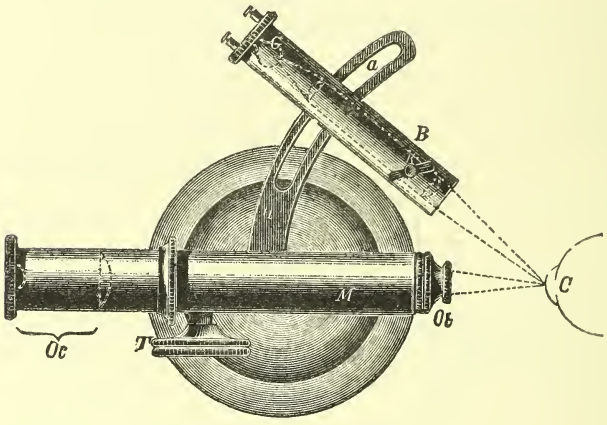
MICROSCOPY.

a. Instruments, Accessories, &c.*

(1) Stands.

A Cornea-Microscope.†—Dr. S. Czapski and Dr. F. Schanz have devised an instrument with which it is possible to adjust a Microscope upon the cornea, and at the same time keep the spot under observation intensely illuminated from the side.

Fig. 95.



The instrument consists of a Microscope M and an illuminating tube B in rigid connection with it (fig. 95). The Microscope M is adjustable by rack and pinion T. To the body-tube M is attached an arc *a*, on which the illuminating tube B can be firmly fixed by a clamping screw in different positions so as to vary the angle of incidence of the light, while the point of convergence C remains always the same.

The illuminating tube contains at one end a glow-lamp G, which is fixed in the focus of a condensing lens in the interior of the tube. A second lens near the other end of the tube is fastened in a small tube and can be displaced by the knob *k* in the direction of the axis so that the point of convergence of the light can be regulated.

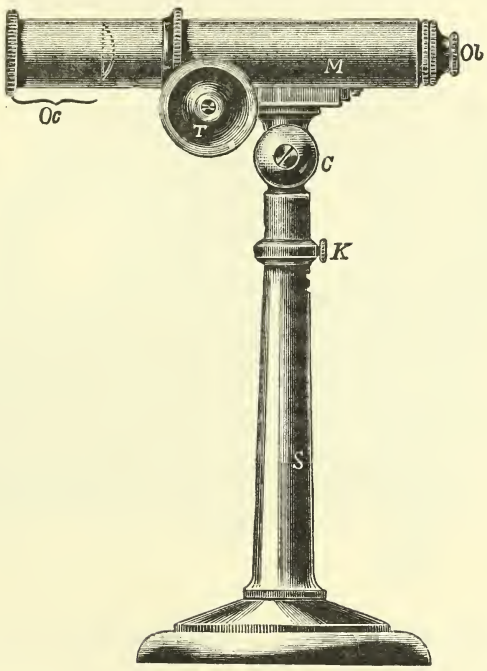
The instrument is mounted on a pillar which stands on a heavy

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

† Zeitschr. f. Instrumentenk., xiii. (1893) pp. 250–2; Klein. Monatsblätter f. Augenheilkunde, 1893.

round foot. It can be adjusted in height by drawing a rod connected with it out of the pillar and clamping with a screw; it can, also, be rotated about a hinge.

Fig. 96.



(3) Illuminating and other Apparatus.

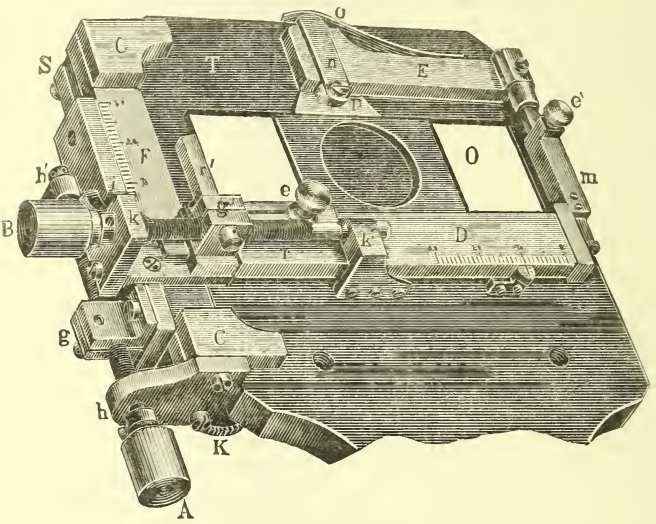
Winkel's Movable Object-stage.*—Dr. W. Behrens describes the new movable stage of the firm of R. Winkel of Göttingen. One peculiarity, in which it differs from most other stages, is that it is attached to the side of the stage-plate instead of to the pillar of the Microscope. It also possesses a new arrangement for fixing the object-holder on the stage. As seen in fig. 97, which represents the apparatus in 0·6 of its natural size, it is attached to the left side of the object-stage T T. For this purpose it possesses a plate F, with end-cheeks C C resting on the stage-plate, which is fastened to the edge of the stage by two clamping screws, the front one of which at *k* is visible in the figure.

On the side of F, visible at S, is a swallow-tail groove in which moves a sliding-piece *i*. Through the nut *g* on this slide passes the screw A, which is attached to F at *h h'*, so that by turning the screw-head A the nut *g* is moved backwards or forwards, and with it the slide *i*. The amount of displacement is read off on the millimeter division on F by means of the index *i*.

* Zeitschr. f. wiss. Mikr., ix. (1893) pp. 433–8.

Projecting from i at right angles is the metal-piece $k\,i$ on which, in a groove, not visible in the figure, moves the slide D. This movement is effected by the screw B which is attached to i at k and k' and works in the nut g' fixed to D. The amount of displacement, as before, is read off on the millimeter division on D by means of the index i'.

Fig. 97.



The object-holder O is firmly clamped against the inner edge of the slide D by the arrangement $r\,r'\,e$ on the one side, and $m\,\mathrm{E}\,p$ on the other. At r is a cross-piece sliding on D, and this is moved forward to a position corresponding to the size of the object-holder, where it is clamped by the screw e; the left small side of the object-holder is then pressed against the projecting-piece r'. In rigid connection with the slide on the right is the piece m, and sliding in this is the angle-arm E, which can be clamped by the screw e'. In E slides the metal-piece n which carries at one end the movable square piece p, while it is pressed at the other by the steel spring o. Thus by loosening the screw e', pressing E up against the object-holder and then again clamping e', the object-holder is firmly fixed in the apparatus, so that its displacement can then only be effected by means of the screws A and B.

The right small side of the object-holder is free, so that any strain upon it is prevented.

The apparatus can be easily fitted to any rectangular stage the side of which exceeds 80 mm. in length.

The method of using the apparatus as a "finder" needs no explanation, except that it must be fixed to the stage-plate in such a way that the projecting piece seen at S shall be flush with the front edge, and that the plate $r\,r'$ must be moved back as far as it will go to the left before the object-holder is clamped in.

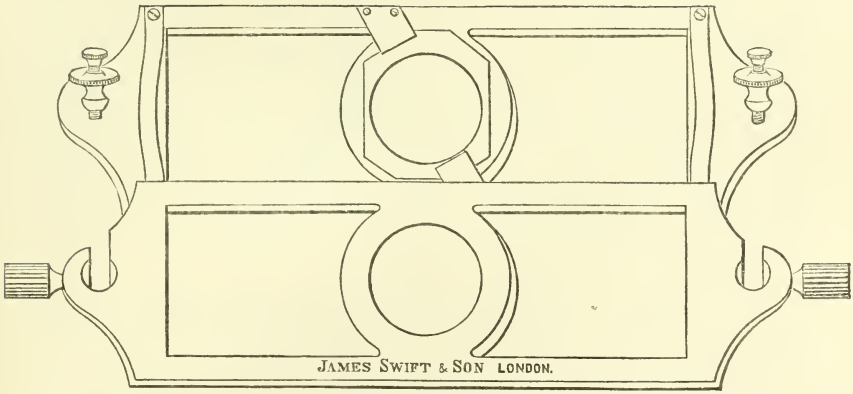
According to experiments made by the author, the apparatus may be used as a finder, even with high magnifications, although in these cases it is on many grounds preferable to mark the desired point with a medium system, and having found it again by means of this, to replace the latter by a higher system.

Value of Artificial Sources of Light.*—Prof. Rogers has recently made a series of new experiments on the value of different sources of light as regards white light and illuminating effect; the result is in favour of the light of burning magnesium.

In the experiments the spectra were produced and the intensities of the individual colours of the different sources were compared by measurement with one another. The results were represented by curves, and it was seen that the curve generally corresponded with that of daylight with a more or less cloudy sky. With a cloudless sky, on the other hand, daylight had a considerably higher effect on the more refractive parts of the spectrum in the green, blue, and violet. The electric arc-light, according to Nichols, is in these parts weaker than the sun or magnesium light, but increases in intensity very strongly in the violet and ultra-violet parts. Gaslight naturally showed itself brightest in the less refractive parts.

The temperature of burning magnesium is much lower than one would expect, viz. about 1340°, or between the temperature of the so-called luminous flame and that of the Bunsen flame. The radiation effect is greater with magnesium than with any other artificial light, being forty times greater than that of gaslight. Only the electric discharge in vacuo is superior to it in this respect.

Fig. 98.



Macer's Reversible Compressorium.—Mr. R. Macer has devised a reversible compressorium which can be worked with a high-angle condenser and high-power objectives (fig. 98). It has a vertical compression, and the smallest object can be fixed and examined on both sides. It is simple in its use and construction, and is made as follows:—In the

* Central-Ztg. f. Optik u. Mechanik, xii. (1893) p. 143.

centre of two flat brass plates, long enough to extend beyond the stage, is a 3/4-in. hole slightly recessed to receive a 7/8-in. No. 2 cover-glass, and at each end a screwed stud is fixed to receive mill-edged nuts for compression. The holes in top-plate are slotted through on one side in order to remove the plate by unscrewing the milled-edged nuts and lifting the plate above the steady-pins which are fixed at each end to prevent any lateral or longitudinal motion; the bottom plate (or both plates) has a transverse chase cut in to receive two springs to keep the plates apart, but sufficiently flexible to allow them to come into contact. The above plates may be made solid or perforated in order to lighten them, and the cover-glasses may be oblong and slipped under spring clips, two on each plate. The steady-pins may be dispensed with by having the under side of milled-edged nuts made conical and the top-plate coned to receive the same. These compressors may be made any length, to suit different stages.

Application of Polarized Light to Histological Investigations.*—Dr. H. Ambronn suggests, in the modest little work he has just published, that polarized light might be occasionally useful for histological purposes. This is quite possible, but it would be well to show what practical results, however small these may be, have been obtained in addition to describing polarization phenomena.

(4) Photomicrography.

Apparatus for the Projection of Microscopic Images.†—The firm of Carl Zeiss publish details of the latest changes in the construction of their photomicrographic apparatus, by which it is rendered more suitable for purposes of the *projection of images on a screen.*

As source of light they recommend the electric arc projection lamp of S. Schuckert and Co. of Nürnberg which, with a current of 16 amperes and 60 volts, gives a light of about 2500 candle power. The regulation of the distance of the carbons is effected very readily at any moment by means of two screws. The special feature of the lamp is that the carbons are not placed vertically but obliquely. The advantage of this is that the light of the glowing hollow in the positive carbon, which is generally lost, is to a large extent utilized; so that such lamps give in the direction of projection, for the same current, a more intense illumination than other systems. The projection table (fig. 99) carries at one end the lamp C, and at the other the Microscope M, with the optical bank D D between.

The Microscope is attached to a base-plate which can be adjusted in height, and also to the right and left, by means of a rod passing beneath the table, so that the axis of the Microscope can easily be brought into coincidence with that of the apparatus on the bank.

The chief requirements of a Microscope for projection work are:—

(1) A mechanical movable stage with micrometer movements.

(2) A sliding objective changer.

(3) A condenser which can be adjusted in two directions at right

* 'Introduction to the Use of Polarized Light for Histological Research,' Leipzig, 1892, 59 pp., 8 pls., 27 figs. See Bot. Ztg., li. (1893) pp. 122–3.

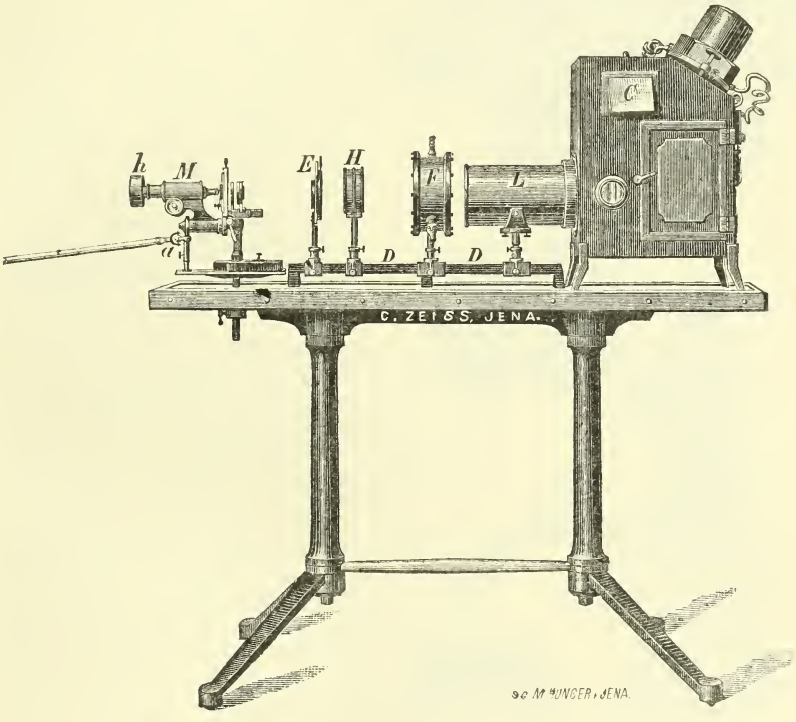
† 'Carl Zeiss Optische Werkstätte,' Jena, 1892, 17 pp., 9 figs.

angles to the optic axis, so that a change in position of the light may be within certain limits compensated for without the necessity of altering the illumination.

The achromatic centering condenser shown in fig. 100, which answers to these requirements, can be fitted into the socket of the illuminating apparatus in place of the ordinary condenser.

(4) An illuminating apparatus (fig. 101) adjustable in the direction of the axis.

Fig. 99.



(5) For projection with very low magnifications (system of 70 mm. focal length without eye-piece) a body-tube of extra width.

(6) Of especial importance is a good micrometer movement on the stand.

(7) A Hooke's key for the fine-adjustment if the operator prefers to be nearer the screen than the Microscope. In this case the base-plate of the Microscope is provided with an arrangement (*a*, fig. 99) for readily connecting the Hooke's key with the micrometer screw of the stand.

As answering to the above requirements the firm of Zeiss offer their stand for photomicrography which was described and figured in this Journal, 1889, p. 278.

The accessory apparatus on the optical bank are, the condensing lens L which makes light-proof connection with the lamp, the heat-absorption apparatus F, and the two iris diaphragms, one between F and M, and the other between L and F. As regards the centering of the apparatus, the height above the table of the positive carbon for mean adjustment is first determined. The centres of the two iris diaphragms are then brought approximately to the same height. The axis of the condensing system has then to be adjusted. For this purpose the iris diaphragms are brought near the ends of the optical bank, one on each side of the condenser. One of them is then illuminated from behind by a lamp, and the condensing system is displaced until the image of one diaphragm falls in the plane of the other. The condensing system is then adjusted so that the image is concentric with the aperture of the diaphragm. By interchanging the positions of the diaphragms, they can be brought to exactly the same height.

Fig. 100.

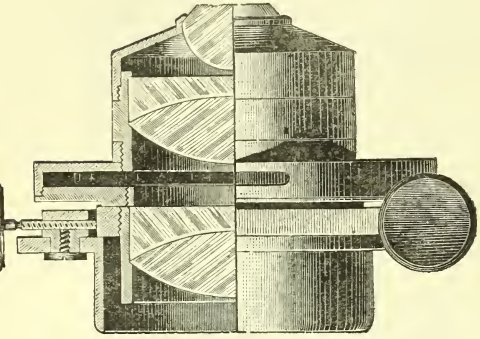
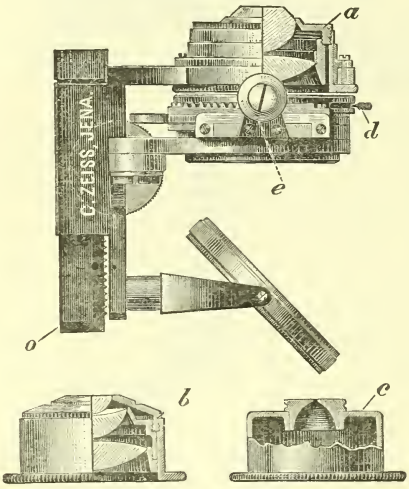


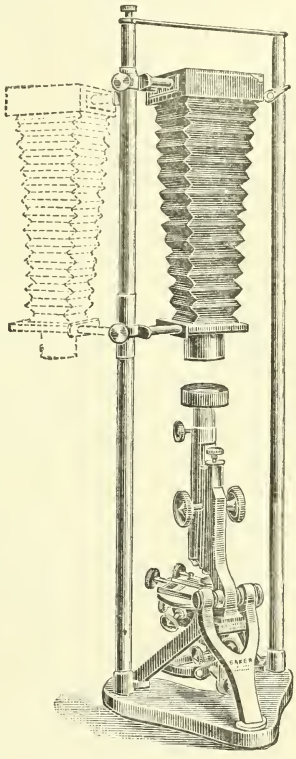
Fig. 101.



The arc lamp is then brought into its place and connected with the condensing system. Its position is regulated by adjusting the screws so that the light passes centrically through the two diaphragms. The axis of the Microscope has then to be brought into the same direction. For this purpose the condenser of the Microscope is removed, but its iris diaphragm retained. The base-plate is adjusted until the light passing through the diaphragms on the bank falls centrically on the diaphragm of the Microscope. To determine whether the axis of the Microscope is in the same straight line as the centres of the diaphragms, a low power, about 70 mm., is used, and a piece of ground glass is fitted on to the eye-piece end of the body-tube. The Microscope diaphragm is then opened to its full extent, but those on the bank to a few millimetres only. The latter are then displaced until a sharp image is formed on the glass. The position of this image is adjusted by turning the base-plate about its axis.

For low powers the condensing system on the bank is sufficient. For projection work apochromatics are not essential. Low and medium systems can be used direct without eye-piece. With high powers the image of the source of light should be thrown upon the preparation; with low powers, on the objective, so that the preparation is illuminated by a convergent pencil. An important point is the exclusion of all extraneous light. This is effected by the use of paper covers over the optical bank, &c.

Fig. 102.



Pringle's Vertical Photomicrographic Apparatus.—Mr. Andrew Pringle's vertical photomicrographic apparatus (fig. 102) consists of a 1/4-plate bellows-body camera, 18 in. long, sliding between two metal uprights which are fixed to a heavy iron base upon which the Microscope stands. The camera can be turned aside, if wished, while the Microscope is being adjusted, and clamped at any part of the uprights. The usual ground- and plane-glass focusing-screens are supplied with the apparatus.

Practical Photomicrography.*—After stating that his photomicrography was of a peculiarly utilitarian nature, his object being, not to perform a difficult feat for the sake of overcoming difficulties, but rather to produce a lasting record of appearances presented by some special microscopical preparation, Mr. A. F. Stanley Kent went on to remark that, one of the first essentials to good microscopic work is a stand of first-class workmanship; for, while it is quite true that work with low powers may be done with low-priced instruments, it is, nevertheless, a fact that for really good work, and more especially for work with the higher powers, the very best of everything in the way of apparatus is absolutely essential.

So far as the stage is concerned, Mr. Kent thinks that individual tastes play a large part in the selection, the simple stage being held to be amply sufficient by some workers, while others regard a mechanical arrangement as almost a *sine qua non*. Personally, he is inclined to recommend that, in a case of a Microscope to be entirely devoted to photography, and more especially if any considerable amount of high-power work be contemplated, a mechanical stage of the best construction should be selected.

The length of the Microscope-tube is an important matter, and one about which there has been much discussion; but, inasmuch as several

* Anthony's Photographic Bulletin, xxiii. (1892) pp. 621–4, 660–3.

makers are now making Microscope-stands with a series of draw-tubes, which enable one to vary the tube-length from something less than the Continental to something greater than the English length of tube, it is possible so to arrange the apparatus as to work at any length that seems to give the best results.

If a large amount of difficult high power work is contemplated there cannot be the slightest doubt that it is true economy to buy the very best objectives that can be procured. And it may here be stated generally that objectives having as high an angular aperture as possible, and, in fact, giving the best possible image when used in the ordinary manner, will be found best adapted for photographic work.

A form of apparatus that Mr. Kent has largely used, consists of the following parts :—A bracket is fixed upon a wall just below an aperture through which light enters. Upon the bracket the Microscope is supported in a vertical position, and the entering light is thrown upwards and through the Microscope by means of a mirror. Immediately above the bracket is fitted a support for the photographic plate, and this support can be placed nearer to or farther from the Microscope as a less or greater amplification is desired. Around the whole of the Microscope and bracket an opaque cloth is arranged to prevent the light entering by the aperture in the wall from escaping into the room. The eye-piece of the Microscope projects through a hole in the cloth. The plate support is provided with three points upon which the plate rests. Thus, there is no possibility of want of register between the focusing plate and sensitive surface as in the camera slide. Exposure is effected by means of a plate of ruby glass. The focusing is accomplished by placing the focusing screen upon the three points of the plate-holder. A general idea of the image is gained by using an unexposed gelatino-bromide plate as a focusing screen, and the final touches are given by replacing this with a piece of plate glass, and examining the image upon it by means of a double convex lens of long focus, or what does equally well, the field lens from an ordinary eye-piece of low power. All adjustments of the fine focusing screw are made through opaque cloth with ease. In an apparatus of this kind one is working inside the camera, and it is essential that all white light shall be excluded. The apparatus is equally well adapted for photographing either wet or dry preparations; and while admitting that for constant work with the highest powers and dry specimens, one of the horizontal forms of apparatus would probably prove more satisfactory, yet for doing work which is only taken up at intervals, and where the Microscope cannot be devoted exclusively to photomicrography, it will be found an arrangement possessing many advantages.

Whatever the form of apparatus decided upon, an efficient form of illuminant is a necessity; and while many good workers prefer still to use the common paraffin lamp, perhaps the best illuminant for all-round work is the oxy-hydrogen limelight, and particularly that form of the light in which the gases are mixed before ignition. In this form of illuminating apparatus an extremely small point of very high brilliancy is obtained, and the diffusion of brilliancy observable in the blow-through form of jet is absent. With proper care it is quite possible

to use hydrogen for the mixed jet direct from the main, i. e. from the nearest gas bracket, so that only one bottle is necessary, and with proper management such a light is very economical, though, of course, it cannot compare with the paraffin light in this respect.

The electric light, both arc and incandescent, has been extensively tried, but with disappointing results, and Mr. Kent has practically given it up, except in cases where it is necessary to take instantaneous photographs of moving objects. Even under such circumstances, direct sunlight, controlled by a suitable heliostat, is quite as efficient if the weather happens to be favourable.

Whatever illuminant is ultimately chosen, a great deal depends on the condenser that is used. Rack and pinion for focusing the condenser is necessary, as also is some form of centering adjustment for placing the condenser accurately in the optic axis of the Microscope. Far too little attention has hitherto been given to the advantages resulting from an intelligent use of the condenser, and it is not at all unusual to see, even in first-class laboratories, microscopists who keep their condenser invariably in one position and never think of focusing it accurately upon the object under examination.

Very often, too, the stops or diaphragms are most unintelligently managed, and the result is an unsatisfactory visual image; and if such an image is photographed, it must result in an unsatisfactory photograph, for one of the first things to be thoroughly understood, and one of the most important lessons that a photomicrographer can learn, is that the best visual image gives the photograph and no satisfactory negative can be hoped for unless a satisfactory visual image has first been obtained.

Having then made certain that the image is accurately focused, another difficulty arises, viz. that of the exposure. And for exposure in photomicrography, just as for exposure in landscape work, no definite rules can be given. Practice only can teach the correct amount to be given to each preparation under different conditions of magnification and illumination. It is far better to use up a few plates at the beginning by making experiments than to attempt to be economical and learn exposure from books.

Fuller, R. M.—**An Improved Method of Photomicrography of Bacteria and other Micro-organisms.** *Med. Record*, 1892, pp. 698–9.

(5) Microscopical Optics and Manipulation.

New Method for the Determination of the Refractive Indices of Anisotropic Microscopic Objects.*—Herr H. Ambronn gives a new method for determining the refractive indices of anisotropic microscopic objects. It consists in finding two liquids with refractive indices intermediate between the two refractive indices of the mineral section under examination. When immersed in such liquids and observed in polarized light, the object does not lose its outline when the axes of elasticity are parallel to the plane of polarization; but between these positions an azimuth may be found in which a complete disappearance of outline does take place. This azimuth is determined in the case of the two

* Ber. Verhandl. K. Sächs. Gesell. zu Leipzig, iii. (1893) pp. 316–8.

different liquids, and from these two angular measurements the refractive index can be readily found by calculation by means of the well-known formula

$$e_m = \frac{e_o\, e_e}{e_o \cos^2 a \times e_e \sin^2 a}.$$

On Work with a Polarization Microscope and a Simple Method for the Determination of the Sign of the Double-refraction.*—Prof. C. Klein gives a critical and historical account of the various methods which have been devised for determining the sign of double-refraction both in convergent and parallel light. In treating of the modes of observation of the interference figure in convergent light in the Microscope, he shows that he was the first to make use of the method in which the figure is observed by means of a lens held above the ordinary eye-piece of the Microscope.

Having passed in review the various methods which have been proposed for determining the sign of double-refraction, such as comparison with a plate of known optical character cut at right angles to the optic axis, use of Biot's compensation quartz and gypsum wedges, and of retardation plates of gypsum and mica, including the usual quarter-wave plate, he comes to the conclusion that the succession of colours obtained by the use of a wedge of quartz or gypsum affords the most general, the simplest and the most convenient process for determining the character of the double-refraction; because in this succession of colours we have the means of replacing, not only for the observation in parallel light, all gypsum and mica plates of different tints, but also for observation in convergent light, all plates devised in order to give the various and distinctive interference phenomena in the different quadrants of the interference figure.

For this purpose the polarization Microscope should be provided beneath the upper nicol and above the objective, with a slit running from the right in front to the left behind. In the slit can be inserted either:—

(1) A gypsum wedge giving colours of the first order in which the smaller axis of elasticity is in the plane of the plate and parallel to the edge.

(2) A similar or quartz wedge giving colours from the first to higher orders with similar optic orientation.

(6) Miscellaneous.

Progress in Microscopy.—We are glad to read the following note in the Journal of the British Dental Association: †—"Our Association has recently shown its appreciation of the value of microscopical research in connection with dental histology by authorizing, at our last annual meeting, the formation of a Microscopical Section (as an experiment for that occasion). We think that the success of that experiment is undoubted. The opening address by the president, Mr. Charles Tomes, as well as the special discussion and lantern demonstrations which followed, were very fully attended, and it is to be hoped that the

* SB. K. Preuss. Akad. Berlin, xviii. (1893) pp. 221–45. † xiv. (1893) p. 465.

success of the Microscopical Section may ensure it a permanent place in all our future annual meetings."

Microscopy at the Columbian Exhibition.*—Mr. H. L. Tolman has the following interesting notice of that part of the great exhibition at Chicago which ought most to interest our readers :—" The display of Microscopes and accessories at the World's Fair, though so scattered as to be difficult to see without considerable trouble, is probably the largest ever made at any exposition, and well worth all the trouble necessary to find it. The displays are scattered among the American, English, French, German, and Italian exhibits, most of them being in the great Liberal Arts Building. The American displays of scientific instruments are in the north gallery of this building, and the finest show of Microscopes is that of the Bausch and Lomb Optical Company. They have a good place in section E, and display forty Microscopes, microtomes and magnifying glasses, besides sterilizers and numerous specimens of prisms, condensers, and photographic lenses. Their newest form of Microscope-stand is an imitation of the well-known German horse-shoe model, which seems to be liked very much notwithstanding its inherent awkwardness. Another style which they have begun to make is the Wenham radial, which seems to have some striking advantages, though it is slow in coming into popularity.

Next to the Bausch and Lomb Company is the Gundlach Optical Company, with an excellent assortment of lenses, and a collection of stands on the German model. A little to the west is the McIntosh Optical Company, with a good selection of the lower-priced grade of instruments. Near them is the booth of Queen & Co., with their well-known style of stands, and also some specimens of Carl Reichert of Vienna, for whom they are American agents. The house of E. B. Myrowitz of New York, who manufactures the handsome form of stand made popular by the late W. H. Bulloch, is represented by three excellent specimens, which are displayed in the exhibit of the section of Microscopy of the Chicago Academy of Sciences. Among Microscope-makers, Joseph Zentmayer of Philadelphia, one of the oldest and best-known men of his line, is unfortunately not represented. Grunow and McAllister, once so well known, are also absent, but for better reason, as they no longer make either instruments or objectives. Of objective-makers, Spencer and Wales are both conspicuous for their absence, so that there is a serious gap in the list of Microscope-makers of the country which ought to be best represented.

Of English makers, three are represented :—Beck and Beck, W. Watson and Sons, and Ross. The first named has the largest exhibit and makes a really fine display, adhering in all material points to the styles so long known. Watson's exhibit is smaller, but he has a novelty, the Van Heurck pattern, which combines a number of conveniences, and partakes more of the English than of the German model. Ross only shows three instruments of the well-known Ross-Jackson model of stand.

In the French department, Nachet makes by far the best showing, but his exhibit is scarcely worthy of him. He makes fine stands and

* Amer. Mon. Micr. Journ., xiv. (1893) pp. 219–22.

accessories, and they were worthily shown at the Paris Photographic Convention last September, but here the large photomicrographic camera is absent, and its place is supplied by a small and ill-constructed one. The stands are badly arranged, and the objectives are limited to a single series shut up in a case. There are, however, a few novelties, one being a stand with a stage nearly 6 by 9 in., for examination of sections across a whole brain and the like, and another being specimens of "palladiumized" stand or of brass plated with palladium. They resemble oxidized brass and give a fine effect. Vion Frères have a large number of cheap stands, Teigne and Moreau show a few of the conventional forms, and J. Duboscq, the well-known instrument-maker, exhibits a fine vertical and projecting Microscope.

Italy also appears in the list with a case of stands and objectives manufactured by F. Koristka of Milan. The objectives include an apochromatic of 2 mm. of 140 N.A., but both lenses and stands are a close and servile imitation of German patterns.

But by far the most scientific display of Microscopes and accessories of all kinds at the Fair, is that of the famous Zeiss establishment of Jena. It is located in the north-west portion of the gallery in the Electricity Building with the exhibit of the German Society for Mechanics and Optics of Berlin, the Society not being able to get the necessary space in the Liberal Arts Buildings. There seems to be something of the proverbial "yankee" energy and push in the way the Zeiss business is conducted, and it is shown in the exhibit. Every kind of instrument made by the firm is to be seen here, from the simplest hand-lens to the most complex outfit for photomicrography and complete sets of achromatic and apochromatic objectives.

In the way of stands there is nothing specially new which has not been exhibited for several years, but there are some novelties in accessories. One is a mechanical stage, square in form, attached to the main stem of the instrument and removed by unscrewing a screw and raising a bar. It could be easily attached to almost any instrument and ought to offer a good hint to American makers. The photomicrographic apparatus is very complete, and has many peculiarities. The tube of the Microscope is very wide (50 mm.) and only 3 in. long, but has of course a draw-tube. The camera is designed to be used with electric light, and a beautifully designed lamp for the arc light is attached. The whole apparatus with achromatic condenser, monochromatic light attachment, centering apparatus, stand, camera, &c., costs 500 dollars in Germany or 750 dollars with duty and freight paid. There are other interesting specimens in the exhibit, such as the microspectroscope, the microspectral photometer for quantitative microspectrum analysis, the microspectral objective for observing and measuring the effects of the colours of the spectrum on microscopical objects, the spectropolarizer for determining the character of double refraction in microscopical specimens for particular wave-lengths, and the refractometer for determining the refractive index of glass and liquids.

F. W. Schieck of Berlin, one of the oldest Microscope-makers in Europe, makes a neat exhibit of cheap instruments, two of them being of an old pattern, rarely seen at present. One of these is designed to have the specimens mounted on a large circular glass which are successively seen by revolving the glass. This form is sometimes used

for class demonstration. In the other instrument, the objects are mounted in the rim of a brass barrel, which is turned around for each specimen to be shown.

F. Leitz of Wetzlar has a fair exhibit of his stands under the charge of his American agents, Richards & Co. It is located in the south end of the Mines and Mining Building, but the exhibit is not in a place where it can be seen to advantage. He has also a few instruments in the German Educational Exhibit, where Hartnack of Potsdam, Seibert of Wetzlar, and a few other minor makers are also represented. The only foreign makers of note who do not exhibit are Crouch and Swift of London, and Klönne and Müller of Berlin, so that the foreign representation as a whole is very complete.

In order to bring together microscopists and Microscopes, and promote discussion and acquaintance, the members of the Section of Microscopy of the Chicago Academy of Sciences, formerly the Illinois State Microscopical Society, have made an exhibit, where they have on exhibition not only specimens of the leading kinds of Microscopes, but a large number of mounted objects and photomicrographs made by their members. Demonstrations of methods of mounting, and instruction in the use of the Microscope and testing of lenses are given every other day by experts, and the exhibit, which is in section E of the north gallery of the Liberal Arts Building next to the Bausch and Lomb display, is designed for headquarters for all interested in microscopy, when attending the Fair."

The late Mr. George Brook, F.R.M.S.—Mr. Brook had lived for so comparatively short a time in London that he was not known to the Fellows who attend the meetings of the Society, but it was hoped that he might soon have become a regular attendant. While resident in Edinburgh, at the University of which he was Lecturer on Embryology, he took a large share in the formation of the Scottish Microscopical Society. His work on the development of fish, his report on the Antipatharia of the "Challenger" Expedition, and his splendidly illustrated Catalogue of the specimens of *Madrepora* in the collection of the British Museum, were all of a high order of merit, and bear testimony to his great intellectual powers. By his death, at the early age of thirty-six, Zoology has lost a valuable worker, and his many friends have been deprived of a man of sterling worth.

The Microscope in Public Schools.*—Mr. W. W. Weir says, "I am using a Microscope in my school. I have a regular hour set apart, when each pupil comes to the glass and makes his observation, passes quietly to his seat, and the next comes, and so on, till all have made an observation. From the outset great interest has been manifest. A great majority are enthusiastic. During the noon and recess hour there is a throng at my desk seeking admission to the glass.

In the higher grades, I use the glass mostly for technical purposes. In the lower grades, the main purpose is to please, but even here I find appreciation. It is amusing to see the primary children crowd round the table, exultant with joy, when the glass goes to their room. I believe that there is more disciplining power in the Microscope than in iron-clad rules or rods. Bring the Microscope into a room where all is confusion, and instantly the scene is changed."

* Microscope, i. (1893) pp. 39–40. From 'The Naturalist Teacher.'

B. Technique.*

(1) Collecting Objects, including Culture Processes.

Collecting Mollusca.†—Mr. W. H. Dall has put his great experience at the service of his fellow-workers in a pamphlet entitled 'Instructions for Collecting Mollusks, and other useful hints for the Conchologist.' Land-shells, freshwater species, and marine species are considered separately. Our ignorance with regard to the eggs of most marine Mollusca is pointed out, and there is here certainly an interesting field for study and observation. The hints on the use of the dredging apparatus and the tow-net will, no doubt, be useful to naturalists at large.

Collecting and Preserving Insects.‡—Dr. C. V. Riley has published a very full handbook of this subject. Not only are general methods of collecting described, but special hints are given for each large group. The chief drawbacks to the use of alcohol as a preservative agent appear to be that all hairy specimens are liable to spoil in it, and that Coleoptera with soft integuments, if kept too long in it, spread the wing-cases apart. Under the head of entomotaxy is considered the preparation of insects for the cabinet. After dealing with various other subjects, including Museum pests, insect boxes, and economic displays, directions are given for rearing, packing, and transmitting insects. There are a few hints for the collectors of Arachnids and Myriopoda, and some bibliographical hints conclude a work which should be widely useful.

Examining for Influenza Bacilli.§—Dr. E. Klein records some observations on the influenza bacillus, made in December 1889 and January 1891. The blood was examined on cover-glass films, and in cultivations on gelatin and agar. The blood films were stained with rubin and methyl-blue anilin water. In one out of six cases examined, a few minute bacilli resembling those described by Pfeiffer and Canon were found. The remaining five, as well as the blood-cultivations, were negative.

Microscopical examination of the bronchial sputum showed minute thin bacilli, about the thickness of the bacilli of mouse-septicæmia, half their length, and most exhibiting the characteristic polar staining. Cultivations from the sputum were made by inoculating a few ccm. of salt solution with a particle of sputum, and shaking the mixture in a test-tube. From this, gelatin-agar and broth tube-cultivations were made. In some of the broth tubes incubated at 37°, there appeared in from 24–48 hours glassy, fluffy masses at the bottom of the fluid, the supernatant broth remaining quite clear. In the agar tubes there were a few translucent colonies looking like droplets of water, and some other opaque white colonies. In the gelatin tubes there were only white liquefying colonies.

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

† Bull. U.S. Nat. Mus., No. 39, part G. Washington, 1892, 56 pp.

‡ Bull. U.S. Nat. Mus., No. 39, part F. Washington, 1892, 117 pp. and 1 pl.

§ Brit. Med. Journ., 1892, No. 1621, pp. 170–1.

Subcultures from the fluffy glassy growth at the bottom of the broth cultivations were made on agar-gelatin and on broth. On agar at 37° developed circular small translucent droplets, having no tendency to become confluent. In the broth subcultures at 37° glassy fluffy masses developed at the bottom of the tubes, the supernatant fluid remaining quite clear. The gelatin tubes incubated at 20° failed. Cover-glass specimens of the broth cultures stained with rubin (2 per cent. watery solution), methyl-blue-anilin water, and in gentian-violet-anilin water, showed the growth to be made up of strings and filaments; the filaments were composed of short, thin rods, most of which had a granule at each end. The growth in agar also showed filaments, but also many groups of minute bacilli resembling those found in the sputum.

Method of Examining Saliva for Pathogenic Organisms.*—Dr. W. D. Miller finds that, owing to the large number and different sorts of micro-organisms infesting the mouth, it is almost impossible to arrive at any conclusion regarding the presence or absence of any particular kind by a simple microscopical examination. Agar-cultures also often fail, first, because many pathogenic mouth bacteria do not grow on this culture medium; or, secondly, they grow so slowly that they are soon overgrown and hidden by the more proliferous oral saprophytes. Gelatin is still less adapted to the purpose. Pathogenic organisms must therefore be isolated through the medium of an animal body.

The person whose saliva is to be examined should be instructed to rub the tongue against the cheeks and gums, so as to make the saliva mix with the dead epithelium and other deposits. One or two drops thus obtained were injected into the abdominal cavity of a white mouse. When the mouse died within five days the cause of death was found to be acute peritonitis, or blood poisoning, or a combination of both; if later, death was nearly always due to the local suppuration processes. Thus, from these experiments the author (111 mice were injected) was able to divide the pathogenic mouth bacteria into two classes, and he also found that injections made with the blood or peritoneal exudations of the dead mice produced the same results as injections with saliva.

Preparing the Antitoxic Serum of Tetanus.†—MM. E. Roux and L. Vaillard, in a contribution to the study of tetanus, in which they deal with the prevention and treatment of this disease, state their method of obtaining an antitoxic serum.

They use tetanus cultures in peptonized bouillon about four or five weeks old; these cultures, filtered through unglazed porcelain, furnish a clear liquid. This liquid is the author's tetanotoxin in a condition of extreme activity, as 1/4000 ccm. kills a mouse. This toxin mixed with a solution of iodine loses in great measure its harmful properties, and forms the vaccinal fluid, which is in no way caustic.

The serum is obtained from a rabbit (say of 2½ kilo. weight). On the first day the animal is injected subcutaneously with a mixture of 3 ccm. of toxin and 1 ccm. of Gram's iodine solution. On the fifth day, 5 ccm. of toxin and 2 cc. of Gram's solution. On the ninth day, 12 ccm. of toxin and 3 ccm. of the iodide solution. Eight days after the third

* Trans. Seventh Internat. Congress Hygiene, ii. (1892) p. 46.
† Ann. Inst. Pasteur, vii. (1893) pp. 72–7.

injection the animal gives a serum which will neutralize its own volume of toxin.

The serum is preserved by drying it in vacuo and diluting it with six times its weight of distilled water when required for use.

Concentrated Must as a Nutrient Material for Fungi.*—Prof. J. Wortmann recommends the use of a specially prepared must, from ripe grapes, as a nutrient material for fungus-cultures. It has the advantage of presenting all the nutrient substances in a convenient form for assimilation.

Sterilizing Power of Porcelain Filters.†—Dr. P. Miquel compares the sterilizing power of four different kinds of unglazed porcelain filters; the names are not given, the author's object being to show that the results, good or bad, are closely connected with the construction of the filters. However good any particular system may be, the filtering power is only of comparatively short duration, and this is associated with the kind of water that is filtered and the difference in the bacteria. The author quotes some interesting facts; the typhoid bacillus does not pass through the filter under ordinary circumstances, as may be shown by immersing the filter in clear broth. At any rate the bouillon remains quite clear. But if some few drops of water from La Vanne be added to the culture, the typhoid bacteria will pass in a few days. The cholera vibrio passes in four days. Anthrax behaves like enteric. Large organisms such as Saccharomycetes never pass.

The author praises the Chamberland filter highly, though he admits that it has defects: but contends that these will eventually be remedied, possibly altogether.

Cultivating Lower Algæ in Nutrient Gelatin.‡—M. W. Beyerinck reports on the cultivation experiments he has made during the past three years with the lower algæ. *Scenedesmus acutus* was the only species which exhibited very marked loss of vitality. The others were more resistant, and though their growth was slow, the cultivations were successful. Of these there were five, and though the number seems small, yet, from morphological considerations, they are important, inasmuch as they represented the three chief forms of cell proliferation in algæ; that is to say, simple division in one direction in *Stichococcus*, sporangial division in *Chlorella*, and vegetative division and swarm-spore-formation in *Chlorosphæra* and *Chlorococcum*.

Dachnewski, P. N.—**Eine vergleichende Untersuchung der Chamberland-Pasteur'schen und Berkefeld'schen Filter.** (A Comparative Examination of the Chamberland-Pasteur and Berkefeld Filters.)
Wratsch, 1893, pp. 543–5 [Russian].

Lacour-Eymard—**Expériences sur le filtre Chamberland.** (Experiments with the Chamberland Filter.) *Rev. d. Hygiene*, 1893, pp. 486–500.

Migula, W.—**An Introduction to Practical Bacteriology.** Translated by M. Campbell and edited by H. J. Campbell. London, 8vo, 1893, 234 pp.

Pfeifer, V.—**Eine leicht sterilisierbare Aspirationsspritze zum Zwecke bakteriologischer Untersuchungen am Krankenbette.** (An easily sterilizable Injection Syringe for Bacteriological Investigations by the bedside.)
Wien. Klin. Wochenschr, 1893, pp. 293–4.

* Bot. Ztg., li. (1893) 2te Abtheil., pp. 177–84.
† Ann. de Microgr., 1893, pp. 138–44.
‡ Centralbl. f. Bakteriol. u. Parasitenk., xiii. (1893) pp. 368–73.

(2) Preparing Objects.

Mode of Studying Gills of Lamellibranchs.*—Dr. F. Janssens used injections of gelatin, gum arabic, and especially nitrate of silver in order to study the blood-cavities of the gills of Lamellibranchs. Immediately after injecting a 1 or 2 per cent. solution of osmic acid distilled water must be introduced by the same means, and then another solution of nitrate of silver of half the strength. It is best to wash with water and not to expose the organ to the light until it has been put in 70 per cent. alcohol.

Teasing was found to be of much use for the study of the epithelium; a solution containing a third part of alcohol, the boric and salicylic acids employed with so much success by Engelmann, and very weak osmic acid acting for two hours all gave very interesting preparations. Maceration in strong carbonate of potash in the oven at 70° for several days was very useful in the study of the skeletal part of the gill.

Gilson's was found to be the best fixing method. Staining the sections is strongly recommended; one point is that one is able to make use of various new staining reagents used in the industrial manufacture of wools; a number were tried, and one—the blue carmine (breveté N., Meister, Lucius, & Brüning, Höchst a/M) is strongly recommended. Since the author used it it has been introduced into the laboratory at Louvain, and it has been shown that it has a special predilection for those parts of the protoplasm which undergo cuticular differentiation. It has the advantage of being a solution that can be employed in alcoholic solution; it does not stain the collodion employed to fix the sections, if one is careful to wash in alcohol after staining. It is as well to add two or three drops of hydrochloric acid to every hundred ccm. of the reagent.

Preparation of Early Stages of Distichopora violacea.†—Dr. S. J. Hickson, who has tried many stains and combinations of stains, finds that the best treatment is to place the sections of *D. violacea*, when fastened to the slide, in a strong solution of eosin in 90 per cent. spirit for an hour, then to wash in 90 per cent. spirit, and stain in weak hæmatoxylin for twenty minutes. This treatment gives a beautiful double stain, which shows the nuclei and the chromatin granules better than any preparations treated with carmine.

Examination of Protozoa in Cancerous Tumours.‡—Messrs. M. A. Ruffer and H. J. Plimmer, who have confined their investigations to carcinoma of the breast, report that, for fixing purposes, they have entirely given up alcohol alone, as the results are very uncertain. Osmic acid (1 per cent.) and Foà's solution—equal parts of salinated solution of corrosive sublimate in ·75 per cent. salt solution, and of 5 per cent. solution of potassium bichromate—gave excellent results. The osmic acid preparations, stained with eosin and hæmatoxylin, were extremely instructive; those fixed with Foà's solution stained fairly well with Biondi's reagent, or with eosin and anilin-blue. Striking results have been obtained by using for fixation purposes the solution of chromic

* La Cellule, ix. (1893) pp. 8–10.

† Quart. Journ. Micr. Sci., xxxv. (1893) p. 129.

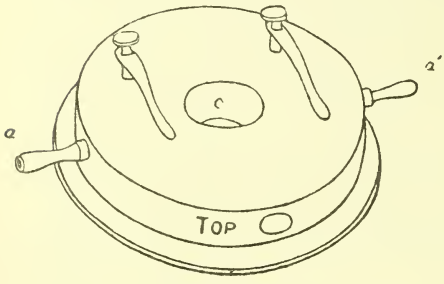
‡ Journ. of Pathol. and Bacteriol., i. (1893) pp. 397 and 9

acid and spirit recommended by Dr. Klein for the study of karyokinetic figures. The most likely place to find the parasites is in a section passing through or near the growing edge of the cancer; indeed, care must be taken that the parts selected be really from the growing edge.

Taylor's Freezing Attachment to Microscopes.*—Dr. T. Taylor gives the following description of his apparatus:—

"This device, which I have prepared for use with the Microscope, is the result of a long experienced want of some method of crystallizing the various oils and their acids, so as to obtain microphotographic views of their respective crystalline arrangement, a knowledge of which is important in microscopic investigations relating to adulteration of food, and other oils. Another advantage offered by this invention is, that by this method objects in natural history mounted in varnish or other media may be thrown on a screen and photographed. In the use of sunlight or Drummond light the liquid soon reaches 212° Fahr., and thus renders a valuable mount useless."

Fig. 103.



The freezing-box (fig. 103) is made of brass or of German silver, and is attached to the stage of the Microscope by means of two clamps; *a a'* represent tubes, one of which supplies the freezing solution and the other carries it off. A pail to receive the waste liquid is in readiness, and is connected in the usual way by means of rubber tubing. *c* is an opening through the centre of the box to admit of the transmission of rays of light to the object under investigation. The freezing liquid may be used repeatedly, or until it ceases to be cold enough for the purpose. Any of the usual freezing liquids, or ammonia, gas, or ether may be used. The tube which carries off the liquid from the freezing-box should terminate in a small orifice, to prevent unnecessary waste. The box is provided with an air-escape, to facilitate the operation of filling the box with freezing liquid. When this is accomplished, plug the opening and secure the box in position. In using ether, remove the plug to allow the ether to escape, or insert a tube to convey it to a separate vessel, where it may be condensed."

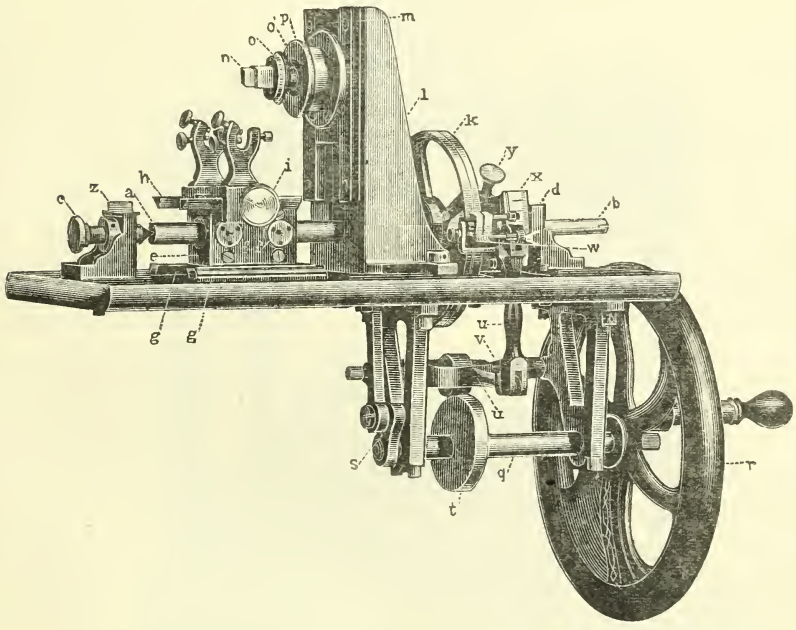
(3) Cutting, including Imbedding and Microtomes.

Reinhold-Giltay Microtome.†—Dr. J. W. Moll describes the microtome designed and constructed by Herr H. Reinhold of Amsterdam in collaboration with Herr J. W. Giltay of Delft. The main axis of the instrument *a b* (fig. 104) is supported on the left against the conical end of the screw *c*, and on the right by the metal block *d*, in which it rotates.

* St. Louis Med. and Surg. Journ., xiv. (1893) pp. 162-3 (2 figs).
† Zeitschr. f. wiss. Mikr., ix. (1893) pp. 445-65.

That part of it which passes through the block *e*, carries the micrometer screw. The block *e* contains the nut in which the screw engages, and is therefore moved forward at each revolution of the axis. The nut is made up of three strips, two of which are fixed, while the third (in the figure facing the observer) is adjustable by the screws *f f*, so that the whole can be tightened up when the micrometer screw becomes worn after long use. The block *e* slides on two rails *g g* screwed to the base-plate of the instrument. It carries above a plate *h*, on which the knife-holder is fastened by the screw *i*. The knife can be

Fig. 104.



adjusted to any inclination desired by means of the three screws on the holder.

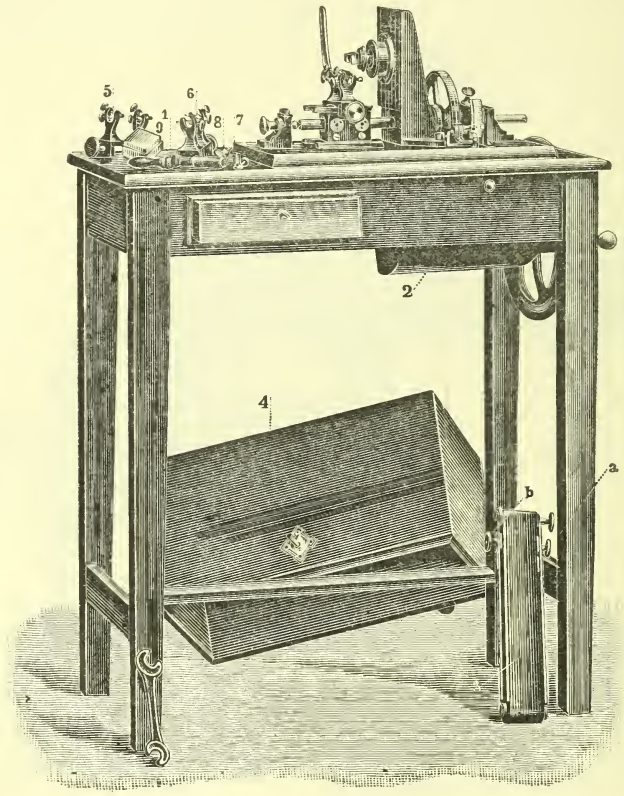
The toothed-wheel *k*, fixed to the axis on the right, has 500 teeth, and the pitch of the micrometer screw is 0·5 mm., so that by a turn of one tooth the knife is advanced 1 micron.

The plate *m* to which the object-holder is attached by a ball-and-socket joint slides in swallow-tail grooves in the vertical holder *l*. The clamping ring *p* of the ball-and-socket joint is not in direct contact with the ball, but acts upon a second ring between the two, which is only movable in the horizontal direction, so that a horizontal pressure is alone produced and the adjustment of the object is not altered on clamping up.

The movements of the various parts are effected in the following way. The axis *q* beneath the instrument is turned by the handle of the

flywheel *r*. On this axis to the left is the crank *s* by which the up and down movement of the slide *m* with the paraffin block is produced. On the same axis more to the right is the excentric disc *t*, the rotation of which effects the movement of the toothed-wheel *k*. By means of the rods *u u* and the axle *v*, the piece *w* is moved by each rotation once up and down. By the pressure of a spiral spring the two pawls attached to *w* engage in the teeth of the wheel *k* on the ascending movement, but

Fig. 105.



glide over them, since they are pointed obliquely downwards, in sinking. The left pawl can be slightly raised by a screw and thus put out of action. Both pawls are regulated by the segment *x* which is adjusted on the main axis by the screw *y*. It allows of a displacement of the knife up to 40 microns. The capability of adjustment of the left pawl enables displacements of 1/2, $1\frac{1}{2}$, $2\frac{1}{2}$, &c., microns to be made. Thus by making the left pawl shorter by half a tooth and adjusting the right pawl by the segment *x* to half a tooth, the two pawls will act alternately in raising the wheel by half a tooth.

The length of the micrometer-screw on the main axis is 3 cm.

When this has been worked through, the screw can be drawn back by the handle shown at 1 in fig. 105.

The special table required for the microtome is seen in fig. 105. The lower mechanism is enclosed in a metal cover 2. At 3 is shown a band which can be attached to the screw *z* in fig. 104, and then stretched out above the table to the left, where it is adjusted near to the knife by the screws *a* and *b* (3 in fig. 105). At 4 is seen a wooden cover for the upper part of the instrument. At 5 and 6 are two smaller knife-holders, with corresponding object-holders at 8 or 9. At 7 are the small screw-heads which serve to adjust the screws *ff* in fig. 104.

The chief advantages offered by the instrument are as follows:—

(1) The very great stability of all its parts.

(2) Sections as large as 4 × 4 cm. can be easily prepared with it.

(3) The limits of the cutting thickness lies between 0·5 and 40 microns and 80 different thicknesses of section can be obtained.

(4) The movement of the knife begins in all cases when the paraffin block is raised above it, and ends before the knife again begins to cut.

(5) The length of the paraffin block can amount to 7 cm. and even more if necessary.

(6) The paraffin block is freely movable in all directions and can be fixed in any position without altering the adjustment.

With respect to the use of the instrument in preparing series of paraffin sections the author discusses the difficulties commonly met with. Of these the two most serious are—

(1) The pressing together of the sections.

(2) The slitting of the band along its length.

The first difficulty was found to increase regularly with the angle between the faces forming the edge of the knife.

The kind of grinding powder employed in sharpening the knife has great influence on the behaviour of the edge. The author divides such powders into two categories distinguished as "sharp" and "polishing."

Emery is a type of a "sharp" powder. Sharpened with this the edge shows beneath the Microscope a number of sharp notches, and the fault of tearing the sections is very marked with such a knife for sections thicker than 5 μ. On the other hand there is very little pressing together of the sections even with the thinnest. Vienna lime can be taken as a type of a polishing powder. With this the knife shows under the Microscope a straight edge almost without notches. With such a blade no tearing of the band is to be feared, and the pressing together of the sections is unimportant for sections thicker than 5 μ, so that it can be recommended for all ordinary work.

For very thin sections then, some sharpening material intermediate in properties between the two preceding is necessary.

The author's experiments with various materials have led him to the choice of the three following:—

(1) Oxide of iron prepared by igniting the oxalate which has been precipitated from a hot solution of ammonium oxalate by ferrous sulphate.

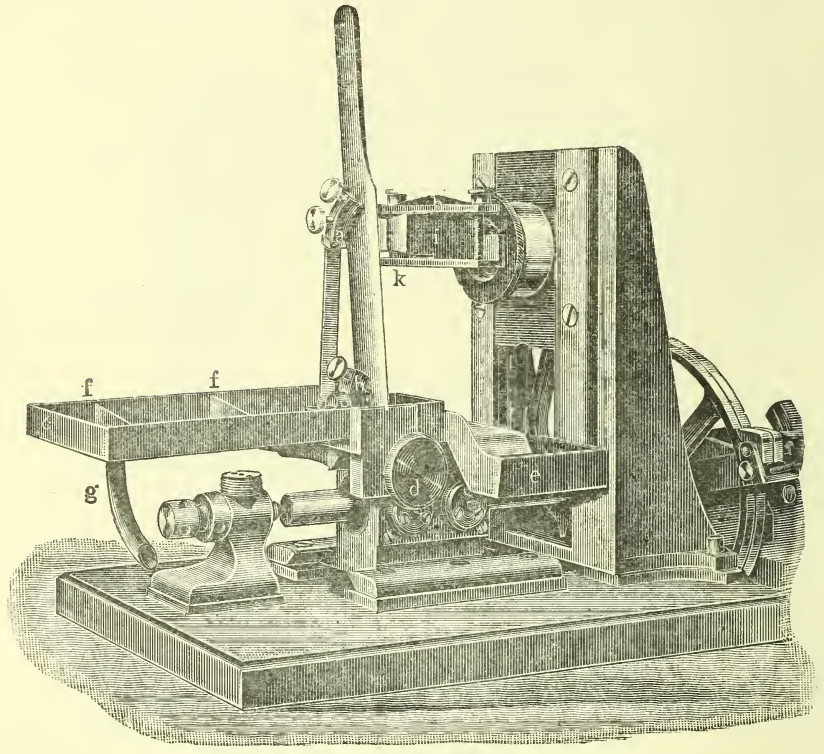
(2) Oxide of iron obtained by igniting the double sulphate of iron and ammonium.

(3) Diamantine No. 1, the composition of which is unknown to the author.

Treatment of a knife-blade which has first been sharpened by Vienna lime with either of these powders for a few moments suffices to give to the edge the extremely small notches necessary in order to prevent the pressing together of the sections.

For the preparation of celloidin sections a very obliquely set knife, which must be kept moistened with alcohol, is required. For this purpose, therefore, the form of the knife-holder and object-holder are modified as shown in fig. 106. The knife-blade is clamped above and

Fig. 106.



below. The upper clamp *a* is carried by a vertical rod, the under *b* is attached to the base of the flat reservoir *c*, and is adjustable in the horizontal direction. Both clamps are provided with screws by which the inclination of the knife can be regulated.

The knife-holder (fig. 106) is fastened to the microtome by the screw *d*. Beside the reservoir *c* there is a second one *e* more to the right, which serves to protect the instrument from the alcohol which is allowed to drop upon object and knife during the cutting.

The reservoir *e* in which the sections are collected is at first filled with alcohol, which is kept at a constant level by means of the exit tube *g*.

The object-holder *h* allows of the object being shifted horizontally. It consists of two metal plates, the upper one of which is movable in the vertical direction and can be fixed by two screws. Between these plates, therefore, the wooden block *i* on which the celloidin block is fastened can be adjusted in the horizontal direction and fixed.

With an inclination of the knife-edge to the horizontal of 60° which is sufficient for sections 50 μ thick, the size of the sections can with this instrument amount to 2·5 × 2·5 cm.; but for thinner sections of 15 to 10 μ the inclination of the knife must be increased to 80°, and in this case the maximum size of the sections is only 1 × 2·5 cm.

(4) Staining and Injecting.

Nature of the Staining Process.*—Herr G. Spohn has attempted to solve the question whether the colouring of cellulose-fibres by staining reagents depends on a chemical or on a mechanical combination. Microscopical examination of cotton-wool stained by mineral pigments showed no change whatever in the structure of the fibre itself. Even when the fibres were macerated before staining with alizarin, they acted simply as a carrier of the pigment, on which the macerating fluid acts chemically. In all cases the combination of the fibre and the pigment depends entirely on mechanical causes.

New Process of Double-staining Vegetable Membranes.†—M. C. Roulet describes a method of double-staining by the successive use of cyanin and Congo-red. The sections are first decolorized by eau-de-Javelle, and then left for a quarter of an hour in a concentrated alcoholic solution of cyanin, then washed with absolute alcohol, and placed for a quarter of an hour in a 5 per cent. ammoniacal solution of Congo-red. After washing in alcohol, and mounting in xylol-Canada-balsam, the sections present a magnificent double staining, the lignified membranes are coloured an intense blue, the cellulose-membranes rose-coloured or red.

Staining living Sex-cells.‡—Dr. M. Waldner, having observed that the spermatozoids of *Marchantia* survived staining with a weak solution of eosin-red, treated the spermatozoa of the trout in the same way. They took on the stain, remained active for fifteen minutes, and were able to fertilize ova. The egg-membrane resisted the stain, so that ova similarly treated remained colourless.

Demonstrating Malaria Parasites.§—M. A. Laveran spreads thin layers of blood on cover-glasses after the manner in which a layer of sputum is obtained. The blood-films are then dried in the air, and afterwards passed thrice through the flame of a spirit-lamp. The preparations are then mounted as they are, that is in air or dry, and the edge of the cover-glass just ringed round with paraffin to keep out dust and moisture. The films may be stained with an aqueous solution of methylen-blue for 30 seconds. After this they were washed rapidly in distilled water, dried, and mounted dry. The parasites are stained, but much paler than the nuclei of the leucocytes; the red corpuscles are unaffected.

* Dingler's Polytechnisch. Journ., cclxxxvii. (1893) Heft 9. See Bot. Centralbl., liv. (1893) p. 293.

† Arch. Sci. Phys. et Nat,, xxix. (1893) p. 100.

‡ Anat. Anzeig., viii. (1893) pp. 564–5.

§ Trans. Seventh Internat. Congress Hygiene, ii. (1892) pp. 12–13.

The preparations may be contrast stained with eosin in aqueous solution. In this case the cover-glasses are first stained with eosin and afterwards with methylen-blue, and finally mounted dry or in balsam. The eosin stains the red corpuscles pink, the parasites are pale-blue, and the nuclei of the leucocytes dark blue. Besides methylen-blue the author also used gentian-violet and dahlia, but the results were not so happy.

Preparing and Staining Blood-films for Examination of Leucocytes.*—The method adopted by Mdlle. C. Everard, MM. J. Demoor and J. Massart for examining the condition of the blood, and especially the modification of the leucocytes therein, was as follows:—The blood was obtained by puncturing a small superficial vein of the animal's ear. Very thin films were then spread on cover-glasses and fixed with heat. The cover-glasses were then laid on a metal plate and heated for an hour at 65°–70°. Such preparations, which would keep quite a long time, were stained by immersing them for 5–10 minutes in a mixture of equal parts of the following liquids:—(1) Eosin 1 grm., alcohol 25 grm., water 75 grm., glycerin 50 grm.; (2) Hæmatoxylin 1 grm., alcohol 10 grm., alum 20 grm., water 200 grm. The alum is dissolved by aid of heat in the water, and the solution filtered when cold. Twenty-four hours after, the alum solution is added to the alcoholic solution of hæmatoxylin, and the mixture filtered after standing for eight days.

The stained preparation, having been carefully washed in water, is passed through 90 per cent. alcohol, absolute alcohol, oil of cloves, and mounted in balsam. By this method the nuclei are stained by the hæmatoxylin, while the eosin colours the "protoplasmic granulations." The authors also employed orange, acid fuchsin, and methyl-green, but found that the first method was by far the most effective.

Mode of Investigating Retina of Vertebrates.†—Prof. S. Ramon y Cajal finds that the most satisfactory method of studying the retina is the rapid method with chromate of silver, already used by Tartuferi. As a general rule, he has employed methylen-blue to control the facts revealed by the method of Golgi; it can, also, give, as Dogiel has shown, very brilliant and quite new results. At the same time it is to be noted that methylen-blue does not stain either the fibres of the rods and cones or their lower swellings; nor does it impregnate the fibres of Müller, the centrifugal nervous prolongations, or several varieties of ganglionic cells or spongioblasts. The transparency is imperfect when the retina is fixed with picrate of ammonia, or the mixture of this reagent and osmic acid which is recommended by Dogiel. The only departures from Dogiel's method of applying methylen-blue are that the retina is stained *in situ*, and that the fixing reagent is allowed to act only for two instead of for twenty-four hours.

Apáthy's preservative fluid—a syrupy solution of gum arabic and sugar, has been found satisfactory. The valuable rapid method of Golgi does not always act in the same way on the small retinæ of Fishes, Batrachians or Reptiles; in fact, the more delicate the retina, the more difficult is it to impregnate it well. For example, more satisfactory preparations are obtained with the eyes of *Lacerta viridis* than of *L. agilis*. For small eyes a method of double impregnation is recommended: the

* Ann. Inst. Pasteur, vii. (1893) pp. 166–7.
† La Cellule, ix. (1893) pp. 126–31.

hinder hemisphere of the eye, after removal of the vitreous humour, is immersed in the ordinary osmio-bichromic mixture (bichromate of potash 3 per cent., 20 parts ; 1 per cent. solution of osmic acid, 5 or 6 parts). After being for one or two days in the mixture, the mass of liquid is drawn off from the parts, which are then put for twenty-four hours in a 0·75 or 1 per cent. solution of crystallized nitrate of silver. Without any washing the parts are returned to the osmio-bichromic mixture, care being taken that there is proportionately too much osmic acid. For a day at least the parts are again placed in the silver solution. For a few minutes they are then put into 40 per cent. alcohol, loosely imbedded in paraffin and cut into thick slices. After an hour's washing with alcohol they are cleared and mounted.

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

Gum Thus.*—Dr. A. M. Edwards writes :—"I had supposed that Gum Thus was procurable in England as well as in the United States ; but it is not, as I learn from an inquiry in your December number. It is Gum Thus or Frankincense, and is got here from the tree of the pine. I procured it from the L. R. Barnard Chemical Company, dealers in dye-stuffs, chemicals, acids, oils, &c., at 58, Market Street, Newark, N.Y., U.S.A. I dissolve in commercial alcohol, with moderate heat, and then pour it off from the sediment. To this, three parts, I add one part of oil of cinnamon. It is used like Canada balsam, but dissolves in weak ammonia, alkali, carbonate of ammonia, soda or potash or borax. These can be used to clean the slides from superabundant medium. Those who have tried it, speak in flattering terms of it. It is of a high refractive index, makes diatoms come out well with an ordinary one-fifth, and resolves the *Amphipleura pellucida* with a 1/12 immersion. The colour, lightish-brown, is in the way, but I will bleach it by-and-by. Chlorine does not bleach it well. Try it, is all I say."

Pneumatic Bubble-remover.†—Mr. A. P. Weaver writes as follows :—"Being annoyed with air-bubbles in my mounts, I have made a simple air-pump for removing them, as follows :—Take a small rubber syringe, the packing on the cylinder of which ought to be adjustable so as to fit the body of the syringe rather tightly ; cut off the nozzle rather close to the body, and bore a hole 3 mm. in diameter near the top of the latter, so that the packing will always be below the hole. Cut from an old rubber boot two washers 2 5 cm. in diameter, and with a central aperture of 2 cm. ; cement these washers together with Red Cross cement (such as is used for mending punctures in pneumatic bicycle tyres) ; cut from the boot two more washers of the same outside diameter and with a central hole a little wider than the nozzle of the syringe ; cement these last two washers together also, and cement them to the first two prepared ; you will now have a shallow chamber a little larger than the cover-glass. Force the nozzle of the syringe through the opening in the two plates and firmly cement it there. All these joints must be air-tight.

To use the instrument, place the slide on a smooth surface, wet the under surface of the rubber washers and apply the same to the slide

* Science Gossip, 1893, p. 68. † Amer. Mon. Micr. Journ., xiv. (1893) p. 126.

with the cover-glass in the shallow chamber. To make a good air-tight contact with the slide, grasp the syringe with the left hand and allow the lower side of the latter to hold the washers firmly to the slide. The hole drilled in the syringe is to act as a trap or valve, and is to be tightly covered with the first finger of the left hand (keeping the latter in position, grasping the syringe and holding the washers to the slide) at each downward stroke of the piston, and uncovered at each upward stroke. This is, of course, done to prevent the entrance of air to the vacuum chamber beneath after it has once been exhausted. I have found that three or four strokes are sufficient to bring all the bubbles to the surface of the mounting fluid and cause them to burst."

New Fixing Fluid for Animal Tissues.*—Dr. G. Mann has obtained good results (minimum shrinkage, distinctness of cell-outline, admirable fixing of cell-plasma and nuclei) by using the following mixture:—Absolute alcohol, 100 ccm.; picric acid, 4 grm.; corrosive sublimate, 15 grm.; tannic acid, 6–8 grm.

In order to obtain good results it is essential to use only living tissue; to have thin pieces (·5–1 cm.); to have an amount of fluid twenty times the bulk of the tissue; to go through an elaborate series of washing and alcohol transferences; to add chloroform very gradually; to saturate the chloroform gradually with solid paraffin, first at the ordinary temperature, then at 25° C., and lastly at 52° C., keeping the bottle well stoppered; to allow the chloroform to evaporate gradually, avoiding accelerating devices which cause shrinkage, and so on. For minuter details of a method which has certainly yielded good results reference should be made to the original paper.

(6) Miscellaneous.

Apparatus for Observing Movements in Plants.†—**Dr. F. Noll** describes a modification of the stroboscope (zoëtrope), by means of which the movements of a seedling plant which elevates itself by means of geotropism can be demonstrated, and exhibited in the lecture-room. The instrument may also be applied to the observation of the movements of tendrils, the periodical movements of foliar organs, &c.

Determination of Diastase in Leaves and Stems.‡—**M. St. Jentys** explains the failure of Wortmann to find diastase in the aqueous extract of leaves and stems on the following grounds:—It is probable that the diastase is formed only in small quantities, as it is required for the conversion of starch into sugar. The presence of tannin in the aqueous extract causes the precipitation of the starch, which is then only with great difficulty acted upon by diastase; it also precipitates the diastase itself. Finally, diastase possesses only a very feeble power of diffusion; and therefore, when contained within cells, passes into the solution only after the complete destruction of the cell-walls, and in company with the tannins which then precipitate it.

* Anat. Anzeig., viii. (1893) pp. 441–3.

† Verhandl. Naturh. Ver. Preuss. Rheinland, xlix. (1892) pp. 37–41.

‡ Verhandl. Akad. Wiss. Krakau, xxiv. (1893) 47 pp. See Bot. Centralbl., liv. (1893) p. 193.

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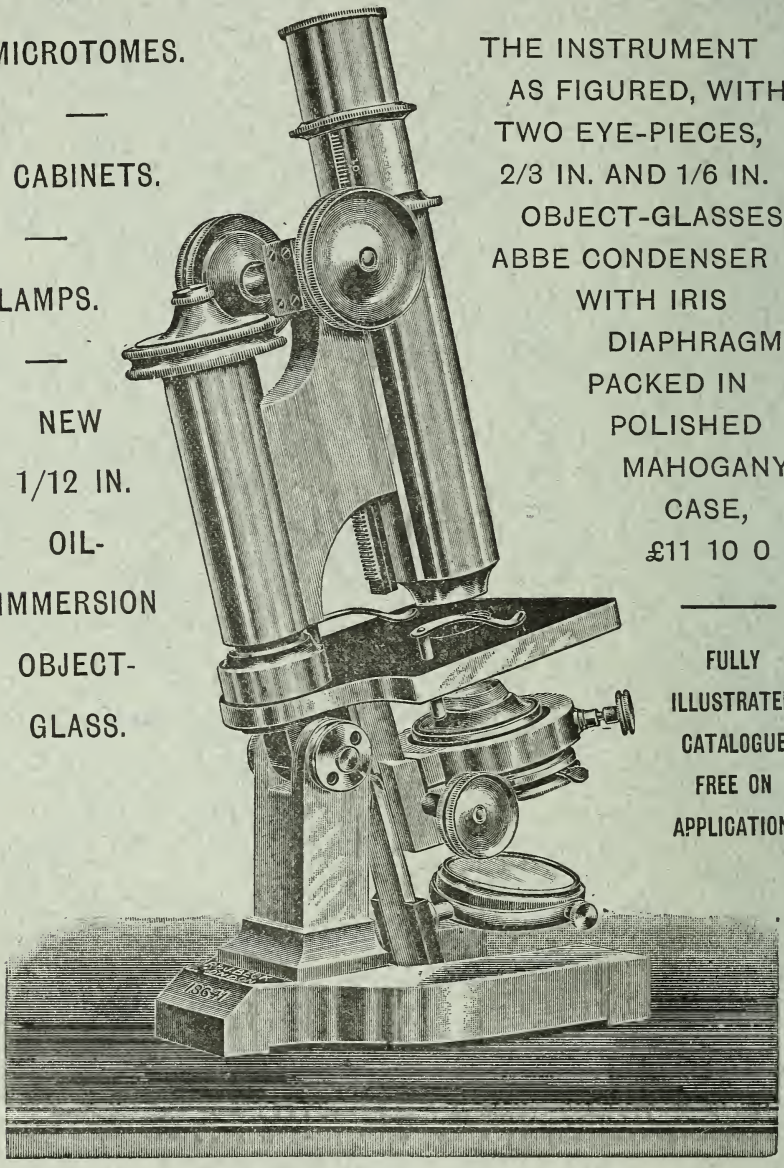

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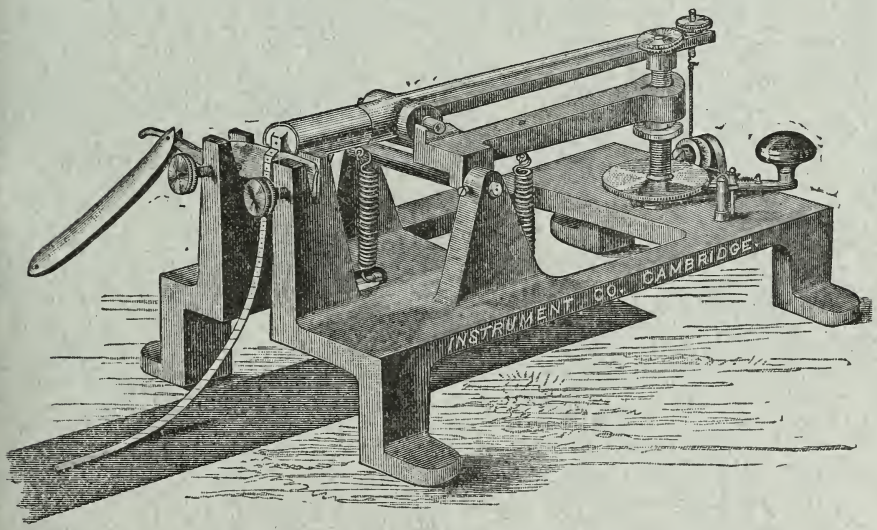

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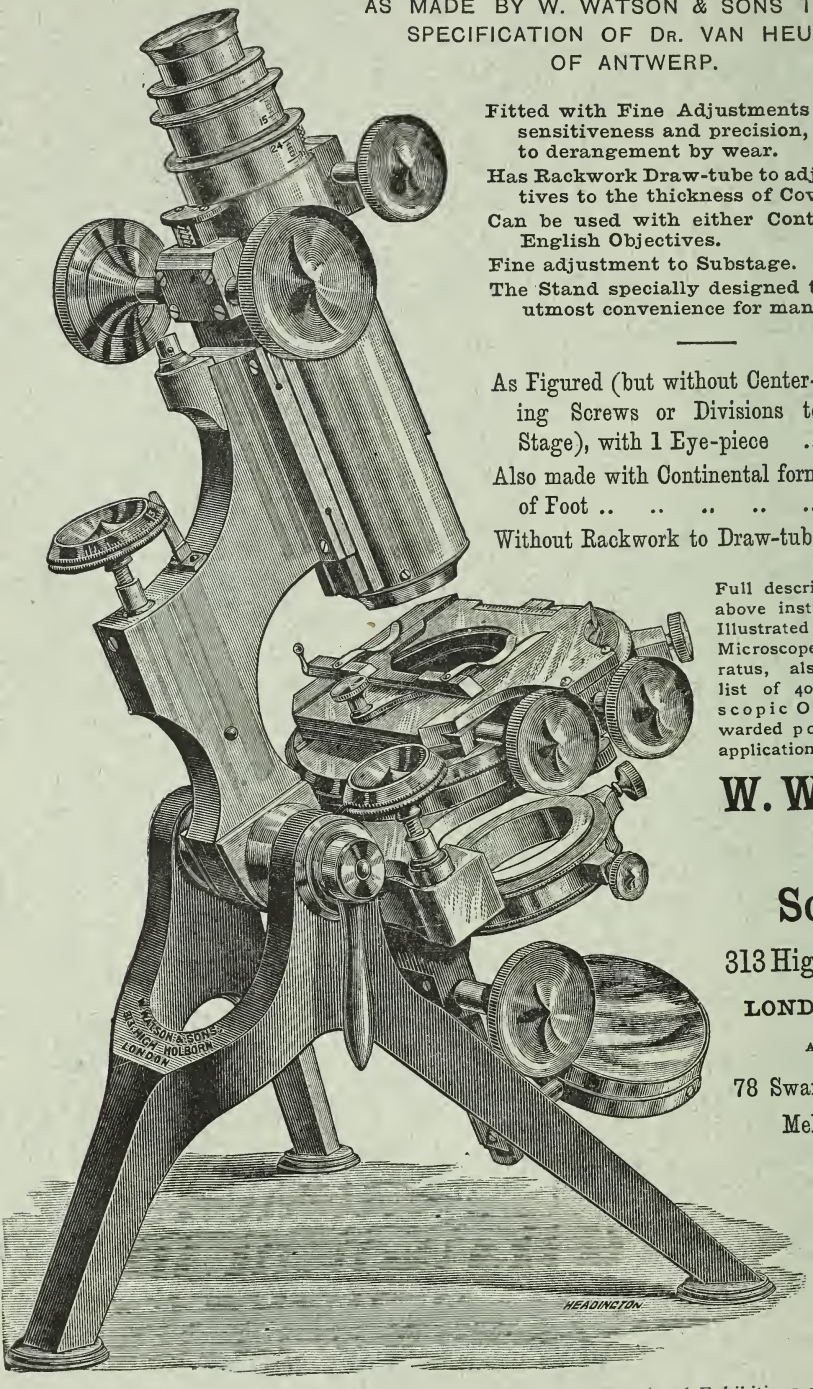

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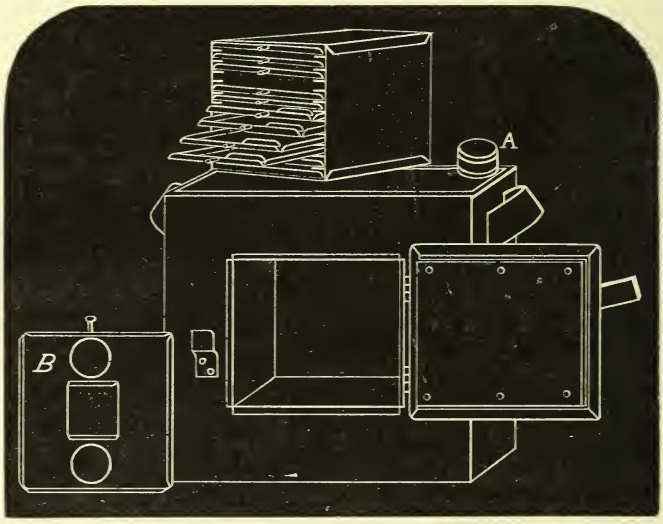
(3) Illuminating and other Apparatus.

Practical Drying Oven.†—Feeling the need of a compact drying or hardening oven for slides in which a uniform temperature could be maintained—one in which the slides would be held in place without disturbing the specimen and at the same time be easy of access, Mr. W. N. Preston made the oven illustrated in fig. 107. As will be seen by the figure, the rack is placed in a 6½ inch water-bath, which, having a hole bored in the screw cap A, keeps the heat at or below boiling point. This oven may be set on a stove or on a tripod over a Bunsen burner or other flame. The rack is made with slides or ways for the drawers to run on. The drawers, twelve in number, and holding

Fig. 107.



three slides each, are made from one piece of metal, the sides and ends being 1/8 in. high, and two similar elevations being turned up from the centre hole make three divisions in the drawer, each holding a slide which may be taken out, examined, and replaced at pleasure.

The three holes in the drawers, as shown at B, are for the purpose of allowing the ready removal of the slides by placing the finger under and raising them, and also admit of the hardening of inverted mounts. Should spring clips be necessary for holding the cover-glasses in place,

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

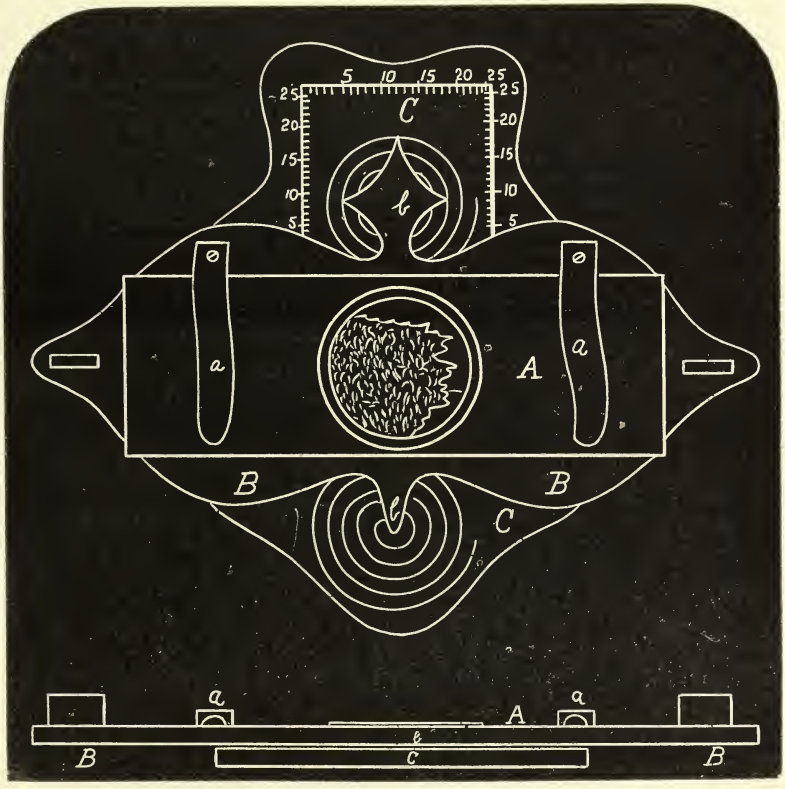
† Proc. Amer. Mier. Soc., xiv. (1893) pp. 152–3 (1 fig.).

they may be accommodated by removing the drawer next above and placing but two slides in each drawer at right angles to the position occupied by three, the springs thus coming to the centre. Being made entirely of copper, the durability of the apparatus is assured as well as its safety from rust.

Mr. Preston adds that the object of the rack is to allow the ready removal of the entire lot of slides from the oven without the necessity of taking the oven as well.

Slide Carriage and Object-finder.*—Mr. F. L. J. Boettcher, finding it very difficult to get on without an object-finder, has constructed a contrivance whose object is twofold; first, to bring every part of the

Fig. 108.

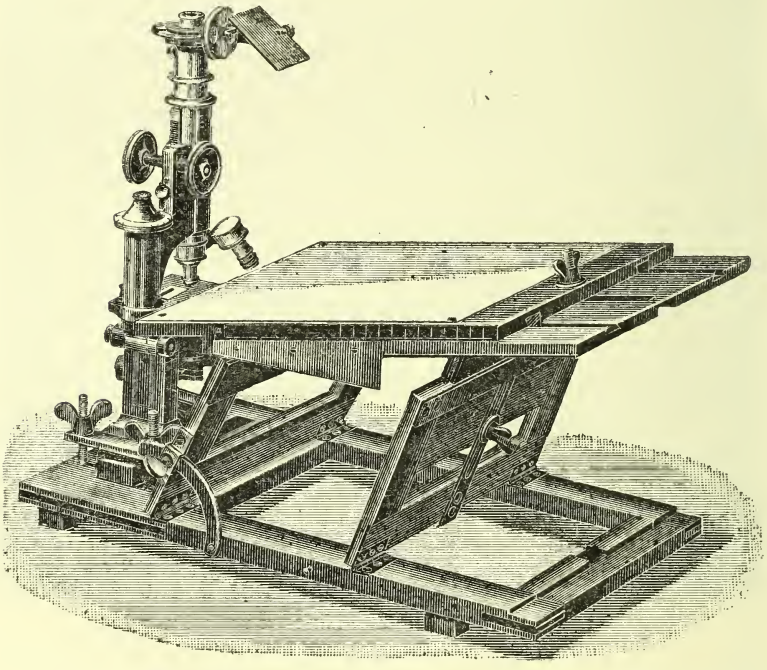


section by the shortest route once and once only under the Microscope; and secondly, to enable any point in the section to be recorded. In fig. 108 A represents a slide 3 in. by 1 in., lying in a recess or hollow of the carriage B, into which it fits closely and is held by the clamps *a a*.

* Amer. Mon. Micr. Journ., xiv. (1893) pp. 200-2 (1 fig.).

B lies firmly upon the table C, and contains at *b b* two short pins which rest firmly in the two spiral grooves. "These two pins will direct the motion applied; the section describing exactly similar revolutions, as the pins *b b*, will bring exactly the width between the lines of the spiral groove under the focus as a definite part of the same, decreasing in diameter as the power of magnification increases. The diameter of the field and the space between the lines of the spiral groove can correspond exactly only with the power for which the instrument has been made, and the possibilities lie between 50 and 250 diameter magnification. To find the actual field, measure the diameter of the field in millimetres and divide this by the previously ascertained magnification. The diameter of the actual field will be the exact distance between the lines of the spiral groove. In most instruments, 100 to 150 diameters give fields of 1 mm. diameter, just wide enough for the grooves, while the powers beyond these furnish too small a space. The apparatus should therefore be exactly fitted for one of the lower powers of the Microscope. C, the table, is firmly but not permanently attached to the stage of the Microscope by means of pins and sockets, clamps or screws, according to the stage of the instrument."

Fig. 109



Desk for Microscopical Drawing.*—Dr. W. Bernhard has designed a new desk for microscopical drawing which in many respects is an

* Zeitschr. f. wiss. Mikr., ix. (1893) pp. 439-45.

improvement on that of Dr. Giesenhagen, described in this Journal, 1891, p. 291. The latter instrument, as seen in figs. 30 and 31 (loc. cit.), was lacking in stability. In the design of the present apparatus the author was guided by the following principles:—

(1) Microscope and drawing-table must be rigidly connected together upon the same base-plate. (2) The plane of the drawing must be at the normal distance of distinct vision, i. e. 250 mm. from the eye of the observer, since (3) in general the drawing should correspond in its dimensions with the microscopic magnification, and therefore also (4) the drawing-desk must be adjustable in height and in inclination to the Microscope.

The mode of construction of the desk is seen in fig. 109.

On a base-plate, 25 × 44 cm., supported on three short feet, at distances from its left edge of 11·5 and 28·5 cm. respectively, are hinged two frames, each 15 cm. high, which are connected above with an upper plate, 25 by 38 cm. The frame on the left is directly hinged to this upper plate, while the other is only connected with it by means of a sliding-piece which is adjustable by a screw. By means of the arc-guide and clamping screw on the first frame the upper plate can be raised and fixed in any position, while its inclination can be regulated by drawing out the slide in the second. A sector of 10° on the upper plate gives its inclination. The height above the base-plate to which it can be raised is from 3 cm. to 17 cm.

The drawing-board proper moves in a swallow-tail groove on the upper plate and is clamped by a binding-screw. The Microscope is screwed on the free portion of the base-plate to the left of the first frame.

Improved Means of Obtaining Critical Illumination for the Microscope: Piffard's Electric Lamp.*—Dr. H. G. Piffard being unable to use with comfort either gas or an oil lamp in microscopic work, and finding that he could work by electric light for several hours continuously without inconvenience, applied to the Edison Lamp Works for a lamp to be constructed according to his own specifications. These were carried out, and the result was a lamp of fifteen candle-power requiring a current of about 3 ampères under a pressure of 15 volts. The lamp (fig. 110) has a cylindrical glass bulb about 3 in. long by 1 in. wide. The carbon filament is much broader and thicker than in the ordinary electric lamp, and is only 3/4 in. long, while the rest of the apparent filament is composed of copper wire arranged so as to support the carbon in a vertical position. When the carbon is rendered incandescent it shows a streak of light of intense brilliancy about 3/4 in. long and apparently 1/8 in. wide. The minified image of this is focused by mirror or condenser on the object and constitutes "critical" illumination. On examining the object with a 1/4 in. objective it was found that the field was not evenly illuminated, as there was a central brilliant streak on each side of which the light was comparatively feeble; but the portion of the object within the area of the streak was illuminated in the manner most favourable for the revelation of its intimate structure. In systematic work critical illumination is rarely called for except as a

* New York Med. Journ., lvi. (1892) pp. 71–2.

means of control, and subcritical or diffuse illumination, as obtained by racking the condenser a little out of focus, is preferable and more commonly employed.

While the lamp can be readily maintained at full incandescence by the current from an eight-cell storage battery, the care of this latter is by no means an insignificant matter, and Dr. Piffard is not prepared to recommend its use unless one has access to a street circuit. In New York they have both the Edison circuit with a pressure of from 110 to 120 volts, and the alternating current distributed to houses under the pressure of 55 to 60 volts. If the lamp was connected directly with either of these circuits it would be instantly destroyed unless the pressure was neutralized by the introduction of suitable resistance. This was accomplished on the Edison circuit by the interposition of a 100-candle power, 100 volt, 3-ampère lamp of the "*municipal*" type, the two lamps being in *series*. Both lamps will, when thus arranged, burn at full incandescence; and the large lamp can be covered up if not desired.

Fig. 110.

In photomicrography Dr. Piffard has used nearly all the methods of artificial illumination, including the arc, calcium, Welsbach gaslight, and oil, but the lamp described was found infinitely more convenient and amply efficient.

For ordinary work and for the study of absorption spectra by means of artificial light, this lamp is said to be an ideal illuminant.

New Mounting Table.*—Mr. W. N. Preston in describing his mounting table, says that it is intended to aid the microscopist in putting up uniform mounts. "A circular brass plate, 6 in. in diameter, turned perfectly flat on top, is set on three legs having levelling screws at the bottom. This table may be set over a Bunsen burner or alcohol lamp and kept warm while working.

The figure (fig. 111) shows a plan of the top, laid out in four sections, by placing the three pins, 1, 2, 3 (which are set in sockets and may be changed at pleasure or removed altogether), in the holes opposite the single set of circles and laying a slide against them, an object and its cover-glass may be exactly centered on the slide.

By using the set of double circles two objects may be set at equal distances from the centre and covers accurately placed; likewise the triple set, when three are wanted on a slide.

The first section is for cover-glass mounts, the cover being laid in the elevated socket A, object up; the slide, guided by the outer pins, is gently lowered till it touches the drop of balsam, the two shorter pins 4 and 5 holding it level with the top of the socket.

At the suggestion of my friend Mr. Summers, to whom I am indebted for many ideas in this table, I intend having a semicircular piece of

* Proc. Amer. Micr. Soc., xiv. (1893) pp. 150–1 (1 fig.).

plate-glass cut and ground on the surfaces, to rest on one half of the table for the purpose of evaporation in mounting diatoms, a more uniform

Fig. 111.

distribution of the heat being thus obtained as well as absorption for any particle of water which may overflow the cover-glass."

(4) Photomicrography.

Photography as an Instrument for recording the Macroscopic Characters of Micro-organisms in Artificial Cultures.*—Prof. G. F. Atkinson recommends the following mode of proceeding for this purpose. By cutting off the perpendicular rays of light, and throwing oblique rays from several directions through the plate-culture upon the sensitive plate, the colonies are differentiated strongly in all their exquisite forms and tracings. The culture plates (Petrie dishes) or tubes are inserted in an opening in the end of a box, which is painted perfectly black on the inside. Sliding boards in a grooved frame, each cut to clamp over half the Petrie dish, and lined with black velvety stuff, hold the plate-culture in position. The lens of the camera is pointed towards a window with the plate-culture between them. A perfectly black screen 30–40 cm. in diameter is then hung upon the window directly in front of the object, in order to cut off the perpendicular rays of light.

* Bull. Torrey Bot. Club, xx. (1893) pp. 357–8.

A suggested Improvement in the Correction of Lenses for Photomicrography.*—Dr. H. G. Piffard writes:—"Prior to the time of the late Colonel J. J. Woodward, M.D., Surgeon of the United States Army, say twenty-five years ago, photomicrography was in its first infancy. It is true that photographs of microscopic objects had been made, but they were crude and unsatisfactory, and were all made with what we would call low-power objectives. Although the objectives then made were of excellent construction and well adapted to the revelation of the structure of minute objects to the eye, yet the photographs made with them were greatly inferior in clearness and sharpness to the virtual image appreciated by the retina. The cause of this was not far to seek, and was due to the lack of coincidence of the visual with the so-called actinic focus. At the period mentioned the art of photography was almost exclusively practised with the aid of collodio-iodide plates, which were very sensitive to the blue, violet, and ultra-violet (more refrangible), and but feebly sensitive to the green, yellow, and red (less refrangible) rays. *Per contra*, these latter rays impress the eye so forcibly that the effect of the more refrangible rays is almost obscured—that is, when mingled with the others, as in ordinary white light. The practical outcome of this condition was, that when the ground glass of the camera was in a position that gave the sharpest image to the eye, this image could not be duplicated as to sharpness in the developed photographic plate occupying the plane previously occupied by the ground glass.

In order to obtain a sharp photographic image it was necessary either to shorten the anterior conjugate focus, which involved the veriest guess-work, and was practically unavailable, or else to move the plate to a point nearer the lens where the actinic rays came to their posterior conjugate focus. This was perfectly practical, and by repeated experiment the relation of the actinic to the visual focus in a given lens could be ascertained. Although practical, this method was hardly satisfactory.

In ordinary photography, the difficulty attending this difference in the natural positions of the actinic and visual foci had already been overcome by making the visual focus correspond with the actinic by constructing the lens so that it should be left in a state of moderate 'under-correction,' as it is termed by opticians.

Among the first to appreciate the value of this, as applied to photomicrography, was Colonel Woodward, and the first opticians to give it practical form were, I believe, Mr. William Wales, of New York, and Mr. Ernst Gundlach, then of Berlin, but now for many years a practical optician in this country. This example was followed by Tolles, of Boston; Powell and Lealand, of London, and others.

Woodward was one of the most accomplished microscopists, so far as the manipulation of the instrument was concerned, that ever lived. His skill in securing the virtual image and in projecting the real image was at that time equalled by few and probably surpassed by none.

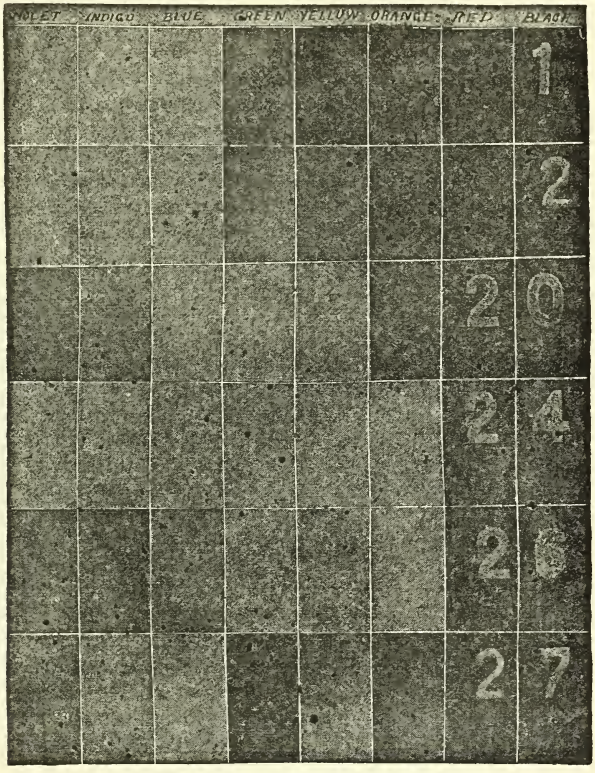
With Woodward's skill and the possession of lenses specially adapted to his purpose, the results obtained by him were the wonder of the scientific world.

Since his time photomicrography has, in the main, followed the paths

* Amer. Journ. Med. Sci., cvi. (1893) pp. 23–9.

he marked out, and the improvements in the art since then have simply kept pace with the gradual improvement of the objective, and especially in the direction of increased apertures. One notable advance in the technique, however, is Abbe's happy conception of the projection ocular.*

Fig. 112.



Photograph of Artificial Spectrum.

The collodio-iodide gave place some years ago to the gelatino-bromide plate, which, like its predecessor, is especially sensitive to the blue and more refrangible rays, and almost wholly insensitive to those which give the strongest visual impression. The relative sensitiveness of such a plate to pigment colours is clearly shown in the annexed photograph of an artificial spectrum. (See fig. 112.)

In order to obtain the sharpest image on such a plate the lens must

* Peculiar advantages have been claimed in behalf of objectives constructed according to the so-called "apochromatic" system. These lenses, however, possess certain disadvantages which restrain me from giving them unqualified commendation.

of necessity be under-corrected, as already stated. In accomplishing this, however, there is a certain loss of visual excellence which, however, is of little moment in ordinary photography. That this under-correction of lenses for photomicrography results in an impairment of their visual excellence is well known to opticians, bnt has thus far received but little notice from the actual users of the lenses in question. A few recent writers, however, have directed attention to the matter.

Londe * says: 'The first and most important question is the choice of objectives. These may be excellent for observation and more than mediocre for photography.'

Mercer,† in speaking of some of the objectives used by him in photomicrography, says. 'The Wales objectives are corrected spherically for the violet ray. The violet image is, therefore, somewhat superior to the visual, with which, however, it is coincident.'

Czapski, in a letter published in Van Heurck's treatise on 'The Microscope,' London, 1893, says, 'In every case the objectives specially constructed by opticians for photography can never be advantageously employed for observations, and inversely.'

From the foregoing it will be clear that lenses which were best for visual purposes were not the best for photographic use, and it was necessary, therefore, when the most perfect results were sought in both departments, to have a double set of objectives, and many investigators did provide themselves with such an outfit.‡

The inconvenience and lack of economy involved in this arrangement is manifest, but how to obviate it does not appear to have occurred to opticians or others interested in the subject.

Having been practically familiar with photography and photomicrography for upward of twenty years, I have had the opportunity in that period to become reasonably familiar with the inherent defects of their technique, but it was not until the latter part of 1891 that I perceived that a way out of the difficulty might be readily found.

During the past five or six years the manufacturers of gelatino-bromide plates have placed on the market plates which are extremely sensitive to yellow light, and but feebly so to the blue, violet, ultra-violet rays of the spectrum, as will be perceived on examination of the band marked 26 (see fig. 112), and comparing it with band marked 1, of the same figure. (The other bands do not concern the purposes of this paper).

If now the objective be corrected for yellow instead of for blue or violet light, the negative being made on one of these yellow sensitive or so-called 'orthochromatic' plates, there should be an exact correspondence of the visual and chemical foci, and the resulting picture should be superior to one that could be obtained by the ordinary procedures—that is, an under-corrected lens and blue-sensitive plate; and at the same time the objective would not have its visual excellence impaired, supposing, of course, that the optician performs his part of the work with care and skill.

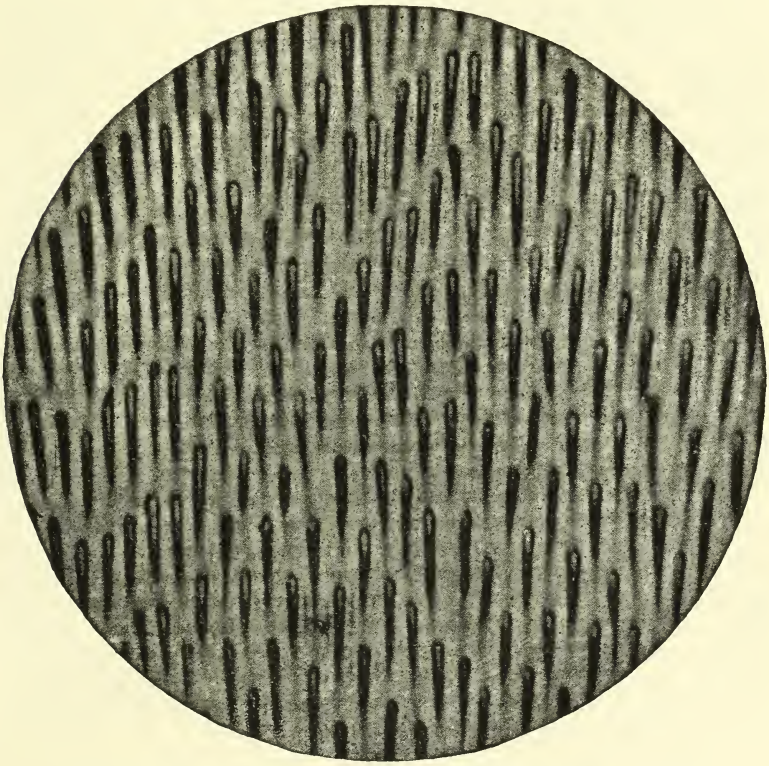
* 'La Photographie Médicale,' Paris, 1893.

† Journ. Roy. Micr. Soc., June 1892.

‡ It must be admitted that some of the apochromatics of short focus (2 mm.) obviate, in a measure, this difficulty, but those of longer focus have not, at least in my hands, proved satisfactory.

In order to test the practical value of this theoretical reasoning, I requested Mr. H. R. Spencer, now of the Spencer & Smith Optical Co., of Buffalo, N.Y., to calculate the formula and construct a lens which would fulfil the stated requirements. The result was a lens of 1/6 in. equivalent focus, and possessing a numerical aperture of 1·35. With this objective I have resolved and photographed the *Amphipleura pellucida* in lines, and have photographed both the *Navicula rhomboides* and the *Van Heurckia crassinervis* in lines and beads.*

Fig. 113.



Photograph of the Test *Podura* (*Lepidocyrtis curvicollis*). × 3000.
Spencer & Smith Obj. 1/15, N.A. 1·35.

In ordinary histological work, with amplification ranging from 200 to 400 diameters, the results with this lens have been very much more satisfactory than I have been able to obtain by any other combination of lenses or plates.

With a 1/4 in. objective of the same construction, made by Spencer &

* As regards the last-named object, it has been previously photographed in beads, so far as I am aware, only by Van Heurck with the aid of a lens of higher power, 1/8 in., and much larger aperture (N.A. 1·60).

Smith on the order of Dr. J. A. Fordyce, of this city, I have resolved the *A. pellucida* with white light, and have demonstrated the resolution to him and to others. With a 1/15 in. of the same construction, the property of Dr. J. H. Kellogg, of Battle Creek, Michigan, I made the photograph of the podura which accompanies this paper (fig. 113).

In order to further test the correctness of the principles involved, I requested Mr. Turner, of the Gundlach Optical Co., Rochester, N.Y., to make a 3/4 in. lens of moderate aperture (N.A. 0·33). Considering the power, aperture, and price (12 dollars), the lens gave very satisfactory results, and wholly confirmatory of the theoretical demand.

In using these lenses with yellow sensitive plates there is a distinct gain in definition and purity of image, both visual and photographic, if the object be illuminated with light of corresponding refrangibility (λ 5892). This may be obtained absolutely by employing a sodium flame, or approximately by intercepting the white light with a medium capable of absorbing the rays of short wave-length.

For the greater part of photomicrographic work, and especially that which deals with histology, I unhesitatingly recommend the technique here described, which, briefly stated, consists in the use of objectives whose corrections shall be adjusted to the D instead of the G or H lines, and in connection with plates specially sensitive to D light, and having the object illuminated as near as may be with rays of the same refrangibility.

If, however, we have to deal with objects in which we must resolve or optically separate particles whose approximation to each other is less than, say, 1/100,000 in., the foregoing statements do not apply.

The studies of Helmholtz and of Abbe have placed us in possession of a formula which appears to be theoretically and practically true, and may be expressed as follows :

$$\text{R. P.} = \frac{n\, x \sin u}{\lambda}.$$

R. P. here indicates the resolving power of the objective; n, the refractive index of the medium lying between the cover-glass of the object and the front lens of the objective (be the same air, water, glycerin, or oil); u, the semi-angle of the aperture of the objective; sin, the natural sine of said semi-angle; and λ, the wave-length of the light employed. Now the 'numerical aperture' of the lens is equal to $n\ x$ sin u, and the equation becomes simplified into

$$\text{R. P.} = \frac{\text{N.A.}}{\lambda}.$$

From this it will be seen that if we desire to obtain extreme resolution, it is necessary to employ objectives of the greatest numerical aperture, and employ in connection therewith such visible rays as possess the shortest wave-lengths. For the photographic reproductions of such images blue-violet sensitive plates, with under-corrected lenses and approximately blue or violet illumination (Woodward's technique) will give the best results. At the present time Mr. E. M. Nelson, of London, is devoting special attention to the development of this branch of photomicrography.

It will be noted that the formula above given does not take into account the equivalent focus or magnifying power of the lens; in other words, that this factor has no influence on the resolving power of the objective. This is correct. A well-connected 1 in. objective will resolve exactly as well as an equally good 1/4 in., provided the factors N.A. and λ remain the same. I here allude to this matter, as every few years some one imagines that he is on the verge of great discoveries to be brought about by the simple feat of increasing the amplification of the image. Let us assume that a photograph be made with an amplification of 3000 diameters, with N.A. the greatest and λ the least possible. This photograph may then be further enlarged to 30,000 or 300,000, but the enlarged pictures will not show any finer or more intimate structure than was delineated on the original smaller picture." *

(5) Microscopical Optics and Manipulation.

Unusual Microscopic Images.†—Herr L. Sohncke describes and explains a curious observation which he accidentally made with an Abbe diffraction plate. He found that, with the Microscope left quite unaltered, there were five different distances of the plate at which microscopic images of the grating upon it were obtained. The images were partly inverted, partly erect, and of different magnifications. The unusual images differed from the normal one by considerably diminished brightness. The phenomenon was not dependent on the particular Microscope employed nor on the mode of illumination. It was not connected with the known focal properties of diffraction plates, for it was found to be quite independent of the grating nature of the object. Its production was finally determined to be due to the plate carrying the object having the properties of a mirror. A plate, however, can only act as a mirror if it is illuminated from the side of the Microscope. Thus certain faces of the Microscope lenses must also act as mirrors. Only bounding surfaces between glass and air need be taken into account, not those between glass and glass, because in the latter case the reflected intensity is too slight. By this double reflection an image of the object may be produced at the right object distance from the front lens of the Microscope. The author shows that in this way the phenomenon in question is completely explained.

The following table contains the data of observation on the position and magnitude of the five images which were obtained by a Zeiss Micro-

* Some months ago a friend, who is a sub-chief in one of the principal bacteriological laboratories of this city, remarked to the writer that the height of his ambition was to possess and work with a Zeiss 1/18 in. apochromatic. I replied that if he fancied Zeiss lenses he had better select a 1/12 in., as with it he would be able to do more and better work in the line of research and discovery than with the 1/18 in. My reply was evidently received with extreme incredulity. If we refer to Zeiss' catalogue, we shall find that the numerical aperture of the 1/18 in. is given as 1·18, but the 1/12 in. of the same maker has a N.A. of 1·30. He makes still another 1/12 in. N.A. 1·40. Applying these figures to the equation above given, and assuming for white light λ 5269, we shall find that the 1/18 in. will resolve or differentiate particles that approach each other as closely as about 114,000 to the inch, while the 1/12 in. of N.A. 1·30 will resolve particles as close as about 125,000 to the inch, and the 1/12 in., N.A. 1·40, will take optical cognizance of lines or particles that approximate each other to within about 1/135,000 in.

† SB. K. B. Akad. Wiss. München, 1893, pp. 223–35.

scope. The first column contains the number of the image; the second the distances *e* of the front face of the objective from the upper face of the diffraction plate; the third column gives the position of the image in which the normal image (No. IV.) is reckoned as "normal," the inverted ones as "abnormal"; while the fourth column shows the relation of the magnifications:—

Image.	*e*.	Position.	Relation of Magnifications.
	mm.		
I.	0·50	Normal	3·21
II.	4·15	,,	1·00
III.	8·55	Abnormal	0·61
IV.	12·70	Normal	1·00
V.	25·05	Abnormal	1·09

The objective aa of the Zeiss Microscope consists of two lens systems. The front one of these is a plano-convex lens, the plane face of which forms the front surface of the whole objective. The front face of the second system is convex. The author shows that the surfaces concerned in the phenomenon under examination are—*a*, the plane front face of the objective; *b*, the back surface of the plano-convex lens; and *c*, the convex front face of the second system of the objective. By means of the ordinary rules for reflection at plane, concave, and convex surfaces he demonstrates that the effect of *a* is to produce the image II. with magnification equal to that of the normal image IV.; that from *b* result the images I. and III. with magnifications, as compared with image IV., of 3·29 and 0·62 respectively, which agree very closely with the actual numbers given in the above table; and that *c* is responsible for image V., which should theoretically have a magnification of 1·10 as compared with that of image IV.

(6) Miscellaneous.

The late Mr. Charles Baker, F.R.M.S.—Mr. J. E. Ingpen, at the meeting of the Society on October 18th, made the following remarks:—"By the death of Mr. Charles Baker, the optician, of High Holborn, a Fellow of thirty years' standing, a link between the earlier and later stages of microscopic work has been severed; a few words of reference to his share in that work may, therefore, perhaps, be not out of place. When, some five-and-forty years ago, Mr. Baker turned his attention to Microscope manufacture, good Microscopes were very scarce and expensive, and students' Microscopes, in the present acceptation of the term, almost unknown. By the introduction of French objectives, which were of very good quality, and their adaptation to simple and serviceable stands, the Microscope was placed within the reach of many who could not afford to purchase the higher class work. In more recent times Mr. Baker was chiefly instrumental in introducing into this country the optical improvements developed by Prof. Abbe and Dr. Carl Zeiss, which have given so great a stimulus to microscopical research, and of which our English opticians have so wisely availed themselves.

Mr. Baker very rarely attended our meetings; but his establishment

has always been well known to many of us, who have from time to time availed themselves of its facilities for the discussion of current scientific topics, and of the assistance always obtainable there towards the practical construction and improvement of microscopical accessories."

The late Mr. Joseph Zentmayer.*—The American Microscopical Society publish in their Proceedings the following abstract of an obituary notice of this celebrated optician, which originally appeared in the 'Journal of the Franklin Institute,' December 1888. "Joseph Zentmayer, optician, whose name was known all over the world, was born in Mannheim, Baden, in South Germany, in 1826. He received a good education, and learned his trade as an instrument maker. At the termination of his apprenticeship, and after having made his 'masterpiece,' as is the custom among German mechanics, he travelled throughout Germany, working in the best establishments, and improving himself in the knowledge and use of scientific instruments. He was an ardent republican, and his natural love of liberty led him to take an active part in the agitation that had as its objects the establishment of republican institutions in Germany.

He came to America in 1848, in the twenty-fourth year of his age, hoping to find a free scope for his notions of freedom in the Western Republic. Between 1848 and 1853 he worked for the best instrument-makers in Baltimore, Washington, and Philadelphia.

In 1853 he began to make mathematical instruments in Philadelphia at Eighth and Chestnut Streets with but one single lathe. The high character of his work and the boldness of his conceptions attracted the attention of leading scientific men. Among these the late Dr. Paul B. Goddard was practically drawn to him, and it was Dr. Goddard who persuaded him to make the first of his large compound Microscopes. This early effort was so successful that the Academy of Natural Sciences and many of leading physicians who required such instruments, purchased those of his make and discarded the heavy and yet unstable instruments of European manufacture. Once fully embarked in this enterprise, it seemed to absorb his attention, and many were the improvements that followed each other in rapid succession, not only in the stand of the Microscope, but in its objectives. At the present time there is not a maker of Microscopes in the world who does not use some of the important inventions of this Philadelphia mechanician. During the war for the Union he furnished most of the Microscopes used in the Government hospitals, and he received the highest commendations from all the officers and other authorities for his work.

In 1865 he invented his photographic lens. The story of his invention of this photographic objective is very interesting. At the time when the Harrison globe lens was attracting attention, Prof. Coleman Sellers was requested to write a paper for the 'American Journal of Science and Arts' on the nature and advantages of the globe lens for the photographic camera. After this was published its writer consulted Mr. Zentmayer about the combination, and he said that it was quite possible to make a lens of two simple uncorrected concavo-convex or meniscus glasses, made thin and of proper curves, and that such a lens would be chemically

* Proc. Amer. Micr. Soc., xiv. (1893) pp. 161–6.

correct as to focus, and would also copy a drawing with the marginal lines straight, that is, without any bending of the lines either out or in. He was urged to make a lens of this kind, and finally he did so, sending it to Prof. Sellers to test. That first lens, made as he had proposed, was perfect in its definition, and had all the good qualities he had promised. Most lenses for this kind of work have been the result of a long series of experiments ending in the form adopted. In this case a lens constructed upon a theory proved the correctness of that theory in a most remarkable manner. The Zentmayer lens, which in working is as rapid, if not more so, than other globe lenses in the market, was more simple, and filled a want, inasmuch as his system enabled him to make a series of lenses, the front of one lens being used as the back one of another through a series of sizes from the longest focus wanted to the shortest; a set of these lenses, combined as required, meeting all cases that could occur both as to size of plate and proportion of reduction. Mr. Zentmayer's patent for these lenses was not granted at once, but he was obliged to contest his claim before a master, in which on examination his claim in regard to priority was fully sustained.

So radically original was the invention embodied in this lens, that the descriptions of it were at first regarded by the practical opticians of Europe as incredible, and as American exaggerations, and these ideas led to quite an animated controversy, which may be found in the 'Journal of the Franklin Institute,' 1867, vol. lxxxiii. p. 349; also 1868, vol. lxxxv. p. 153, and more fully in the 'Philadelphia Photographer,' 1867, vol. iv. pp. 177, 251, 253, 344; also 1868, vol. v. pp. 79, 109.

After the system of screw-threads as the "United States" or the "Franklin Institute standard of screw-threads" was introduced, and makers called for instruments to measure the amount of reduction or the width of the flat top and bottom of the threads, a set of thin steel plates ground to an angle of 60° was sent to Mr. Zentmayer to have him grind the apex of each to the proper amount, the width of each being given to him in decimals of an inch to the fourth point. In topping these off he measured the flat by means of a stage and eye-piece micrometer. The correctness of his work was then verified by a member of this committee, who, taking the finished pieces, measured them on his own Microscope in the same manner, setting down the dimensions as found, and afterwards comparing them with what was required, with the result of finding them correct to the fourth place of decimals in each case. This was, in the first place, one of the earliest instances in which the Microscope was used in such a mechanical process, and a remarkable example of the facility with which good instruments can be used in such work of precision. The standard gauges, made since by the Brown and Sharpe Manufacturing Company, have all been adjusted to the standard pieces prepared by Mr. Zentmayer.

The wonderful comparator designed by Prof. Rogers, of Boston, and made and used by the Pratt and Whitney Company, of Hartford, Conn., is furnished with Microscopes made by Mr. Zentmayer, who took great pains to perfect the instruments to be applied to this system of comparing measurements. In all cases where work of great nicety has been required, those who knew Mr. Zentmayer's skill were in the habit of seeking his aid, even in matters not pertaining to optics. The freedom

from petty jealousy that marked his character was pleasing to his many friends. No one ever heard him say a harsh word about rivals in trade, even when in the contests, called by some sharpness in trade, he might justly blame some for having acted unfairly. Those who have been for years in the habit of visiting him in his shop know how kind he always was and how patiently he listened to what they had got to say, giving freely from his great store of knowledge, showing his methods and even supplying to those who wished to make any piece of apparatus themselves such parts as he could find suited to their purpose.

Mr. Zentmayer's office in Walnut Street, where he had his lathe close to his counter, and near to the cases containing his instruments, was the meeting place of all the scientists of the day. There at all times, while he was working, professors and physicians, and mechanical engineers, would meet and discuss problems in optics or in mechanism, all of these men learning to love the good man who was so simple-minded and so honest in his dealings. Many times young men coming to purchase their first Microscope, found the great optician advising the purchase of a good working instrument cheaper than the one they had come to buy, but well fitted to do what would be required of it. No instrument would leave his hands without being personally inspected by him, after he had advanced to the condition of employing workmen to do what at first he did with his own hands. All those who knew Mr. Zentmayer felt the influence of his honest, straightforward seeking after truth. It was always a source of pride to him that among the many thousand instruments which he constructed, none ever came back for repair after years of hard usage, except in the case of severe accident, such as would come from a fall or the like. No amount of work ever did them harm.

The great triumph of his Microscope-making was the perfection of the stand, known as that of 1876, which elicited so much favourable comment during our Centennial Exhibition. The invention and practical application of his swinging substage, that enabled him to rotate the illuminating apparatus completely round the object without disturbing its focus, were marked examples of his talent. Others may claim to have made something similar, but none had ever made it so perfect as to be substantially new to all who used it. Now no good Microscope is made without this important arrangement of stand. The binocular Microscope, under his hands, became more useful than ever before. It was not until he had perfected this form that he was willing to sell a binocular instrument. He knew the good that was to be obtained by means of the binocular principle, but he was unwilling to make one for sale until at last he had surmounted all the objections he saw in the system, and had made so perfect an instrument that he did not fear to attach his name and reputation to it.

In the construction of his simple form of sliding stage, others may claim the prior invention of the principle in a crude form, but it is very certain that to Mr. Zentmayer, and to him alone, is due the credit of making this simple device as perfect as the most costly compound stage, so far as comfort of working and certainty of motion are concerned. To suggest is one thing, but to perfect into an efficient instrument is perhaps the most important after all.

Mr. Zentmayer was not willing to push himself forward, but when he was at last pursuaded to lecture on optics at the Franklin Institute, his lecture proved to be as well worthy of the man as all his mechanical work. It stands to-day as an important addition to the literature of optics.

Mr. Zentmayer's musical education, as well as his artistic, made him an appreciative critic, and among his countrymen his poetry is valued. He was so loving and so kind, so winning in his ways, that all who came in contact with him were attracted towards him, and when his last illness came, warning them that the mind they had valued so highly was losing its great strength, they mourned his death long before the actual dissolution of his body.

The illness that at last resulted in the death of Mr. Zentmayer came on very slowly, and fortunately only after he had instructed his sons in the processes that had made his work so celebrated. Those sons have had charge for a number of years of the construction of the instruments which have given such great satisfaction to all who have used them. To members of the committee of the Franklin Institute the father confided his system of education of his children, and to them he explained how thoroughly he had informed them of the minutiæ of his operations that they might worthily carry on a business of which he was so proud. Mr. Zentmayer would never do any work slightingly. What was to be done must be done well, his constant effort being to improve his methods as well as improve the construction of his instruments.

As a writer Mr. Zentmayer was not prolific, preferring to express his ideas verbally to his friends rather than to put them on paper for publication. We find, however, the following articles which were his work in the 'Journal of the Franklin Institute':—

"On a Mechanical Finger for Use in Mounting Diatoms under the Microscope," 1870, vol. lxxxix. p. 334.

"On an Erecting Prism for Use in the Microscope," 1872, vol. xciii. p. 375; "A Lecture on Lenses," 1877, vol. civ. p. 49.

Also in the 'Philadelphia Photographer,' 1867, vol. iv. p. 251, we find an article entitled "Refraction without Dispersion, and some Reflections," in which he takes a hand in the controversy about his photographic lens with marked ability."

β. Technique.*

NABIAS, B. DE, & J. SABRAZÈS—**Bemerkungen über einige Punkte der histologischen und Bakteriologischen Technik.** (Remarks on some points in Histological and Bacteriological Technique.)

Prag. Med. Wochenschr., 1893, pp. 286–8.

(1) Collecting Objects, including Culture Processes.

Non-albuminous Nutritive Solution for Pathogenic Bacteria.†—Dr. Uschinsky has devised a non-albuminous medium for cultivating pathogenic microbes in which they grow as luxuriantly as in ordinary bouillon. The solution is composed of the following ingredients:—

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

† Centralbl. f. Bakteriol. u. Parasitenk., xiv. (1893) pp. 316–9.

Water 1000; glycerin 30–40; sodium chloride 5–7; calcium chloride 0·1; magnesium sulphate 0·2–0·4; calcium biphosphate 2·0–2·5; ammonium lactate 6–7; sodium asparaginate 3·4.

Cholera, diphtheria, swine-erysipelas, peripneumonia bovina, tetanus, typhoid, &c., grow in this solution as freely as in bouillon. Tuberculosis has not yet been successfully cultivated in this medium, while diphtheria and tetanus seem to have claimed most of the author's attention.

Growing Yeasts on Solid Media.*—Herr P. Lindner cultivated various species of yeasts in "giant colonies" on gelatin, and found that this medium is specially suitable for recognizing and studying the different kinds of yeasts. When used for the purpose of comparing yeasts it is of great importance that each young colony should be laid down in exactly the same way. A colony is sown by just touching the surface of the gelatin with a small drop. The surface should not be damaged in the process, and hence the gelatin should not be too dry from age or too soft. The best cultivation vessels are small flasks plugged with cotton-wool, because they are more easily photographed and because contamination during inoculation is more easily avoided.

During the development of the culture care should be taken that neither sunshine nor radiant heat shall act unequally. The giant colonies of particular species of yeast exhibit a quite definite form of growth which is typical of the species, and developes with precision in newly formed colonies. Experiments as to the influence of the medium on the form and shape of giant colonies showed that even considerable alterations in the composition of the medium were not altogether able to efface the type of growth.

Cultivation of Gonococcus.†—Dr. Steinschneider has cultivated gonococcus on an artificial medium composed chiefly of human blood-serum and agar. The incubation temperature was from 35°–40°. The results were very satisfactory. The growth was still more luxuriant if the blood-serum-agar were mixed with sterile human urine, or if the serum were previously heated up to 55° in order to remove its bactericidal property. Additions of grape-sugar and mucin are harmful; an increase of pepton (1½–2 per cent.) is beneficial.

Two experiments on the human urethra with pure cultivations are recorded. (1) A twelfth-generation culture caused a moderate urethritis, in which pus-corpuscles and diplococci were found. (2) With a fourth-generation culture, a typical gonorrhœa was excited in a college student who had never had the disease. The gonococci were in considerable quantity, and their disposition was typical.

Inoculation on the peritoneum of animals excited an exudative peritonitis, and experiments on the cornea resulted in suppurative inflammation, but in neither instance could the gonococcus be demonstrated in the secretion by cultivation.

New Apparatus for Counting Bacterial Colonies in Roll-Cultures.‡—Dr. G. Buchanan Young being dissatisfied with Von Esmarch's

* Wochenschr. f. Brauerei, 1893, No. 27. See Centralbl. f. Bakteriol. u. Parasitenk., xiv. (1893) p. 372.

† Berlin Med. Wochenschr., 1893, No. 29. See Centralbl. f. Bakteriol. u. Parasitenk., xiv. (1893) pp. 331–2.

‡ Proc. Roy. Soc. Edinb., xx. (1893) pp. 28 and 29 (1 pl.).

apparatus, which does not permit of the whole contents of the culture-tube being actually counted, since colonies are never so uniformly distributed that the counting of them in a given area or areas can give more than a rough approximation of the number actually present, has invented a new apparatus. It consists of a glass tube, 15 cm. long, the surface of which is divided by finely etched lines into square cms. The bore of this tube is such that the roll-culture-tubes just slide without play in it. Indiarubber rings keep the culture-tubes in position during the process of counting. A sheet of optical black glass forms a suitable blackground.

The contents of each longitudinal row of squares are counted seriatim, the counting-tube being rotated by means of a milled collar. The number of colonies in each square is noted on a paper scheme having squares corresponding to those on the counter. It is only necessary to add together the contents of all the squares to obtain the total.

In practice it has been found better to count the number of colonies in the space between the adjacent lines for the whole circumference of the tube—rotating the tube as the counting is done.

Diagnosis of Cholera Bacilli by Means of Agar Plates.*—The recommendation of Koch induced Dr. Schiller to try agar plates for cultivating and examining cholera bacilli. The liquefied agar was cooled down as far as possible, inoculated, and plates made. After six hours in the incubator the condensation-water was found to have evaporated. The superficial and deep-lying colonies were found to be well separated. The former consisted of badly formed and badly staining bacilli, while the latter made good preparations. By allowing the surface to dry the superficial growth was stopped, and only the deep-lying colonies were made use of. With a little practice these could be easily recognized, though Finkler-Prior, Metschnikoff, and typhoid have some resemblance. These deep colonies are easily removed with a thin platinum needle. This needle was made by heating a platinum wire 0·2 mm. thick in a Bunsen's burner, and carefully drawing it out until it broke. When examined, comma-forms, spirilla, and S-forms are seen dancing about like a swarm of gnats; this is sufficient to exclude typhoid, while on the other hand Finkler-Prior, that bugbear of the tyro bacteriologist, and Metschnikoff would hardly be found in a cultivation made directly from fæces.

With a fine platinum needle the whole colony can be easily removed and used for further examination. The cultivations were also characterized by staining well and showing well comma- and S-forms and spirilla. Even old colonies showing atypical growth returned to typical growth.

Use of Formalin for Preserving Cultivations of Bacteria.†—According to Dr. G. Hauser the vapour of formalin possesses disinfecting power sufficient to quickly inhibit the development of, and kill deep-lying colonies in plate cultivations. Plate cultivations can,

* Deutsche Mediz. Wochenschr., 1893, No. 27. See Centralbl. f. Bakteriol. u. Parasitenk., xiv. (1893) pp. 292–3.

† Münchener Med. Wochenschr., 1893, No. 30. See Centralbl. f. Bakteriol. u. Parasitenk., xiv. (1893) pp. 290–1.

therefore, be fixed at any particular stage, and the previously liquefied gelatin sets again, but without losing the appearance due to liquefaction. The bacteria look and stain just as well as they ever did, even when they have been exposed to the action of formalin vapour for some weeks. Test-tube puncture cultivations of liquefied species are also fixed by means of formalin. Thus puncture cultivations of cholera and Finkler-Prior spirilla can be preserved to show their characteristic funnel-shaped liquefaction.

When Petri's plates are used the method is carried out by inserting under the lid a layer of filter paper, upon which 10–15 drops of formalin are deposited; the capsules are placed in a moist chamber also containing a dishlet with some damp cotton-wool. Test-tube puncture cultivations are treated by moistening the lower end of the cotton-wool plug with about 10 drops of formalin, and then placing the glass in a vertical position in a tall glass vessel, on the floor of which is placed some cotton-wool moistened with formalin (50–60 drops to 1000 ccm.). The glass is then closed. To obtain a good result it is necessary to use fresh undecomposed formalin.

Sander—**Ueber das Wachsthum von Tuberkelbacillen auf pflanzlichen Nährböden.** (On the Growth of Tubercle Bacilli on Vegetable Media.)
Arch. f. Hygiene, XVI. p. 238.

Schmidt, A.—**Ueber die Benutzung verschiedener Sputa als Nährböden und das Wachstum der Pneumokokken auf denselben.** (On the use of various Sputa as Culture-media and the Growth of Pneumococci on them.)
Centralbl. f. Klin. Med., 1893, pp. 625–8.

(2) Preparing Objects.

Fixing Fluid for Animal Tissues.*—Dr. G. Mann recommends the following fluid for fixing animal tissues:—Absolute alcohol 100 ccm., picric acid 4 grm., corrosive sublimate 15 grm., tannic acid 6–8 grm. It is essential to use only living tissue, and the pieces should not exceed 0·5–1 cm. in thickness and the amount of fluid used should be 20 times the bulk of the specimen. The tissue must be immersed for 12–24 hours, after which it is washed (*a*) twice in absolute alcohol for five hours each time, or (*b*) for two hours in running water, and then placed for 12 hours in 30 per cent. spirit containing enough tincture of iodine to give it a brown colour. Then for 12 hours more in 50 per cent. spirit containing potassium iodide. Transfer to 50 per cent. spirit for three hours, and next place for five hours in each of the following, 70, 80, 85, 90 per cent. spirit. (If process *a* be employed it is necessary to immerse the sections before staining for five minutes in iodine-iodide solution.) Then transfer to absolute alcohol for six hours (twice). After this they may be saturated with chloroform and finally imbedded in paraffin.

The advantages claimed for this method are that it causes less shrinkage than other methods; the cell outlines are well marked and the cell plasma and nuclei are very distinct.

Preservation of Colours in Dragon-Flies.†—Prof. P. Stefanelli recommends a simple method of making dry preparations of Odonata.

* Anat. Anzeig., viii. (1893) pp. 441–3.
† Bull. Soc. Entomol. Ital., xxv. (1893) pp. 1–11.

The insects are immersed for two days in an alcoholic solution of naphthaline, and are rapidly desiccated by heat. Sometimes a little touching up with brilliant anilin-azure and alcoholic tincture of curcuma is advisable. For the refinements of the author's method the original paper must be consulted.

Embryology of Echinocyamus.*—Dr. Théel did not succeed in raising larvæ of *Echinocyamus pusillus* to the stage of the young sea-urchin till he adopted the following precautions. The aquaria ought to be of a capacity of 30 litres or more, rather high, made altogether of glass, and be covered in. Clean marine plants in sufficient number must grow in the water. The water itself must be cautiously stirred with a glass rod several times a day, and no film must be allowed to form on the surface. All the water used must be fetched from the open sea and filtered through cloth or the finest canvas. The foul matter from the bottom must be taken away every other day. The temperature ought not to be too high, or, in other words, the aquaria should not be placed in sunny rooms.

The form of moist chamber preferred by Dr. Théel is that in which the drop of water is slightly pressed between the slide and the cover-glass; compression of the eggs may be prevented by small particles of wax, and evaporation hindered by fixing the cover-glass with melted paraffin or wax. In such chambers the author succeeded in following the gradual changes in the development of the same egg for several days.

There is no difficulty at all in artificially fertilizing the eggs of this animal if care be taken to choose males and females accustomed to live under similar conditions.

Preparation of Sections of Protozoa.†—Mr. J. E. S. Moore killed specimens of *Spirostomum* by osmic acid or by heating, fixed them in Flemming's or Hermann's solution, and, after 12 to 18 hours, transferred them to a tall tube, from which the supernatant liquid was repeatedly decanted and replaced by distilled water for some hours. After the last filling up the water was poured off and alcohol added very gradually until a 50 per cent. solution was obtained; in this the infusoria remained, like a coarse precipitate, for 12 or 18 hours more. The strength of the spirit was then increased until the whole was gradually replaced by absolute alcohol. After treatment with cedar oil or chloroform the objects were transferred to paraffin.

(3) Cutting, including Imbedding and Microtomes.

Method of Fixing and Imbedding Tissues for the Rocking Microtome.‡—Mr. J. H. Mummery, in giving a demonstration at the Annual Meeting of the British Dental Association, gave the following lucid directions for preparing tissues for the microtome:—

"By 'fixing' two things are implied:—

(1) The rapid killing of the element, so that it may not have time to change the form it had during life.

* Nova Acta Reg. Soc. Upsala, xv. 1 (1892) vi. pp. 3–6.

† Journ. Linn. Soc. Lond., xxiv. (1893) p. 365.

‡ Journ. British Dental Assoc., xxiv. (1893) pp. 489–90.

(2) The hardening of it so that it may resist, without changing form, the action of reagents with which it may subsequently be treated.

The fixing agents in use are chiefly osmic acid, chromic acid, perchloride of mercury, or picric acid.

After hardening, the tissue must be washed, so as to remove all traces of the fixing reagent. The washing may be done with water if any of the first three agents have been used, but if picric acid has been used, then alcohol must be used for washing.

After this, the water of the tissues must be removed, i. e. the tissue must be dehydrated, so that *post-mortem* decomposition may be prevented. Dehydration is performed as follows:—Put the object into 50 per cent. alcohol for 2 hours; then into 70 per cent. for 24 hours; then into 80 per cent. for 12 hours; then into 95 per cent. for 2 hours; then into absolute alcohol for a short time.

The object, dehydrated, must now be cleared, i. e. the alcohol must be removed and its place taken by some anhydrous substance, miscible with the material used for imbedding. Put some of the clearing medium, e. g. cedar wood oil or turpentine, into a test-tube, on to the top of it pour a little absolute alcohol; then the object is put into the alcohol, and sinks slowly into the clearing medium. When it has sunk to the bottom the alcohol may be drawn off with a pipette. The object may now be imbedded. It is removed from the clearing medium and soaked until thoroughly penetrated by the imbedding medium. The imbedding medium is hard paraffin. The paraffin is kept at its melting point, 45° C., and the object is kept in this for 24 to 48 hours; then the paraffin containing the object is allowed to cool. Cut out the block of paraffin containing the object and fix it on a cone of paraffin mounted on the object-carrier of the microtome. Pare it square and close down to the object on all sides. Set the knife of the rocking microtome square. Set the block square to the knife-edge. Cut the sections."

Imbedding Fresh Tissues in Metal.*—According to Dr. Liebreich useful sections may be made from fresh tissues, organs, &c., with a razor, if the specimens be firmly imbedded in some soft metal, such as tinfoil, old colour-tubes, &c. Owing to its softness the metal is easily cut, and not only does not harm the knife, but acts as a support to it. The results are said to be very good.

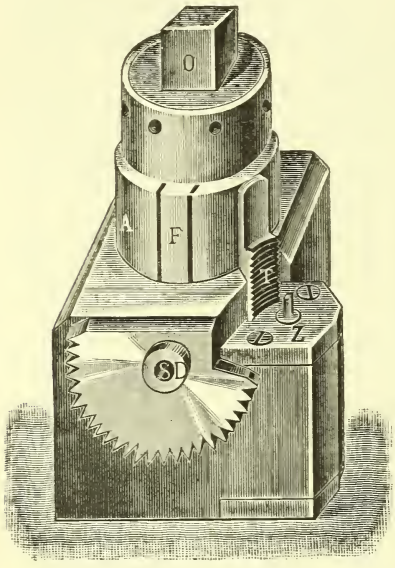
New Arrangement for Raising the Object in Jung Microtome.†—Drs. A. and H. Borgert describe the latest arrangement for raising the object in the Jung microtome. The object-holder consists of two cylinders (fig. 114), the interior one of which supports the object O, and fits exactly in the outer one A. The latter carries on the side turned towards the knife a rack T, in which an endless screw engages. By means of a key fitting over the pin Z, as in a watch, the screw is turned and both cylinders are raised together until the exact adjustment in height of the object is effected. The outer cylinder possesses a spring-piece F, and by the pressure against this of the screw which passes through the axis of rotation D of the metal block the two cylinders are simultaneously fixed in their position.

* Therapeut. Monatshefte, August 1892. See Centralbl. f. Bakteriol. u. Parasitenk., xiv. (1893) p. 193.

† Zeitschr. f. wiss. Mikr., x. (1893) pp. 1–4.

In cutting, when the object slideway has been used as far as possible, the object-holder is brought back again to the lower end, the screw which fixes the two cylinders is loosened, and the object is then brought to the desired height by turning the screw. The cylinders are then again fastened, the key withdrawn and the cutting renewed.

Fig. 114.



(4) Staining and Injecting.

Examination of Brain of Ornithorhynchus.*—Dr. A. Hill stained the left hemisphere in carmine *en bloc*, and cut it into an irregular series of sections. The right hemisphere was treated with much greater care; it was placed for a fortnight in a 2 per cent. solution of bichromate of ammonia, "for even a brain which, like this one, has been for years in spirit, will yield sections which can be stained by Weigert's method, if it is placed in a chrome-salt for a time." It was next placed in a solution of carmine-alum for a week, washed in water, and after dehydration by alcohols of increasing strength, imbedded in celloidin. After being cut into blocks, a certain number of sections from each block were stained by Weigert's method, in order that the arrangement of the fibre-tracts might be determined with certainty.

Staining Nerve-Tissue.†—Dr. Kaiser lays pieces of brain or spinal cord in Müller's fluid for two or three days, cuts them into sections 1 to 2 mm. thick, and leaves them for five or six days longer in the fluid. They are next treated for eight days with Marchi's fluid (Müller's fluid 2 parts, 1 per cent. osmic acid 1 part). After washing in distilled water the hardening of the tissue is completed in alcohol. Sections cut in celloidin are laid in iron solution for five minutes, washed in Weigert's hæmatoxylin solution, and warmed in a fresh quantity of that solution for a few minutes. After washing in water, differentiation is effected by Pal's method; the sections are then immediately washed in ammonia water to neutralize the oxalic acid. The use of a contrast stain is not advisable.

Staining Connective Tissue.‡—Dr. Beneke describes a modification of Weigert's fibrin method, by which the connective tissues of the most

* Phil. Trans., 184 B (1893) p. 373.

† Neurol. Centralbl., June 1st, 1893. See Brit. Med. Journ., No. 1706 (1893) p. 44.

‡ Centralbl. f. Allgem. Path., July 28, 1893. See Brit. Med. Journ., No. 1705 (1893) p. 40.

diverse organs can be consistently stained. Portions of tissue fixed in alcohol are cut in paraffin; sections, fixed upon the slide, are stained with anilin-gentian-violet for 10–20 minutes. After treatment for one minute with lugol solution of a port wine tint, the preparation is dried with filter-paper and decolorized with anilin-xylol. Mount in xylol-balsam.

Fat as affected by Osmic Acid.*—Dr. B. Solger directs attention to a communication which he made ten years ago on the effect of osmic acid on fresh fatty tissue. It separates the fatty substance into a firmer (peripheral) and a more fluid (central) portion. The former probably consists of palmitin and stearin, the latter of olein. This effect of osmic acid does not seem to have been sufficiently appreciated.

Double Staining of Vegetable Membranes.†—M. Ch. Roulet treats sections of vegetable tissue by placing them for a quarter of an hour in a saturated alcoholic solution of cyanin. The sections have been previously decolorized in eau de Javelle. From the cyanin solution they are transferred to spirit, and then for 15 minutes to a 5 per cent. ammoniacal solution of Congo-red. Having been again washed in spirit, the preparations are mounted in xylol balsam. The cellulose membranes are stained red; the ligneous blue.

As a mounting medium for sections stained with Genfer's solution (2–5 per cent. ammoniacal solution of Congo-red with a 0·5 per cent. chrysoidin) the author prefers glycerin or Venetian turpentine to Canada balsam. Glycerin-jelly is less advantageous than pure glycerin.

Method of Staining the Cilia of Living Bacteria.‡—M. Strauss places a loopful of a bouillon culture 1–3 days old of *Spirillum choleræ asiaticæ, Metschnikovi*, or Finkler-Prior upon a slide, and then adds a loopful of Ziehl's solution diluted with three or four times as much water. The two are thoroughly mixed, a cover-glass is imposed, and the preparation is examined as quickly as possible. By this simple method the micro-organisms are stained a deep red, and many retain their mobility for a short time. At one of the poles the delicate corkscrewy or wavy flagellum can be perceived; it is of a pale red hue and contains deeply stained granules in the long axis of the flagellum. Even in the motionless organisms the flagellum can be seen, although it is less distinct. In the preparation can also be observed a number of free or detached flagella in active motion. The author only succeeded in staining by this procedure the flagella of the bacteria mentioned.

Staining Tubercle Bacilli in Tissues.§—For demonstrating tubercle bacilli in tissues Sig. G. Pacinotti hardens the material in Müller's fluid and not in alcohol. The piece to be frozen should not be thicker than 4 mm., but its other dimensions may be of any size. The sections should

* Anat. Anzeig., viii. (1893) pp. 647–8 (1 fig.).

† Arch. Sci. Phys. et Nat. Genève, xxix. (1893) pp. 100–1. See Zeitschr. f. wiss. Mikr., x. (1893) p. 267.

‡ Bull. Méd., 1892, p. 1003. See Centralbl. f. Bakteriol. u. Parasitenk., xiv. (1893) p. 257.

§ Gazzetta degli Ospitali, 1892, p. 726. See Centralbl. f. Bakteriol. u. Parasitenk., xiv. (1893) p. 292.

be placed in a large quantity of water in order to dissolve out excess of chromic acid. They are next placed in weak, and afterwards in strong spirit for 24 hours, and then for 24 hours in Ehrlich's solution, and decolorized in alcohol to which a small quantity of hydrochloric acid has been added. By this procedure the bacilli are not shrunken owing to deprivation of water, as in hardening in alcohol, they stain deeply, and can be well seen without the aid of an immersion lens or a condenser: a Hartnack obj. 7 and oc. 3 will suffice. This method is not applicable to freshly frozen tissue unless it has been previously treated with Müller's fluid, and for ascertaining the relations of the bacilli to the elements of the tissues, the Ziehl-Neelsen or the Fraenkel-Gabbett methods are better suited.

Demonstrating Polar Bodies in Cholera Bacilli.*—Dr. A. Rahmer finds that when cholera bacilli are stained with an aqueous anilin-water solution of methylen-blue, polar bodies are visible at both ends. The solution must be freshly prepared, and when placed on the cover-glass heated until it just begins to vaporize. The author afterwards discovered that polar bodies might be seen when cover-glass preparations were stained with phenol-fuchsin.

New Infection Needle.†—Mr. J. C. Bay proposes a new infection needle for the study of lower plants. A pointed wire, about 6 in. long, bent round at one end to form a handle, and sharpened at the other, is thrust through a metal disc, an inch in diameter. The disc acts as a screen to prevent contamination from falling dust and germs when transferring infection to or from liquid cultures of micro-organisms.

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

Lysol in Histological Technique.‡—Dr. F. Reinke has made some experiments with lysol, which is a solution of cresol in neutral soap, for the purpose of testing its value in histological technique. In strong solution it first shrivels up living tissues, but afterwards causes them to swell. Weak solutions have a swelling and macerating action, while in 10 per cent. solutions the effect of the antiseptic is conservative for a few hours, but afterwards its specific action is manifested. In general this specific action may be described as clarifying, isolating, and macerating, but this is always attended with swelling, and hence on the whole the action is somewhat analogous to that of alkalies. No brilliant results were obtained from its use, though the condition of things were presented in a different light.

The author used the lysol most frequently as 10 per cent. solution in distilled water, but for some things found the following formula useful:—Lysol 10, aq. dest. 60, alcohol abs. 30. If a stronger clearing-up were desired he used Lysol 10, aq. dest. 50, glycerin 10, alcohol 30. For many objects the solution required to be warmed to blood heat.

* Centralbl. f. Bakteriol. u. Parasitenk., xii. (1893) pp. 786–90.
† Bot. Gazette, xviii. (1893) p. 335. ‡ Anat. Anzeig., viii. (1893) pp. 532–8.

(6) Miscellaneous.

Chemical Nature and Chromatophily of Protoplasm.*—Herr E. Zacharias has endeavoured to determine the question whether the cyanophilous and erythrophilous properties of different constituents of animal and vegetable cells are connected, or not, with other differences in the nature of these constituents. His observations were made on spermatozoa of the salmon and of *Triton*, on the epiderm of young leaves of *Galanthus nivalis*, the endosperm of *Ricinus*, pollen-grains, &c. His conclusion is opposed to that of Strasburger that the different reaction towards pigments is the result of a different degree of nutrition of the cell or of the nucleus.

He regards protoplasm and nucleus as consisting largely of substances which are insoluble in artificial digestive fluid. To these substances belong the greater part of the chromatin-substance of the nucleus (nuclein). The remaining insoluble albuminous portions of the cell-contents (plastin) differ in their reactions. In addition to these substances, cell-protoplasm and nucleus contain albumen soluble in the digestive fluid; this is especially abundant in the nucleoli.

* Ber. Deutsch. Bot. Gesell., xi. (1893) pp. 1880–96, 293–37.