AN ILLUSTRATED DESCRIPTION

OF THE

Universal Microscope,

MANUFACTURED BY

R. & J. BECK,

LATE

SMITH, BECK, & BECK.

31 CORNHILL, LONDON, E.C.

AND

LISTER WORKS, UPPER HOLLOWAY, LONDON, N.,

TO WHOM

THE COUNCIL MEDAL OF THE GREAT EXHIBITION OF 1851,

THE FIRST-CLASS MEDAL OF THE PARIS EXHIBITION OF 1855,

AND

THE PRIZE MEDAL, INTERNATIONAL EXHIBITION, 1862,

HAVE BEEN AWARDED, FOR THE

"EXCELLENCE OF THEIR MICROSCOPES, AND CHEAPNESS OF THEIR MANUFACTURES."

London:

PRINTED BY TAYLOR AND FRANCIS,

RED LION COURT, FLEET STREET.

1867.

[*Price Sixpence.*]

PREFACE TO THE THIRD EDITION.

In issuing a Third Edition of this Pamphlet, we would simply mention that since January 1862 we have sent out more than one thousand of our Universal Microscopes. The demand continues to increase, from which we may fairly conclude that they give satisfaction.

R. & J. BECK.

September 1866.

PREFACE TO THE SECOND EDITION.

In issuing a Second Edition of this Pamphlet, we avail ourselves of the opportunity afforded for informing our friends and customers that since January 1862, the date when we sent out the first Instrument, we have supplied about five hundred of them, many in their most complete form, and that they appear to have given universal satisfaction. The letters we are continually receiving bear full testimony to the usefulness and efficiency of the Instrument.

SMITH, BECK, AND BECK.

May 1863.

PREFACE.

We consider this a cheap Microscope, not merely because, when complete with Object-glasses, Eyepieces, and all the necessary appliances to the Stand, it may be purchased for Five Guineas, but also for two other reasons.

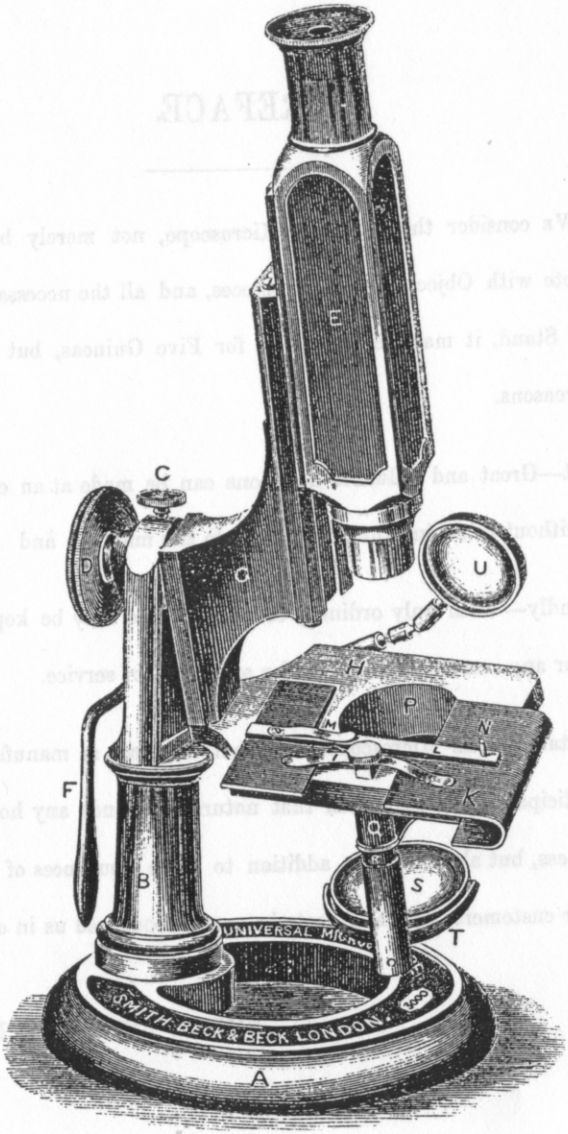
First—Great and valuable additions can be made at an equally cheap rate, without returning the Instrument to the makers; and

Secondly—With only ordinary care the whole may be kept in perfect order for any amount of work, or for any years of service.

It is taking this Microscope as a whole that we, as manufacturers, not only anticipate the gratification that naturally attends any honest success in business, but also no little addition to those assurances of satisfaction from our customers, which hitherto have so encouraged us in our efforts.

SMITH, BECK, AND BECK.

January 1862.



No. 275.

All the Illustrations in this Pamphlet are drawn to a Scale of half size.

Description.

The foundation of the stand is a large circular base (No. 275, A), and near its circumference, on the left-hand side, is a strong pillar (B); at its top is the axis upon which the remainder of the Instrument turns, and with so equal a balance as never to require more than a slight screwing down of the small milled head (C) to secure any particular position.

On the same centre as the axis is a large milled head (D), by turning which a quick motion is given to the body (E), and depending from the smaller part of the same milled head is a lever (F); this of itself hangs free, but when held at the end and pressed sideways, either nearer or further from the pillar, it obtains a gripe upon the milled head, which can then be turned so slowly as to constitute a very good slow motion.

The quick-motion milled head and the slow-motion lever are always in the same position, and do not alter with any inclination of the body; they are also so low down that in using them the hands are very little raised from the table; this latter advantage also applies to the stage (H), which is screwed on at the lower end of the limb (G) at less than four inches from the bottom of the stand.

On the top of the stage is a double spring (I) branching right and left over a brass plate (K), on this there is a ledge (L) for the object to rest upon, and in continuation on the right-hand side the plate is bent over so that it may be firmly grasped by the fore and middle fingers underneath, and by the thumb above. With this arrangement the object can be moved freely in every direction, and will retain its position after the hand is withdrawn. If necessary, the short spring (M) may be used when the object has to be held firmly on the plate. The pin (N) is for holding the forceps.

Beneath the stage is a cylindrical fitting (P) for all the apparatus required in that position.

The Diaphragm (Q) is, however, made a fixture to the mirror stem (R), except that it will turn away entirely on the left side when necessary; it is provided with one small aperture (Fig. 1, X) for the lower powers, and this can be closed by a small shutter (Y).

Fig. 1.



A Concave Mirror (S) swings in a rotary semicircle (T) which is attached to an outside sliding tube, the inner tube being screwed beneath the stage. On the opposite side a Condenser (U) is fixed for the illumination of opaque objects; it is provided with ball-and-socket joints, which afford any necessary movement, and also the means of turning it out of the way when not in use.

The Object-glasses (No. 295, 297) are two in number, 1-inch and a ¼-inch focus, and of the respective apertures of 25 and 75 degrees; these, when combined with the two eyepieces, give the four linear powers of 45, 60, 140, 200; by the addition of a lengthened tube to the body, supplied at an extra cost of 3*s.* 6*d.*, the powers of the 1-inch and ¼-inch object-glasses can be raised to 110 and 320 respectively. The higher power has no adjustment for variations in the thin glass or other media when interposed between its front lens and the object, but it is corrected for a piece of glass ·008 thick, and for objects covered with glass of such measurement its definition will be best.



1-inch. No. 295.



¼-inch. No. 297.

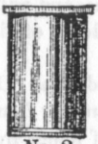
The Eyepieces (Figs. 3 & 4) are of a construction introduced by Kelner, and they give a flat and, for their size, a large field of view. Their chief fault will, we believe, prove a general advantage; any dust or moisture upon the field lens is so annoyingly apparent, from its being in the focus of the eye lens, that those who use this form will be compelled to wipe the lenses frequently, and not only this, but they will soon learn the necessity for the constant examination and the occasional cleansing of every surface of glass that they have about their Microscopes.

Fig. 3.



No. 1.

Fig. 4.



No. 2.

A pair of Forceps (Fig. 6), a small pair of Pliers (Fig. 5), and a Glass Plate with a ledge (Fig. 7) are referred to in the following directions for use, and complete the Microscope, with the exception of the case; this is made of mahogany, and of an upright form; the Instrument, when put away, slides into it so that the pillar occupies the left-hand corner next the door; the stand is blocked to prevent any injury in the carriage; one object-glass and one eyepiece are intended to remain on the Microscope; a small board on the door receives the remaining apparatus, with room for any additional object-glasses or eyepieces that may be required; provision is also made in the case for a small box to contain the extra apparatus alluded to hereafter.

Fig. 5.



Fig. 6.

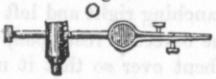


Fig. 7.



Directions for use.

The light should in general be on the left of the observer. The best is that from a white cloud on a bright day; but a satisfactory effect can be obtained from a good candle if protected by a glass, any oil-lamp, or an argand gas-burner, provided they are not more than 10 or 12 inches from the instrument.

The management of the illumination demands particular attention. That of a transparent object is produced by reflection from the Mirror below, which should most frequently have its centre coincident with the axis of the body, and should be at such a distance that the light reflected from it may nearly converge to a focus at the object; this distance will be about 2½ inches when daylight is used, but the rays from a lamp or candle 10 or 12 inches from the Mirror are so divergent that the focus of them will be lengthened to about 3 inches, and the Mirror may have to be slid up or down accordingly.

Accurate adjustment of this focus is often required with the ¼-inch Object-glass, and for this power the Diaphragm must be turned completely on one side; whilst some details of objects, such as delicate striæ, are best seen with this glass when a strong light is thrown on them obliquely by turning the Mirror on one side of the axis. With the 1-inch Object-glass the light is generally in excess, and has to be lessened by the Diaphragm (Fig. 1) under the stage; this admits only so much light as passes through its aperture (X), and by sliding the Mirror up or down, every necessary variation can be made.

To illuminate opaque objects, the light is thrown upon them from above; a small condensing lens (No. 275, U) attached to the stage, and capable of being turned in any direction, answers well for this purpose; its focus, for a lamp or candle 5 inches from it, is about 2½ inches; for daylight, 1¾ inch. A large object can be placed upon the stage at once, but small ones are either laid upon a piece of glass or held in the forceps (Fig. 6), and all light should be excluded from below by having the diaphragm under the stage with its opening closed by the shutter (Fig. 1, Y).

A Glass Plate with a ledge (Fig. 7) is applicable for many purposes, but is specially intended for objects in fluid. Thus a drop is placed upon the plate and covered with a piece of thin glass; or, the object being put upon the plate and the thin glass over it, the fluid is applied near one side and runs under by capillary attraction.

The pair of brass Pliers (Fig. 5), which require no explanation, complete the Microscope; but the whole or any part of the extra apparatus described in the following pages may be added to the instrument at any time, without its being sent back to the makers.

To retain the perfect Working Order of the Instrument.

This is easily effected by attention to only one or two parts.

Should the body work loose in its dovetail fitting, it can be corrected by unscrewing the screw (No. 275, *a*) at the upper part of the limb half a turn, and by screwing up the one (No. 275, *b*) at the lower part of the limb to the same extent; or if this should not be sufficient, it may be repeated until the body will not rock in its fitting. The operation is really that of pushing up by the lower screw a dovetailed wedge; but to retain this in its proper place it is always necessary that the upper screw should also be screwed down firmly upon it.

The chain may also possibly work loose, if so it can be tightened by carefully turning round from left to right the smaller screw head (No. 275, *c*) at the upper end of the limb.

If the fittings of the Eyepieces, or of those parts which slide under the stage, become so much tarnished as to slide stiffly, they can easily be rubbed up with a little rottenstone and oil used on a piece of cloth.

Glass of any kind requires occasional cleaning; a piece of soft wash-leather is the best for the purpose.

Before an Object-glass is used, its back and front surface should be examined, and if not perfectly clean they must be carefully wiped; all the cells in which the lenses of each power are set will also unscrew in case any of the internal surfaces should require cleaning, but great care must be taken to examine only one Object-glass at the time, for fear of mixing the cells in any way.

When cleaning the Eyepieces, which should be done frequently, the cells containing the glasses must be unscrewed and replaced one at a time, so that they may not be mixed.

Any dirt upon the eyepieces may be detected by turning them round whilst looking through the instrument, but if the object-glasses are not clean, or are injured, the result will only be a misty appearance of the object.

ADDITIONAL APPARATUS.

Although the Instrument as already described may be considered complete, and probably sufficient for many observers, yet the following additions can be made.

Extra Object-glasses.



2-inch.
No. 294.



½-inch.
No. 296.



⅛-inch.
No. 298.



No. 280.

In the first place a lower, an intermediate or a higher, magnifying-power may be obtained by the addition of a 2-inch, ½-inch, or ⅛-inch (Nos. 294, 296, 298), the respective angles of aperture of which are 9, 45, and 85 degrees, and their magnifying powers with the two Eyepieces, Nos. 1 and 2,—20, 30; 85, 120; 300, and 410; besides these, a third Eyepiece (No. 280) may be added, which will, as nearly as possible, double the power of the first.

For Opaque Objects.

The illumination of opaque objects, already described, must be more or less one-sided; and in fact it is desirable for most that it should be so. An illumination on any or every side is, however, easily obtained, provided the object is not too large, by means of the Lieberkuhns (Nos. 299, 300); these are silvered cups which slide upon the 1-inch or ½-inch Object-glasses, and light thrown upward by the Mirror will be reflected by them down upon the object; it will then be found that by slightly varying the inclination of the Mirror, every necessary alteration in the direction of the illumination can be obtained.









1-inch.
No. 299.

½-inch.
No. 300.



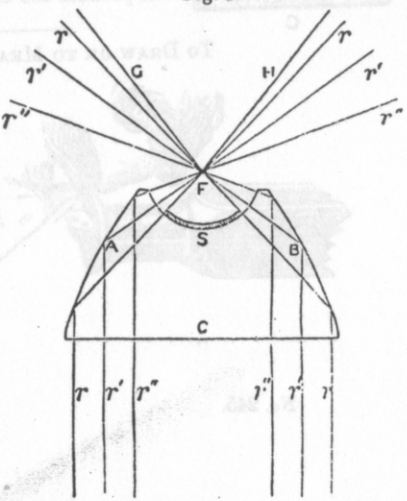
84.

It is in most cases necessary, when using the Lieberkuhns, to slide a dark well (No. 284) under the stage to prevent any light entering the Object-glass direct from the Mirror. The small disk which forms the dark well should always be as close behind the object as possible; and to accomplish this under any circumstances, it is attached to the large sliding tube by a screw which adds considerably to its range of adjustment.

Dark-Field Illumination.

This is, to appearance, a means of seeing a transparent object as an opaque one. The principle, however, is that all the light should be thrown under the object, but so obliquely that none enters the Object-glass but that which is interrupted by the object; this is best accomplished by Wenham's Parabolic Reflector. It may be easily understood by reference to Fig. 8, which represents it in section A B C, and shows that the rays of light, *r r' r''*, entering perpendicularly at its surface, C, and then reflected by its parabolic surface, A B, to a focus at F, can form no part of the largest pencil of light admitted by any of the Object-glasses, and represented by G F H; but an object placed at F will interrupt the rays and be strongly illuminated. A stop at S prevents any light passing through direct from the Mirror.

Fig. 8.



In this Microscope, the Parabolic Reflector (No. 281) fits under the stage by the tube (No. 281, *a*), and the adjustment of its focus upon the object (which is when its apex almost touches it) is made by giving it a spiral motion when fitted in—that is, carefully pushing it up or down at the same time that it is turned round by the milled edge (*b b*). As the rays of light must be parallel when they enter it, a flat Mirror (No. 282), which in this case should be added to the instrument, is generally used; daylight will then require only direct reflection, but the rays from an artificial source will have to be made parallel by putting the Condenser (No. 275, U) between the light and the Mirror, about 1¾ inch from the former, and 4½ inches from the latter. Nearly the whole surface of the Mirror should be equally illuminated, which may be tested by temporarily placing upon it a card or piece of white paper. Parallel rays can also be obtained from the concave Mirror, if the light is put about 2½ inches from it.



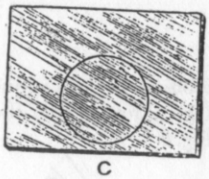
No. 281.

Polarizing Apparatus.

Polarized Light, invaluable to some microscopists, and to others a beautiful appliance by which many objects almost invisible otherwise are shown in every imaginable colour, can here only be treated of by describing the way in which it is applied to this Microscope by the following apparatus:—A Nicol's prism as a polarizer (No. 283, A), fits, and can be turned round, under the stage; another



No. 283.



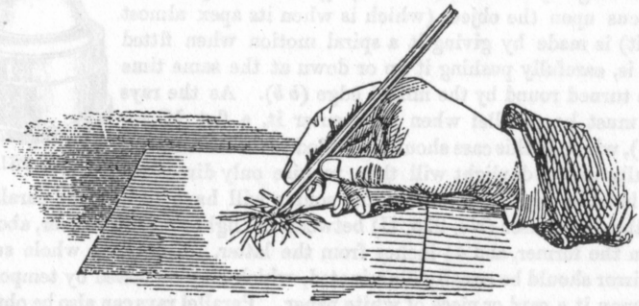
C

prism (No. 283, B) slides in the place of the cap over the Eyepiece, and also revolves; the field of view is slightly cut off when the second Eyepiece is used, but this is unavoidable. When only black and white images are given by the prisms alone, a plate of selenite (No. 283, C) will produce the coloured ones.

To Draw or to Measure an Object.



No. 245.



For this purpose a Camera Lucida (No. 245) is used. It slides on in the place of the cap over the Eyepiece, with its flat side uppermost, as shown. The body of the Microscope must be in a horizontal position, and the whole instrument has to be raised about 4½ inches, or until the flat side of the prism is 10 inches from the table, this being considered the distance of distinct vision with the naked eye, and consequently the standard from which all magnifying powers are calculated. Should any blueness be visible in the field, the prism is pushed too far on, and should be drawn back until the colour disappears.

A piece of paper should then be laid upon the table, and if one half of the pupil of the eye be directed over the edge of the prism, the object will appear upon the paper, and can be traced on it by a pencil, the point of which will be seen with the other half of the pupil.

Only one eye is to be used, and the light must be so regulated that no more than is really necessary is upon the object, whilst a full light should be thrown upon the paper.

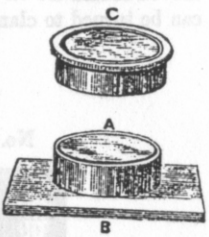
No. 246.



By substituting in the place of the object a piece of glass ruled in 100ths and 1000ths of an inch, termed a Micrometer (No. 246), its divisions can be marked on the same or on another piece of paper, and by comparing them with the sketch, the object can be most accurately measured. These divisions also, if compared with a rule divided into inches and tenths, will give the magnifying power: thus, supposing 1-100th of an inch when marked on the paper measured 1 inch and $\frac{3}{1}_{0}$, the magnifying-power would be 130.

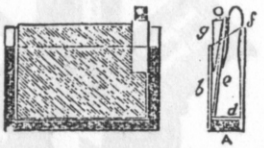
FOR LIVE OBJECTS.

No. 285.



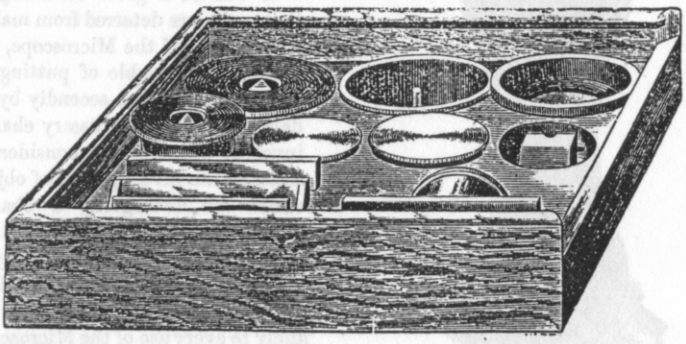
The Live-Box (No. 285) hardly needs description; the object is confined between the glass (A) of the lower part (B) and that of the cap (C); the distance between them can be varied by sliding the latter more or less on. As the thin glass is only fastened in the cap by some Canada balsam or other cement, it can easily be replaced by another when broken.

No. 248.



The Glass Trough (No. 248), for large objects in water, must be used with its thinner plate of glass (*b*) in front. The modes of confining such objects, and keeping them near the front surface, must vary according to the occasion. For many it is a good plan to place a piece of glass (*e*) diagonally in the trough, its lower edge being kept in its place by a strip (*d*) at the bottom; then if the object introduced be heavier than water, it will sink till stopped by the sloping plate.

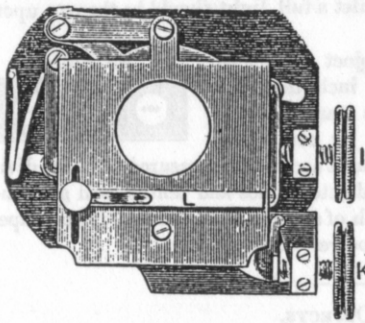
No. 292.



The Box for holding the additional Apparatus is here shown (No. 292) without the lid; no further explanation is required, except that it is made in every instance to a determinate size, so that every case for a Universal Microscope is made with fittings to receive it at any time.

Stage with Actions.

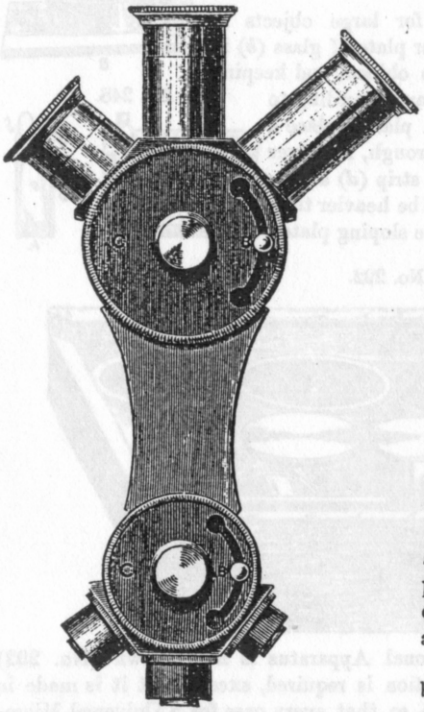
No. 305.



The double spring (No. 275, I) which holds the stage plate (K) can be removed by unscrewing; after this is done the opening (P) will receive what is commonly called a Stage with actions (No. 305); this is contrived so to fit on as to admit of its being turned round as a whole, and consequently always central with the body; or, in other words, during the rotation, the object will not move out of the field of view. The amount of movement at right angles is half an inch each way, and is effected by means of the milled heads (I, K); the object can be moved to and fro on the ledge (L) which slides up and down, and a small spring can be turned to clamp the object when necessary.

The Combined Body.

No. 304.



This is a contrivance so that three Object-glasses and three Eyepieces shall be attached to the Instrument at once (see No. 304). Only one of each of these can be central with the axis of the body at the same time; but any of the others can be brought into the central position by pressing in the rounded head of either of the pins (BB), when either of the disks (CC) can be turned in the required direction, and will be stopped again by the pin (B) springing out.

It will be a great advantage to those who are deterred from making a casual use of the Microscope, first of all by the trouble of putting the instrument up, and secondly by the delays which the necessary changes involve; whilst it will considerably assist in the investigation of objects which are undergoing a change, either in their position or their structure, and when a great range of power is required with the least delay posible. As a luxury, it will apply to every use of the Microscope.

The change from the square body to this one is made by unscrewing a large screw which is at

the back of the dovetail piece fitting into the limb, and the body will then push off downwards. This process is of course reversed when a body has to be put on, but then some care must be taken that the screw in the lower end of the body fits the slot it slides into at the lower end of the dovetail piece, to effect which, the screw may require either a little screwing up or unscrewing before the body is put on.

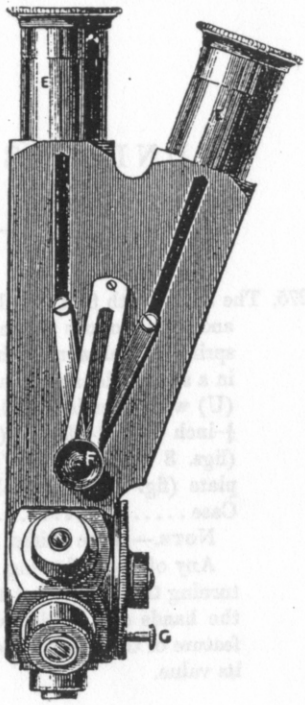
Wenham's Binocular Body.

The purpose of the Binocular Body is to give stereoscopic vision of objects, whereby the form, distance, and position of the various parts are instantly seen; and the result is almost as striking as if the minutest object were placed in the hand as a model.

To accomplish this, we have adopted a contrivance by Mr. Wenham, which is no obstacle to the ordinary use of the instrument, and with it the definition even of the highest powers is scarcely impaired; a small prism, mounted in a brass box, slides into an opening immediately above the Object-glass, and reflects one half of the rays, which form an image of the object, into an additional tube attached at an inclination to the ordinary body. One half of the rays take the usual course, with their performance unaltered, and the remainder, although reflected twice, show no loss of light or definition worthy of notice, if the prism be well made.

The double body (No. 303), as applied to the Universal Microscope, possesses the following advantages:—the Object-glasses are mounted on a rotating disk, as already described, under the combined body; an adjustment for different distances between the eyes is made by turning the milled head (F) which will move the draw-tubes (E E) up or down. The reflecting prism is placed close behind the back lens of each object-glass, and with this arrangement the field of view is not cut off when the objects are viewed as transparent, with the highest power.

No. 303.



The change to the Binocular body can also be made with the same facility as has been already described, under the combined body.

As the eyes of different persons are not the same distance apart, the first and most important thing to observe in using the Binocular Body is, that each eye has a full and clear view of the object; this is easily tried by closing each eye alternately without moving the head, when it may be found that some adjustment is necessary by lengthening the draw-tubes (E E), which will increase the distance of the centres; and on the contrary, when shortened, they will suit those eyes that are nearer together.

It may be found by some that, on first using this particular Binocular Body, there is to a

certain extent a strain upon the eyes; it will, however, only be a temporary sensation that will soon wear off with use, and cannot be injurious to the eyesight in any way.

If the pin (G), which is attached to the prism, be pushed in as far as it will go, the field of view in the inclined body is darkened, and the whole aperture of the object-glass passes into the main body as usual, neither the prism nor the additional body interfering in any way with the ordinary use of the Microscope.

Or if the small milled head of the pin (G) be unscrewed, the prism can be pushed out altogether for the purpose of being wiped; this should be done frequently and very carefully, on all four surfaces, with a perfectly clean cambric or silk handkerchief, or a piece of wash-leather, but no hard substance must be used.

As the Binocular Microscope gives a real and natural appearance to objects, this effect is considerably increased by employing those kinds of illumination to which the naked eye is accustomed. The most suitable are all the opaque methods where the light is thrown down upon the surface; but for those objects that are semitransparent, as sections of bone or teeth, diatomaceæ, living aquatic animalcules, &c., the dark-field illumination by means of the parabolic reflector will give an equally good result. For perfectly transparent illumination, it is much better to diffuse the light by placing under the object various substances, such as tissue-paper, ground glass, very thin porcelain, or a thin film of yellow bees' wax, run between two pieces of thin glass.

PRICE

OF THE

UNIVERSAL MICROSCOPE.

		£	s.	d.
275.	The Stand with firm circular base; an axis for inclination, quick and slow motions to the body; Stage with object-holder and spring; Diaphragm with shutter (fig. 1); Concave Mirror (S) in a semicircle, and on a sliding tube; Side Condensing Lens (U) with complete ball-and-socket movements; 1-inch and ½-inch Object-glasses (Nos. 295 & 297); Two Eyepieces (figs. 3 & 4); Pliers (fig. 5); Forceps (fig. 6); and Glass plate (fig. 7); the whole packed in an Upright Mahogany Case	5	5	0
	NOTE.—If the Pliers, Forceps, and Glass plate are omitted	5	0	0

Any of the following additions can be made, without returning the Instrument to the makers, or even placing it in the hands of a skilled workman. This is a very important feature of the microscope, and one that considerably adds to its value.

Additional Apparatus.

		£	s.	d.
245.	Wollaston's Camera Lucida, for drawing an object	0	15	0
246.	Glass Micrometer, ruled into 100ths and 1000ths of an inch	0	5	0
248.	Small Glass Trough	0	6	6
280.	Third Eyepiece	0	10	6
281.	Wenham's Parabolic Reflector, for Dark-field Illumination	1	0	0
282.	Flat Mirror (in which case a double one is substituted for the single concave, which has to be returned)	0	7	6
283.	Polarizing Apparatus, complete with Prisms and Selenite	1	12	6
284.	Dark-well for Lieberkuhns	0	7	6
285.	Small Live-box	0	5	0
288.	Small Box for Additional Apparatus	0	7	6
290.	Lengthening tube, to increase the Magnifying Power	0	3	6
292.	All the above Additional Apparatus, if ordered at once	5	0	0

Additions to Stand.

		£	s.	d.
303.	Binocular Body, with Adjustment for distance of eyes; Revolving Disk for three Object-glasses; complete fittings for Prism, and Two extra Eyepieces	5	5	0
304.	The Combined Body, with Revolving Disk, capable of receiving Three Eyepieces and Three Object-glasses at the same time	1	10	0
305.	Stage, with Vertical, Horizontal, and Revolving Movements, the latter being always central with the axis of the body	2	10	0
254.	Collection of Two Dozen Objects, in Case	1	1	0

PRICES OF OBJECT-GLASSES.

No.	Focal length.	Linear magnifying power, with eye-pieces	No. 1.	No. 2.	No. 3.	Angle of aperture.	Price £ s. d.
294.	2 inches	Without lengthening tube	20	30	50	9	1 10 0
		With lengthening tube	35	50	95		
295.	1 inch	Without lengthening tube	45	60	120	25	1 10 0
		With lengthening tube	80	110	220		
296.	½ inch	Without lengthening tube	85	120	240	45	2 10 0
		With lengthening tube	150	200	400		
297.	¼ inch	Without lengthening tube	140	200	400	75	1 10 0
		With lengthening tube	230	320	640		
298.	⅛ inch	Without lengthening tube	300	410	820	85	4 4 0
		With lengthening tube	500	700	1400		

PRICES OF LIEBERKUHNS.

No.	Object-glass.	Price. £ s. d.	No.	Object-glass.	Price. £ s. d.
299.	1-inch.	0 8 0	300.	½-inch.	0 8 0

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