IMPROVEMENTS

IN

THE MICROSCOPE.

FROM

THE TRANSACTIONS OF THE SOCIETY OF ARTS,
MANUFACTURES, COMMERCE, &c.

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MICROSCOPE FOR BOTANICAL DISSECTIONS.

The LARGE SILVER MEDAL *was presented to Mr.* W. VALENTINE, *of Nottingham, for his Microscope for Botanical Dissections; from whom the following Communication has been received.*

16, *Carburton Street, Fitzroy Square,*
SIR, *March* 30*th,* 1831.

I WISH to submit to the notice of the Society what I conceive to be an improved Microscope. The following description may serve to give a general notion of its uses, and of the peculiarities in its construction; but for minute details I beg to refer to the instrument itself, which I shall have much pleasure in laying before the Committee for examination.

I am, &c. &c.

A. AIKIN, *Esq.* WM. VALENTINE.
Secretary, &c. &c.

The chief point in the construction of my microscope is the facility which it affords of dissection, while at the same time it possesses all the requisites for the examination of bodies in a more perfect manner than the ordinary instruments do. It is supported on a closing tripod, that being the steadiest, most portable, and at the same time handsomest stand. From the tripod arises a firm pillar, which bears the stage—a very important part of the instrument when employed in dissection. This stage is large, and fixed on brackets to give a firm support to the hands of the operator, which are required in minute dissection to be perfectly steady. When a high power is used, the dissecting instruments are necessarily introduced horizontally between the lens and the object, a thing quite impossible if the object rests on the same plane as the hands. To obtain this power with facility, the object is mounted on a smaller stage rising from the centre of the larger one, and about an inch in height, but capable of being raised higher by a slide tube, to suit the convenience of the operator. With this addition, a person after some practice may dissect readily under the twentieth of an inch focus. The stage being a fixture, the arm carrying the lenses must possess the power of adjusting the focus. In a perfect instrument this adjustment ought to be of two kinds, quick and slow. The pillar contains a triangular tube, made to slide up and down by a fixed screw at the base of the pillar. In this tube is fitted a triangular bar, likewise made to move up and down, but by means of a rack and pinion, the pinion being attached to the back of the triangular tube. This bar carries the arm with the lenses. When a quick adjustment is required, the bar is shifted up and down by the rack and pinion; but when a slow movement is necessary, the tube together with the bar is raised or lowered by the screw. This screw is moved by a large milled head purposely placed at the base of the pillar, to secure facility and steadiness of adjustment. The observer's hand naturally drops on the table, and is steadied by its support; which is of great consequence, when Mr. Brown's moving particles, or when animalculæ are the subjects of examination, as the slightest shake of the instrument disarranges them in some cases for a considerable time. Great pains having been taken to prevent loss of time, it was suggested by Mr. Solly that the screw should have exactly fifty threads in the inch, and that the milled head or wheel should be graduated for the purpose of measuring the diameter of any transparent tube or vessel. Accordingly, the circumference of the wheel is divided into one hundred divisions, each division being equal to the five thousandth of an inch. The upper surface of the tube to be examined is first brought into focus by observing the division at which the index or pin of the tripod stands, and then bringing the under surface accurately into focus by turning the screw: the number of divisions moved will indicate the space through which the lens has passed, which is the diameter of the vessel. The focus of any lens may be ascertained with great accuracy by means of this screw. The lens to be examined is placed as an object on the stage. By bringing first one surface, then the other into focus, the thickness of the lens is ascertained; then, by increasing the distance of the lenses until the image of a distant object is distinctly seen, the space through which the eye-lens has moved, counting from the middle point of the thickness of the lens, will be the focus. This mode of ascertaining the foci of lenses was adopted by the late Mr. Samuel Varley, who had an instrument constructed for that sole purpose. Different parts of an object may be brought under the focus by moving either the stage or the lens. It is quite essential to a perfect instrument that this power of adjustment should be possessed both by the stage and lens, as in some cases it is most convenient to move the object, and in others the lens. For this purpose the stage is formed of three plates, the undermost of which is fixed to the pillar. The middle and upper plates slide in dovetails, by means of a screw across the centre of the lowest, and the upper upon and at right angles to the middle one, by means of another screw. These screws are placed one on each side the pillar, rather than, as is usually done, one on the right side and the other directly opposite the pillar; because the latter mode is extremely inconvenient, both from the difficulty of getting at the screw opposite the pillar, and from the liability of intercepting the light by the hand. By turning first one screw then the other, or both at once, as the case may require, any part of the object may be brought into view. The arm traverses backwards and forwards by means of a rack and pinion, and laterally by a circular sweep, the arm being attached by a pin in a socket to the top of the bar.

To illuminate the microscope, a large mirror, plane on one side and concave on the other, is fixed into the front leg of the tripod. To obtain the advantage of a large mirror with the concave side of a shallow curve, the pillar is made rather high. This likewise prevents the head of the observer from intercepting the light falling on the mirror; a very common occurrence with most microscopes when used in London, as, from the height of the houses and the narrowness of the streets, the light descends on the mirror almost perpendicularly. Underneath the stage is adapted a tube, having a large condenser, capable of being slid up or down to vary the intensity of the light from the mirror. The condenser and mirror may be removed, and Dr. Wollaston's mode of illumination used instead, when very small or delicate objects are to be examined. The Wollaston reflector is furnished at the back with a disc of plaster of Paris, first recommended by Dr. Goring, to produce a dead soft light.

I believe this is the first time of its being applied to the Wollaston illumination. Mr. Ross, the maker of the instrument, suggested this application, which I find to be very advantageous. If the addition of the compound microscope should be considered as desirable, it can be as easily adapted to this stand as to any other; but, in conclusion, I beg leave to quote Dr. Wollaston, when speaking of the microscopic doublet: he says, "However well adapted the compound instrument may be to the exhibition of *known* objects, but little reliance can be placed on it in the examination of unknown bodies."

WILLIAM VALENTINE.

Reference to the Figures.

Fig. 1, Plate VI., is a perspective view of the instrument. *a a a* are the feet, made of hard bell-metal, and prevented from springing by edge bars, as seen on the foot which supports the reflector: these are movable round the base of the pillar, as shewn in the sectional view, fig. 2, and are secured by the collet *b* and three screws, one of which is represented at *c*: the feet can be folded together to render the instrument portable. From the base *d* there is a projecting part, upon which a tube fits which forms the shaft of the pillar, and is secured to the base by three screws, one of which is seen, fig. 1. A capital *e*, fig. 2, is fitted into the tube as low as the dotted lines, and is also secured by three screws; in the axis of this is a triangular hole, into which is fitted the triangular tube *f*; and within the shaft of the pillar is fitted and secured by three screws a piece *g g*, having a triangular hole corresponding in size and direction to that in *e*. The lower end of the triangular tube slides in this, and, to obtain the greatest steadiness, it is placed as far distant from *e* as the required length of motion will admit. Into the lower end of the triangular tube is fitted and screwed a triangular block *h*, shewn by dotted lines, and into this the screw *i* is tapped, end-shake being prevented by the spring *k*;* at the other end of the screw is a collar *l*, working against a plate which passes freely into the cavity *m* in the base of the pillar; against the upper side of the collar a spring presses, with screws passing through and screwing into the plate, thereby preventing end-shake: this plate is secured to the base of the pillar by screws passing through it from underneath, one of which is shewn at *n* fig. 2. Through the base of the pillar passes the tail of the screw *i*; a part of this is made square, and on it is fitted a large flat milled head *o*, for the purpose of giving motion to the screw. This is divided into 100 parts, as a micrometer-head, the uses of which will presently be explained. The springs that prevent loss of time in the collar and the screw, are sufficiently strong to overcome the friction of the motion of the triangular tube, so that the motion of the screw raises or depresses it immediately under any circumstances; and, to prevent any lateral motion of the tube from the friction of the screw, it is pressed into one of its angles by a spring of sufficient strength, represented separately at *p*: this is attached to the inner side of the pillar by two screws. Into the top of the triangular tube is fitted a piece *q*, and as far down the tube as the length of motion will allow is fitted an-

* The action of this sort of spring is fully explained in the account of Mr. Varley's microscope, page 10.

other piece, which is about level to *r*: these pieces have triangular holes through them, and steady the triangular bell-metal bar *s s* which slides in them, in the same manner that the pieces *e* and *g* steady the motion of the triangular tube; and in one side of the triangular bar is a rack, which is moved by the pinion connected with the milled head *t*: the slit *u v* in the shaft of the pillar allows the neck of the milled head to move up and down, for when the screw is in action, both the triangular tube and bar move together. The triangular bar is perforated at both ends; the upper end receives a conical pin, and the lower is for the purpose of admitting the adjusting screw to preserve the length of the bar. The piece *w* is removed to shew the construction of the bearings of the pinion: the opening which it covers is where the pinion and its bearings are introduced to be attached to the triangular tube. The extent of motion in the triangular bar is one inch and a half, and the same in the triangular tube, so that when combined it allows an elevation of three inches.

The large stage *x*, fig. 1, is composed of three plates; the under side of the bottom plate is shewn at fig. 3: this is secured to the capital of the pillar by the ring 1; and to render it perfectly secure from bending, when bearing the weight of the hands, it is supported by two strong brackets 2 2. The middle plate, fig. 4, contains two pair of dovetail slits 3 3 and 4 4 (the widest orifice of each pair being on contrary sides of the plate): the dovetail pieces, with their screws represented in the slits, connect the respective plates. Those in 4 4 screw into the under side of the upper plate, fig. 5, and the points of the screws are seen at 4 4 fig. 5; then the motion of these plates is guided diagonally across each other, and the other dovetail pieces in 3 3 are secured to the upper side of the under plate by the screws 3 3, fig. 3 (one of which is covered by the plate 5): this guides the motion of these diagonally and at right angles to the former. The plates are urged in their directions by the adjusting screws 7 and 8. One of the screws, with its ball and milled head, is shewn at fig. 6. In the adjusting screw 7 the ball is placed in spring-couplings, and made fast to the under side of the upper plate; the screw-heads are seen in fig. 5, near the milled head,—the tapped piece for this screw is secured to the under side of the middle plate; this gives the motion of the upper plate in one direction; and the couplings of the other screw 8 are screwed to the under side of the middle plate, and the tapped piece to the under side of the under plate: this moves both plates in a direction at right angles to the former; so that, by a combination of the motion of both screws, the upper plate can be moved in any direction required.

Fig. 7 is the plan of the arm for supporting the optical powers. From underneath projects a conical steel pin, which fits into a hole made down the triangular bar in fig. 5, shewn at 9. The arm has also a horizontal motion backwards and forwards by the rack and pinion: this is seen in its place 10, fig. 1. Here also, by a combination of the motions of the arm on the conical pin and the rack and pinion, the optical power can be made to pass over any part of an object without moving the stage. This is likewise a useful motion for taking a cursory view of objects with the low powers.

In figs. 1 and 5, 11 represents the elevated stage upon which the objects are to be placed; 12, fig. 8, shews a tube that screws into the upper plate: upon this tube fits 11, carrying the finger-spring shewn in fig. 1. These springs hold objects down upon the stage, which by the pins sliding in the pipes is capable of being adapted to objects of different thicknesses.

Fig. 9 is an elevated stage, that can be inclined so as to view the sides of objects without disturbing them.

Fig. 10 is a lens to condense the light, either for transmission or direct illumination, and the cylinder rods are made to slide into either of the sockets 5 or 6, (which are supplied with a rotary horizontal motion), as convenience may require.

Fig. 11 is a pair of forceps to be applied to the instrument in the same manner.

Fig. 12 is a Wollaston condenser: the large reflector and condensor, shewn fig. 1, may be removed, and this applied, which is the best method of illuminating minute transparent objects, of which a description is given in the *Phil. Trans.* for 1829.

When Wollaston's method of illuminating objects is used by candle or lamp-light, a convex lens should be placed between the candle or lamp and the mirror, in such a position that the rays of light which fall on the mirror from the candle or lamp may be parallel, or nearly so: the distance of the convex lens from the candle or lamp should be equal to its focal distance for parallel rays,

Fig. 13 is a diagram to shew the action of the Wollaston condenser. 13 13 include all the rays, which, falling on the reflector 14, are allowed by the aperture 15 to reach the condensing lens 16 16. This lens is placed at such a distance from the aperture 15 as to give an image of it condensed or reduced to about one quarter the size, and of course one quarter of that distance above. At 17 this focus, or neat little circle of light, reaches through the stage to the place where the object is put, while extraneous or lateral light is excluded. 18 18 two handles by which the lens 16 is moved up and down in the tube 19, fig. 12, to alter or adjust the place of the focus 17.

Fig. 14 is a section of the Wollaston doublet. The lenses are planes, with their flat sides downwards: their focuses are as one to three, and placed one and four-tenths of the shorter focus apart; the smallest lens next the object.

Fig. 15 represents the two lenses of Herschel's doublet, given in the *Phil. Trans.*, 1821.

Focus of the upper lens		10,000
Radius of curvature	Upper surface	+ 5,833
	Under surface	+35,000
Focus of the lower lens		5,497
Radius of curvature	Upper surface	+ 2,054
	Under surface	− 8,128

The first, and probably the only doublet of these curves, and one-sixth of an inch focus, was made at least five years ago, by Mr. Cornelius Varley, at the particular request of Dr. C. R. Goring, who has shewn a very liberal zeal to bring into existence whatever could improve the microscope; and I believe it proves the correctness of the calculation.

Fig. 16 shews the mode of attaching the compound body. The arm 10, fig. 1, with its steel pin, is to be withdrawn, and the pin 20, fig. 16, is made to fit into the same hole in the triangular bar.

An instrument of this construction I have had made by Mr. A. Ross, in his usual style of excellent workmanship; and I find, that from its stability, and the accommodation of its arrangement, I can dissect under a lens of one-twentieth of an inch focus; and from the construction of the motions, that they are instantly effective, and in their directions afford every facility and convenience requisite for minute research.

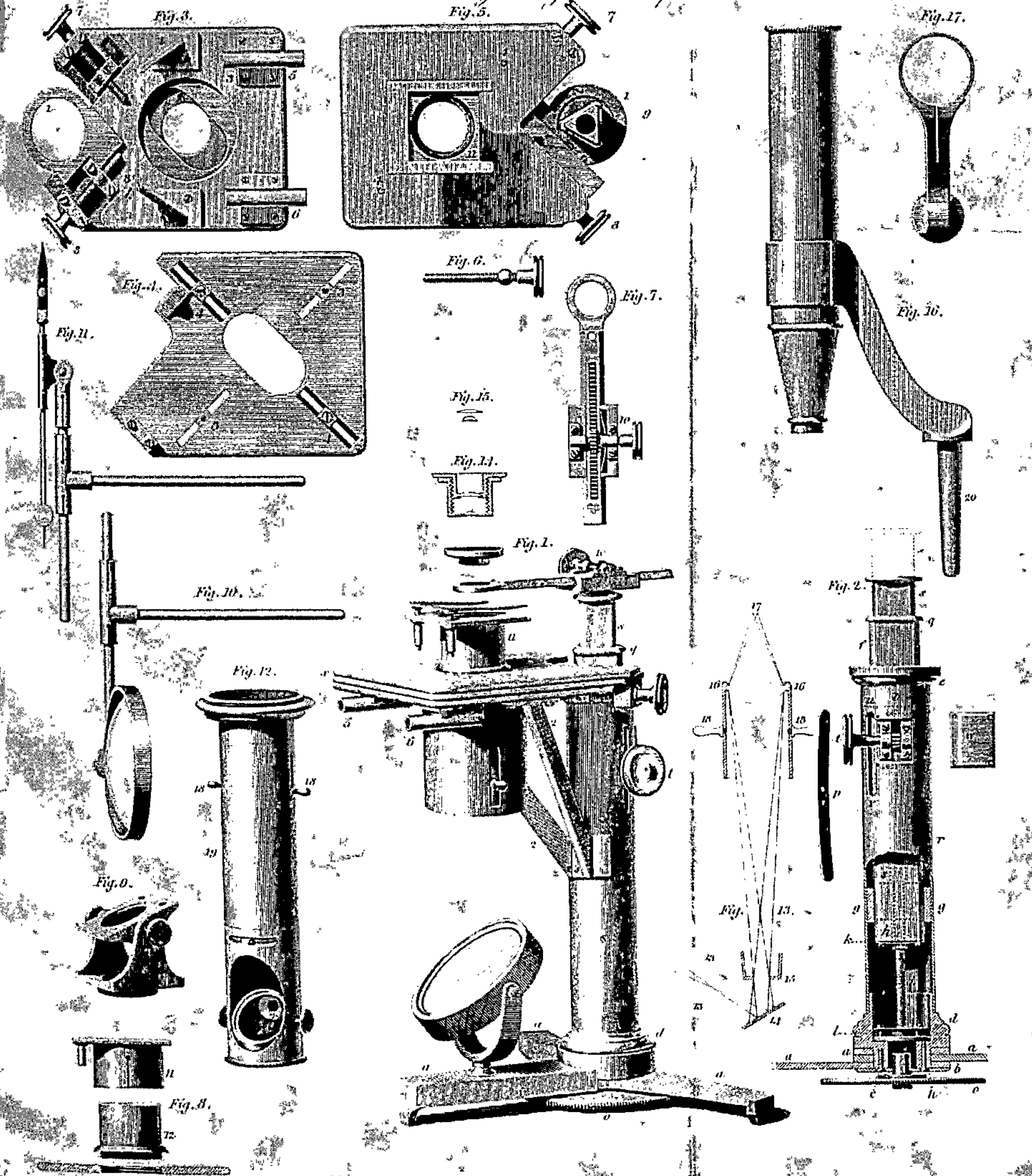
It was suggested to me when constructing the instrument, that the screw for moving the triangular tube can be used as a micrometer, by successively bringing the upper and under surface of any transparent object into distinct vision, and observing the number of revolutions or parts of a revolution passed through by the micrometer head. The screw Mr. Ross has applied contains 50 revolutions in an inch, and the head is divided into 100 parts, making each division = $\frac{1}{5000}$ of an inch, and with some of the Wollaston doublets made by the same artist, in which the focus is very precise, I can measure the diameter of a vessel, or the thickness of a cuticle, within one of these divisions.

ON PRESERVING ANIMALCULÆ.

NOTE supplementary to Mr. VARLEY'S Paper on the MICROSCOPE.

WATER stocked with vegetation is likely to abound in animalculæ; therefore during warm weather we seldom fail of finding great varieties in ponds and stagnant ditches. Also, any vegetable matter suffered to decay in water, with free access of air, produces animalculæ. Such stagnant water is liable to become so foul and disgusting as to kill all the larger sort, and yet will abound with a very minute sort rather peculiar to that

Mr. Wm. Valentine's Dissecting Microscope. Plate 6

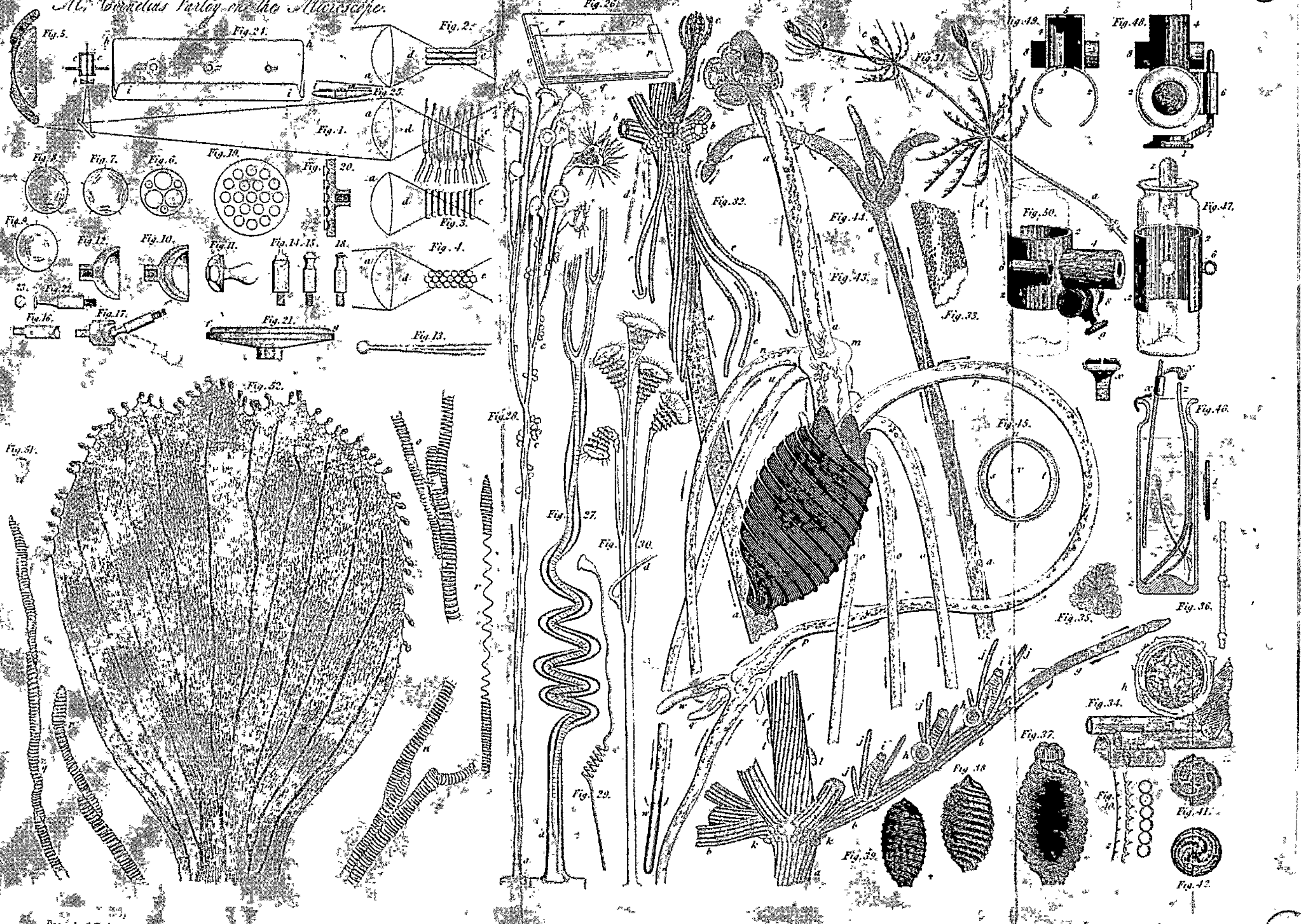


Drawn by C. Varley

Engraved by W. Kelsall

Mr. Cornelius Varley on the Microscope.

Plate 5.



Drawn by C. Varley.

Engraved by

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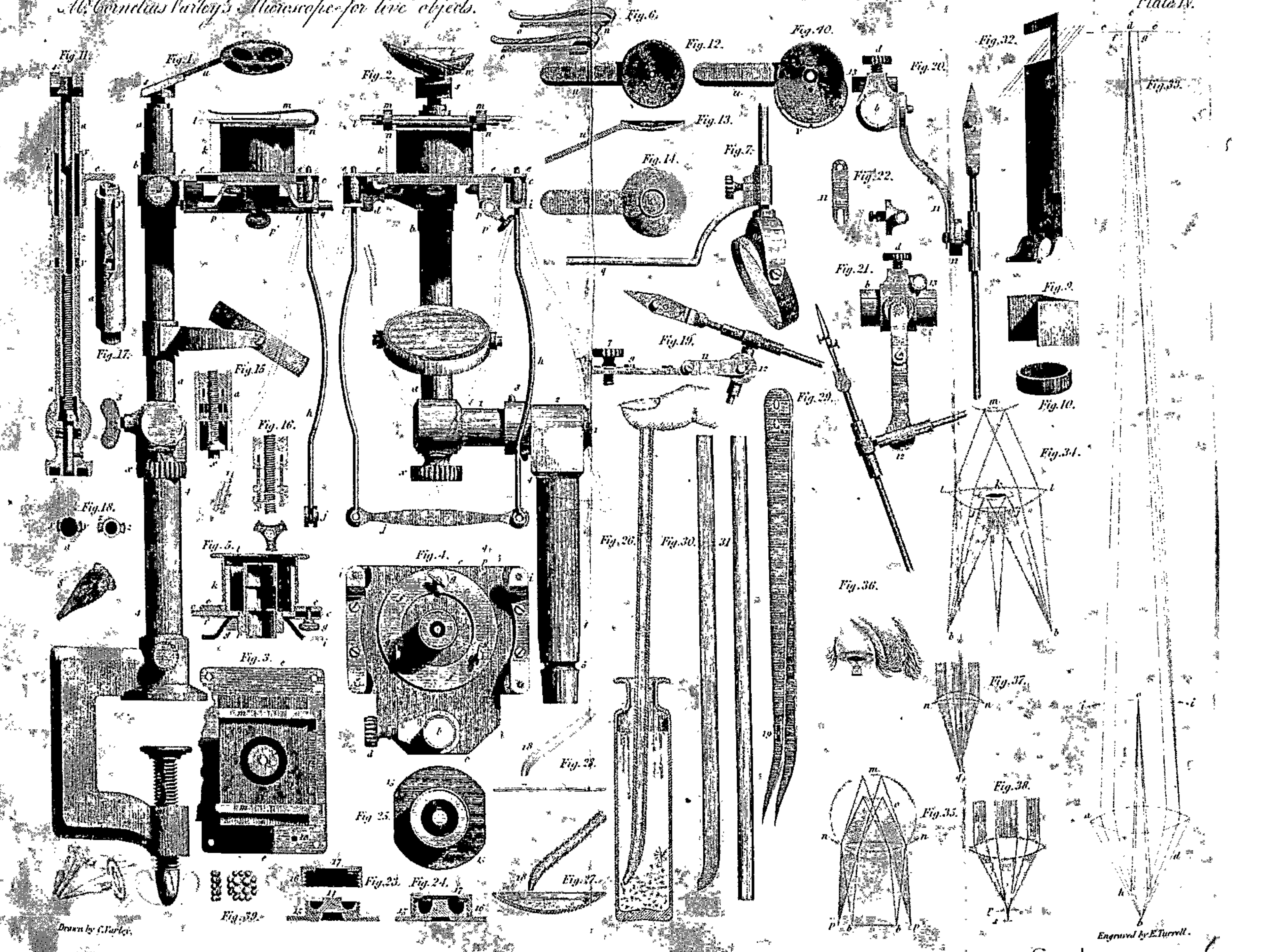
Mr. Cornelius Varley's Microscope for live objects.



Drawn by C. Varley.

Engraved by E. Turrell.