Polarizers for large objects.

Before the extra large polarizer (Plate XVI. fig. 3) was introduced, the illumination of the whole of an object under a low power was often found to be imperfect, and was remedied by the use of some other polarizer: either a piece of black glass (fig. 21) was placed over the mirror and then inclined at the proper angle, or a bundle of thin glass plates (fig. 23), properly mounted, was slid into the cylindrical fitting under the stage, so that the light would be polarized by either passing through or by reflexion from it; but these methods are not much employed at the present time.

Experiments with Double-image Prisms.

The microscope may also be made to exhibit various results produced by polarized light, as the subjoined extract from a paper by Mr. Legg* may explain:—

"The following experiments, if carefully performed, will illustrate the most striking phenomena of double refraction, and form a useful introduction to the practical application of this principle.

"The apparatus necessary is—

"A Nicol's prism (Plate XVI. figs. 2 or 3) to be adapted under the stage.

"A selenite plate, figs. 17 or 18.

"Two double-refracting prisms, adapting to each other and to the eyepieces, figs. 24 and 26.

"A film of selenite adapted to the double-refracting prisms, fig. 25; and

* "On the Application of Polarized Light in Microscopic Investigations." By M. S. Legg. Read before the Microscopical Society of London, Dec. 9, 1846.

" A plate of brass, 3 inches by 1, perforated with a series of holes, fig. 27.

" *Exp.* 1.—Place the piece of brass so as for the smallest hole to be in the centre of the stage of the instrument, employing a low-power object-glass, and adjust the focus as for an ordinary microscopic object; place one double-refracting prism in the place of the cap of the eyepiece, and there will appear two distinct images (Plate XVIII. fig. 1, *a*); then by revolving the prism the images will describe a circle, the circumference of which cuts the centre of the field of view; the one is called the ordinary, and the other the extra-ordinary ray. By passing the slide along so as for the larger orifices to appear in the field, the images will not be completely separated, but will overlap, as in fig. 1, *b*.

" *Exp.* 2.—Place the polarizer (Plate XVI. figs. 2 or 3) into its place under the stage, still retaining the double-image prism over the eyepiece; then by examining the object there will appear in some positions two, but in others only one image; and it will be observed that at 90° from the latter position this ray will be cut off, and that which was first observed will become visible; at 180°, or one-half of the circle, an alternate change will take place; at 270° another change; and at 360°, or the completion of the circle, the original appearance (see Plate XVIII. fig. 3).

" Before proceeding to the next experiment, it will be as well to observe the position of the Nicol's prism used as a polarizer, which should be adjusted with its acute angles parallel with the sides of the stage (see fig. 7), in order to secure the greatest brilliancy in the experiment: the proper relative position of the selenite may be determined by noticing the natural fractures or flaws in the film, which will be observed to run parallel to one another: these flaws should be adjusted to about 45° from the sides of the stage, to obtain the greatest amount of depolarization (see fig. 8).

"*Exp.* 3.—If we now take the plate of selenite thus prepared, and place it under the piece of brass on the stage, we shall see, instead of the alternate white and black images, two coloured images, as in fig. 2, *c*, and fig. 4, composed of the constituents of white light, which will alternately change (by revolving the double-image prism over the eyepiece) at every quarter of the circle; then by passing the plate of brass along, so as to bring the larger orifices in succession into the field, the images will overlap, and where they overlap, white light will be produced (see fig. 2, *d*). If by accident the prism should be placed at 45° from the position just indicated (see fig. 9), no particular colour will be observed, and it will then illustrate the phenomenon of the neutral axis of selenite; because when placed in that relative position, no depolarization takes place.

"The phenomena of polarized light may be further illustrated by the addition of the second double refractor (fig. 26, Plate XVI.) and the film of selenite (fig. 25) between the double refractors.

"*Exp.* 4.—By placing the apparatus as described in the first experiment (that is, removing the Nicol's prism and plate of selenite, but retaining the brass plate), we shall observe the two images as shown in fig. 3, Plate XVIII.; then by placing the second double refractor over the first, so as for all the faces of the one to be parallel to all the faces of the other, as if they formed but one piece, the eye will perceive two distinct images, but at twice the original distance from each other (see fig. 5, *e*). If we now turn the prism nearest the eye from left to right, two faint images will appear; continuing the turn, at 45° the four images will be all equally luminous (fig. 5, *f*); and when the prism has turned round 90°, there will be only two images of equal brightness (fig. 5, *g*); continuing the turn, two other faint images will appear; further on the four images will be equal; still further they will be unequal; and at 180° of revolution they will all coalesce into one bright image (fig. 5, *h*).

"*Exp.* 5.—The above results will be rendered more interesting by interposing between the double refractors the film of selenite. Instead of the two white images, as in the preceding experiment, we shall see three, of which the two outer ones will be one colour (say green), and the middle, its complementary colour or red (fig. 6, *i*); by turning the prism nearest the eye, the middle image will gradually divide, until the completion of a quarter revolution, when four images will appear of equal brilliancy, two of each colour (fig. 6, *k*): revolve the prism until the completion of the half-circle, and the three images will reappear, but with different properties, the outer images being red and the middle green (fig. 6, *l*); at another quarter revolution, four images, but with opposite colours, will be observed (fig. 6, *m*), and at the completion of the revolution the original appearance (see fig. 6, *i*).

"In this experiment the relative positions of the double-refracting prisms and the selenite must be carefully observed, as, if the neutral axis of the selenite be parallel or perpendicular to the plane of polarization, no depolarization takes place, and no colours will be produced, the results then appearing as if the selenite were not interposed."

Crystals to show Rings.

The systems of coloured rings, produced by crystals cut perpendicularly to their axes, can also be beautifully shown

Description of Plate XVI.

Fig. 1. The short tube, fitting by a bayonet-catch to the under plate of the stage.

Fig. 2. The ordinary polarizer of Nicol's prism.

Fig. 3. The extra-large polarizer of Nicol's prism.

Fig. 4. The analyzer of Nicol's prism.

Fig. 5. Tourmaline mounted as an analyzer.

Fig. 6. The selenite plate.

Fig. 7. The ring to hold the selenite plate in its fitting, fig. 8.

Fig. 8. The fitting for the selenite plate, fig. 6.

Figs. 9, 10, 11. Darker's three retarding-films of selenite.

Figs. 12, 13. Two of Darker's retarding-films when placed at right angles.

Fig. 14. Darker's selenite stage.

Fig. 15. The analyzer of Nicol's prism when its cap and its fitting to the eyepiece are removed to suit it for either of the adapters, figs. 19 or 20.

Fig. 16. Darker's three retarding-films, fitted to rotating cells of three arms, which, when in use, fit on the cylindrical fitting under the stage, as shown in fig. 22.

Fig. 17. Selenite mounted in plain brass plate.

Fig. 18. Selenite mounted between two slips of glass.

Fig. 19. An adapter which screws into a stop at the bottom of the draw-tube to receive the analyzer, fig. 15.

Fig. 20. An adapter which screws on the nosepiece of the microscope to receive the analyzer, fig. 15.

Fig. 21. A polarizer of polished black glass, fitting on the rim of the mirror.

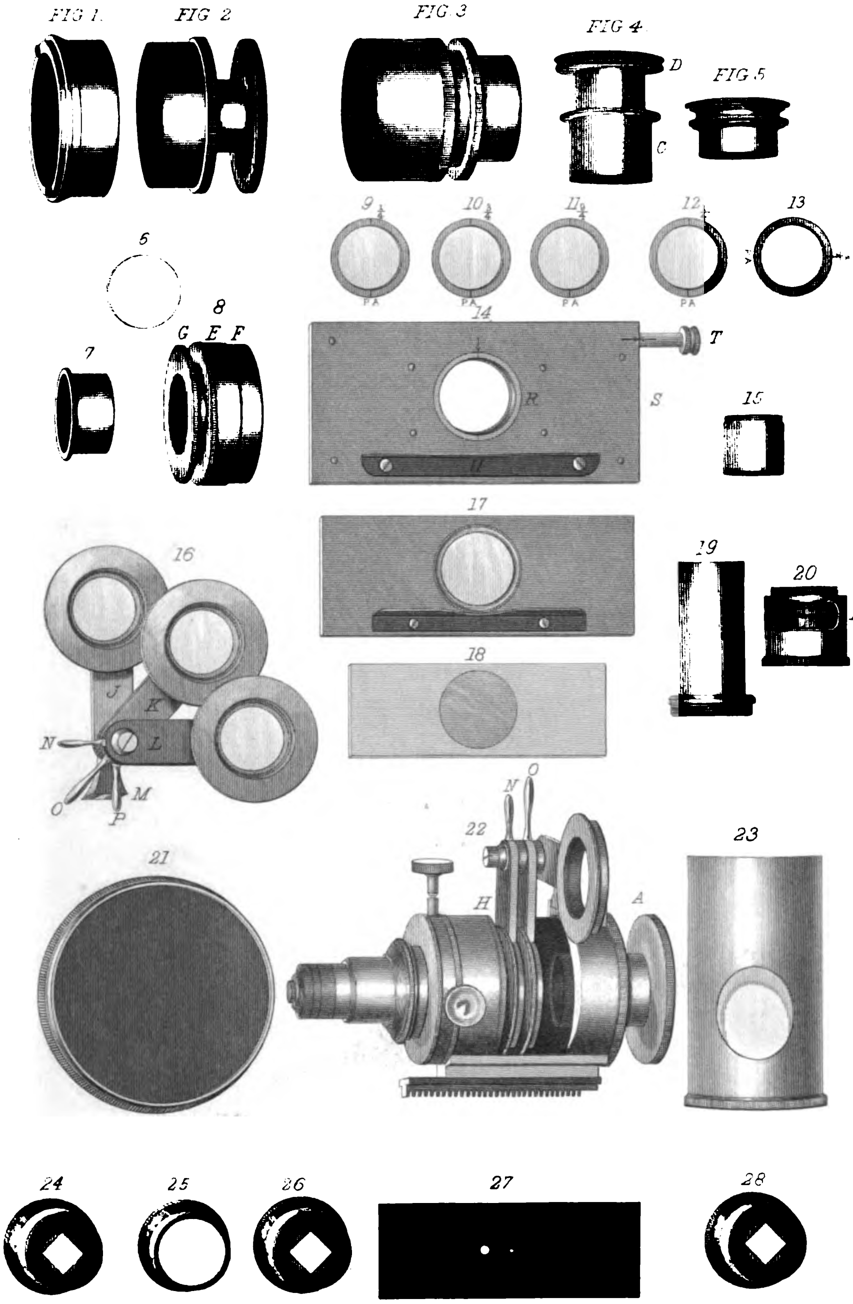
Fig. 22. The Achromatic Condenser combined with a polarizer, and Darker's series of selenites, to increase the brilliancy of the colours under high powers.

Fig. 23. A bundle of thin glass as a polarizer.

Figs. 24, 25, 26. Two double-image prisms and plate of selenite, for experiments with double refraction.

Fig. 27. A brass plate with three small holes for use with double-image prisms.

Fig. 28. A section of a crystal as mounted to show rings.



½ SCALE

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Description of Plate XVIII.

ILLUSTRATIONS OF EXPERIMENTS WITH DOUBLE-IMAGE PRISMS.

Fig. 1. The appearance of three small holes when a double-image prism is placed over the eyepiece.

Fig. 2. The same as fig. 1, with the addition of a polarizer and an interposed plate of selenite. Where the larger images overlap, the complementary tints form white light.

Fig. 3. The change that takes place in the double image, at four equal points, in one revolution of the polarizer.

Fig. 4. The same experiment as that shown in fig. 3, but with the interposition of a plate of selenite.

Fig. 5. The appearances of a small hole, without a polarizer, but with two double-refracting prisms placed over the eyepiece; and the changes that take place when one of the prisms is moved round to four equal points in one revolution.

Fig. 6. The same experiment as fig. 5 repeated, with the addition of a polarizer and interposed plate of selenite.

Fig. 7. A diagram to show when the Nicol's prism is adjusted with its acute angles parallel with the sides of the stage.

Fig. 8. A diagram to show the natural flaws or veins in the selenite plate, and the position in which the greatest amount of depolarization may be obtained.

Fig. 9. A diagram to show when the Nicol's prism is turned 45 degrees from the position shown in fig. 7, and when no depolarization will take place.

Fig. 10. The black cross and coloured rings produced by a piece of calc-spar when its surfaces are cut perpendicular to the axis of the crystal, and when placed under polarized light, by fitting over the cap of the eyepiece of the microscope with an analyzer above.

PLATE XVIII

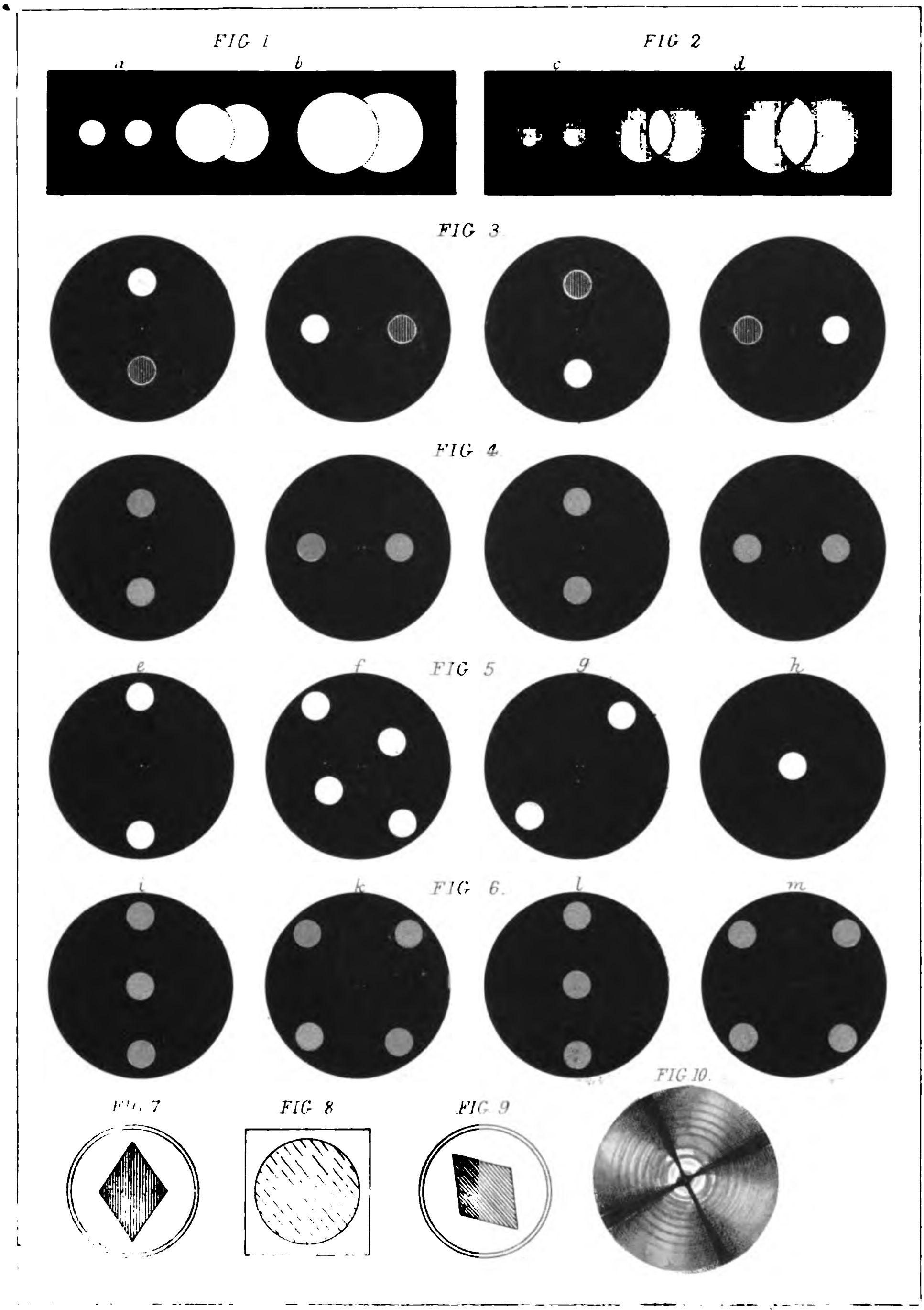
FIG 1
a
b
FIG 2
c
d
FIG 3
FIG 4
e
f
FIG 5
g
h
i
k
FIG 6.
l
m
FIG 7
FIG 8
FIG 9
FIG 10.