THE ACHROMATIC TELESCOPE, AND ITS VARIOUS MOUNTINGS, ESPECIALLY THE EQUATORIAL: TO WHICH ARE ADDED SOME HINTS ON PRIVATE OBSERVATORIES

Published @ 2017 Trieste Publishing Pty Ltd

ISBN 9780649023707

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Edited by Trieste Publishing Pty Ltd.
Cover @ 2017

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Trieste

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BY

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LONDON:
TROUGHTON AND SIMMS, 138 FLEET STREET.
1852.

PRINTED BY TAYLOR AND FRANCIS,
RED LION COURT, FLEET STREET.

PREFACE.

PURCHASERS of Achromatic Telescopes, mounted equatorially or otherwise, having frequently requested me to furnish them with a concise statement of the leading principles upon which the construction and application of such instruments depend, it occurred to me that I should best consult the convenience of such applicants, by preparing for the press a brief summary of the subject. This I have done, and the following pages are the result. It must, however, be understood that these do not contain any discussion of principles; and if in my attempt at explanation of them I have exceeded the scheme I originally proposed to myself, it has been in those cases only in which the simplicity of the subject appeared to be favourable to my so doing. At the same time, in the order I have adopted, my especial object has been so to direct the inquirer, that he may find little difficulty in determining precisely upon what points he requires more elaborate scientific information; and, for his further assistance, I have supplied him with such references as seemed to me to be needful.

W. S.

London, July 1852.

THE

ACHROMATIC REFRACTING TELESCOPE.

REFRACTION is that bending which a ray of light suffers when it passes obliquely from a rarer into a denser medium, or the reverse. This effect is seen if a straight stick be plunged obliquely into water; the part immersed having the appearance of being bent upwards. **Refraction and its effects.**

It is also shown by the well-known experiment of placing an object, such as a coin, at the bottom of an empty basin, and withdrawing the eye till the coin is concealed by its edge, when, if water be poured into the vessel, the coin will reappear.

Similar to the above is the effect produced by the atmosphere upon rays, which, proceeding from the heavenly bodies, traverse it on their passage towards the earth. It is well known that the atmosphere diminishes in density as its distance from the earth's surface increases; and to a spectator at this surface the apparent altitude of a heavenly body will, therefore, be greater than its true altitude. In the horizon the difference between the two exceeds the apparent diameter of the sun, so that, as in the case of the coin abovementioned, an object may appear above the horizon when it is really below it.

A lens is a piece of glass, or other transparent medium, **Lens.**

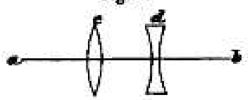
formed with a spherical surface or surfaces, and acts by its refracting power. It is either convex or concave.

If one side of a lens be flat it is *plano*-convex or concave.

If both sides be either convex or concave, and the radii of curvature be equal to one another, the lens is said to be *double* convex or concave. If the curves of a lens be of unequal radii, it is said to be *crossed*.

If one side be convex and the other concave, it forms either a meniscus or a concavo-convex lens; the former having the effect of a convex, and the latter of a concave lens.

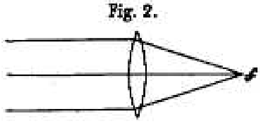
Fig. 1.



The axis of a lens is the line which joins the centres of the spheres of which its surfaces are sections; and it is evident that around this line the lens is in every respect symmetrically disposed. Thus *a b* is the axis of the lenses *c* and *d*.

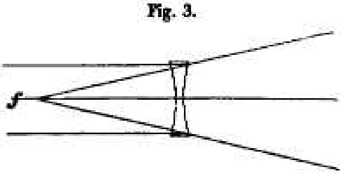
Parallel rays entering a convex lens are converged towards the axis and meet in a point *f*, called the focus. The distance of *f* from the nearest surface of the lens is called the focal distance.

Fig. 2.



Parallel rays entering a concave lens diverge from the axis. The focus *f* is the point in which the diverging lines would meet if produced backwards through the lens to the axis. In this case the focal distance is said to be negative.

Fig. 3.



The focal distance in the case of a plano-convex lens is equal to the diameter of the sphere of which the lens is a section.

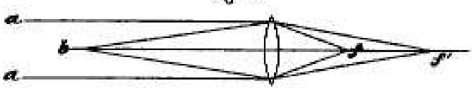
The focal distance in a double convex lens is equal to the radius of the sphere of which its surfaces are sections.

The focal distance in the case of a crossed lens is found by dividing twice the product of the radii by their sum.

The same rules apply to the determination of the foci of concave lenses, and for all lenses made of plate glass the results will be very nearly correct; but the several kinds of glass, and other substances, of which lenses can be formed, having different degrees of refracting power, the focal distance, which depends upon this refracting power, will, to some extent, vary accordingly.

The focus for parallel rays is termed the principal or solar focus, and is the point upon which the rays from a celestial object are condensed; thus, the parallel rays *a a* will be converged to *f*, the principal focus of the lens; but if the radiant

Fig. 4.

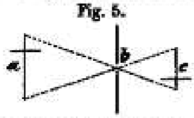


point be nearer to the lens, as at *b*, then the focus will be removed to *f'*, and these two points, *b* and *f'*, are termed conjugate foci, and are in all cases convertible: thus, if *f'* become the radiant point, *b* will be changed into the focus.

Formation of images.

If rays from an object *a* (fig. 5) pass through a small hole in a window-shutter *b*, an inverted image of that object will be formed, either upon the opposite wall, or upon a piece of white paper or screen, placed at any distance, as at *c*. Now, if the hole be enlarged, and a convex lens, the focal length of which is equal to *b, c,* be fixed in the window-shutter, the size of the image will remain unaltered, but the brilliancy and distinctness will be increased by the greater quantity of light received by the lens and condensed upon the screen at *c*.

Fig. 5.



Let *c* (fig. 6) be an image of the object *a* formed by the lens *b* upon a semitransparent screen. Now, if this image be viewed by a lens *d*, of shorter focal length than that of *b*, the combination becomes a telescope; of which *b* is the ob-