TELESCOPIC WORK

FOR

STARLIGHT EVENINGS.

CHAPTER I.

THE TELESCOPE, ITS INVENTION AND THE DEVELOPMENT OF ITS POWERS.

THE instrument which has so vastly extended our knowledge of the Universe, which has enabled us to acquire observations of remarkable precision, and supplied the materials for many sublime speculations in Astronomy, was invented early in the seventeenth century. Apart from its special application as a means of exploring the heavens with a capacity that is truly marvellous, it is a construction which has also been utilized in certain other departments with signal success. It provided mankind with a medium through which to penetrate far beyond the reach of natural vision, and to grasp objects and phenomena which had either eluded detection altogether or had only been seen in dim and uncertain characters. It has also proved a very efficient instrument for various minor purposes of instruction and recreation. The invention of the telescope formed a new era in astronomy; and though, with a few exceptions, men were slow at first in availing themselves of its far-seeing resources, scepticism was soon swept aside and its value became widely acknowledged.

But though the telescope was destined to effect work of the utmost import, and to reach a very high degree of excellence in after times, the result was achieved gradually. Step by step its powers were enlarged and its qualities perfected, and thus the stream of astronomical discovery has been enabled to flow on, stimulated by every increase in its capacity.

There is some question as to whom may be justly credited with the discovery of its principles of construction. Huygens, in his 'Dioptrics,' remarks:—"I should have no hesitation in placing above all the rest of mankind the individual who, solely by his own reflections, without the aid of any fortuitous circumstances, should have achieved the invention of the telescope." There is reason to conclude, however, that its discovery resulted from accident rather than from theory. It is commonly supposed that Galileo Galilei is entitled to precedence; but there is strong evidence to show that he had been anticipated. In any case it must be admitted that Galilei * had priority in successfully utilizing its resources as a means of observational discovery; for he it was who, first of all men, saw Jupiter's satellites, the crescent form of Venus, the mountains and craters on the Moon, and announced them to an incredible world.

It has been supposed, and not without some basis of probability, that a similar instrument to the telescope had been employed by the ancients; for certain statements contained in old historical records would suggest that the Greek philosophers had some means of extending their knowledge further than that permitted by the naked eye. Democritus remarked that the Galaxy or "Milky Way" was nothing but an assemblage of minute stars; and it has been asked, How could he have derived this information but by instrumental aid? It is very probable he gained the knowledge by inferences having their source in close observation; for anyone who attentively studies the face of the sky must be naturally led to conclude that the appearance of the "Milky Way" is induced by immense and irregular clus-

* Galileo Galilei is very generally called by his christian name, but I depart from this practice here.

terings of small stars. In certain regions of the heavens there are clear indications of this: the eye is enabled to glimpse some of the individual star-points, and to observe how they blend and associate with the denser aggregations which give rise to the milky whiteness of the Galaxy.

Refracting lenses, or "burning-glasses," were known at a very early period. A lens, roughly figured into a convex shape and obviously intended for magnifying objects, has been recovered from the ruins of Herculaneum, buried in the ejections from Vesuvius in the year 79 A.D. Pliny and others refer to lenses that burnt by refraction, and describe globules of glass or crystal which, when exposed in the sun, transmit sufficient heat to ignite combustible material. The ancients undoubtedly used tubes in the conduct of their observations, but no lenses seem to have been employed with them, and their only utility consisted in the fact of their shutting out the extraneous rays of light. But spectacles were certainly known at an early period. Concave emeralds are said to have been employed by Nero in witnessing the combats of the gladiators, and they appear to have been the same in effect as the spectacles worn by short-sighted people in our own times. But the ancients supposed that the emerald possessed inherent qualities specially helpful to vision, rather than that its utility resulted simply from its concavity of figure. In the 13th century spectacles were more generally worn, and the theory of their construction understood.

It is remarkable that the telescope did not come into use until so long afterwards. Vague references were made to such an instrument, or rather suggestions as to the possibilities of its construction, which show that, although the principle had perhaps been conceived, the idea was not successfully put into practice. Roger Bacon, who flourished in the 13th century, wrote in his '*Opus Majus*':—"Greater things may be performed by refracted light, for, from the foregoing principles, follows easily that the greatest objects may be seen very small, the remote very near, and *vice versâ*. For we can give transparent bodies such form and position with respect to the eye and the object that the rays are refracted and bent to where we like, so that we, under any angle, see the objects near or far, and in that manner we can, at a great distance, read the smallest letters, and we can count atoms and sand-grains, on account of the greatness of the angle under which they are seen."

Fracastor, in a work published at Venice in 1538, states:— "If we look through two eye-lenses, placed the one upon the other, everything will appear larger and nearer." He also says:—"There are made certain eye-lenses of such a thickness that if the moon or any other celestial body is viewed through them they appear to be so near that their distance does not exceed that of the steeples of public buildings."

In other writings will also be found intimations as to the important action of lenses; and it is hardly accountable that a matter so valuable in its bearings was allowed to remain without practical issues. The progressive tendency and the faculty of invention must indeed have been in an incipient stage, and contrasts strongly with the singular avidity with which ideas are seized upon and realized in our own day.

Many important discoveries have resulted from pure accident; and it has been stated that the first *bonâ fide* telescope had its origin in the following incident:—The children of a spectacle-maker, Zachariah Jansen, of Middleberg, in Zealand, were playing with some lenses, and it chanced that they arranged two of them in such manner that, to their astonishment, the weathercock of an adjoining church appeared much enlarged and more distinct. Having mentioned the curious fact to their father, he immediately turned it to account, and, by fixing two lenses on a board, produced the first telescope!

This view of the case is, however, a very doubtful one, and the invention may with far greater probability be attributed to Hans Lippersheim in 1608. Galilei has little claim to be considered in this relation; for he admitted that in 1609 the news reached him that a Dutchman had devised an appliance capable of showing distant objects with remarkable clearness. He thereupon set to work and experimented with so much aptitude on the principles involved that he very soon produced a telescope for himself. With this instrument he detected the four satellites of Jupiter in 1610, and other successes shortly followed. Being naturally gratified with the improvements he had effected in its construction, and with the wonderful discoveries he had made by its use, we can almost excuse the enthusiasm which prompted him to attribute the invention to his own ingenuity. But while according him the honour due to his sagacity in devoting this instrument to such excellent work, we must not overlook the fact that his claim to priority cannot be justified. Indeed, that Galilei had usurped the title of inventor is mentioned in letters which passed between the scientific men of that time. Fuccari, writing to Kepler, says:—"Galileo wants to be considered the inventor of the telescope, though he, as well as I and others, first saw the telescope which a certain Dutchman first brought with him to Venice, and although he has only improved it very little."

In a critical article by Dr. Doberck*, in which this letter is quoted and the whole question reviewed with considerable care, it is stated that Hans Lippersheim (also known as Jan Lapprey), who was born in Wesel, but afterwards settled at Middleberg, in the Netherlands, as a spectacle-maker, was really the first to make a telescope, and the following facts are quoted in confirmation:—"He solicited the States, as early as the 2nd October, 1608, for a patent for thirty years, or an annual pension for life, for the instrument he had invented, promising then only to construct such instruments for the Government. After inviting the inventor to improve the instrument and alter it so that they could look through it with both eyes at the same time, the States determined, on the 4th October, that from every province one deputy should be elected to try the apparatus and make terms with him concerning the price. This committee declared on the 6th October that it found the invention useful for the country, and had offered the inventor 900 florins for the instrument. He had at first asked 3000 florins for three instruments of rock-crystal. He was then ordered to deliver the instrument within a certain time, and the patent was promised him on condition that he kept the invention secret. Lapprey delivered the instrument in due time. He had

* 'Observatory,' vol. ii. p. 364.

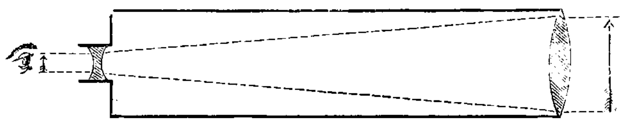
arranged it for both eyes, and it was found satisfactory; but they forced him, against the agreement, to deliver two other telescopes for the same money, and refused the patent because it was evident that already several others had learned about the invention."

The material from which the glasses were figured appears to have been quartz; and efforts were made to keep the invention a profound secret, as it was thought it would prove valuable for "strategetical purposes." The cost of these primitive binoculars was about £75 each.

It is singular that, after being allowed to rest so long, the idea of telescopic construction should have been carried into effect by several persons almost simultaneously, and that doubts and disputes arose as to precedence. The probable explanation is that to one individual only priority was really due, but that, owing to the delays, the secret could not be altogether concealed from two or three others who recognized the importance of the discovery and at once entered into competition with the original inventor. Each of these fashioned his instrument in a slightly different manner, though the principle was similar in all; and having in a great measure to rely upon his individual faculties in completing the task, he considered himself in the light of an inventor and put forth claims accordingly. Not only were attempts made to assume the position of inventor, but there arose fraudulent claimants to some of the discoveries which the instrument effected in the hands of Galilei. Simon Marius, himself one of the very first to construct a telescope and apply it to the examination of the heavenly bodies, asserted that he had seen the satellites of Jupiter on December 29, 1609, a few days before Galilei, who first glimpsed them on January 7, 1610. Humboldt, in his 'Physical Description of the Heavens,' definitely ascribes the discovery of these moons to Marius; but other authorities uniformly reject the statement, and accord to Galilei the full credit.

It is stated that Galilei's first instrument magnified only three times, but he so far managed to amplify its resources that he was ultimately enabled to apply a power of 30. The lenses consisted of a double-convex object-glass, and a small double-concave eye-glass placed in front of the focal image formed by the object-glass. The ordinary opera-glass is constructed on a similar principle.

Fig. 1.

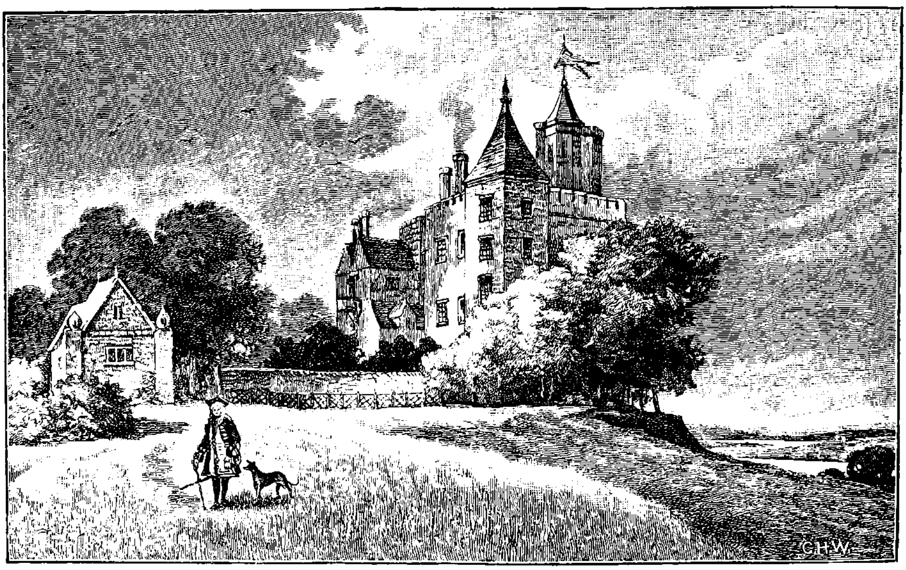


The Galilean Telescope.

The discoveries which Galilei effected with this crude and defective instrument caused a great sensation at the time. He made them known through the medium of a publication which he issued under the title of '*Nuncius Siderus*,' or 'The Messenger of the Stars.' In that superstitious age great ignorance prevailed, bigotry was dominant, and erroneous views of the solar system were upheld and taught by authority. We can therefore readily conceive that Galilei's discoveries, and the direct inferences he put upon them, being held antagonistic to the ruling doctrines, would be received with incredulity and opposition. His views were regarded as heretical. In consequence of upholding the Copernican system he suffered persecution, and had to resort to artifice in the publication of his works. But the marvels revealed by his telescope, though discredited at first, could not fail to meet with final acceptance, for undeniable testimony to their reality was soon forthcoming. They were not, however, regarded until long afterwards as affirming the views enunciated by their clever author. Ultimately the new astronomy, based on the irrepressible evidence of the telescope, and clad in all the habiliments of truth, took the place of the old fallacious beliefs, to form an enduring monument to Copernicus and Galilei, who spent their lives in advancing its cause.

No special developments in the construction of the telescope appear to have taken place until nearly half a century subsequent to its invention. Kepler suggested an instrument formed of two convex lenses, and Scheiner and Huygens made telescopes on this principle in the middle of the 17th century. Huygens found great advantage in the employment of a compound eyepiece consisting of two convex lenses, which corrected the spherical aberration, and, besides being achromatic, gave a much larger field than the single lens. This eyepiece, known as the "Huygenian," still finds favour with the makers of telescopes.

Fig. 2.



Royal Observatory, Greenwich, in Flamsteed's time*.

Huygens may be said to have inaugurated the era of *long* telescopes. He erected instruments of 12 and 23 feet, having an aperture of $2\frac{1}{3}$ inches and powers of 48, 50, and 92. He afterwards produced one 123 feet in focal length and 6 inches in aperture. Chief among his discoveries were the largest satellite of Saturn (Titan) and the true form of Saturn's ring. Hevelius of Dantzic built an instrument 150 feet long, which he fixed to a mast 90 feet in height, and regulated by ropes and pulleys. Cassini, at the Observatory at Paris, had telescopes by Campani of 86,

* Reproduced, by permission, from Cassell's 'New Popular Educator.'

100, and 136 French feet in length; but the highest powers he used on these instruments do not appear to have exceeded 150 times. He made such good use of them as to discover three of the satellites of Saturn and the black division in the ring of that planet. The largest object-glasses employed by Hevelius and Cassini were of 6, 7, and 8 inches diameter. This was during the latter half of the 17th century. In 1712 Bradley made observations of Venus, and obtained measures of the planet's diameter, with a telescope no less than 212 feet in focal length. The instruments alluded to were manipulated with extreme difficulty, and observations had to be conducted in a manner very trying to the observer. Tubes were sometimes dispensed with, the object-glass being fixed to a pole and its position controlled by various contrivances—the observer being so far off, however, that he required the services of a good lantern in order to distinguish it!

The immoderate lengths of refracting-telescopes were necessary, as partially avoiding the effects of chromatic aberration occasioned by the different refrangibility of the seven coloured rays which collectively make white light. In other words, the coloured rays having various indices of refraction cannot be brought to a coincident focus by transmission through a single lens. Thus the red rays have a longer focus than the violet rays, and the immediate effect of the different refractions becomes apparent in the telescopic images, which are fringed with colour and not sharply defined. High magnifying powers serve to intensify the obstacle alluded to, and thus the old observers found it imperative to employ eye-glasses not beyond a certain degree of convexity. The great focal lengths of their object-lenses enabled moderate power to be obtained, though the eye-glass itself had a focus of several inches and magnified very little.

Sir Isaac Newton made many experiments upon colours, and endeavoured to obviate the difficulties of chromatic aberration, but erroneously concluded that it was not feasible. He could devise no means to correct that dispersion of colour which, in the telescopes of his day, so greatly detracted from their effectiveness. His failure seems to have had a pre-

Cambridge University Press
978-1-108-01413-7 - Telescopic Work for Starlight Evenings
William F. Denning
Excerpt
More information

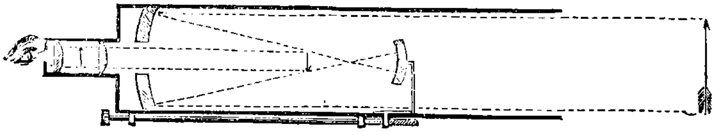
judicial effect in delaying the solution of the difficulty, which was not accomplished until many years afterwards.

Fig. 3.

Sir Isaac Newton *.

The idea of reflecting-telescopes received mention as early as 1639; but it was not until 1663 that Gregory described the instrument, formed of concave mirrors, which still bears his name. He was not, however, proficient in mechanics,

Fig. 4.



Gregorian Telescope.

and after some futile attempts to carry his theory into effect the exertion was relinquished. In 1673 Cassegrain revived the subject, and proposed a modification of the form pre-

* Reproduced, by permission, from Cassell's 'New Popular Educator.'