JAMES NASMYTH'S (1808-1890) TELESCOPES

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James Hall Nasmyth (1808-1890) was a master engineer with his own workshop for casting specula in Patricroft (near Manchester, U.K.). As a young man, Nasmyth spent a considerable amount of time in foundries and chemical laboratories. He became well known as a maker of working models of steam engines. He is also known as the investor of the steam hammer. In 1827, at the age of 19, Nasmyth built a road steam-carriage that can be considered as a precursor to the automobile. Nasmyth many years later refers in his autobiography:

About the year 1827, when I was nineteen years old, the subject of steam carriages to run upon common roads occupied considerable attention. Several engineers and mechanical schemers had tried their hands, but as yet no substantial results had come of their attempts to solve the problem. Like others, I tried my hand. Having made a small working model of a steam-carriage, I exhibited it before the members of the Scottish Society of Arts. The performance of this active little machine was so gratifying to the Society that they requested me to construct one of such power as to enable four or six persons to be conveyed along the ordinary roads. The members of the Society, in their individual capacity, subscribed 60, which they placed in my hands as the means for carrying out their project.

I accordingly set to work at once. I had the heavy parts of the engine and carriage done at Anderson's foundry at Leith. There was in Anderson's employment a most able general mechanic named Robert Maclaughlan, who had served his time at Carmichaels' of Dundee. Anderson possessed some excellent tools, which enabled me to proceed rapidly with the work. Besides, he was most friendly, and took much delight in being concerned in my enterprise. This "big job" was executed in about four months. The steam-carriage was completed and exhibited before the members of the Society of Arts. Many successful trials were made with it on the Queensferry Road, near Edinburgh. The runs were generally of four or five miles, with a load of eight passengers sitting on benches about three feet from the ground.

The experiments were continued for nearly three months, to the great satisfaction of the members. I may mention that in my steam-carriage I employed the waste steam to create a blast or draught by discharging it into the short chimney of the boiler at its lowest part, and found it most effective. I was not at that time aware that George Stephenson and others had adopted the same method; but it was afterwards gratifying to me to find that I had been correct as regards the important uses of the steam blast in the chimney. In fact, it is to this use of the waste steam that we owe the practical success of the locomotive-engine as a tractive power on railways, especially at high speeds[1].

Nasmyth started his own factory at Patricroft after working for three years with the famous engineer Henry Maudslay (1771-1831). Machinery of all kinds was manufactured such as steam engines and especially improved machine tools. His many inventions (which included steam hammers, pile drivers, hydraulic pumps and flexible shafting for driving small drills…) made him a rich man. Nasmyth retired at an early age of 48 devoting all his time to astronomy and the construction of telescopes.

His first telescope was built in 1827 (a 6-inch reflector with a speculum mirror). He recalls in his autobiography:

I cannot find words to express the thoughts which the impressive grandeur of the Stars, seen in the silence of the night, suggested to me; especially when I directed my Telescope, even at random, on any

[1] Nasmyth, J. (1897). James Nasmyth: Engineer: An Autobiography. Edited by Samuel Smiles. John Murray, London.

portion of the clear sky, and considered that each Star of the multitude it revealed to me, was a Sun! The centre of a system! Myriads of such stars, invisible to the unassisted eye, were rendered perfectly distinct by the aid of the telescope. The magnificence of the sight was vastly increased when the telescope was directed to any portion of the Milky Way. It revealed such countless multitudes of stars that I had only to sit before the eyepiece, and behold the endless procession of these glorious objects pass before me. The motion of the earth assisted in changing this scene of inexpressible magnificence, which reached its climax when some object such as the "Cluster in Hercules" came into sight. The component stars are so crowded together there as to give the cluster the appearance of a gray spot; but when examined with a telescope of large aperture, it becomes resolved into such myriads of stars as to defy all attempts to count them. (…) I had already a slight acquaintance with Astronomy. My father had implanted in me the first germs. He was a great admirer of that sublimest of sciences. I had obtained a sufficient amount of technical knowledge to construct in 1827 a small but very effective reflecting telescope of six inches diameter. Three years later I initiated Mr. Maudslay into the art and mystery of making a reflecting telescope. I then made a speculum of ten inches diameter, and but for the unhappy circumstance of his death in 1831, it would have been mounted in his proposed observatory at Norwood. After I had settled down at Fireside, Patricroft, I desired to possess a telescope of considerable power in order to enjoy the tranquil pleasure of surveying the heavens in their impressive grandeur at night[2].

Nasmyth was planning to build a 24-inch telescope for Maudslay's private observatory when the latter died in 1831. Telescope making was resumed at Patricoft with great success. His close collaboration with William Lassel (1799-1880) also began in 1840, a collaboration that lasted for forty years.

As I had all the means and appliances for casting specula at the factory, I soon had the felicity of embodying all my former self-acquired skill in this fine art by producing a very perfect casting of a ten-inch diameter speculum. The alloy consisted of fifteen parts of pure tin and thirty-two parts of pure copper, with one part of arsenic. It was cast with perfect soundness, and was ground and polished by a machine which I contrived for the purpose. The speculum was so brilliant that when my friend William Lassell saw it, he said "it made his mouth water." It was about this time (1840) that I had the great happiness of becoming acquainted with Mr. Lassell. Mr. Lassell was a man of superb powers. Like many others who have done so much for astronomy, he started as an amateur. He was first apprenticed to a merchant at Liverpool. He then began business as a brewer. Eventually he devoted himself to astronomy and astronomical mechanics. When in his twenty-first year he began constructing reflecting telescopes for himself. He proceeded to make a Newtonian of nine inches aperture, which he erected in an observatory at his residence near Liverpool, happily named "Starfield." With this instrument he worked diligently, and detected the sixth star in the trapezium of Orion. In 1844 he conceived the bold idea of constructing a reflector of two feet aperture, and twenty feet focal length, to be mounted equatorially. Sir John Herschel, in mentioning Mr. Lassell's work, did me the honour of saying "that in Mr. Nasmyth he was fortunate to find a mechanist capable of executing in the highest perfection all his conceptions, and prepared by his own love of astronomy and practical acquaintance with astronomical observations, and with the construction of specula, to give them their full effect." With this fine instrument Mr. Lassell discovered the satellite of Neptune. He also discovered the eighth satellite of Saturn, of extreme minuteness, as well as two additional satellites of Uranus. But perhaps his best work was done at Malta with a much larger telescope, four feet in aperture, and thirty-seven feet focus, erected there in 1861. He remained at Malta for three years, and published a catalogue of 600 new nebulae, which will be found in the Memoirs of the Royal Astronomical Society. One of his curious sayings was, "I have had a great deal to do with opticians, some of them—like Cooke of York—are really opticians; but the greater number of them are merely shop opticians!" and profiting by his devotion to astronomical pursuits and his profound knowledge of the subject. He had acquired much technical skill in the construction of reflecting telescopes, and the companionship between us was thus rendered very agreeable. There was an intimate exchange of opinions on the subject, and my friendship with him continued during forty successive years. I was perhaps a little ahead of him in certain respects. I had more practical knowledge of casting, for I had begun when a boy in my bedroom at Edinburgh. In course of time I contrived many

[2] Nasmyth, J. (1897). James Nasmyth: Engineer: An Autobiography. Samuel Smiles Ed. John Murray, London.

practical "dodges" (if I may use such a word), and could nimbly vault over difficulties of a special kind which had hitherto formed a barrier in the way of amateur speculum makers when fighting their way to a home-made telescope. I may mention that I know of no mechanical pursuit in connection with science, that offers such an opportunity for practicing the technical arts, as that of constructing from first to last a complete Newtonian or Gregorian Reflecting Telescope. Such an enterprise brings before the amateur a succession of the most interesting and instructive mechanical arts, and obliges the experimenter to exercise the faculty of delicate manipulation. If I were asked what course of practice was the best to instil a true taste for refined mechanical work, I should say, set to and make for yourself from first to last a reflecting telescope with a metallic speculum. Buy nothing but the raw material, and work your way to the possession of a telescope by means of your own individual labour and skill. If you do your work with the care, intelligence, and patience that is necessary, you will find a glorious reward in the enhanced enjoyment of a night with the heavens—all the result of your own ingenuity and handiwork. It will prove a source of abundant pleasure and of infinite enjoyment for the rest of your life[3].

Nasmyth started building a 20-inch of his own design soon after (Figure 1).

My ambition expanded. I now resolved to construct a reflecting telescope of considerably greater power than that which I possessed. I made one of twenty inches diameter, and mounted it on a very simple plan, thus removing many of the inconveniences and even personal risks that attend the use of such instruments. It had been necessary to mount steps or ladders to get at the eyepiece, especially when the objects to be observed were at a high elevation above the horizon. I now prepared to do some special work with this instrument. In 1842 I began my systematic researches upon the Moon. I carefully and minutely scrutinized the marvelous details of its surface, a pursuit which I continued for many years, and still continue with ardour until this day. My method was as follows:

I availed myself of every favourable opportunity for carrying on the investigation. I made careful drawings with black and white chalk on large sheets of grey-tinted paper, of such selected portions of the Moon as embodied the most characteristic and instructive features of her wonderful surface. I was thus enabled to graphically represent the details with due fidelity as to form, as well as with regard to the striking effect of the original in its masses of light and shade. I thus educated my eye for the special object by systematic and careful observation, and at the same time practiced my hand in no less careful delineation of all that was so distinctly presented to me by the telescope—at the side of which my sheet of paper was handily fixed. I became in a manner familiar with the vast variety of those distinct manifestations of volcanic action, which at some inconceivably remote period had produced these wonderful features and details of the moon's surface. So far as could be observed, there was an entire absence of any agency of change, so that their formation must have remained absolutely intact since the original cosmical heat of the moon had passed rapidly into space. The surface, with all its wondrous details, presents the same aspect as it did probably millions of ages ago.

This consideration vastly enhances the deep interest with which we look upon the moon and its volcanic details. It is totally without an atmosphere, or of a vapour envelope, such as the earth possesses, and which must have contributed to the conservation of the cosmical heat of the latter orb. The moon is of relatively small mass, and is consequently inferior in heat-retaining power. It must thus have parted with its original stock of cosmical heat with such rapidity as to bring about the final termination of those surface changes which give it so peculiar an aspect. In the case of the earth the internal heat still continues in operation, though in a vastly reduced degree of activity. Again in the case of the moon, the total absence of water as well as atmosphere has removed from it all those activities which, in the earth, have acted so powerfully in effecting changes of its surfaces as well as in the distribution of its materials. Hence the appearance of the wonderful details of the moon's surface presents us with objects of inconceivably remote antiquity[4].

[3]Nasmyth, J. (1897). James Nasmyth: Engineer: An Autobiography. Samuel Smiles Ed. John Murray, London.

[4] Nasmyth, J. (1897). James Nasmyth: Engineer: An Autobiography. Samuel Smiles Ed. John Murray, London.

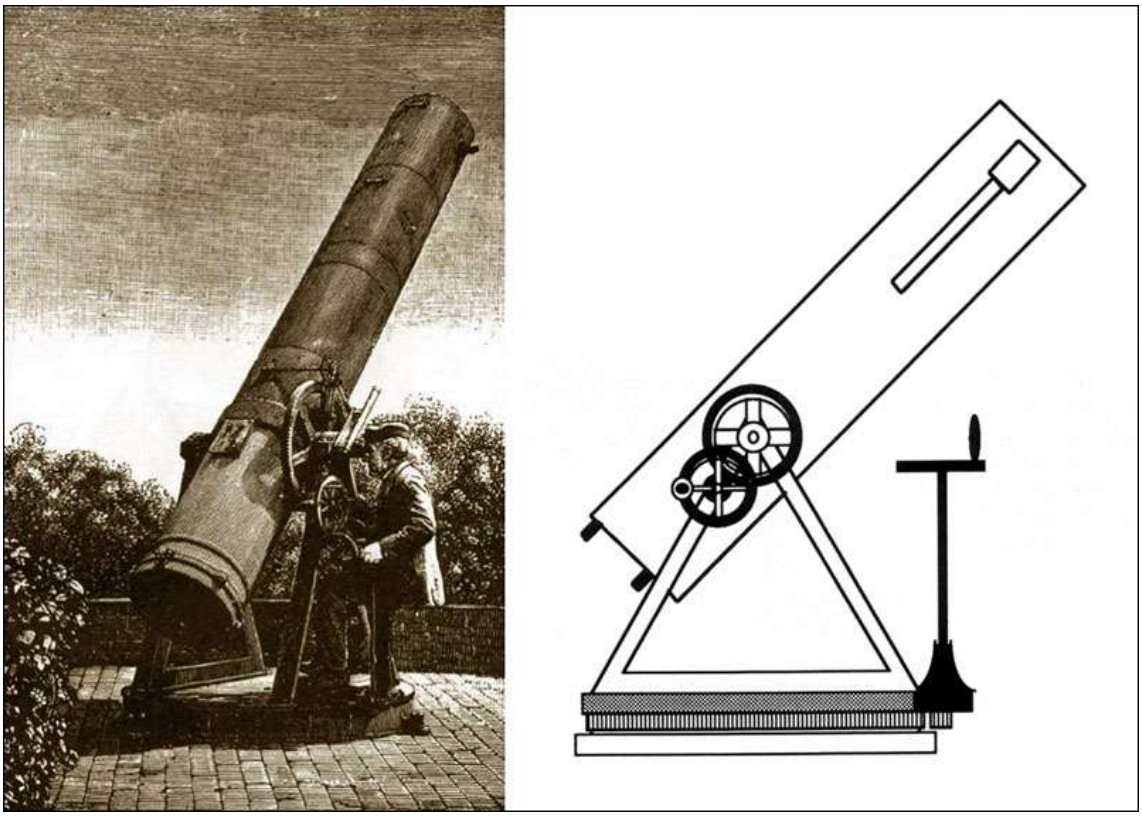

Figure 1- Nasmyth's 20-inch Cassegrain-Newton (*ca.* 1845) (left).
Diagram of a Nasmyth stationary-eyepiece telescope (right).

A systematic lunar observation program started in 1842. Nasmyth was convinced that all Moon craters were produced by volcanic activity. These innovative ideas were described in the book *The Moon Considered as a Planet, a World, and a Satellite* published in 1874 by James Nasmyth and James Carpenter (1840-1899). Several photographs of plaster models of lunar features were included based on drawings and not on precise measurements of the lunar surface features. Nasmyth made also many observations of the fine structure of the Sun surface. He interpreted the features he saw as similar to willow leaf shaped objects (Figure 2):

I had been busily occupied for some time in making careful investigations into the dark spots upon the Sun's surface. These spots are of extraordinary dimensions, sometimes more than 10,000 miles in diameter. Our world might be dropped into them. I observed that the spots were sometimes bridged over by a streak of light, formed of willow-leaf-shaped objects. They were apparently possessed of voluntary motion, and moved from one side of the spot to the other. These flakes were evidently the immediate sources of the solar light and heat. I wrote a paper on the subject, which I sent to the Literary and Philosophical Society of Manchester … Memoirs of the Literary and Philosophical Society of Manchester, 3d series, vol. I, p. 407. My first discovery of the "Willow-leaf" objects on the Sun's surface was made in June 1860. I afterwards obtained several glimpses of them from time to time. But the occasions are very rare when the bright sun can be seen in a tranquil atmosphere free from vibrations, and when the delicate objects on its surface can be clearly defined. It was not until the 5th of June 1864 that I obtained the finest sight of the Sun's spots and the Willow-leaf objects; it was then that I made a careful drawing of them, from which the annexed faithful engraving has been produced. Indeed I never had a better sight of this extraordinary aspect of the Sun than on that day (…) The results of my observations were of so

novel a character that astronomers for some time hesitated to accept them as facts. Yet Sir John Herschel, the chief of astronomers, declared them to be "a most wonderful discovery"[5].

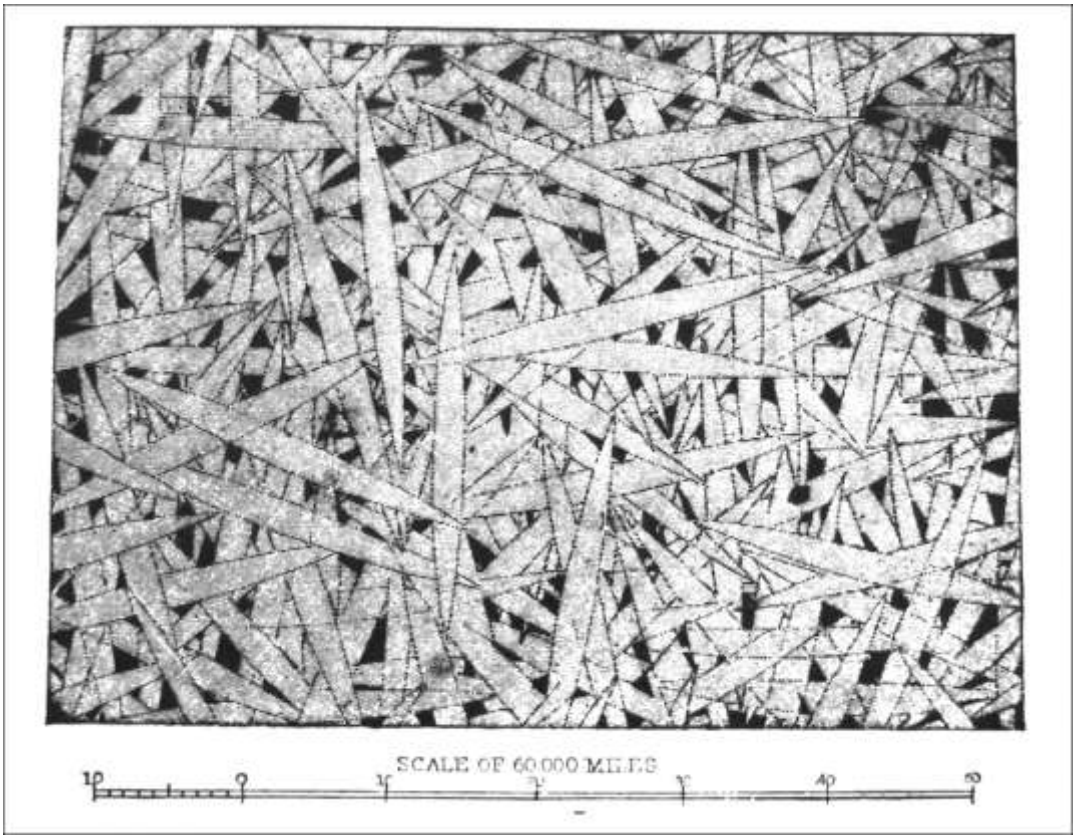

Figure 2- Nasmyth's "willow-leaf" pattern on the Sun.
From *The New Astronomy* by Samuel Pierpoint Langley, 1888.

Nasmyth was of course observing the granulation pattern on the photosphere of the Sun. The term "granulated" was first introduced by William Rutter Dawes (1799-1868) in 1864. This pattern is still difficult to observe in visual studies of the Sun with modern instruments.

The 20-inch reflector consisted of a modification of the Cassegrain design. The description of this instrument can also be found in Nasmyth's autobiography:

In order to avoid the personal risk and inconvenience of having to mount to the eye-piece by a ladder, I furnished the telescope tube with trunnions, like a cannon, with one of the trunnions hollow so as to admit of the eye-piece. Opposite to it a plain diagonal mirror was placed, to transmit the image to the eye. The whole was mounted on a turn-table, having a seat opposite to the eye-piece, as will be seen in the engraving on the other side. The observer, when seated, could direct the telescope to any part of the heavens without moving from his seat. Although this arrangement occasioned some loss of light, that objection was more than compensated by the great convenience which it afforded for the prosecution of the special class of observations in which I was engaged namely, that of the Sun, Moon, and Planets.

In the Nasmyth-Cassegrain the primary mirror is not perforated. The light falls on a concave primary mirror and into a convex secondary mirror. A small flat mirror (placed on the altitude

[5] Nasmyth, J. (1897). James Nasmyth: Engineer: An Autobiography. Samuel Smiles Ed. John Murray, London.

axis) reflects the light to one of the sides of the telescope. This innovative telescope design became widely adopted during the latter part of the 20th century.

Sources:

- King, H.C. (1955). *The History of the Telescope*. Dover Publications, Inc. New York.
- Nasmyth, J. (1897). James Nasmyth: Engineer: An Autobiography. Samuel Smiles Ed. John Murray, London.