

## CHAPTER XXIV.

### THE TELESCOPE OF THE ROCKY MOUNTAINS.

On the 20th of October of the preceding year, after the subscription list was closed, the president of the Gun Club had credited the Cambridge Observatory with the sums necessary for the construction of a vast optical instrument. This telescope was to be powerful enough to render visible on the surface of the moon an object being at least nine feet wide.

There is an important difference between a field-glass and a telescope, which it is well to recall here. A field-glass is composed of a tube which carries at its upper extremity a convex glass called an object-glass, and at its lower extremity a second glass called ocular, to which the eye of the observer is applied. The rays from the luminous object traverse the first glass, and by refraction form an image upside down at its focus. This image is looked at with the ocular, which magnifies it. The tube of the field-glass is, therefore, closed at each extremity by the object and the ocular glasses.

The telescope, on the contrary, is open at its upper extremity. The rays from the object observed penetrate freely into it, and strike a concave metallic mirror--that is to say, they are focussed. From thence their reflected rays meet with a little mirror, which sends them back to the

ocular in such a way as to magnify the image produced.

Thus in field-glasses refraction plays the principal part, and reflection does in the telescope. Hence the name of refractors given to the former, and reflectors given to the latter. All the difficulty in the execution of these optical instruments lies in the making of the object-glass, whether they be made of glass or metallic mirrors.

Still at the epoch when the Gun Club made its great experiment these instruments were singularly perfected and gave magnificent results. The time was far distant when Galileo observed the stars with his poor glass, which magnified seven times at the most. Since the 16th century optical instruments had widened and lengthened in considerable proportions, and they allowed the stellar spaces to be gauged to a depth unknown before. Amongst the refracting instruments at work at that period were the glass of the Poulkowa Observatory in Russia, the object-glass of which measured 15 inches in width, that of the French optician Lerebours, furnished with an object-glass equally large, and lastly that of the Cambridge Observatory, furnished with an object-glass 19 inches in diameter.

Amongst telescopes, two were known of remarkable power and gigantic dimensions. The first, constructed by Herschel, was 36 feet in length, and had an object-glass of 4 feet 6 inches; it magnified 6,000 times; the second, raised in Ireland, at Birrastle, in Parsonstown Park, belonged to Lord Rosse; the length of its tube was 48 feet and the width

of its mirror 6 feet; it magnified 6,400 times, and it had required an immense erection of masonry on which to place the apparatus necessary for working the instrument, which weighed 12-1/2 tons.

But it will be seen that notwithstanding these colossal dimensions the magnifying power obtained did not exceed 6,000 times in round numbers; now that power would only bring the moon within 39 miles, and would only allow objects 60 feet in diameter to be perceived unless these objects were very elongated.

Now in space they had to deal with a projectile 9 feet wide and 15 long, so the moon had to be brought within five miles at least, and for that a magnifying power of 48,000 times was necessary.

Such was the problem propounded to the Cambridge Observatory. They were not to be stopped by financial difficulties, so there only remained material difficulties.

First of all they had to choose between telescopes and field-glasses. The latter had some advantages. With equal object-glasses they have a greater magnifying power, because the luminous rays that traverse the glasses lose less by absorption than the reflection on the metallic mirror of telescopes; but the thickness that can be given to glass is limited, for too thick it does not allow the luminous rays to pass. Besides, the construction of these vast glasses is excessively difficult, and demands a considerable time, measured by years.

Therefore, although images are better given by glasses, an inappreciable advantage when the question is to observe the moon, the light of which is simply reflected they decided to employ the telescope, which is prompter in execution and is capable of a greater magnifying power; only as the luminous rays lose much of their intensity by traversing the atmosphere, the Gun Club resolved to set up the instrument on one of the highest mountains of the Union, which would diminish the depth of the aërial strata.

In telescopes it has been seen that the glass placed at the observer's eye produces the magnifying power, and the object-glass which bears this power the best is the one that has the largest diameter and the greatest focal distance. In order to magnify 48,000 times it must be much larger than those of Herschel and Lord Rosse. There lay the difficulty, for the casting of these mirrors is a very delicate operation.

Happily, some years before a savant of the Institut de France, Léon Foucault, had just invented means by which the polishing of object-glasses became very prompt and easy by replacing the metallic mirror by taking a piece of glass the size required and plating it.

It was to be fixed according to the method invented by Herschel for telescopes. In the great instrument of the astronomer at Slough, the image of objects reflected by the mirror inclined at the bottom of the tube was formed at the other extremity where the eyeglass was placed.

Thus the observer, instead of being placed at the lower end of the tube, was hoisted to the upper end, and there with his eyeglass he looked down into the enormous cylinder. This combination had the advantage of doing away with the little mirror destined to send back the image to the ocular glass, which thus only reflected once instead of twice; therefore there were fewer luminous rays extinguished, the image was less feeble, and more light was obtained, a precious advantage in the observation that was to be made.

This being resolved upon, the work was begun. According to the calculations of the Cambridge Observatory staff, the tube of the new reflector was to be 280 feet long and its mirror 16 feet in diameter. Although it was so colossal it was not comparable to the telescope 10,000 feet long which the astronomer Hooke proposed to construct some years ago. Nevertheless the setting up of such an apparatus presented great difficulties.

The question of its site was promptly settled. It must be upon a high mountain, and high mountains are not numerous in the States.

In fact, the orographical system of this great country only contains two chains of average height, amongst which flows the magnificent Mississippi, which the Americans would call the "king of rivers" if they admitted any royalty whatever.

On the east rise the Apalachians, the very highest point of which, in

New Hampshire, does not exceed the very moderate altitude of 5,600 feet.

On the west are, however, the Rocky Mountains, that immense chain which begins at the Straits of Magellan, follows the west coast of South America under the name of the Andes or Cordilleras, crosses the Isthmus of Panama, and runs up the whole of North America to the very shores of the Polar Sea.

These mountains are not very high, and the Alps or Himalayas would look down upon them with disdain. In fact, their highest summit is only 10,701 feet high, whilst Mont Blanc is 14,439, and the highest summit of the Himalayas is 26,776 feet above the level of the sea.

But as the Gun Club wished that its telescope, as well as the Columbiad, should be set up in the States of the Union, they were obliged to be content with the Rocky Mountains, and all the necessary material was sent to the summit of Long's Peak in the territory of Missouri.

Neither pen nor language could relate the difficulties of every kind that the American engineers had to overcome, and the prodigies of audacity and skill that they accomplished. Enormous stones, massive pieces of wrought-iron, heavy corner-clamps, and huge portions of cylinder had to be raised with an object-glass, weighing nearly 30,000 lbs., above the line of perpetual snow for more than 10,000 feet in height, after crossing desert prairies, impenetrable forests, fearful rapids far from all centres of population, and in the midst of savage

regions in which every detail of life becomes an insoluble problem, and, nevertheless, American genius triumphed over all these obstacles. Less than a year after beginning the works in the last days of the month of September, the gigantic reflector rose in the air to a height of 280 feet. It was hung from an enormous iron scaffolding; an ingenious arrangement allowed it to be easily moved towards every point of the sky, and to follow the stars from one horizon to the other during their journey across space.

It had cost more than 400,000 dollars. The first time it was pointed at the moon the observers felt both curious and uneasy. What would they discover in the field of this telescope which magnified objects 48,000 times? Populations, flocks of lunar animals, towns, lakes, and oceans? No, nothing that science was not already acquainted with, and upon all points of her disc the volcanic nature of the moon could be determined with absolute precision.

But the telescope of the Rocky Mountains, before being used by the Gun Club, rendered immense services to astronomy. Thanks to its power of penetration, the depths of the sky were explored to their utmost limits, the apparent diameter of a great number of stars could be rigorously measured, and Mr. Clarke, of the Cambridge staff, resolved the Crab nebula in Taurus, which Lord Rosse's reflector had never been able to do.