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THE 72-INCH REFLECTING TELESCOPE.

BY

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THE 72-INCH REFLECTING TELESCOPE.

By J. S. Plaskett

THE completion of the mechanical parts or mounting of the 72-inch telescope and the near approach to completion and erection of building and dome for the telescope make it fitting to present to readers of the Journal a short note, illustrated by some photographs, of the present condition of the enterprise.

The mounting of the telescope was practically completed, and it was temporarily erected in the factory of the makers, the Warner and Swasey Co., of Cleveland, Ohio, about the end of March last. Some finishing touches to one or two details, the holding of a formal reception and exhibition of the telescope, which was delayed by the absence of members of the firm until May 25th, and the fact that the dome was not sufficiently advanced to offer protection from the weather, caused the postponement of the shipment to Victoria until the early part of June. The erection of the mounting will occupy some three months, hence occurring during [illegible]vorable season, and should be completed by the early a[illegible]

[illegible]-inch mirror is 12 inches thick at the edge, has a hole $10\frac{1}{8}$ inches in diameter through the centre, and weighs some 4,340 pounds. It is finished on edges and back and its front surface is now practically spherical. Before it can be made a paraboloid of revolution, which is the surface necessary to bring the parallel pencil of light from any celestial object accurately to a focus, it is necessary to prepare a large flat surface for the purpose of testing the paraboloid. It is hoped that this will be finished and the mirror completed as soon as the mounting is ready to receive it.

A fine road to the summit of Saanich Hill, the site of the new observatory, was completed early last spring by the Government of British Columbia, which has most promptly fulfilled its undertakings in the matter. Although the first source of water supply was a failure, this important question is now satisfactorily solved.

The concrete pier for carrying the telescope (Plate VII.), and the surrounding circular steel building (Plate VIII.), whose wall serves to support the dome, was commenced last summer and is now completed, except for some minor details, which are delayed until the telescope arrives. One of the essential features about the building and dome is that they are entirely of steel construction, which allows them to assume rapidly the air temperature; and they are provided with double walls and a system of louvres at the top of the dome, ensuring a thorough circulation of the air and the maintenance of the interior at the shade temperature.

A contract for the 66-foot revolving dome, which, in the case of a large reflecting telescope, is a most important part of the equipment, as it has to be provided with many accessories required in the handling of and observing with the telescope, was awarded last spring to the Warner and Swasey Co., so that dome and telescope were designed together and should work in proper relation to one another. This dome is now being erected on its building at the observatory site, and although it has not yet been operated, its temporary erection at Cleveland sufficed to show that it will be the most complete and convenient in every operating detail of any ever built. (Plate IX.)

One of the observers' houses is completed, but none of the other buildings required have yet been begun. This dwelling will enable the supervision of the erection of dome and telescope, and the preliminary adjustments and experimental work to be efficiently performed. It is hoped that by the time the telescope is in shape for regular and systematic operation the necessary additional building equipment will be provided.

It may be of interest to give a summary of the main features of the telescope mounting at this time, leaving a full account until its final erection and completion.

PLATE VII.

TELESCOPE PIER AND FOUNDATION FOR BUILDING

Saanich Hill, Victoria, B.C.

The telescope is to be used in three different forms, observations being made at the prime focus, at the Newtonian focus or at the Cassegrain focus. In the photography of the heavenly bodies, or in obtaining spectra of very faint objects, the photographic plate or small spectrograph may be placed at the upper end of the tube in the prime focus, 30 feet above the great mirror. In the Newtonian form a plane mirror 19 inches in diameter, about 4 feet down the tube and inclined at 45°, reflects the light to a focus on the plate or spectrograph at the side of the tube. In the Cassegrain form a convex mirror 19 inches in diameter, placed 7 feet below the prime focus, reflects the light back through the central hole of the main mirror to a focus below the mirror cell, where it can be visually observed, photographed or analysed by the spectrograph. The equivalent focal length of this combination is 108 feet, giving images of exactly the same size as a refractor with a tube 108 feet long.

The function of the mechanical parts or mounting of this or any telescope is to hold the optical parts invariably, and at the same time without flexure or strain, in their correct relative positions, to enable them to be readily pointed to any desired object, and to move them as a whole delicately and accurately to follow the motion of the stars. Evidently in the case of a great telescope like the 72-inch, whose moving parts weigh some 45 tons, this is an engineering problem of a very exacting character. The previous experience of the makers in the design and construction of the largest refracting telescopes in the world, the Yerkes 40-inch, the Lick 36-inch, and many others, has been of great value in this connection. Further, the great advances in recent years in the production of high grade steel castings, in the manufacture of bearings in which friction has been reduced to a minimum, and in other directions has enabled a telescope to be constructed which is not only considerably larger in size but is superior in design, in accuracy, and in convenience and smoothness of operation to any existing instrument.

The telescope, whose general form follows the English type of equatorial mounting and is well shown in the photograph (Plate XI.), has a long polar axis supported at its north and south ends by bearings, in a direction parallel to the earth's axis. The declination axis, to which the tube is attached at right angles, passes rectangularly through the central cubical portion of the polar axis, the weight of the tube on one side being counterpoised by the declination gearing and housing on the other.

The polar axis is composed of three sections, all of the best steel castings, firmly bolted together, namely, the central cubical section above mentioned and north and south conical tubular sections. It is nearly 23 feet long and weighs about ten tons. The declination axis is a steel forging, 5¼ tons in weight, 14½ feet long, 15½ inches in diameter, with a flange 41 inches in diameter and 4 inches thick, to which the tube is bolted. The tube is also in three sections, the central cylindrical steel casting, about 7½ feet in diameter and 6 feet long, weighing 7 tons, being attached to the flange of declination axis; to its bottom flange is bolted the steel mirror cell, weighing, with mirror counterpoises and mirror, 6 tons; while to its upper end is firmly attached the skeleton tube, a beautifully designed and extremely rigid piece of structural work, upwards of 23 feet long, 7½ feet in diameter, and weighing, with attachments, about 2 tons.

Below the mirror cell the spectrograph and visual appliances for use at the Cassegrain focus are attached. At the upper end of the skeleton tube an exceedingly ingenious arrangement, avoiding the use of several heavy and awkward extensions of the skeleton tube which were necessary with all previous reflectors, enables either the prime focus, Newtonian or Cassegrain attachments to be used at will and with the minimum of trouble and delay in changing from one to the other.

The driving clock, similar in design to that which has been so successful in the Lick and Yerkes telescopes, moves the telescope in right ascension by means of an accurately cut worm-wheel, 9 feet in diameter, mounted on the polar axis by ball and ball thrust bearings, and clamped to it when required by an electric motor.

The telescope is moved from one position to another and set and guided wholly hy electric power, no less than seven motors besides several solenoids and magnetic clutches being required for these motions. The quick motion motors move the telescope at the rate of 45° per minute, one revolution in 8 minutes, in both co-ordinates. The slow motions have two speeds, a fast one for fine setting at the rate of one revolution in 36 hours, and a slow one for guiding, one revolution in 720 hours or 30 days. With the Cassegrain focal length of 108 feet the guiding speed of the star image at the focal plane is 1/300 inch per second or 1/5 inch per minute.

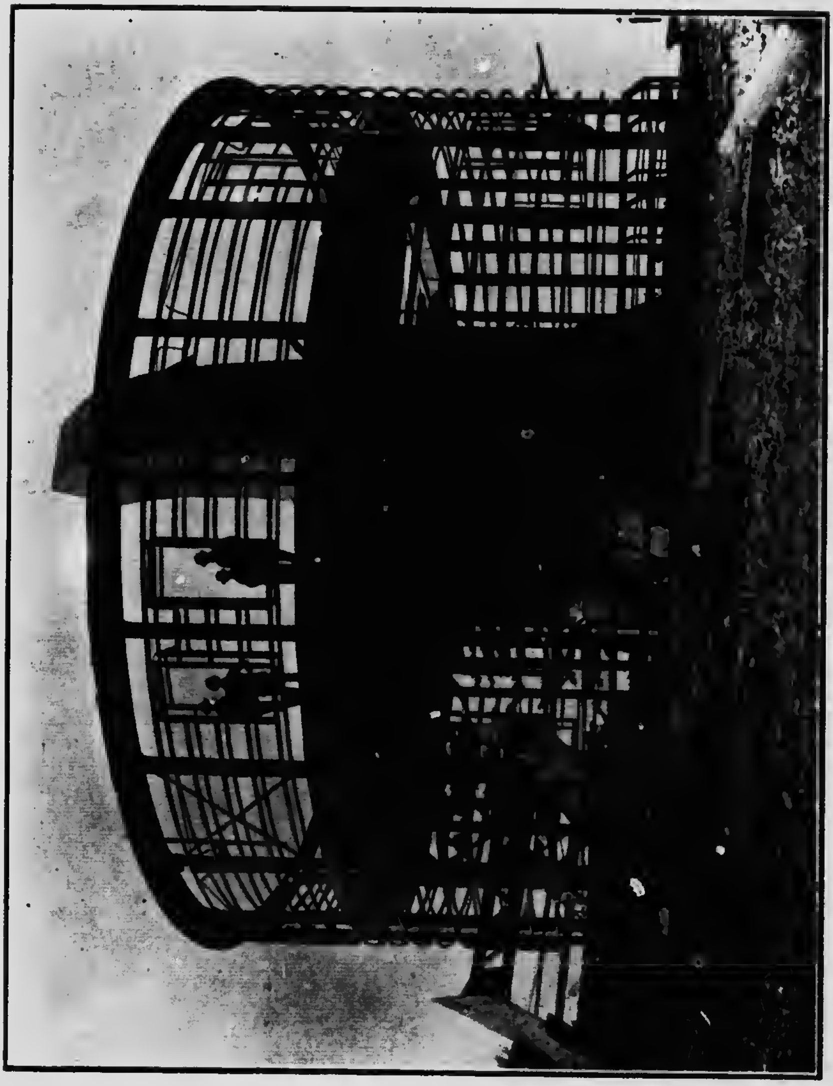
The electric wiring and control systems have been very carefully worked out, all sliding brush contacts avoided, and the whole system installed in a permanent and yet easily accessible form, giving the maximum of convenience in operation with the minimum of attention and repair. The method of operation will be as follows:—An operator on the ohserving floor controls the quick motions and clamps of the telescope and the rotation of the dome from the more convenient of two switchboards, one on the east and the other on the west side of the south pier, the telescope being quickly set approximately to the tabular position of the desired ohject by the sidereal and declination setting circles. The observer at either the upper or lower ends of the tube can clamp or unclamp the telescope, make the fine settings and guide by means of push buttons located on a small keyboard which he can carry around with him or attach to any convenient place.

Every attachment that will add to the convenience and accuracy of operation of the telescope has been provided and the instrument can be handled with great ease and moves with great smoothness. A very slight pressure at the upper end of the tube suffices to set it in motion in either right ascension or declination, and some idea of the ease with which it moves is conveyed by the fact the actual increase of current required to move the telescope in quick motion over that needed to run the motors idle is barely sufficient to light a 16 c.-p. lamp. These small forces show, when the great mass, 45 tons, of the moving parts is considered; the perfection of design and workmanship in the instrument.

I desire to place on record my appreciation of the spirit which has governed the Warner and Swasey Co. throughout the design and construction of this telescope. Their ideal has been to make this instrument the most accurate, perfect running, and convenient of any ever constructed, and to that end no pains or expense has been spared. When to this purpose is added their unequalled experience in the design and construction of large telescopes, and their unrivalled facilities for producing the highest grade of workmanship, the result can not fail to be, and undoubtedly is, an instrument of the greatest accuracy and one in which every needful and desirable attachment or movement is provided in the most direct and simple way.

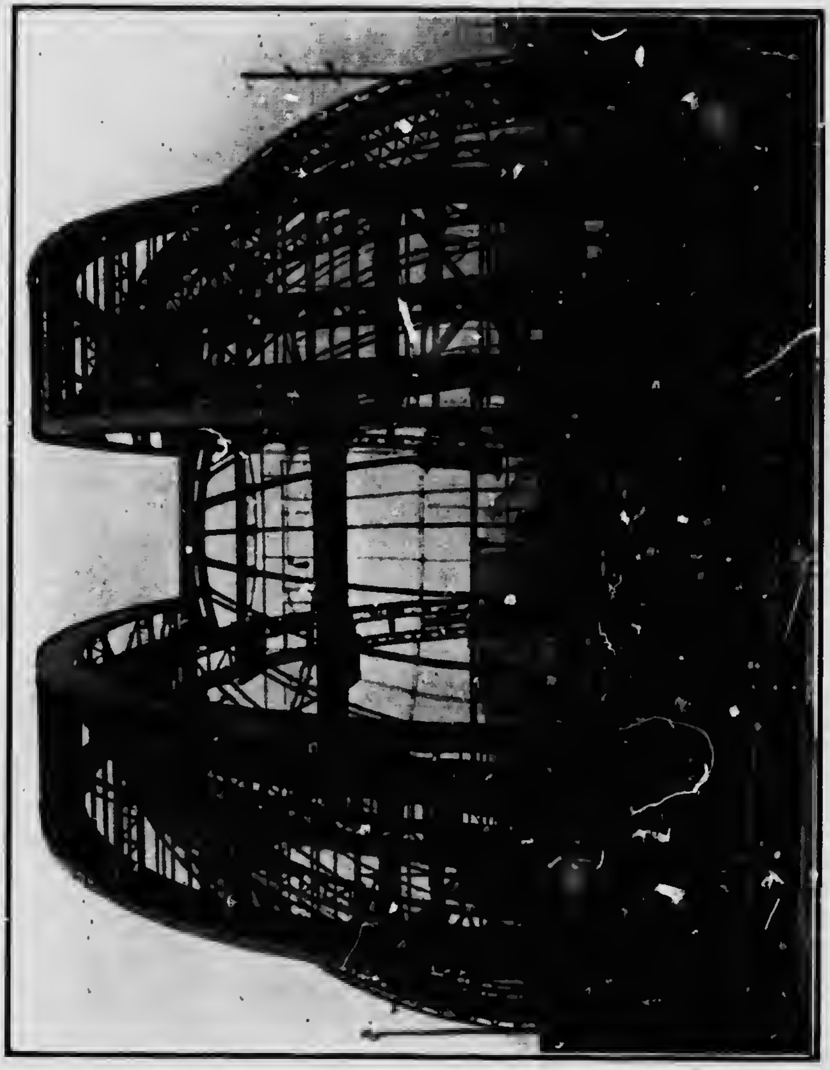
The cause of astronomical research in Canada is to be congratulated that this great addition to its equipment was entrusted to such capable and sympathetic hands, and that this magnificent instrument has been so promptly and adequately completed.

PLATE VIII.



STRUCTURAL STEEL FRAMEWORK OF TELESCOPE BUILDING SURROUNDING TELESCOPE PIER

PLATE IX.



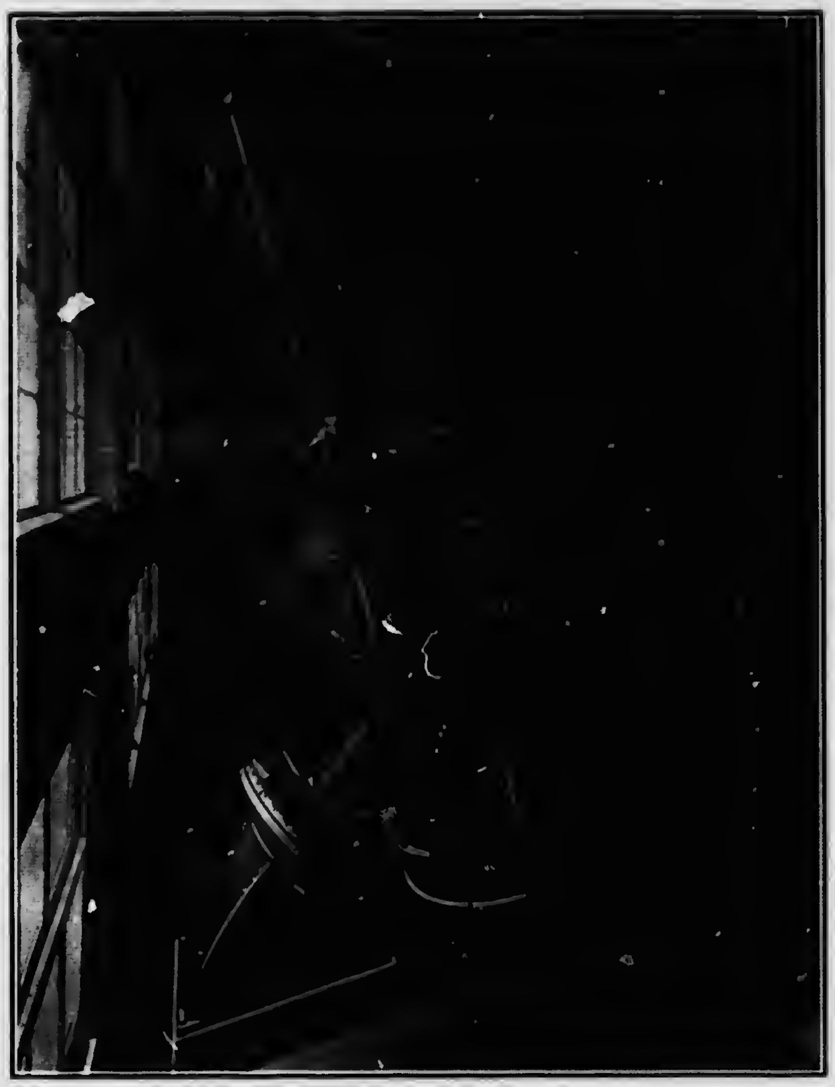
DOME FOR THE 72-INCH REFLECTOR.

As temporarily mounted at Cleveland, Oh

PLATE X.

DOME AND BUILDING,
May 5, 1916.

PLATE XI.



THE MOUNTING OF THE 72-INCH REFLECTING TELESCOPE

Temporarily erected at Cleveland, Ohio