Compliments of the Author.

Reserve

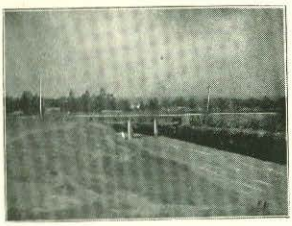
Jan. 97.

The Lowell Observatory in Mexico.

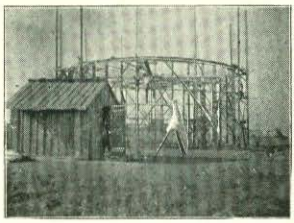
A. E. DOUGLASS.

Reprint from POPULAR ASTRONOMY. No 39

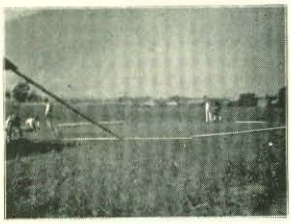
PLATE XLVII.



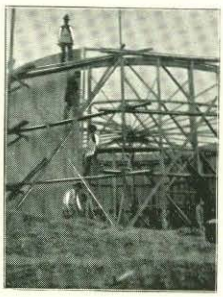
1. From Observatory Site, looking east towards Mexico.



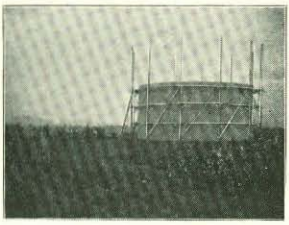
2. Laying the sill.



3. Centering the walls.

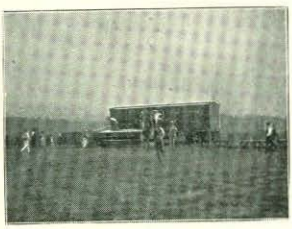


4. Finishing the walls.

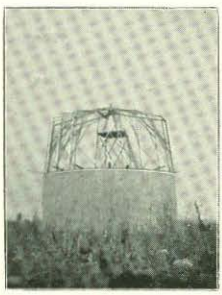


5. The finished Walls.

6. Pulque for the men.



7. Unloading the car.



8. The rafters in place.

LOWELL OBSERVATORY IN MEXICO

THE LOWELL OBSERVATORY IN MEXICO.

A. E. DOUGLASS.

For Popular Astronomy.

During the winter of 1894-5 observations at Flagstaff were made on every clear night and on the average the seeing was very poor, a condition attributed to the presence of snow. It was therefore deemed advisable to try a more southern latitude for this present winter. Not knowing with any certainty the relative merits of different parts of the Republic of Mexico, the City of Mexico was decided upon as affording the best combination of convenience and southern latitude.

At the time of my arrival in the City of Mexico on the 7th of November, it was full time for the weather to be changing from the wet to the dry season but for a month afterward rains were of almost daily occurrence and the test of the localities were not as complete as hoped. The points examined were the hill of Guadalupe, four and a half miles north of the city, and the slope rising to the west of Tacubaya, a suburb of Mexico, about an equal distance west. Each point was somewhat less than 150 feet above the level of the streets of Mexico. There seemed little reason to suppose either one better than the other, astronomically; so with a view to accessability a location in Tacubaya was chosen some 250 feet north of the stage road which passes over the mountains to Toluca and an equal distance west of the new Cuernavaca railroad. The spot was on the finca belonging to Senores Jose A. Bonilla and Juan Martinez del Cerro who most courteously charge no rent for the use of the land. It is half-a-mile south of the Mexican National Observatory and is separated from it by a small ravine.

An English carpenter was engaged on the 20th of November and rough plans of the walls of the dome put into his hands. As much of the timber had to be cut to the curve of the walls—a 20-foot radius—it was on Tuesday, the 24th, that the material reached the site and work began. The land was levelled and the first actual timbers were put in place on Wednesday afternoon. On Saturday, the 5th of December, the walls were finished and everything ready for the arrival of the telescope and dome save the leveling of the track upon which the wheels supporting the dome, were to move.

On the late afternoon of the 9th of November the lens was removed from the telescope in Flagstaff and the work of dismounting immediately begun. This and the carting required eight days. Through a mistake in the size of the railroad car it took four days to pack the heavy weights and awkwardly shaped pieces, and one roof-piece and the wooden shutters had to be left behind. The canvass shutters, described below, were substituted here in Mexico. The car left Flagstaff on the early morning of the 22d.

In order to get the Observatory material through the Custom House Mr. Lowell had corresponded with President Diaz during the summer, and the Mexican Government had with great courtesy issued an order to allow the dome (newly made in Flagstaff) and the telescope and personal baggage of the observers to pass through free of duty. On entering Mexico Dr. See carried with him a library of about three hundred volumes and these were held, the custom officers declaring that books were not included in the order issued. So after waiting a day he left them behind and came on to the city, reaching here on the 17th. On the 19th, as the books had not yet come through, and as we knew quite well that it was the purpose of the government to render us every possible aid, Dr. See drew up an application to the government to pass without delay everything that pertained to the Observatory or its work and we presented it to the Secretary of the American Legation. He forwarded it at once to the proper officials and the next day a telegram was despatched to the frontier conveying an order which seemed to cover everything. The promptness and courtesy of the Mexican Government in this act certainly could not be surpassed and I gladly take this opportunity of expressing thanks to them.

After three days detention by the local officials the car passed on the 28th of November and arrived in Mexico on Saturday, December 5th. It had then to be inspected at the City custom house but through legal details this could not be done until Mon-

day morning. Through the kindness of the Sub-Secretary of the Treasury a special inspector was sent from that department with instructions to get the car through as early in the day as was desired. The inspection accordingly was extremely brief and we were not obliged to remove the goods from the car, a privilege of great value to us as such a proceeding would have cost several days of valuable time as well as danger to the instruments and dome. In the entire transportation both the Sante Fe system and the Mexican Central Railroad made reductions in their customary rates, for which we desire to express our obligations.

Mr. M. S. McKay, General Manager of the Mexico, Cuernavaca and Pacific R. R. was also most kind to us. He not only allowed the car to be stopped for seven hours at the point on his road nearest the Observatory site but loaned us bridge timbers for making a platform upon which the heavy weights might be left so that the unloading could be done even more rapidly. At the unloading, which took place on December 8th, we had a gang of fifteen Mexican laborers under the direction of Mr. France, our carpenter, besides Mr. Sykes and the observatory assistants. The entire unloading of nearly seventeen tons of material exceedingly difficult to handle, was accomplished between half past eight and one o'clock. At intervals a glass of pulque, the National drink, was passed to the native workmen in order to keep their energies alive. From that day on we were engaged upon the work of mounting the telescope and dome.

A few days later, while carting the sections of the pier to the dome, we had an unfortunate accident which we much regretted but which, under circumstances like ours, when skilled labor is very difficult to procure, sometimes cannot be prevented. A man brought out a cart from Mexico to carry the heavy iron castings the 300 feet from the platform to the dome. He asked an exorbitant price and then showed himself not only an incapable workman but an ignorant driver. He was undoubtedly intoxicated. At noon he proceeded to do more drinking and almost the first thing in the afternoon fell from his wagon and was killed. Strange to relate, and I think through the care of the police, neither widows nor orphans have applied to us for money on the plea of keeping themselves alive. No one seemed to know where the man lived.

The telescope was mounted without trouble of any kind but the dome took longer than we expected. An entire week was consumed in leveling the double track on top of the walls and in

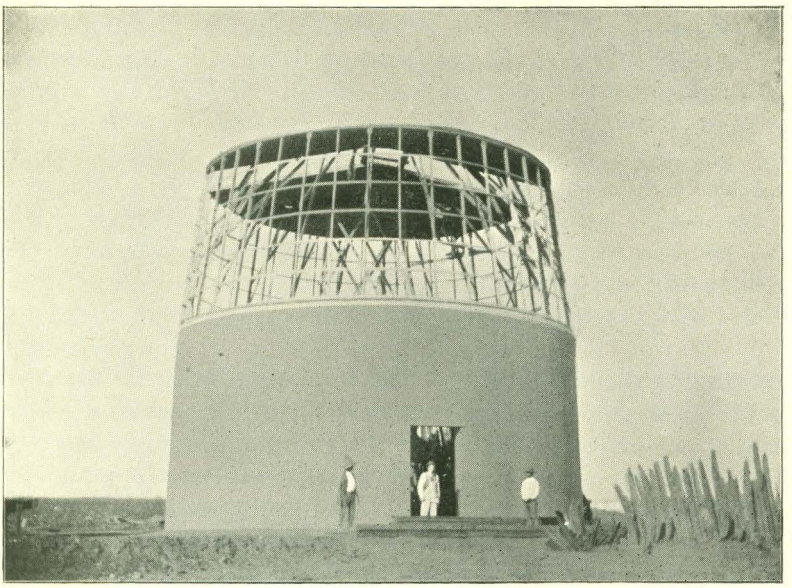
fitting together the sections of sill and putting on the various iron bands, so that we had a long wait before seeing anything appear well above the top of the walls. At length on December 16th the first rafter was raised into place and secured. Several days were taken in putting in the remaining uprights and rafters and in running slats around the walls upon which one could climb to the roof, but which later were destined to support the canvas. On the 21st the roof pieces were raised into place. Left by ourselves, through the departure of Mr. Sykes, on the same day, the canvas was put in place, in the course of a week, the roof was soldered, the floor put in, the observing chair put together, the arrangements for turning the dome put on and the shutters mounted. A gallery was put around the inside of the walls to give access to the wheels and machinery of the dome, doors made, ladders put in place, and innumerable little things finished neccessary to the running of an astronomical institution. At last on the afternoon of December 28th, seven weeks from the day of dismounting, Mr. Lowell brought the great lens out in a hack and it was placed in the telescope just before dark. With a very minimum of adjustment it gave excellent images.

We felt that much was accomplished when at last the lens was in place and we could get observations. Our hopes of being ready for the opposition of Mars were disappointed, so Mr. Lowell had deemed it prudent not to mount the lens until work had so far progressed on the dome that the lens was never endangered. The dome was, by the 28th, so nearly completed that it was safe to use the telescope, but much testing and adjustment of the turning apparatus remained to be done so that it was not until January 18th that it revolved satisfactorily. This result was delayed by the fact the affective work could only be done in the mornings because the dome was in use for the rest of the day and evening.

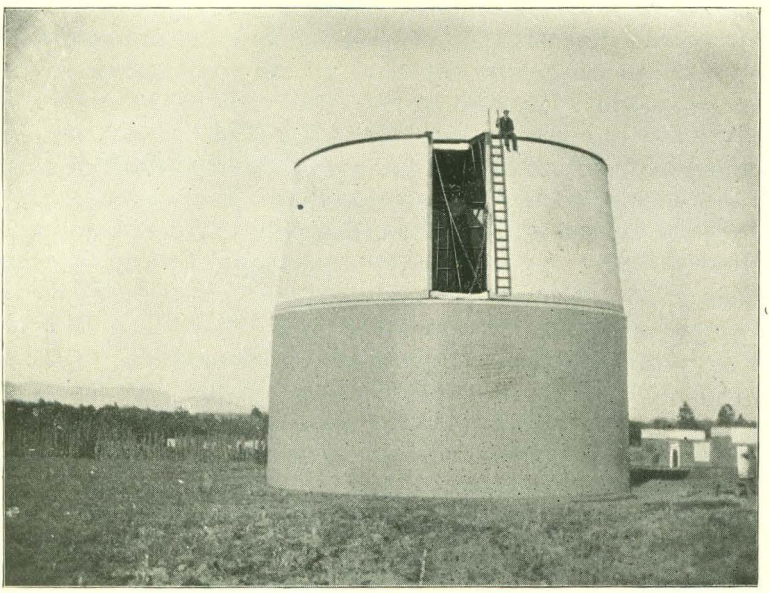
The Dome.

The dome was designed and built by Mr. Godfrey Sykes during October and half of November. It is framed entirely of wood and having an outside diameter of 42 feet is probably the largest wooden dome in the world. It gives a clear radius of 20 feet in every direction from the centre of the motion of the telescope. In some general points it resembles the new Edinburgh dome which is smaller and of iron; but in its construction Mr. Sykes showed remarkable originality in adapting to his ends simple and ready-made mechanical appliances and for such work deserves great credit.

PLATE XLVIII.



9. Dome; looking west; showing framework.



10. Dome, finished; looking east.

LOWELL OBSERVATORY IN MEXICO.

The general plan of the dome is as follows. The lower walls of the building are surmounted by two complete concentric circles separated by something over three inches. The wheels which support the dome are about a foot in diameter and made in one solid piece with a heavy two inch axle. The wheels, twenty in number, pass between these circles and their axles rest upon them, the wood of each circle being guarded by a track of 1 x ¼ inch iron placed horizontally and bent to curve. The dome resting upon the circumference of the wheel moves about seven times as fast as the wheel so that in addition to absence of friction between surfaces, resistance due to uneveness of the track, is minimized.

The sill of the dome has a core of wooden boards screwed together and beneath them a plate of 4 x ½ inch iron, bent to curve, which serves as an upper track for the wheels to run on. On each side of the sill are vertical bands of iron and in addition, on the inside, an angle iron is placed to aid in general stiffness. Its horizontal half passes immediately beneath the guide wheels and makes a safety catch in case of wind raising the dome. The superstructure is in general drum-shaped but with the walls not quite vertical and the roof well inclined. To support this immense roof and yet allow the necessary length of open shutter the framing had to be carefully planned. The sides of the shutter are two immense rafters six feet apart in the clear, which pass entirely over the building from side to side. The upper end of the shutter is marked by a heavy cross beam some four feet beyond the apex. Beyond this beam the roof is boarded and covered with painted canvas. At the centre and highest point of each big rafter smaller rafters, cross-braced to studding, divide the roof into triangles of approximately equal size. Each triangular space is fitted with a roof piece made of very light wood and covered with tin. With strips of tin soldered over the intervening cracks the roof becomes as one piece and increases the strength of the structure. The walls of the dome are simply of light canvass tacked to slats passing aronnd the dome.

The shutters are sheets of canvas suspended on wires. One shutter passes from the apex to the eaves and another from there down. When closed they meet at the eaves and shut out the rain and when open one moves to the apex and the other to the sill. For turning the dome a rope passes around outside the sill and is tied at the shutter. At the north northeast point, as being the point least likely to be used, it takes two turns around a drum whose circumference is of a shallow V-shape. By carefully feed-

ing the rope onto the drum by proper guides the rope never gets crossed on itself. The axle of the drum passes inside the dome where it supports a six-foot wheel around which an endless cable is suspended reaching to the floor. Upon pulling this cable the dome turns. The weight of the dome is a little over four tons.

As a result of the trial of the dome two features not in the original plan, were added. A large proportion of the weight of the roof falls on the two big rafters, and notwithstanding the bands of iron, the sill spread a trifle in their direction. This was corrected by a heavy iron band, 3 inches by ⅜ inch, with three large turn buckles, passing entirely around the sill and in the longest diameter passing outside four horizontal struts, two and one-half feet long, which butt against the bases of the big rafters. This drew the dome into shape with perfect ease. It was found necessary to support the band at intervals of about four feet on small blocks of greased wood to act as rollers and allow the strain to distribute itself properly without having friction interfere to any extent.

The other feature was this. To insure the more perfect running of the dome by firmly holding and directing the wheels which support it, these wheels were turned into a live-ring by connecting them all into one solid circle. Castings were made and bored to fit onto the ends of the axles of the wheels and boards were cut into a suitable shape to rest between the wheels and be bolted to the castings. Special arrangements were made for the ends of the axles toward the centre of the dome, so that the direction of the wheel could be adjusted. In this manner the wheels can be trained in line and retained there with considerable accuracy.

The telescope of the Lowell Observatory needs little more than mention. Its aperture is 24 inches and the focal length 31 feet. Its general style of construction is so heavy that it is probably one of the steadiest, if not the steadiest, in the world. The massive iron pier twelve feet high weighs five and one-half tons. The mounting of the lens from the bed-plate upward weighs seven and one-half more. The polar axis alone weighs twelve hundred pounds and in placing it in position has to be handled with the greatest nicity while the driving wheel and the declination case are being fitted on. The counterpoise consists of five cylindrical weights of four hundred pounds each. In Flagstaff, in July, this instrument was carted a mile from the station to the Observatory and set up ready for the lens in one week. Here in Mexico work on the dome was carried on at the same time so that the telescope was not ready for the lens until some two weeks had

elapsed but the total time actually put on it was even less than in Flagstaff. This was surprising considering the labor which we were able to employ. The work was directed by Mr. Sykes of Flagstaff.

LOWELL OBSERVATORY, Mexico, January, 1897.