THE ORWELL PARK OBSERVATORY.

As the observations required in the practical pursuit of astronomy are more delicate and accurate than any other, so is it necessary to use extraordinary care, not only in the construction of the instruments, but also with regard to the foundations and construction of the observatory which contains them. In the following remarks the writer will refer briefly to the considerations which should be kept in view in the design and construction of a private observatory of high class, and will illustrate his remarks by reference to the observatory recently constructed from his designs and under his direction for Mr. George Tomline, at Orwell Park, near Ipswich.

The first consideration is the situation of the observatory. The most favourable position is on the top of a low hill or rise of ground, so as to command the horizon all round without the necessity of raising the observatory. For ordinary observations a clear view of the horizon is not extremely important, as the observations are much affected by refraction, but for extraordinary observations, such, for example, as the observation of a comet when near the sun, it is of great importance; and it must be borne in mind that the chief use as well as enjoyment of a private observatory consists in the careful examination of extraordinary objects. Again, if the observatory be near a river, an elevation of 100 ft or 150 ft is often necessary in order to keep above the river fogs; these fogs commonly occur on cold nights in winter when the sky is beautifully clear, and unless the observatory were above the fog the night would be lost. The writer has frequently seen a dense fog extending as high as 100 ft. above the Thames at Greenwich, while at the Royal Observatory, 150 ft. above the river, the air was perfectly clear and the stars brilliant. In the case of the Orwell Park Observatory it was desired that the observatory should be attached to the mansion (which itself stands on a lofty bank overlooking the River Orwell), and since of necessity the observatory had to be raised so as to clear the house and surrounding trees, the conditions as to elevation were amply secured. But, as might be expected, much expense and difficulty in construction were caused by the great height of the observatory, which will be referred to immediately. As a subsidiary matter of some importance, it may be mentioned that it requires some skill to secure a good architectural effect in an observatory attached to a mansion in the manner referred to; in the present instance, however, this matter received the most skilful attention from the architect, Mr. J. Macvicar Anderson, of Stratton-street.

For the proper support of an astronomical instrument it is essential that a column or columns should be carried up from the ground without contact of any sort with the walls, floors, or other parts of the building. If this were not carefully attended to, such is the delicacy of the instrument that the effect of a person walking about any parts of the building adjacent would be rendered immediately perceptible at the instrument by a tremor very annoying to an observer. This condition is sometimes inconvenient, as in the case of the Orwell Park Observatory, for it was there necessary to run up a column 60 ft. high to carry the instrument. This column was 10 ft. in diameter at the bottom, tapering to 6 ft. diameter at top; the materials were brickwork in mortar; mortar is better than cement, as it is less subject to expansion, but the work needs to be carried up slowly to let the mortar set in so thick a mass of brickwork. The only disadvantage of brickwork is its high degree of elasticity, which gives some trouble in the case of a tall column while the work is fresh; probably except for the expense, stonework would be better. For the foundation of such a column, unless it was upon the natural rock, piling would seem best, as more effectually separating the column from shakes transmitted through the foundations. But in the case of the Orwell Park Observatory, piling was out of the question by reason of the many buildings closely adjacent, and it was necessary to set the columns on a large bed of concrete, which carried also the walls of the observatory. The foundation ground was sand, with much water.

The instrument best suited for a private observatory is a powerful equatorial instrument, which must be supplemented by a small transit instrument for obtaining time and adjusting the clock. An equatorial instrument requires a revolving dome, and it is of great importance that this dome and its shutter should move easily, and with no unnecessary labour to the observer. The domes are usually made to run upon cannon balls, or upon a live ring of wheels, but in the case of the Orwell Park Observatory it was considered best to run the dome upon wheels in fixed wall-boxes. The reason for this arrangement was, that the edge of the dome could then be kept about a foot lower than the live ring arrangement would allow, and yet give the necessary height of doorway: of course, the object of keeping the edge of the dome as low as possible is to keep the centre of motion of the telescope as low down as possible and avoid climbing about into inconvenient positions while observing.

With regard to the construction of domes for observatories, it is best to make the shell double, so as to prevent the observatory from getting too hot in the sun, and it would be well to have the skeleton of the dome of iron in order that it may keep its shape and run true on the wheels: a wooden dome is apt to warp and run very heavy. The shutter of the dome should run easily and leave open a space from the horizon to beyond the zenith. Various arrangements of shutter have been adopted at different observatories, but there is none so convenient as that adopted at Orwell Park (see engravings on page 259), where the shutter runs on two tangent bars at the top and bottom of the dome respectively, and draws away to one side in order to open the slit.

The details of the Orwell Park dome will be understood from the engravings on page 259: the internal diameter is 20 ft., and the weight rather less than 3 tons; the skeleton is of wrought iron, the internal casing is of polished mahogany, and the external casing (which carries the copper sheathing) is of thin deal. The moving power to turn the dome is applied by means of an endless rope on a grooved wheel; the axle of the wheel carries a pinion gearing into a circular rack which is fixed on the wall of the observatory, and the dome revolves with great ease by the power of one man applied at the rope. In some observatories the power is applied directly to one of the live-ring wheels which carry the dome, but this method is not always satisfactory, as the driving wheel is apt to slip, and it then becomes necessary to distribute the weight of the dome unequally, so as to throw more weight upon the driving wheel and increase the friction. The Orwell Park dome was well constructed by the contractors, Messrs. George Smith and Co. It may be well to mention that when wall-boxes are used it is advisable to provide an arrangement for getting at each of them without disturbing the dome, in case they should require adjustment, or get choked with rain-water or rubbish; in the case of the Orwell Park Observatory this was done by means of a movable slab of stone which was held by bolts against the side of the wall-box on the inside of the wall, and could be removed at will for the purpose of getting at the wall-box.

In designing an equatorial instrument, the first consideration is the size of the object-glass (which will rule the size of the instrument, and the size of the observatory); the next consideration is the system of mounting which shall be adopted; and the last is the construction of the object-glass and instrument. As regards the size of the object-glass, it may be observed that in the hands of a skilful observer a 6-inch glass is sufficient for most observations, and a very large part of the delicate work done in modern times, such for example as the discovery of small planets, has been done by means of 6-inch glasses; but for the careful examination of the moon and planets a larger glass adds greatly to the enjoyment of an observer. In spectroscopic and other observations of recent interest also, in which the amount of light is of great consequence, a large glass is almost essential. But the point of first importance is the definition and purity of the glass, and the difficulty of insuring these requisites increases rapidly with the size of the glass. There have undoubtedly been made object-glasses of large size, 15 inches and upwards, of great excellence, but in the opinion of the writer, a 10-inch glass is the largest that can at present be relied upon for superior excellence when made to order. The object-glass of the Orwell Park Observatory is a 10-inch glass. It would probably be advisable, in all cases, to order a glass from a professed manufacturer of astronomical object-glasses. There are, unfortunately, not many such manufacturers, and the best are foreigners, but they have a great advantage in possessing always in stock a large number of lenses of all sorts, and by fitting together different lenses (so as to form an object-glass, which is compounded of two lenses) they are generally enabled to insure an object-glass of great excellence. The object-glass of the Orwell Park Observatory was procured from Messrs. Merz, of Munich, and is an excellent glass. In no case should a glass be accepted without being tested, and to test a glass requires the skilled eye of a practical observer. Probably the best method of testing a glass is to compare it by observation of a star with a similar glass of known excellence. In the case of the object-glass for the Orwell Park instrument, the writer obtained permission to attach a temporary tube containing the glass to be tested to the polar axis frame of the large equatorial at the Royal Observatory; the two telescopes were then turned upon the same star, and a comparison instituted of their efficiencies. The best object to observe as a test of definition is a bright double star (both stars of which are bright), ρ. Bootis, for example; if the two stars of the double star stand distinctly apart, it is a good glass. Also every star should appear in the glass as if surrounded with several concentric thin black rings (known as diffraction rings). These rings may bc accounted for theoretically, and their existence is a strong proof of the accuracy with which the lense have been formed.

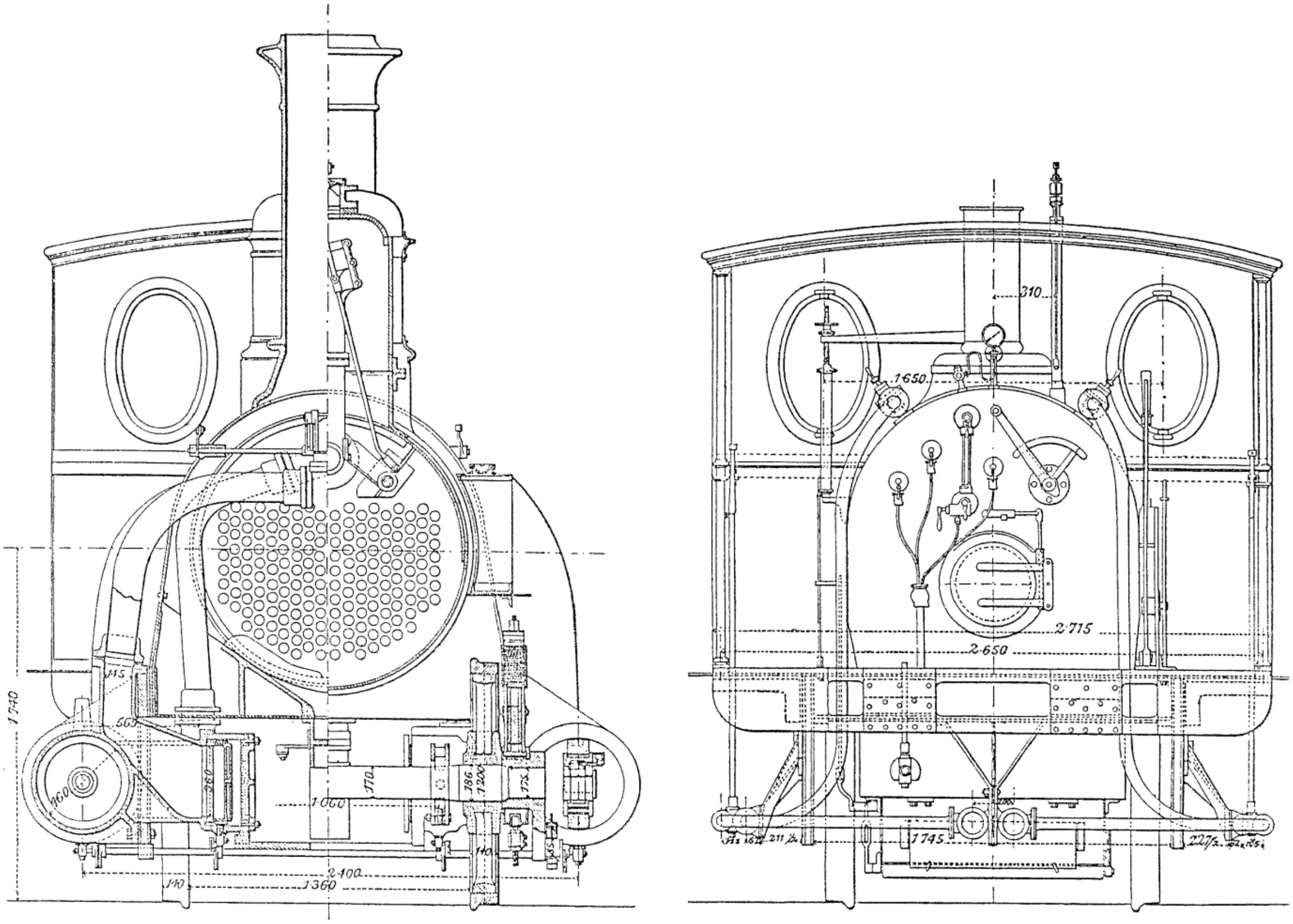
There are two methods of mounting equatoria telescopes in common use, which are known as th English and German methods respectively. According to the English method, the polar axi frame is carried by two powerful standards, place at the north and south sides of the observator respectively, and the telescope is slung midwa between them. The advantages of this arrangement are, that the long polar axis admits of ver accurate adjustment of the instrument, the telescop is easily accessible in all ordinary positions, and th floor of the observatory is not hampered by central pier, as in the case of the German metho of mounting. The disadvantages are, first, that however stiff the polar axis frame may be made, yet th weight of the telescope will cause a sensible deflection of the polar axis; secondly, that the nort standard sometimes obstructs the view of an objec in the north; and thirdly, that the total weight c the instrument and the polar axis frame is considerable. According to the German method of mounting, the polar axis is much shorter than accordin to the English method, and it is carried entirely b a single standard, which is commonly vertical, an placed in the centre of the observatory, the telescop being carried on the upper end of the polar axi The advantages of this method are the compactnes steadiness, and ease of motion which it admits o The disadvantages are the shortness of the pola axis, the small size of the hour circle, and the inconvenience of the central pier, which brings up th telescope when following a star within 20 deg. c 30 deg. of the pole, and so compels a readjustmen of the telescope. In the case of the Orwell Par instrument the writer adopted an arrangemer which he thinks secures all the advantages of th German method, and avoids the disadvantages c the English method above referred to. The standar is a very powerful casting, and is cast in a ber form (see dotted lines in Fig. 1, page 259) so as t permit the telescope to clear the standard whe following any star whatever; the polar axis is pro duced to the floor, and its pivot end is carried by solid bracket which forms part of the standar casting; this arrangement admits of a 3-foot hou circle. The telescope is carried on the north end c the polar axis, as in the German method. The weigl of the standard casting is rather more than two ton

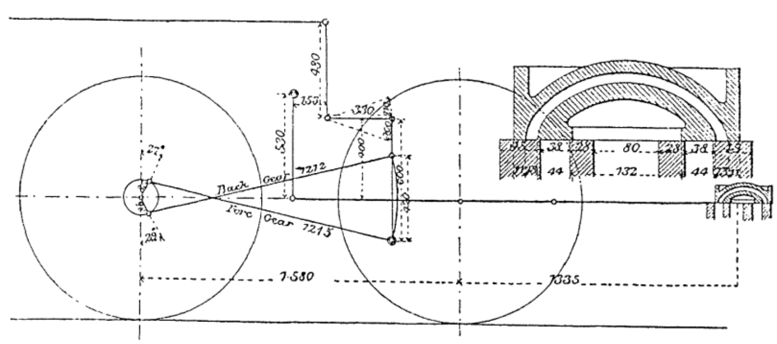
When the object glass is determined upon (an if possible procured before proceeding further), an the general design of the instrument is got out, remains to make fit choice of a manufacturer t construct the instrument and carry out the detai in the best manner. In making this selection it necessary to have regard not only to the person skill and experience of the maker himself, but als to his means of carrying out the work effectuall This precaution need not apply in the case of sma instruments, as any good instrument maker ha the means of constructing them with the utmo accuracy, but for large instruments, when the par are ponderous and yet require the utmost accurac of finish, it is very necessary to put the work the hands of an instrument maker who is provide with large and powerful lathes and other toc of the best and most modern construction. Tl instruments for the Orwell Park Observatory we constructed throughout, and the details designed b

GOODS LOCOMOTIVE FOR THE ROYAL HUNGARIAN STATE RAILWAYS.

CONSTRUCTED AT THE WORKS OF THE COMPANY, PESTH.

(*For Description, see Page* 264.)





Mr. James Simms (Messrs. Troughton and Simms), with great skill and beauty of workmanship.

There is scarcely a detail connected with a large astronomical instrument which would not furnish the subject of an essay. One of the most important parts of an equatorial instrument is the driving clock. According to the ordinary method of German mounting the driving clock is bolted against the standard, and adds much to the inconvenience of the standard. In the case of the Orwell Park instrument, the driving clock is placed at some little distance from the instrument in a window recess, and the motion is communicated to the instrument by means of a strong horizontal spindle just above the floor; the driving weight of the clock descends alongside the central pier, and a small door has been made in the circular wall surrounding the pier below the observatory for the purpose of getting at the weight when required. The eye-pieces, micrometers, &c., need to be suited to the work for which the instrument is to be used, and are best left to the decision of the observer who has the permanent charge of the observatory. There is much difference of opinion concerning the observing chair which is best adapted for an equatorial. In most observatories the observing chair is carried by a frame which runs on a circular arc concentric with the instrument, and the chair is raised, lowered, or tilted by gearing, which the observer can work while sitting on the chair, so as to suit his position exactly to that of the eye-end of the telescope. Such an arrangement is rather too cumbrous and elaborate to suit practical observers, and it has further the disadvantage of being a good deal in the way of movement about the floor of the observatory. For the Orwell Park Observatory the writer designed a chair consisting of a small flight of steps; the chair runs upon castors and can be placed in any position; the steps are well padded both on seats and backs, and the observer by sitting on one or other of the steps can easily adjust his position so as to make any requisite observation. For the preservation of the instrument and observatory it is advisable to have the means of warming it when observations are not being carried on, and in the case of the Orwell Park Observatory this is managed by hot air admitted through gratings in the floor of the observatory. The transit instrument at Orwell Park is placed in a small turret alongside the equatorial room; the telescope is of 3 in. aperture. The astronomical clock was made by Dent; it is placed in a recess of the wall of the transit room, and is in the line of the two piers of the transit instrument, so as to be read equally well from one side or the other.

It is to be assumed that the establishment of a private observatory of high class is with a view to the pursuit of certain branches of useful scientific investigation, as well as for the enjoyment of its possessor. But in order to carry out effectually any long course of investigation, it will generally be found advisable to put the observatory in charge of a permanent assistant. There is no lack of subjects which may be usefully investigated—spectroscopic observations, the colours of stars, the careful and constant examination of certain double stars, and above all a good and accurate series of observations of the satellites of Jupiter, may all be mentioned as subjects of useful investigation well suited to an equatorial instrument. Such observations would not be of so exacting a nature as to hinder the use of the instrument for any casual observations, as, for instance, that of a comet or planet in any peculiar position, and they would greatly tend to the preservation of the instruments in good order, as also to the credit of the observatory at which they were carried out.

W. Airy.

7, Queen Anne's Gate, Westminster, S.W.

DOME OF THE OBSERVATORY AT ORWELL PARK.

(For Description, see Page 257.)