the observer has to follow the eye-end in a comparatively small circle; another good point is the flattening of the cast-iron centre­piece of the tube so that the flange of the declination axis is attached as near to the axis of the telescope tube as is consistent with free passage of the cone of rays from the object-glass. The substitution of small incandes­cent electric lamps is an improvement now uni­versally adopted.

(2) *Telescopes for General Purposes.—*The modern equatorial should, for general purposes, be capable of carrying spectroscopes of considerable weight, so that the proportional strength of the axes and the rigidity of the instrument have to be considerably increased. The original mounting of the Washington refractor of 26-in. aperture and 32½-ft. focal length (described in *Washington Observations,* 1874, App. 1) was in these respects very defective, the polar and declina­tion axes being only 7 in. in diameter.

The great Pulkovo refractor (fig. 16) erected in 1885 is of 30-in. aperture and 45- ft. focal length. The object-glass is by Clark, the mounting by the Repsolds. The tube is cylindri­cal, of riveted steel plate, gradu­ated in thickness from the centre to its extremities, and bolted by very powerful flanges to a strong short cast-iron central tube, in which, as in Dr Engelmann’s telescope (fig. 15), the attachment to the flange of the declination axis is placed as close as it can be to the axis of the tube without interfering with rays converging from the object-glass to any point in the field of view. A new feature in this instrument is the platform at the lower end of the polar axis, where an assistant can view the hour circle by one eye- piece and the declination circle y another (looking up the per­forated polar axis), and where he can also set the telescope to any hour angle by one wheel, or to any declination by a second, with the greatest case. The observer at the eye-end can also read off the hour and declination circles and communicate quick or slow motions to the telescope both in right ascension and declination by conveniently placed handles. The eye end presents an appearance too complicated to be figured here; it has a micrometer and its illumination for the position circle, a micrometer head, and a bright or dark field, clamps in right ascension and declination and quick and slow motion in the same, a finder, micro­scopes for reading the hour and declination circles, an illuminated dial showing sidereal time and driven by an electric current from the sidereal clock, and counter weights which can be re­moved when a spectroscope or other heavy appliance is added. All these, although making up an apparently complicated ap­paratus, arc conveniently

arranged, and are all necessary for the quick and easy working of so large an instrument. We have the authority of Otto Struve for stating that in practice they are all that can be desired. There is in this instrument a remarkably elegant method of relieving the friction of the polar axis. Let A A (fig. 17) be a section of the polar axis; it is then easy to adjust the weight P attached to its lower end so that the centre of gravity X of the whole moving parts of the instrument shall be in the vertical (V V) of a line passing through the apex of the hollowed flange *p q* at *q,* which flange forms part of the polar axis. If now a wheel W is forced up against *q* with a pressure equal to the weight of the moving part of the instrument, the whole weight of the moving part would rest upon W in unstable equilibrium; or if a pressure K, less than W, is employed, we have the end friction on the lower bearing removed to an extent =R sin *φ,* and the friction on the bearings of the upper pivot removed to the extent of F cos *φ,—*where *φ* is the latitude of the place. The wheel W is therefore mounted on a guided rod, which is forced upwards by suitable levers and weights, and this relief of pressure is precisely proportional to the pressure on the respective bearings. The Repsolds find it unnecessary to relieve the friction of the declination axis.

In such large telescopes it becomes a matter of the first import­ance to provide means of convenient access to the eye-end of the instrument. This the Repsolds have done in the Pulkovo telescope by means of two platforms, as shown in fig. 16. These platforms are capable of easy motion so that the astronomer may be con­veniently situated for observing an object at any azimuth or altitude to which the telescope may be directed. For the great refractor more recently erected at Potsdam, Messrs Repsold arranged a large platform mounted on a framework which is moved in azimuth by the dome, so that the observer on the platform is always opposite the dome-opening. This framework is provided with guides on which the platform, whilst preserving its horizontality, is raised and lowered nearly in an arc of a circle of which the point of intersection of the polar and declination axes is the centre. The rotation of the dome, and with it the platform-framework, is accomplished by means of electric motors, as also is the raising and lowering of the platform on its framework. The current is supplied by accumulators, and the switch-board is attached to the platform in a position con venient f or use by the astronomer or his assistant.

In the original design sup­plied for the 36-in. telescope of the Lick Observatory at Mount Hamilton, Cali­fornia, Grubb suggested that the whole floor, 70 ft. in diameter, should be raised and lowered by water power, under ∣ control of the ob­server by means of electric keys which act on secondary mechanism that in turn works the valves and reversing gear of the water engines. Other water engines, similarly connected, with keys at the observer’s hands, rotate the dome and perform the quick motions in right ascension and declination. (An illustration showing these arrangements appeared in *The Engineer* of July 9, 1886.) Grubb’s suggestion of the “ rising floor ” was adopted, although his original plans for the mounting were not carried out; the construction of the mounting, dome, floor, &c., having been entrusted to Messrs Warner & Swasey of Cleveland, Ohio, U.S.A. It has been contended that it is un­desirable to move so great a mass as a floor when a platform alone is required to carry the observer. But a floor, however heavy, suspended by three Wire ropes and properly balanced over large, well-mounted pulleys, requires an amount of energy to work it which does not exceed that required to operate a platform of moderate dimensions, and there is a freedom, a safety and a facility of working with a complete floor which no partial platform can give. A floor can be most satisfactorily operated by hydraulic means, a platform cannot be so well worked in this w,ay. The best floor mounting we know of is that designed by O. Chadwick for the Vic­toria Telescope of the Cape Observatory. An account of it will be found in the *History and Description of the Cape Observatory.* This floor can be raised at the rate of I ft. per second or as slowly as the ob­server desires—whilst in all the large platforms we have seen (Pots­dam and Paris), the rate of shift is tedious and time-consuming.

The largest refracting telescope in active use is the Yerkes tele­scope, w'ith an object-glass of 40-in. diameter by Alvan Clark & Son of Cambridge, U.S.A., and with a mounting, dome and rising floor by Warner & Swasey of Cleveland, Ohio, U.S.A. The reader will gather a good general idea of the design from fig. 16. The eye-end is shown on the plate, fig. 25.

The chief defect in equatorial mountings of type C is that in general they are not capable of continued observing much past the meridian without reversal. This is an unquestionable draw­back when long exposures near the meridian are required. By the