this circle to measure the polar distance of any star seen in the tele­scope, and these readings will also be true (apart from the effects of atmospheric refraction) if we rotate the instrument through any angle on the axis A A. Thus one important attribute of an equatorially mounted telescope that, if it is directed to any fixed star, it will follow the diurnal motion of that star from rising to setting by rotation of the polar axis only. If we now attach to the polar axis a graduated circle D D, called the “hour circle," of which the microscope or vernier R reads o' when the declination axis is horizontal, we can obviously read off the hour angle from the meri­dian of any star to which the telescope may be directed at the instant of observation. If the local sidereal time of the observation is known, the right ascension of the star becomes known by adding the observed hour angle to the sidereal time if the star is west of the meridian, or subtracting it if cast of the meridian. Since the transit circle is preferable to the equatorial for such observations wherein great accuracy is required, the declination and hour circles of an equatorial are employed, not for the determination of the right ascensions and declinations of celestial objects, but for directing the telescope with ease and certainty to any object situated in an approximately known position, and which may or may not be visible to the naked eye, or to define approximately the position of an unknown object. Further, by causing the hour circle, and with it the polar axis, to rotate by clockwork or some equivalent mechanical contrivance, at the same angular velocity as the earth on its axis, but in the opposite direction, the telescope will, apart from the effects of refraction, automatically follow a star from rising to setting.

*Types of Equatorial;.—*Equatorial mountings may be divided into six types. (A) The pivots or bearings of the polar axis are placed at its extremities. The declination axis rests on bearings attached to opposite sides of the polar axis. The telescope is attached to one end of the declination axis, and counterpoised by a weight at the other end, as in fig. io. (B) The polar axis is supporte<l as in type A; the telescope is placed between the bearings of the declina­tion axis and is mounted symmetrically with respect to the polar axis; no counterpoise is therefore requisite. (C) The declination axis is mounted on the prolongation of the upper pivot of the polar axis; the telescope is placed at one end of the de.clination axis and counter­poised by a weight at the other end. (D) The declination axis is mounted on a forked piece or other similar contrivance attached to a prolongation of the upper pivot of the polar axis; the tele­scope is mounted between the pivots of the declination axis. (E) The eye-piece of the telescope is placed in the pivot of the polar axis; a portion or the whole of the axis of the telescope tube co­incides with the polar axis. (F) The telescope is fixed and the rays are reflected along its axis from an external mirror or mirrors. Mountings of types A and B—that is, with a long polar axis sup­ported at both ends—are often called the “ English mounting,” and type C, in which the declination axis is placed on the extension of the upper pivot of the polar axis, is called the “ German mounting,’ from the first employment of type C by Fraunhofer. A description of some of the best examples of each type will illustrate their relative advantages or peculiarities.

*Type A.—*Fig. io may be taken as a practical example of the earlier equatorials as made by Troughton in England and afterwards by Gambey for various Continental observatories. In the *Phil. Trans.* for 1824 (part 3, pp. 1-412) will be found a description by Sir John Herschel and Sir James South of the equatorial telescope which they employed in their measurements of double stars. The polar axis was similar in shape to that of fig. 10 and was composed of sheets of tinned iron. In Smyth’s celebrated Bedford telescope the polar axis was of mahogany. Probably the best example of this type of mounting applied to a refractor is that made by the elder Cooke of York for Flct- , cher of Tarnbank; the polar axis is of cast iron and the mounting very satisfactory and convenient, but unfortunately no detailed description has been published. In recent years no noteworthy refractors have been mounted on this plan; but type A has been chosen by Grubb for the great Melbourne reflector, of 48-in. aperture, with marked ingenuity of adaptation to the peculiar requirements of the case. Fig. 11 shows the whole instrument on a small scale with the telescope directed to the pole, and the hour circle set 64 from the meridian.

*Type B.*—The most important examples of type B are Airy’s equatorial at Greenwich (originally made to carry a telescope of 13-in. aperture, but now fitted with a telescope by Grubb of 28-in. aperture), and the photographic equatorials of 13-in. aperture employed at Paris and other French observatories, of which the object-glasses were made by the brothers Henry and the mountings by Gautier of Paris.

These instruments have done admirable work in connexion with

the great international undertaking, the *Carle du Ciel.* The general construction will be understood from fig. 12. The double polar axis is composed of hollow metal beams of triangular section. The hour circle has two toothed circles cut upon it, one acted upon by a worm screw mounted on the pier and driven by clockwork, the other by a second worm screw attached to the polar axis, which can be turned by a handle in the observer’s hand and thus a slow movement can be given to the telescope in right ascension inde­

pendently of the clock. Slow motion in declination can be com­municated by a screw acting on a long arm, which latter can be clamped at pleasure to the polar axis. An oblong metallic box fitted with pivots, whose bearings are attached to the triangular beams, forms the tube for two parallel telescopes; these are separated throughout their length by a metallic diaphragm. The chromatic aberration of the object-glass of one of these telescopes is corrected for photographic rays, and the image formed by it is received on a highly sensitive photographic plate. The other telescope is corrected for visual rays and its image is formed on the plane of the spider-lines of a filar micrometer. The peculiar form of the tube is eminently suited for rigid preservation of the relative parallelism of the axes of the two telescopes, so that, it the image of a certain selected star is retained on the intersection of two wires of the micrometer, by means of the driving clock, aided by small corrections given by the observer in right ascension and declination (required on account of irregularity in the clock movement, error in astronomical adjustment of the polar axis, or changes in the star’s apparent place produced by refraction), the image of a star will continue on the same spot of the photographic film during the whole time of exposure. In these telescopes the photographic object­glass has an aperture of 13 in. and the visual object-glass of 10 in. Both telescopes have the same focal length, viz. 11∙25 ft., so that, in the image produced, 1 mm. is = l1 of arc. An excellent mounting of type B, made by T. Cooke & Sons of York, has been employed by Franklin Adams for making his maps of the sky.

*Type C.—*Many more telescopes have been made of type C than of any other, and this form of mounting is still most generally employed for the mounting of modern refractors. Fraunhofer’s *chef-d’oeuvre,* the great Dorpat refractor, made for Otto Struve about 1820, had a mounting of this type, and was the first equatorial of any importance to be provided with clockwork. The instrument, shown in fig. 13, is described in detail by Struve *(Beschreibung des auf der Sternwarte zu Dorpat befindlichen grossen Refractors von*