the telescope. If after this adjustment has been perfected the dif­fraction rings are still not circular round the images of stars, the fault is in the centring of the lenses of the object-glass with respect to each other, and the object-glass should be sent to the maker for rectification.

*Driving Clock.*

The means employed to cause an equatorial telescope to follow the diurnal motion of a star obviously must not resemble the intermittent motion of an ordinary clock. Numerous devices have been contrived for producing uniform mo­tion. But the limits of this article will only allow us to refer briefly to a few of those most commonly in use. Fig. 37 represents Fraun­hofer’s governor. On its axis C is a pinion driven by a train of wheels. The axis carries an arm BB, at the ex­tremities of which, at­tached by springs *f*, *f*', are the weights D, D'. When these weights ac­quire a certain velocity of rotation the centri­fugal force is sufficient to cause the weights to fly out and rub against the inside of the cylinder AA, and their velocity is checked. Instead of a cylinder, the balls may rub against the inside of a hollow cone, and by raising or lowering the axis C the contact of the weights with the cone may be made to take place when the balls have slightly greater or less velocity, and thus the rate of the clock is regulated. A much better arrangement is a modification of Watt’s governor, employed by Grubb and Cooke. The governor balls *g, g* (fig. 38) repose on the points *h*, *h* of the arm KK till they reach their normal velocity, when they fly outwards and bring the point S (tipped with leather) into contact with the friction plate *p.* These clocks are simple in construction and act very well. Newcomb in the Washington equatorial has employed a long suspended conical pendulum ; when this pendulum in the least exceeds its normal velocity (that is, its

normal departure from the vertical) it establishes an electrical con­tact which brings friction to bear, and thus reduces the power applied to the pendulum. There is occasional tendency to elliptical motion, and the clock is otherwise troublesome. In the Repsolds’ driving clock of the 30-inch Pulkowa refractor the conical pendulum is reversed, being a heavy weight at the top of a vertical steel rod, kept in conical rotation by a pin at its upper end, which enters a slot in a revolving arm. The rod is in fact a spring of such a form as to cause the revolutions to be nearly or perfectly isochronous whatever the angle of the cone of motion ; the clock is therefore, within limits, independent of the power applied to it or the force to be overcome.

Many forms of air-fans have been suggested; probably the best is the modification of Foucault’s proposed by Hilger (see *Monthly Notices R.A.S.,* vol. xlvi. p. 155), which is shown in fig. 39. E is the axis of rotation ; C and D are fans that are pulled towards the spindle E by chronometer springs in the boxes A and B. The fans fly out symmetrically when the velocity exceeds 25 or 30 revolu­tions per second ; the increased resistance of the air thus pro­duced checks the velocity of ro­tation. By means of the small weights W, W attached to arms on the fans Hilger states that it is possible to adjust this governor so that it shall even lose by an increase of the driving weight.

For the most refined work none of these governors can be said to be perfect ; none would be even tolerable as a clock for astrono­mical time-keeping purposes. It is possible that the elaborate Greenwich driving clock may give better results, but its construc­tion is too complicated to be fre­quently repeated (see, for a de­scription of it, the Greenwich *Observations for* 1868). The only way in which nearly perfect uni­form motion can be realized is to control it in some way from a swinging pendulum. This is done in Bond’s spring governor@@1 and by Grubb, the latter employing the arm of a remontoir train connected with a dead-beat escapement to bring friction to bear on a revolving plate connected with the axis of his governor (see fig. 38). The best existing driving clock is probably that at Lord Crawford’s observatory at Dun Echt.@@2 An account of its performance is given by Dr Copeland in *Viertel- jahrsschr. astron. Gesellsch.,* 16 Jahrg., p. 305. In this clock gain of a hundredth of a second, or even less, introduces increased fric­tion on the revolving disk during the next second, or until the gain has been corrected. A still more perfect clock could probably be made on a similar plan by abolishing the clock weight and making the origin of power an electromotor, the current being cut off in a way similar to that in the Dun Echt clock if the clock of continuous motion gets in advance of the ordinary clock.

For information on clockwork of equatorials and telescope mount­ings generally, see Konkoly’s *Practische Anleitung zur Anstellung astron. Beobachtungen.* (D. GI.)

TELESPHORUS, bishop of Rome from about 128 till about 137, succeeded Sixtus I. and was followed by Hyginus. Eusebius in his *History* gives the date of the martyrdom of Telesphorus as the first year of Antoninus Pius (138) and in his *Chronicle* as the eighteenth year of Hadrian (135).

TELFORD, Thomas (1757-1834), civil engineer, was the son of a shepherd in Eskdale, Dumfriesshire, and was boru in the valley of the Megget, 9th August 1757. From early childhood he was employed as a herd, occasionally attending the parish school of Westerkirk, where his quickness and diligence helped to make up for his lack of opportunity. On being apprenticed, at the age of fifteen, to a stone mason at Langholm, he found leisure not only to gain an acquaintance with Latin, French, and German, but to gratify his literary tastes by a wide variety of reading. In his early manhood he was much given to

the writing of verse: a poem of some length on Eskdale appeared in 1784 in the *Poetical Museum,* published at Hawick ; under the signature of “ Eskdale Tam ” he con­tributed verses to Ruddiman’s *Weekly* *Magazine* ; and he addressed an epistle in rhyme to Burns, which was published in Currie’s *Life* of the poet. But these poetical effusions were of comparatively little value. In 1780 Telford went to Edinburgh, where he was employed in the erection of houses in the “ new ” town, and occupied much of his spare time in learning architectural drawing. Two years later he proceeded to London, finding employ­ment in the erection of Somerset House. Having in 1784 superintended the erection of a house for the commissioner at Portsmouth dockyard, he next repaired the castle of

@@@1 Konkoly, *Practische Anleitung zur Anstellung astron. Beobacht­ungen,* Brunswick, 1883.

*@@@2 Monthly Notices R.A.S.,* November 1873.