

a measure of time more accurate than the sun itself. Hence astronomers were soon led to obtain the right ascension of a star, not directly, by measuring a Distance in the heavens, but indirectly, by observing the Moment of its Transit. This observation is now made with a degree of accuracy which might, at first sight, appear beyond the limits of human sense, being noted to a *tenth of a second of time*: but we may explain this, by remarking that though the number of the second at which the transit happens is given by the clock, and is reckoned according to the course of time, the subdivision of the second of time into smaller fractions is performed by the eye,—by seeing the space described by the heavenly body in a whole second, and hence estimating a smaller time, according to the space which its description occupies.

But in order to make clocks so accurate as to justify this degree of precision, their construction was improved by various persons in succession. Picard soon found that Huyghens' clocks were affected in their going by temperature, for heat caused expansion of the metallic pendulum. This cause of error was remedied by combining different metals, as iron and copper, which expand in a different degree, in such a way that their effects compensate each other. Graham afterwards used quicksilver for the same purpose. The *Escapement* too (which connects the force which impels the clock with the pendulum which regulates it), and other parts of the machinery, had the most refined mechanical skill and ingenuity of the best artists constantly bestowed upon them. The astronomer of the present day, constantly testing the going of such a clock by the motions of the fixed stars, has a scale of time as stable and as minutely exact as the scales on which he measures distance.

The construction of good Watches, that is, portable or marine clocks, was important on another account, namely, because they might be used in determining the longitude of places. Hence the improvement of this little machine became an object of national interest, and was included in the reward of 20,000*l.* which we have already noticed as offered by the English parliament for the discovery of the longitude. Harrison,² originally a carpenter, turned his mind to this subject with success. After thirty years of labor, in which he was encouraged by many eminent persons, he produced, in 1758, a time-keeper, which was sent on a voyage to Jamaica for trial. After 161 days, the error

² Mont. iv. 554.