himself to work accurately and minutely in brass and other metals. Having been unable to obtain any assistance from the Board of Longitude, he was under the necessity, while carrying forward his experiments, of maintaining himself by working at his trade of a carpenter and joiner. This will account for the very long period that elapsed before he could bring his chronometer to such a state that it might be tried with any approach to certainty in its operations.

Harrison, besides his intentness and earnestness in respect of the great work of his life, was a cheerful and hopeful man He had a fine taste for music, and organized and led the choir of the village church, which attained a high degree of perfection. He invented a curious monochord, which was not less accurately than his clocks in the mensuration of time. His ear was distressed by the ringing of bells out of tune, and he set himself to remedy them. At the parish church of Hull, for instance, the bells were harsh and disagreeable, and by the authority of the vicar and church wardens he was allowed to put them into a state of exact tune, so that they proved entirely melodious.

But the great work of his life was his marine chronometer. He found it necessary, in the first place, to alter the first mover of his clock to a spring wound up, so that the regularity of the motion might be derived from the vibrations of balances, instead of those of a pendulum in a standing clock. Mr. Folkes, President of the Royal Society, when presenting the gold medal to Mr. Harrison in 1749, thus describes the arrangement of his new machine. The details were obtained from Harrison himself, who was present. He made use of two balances situated in the same plane, but vibrating in contrary directions, so that the one of these being either way assisted by the tossing of the ship, the other might constantly be just so much impeded by it at the same time. As the equality of the times of the vibrations of the balance of a pocket watch is in a great measure, owing to the spiral spring that lies under it, so the same was here performed by the like elasticity of four cylindrical springs or worms, applied near the upper and lower extremities of the two balances above described.

Then came in the question of compensation. Harrison's experience with the compensation pendulum of his clock now proved of service to him. He proceeded to introduce a similar expedient into his proposed chronometer. As is well known by those who are acquainted with the nature of springs moved by balances, the stronger those springs are the quicker the vibrations of the balances are performed, and *vice versa*; so it follows that those springs, when braced by cold, or when relaxed by heat, must of necessity cause the timekeeper to go either faster or slower, unless some method could be found to remedy the inconvenience.

The method adopted by Harrison was his compensation balance, doubtless the backbone of his invention. His "thermometer kirb," he himself says, "is composed of two thin plates of brass and steel, riveted together in several places, which, by the greater expansion of brass than steel by heat and contraction by cold, becomes convex on the brass side in hot weather and convex on the steel side in cold weather; whence, one end being fixed, the other end obtains a motion corresponding with the changes of heat and cold, and the two pins at the end, between which the balance spring passes, and which it alternately touches as the spring bends and unbends itself, will shorten or lengthen the spring, as the change of heat or cold would otherwise require to be done by hand in the manner used for regulating a common watch." Although the method has since been improved upon by Beroy, Arnold, and Earnshaw, it was the beginning of all that has since been done in the perfection of marine chronometers. Indeed, it is amazing to think of the number of clever, skilful and industrious men who have been engaged for many hundred years in the production of that exquisite fabric—so useful to everybody, whether scientific or otherwise, on the land or on sea—the modern watch.

It is unnecessary here to mention in detail the particulars of Harrison's invention. These were published by himself in his "Principles of Mr. Harrison's Timekeeper." It may, however, be mentioned that he invented a method by which the chronometer might be kept going without losing a second of time. This was during the process of winding up, which was done once in a day. While the mainspring was being wound up a secondary one preserved the motion of the wheels and kept the machine going.

After seven years' labor, during which Harrison encountered and overcame numerous difficulties, he at last completed his first marine chronometer. He placed it in a sort of movable frame, somewhat resembling what the sailors call a "compass Jumble," but much more artificially and curiously made and arranged. In this state the chronometer was tried from time to time on a large barge on the river Humber, in rough as well as in smooth weather, and it was found to go perfectly, without losing a moment of time.

Such was the condition of Harrison's chronometer when he arrived in London with it in 1735, in order to apply to the commissioners appointed for providing a public reward for the discovery of the longitude at sea. He first showed it to several members of the Royal Society, who cordially approved of it. Five of the most prominent members—Dr. Halley, Dr. Smith, Bradley, Mr. John Machin, and Mr. George Graham—furnished Harrison with a certificate, stating that the principles of his machine for measuring time promised a very great and sufficient degree of exactness. In consequence of this certificate, the machine, at the request of the inventor and at the recommendation of Sir Charles Wagner, First Lord of the Admiralty, was placed on board a man-of-war, and carried, with Mr. Harrison, to Lisbon and back again. The chronometer was not affected by the roughest weather, or by the working of the ship through the vast rolling waves of the Bay of Biscay. By means of its exact measurement of time an error of almost a degree and a half (or ninety miles) in the computations of the reckoning of the ship was corrected at the mouth of the Channel.

Upon this first successful trial of his chronometer the Commissioners of Longitude gave Harrison the sum of 500*l*., on condition that he should proceed to make further improvements in his machine. Mr. George Graham urged that the Commissioners should award him double the amount, but this was refused. At the recommendation of Lord Monson, however, Harrison accepted the sum as a help towards the heavy expenses and labor which he had incurred, and was about to incur, in perfecting the machine. He was instructed to make his new chronometer of less dimensions than the first, which was thought too cumbersome