

and is supported on pillars from the bottom of the lock, the same as on dry ground. The double train of vessels having all entered the lock, half on one side the rail, and half on the other, they are hooked on to the axletrees of the wheels which are already upon the rail, prepared for that purpose. The gates next to the river, or canal, are then closed, and all being fast, the water is let out of the lock by a sluice, (shown in the drawing,) till it falls below the bottom of the outer gates, at which time the vessels are all suspended on their axles, in the air—the gates are opened, and they sail out across the valley;—or they are propelled by whatever other power may be eligible.

“Description of the Plan of the Lock.”

“A is the end of a canal or cut from a river, with the lock gates adjoining. B is the exterior of the other end of the lock, over the whole length of which the rail-way extends; a portion of which is seen at B. On the rail-way are shown the edge view of the wheels, with the axletrees, which extend over the vessel, two to each vessel; the vessels are thus arranged, and hooked on to the axletrees, when the sluice D is opened, and the water let out, which leaves the vessels suspended.”

Observations on Coppering Ships, and a description of the Method of Fastening a Ship's Side with the Iron Knees, invented by E. CAREY, Inspecting Shipwright, and Surveyor of Shipping.

ON observing one of my ships, after being coppered on the blocks in a dry dock, when floated out, I found that her copper under the buttocks, for a considerable way forward, and on the luff of the bows, for a great way aft, had become a great deal wrinkled or puckered; as this appeared very unsightly, and as I knew that the raised parts of the copper, from meeting with resistance, would soon be worn through, I gave the ship a careen, took the copper carefully off, had it beaten smooth, and put on again. The consequence was, that the copper remained smooth until I new coppered the same ship again.

I find that all ships drop forward and aft, more or less, according to their strength, when first launched off the stocks, or floated from a straight block, in a dry dock. I therefore now determined to sheath my ship up no higher than light water-mark, while in dock, on straight blocks, and, in two or three days after the ship had settled, to finish the coppering. I did so, and had the satisfaction to see my copper continue smooth to the last. This information may be worthy the notice of merchants and ship-owners.

Method of Fastening a Ship's Side with the newly-invented Iron Knees.

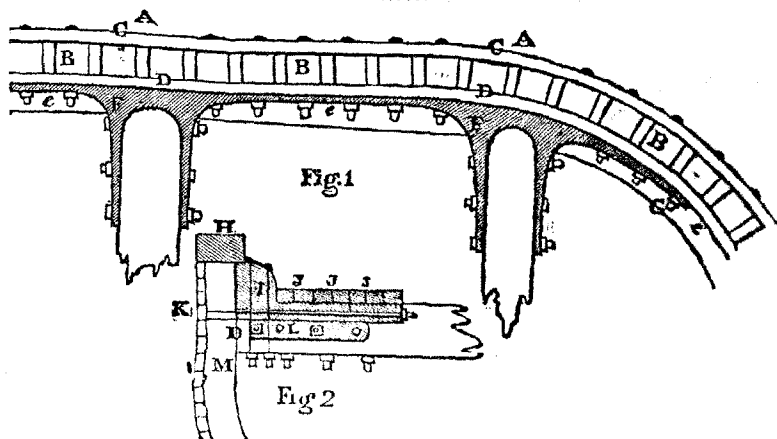


Fig. 1 is a horizontal section of a portion of a ship's side and beams.

A A shows the ship's side—B B B the timbers—C C the thickness of the outside planking—D D a plank, $3\frac{1}{2}$ inches thick, which goes all round the ship, inside the timbers, against which the iron knees are fixed, and bolted through the side—e e e a horizontal clamp, 10 inches wide, and 6 inches thick—F F the iron knees, 4 inches wide, and 2 inches thick, which are bolted through the beams and ship's side, as at G G.

Fig. 2 is a vertical section of the same parts as fig. 1.

H is the plank-sheer—I the water-way—J J J the ends of the planks—K a bolt that goes through the ship's side, through the edge of the water-way, and six streaks of the deck, below the beam, and is clenched on an iron plate on the inner plank—L arm of the knee—M the ship's timber and side—D is an edge view of the inner plank, as shown at D, fig. 1.

The above is a rough sketch of my new-invented Iron Knee and water-ways, which are let down upon the beam 3 inches, and also six of the deck planks, and bolted through all; under the beam a plank $3\frac{1}{2}$ inches thick is first brought on, inside the ship, against which the ends of the beam are fixed. The horizontal clamp, 10 inches wide and 6 thick, is then brought on under the edge of the plank, and bolted through the side. On this clamp the beam is dovetailed in one inch down, and bolted through the end of the beam. A ship fastened in this way will render it impossible for the side to move; consequently no wet can possibly get down, and the ship must be kept perfectly dry and sound.

E. CAREY
[Register of *etc.*]

OF CLOCK AND WATCH-MAKING, AND OF THE METHOD OF DIVIDING
THE DAY AT DIFFERENT PERIODS OF TIME.

[Continued from p. 248.]

Further progress of the theoretico-practical part of Clock and Watch-making till the end of the 18th century.

HUYGHENS, it has already been said, applied the pendulum to clocks, in the year 1657, but it was soon found that a pendulum vibrating in the arc of a circle, varied in the time of its vibration, as the arc decreased or increased. To obviate this, Huyghens invented the cycloidal plate; and De la Hire assures us, that this cycloidal pendulum clock, though often compared with the motion of the fixed stars, did not differ in eight days but a few seconds from the mean motion of the sun. But Huyghens himself soon found that the plate could not be made in a cycloidal form, and that the silken threads by which the pendulum was suspended did not answer the purpose, but that a pliable spring could be used in their stead. He then invented, for the purpose of more perfect regulation, that singular pendulum called *pirouette*, which has a cruciform motion. This, however, was also rejected. About the end of the 17th century, Derham and Hook conceived the idea of making the pendulum swing in small arches, and applying heavy lenticular weights. This method was adopted by Le Bon and De Rivaz at Paris, and by Clement in London, who also invented the, so called, English pallet.

Another difficulty to be overcome in regard to clocks and watches, was the influence which heat and cold have upon the expansion and contraction of metals, and which alters the motion of the whole. Graham is considered as the first who made experiments with a view of freeing the pendulum from such changes. He first conceived the idea of making pendulums of ebony, fir-wood, walnut-tree, &c.; but found that the moisture of the air produced other inconveniences. Experiments of the same kind were afterwards made by Magellan, Fontana, Ludlam, Schröter, Crostwaite, and Köhler. Graham next constructed a pendulum of an iron tube, which was filled to a certain height with quicksilver. Troughton, instead of an iron tube filled with quicksilver, employed one of glass, having at the end a bulb like the tube of a thermometer. But still happier was Graham's idea, to construct a pendulum of several rods of different metals, so combined, that the expansion of the one should be fully compensated by the contraction of the other; and this gave rise to the gridiron pendulum. Before Graham, however, Short, Cassini, and Ellicot had entertained a similar idea of a compound pendulum; and the plan of a gridiron pendulum was first carried into execution by Harrison in the year 1726. Besides the pendulum proposed by Graham and by Harrison, several other modifications of the same principle were applied by different persons, as by Berthoud, Grenier and Syllert. A lever pendulum was invented by Ellicot, and another by Grenier: the tubular pendulum was contrived by Rivaz, and the most simple

of all, the compensation pendulum, by Faggot, a Swede, about 1740, and which Schmidt, a watchmaker of Stettin, has lately employed with much ingenuity.

The highest degree of perfection, however, to which watch-making has attained, is in the construction of the nautical time-keepers, for the invention of which large premiums were offered in England, France, Holland, and Spain. Huyghens and Sulley made attempts for this purpose, but they were not attended with success; and the ingenious proposals of Leibnitz were not found sufficient. Harrison's first time-keeper, which he presented to the Royal Society in 1736, was regulated by balancing rods, placed crosswise over each other, with circular springs at the ends, which rested against two plates, which by the dilatation of the circular springs, in consequence of heat, separated, and on their contraction, by cold, approached each other. The friction also was lessened, and the time-keeper was suspended like the mariner's compass. In a voyage of twelve weeks, the error in going amounted only to 36 seconds. A second one, constructed in 1749, which was smaller and more convenient, surpassed the first. To a third, constructed in 1753, he applied a balance with a spiral spring, and a compensation rod of brass and steel. In 1761 he constructed a fourth, which, on a voyage of experiment that lasted 81 days, erred only 1 minute 54 $\frac{1}{2}$ seconds. A fifth, finished in 1764, erred only 54 seconds in six weeks. Dr. Maskelyne, however, to whom it was afterwards referred for trial, did not give so favourable a report of it. Berthoud and Le Roy made attempts also to construct time-keepers; but the first were not successful. In the year 1741 Le Roy's time-keeper, which in six weeks erred only half a degree, was preferred to that of Berthoud, which in the same time erred 34 minutes 36 seconds. The time-keepers of Arnold, Rendai, and Mudge, were found to be exceedingly correct. Mudge constructed only three; the first of which was tried, in the year 1774, by Dr. Maskelyne, Hornsby, Count Bruhl, Von Zach, and Campbel. The other two were tried by Dr. Maskelyne in 1777. One of them, in the course of 93 days, was found to have exceeded the mean time by only 1 minute 1.8 second. It showed the longitude between London and Oxford within 1.6 second. The balance vibrated altogether independently of the wheel-work, and always received from the moving power a new impulse, which at each vibration was uniform. The balance had two spiral springs, which produced a very uniform action. Besides this, the machine was furnished with a compensation balance. In imitation of the nautical time-keepers, pocket chronometers were constructed. These serve for determining the geographical longitude on land. In these the free scapement of Mudge is employed. Emery, an artist from Neufchatel, made the first, which, after a passage of four weeks, gave the longitude of St. John's, Newfoundland, correct within six seconds. Another, constructed by Mudge, in a voyage of 14 weeks, erred only 17 seconds. Mudge never made but two pocket chronometers. Arnold made above 900, of various constructions. His chronometers of the best kind, with gold cases, cost 120 guineas, with silver cases, 100.