PHILOSOPHICAL

TRANSACTIONS.

VIII. *On a new principle of constructing ships in the mercantile navy.* *By Sir* Robert Seppings, *F. R. S.*

Read March 9th, 1820.

So deeply is this country in particular interested in whatever may tend to give additional safety to the number of persons, and the immense sums of money employed in commerce, that I trust I shall stand excused for again bringing to the notice of the Royal Society, the subject of the construction of ships. The description of vessels of which I am now about to treat, are those employed in our mercantile service, in the construction of which, the imperfections are such as on a close examination will, I conceive, leave but little doubt that lives and property to an immense amount, must, from time to time, have been sacrificed by the present injudicious mode of constructing these ships; and under that impression I have presumed to lay this paper before the Society.

And first, as to the principle on which mercantile ships are at present built, and particularly as regards the putting together their ribs or frames, and the arrangement of the materials.

In forming the frames or ribs, half of the timbers only are united so as to constitute any part of an arch; every alternate couple only being connected together: the intermediate two timbers (termed fillings) being unconnected with each other, and merely resting upon the outer planking, instead of giving support to it. Now, it must be very evident that ships so constructed, can by no means possess equal strength with those that have the whole of their timbers formed into frames or arches.

This loose practice is, I believe, peculiar to the English merchant ship-builder; and indeed was pursued till very lately even in His Majesty's Navy, while the preferable system of connecting the ribs was common to other maritime powers.

The principle of uniting the frames, lately introduced in the construction of English ships of war, might, no doubt, be also introduced into the mercantile navy; which would give to the ships in that employ additional strength and increased durability, without adding to the expense of building.

But the present mode of joining together the several pieces of the same rib, is also highly objectionable. It is done by the introduction of a third piece, technically termed a *chock* or *wedge piece*, (Pl. VIII. Fig. 1, marked A) of which pieces the number amounts to upwards of 450 in a 74 gun ship, and not less than that number in an Indiaman of 1200 tons: (to which class of ships the drawings in this statement have reference.) Of these chocks not one in a hundred is ever replaced in the general repair of a ship; for they are not only found defective, but very generally to have communicated their own decay to the timbers to which they are attached. Besides this, the grain of the rib-pieces being much cut, to give them the curvature required, has a considerable share in weakening the general fabric. That they occasion a great consumption of materials, is obvious, as the ends of the two rib-pieces must first be cut away, and then be replaced by the chock.

This mode of putting together the frame, is also peculiar to the English ship-builder ; and I find, from an old work in my possession, dedicated to GEORGE the First, that the practice was introduced in the construction of English ships about the year 1714 ; and having heard that so unfriendly to it was the builder (Mr. NAISH) of the Royal William, that he refused to adopt it ; and being desirous of ascertaining the fact, when that ship was taken to pieces at Portsmouth, in 1813, I found that she was built without the wedge pieces or chocks, to which, in a certain degree, I ascribe her strength and durability ; her ribs being by her structure less grain-cut, and for want of chocks, less liable to decay in those parts where they are inserted.

The introduction of chocks, was no doubt to procure that curvature which is so necessary in the formation of a ship, when crooked or compass timber became scarce ; as may be seen by Pl. VIII. Fig. 2. which describes the shape of a piece of timber in the converted form ; and by which it will also be seen, that the introduction of the chocks assists in obtaining the required curve. But this curve may equally be obtained by a different combination of materials, and at a considerable less consumption of useful timber.

The frames of a mercantile ship (on the present mode of building) before they are placed and united to each other, may be seen in Pl. VIII. Fig. 3, with their chocks or wedge-pieces. To the evils already stated of the present practice, may be added that of imperfect workmanship, so that the surfaces of the chocks are seldom in contact with those of the timbers; and the ends of both are frequently reduced so thin, as to split by the fastenings that are necessary to secure the planks to the ribs; and thus the ship, in the event of grounding, or even in the act of rolling, derives little support from timbers united only, in fact, by two narrow edges.

Another great defect arising out of the present plan of constructing mercantile ships is, that the ends of the lower ribs or timbers, commonly termed the lower futtocks, (Pl. VIII. Fig. 3. B) are not continued across the keel C, so that no support is given in a transverse direction when the ship touches the ground; nor any aid to counteract the constant pressure of the mast. This great sacrifice of *strength* and *safety* is made for no other purpose than that of giving a passage for the water to the pumps.

The floor timbers, which by this mode of construction are the only timbers that cross the keel, are also weakened for the same purpose, as shown at D, Pl. VIII. Fig. 3. This mode also makes the conveyance of the water very uncertain, for the passage is not unfrequently choaked; and the pumps (from its not being practicable to continue them sufficiently down) always leave from 6 to 8 inches of water in the ship; so that these compartments constantly contain a certain quantity of putrid bilge water, offensive and injurious to the health of those on board.

The deficiency of strength causes also an alarming insecurity in the plank of the bottom, as shown at E, Pl. VIII. Fig. 3. termed the garboard strake; which consequently, has no other fastening to the general fabric, than its connection with the keel at F, Pl. VIII. Fig. 3. and a slight security at G, Pl. VIII. Fig. 3: hence it is obvious, that in the event of the keel being disturbed, the garboard strake, from its being attached to it, must share the same fate as the keel, and in that case the loss of the vessel would be inevitable.

To obviate these serious defects, is the principal object of this paper.

The principle I would recommend is explained in Pl. IX. Fig. 4; by which it will be seen, that the component parts of each rib are of shorter lengths and less curvature, and consequently less grain-cut; that they are more firm and solid by the substitution of coaks or dowels, for chocks or wedge-pieces; and that the mode of connecting the lower timbers is better adapted, in the event of a ship grounding, to give support and strength to the fabric, as will appear by the line marked H.

The plan of connecting the ends of the timbers by circular dowels or coaks (as at I,) is simply that which has, from time immemorial, been practiced to unite the fellies of carriage wheels; and we learn from Mr. Wood, that the same method has been observed in joining together the separate pieces of the shafts of the stone columns in the ruins of Balbec. "Little more of this great edifice (says this author) "remains, than nine lofty columns supporting their entabla-"ture. It is remarkable, that the shaft of these columns "consists of three pieces most exactly joined together with-

" out cement, which is used in no part of the buildings, they " being strengthened *with iron pins received into a socket.* " How much this method contributed to the strength of the " building, is remarkably seen in the most entire temple, " where a column has fallen against the wall of the cell with " such violence, as to beat in the stone it fell against, and " break part of the shaft, *while the joinings of the same shaft* " *have not been in the least opened by the shock.*"

That the frame of the Thunderer, (now Talavera) built on this principle, is superior in point of strength, to a frame constructed on the common system, is fully established by a report from the officers of His Majesty's Yard at Woolwich to the Navy Board, who directed them to compare the strength of the frames so united, with those of the Black Prince, constructed in the usual way with chocks or wedges.

It may be necessary to observe, that the frame of the Thunderer is composed of small timber, hitherto considered applicable only for the frames of frigates. I was prompted to attempt the introduction of the plan on which she is built, from there being a surplus store of small timber in the yard, and from a conviction, that a well combined number of small timbers, might be made equal, if not superior, both in strength and economy, to the large, overgrown, and frequently graincut materials, made use of in constructing the frames of large ships; and the result has shown the correctness of the principle; the adoption of which cannot fail to prove of great national advantage, in the application of sloop timber to the building of frigates, and of frigate timber to ships of the line, whenever larger timber cannot be procured. On this principle also, may frigates and small ships of war, or merchant vessels, be built of straight fir, without the assistance of oak or elm, which were formerly employed to give the necessary curvature of the sides. As it respects the general safety of the ship, it will be seen, by Fig. 5 and 6, Pl. IX. X, that the timbers uniformly cross the keel; that the frame of the ship is filled so as to form one compact body to the height marked K; and that only certain internal strakes of plank, or thick-stuff, as it is termed, are introduced, which are those on the joints of the timbers, for the purpose of giving strength where every alternate timber necessarily joins, as shown at L (Pl. X.) All the rest of the inner planking may be omitted; and dunnage battens, brought in a perpendicular direction, upon the timbers *between* the plank, as shown at M, forming regular spaces between each, as is usual at present *upon* the plank; thereby giving an increase of stowage in proportion to the thickness of the plank omitted. Water courses, as shown by dotted lines at N, are to be left in the joints of the timber under the plank, for the purpose of conveying the water to the pumps; which, by this plan, will reach below the water, instead of being some inches above, as is the case with the present mode, before described; consequently, by the proposed system, no stagnant water will remain; and farther, the limber passage, or water course, will be one smooth, uniform channel, which can be cleared with ease, should it be required, whenever the hold is unstowed; whereas at present it is inaccessible in places, and forms compartments for putrid water, without there being any means of removing it.

It is obvious, that a ship on the principle I have here recommended, may sustain the loss of certain planks of the bottom, and also the keel, (which has frequently been found to have happened to ships of war on their being taken into dock) and still reach the place of her destination; when the loss of *either*, would be the destruction of a ship built on the present mode. It will be evident also, that a ship constructed as now recommended, possesses greater stowage, and more space for leakage, than by the old plan; by the omission of the useless inner planking, and by laying the kentlage on dunnage, leaving a space for the water, which was formerly occupied by the inner lining. This dunnage in the bilge may be formed with the iron kentlage, and thereby serve as ballast, for which it is well calculated from its situation; and by its occupying a space heretofore forming part of the fabric of the ship, will give an increase of stowage, as before stated.

The best mode of closing the openings between the timbers, is by filling the intermediate spaces with pieces of wood, about three inches in depth, of such lengths as the inferior conversions will supply, abundance of which may be procured from the offal. These fillings are to be well caulked, after which the exterior plank is to be brought on. When the works are going on within board, similar pieces are to be fitted internally, and afterwards taken out for the purpose of filling the spaces between the pieces so fitted, with a mixture of PARKER's Roman cement and drift sand, in the following proportions, viz.

PARKER's Roman cement, $\frac{2}{3}$
Drift sand, - - - - $\frac{1}{3}$

previously paying the opening well with coal tar. Where there is sufficient space, a brick, or part of one, may be introduced, provided there is room for cement between it and the timbers. When filled in to within about two inches of the surface of the frame, the pieces of three inches already fitted and taken out, are to be well driven in and caulked, and by so doing, no space will be left unoccupied. If considered desirable, these pieces may be driven below the surface of the timber, thereby leaving water courses to convey the leakage to the pumps in channels. And prior to launching or undocking of ships, built on the principle I have recommended, it has been the practice to inject the part filled in with mineral tar, by means of a simple forcing pump, boring holes in the joints of the timbers for the introduction of the pipe. By following this method, the air will be excluded, which, as experience has shown, tends much to the durability of the fabric; confirming the assertions made by Doctor HALES on this subject, in his work on Ventilators, published in 1750, and also of Doctor HENRY, in his work on the Elements of Chemistry. If what is here recommended be attended to, and mercantile ships were built under roofs, as ships of war now are, durability would be obtained in addition to safety, from the mode of their construction.

The beams are to be attached to the sides, as shown at O, Pl. IX. Fig. 5. rendering wood knees unnecessary, and requiring only a small number of those of iron.

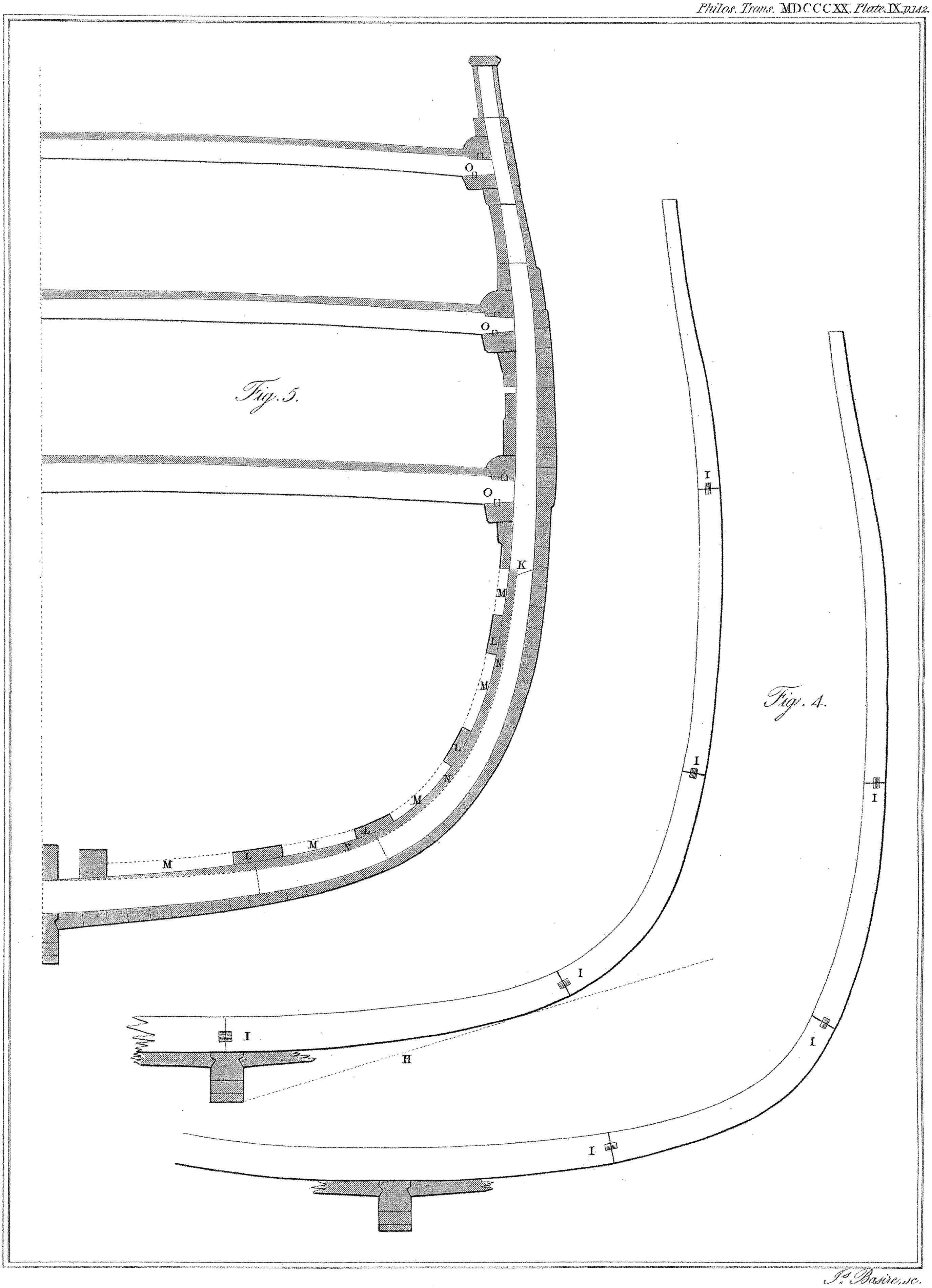
Pl. XI, marked P, describes the old principle of framing the stern with transoms. Q, the new principle, with timbers similar to the bow, omitting the transoms below the wing or upper transom; and by introducing the new principle on which the floors are made, the necessity of using valuable compass, or crooked timber, hitherto required, and with difficulty procured for these purposes, is avoided. Uniform support will thus be given, and also an increase of room for stowage.

In large mercantile ships above 500 tons, I would recommend that plate-iron be laid diagonally, as shown in Pl. X.

The principle now recommended will cause a decrease in the consumption of materials, and the difficulty of procuring the necessary curvature will be obviated. It also affords protection from worms externally, and vermin internally. Leaks may be more easily discovered and stopped than by the old method; and in point of additional strength, there can be no doubt. But were farther proof required, I need only state, that the Malabar, of 74 guns, built at Bombay, arrived at Portsmouth in October last, loaded to her upper deck with timber, and during her passage encountered four heavy gales of wind, without showing a symptom of weakness, as will appear by the following Extract from the Survey made by the Officers of Plymouth Yard, on that ship, by order of the Lords Commissioners of the Admiralty.

" When we consider the nature of the lading that this " ship has brought home, with the temporary security to " the beams of all the decks, except the orlop, and that on " her passage she encountered four very severe gales of " wind, it must, we presume, be very gratifying to your " Honorable Board to find, that she does not indicate any " past symptoms of weakness or straining in any part."

This ship had no other attachment for her beams than the internal hoops and thick waterway; the remainder of her security, the iron knees, being omitted, (from the difficulty of



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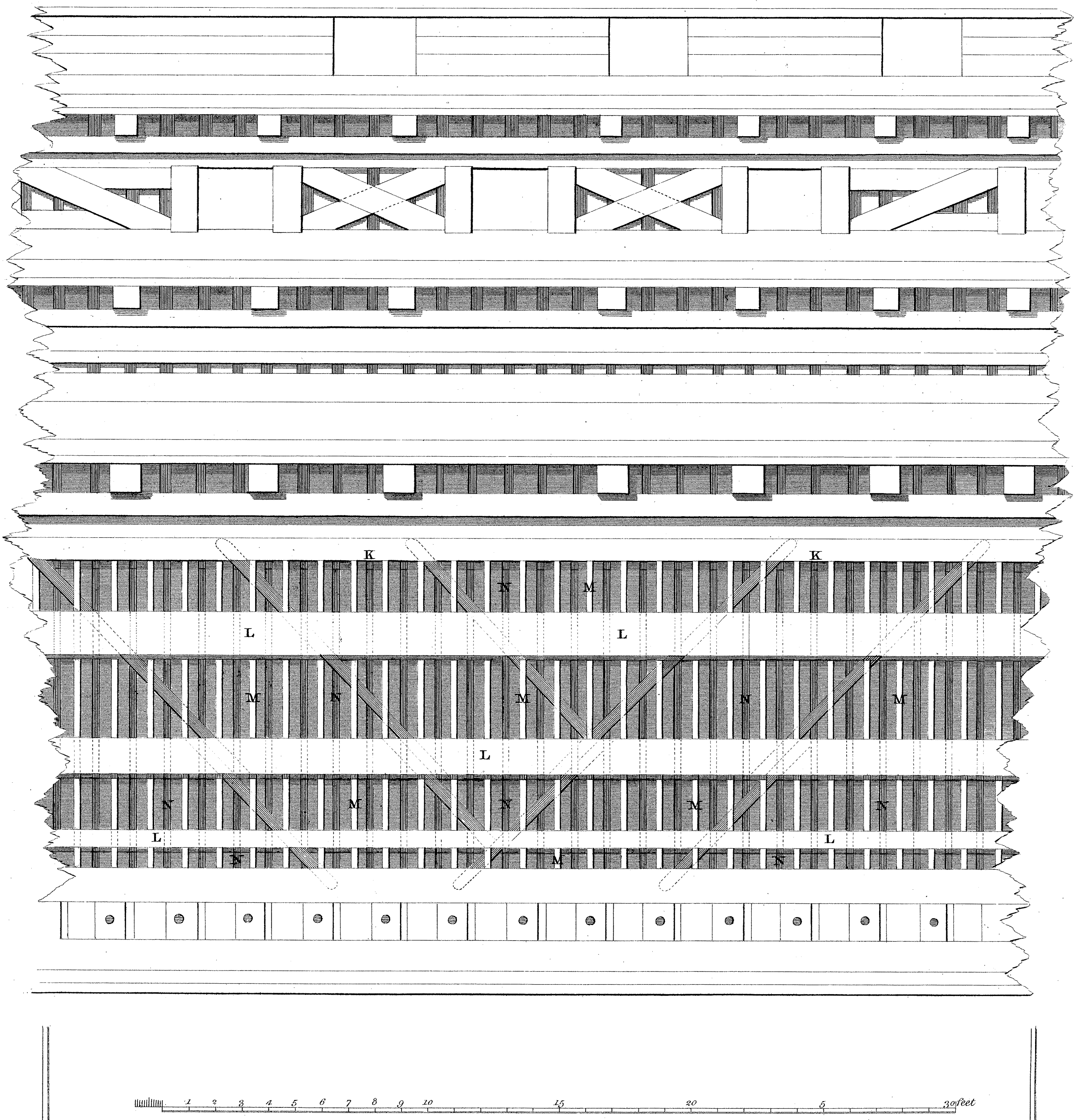

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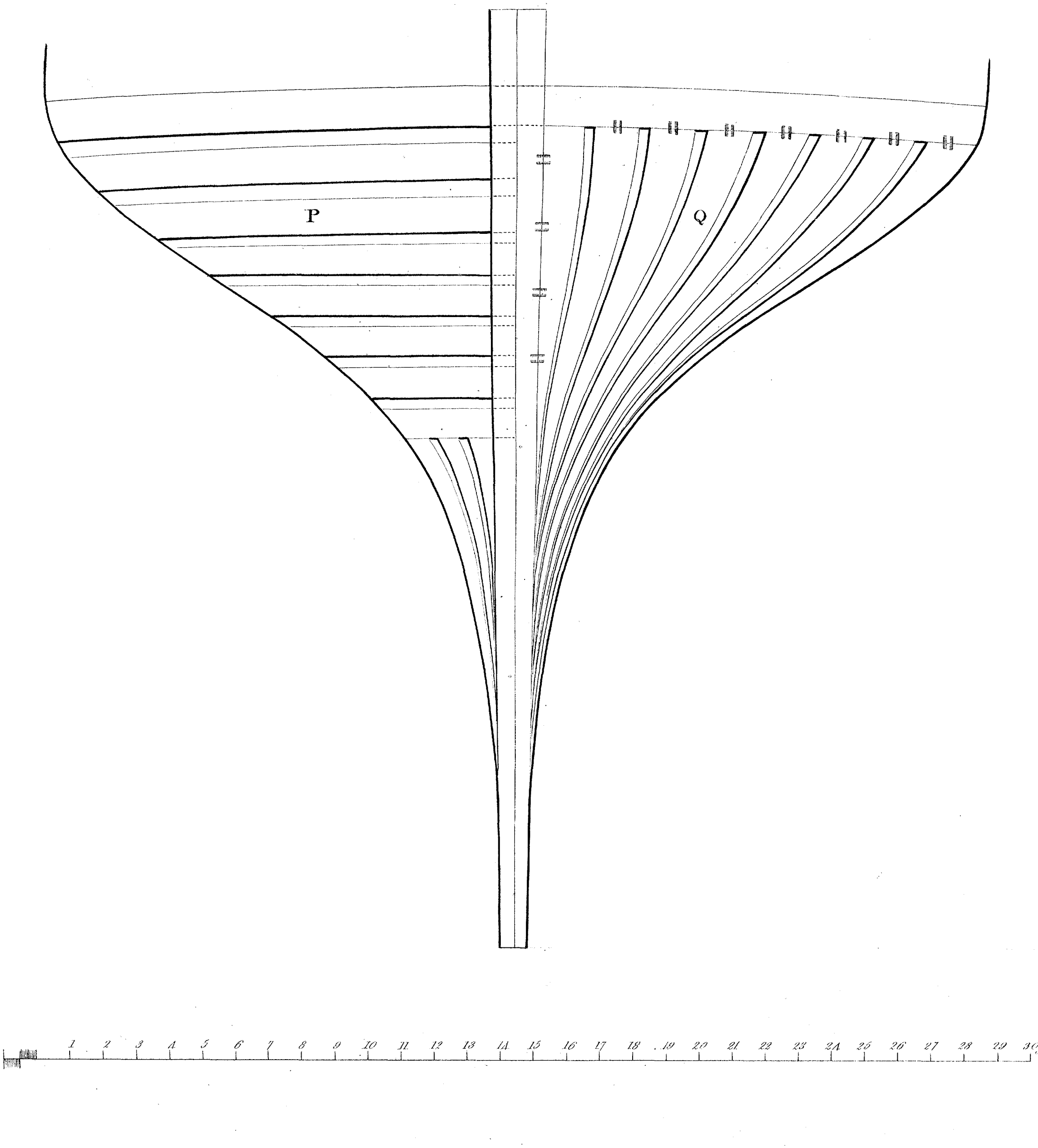
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procuring them in India) until her arrival in this country; thus supporting her cargo without the aid of knees, either of wood or iron.

The advantages of this plain, but important subject, particularly in point of safety, has induced me to bring it before the Society, in the hope that its utility and importance to this great maritime nation, may plead an excuse for the absence of abstract science, to which the attention of the Society may, perhaps, be more peculiarly directed.