

PHILOSOPHICAL  
TRANSACTIONS.

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I. *On the great strength given to Ships of War by the application of Diagonal Braces.* By Robert Seppings, Esq. F. R. S.

Read November 27, 1817.

SINCE the time that I first suggested the principle of applying a diagonal frame-work to ships of war, which was first partially and successfully adopted in the *Kent*, a seventy-four gun ship, in the year 1805, my mind has been continually and anxiously turned to this important subject; and it was not until the utility of the experiment had been fully established in the opinion of most naval officers, that I ventured to present to the Royal Society, a paper on the application of this well known principle to the construction of large ships of war, but which, as far as my knowledge extends, never had before that time been so applied, either theoretically or practically, in this, or any other maritime country; and I am well assured, that no such application, or suggestion, appears in any of the Continental writers on naval architecture. I merely mention this, because it has been pretty broadly insinuated, that the idea was borrowed from the French. The propriety of a different disposition of

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the materials entering into the construction of a ship, has at different times, for more than a century past, been suggested by English ship-builders; and partial alterations have, in consequence, been introduced; but no one, that I am aware of, has at any time proposed the system of a diagonal trussed frame. If I have received any assistance in the progress of this new system, now universally adopted in the British navy, it was from the plans and drawings of the celebrated bridge of Schaffhausen, and from no other source.

The extensive application of this principle to no less than thirty-eight sail of the line, and thirty frigates, might perhaps be conclusive as to the advantages expected to be derived from the new system; but as the Royal Society did me the honour to introduce my account of that system into their Transactions, at an early period of its adoption, I am led to hope that the result of a practical experiment, made with a view of proving the correctness of the principle, may not be deemed an improper or an uninteresting corollary to my former paper.

In the early part of this year (1817) the *Justitia*, an old Danish seventy-four gun ship, was ordered to be broken up on account of her defective state; and having observed her to be considerably arched, or hogged, as it is usually termed, I determined, notwithstanding her age and defective state, to apply the trussing principle to a certain extent, with a view to observe what effect it would produce on a fabric reduced to so weak and shaken a condition.

The officers of the yard were directed to place sights on the lower and upper gun-decks, prior to her being taken into the dock; and to ascertain, when she grounded on the

blocks, how much she had altered from the state in which she was when afloat. They were then to place a certain number of trusses (conformably with the annexed drawing, Plate I. No. 1.) in the following manner: those in the hold marked A, to be placed in an angle of  $45^{\circ}$ , or thereabouts, and those marked B, at right angles to them; those in the ports marked C to be placed from the midships forward, in an angle of about  $40^{\circ}$ , and, from the midships aft, at the same angle, but in an opposite direction. As it was uncertain where the centre of fracture (or point of separation) would take place, a few of the port-holes about the centre of the ship were crossed, as shown in Plate I. at D. Wedges were applied to the heels of the trusses, which were then set tight. The ship being thus partially trussed, the water was then to be let into the dock, and the ship floated out of it into the bason, where she was to lay one hour, when a committee was to examine the sights, and ascertain how much the ship had altered; and again, what change had taken place in twenty-four hours after floating. This being done, the trusses were to be disengaged in as short a time as possible, in order to observe whether the effect of their removal would be instantaneous, or gradual.

The following is an extract of the report of the committee:

“ When the ship was in dock, on blocks perfectly straight,  
“ she came down in the midships, by the sights placed on  
“ the gun-deck, two feet two inches and a half; and by  
“ those on the upper deck, two feet three inches and a quar-  
“ ter; and when undocked, with the trusses complete, and  
“ in their places, she hogged, or broke her sheer, by the  
“ sights on the gun-deck, one foot two inches; and by those

“ on the upper deck, one foot two inches and five eighths;  
“ and at the expiration of twenty-four hours she had hogged  
“ or further broke her sheer two inches and five-eighths,  
“ and then appeared stationary, and completely borne by the  
“ trusses.

“ We then proceeded to take away the trusses in the  
“ hold, and when they were wholly disengaged, she further  
“ hogged, or broke her sheer, six inches. We next pro-  
“ ceeded to take away the trusses in the ports, and when  
“ they were wholly cleared, she dropped at the extremities,  
“ (or further hogged) three inches and a half, and was in  
“ the same position when tried twenty-four hours after.

“ We further beg leave to state, that the whole of the  
“ trusses marked B, slackened as the ship floated from the  
“ blocks, and became short from half an inch to three inches  
“ and a half, and partook of no part of the pressure; which in  
“ our opinion clearly proves that the direction in which Mr.  
“ SEPPINGS has applied his diagonal frame is correct, as also  
“ the great utility of the trussing system; for although this  
“ ship, from her very defective state, was much against so  
“ severe an experiment, it has proved to us its good effects  
“ most satisfactorily; for many of the trusses in the ports  
“ forced *the timbers* three eighths of an inch within the ends  
“ of their covering planks, thereby lessening their effect from  
“ what it would have been if the ship had been of a sounder  
“ texture; yet on a ship in this state, the trussing between  
“ the ports alone, after those in the hold were wholly disen-  
“ gaged, had the effect of sustaining the immense pressure  
“ of both ends of the ship in her worst position, and pre-  
“ vented her from breaking, which she otherwise would

“ have done, from three to four inches, and which she actually and *immediately* did on their being disengaged.”

This statement of the Portsmouth officers, I trust, will be considered conclusive as to the benefits to be derived from the principle of trussing in the construction of ships; and although it was only applied from the keelson to the beams in the hold, and not to the ribs or frame of the ship, as is the case when ships are regularly built on this system, yet it sufficiently establishes the soundness of the principle.

When the *Justitia* first floated, after being partially trussed as described, the noise occasioned by the pressure on the trusses is stated to have been “ truly terrific,” until she was fairly settled on them. The disengaging them also caused a similar crash.

As, previous to the abovementioned trial on the *Justitia*, some professional persons had expressed a doubt, whether the braces ought not to have been placed in the direction of the trusses, and *vice versa*; the following experiment was exhibited to show what was expected to take place, and which did actually take place on the trial made upon the ship.

Let No. 2. Plate I. represent a frame of wood, having the braces B pinned to the upper and lower ties C; let the trusses D and the longitudinal pieces E, be merely let in without any fastenings; then make the point F the fulcrum, and pressing down the ends GG, it will be found that the frame comes more in contact by the pressure. Next reverse the frame, and let H become the fulcrum, and by pressing at I, I, it will be seen that the trusses D and the longitudinal pieces E will immediately be disengaged and fall out; this proves that, had the long braces in the ships built on this

system in the diagonal frame, been placed in the same direction that those in this experiment were that are marked A, the ships so constructed would, in the act of launching, pitching in a sea, and as they grew old, have slackened certain parts of the diagonal frame, and the fabric would have been supported by long *crooked trusses*, whose ends would have had but one point of support, namely, the shelf piece or internal hoop; and what is more objectionable, the ends of the trusses would, if so placed, have been cut off to an angle of  $45^{\circ}$ . On the contrary, by making the ties in the diagonal frame the abutments, as many additional points of support are gained, as the trusses B exceed the braces A; and further, the trusses B are now straight and short, and their ends are cut off to a right angle, and thereby give a support, and the longitudinal pieces a fixedness, which would not have been the case had they been laid in the other direction.

Indeed no stronger proof could be adduced in favour of the efficacy of the principle, than that which was furnished in the launching of three ships of 120 guns (the Nelson, the St. Vincent, and the Howe). In form and dimensions these three ships are precisely the same, and their frames, beams, and external planking, of the same scantlings: the two former were built according to the old plan, and the latter upon the diagonal system. After the Nelson was launched, she was found to have altered nine inches and a half from her original sheer, and the St. Vincent nine inches and a quarter, while the Howe altered only three inches and five eighths. The whole machine in the case of the two former ships was generally disturbed; the Howe exhibited no such symptoms.

I shall only further state, that after the memorable battle

of Algiers, I requested the Navy Board to call upon Captain COODE, of His Majesty's ship the Albion, to report on the state of that ship, she being built on the new principle; and the following is an extract of his letter to them:

“ I beg to inform you, that it is the opinion of myself and  
“ the officers of the Albion, that it was impossible any ship  
“ could have stood the concussion from firing, and the recoil  
“ of the guns, better than she did; and on a very minute  
“ inspection of the ship after the action, there was not the  
“ least difference to be observed, except what had been made  
“ by the enemy, between the side of the ship that all the  
“ firing was from, and the side that not a single gun was  
“ fired from during the action; and every bolt and knee was  
“ as perfect and secure as before the action commenced,  
“ which was also the case of the lower and main gun decks,  
“ but the quarter deck was staved in several places; which in  
“ my opinion would not have been the case, had it been on  
“ the same construction as the decks that stood so well.”

The Albion's decks, so well spoken of by Captain COODE, are laid diagonally; the quarter deck as usual, fore and aft.

To submit the diagonal decks to the test of experiment, I caused the decks of the Northumberland, of 80 guns, to be laid on one side fore and aft, as is usual, and on the other side diagonally, conformably with my principle; the materials on each side were of the same description, and the beams attached to both sides of the ship by the same mode.

This ship was ordered to convey General BONAPARTE to St. Helena, and Rear Admiral Sir GEORGE COCKBURN was, by the Lords Commissioners of the Admiralty, directed to report on the comparative merits of the decks. The following is an

extract of a letter from Captain Ross of the Northumberland, to Sir GEORGE COCKBURN, which was transmitted to the Admiralty :

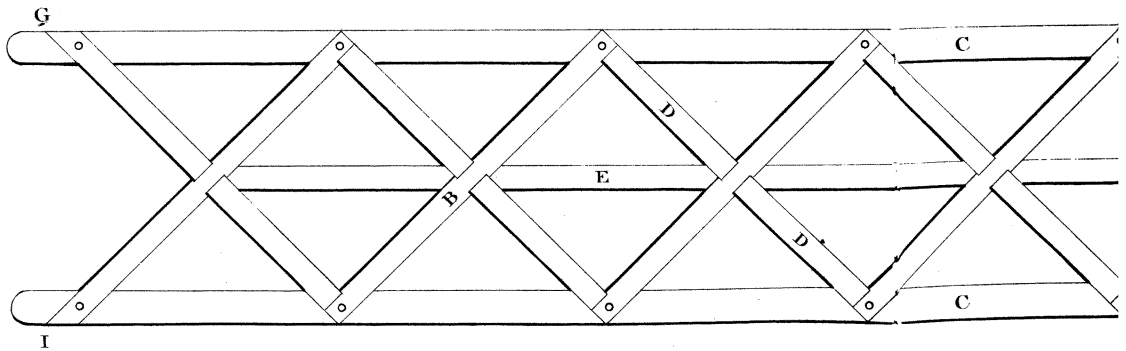
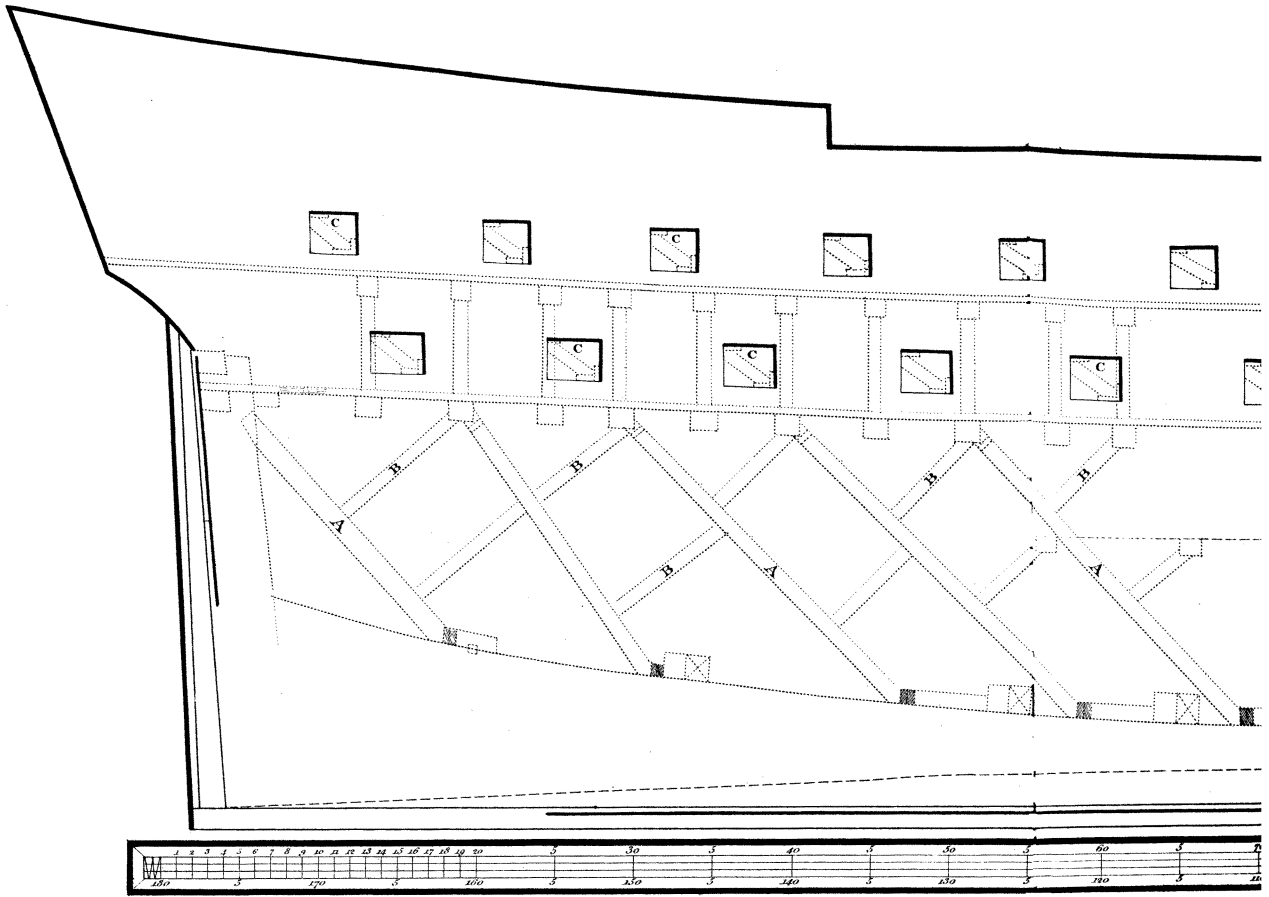
“ I have to state, that the fore and aft side required caulking on the passage from England (which was partially done) when the diagonal side did not ; the fore and aft side now requires caulking all over, and the diagonal side very little ; being, in my opinion, and that of the carpenter, much in favour of the diagonal decks.”

On the return of the Northumberland to Sheerness, the officers of the yard were directed very particularly to survey her decks. After speaking of the favourable report made to their enquiries by the officers of the ship, they stated as follows :

“ This report of the officers was confirmed by the general appearance of the ship on her arrival at this port, and having subsequently caulked and minutely examined the state of the decks and water-ways, we find the comparison so much in favour of the larboard side, as to determine, that the diagonal system of laying decks is preferable to the common system.”

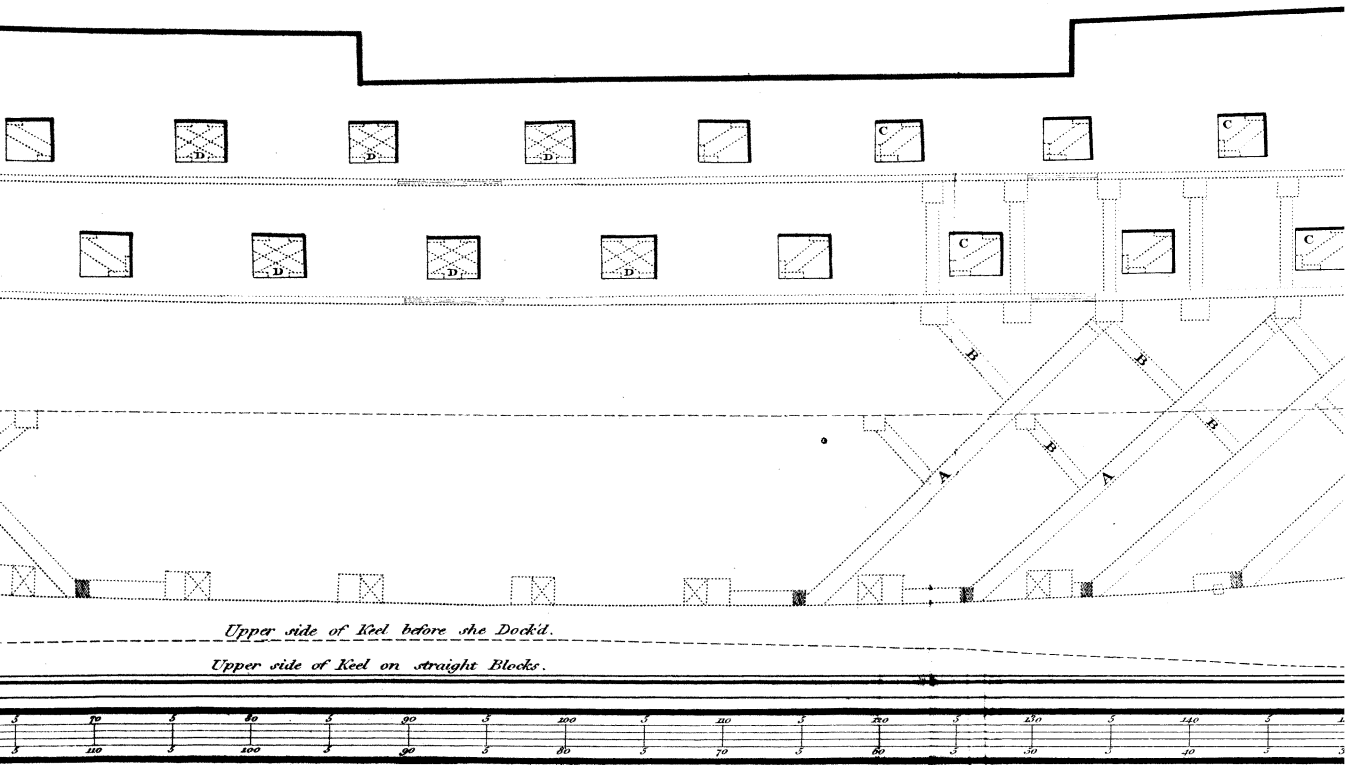


*A Sketch, showing the manner  
His Majesty's Ship Justitia,*

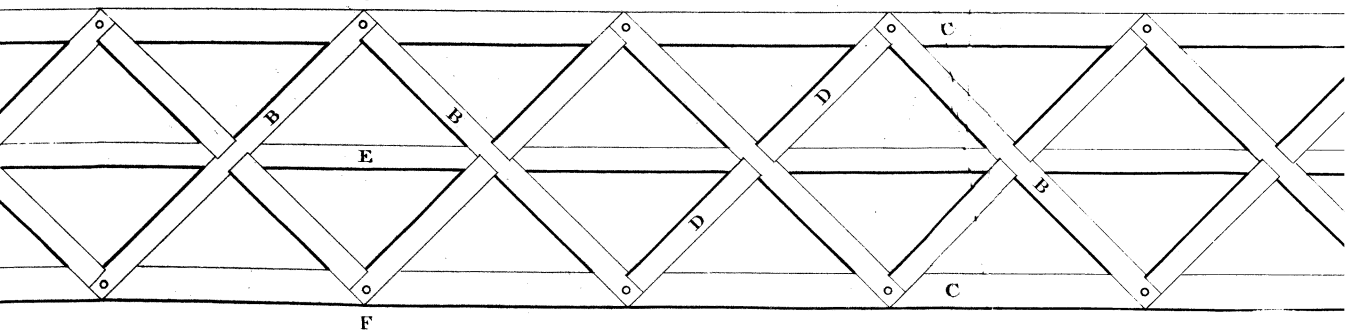


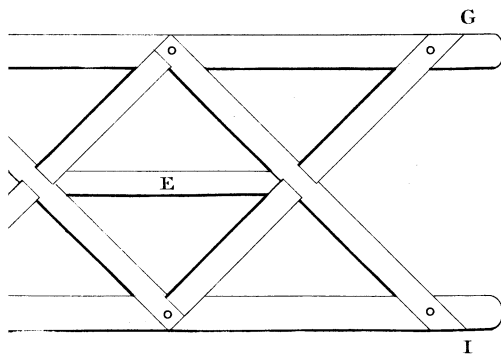
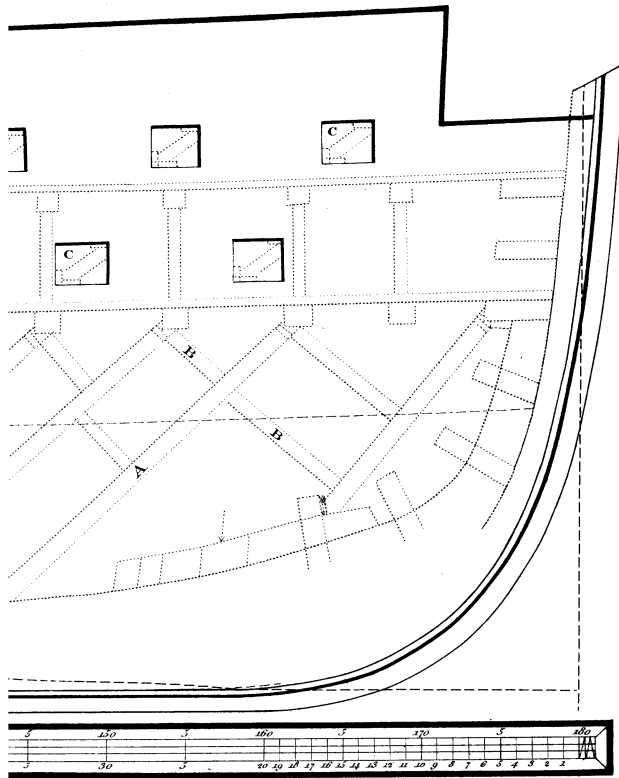
manner of applying the Trusses, in the Ports, and in the Hold, of  
 lities, of 74 Guns: preparatory to a trial for ascertaining their effects.

N<sup>o</sup> 1.



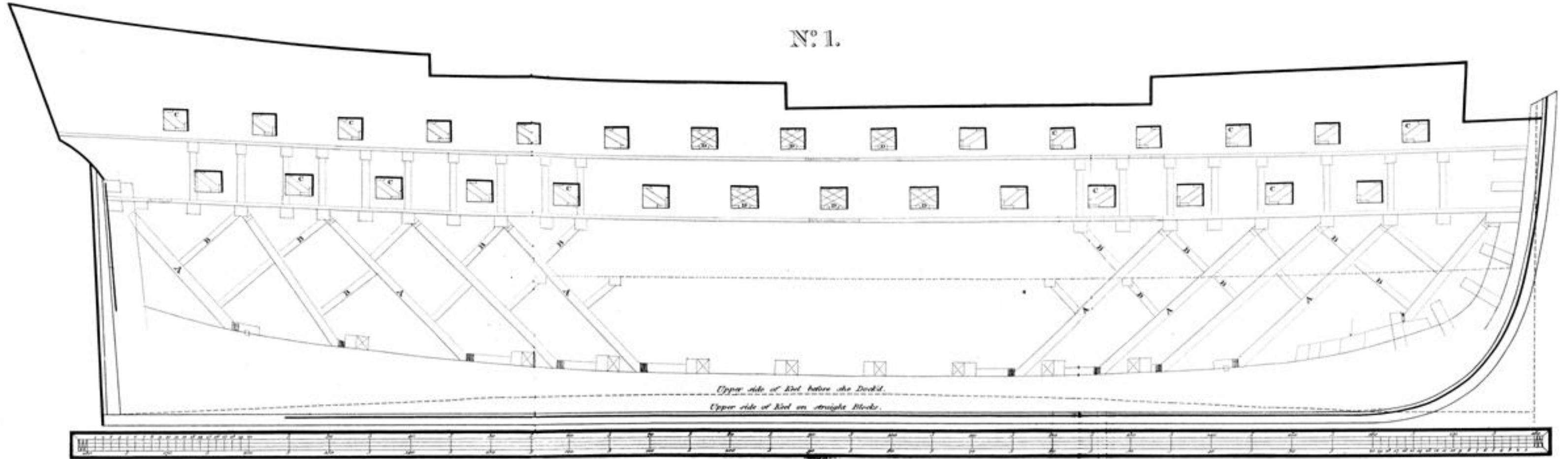
H N<sup>o</sup> 2.





*A Sketch, shewing the manner of applying the Trusses, in the Ports, and in the Hold, of  
His Majesty's Ship Justitia, of 74 Guns, preparatory to a trial for ascertaining their effects.*

N<sup>o</sup> 1.



N<sup>o</sup> 2.

