J. K. Howe.

Form.

No. 5,771. Patented Sep. 19, 1848.

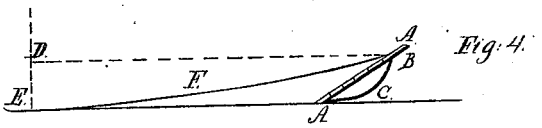


Fig. 4.

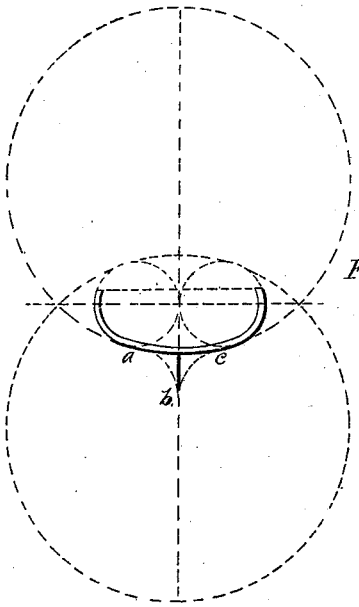
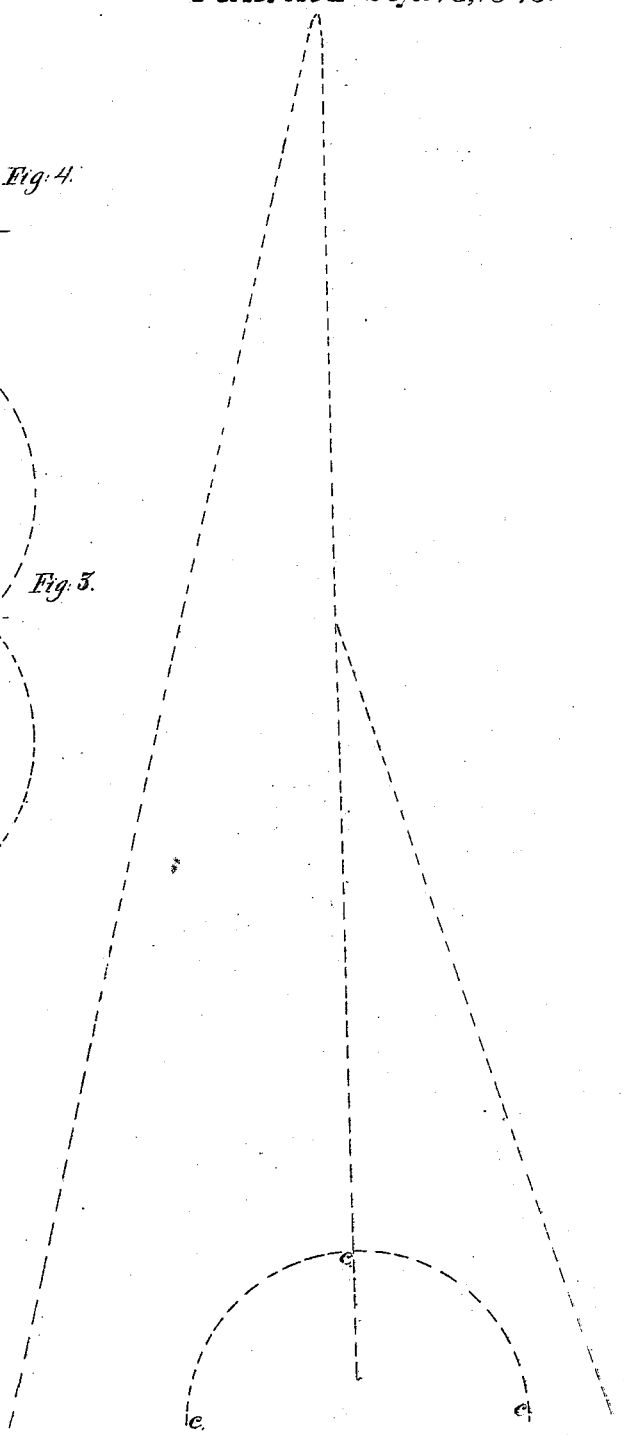


Fig. 3.



Witnesses:

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JAMES K. HOWE, OF NEW YORK, N. Y.

THEORY OF CONSTRUCTION OF VESSELS.

Specification of Letters Patent No. 5,771, dated September 19, 1848.

To all whom it may concern:

Be it known that I, JAMES K. HOWE, of the city, county, and State of New York, and a citizen of the United States, have discovered a new and useful improvement in ship-building, being a new and improved method of constructing vessels of all sizes by the application and use of curves and arcs of circles or of ellipses; and the following is a full and exact description of my said improvement.

My improvement consists in a method of giving to the outline or external shape of the hull of the vessel or boat of whatever size may be required the form of arcs of circles in combination approaching or resembling elliptical lines, and of ellipses, under certain rules and relative proportions hereafter to be described; and these circles or ellipses are to be applied as well to the lateral shape and position of the sides or ribs of the vessel as to the shape of the underside or bottom of the vessel measuring on a line following the keel from stem to stern. In order to carry out this method, (taking one particular example for illustration,) I first take the exact length of the vessel required upon a straight keel measured between two perpendiculars from stem to stern, and in order to find a point which I call the center or central point upon said keel to work from I take a point distant one third from the end of this line forward, and two thirds from the end aft, the one third forward being for the bows of the vessel, and the two thirds aft being for the after part and dead rise. This rule of taking a central point to start from to form the hull of the vessel forward and aft is invariable, and as will hereafter be seen is the starting point in my discovery in any given length of vessel to be constructed. I next proceed to obtain the width or breadth of beam of the vessel over this central point, and the proper width or breadth of beam over this point for a vessel strictly according to my improvement, and taking a particular scale for illustration, is just one sixth of the length; and the depth of the hold between the keel line aforesaid and the deck or rather what I call the deck line, upon the same strict plan should be just one half of this, that is to say one twelfth the length of the vessel. It should be observed that the deck may be placed in practice above or below this line which I call the deck line as set forth hereafter. I then proceed to obtain the curves for the ribs or side of the vessel. To do this I take a vertical line from the central point upon the keel just described and extend that vertical line to a point distant above the central point one half the breadth or one twelfth the length of the vessel, and I make this point the center of a circle, with this vertical line for a radius; and the arc of the circle formed by this line for a radius will be the curve or arc required for the ribs of the vessel and her sides vertically.

Having thus given the method of obtaining the depth of hold from the deck line to the upper surface of the keel at the central point aforesaid, and also the breadth of beam above this central point and the curve of the vessel's ribs or sides vertically, I now proceed to obtain the form or shape of the vessel longitudinally, following the underside or bottom of the vessel along the keel from stem to stern. And first to obtain the curve or dead rise forward of the above-mentioned central point upon the line of the keel: this must be formed also upon the arc of a circle to be obtained as follows: Take for a center of this circle a point vertical to the central point aforesaid in the keel line aforesaid and distant from it so far that a line between these two points for a radius will describe an arc or circle the arc of which beginning at the central point upon the keel line aforesaid, shall, being extended pass through a third point distant from this vertical line or radius one third the length of the vessel forward, and at the height above the line of the keel aforesaid of one twelfth the length of the vessel, or in other words so that this arc will pass through a point in the deck line above described forward distant one third the vessel's length from the vertical line just described for a radius, and vertical to the keel line, this point being the point of the stem or forward end of the vessel. Upon the keel or into it with this arc or curve for its rise and the dead rise forward are to be placed the ribs, the keel rising according to this curve for this purpose, the said ribs being placed or arranged according to a rule hereinafter to be described. It

will be observed that the curves of the ribs or sides of the vessel vertically at the central point having been obtained in the manner before described, all the ribs or standing side timbers for the whole length of the vessel fore and aft from stem to stern are to be of this same arc or curve so that every part of the bottom and sides of the hull looking horizontally of the vessel shall have the same curvature, and but one curve of rib will be required throughout the whole length of the vessel.

The next thing to be determined is the rise of the vessel upon the keel abaft the central point, or the dead rise aft as it is called. This rise must also be the arc of a circle whose radius shall be the same line as that for the circle or curve for the forward part or bows just described, but this line for radius for the curve now required must be between three and four times the length of the line for radius for the circle or curve for the bows, or about the proportion of three and one third to one, for entire exactness is not easily attainable, and a circle or arc drawn with this line for a radius, the center being at the vertical point at the end of the line and carried from the aforesaid central point aft in continuation of the curve or arc forward will pass through a point upon the deck line at the stern of the vessel which will be distant from the central line of radius along the deck line in the same plane as the circle two thirds the length of the vessel.

Upon this curve between the central point and the point last mentioned at the stern the keel is to be raised and formed and the ribs are to be set into the keel upon the same curve. The combination of the two arcs of circles and the continuation of their curves together in one line, the smaller one forward and the larger one aft forms nearly an elliptical curve and approaching an elliptical water line from stem to stern. The result of this mode of applying the arcs of two unequal circles for the bottom curve on the line of the keel is that for every amount of dead rise forward of the central point on the line of the keel for any given distance you measure twice the distance upon the keel line aft the central point for the same amount of dead rise—that is to say if your keel or dead rise rises one inch for one foot measured on the keel line forward, it must rise but one inch for every two feet measured on the keel line aft the central point; this proportion of measurement is not strictly and perfectly exact, and would produce a slight variation from the true curve line aft in vessels of considerable length; to be perfectly accurate the curve line must be strictly followed. It is next to be observed that the ribs are to be set into the dead rise or keel in such a manner that they shall all point to the center of the circle the arc of which forms the dead rise fore or aft as they are fore or aft of the central point respectively: this it will be seen will make the rib at the central point rise in a plane vertical to this point while those fore and aft gradually converge as they rise upon the curve of the circle and their planes point toward the respective centers of the circles of which the curves fore and aft are a part.

It will be observed that in placing the ribs fore and aft of the central point in their proper places upon the curve or arc of the dead rise forward or aft respectively in the manner above described, the upper ends of the ribs, if of the same length as the central rib or nearly so will necessarily rise up toward the bows and stern above the deck line according as the curve for dead rise at bows or stern rises. These upper ends of the ribs are to be cut off as they rise at such point above the deck line as may be required for bulwarks, so that a line drawn along their ends when so cut off will be level or in the same level plane or nearly so: the shear or rise of bulwarks however may be varied. The planking of the vessel may be placed over the ribs or sides of the vessel in the usual manner.

The keel which I have described above as laid out the whole length of the vessel upon square lines between perpendiculars may if actually so made in practice be afterward cut away and shaped to suit the shape or dead rise of the vessel as may be required.

Having thus described the method of building the hull of a vessel upon one particular scale or rule of my discovery and improvement I now proceed to further illustrate this by reference to the drawings.

In Figure 1, the line B A represents the keel line of the length of the vessel required between the perpendiculars J A and C B; the line E E E E between C and J is the deck line; the line H I is the line of the rib tops or ends extending above the deck line and forming the bulwarks above the deck line J C; O is the central point in the keel line one third of the length of the keel line from A J and two thirds from B C; the line between F and O is the radius of the circle forming the curve of the bows or dead rise forward; F J is the radius of the same circle touching the deck line at J, and O J is the arc or curve. The line O F, the radius of the circle for the bows being extended between three and four times its length to G making the vertical line G F O, constitutes the radius for the circle or arc for the dead rise aft between O C producing a rise aft the central point as nearly as possible one half for the same distance of the rise forward of the central point. The ribs are shown by

the numerals from 1 to 30. The inclination of the ribs toward the centers of the respective circles forming the curve of the bows and stern is shown by the variation from the vertical dotted lines 1, 7, 13, 25, 30. The line O K shows the depth from deck line to keel line at the central point. The curve C O J shows the entire shape of the hull on the keel line and the dead rise fore and aft. The circles L L L L L L show the curve of the ribs and the points where they are cut off and what height or portion of the arc is left when cut off to a level with the top of the central rib at the points indicated by the dotted lines running from these circles to the ribs 7, 18, 20, 25, 30. In these circles the continuous black lines show the exact length of the arc constituting the ribs at the points just referred to by the numbers, 7, 13, 20, 25, 30, the points where the continuous black lines meet in the circles L L L L L L being all on the same level. The breadth of the vessel at these points is also shown by the space between the points where the ribs are cut off.

Having thus set forth the method of shaping the hull according to the particular scale above set forth, I now proceed to describe how my discovery and improvement is to be applied to vessels whose hulls are required of greater or less depth of hold or greater or less width of hold at the bottom, or greater or less curve of dead rise following the line of the keel fore and aft. This system is susceptible of every variety of form in its application to the hulls of vessels but always preserving the relative proportion fore and aft of the central point in the curve of the line of the keel above set forth, and also always making the curves of the ribs through the whole length of the vessel the same, or upon the same parts of circles; so as to make every part of the water line of the vessel the same and carrying out the application of the arc of the circle or circles combined through her sides and shape below externally from bows to stern, so that there shall be no straight line or surface in the outline.

If it be required to build a vessel of a given length but of a more moderate dead rise fore and aft, the points D C through which the circles fore and aft are to pass from O, are to be lowered so as to make the circles larger as in Fig. 2. The line C, O, D represents the bottom curve the radius of the arc C O being between three and four times in length that of the radius of the arc O D, the length of the vessel in Fig. 2, being the same as that in Fig. 1, but the curve of the bottom fore and aft and of the ribs or sides very different.

When it is required to give the vessel an increased area of bearings on her sides, or to have her width or flattening of bottom greater than would result from the form of the circle given by the rule above laid down in the first part of the specification, it will be necessary, to carry out my system, of elliptical curves or arcs of circles or of both combined, to adopt the following method or rules. Take a line equal to the width or breadth of beam of the vessel at the deck line over the central point O. Divide this line into two equal parts and let these parts of the line when so divided be the horizontal diameters of two circles touching each other (as in Fig. 2 at L L L L &c.). The curves of these circles will be the curve for the ribs of the vessel for a certain length upon the sides. Then to get the curve for the bottom of the vessel or lower portion of the ribs in connection with and continuation of the arcs or segments of those circles, a larger circle must be drawn the curve of which shall touch externally the lower curves of the two circles just mentioned but must never cut them as is shown in Fig. 2, L^1, L^2, L^3, L^4, L^5, L^6, the arcs of the two circles together in continuation forming a curve approaching the curve of an ellipse, and that part of the curve of the greater circle which touches the two lesser ones, is to be taken for the curve for the remaining part of the ribs required, the arcs of the three circles together in combination forming a curve resembling an elliptical curve, and constituting the curve or shape of rib or sides of the vessel throughout. Take in Fig. 2, L^4 the two smaller circles of which are formed upon two diameters equal together to the width of the vessel. The larger circle with radius equal to the two diameters of the smaller circles represented by the dotted lines, *c*, *c*, *c* strikes the outer lower curves of the two smaller circles at *d e* and the arc of the larger circle between these two touching points *d e* is the curve for the bottom of the vessel or lower part of the rib.

When it is required to have the vessel of a still greater width in proportion to the depth, or to have the bottom still more shallow and spreading two circles are to be drawn as before; their two diameters united, however, being less than the width of the vessel, so that their arcs shall not be cut by the arc of the greater circle to be drawn for the curve of the bottom—these circles are then to be so far apart that the space between them together with their diameters united shall equal the width of the vessel over the central point on the deck line, and so that the larger circle to be drawn as before so as to touch the points corresponding to *d e*, will be the curve in continuation with the smaller circles for the sides, the three arcs or segments together forming the entire rib. All the ribs fore and aft are to

be cut of this form of curve precisely, and placed upon the curve of the dead rise of the keel fore and aft—their tops being cut off at the required distance for the bulwarks on nearly an even line having three fifths of the circle above the keel or keel line for the bulwarks which hence curve slightly inward, the height of these however may be varied. The curves and form of these sections of ribs, cut off as they rise at particular points when they are set into the keel are shown in Fig. 2 at L^1, L^2, L^3, L^4, L^5, L^6, their tops being on an even line and being set into the keel on the curve line C O D at the points indicated by the lower extremity of the dotted lines m^1, m^2, m^3, m^4, m^5.

It will be seen by experiment that these methods of forming the entire ribs for the vessel's sides are capable of every degree of variation within any given length or length and width, preserving at the same time in every variation the principle of the curved lines of the circle or ellipse or both combined throughout the whole lower external shape of the vessel.

With regard to the method of obtaining the arcs of the circles required in actual practice it may be done in any way most convenient either by the use of a line or cord for a radius or by using the dividers upon a scale adapted to their powers and then measuring the circles and parts of circles and adapting them in proper proportions to the large scale required.

The keel of a vessel her hull or bottom being constructed as above, will stand out at a pretty sharp angle to the vessel's bottom, which in a large vessel for ocean navigation would be inconvenient as offering too straight a surface upon the side of the keel to the action and force of the waves. The angle between the dead wood and bottom may be carried out or filled by an easy line formed by taking a section of the arc of one of the smaller circles used for the curves of the ribs, and placing it reversed on either side of the dead wood, as at *a*, *b*, *c*, in Fig. 3; in Fig. 3, *b* represents the bottom of the keel at the stern; *a*, *c* the bottom of the vessel, *a b*— *c b* the filling up of the angle by the reversed section or arc of the circle. Where the space between the keel and bottom aft is carried out or filled as just described, the space between the keel and bottom forward, must also be carried out or filled in the same manner, so as to preserve even or equal bearings fore and aft; but it is to be observed that this filling out both fore and aft must be continued from the central point O beginning with nothing at that point and gradually widening toward the stern and bows upon a curve beginning at the said central point and being the curve or arc of a circle somewhat larger than that forming the curve of dead rise aft and forward respectively, so that an easy line will be produced; but the filling out forward may in some cases be dispensed with.

The position of the rudder should be somewhat different from the common mode. The rudder is to be hung in the same plane as the keel but obliquely so that the lower part shall be hung farther forward (the keel being beveled off for that purpose) than the upper part so that when the helm is turned, the rudder will not turn upon a vertical axis, but one considerably oblique. The operation of the rudder hung in this manner tends to lift the stern of the vessel when putting about and causing her to turn quicker and easier.

The bottom or line of dead rise of the vessel may also be obtained by lines composed of ellipses by taking the same point O for a center or starting point, and making the dead rise aft that point of an ellipse whose larger (or transverse) axis shall be equal to twice two thirds the length of the vessel, and whose shorter (or conjugate) axis shall be equal to twice the depth of the vessel; and for the dead rise forward of the central point an ellipse whose larger (or transverse) axis shall be equal to twice one third the length of the vessel, and its shorter (or conjugate) axis the same as that of the other ellipse. These two ellipses divided at their shorter axes and the half of the two joined together at their shorter axes so that their longer axes may be in one and the same straight line, will form the dead rise for the whole length of the vessel and her shape underneath from stem to stern, the form of the ribs also may be that of an ellipse produced by taking for the curve of rib over or at the central point the outline of ellipse produced by taking for one axis the width of the vessel and for the other axis twice the depth of hold—all the other ribs to be of the same form: the ribs in this case are to be set in their places upon the line of dead rise, their planes being perpendicular to the line of dead rise, and as they rise upon it are to be cut off to suit the sheer of the vessel required, the central rib should however always rise to three fifths of its diameter, as it should also in cases where the rib is obtained of circles.

The combination and arrangement of curves as above described in all the various proportions or figures which may be required for the length, breadth, depth, curvature of bottom and sides, &c., for the vessel required I believe to be upon a principle conformable to mathematical or geometrical truths or principles strictly, and they produce for vessels the figures most nearly corresponding to those natural figures and

forms of creatures whose element is the water, and whose shapes are adapted in the most perfect proportions for rapid motion in that element. I believe it will be found that carrying out the principle of the rule herein first above laid down so as to fill up the figure above as well as below, a figure will be produced corresponding very accurately in outline with that of the hump-backed whale which is a fish of great speed.

It follows from the foregoing system that the hulls of vessels produced according to it present no straight lines or surfaces whatever to the water but every where horizontally and vertically are curves, a thing which I believe has never before been attained in ship building. Another result is that their sides must always exactly correspond with each other, which has not before been attained with entire accuracy. A further effect is that the sides being throughout their length upon the same curve, or rather equal curves, when the curve of the central rib is obtained all the others may be cut or sawed to correspond, doing away with the necessity of molds and of laying off upon the molding floor in a great measure, and producing a great reduction in the expense of building by the ordinary method, as well as saving of labor, &c. Also further, a vessel built in this manner owing to the shape of the ribs and manner of setting them upon the keel their planes pointing to centers, will be of greater strength and power to resist the action of heavy seas, and will present also an easy surface so that their force will be much less felt and the waves more easily turned aside. Further the vessel will sail faster and nearer to the wind than vessels built in the usual manner and will also be more stanch and steady; it will also come about quicker and easier when sailing on a wind; the proportions are also extremely beautiful and perfect.

With regard to the constructing the keel of the vessel, it may be observed that its construction both as to the parts where the ribs touch the line of dead rise and the other parts is the same as that used in ordinary ship building, and so with other parts of the vessel's hull so far as is consistent with the principles or mode of construction above set forth.

It may be proper to observe that the length of the respective radii of the circles of the dead rise fore and aft may be obtained with accuracy by the following rules obtained mathematically.

In all sizes of vessels built according to my plan the length of the radius of the curve of dead rise forward may be accurately obtained by the following rule: Add the square of the depth to the square of one third the length of the vessel and divide the sum thus obtained by twice the depth; the quotient will be the required radius. Thus for example in Fig. 1, to find the radius F O: Given the length of the vessel J C=6 inches; given the depth of the vessel K O=$\frac{1}{2}$ inch. Hence

$$\frac{(\frac{1}{2})^2+(2)^2}{2(\frac{1}{2})}=\frac{4\frac{1}{4}}{1}=4\frac{1}{4}=\text{FO}$$

the required radius in inches. The reason of this rule may be learned from the following mathematical solution founded on Fig. 1.

$$\text{FO}=\text{FJ}$$
$$\text{FJ}^2=\text{FO}^2=\text{FK}^2+\text{JK}^2$$
$$\text{FO}^2=(\text{FO}-\text{KO})^2+\text{JK}^2$$
$$\text{FO}^2=\text{FO}^2+\text{KO}^2-2(\text{FO.KO})+\text{JK}^2$$
$$2(\text{FOKO})=\text{KO}^2+\text{JK}^2$$
$$\text{FO}=\frac{\text{KO}^2+\text{JK}^2}{2\text{KO}}$$

Upon examination it will be seen that this last equation is the mathematical form of expressing the rule above laid down.

Again, in all sizes of vessels built according to my plan the length of the radius of the curve of the dead rise aft may be accurately obtained by the following rule: Add the square of the depth to the square of two thirds the length of the vessel, and divide the sum thus obtained by twice the depth; the quotation will be the required radius. Thus for example in Fig. 1, to find the radius GO: Given the length of the vessel JC=6 inches; given the depth of the vessel KO=$\frac{1}{2}$ inch. Hence

$$\frac{(\frac{1}{2})^2+(4)^2}{2(\frac{1}{2})}=\frac{16\frac{1}{4}}{1}=16\frac{1}{4}=\text{GO}$$

the required radius in inches. The reason of this rule may be learned from the following mathematical solution founded on Fig. 1:

$$\text{GO}=\text{GC}.$$
$$\text{GC}^2=\text{GO}^2=\text{GK}^2+\text{KC}.^2$$
$$\text{GO}^2=(\text{GO}-\text{KO})^2+\text{KC}.^2$$
$$\text{GO}^2=\text{GO}^2+\text{KO}^2-2(\text{GO.KO})+\text{KC}.^2$$
$$2(\text{GO.KO})=\text{KO}^2+\text{KC}^2$$
$$\text{GO}=\frac{\text{KO}^2+\text{KC}^2}{2\text{KO}}.$$

Upon examination it will be seen that this last equation is the mathematical form of expressing the rule last above laid down.

What I claim as my discovery and improvement, and desire to secure by Letters Patent, is—

The method herein made known of determining the configuration of vessels of all sizes, by describing the outline of the bottom or what I call the "dead-rise" by two arcs of unequal circles or ellipses which meet on the upper edge of the keel (which is their common tangent) at what I call the "central

point," in combination with curves or arcs of circles, or ellipses described as aforesaid and forming the outline of the ribs, all the ribs in the same vessel, being segments of the same curve, and set upon or along the curve of the "dead rise," fore and aft, the transverse plan in which the ribs are placed coinciding with planes radiating from the centers of the circles, or ellipses, of which the curves of the "dead rise" are segments.

JAMES K. HOWE.

In the presence of—
JOHN B. STAPLES,
ROBERT G. PIKE.