United States Patent [19]

Kline

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[54] **BOAT HULL WITH A BOTTOM OF A PORTION OF THE SURFACE OF A HYPERBOLOID**

[76] Inventor: **John P. Kline,** P.O. Box 100, East Hampton, N.Y. 11937

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[52] **U.S. Cl.** **114/62;** 9/6

[51] **Int. Cl.** **B63b 1/04**

[58] **Field of Search** ..... 9/6; 114/56, 61, 62, 66.5 H, 114/66 R, 66 S

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Primary Examiner—Trygve M. Blix
Assistant Examiner—Sherman D. Basinger
Attorney, Agent, or Firm—John M. Montstream

[57] **ABSTRACT**

A boat hull of the sea sled type is disclosed in that it has spaced chines which may be parallel or may be tapered somewhat inwardly towards the transom for the full length or a portion of the length of the hull. At least the forward part of the bottom between chines is a portion of the surface of a hyperboloid. The hyperboloid may be the simpler form which is generated by a rotating straight line or lines extending at an angle to its axis and spaced therefrom and having either a circle or an oval as its directrix. The hyperboloid surface may be that of the parabolic hyperboloid, more commonly known as a hyperbolic paraboloid, which surface is generated also by straight lines extending at angles between chines. The hyperboloid form of bottom may extend the full length of the hull or may extend for a substantial length thereof from the bow, and the rest of the bottom to the transom at the rear may take another form of surface. The transverse axis of the hyperboloid surface may be at the longitudinal center of the hull but usually it will be forward of the center to give suitable curvature for the bow and fore-bottom surface of the boat hull. There is wide latitude in the spacing of the chines, however, it is no greater than the dimension of the gorge of the simple hyperboloid surface. Preferably the rear portion of the bottom extending from the hyperboloid portion to the transom is a portion of the surface of a conoid with straight lines extending longitudinally. With a conoid form for the rear part of the bottom, the bottom edge of the transom may be straight, concave or convex. The sides and top or deck of the hull may take any desired form as well as the transom except as the bottom edge will conform to the hull bottom.

22 Claims, 11 Drawing Figures

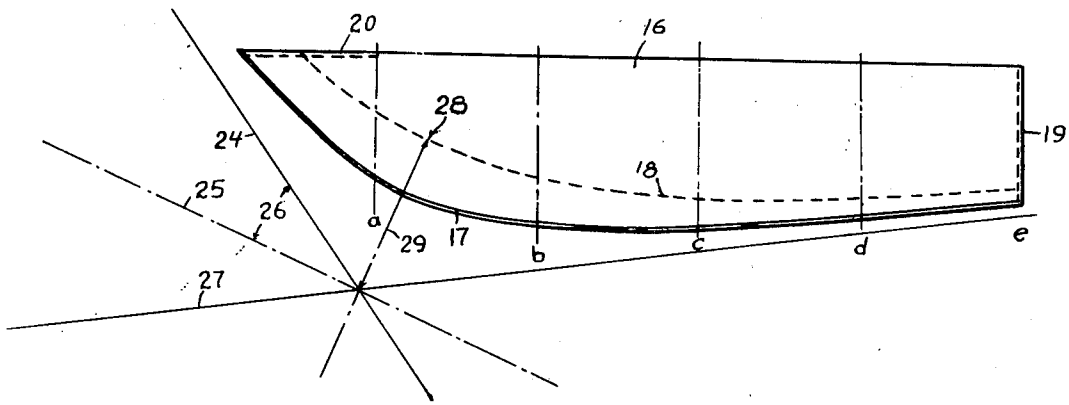


Fig 1

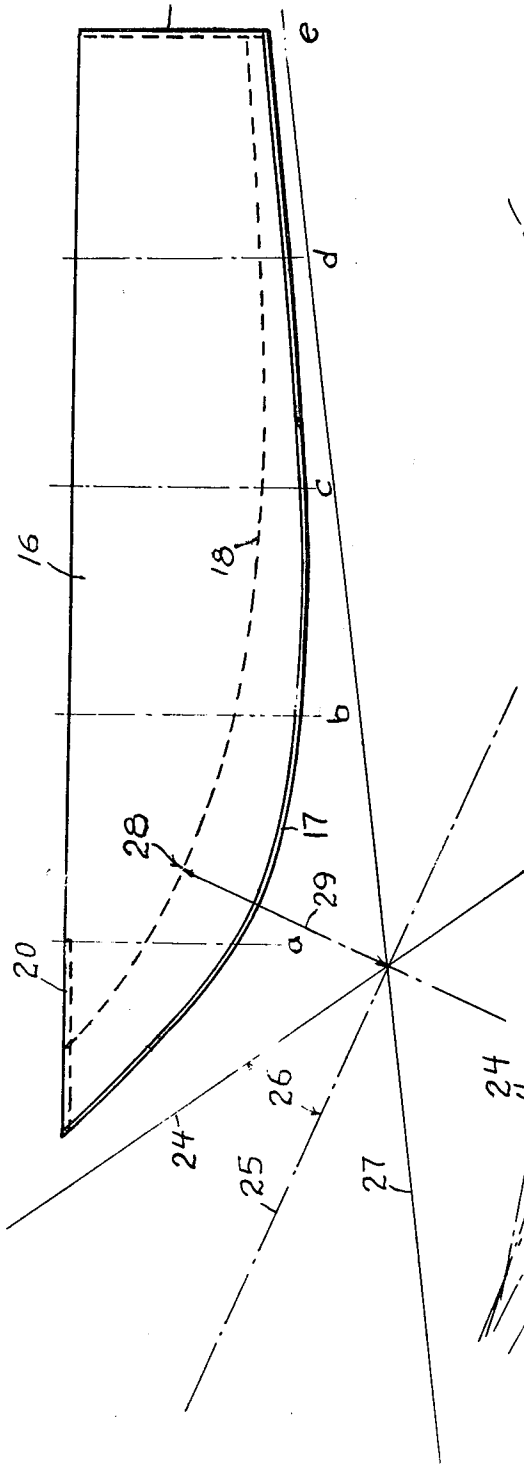
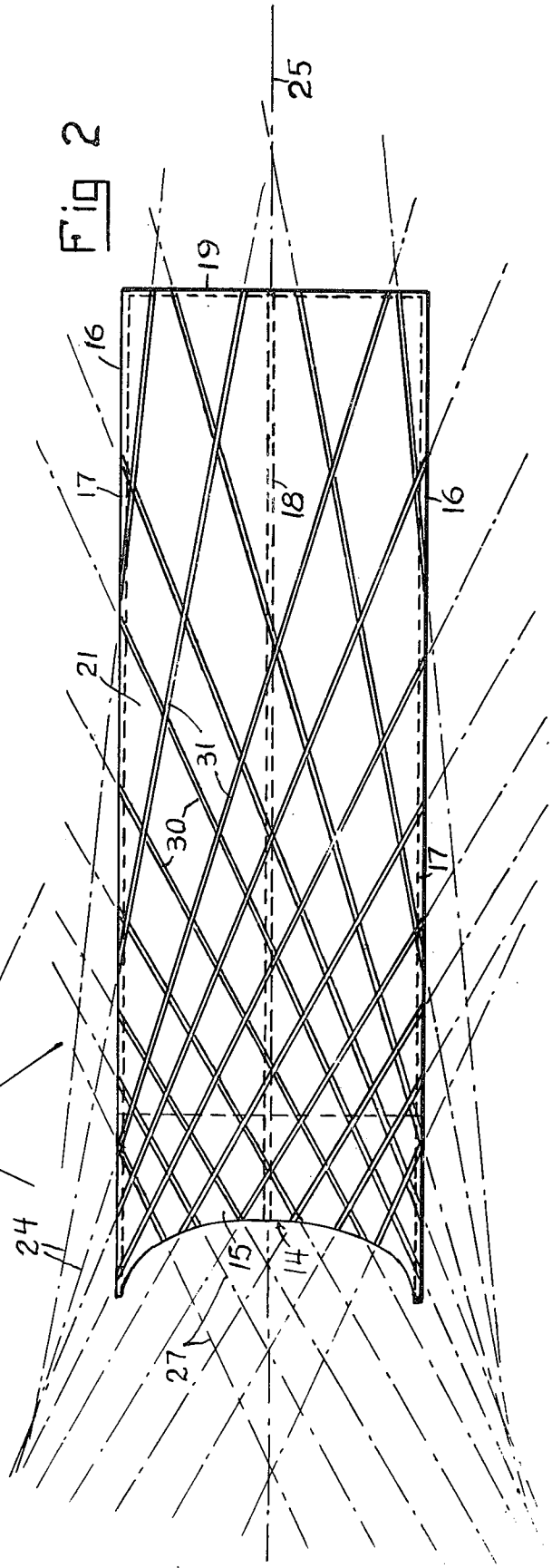

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Fig 2


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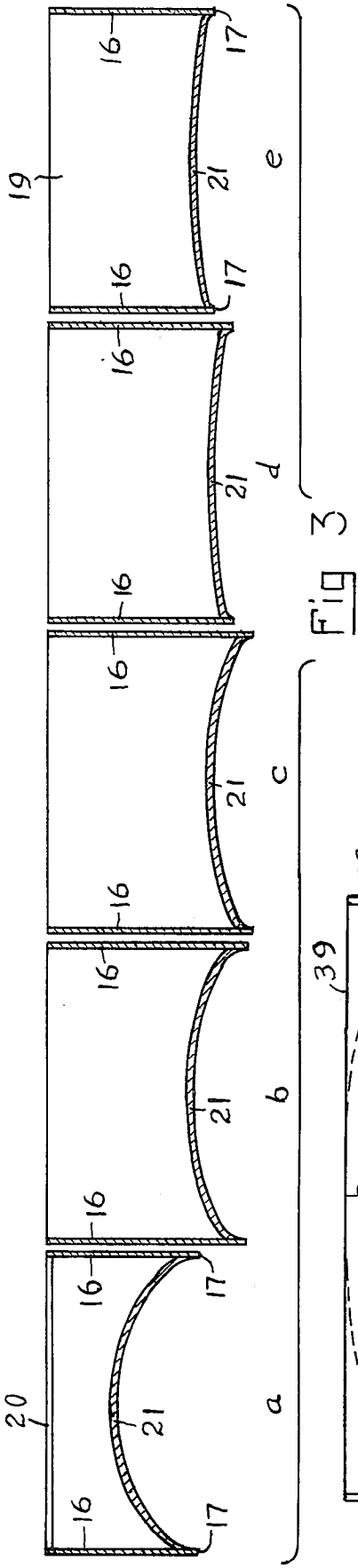


Fig. 3

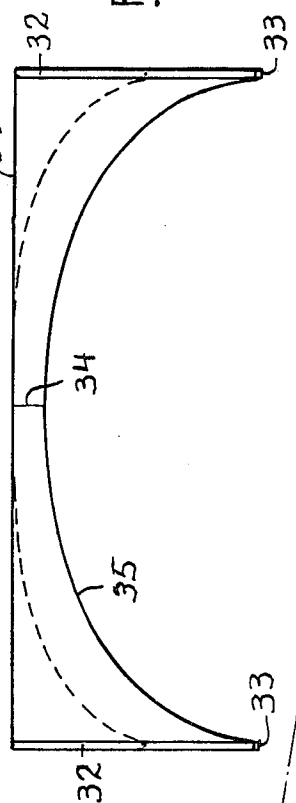


Fig. 5

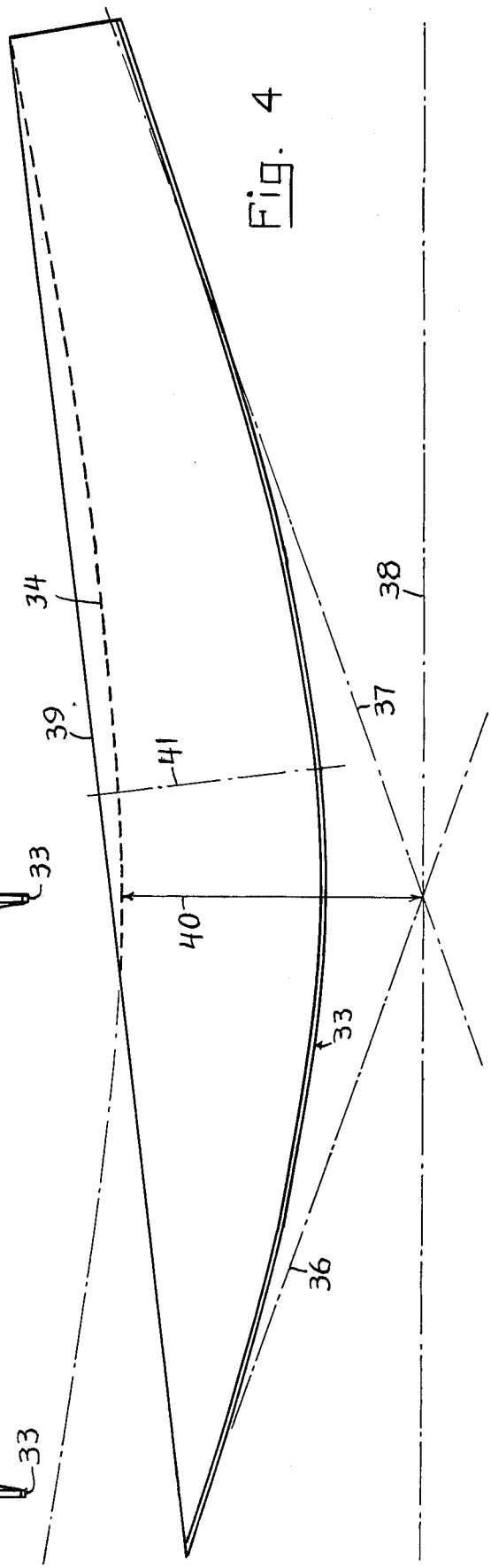


Fig. 4

Fig. 8

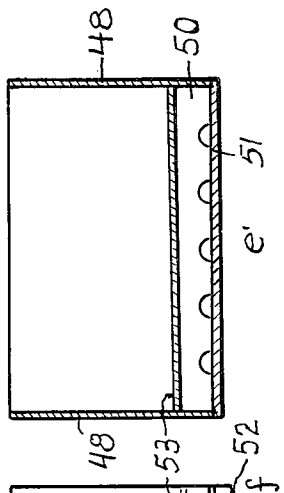


Fig. 6

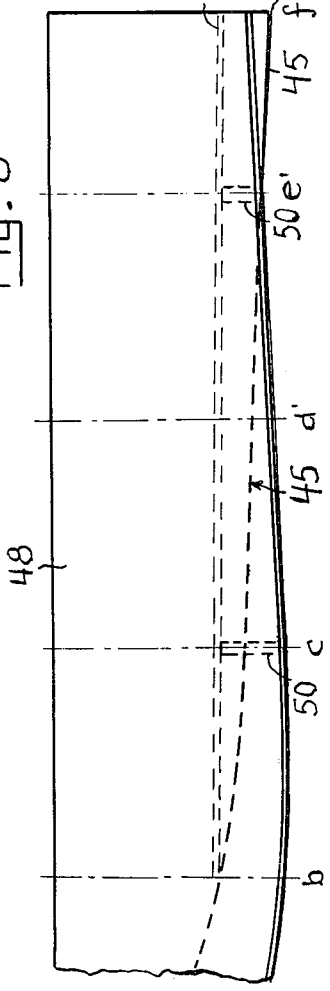


Fig. 9

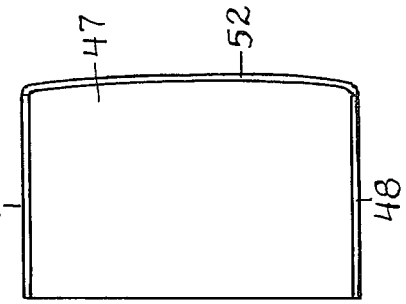
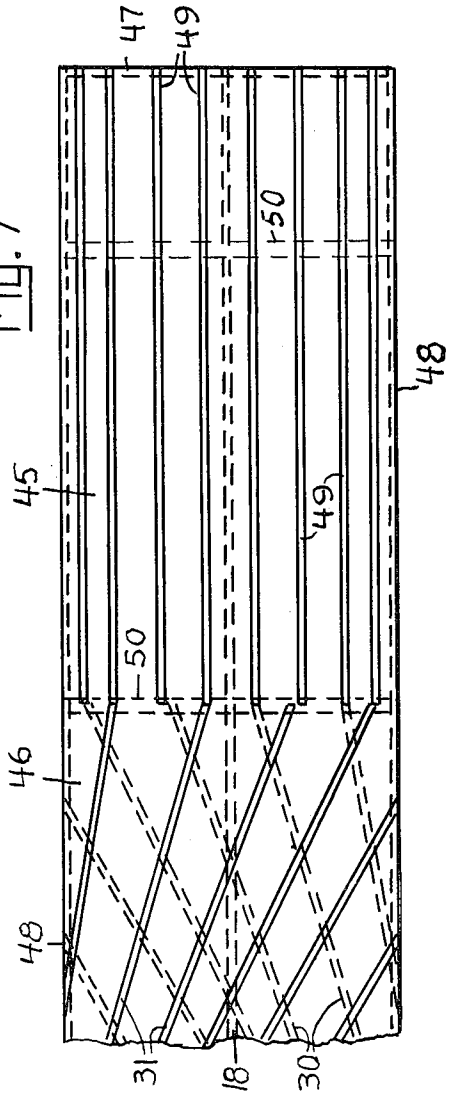


Fig. 7



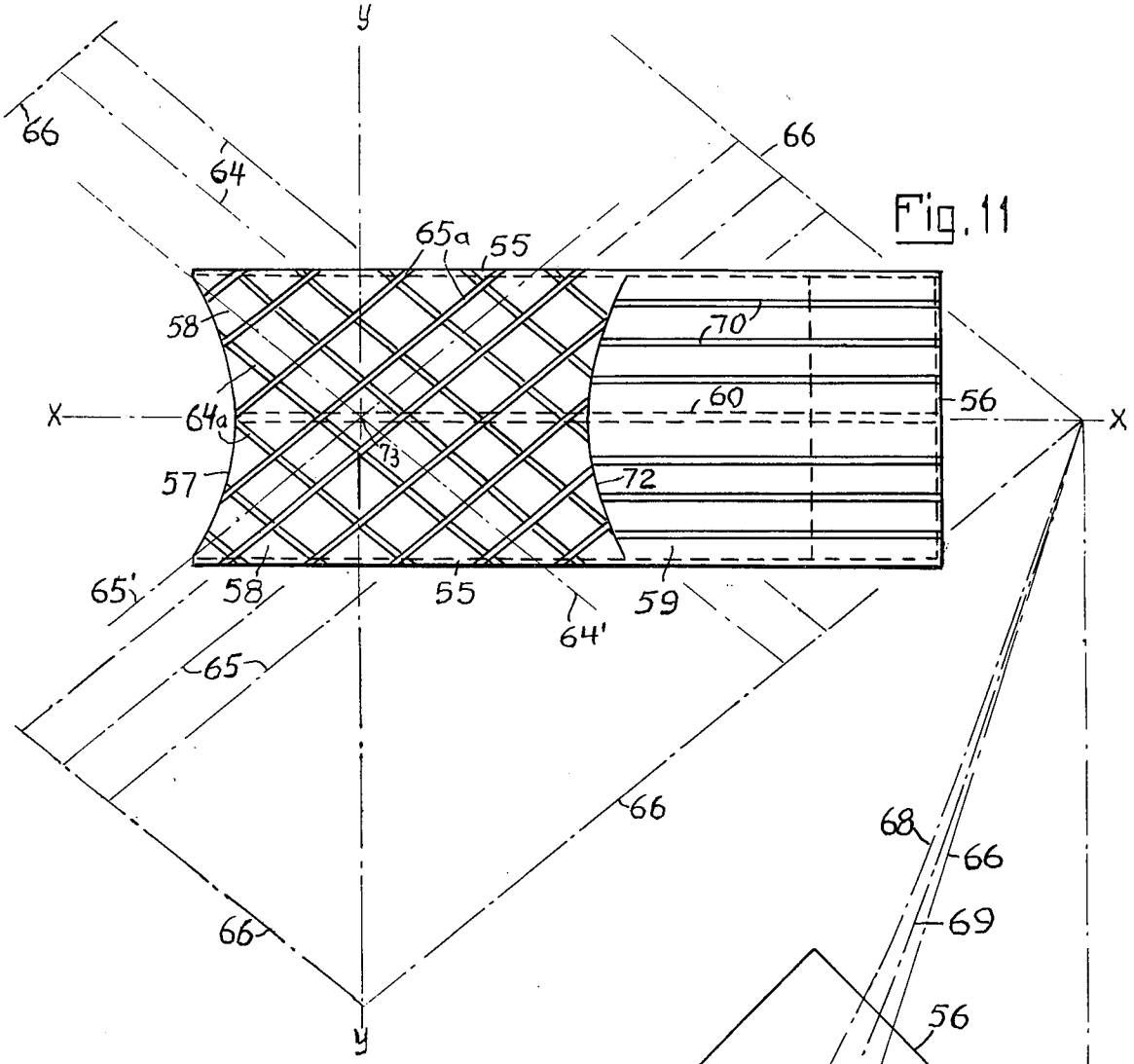

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70
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72
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Fig. 11

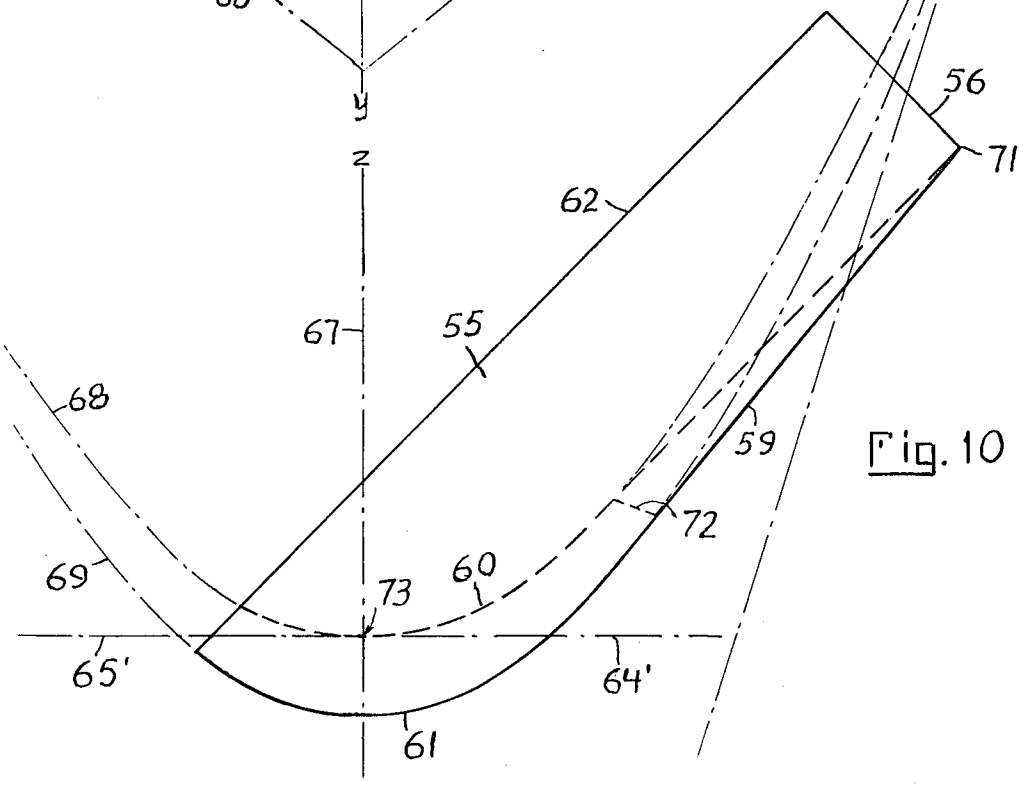

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69
56
71
z
62
67
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73
65'
64'
61

Fig. 10

BOAT HULL WITH A BOTTOM OF A PORTION OF THE SURFACE OF A HYPERBOLOID

The boat hull to be described is of the sea sled type in that it has spaced chines and a double pointed bow. The bottom between the chines is a ruled surface or surfaces with at least the forward portion being a portion of the double ruled surface of a hyperboloid. There are two such surfaces, one being a simple hyperboloid and the other a parabolic hyperboloid, more commonly known as a hyperbolic paraboloid. Both of these surfaces are generated by straight lines which extend at an angle to the chines. The chines and keel line for the simple hyperboloid surface are hyperbolas and the chines and keel line for the parabolic hyperboloid surface are parabolas. The hyperboloid surface may extend for the full length of the hull or it may extend for a substantial part of the length of the hull from the bow and the bottom from the end of the hyperboloid portion to the transom preferably is a conoid surface which is a ruled surface also with all buttock lines being straight.

The principle object of the invention is to construct a boat hull having a bottom which is a portion of a hyperboloid surface for at least a substantial distance from the bow.

Another object is to construct a hull as above in which the bottom is the surface of a portion of a simple hyperboloid for at least a substantial distance from the bow.

A further object is to construct a boat hull in which the bottom is a portion of the surface of a parabolic hyperboloid for at least a substantial distance from the bow.

Another object is to construct a boat hull with a bottom which is a portion of a hyperboloid surface and in which the concave tunnel is deep so that the hull approximates a twin hulled craft or catamaran.

Another object is to construct a boat hull in which the forward portion of the bottom is a portion of a hyperboloid surface and the aft portion is the surface of a conoid with the bottom edge of the transom being either straight, concave or convex.

Other objects of the invention will be more apparent from the following description when taken in connection with the accompanying drawings which illustrate some preferred embodiments thereof in which:

FIG. 1 is a profile of a boat hull with a hyperboloid bottom surface;

FIG. 2 shows the boat hull of FIG. 1 laid on a portion of a hyperboloid surface;

FIG. 3 shows sections of the hull of FIG. 1;

FIG. 4 is a profile of a hull with a deep tunnel;

FIG. 5 is a bow view of the hull of FIG. 4;

FIG. 6 is a partial view of a hull with a hyperboloid bottom surface for the bow and a conoid surface for the aft portion of the bottom;

FIG. 7 shows the bottom of the hull of FIG. 6;

FIG. 8 is a section of the hull of FIG. 6 on line *e'*;

FIG. 9 is an end view of the hull of FIG. 7;

FIG. 10 shows the profile of a boat hull with the bow area of the bottom being a portion of the surface of a parabolic hyperboloid and the aft portion being a conoid surface; and

FIG. 11 shows the bottom of the hull of FIG. 10.

The hull of FIG. 1 includes a bow curve **14** for the bow **15**, sides **16** of any desired form having chines **17**, a keel or keel line **18**, a transom **19**, preferably a deck **20** over at least a part of the hull and a bottom **21** between chines from the bow to the transom. The chines may be parallel for the full length of the hull as illustrated or may be parallel for the forward portion and taper somewhat inwardly in the aft portion or may taper somewhat for the full length of the hull which tapers however are essentially parallel. The bottom is a ruled surface for the full length of the hull that shown in FIG. 1 being a portion of the surface of a simple hyperboloid of one nappe or sheet.

The simple hyperboloid surface of FIGS. 1, 2 and 3 is generated by a straight line or generator **24** which rotates around an axis **25** and spaced therefrom and also extending at an angle **26** with respect to the axis. A second straight line or generator **27** equally spaced from the axis and extending at the same but an opposite angle would generate the same hyperboloid surface so that it is a double ruled surface. The angle of the generators may be in the region between about 20° to 60°. There are then pairs of straight lines in this surface which extend at an angle to the chines. The angle of the generators of the surface illustrated with respect to the axis is about 31°. The simple hyperboloid has a gorge or saddle portion **28** of minimum diameter or dimension at the transverse axis **29** where the arc or curvature of the saddle portion has a minimum radius. The chines are spaced apart a distance not greater than the gorge diameter and preferably is somewhat less than this dimension. The chines are in the hyperboloid surface and hence are hyperbolas for the length of the hyperboloid surface as is the keel line **18** and any longitudinal section of the bottom of the hull. The vertical sections *a*, *b*, *c*, *d* and *e* of FIG. 3 show the bottom as concave ovals of successively reduced depth.

The bottom of the hull may be shaped by applying a ply of straight elements **30** such as tapes, strips or slats extending at an angle to the chines which are in line with the generator lines **27.** If desired the bottom may be further supported and strengthened with a second ply of straight elements **31,** such as tapes, strips or slats extending crosswise of the bottom from chine to chine in alignment with the straight line generators **24.**

FIGS. 4 and 5 illustrate a hull which approximates a catamaran hull of spaced hull sections. This hull has any form of sides **32** with chines **33,** a keel line **34** and a bottom **35.** The bottom is a portion of the surface of a simple hyperboloid with straight line generators **36** and **37.** The generators particularly shown extend at about **20** degrees with respect to the hyperboloid axis **38.** The keel line **34** is adjacent to the deck or deck line **39** so that a deep tunnel results as shown in FIG. **5.** The chines and keel line are in the surface of the hyperboloid and hence are hyperbolas. For increased buoyancy the sides may extend outwardly in any suitable fashion. The hull illustrated has the gorge or transverse axis **40** forwardly of the longitudinal center **41** of the hull although it could well be located at the longitudinal center in which event the fore and aft halves of the bottom would be identical. The bridge connection between the two hull sections is within the hull structure between the keel line **34** and the deck line **39.**

The surface of the simple hyperboloid used for the hulls of FIGS. **1** to **5** may have circles as the directrices guiding the movement or rotation of the generators or the directrices may be oval or even one oval and one circular. If the rear directix is oval, the oval tunnel flat-

tens out faster as it approaches the transom when the rear portion of the bottom is at the greater dimension of the oval directrix.

The hull of FIGS. **1** to **3** has an oval and concave bottom edge for its transom **19**, as shown by section FIG. **3***e*. If it should be desired that the bottom edge be straight as shown in FIG. **8** or convex as shown in FIG. **9**, this can be accomplished by constructing the aft part of the bottom with a portion of the surface of a conoid **45** which would extend from the end of the hyperboloid portion **46** to the transom **47**. The sides **48** may be of any form. The conoid surface is a ruled surface having straight generators extending longitudinally as illustrated by the elements **49** extending to the bottom edge of the transom. Preferably the elements are tangent to the hyperboloid surface in which event the section at the juncture of the two surfaces would be an elipse. An approximation of the tangent structure would be a rib **50** extending across the hull as illustrated. If it should be desired to have the bottom edge **51** of the transom to be straight, the straight line directrix of the conoid would then be the bottom of the transom, for example, as illustrated by the section FIG. **8**. If on the other hand a convex bottom surface for the aft part of the hull is desired then the conoid surface will extend beyond the straight line directrix **51**, and the bottom edge of the transom will be convex. If a longer area of convexity is wanted, the conoid surface may be extended farther beyond the directrix. For a concave surface the directrix would be rearwardly of the transom. There are many variations of this combined form of hull bottom such as the transom may be deeper for increased bouyancy and freeboard in which event the juncture **72** of the hyperboloid and conoid surfaces would be farther forward and preferably with tangency between the surfaces at their juncture.

It has been mentioned that a second ruled surface a portion of which may be used to construct or shape the bottom of the hull is that of a parabolic hyperboloid or hyperbolic paraboloid. A hull using this surface for the bottom is illustrated in FIGS. **10** and **11** having sides **55**, transom **56**, bow **57** and bottom **58,59**. The chines **61** are shown as parallel to each other and for the hyperboloid portion lie in the surface so that they are parabolas as are the keel line and all longitudinal sections. The chines may be parallel in the forward portion and taper in the aft portion or may taper somewhat for the length of the hull. The sides may take any form deemed desirable and the chines may be spaced apart any desirable distance since there is no gorge limitation. There is no known empirical or theoretical data for this type of hull, however, it is thought for most craft a ratio of chine spacing to tunnel depth at the saddle point would be between a higher ratio of 4:1 and a lower ratio of 2:1 with lower ratios for a catamaran. The transom may be located any desired distance from the bow. The deck indicated by a deck line **62** may take any form and extend over any area of the hull. Cross sections of this hull in the hyperboloid portion will have a bottom of concave and parabolic form. The bow of the hull is in the region of the saddle point, which is the equivalent of the gorge of FIG. **1**, where the arc or curvature has its minimum radius.

The parabolic hyperboloid is generated by straight lines **64, 65**, several being shown, extending from the directrices **66**. The angle of the generators projected on the *x–y* plane extend at an angle in a range from about 20° to 60° with respect to the *x* axis, and is a double ruled surface. The angle of the directrix **66** in FIG. **10** in the *x–z* plane is 18½° with respect to the *z* axis. The minimal point of the saddle is the saddle or hyperbolic point **73** at the intersection of the generator lines **64′**, **65′** with the vertical axis **67**. The directrices are shown as straight, however, they could be symmetrically curved somewhat and yet provide a double ruled surface which is symmetrical with the keel line. The keel line corresponds with the parabola **68** and the chines correspond with the parabola **69** in the hyperboloid area. The bottom may be constructed in many ways as described hereinafter.

The entire bottom may be a portion of the surface of the parabolic hyperboloid with the keel line following the parabola **68** and the chines following the spaced parabolas **69** to the transom **56**. If this form of bottom is desired the hull illustrated may be tilted or shifted counter-clockwise to provide a greater depth for the transom and more freeboard for the rear. Preferably the rear portion of the hull bottom is a portion of the surface of a conoid **59** with longitudinal straight lines which may be straight elements **70** such as slats, strips, tapes and the like. Preferably too the elements are tangent to the hyperboloid portion at the juncture **72** of these two surfaces. The straight line directrix **71** for the conoid may be at the bottom edge of the transom or may be spaced forwardly of the transom with a convex shaped bottom edge for the transom in the manner described in connection with FIGS. **6** to **9** or may be rearwardly of the transom for a concave bottom edge for the transom. The bow of the hull is in the region of the saddle or vertical axis **67** of this hyperboloid. Straight line generators **64′** and **65′** of the surface which intersect at **73** at the keel line **60** are shown in FIGS. **10** and **11**.

A parabolic hyperboloid surface for the bottom of a hull of the catamaran type with a deep tunnel may be similarly constructed as described and illustrated hereinbefore. For such hull a flater form of this hyperboloid can be used with the vertical axis **67** at or forwardly of the midpoint of the hull. Also such hull can be constructed with a deep tunnel in the manner in which the hull illustrated in FIG. **10** is laid out but with a greater beam and the deck line **62** closer to the keel line **60**.

The bottom of the hull may be constructed in several ways. One such way is to locate the points on the chines where the straight lines terminate and stretch a sheet or fabric on the chines pulling it taut so that it is tensioned at these terminal points. This produces a bottom with a prestressed surface. The sheet will take the hyperboloid form. A bottom may be built up on this sheet in any way such as spraying or otherwise appling plastic, fiberglass or other material thereover. Another way is to apply at least one continuous ply of straight elements **30** or **64a** over the entire bottom and if greater strength is desired to lay a second continuous ply of straight elements **31** or **65a** over the first ply and seal with any suitable material. Another way is to stretch a sheet as described and lay over this sheet one ply of spaced straight elements **30** or **64a** and spray material thereover to form a bottom which is reinforced by the angularly laid elements. For greater strength a second ply of spaced elements may be laid crosswise over the first ply and then sprayed with a plastic or the like for a double reinforced bottom with cross bracing of the chines, transom and bottom by the elements. Any number of

plies may be used in constructing the bottom. When the bottom is tensioned or stressed, ribs, such as **50**, or a floor **53** or both will be provided to brace the chines. The above is merely illustrative of a few of the many ways in which the bottom may be constructed.

With the chines in the simple hyperboloid form of bottom being hyperbolas and the chines of the parabolic hyperboloid form of bottom being parabolas these curves are termed bola curves herein. The keel lines and any longitudinal section are also bola curves.

The angles of the generator or generators for the simple hyperboloid with respect to its longitudinal axis and the angles of the directrices of the parabolic hyperboloid are the control angles which determine the degree of curvature of these two surfaces and range between about 20° and 60°.

The hyperboloid bottom surface at the bow extends for a substantial portion of the length of the hull and would represent the region of greater curvature. This may be roughly at least **25** percent of the hull length for the usual hull. The longer the hull without change in the bow would reduce a percentage figure and at the larger control angles the curvature of the bow becomes sharper. The support for the bottom probably is increased by the number of straight elements which extend from chine to chine, however, at least one such element for each ply would appear advantageous. In the figures of the drawings the deck line is synonymous with the sheer line.

A hull bottom of a portion of the surface of a simple hyperboloid or of a parabolic hyperboloid is particularly desirable for another reason. These surfaces are quadrics so that the various design factors can be programmed into a computer and the surface dimensions and offsets can be determined very quickly and precisely without resorting to lofting. Similarly other pertinent technical hull factors can be quickly determined with a computer. Similarly the conoid is a surface which can be programmed into a computer.

The invention herein is presented to fill a need for improvements in a boat hull of the sea sled type. Various modifications in structure, as well as changes in mode of operation, assembly and manner of use, may and often do occur to those skilled in the art especially after benefiting from the teachings herein. This disclosure illustrates the preferred means of embodying the invention in useful form.

What is claimed is:

1. A boat hull comprising at least a bow, spaced sides, a bottom secured at least to the sides, a transom, and a keel line extending longitudinally and centrally of the bottom; each side having a bottom edge forming chines which are parallel or essentially parallel to each other, the bottom extending between the chines and between the bow and the transom, the bottom for at least a substantial portion of the length thereof from the bow being a double ruled surface having a gorge or saddle with a dimension and an axis, the double ruled surface being of crossed straight lines having a control angle between about **20** to **60** degrees, the chines being spaced apart a distance within the dimension of the gorge or saddle, and the axis of the gorge or saddle being located at or forwardly of the longitudinal center of the hull, and each chine and the keel line being a bola curve for the length of the double ruled surface.

2. A boat hull as in claim **1** in which the double ruled surface of the bottom is a portion of the surface of a hyperboloid.

3. A boat hull as in claim **2** in which the hyperboloid surface of the bottom is a portion of the surface of a simple hyperboloid.

4. A boat hull as in claim **2** in which the hyperboloid surface of the bottom is a portion of the surface of a parabolic hyperboloid.

5. A boat hull as in claim **2** in which the bottom from the bow for a substantial portion of the length of the hull is a portion of the surface of a hyperboloid and the bottom from the hyperboloid portion to the transom is a portion of the surface of a conoid with longitudinally extending straight lines.

6. A boat hull as in claim **5** in which the transom has a bottom edge which is straight.

7. A boat hull as in claim **5** in which the transom has a bottom edge which is convex.

8. A boat hull as in claim **5** in which the transom has a bottom edge which is concave.

9. A boat hull as in claim **5** in which the longitudinal sections of the hyperboloid surface are bola curves and the longitudinal straight lines of the conoid portion are tangent to the bola curves at the juncture of the two surfaces.

10. A boat hull as in claim **5** in which the hyperboloid surface is that of a simple hyperboloid.

11. A boat hull as in claim **5** in which the hyperboloid surface is that of a parabolic hyperboloid.

12. A boat hull as in claim **5** in which the hyperboloid portion of the bottom includes a plurality of first straight elements extending at an angle to the chines and crosswise of the bottom and a plurality of second straight elements extending at an equal but opposite angle to the chines to that of the first elements and crosswise of the bottom, and a plurality of longitudinally extending straight elements shaping the conoid portion of the bottom.

13. A boat hull as in claim **1** in which the bottom includes at least a single ply of straight elements extending at an angle to the chines.

14. A boat hull as in claim **13** including at least one straight element extending from one chine to the other chine.

15. A boat hull as in claim **1** in which the bottom includes at least one pair of plies having a first ply of straight elements extending between chines and angularly with respect thereto in one direction, and a second ply of straight elements extending at equal and opposite angles to the chines with respect to the straight elements of the first ply.

16. A boat hull as in claim **15** including at least one straight element of each ply extending from one chine to the other chine.

17. A boat hull as in claim **1** in which the bottom surface between chines forms a tunnel and the chines are spaced apart a distance to provide a deep tunnel.

18. A boat hull as in claim **17** in which the chines are spaced apart a distance approximating the lateral dimension of the gorge or saddle, and the deck line is adjacent to the keel line.

19. A boat hull as in claim **1** in which the bottom includes fabric prestressed along the crossed straight lines of the double ruled surface.

20. A boat hull as in claim **19** in which the fabric covers the entire bottom from chine to chine.

21. A boat hull as in claim 1 in which the rear portion of the bottom has chines and a bottom surface and a bottom edge for the transom of conoid form and the bottom includes fabric prestressed along crossed straight lines for the double ruled surface, and fabric prestressed along the longitudinally extending lines of a conoid surface for the rear portion of the bottom.

22. A boat hull as in claim 21 in which the fabric covers the entire bottom from chine to chine.

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