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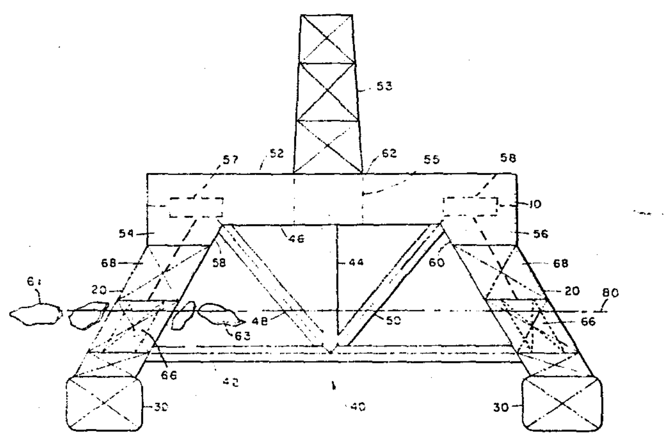
(54) Wide based semi-submersible vessel.

(57) A wide based semi-submersible vessel comprising a watertight buoyant deck (52), a plurality of stability columns (20) extending downwardly and outwardly from the deck, means (30) connected to the lower ends of the stability columns for providing a wide buoyant base, and means (64) for discharging and taking on ballast.



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WIDE BASED SEMI-SUBMERSIBLE VESSEL

The present invention relates to a semi-submersible vessel having a novel arrangement of buoyancy pontoons or footings, stability columns and deck to provide a vessel with improved stability characteristics. A vessel constructed in accordance with the present invention is also particularly suitable for use in ice-infested waters.

The conventional semi-submersible vessel is the product of an evolution in design. During the initial offshore exploration for and production of hydrocarbons, drilling technology was based on shore-side experience. The supporting offshore platforms were either fixed structures or towers built on pilings, or a barge or caison which was floated out to the offshore site and then flooded to rest on the subsea bottom. When further exploration placed wells farther offshore, the increasing water depth required improved structures. The barge or caison approach evolved into a floating structure having submerged buoyant pontoons or footings, stability columns extending upwardly through the water surface, and a non-buoyant deck on top of the stability columns. The deck supported a drilling rig and other exploration equipment. To minimize the vertical movement of the drilling rig, the cross-sectional area of the stability columns was minimized at the water-line level. The resulting vessels are collectively called semi-submersibles.

While the configuration of offshore supporting structures was evolving to accommodate deeper water, the well locations were also extended into more hostile environments. The first offshore wells were drilled in protected waters close to shore. When storms threatened, personnel were evacuated until the danger passed. Today however the frontiers of offshore drillng are located in remote waters far from the shore. The distances from shore prohibit rapid evacuation in stormy weather, and the offshore platforms are exposed to increasingly severe storms since the waters are not protected by land masses.

Because the conventional design of semi-submersibles is a product of evolution through conditions different than those experienced today at remote and often hostile sites, the stability characteristics of the offshore platform do not best accommodate the conditions imposed on the vessel by operation in such remote environments.

Conventional semi-submersibles are deballasted when severe weather strikes to ensure a sufficient air-gap between large waves and the bottom of the deck structure, and to increase the height of the working platform. However, such deballasting has an undesirable effect of exposing more surface to the wind and waves while actually raising the center of gravity and reducing the metacentric height.

There are three facets to the stability phenomenon; initial, large angle, and damaged. The initial stability of a vessel is the familiar concept of metracentric height (GM). It represents the vessel's resistance to heeling over small angles, up to 5° to 10°, and is essentially a characteristic of the vessel's waterplane. The technique of quantifying large angle stability differs from measuring the GM. To measure the stability, the righting arms of the vessel are calculated over a range of heel angles. The area under the resulting curve represents the energy the vessel can absorb. Lastly, damaged stability measures the ability of the vessel to withstand tank or compartment flooding. Though more subjective then the other aspects of stability, a thorough analysis reveals the vessel's ability to survive within the design criteria.

Conventional semi-submersibles lose initial stability when deballasting. Because ballast water is located low in the pontoons, the vertical center of gravity of the vessel (VCG) is raised when it is pumped out, and the GM is reduced. The present rational behind such procedure in adverse weather is that the large angle stability is improved by providing more reserve buoyancy to resist large angle heeling as well as increasing the angle to which the vessel may heel before downflooding occurs. Also, when the operators wish to move the semi-submersible, the draft is reduced until the pontoons surface. The intermediate condition before the waterplane is dramatically increased with the emergence of the pontoons often presents a situation with marginal stability.

The simplistic answer to the problem would be to increase the beam of the vessel until the minimum GM was acceptable. Unfortunately, too much initial stability is also detrimental. The high accelerations resulting from extreme GM at the operational draft would both degrade the crew and require additional steel throughout the structure to handle the inertial loadings. Further, the entire deck structure itself would increase due to the larger spans encountered between the stability columns.

Another problem occurs in exploiting offshore ice-infested areas where masses of ice continuously form during certain parts of the year. These ice masses may include sheets of ice having thicknesses of eight feet thick or more which may have substantially thicker "pressure ridges". These ice masses are not stationary and may move several hundred feet per day under the influence of surface winds and currents. Obviously, these moving ice masses develop substantial forces which, in turn, may be destructive to objects lying in the path of the ice masses.

In accordance with the present invention, there is provided a wide based semi-submersible vessel comprising a deck, a plurality of stability columns extending downwardly and outwardly from the deck, means connected to the lower ends of the stability columns for providing a wide buoyant base and means for taking on and discharging ballast to increase and decrease the draft of said vessel.

The present invention solves the stability problem by angling the stability columns outboard from the deck structure to a wider supporting base, and by making the deck structure itself watertight and effective at large angles and when damaged. The wide effective beam at shallow drafts provides greater GM while the angularity of the columns limit the stability at deep drafts and does not require additional deck steel. The buoyant deck structure contributes to the large angle stability when immersed and provides reserve buoyancy in the event of catastrophic damage, i.e., the loss of a stability column.

The resulting wide based semi-submersible vessel is superior to the conventional design of semi-submersibles. The GM over the range of drafts can be optimized such that the stability never degrades below minimum values. At the same time, the angularity of the columns prevents the GM from becoming excessive. In all cases, the large angle stability of the wide based semi-submersible vessel exceeds that of the conventional straight-legged configuration. When damaged, the wide based semi-submersible vessel better withstands flooding resulting in greater residual righting energy and less danger of downflooding. It is contemplated that the angularity of the columns with respect to the vertical can be within the range of greater than 0° to less than 90°.

A semi-submersible vessel is particularly suitable for use in ice-infested waters. The strength of an ice mass in compression is substantially greater than in flexure or bending. In accordance with an aspect of the present invention ballast is discharged and taken on when desirable to bring the stability columns into contact with an ice mass. As the vessel rises the outboard surfaces of the downwardly and outwardly extending columns would exert an upward or bending force against an ice mass located outboard of the vessel to break such mass. Conversely, lowering the vessel causes the inboard surfaces of the columns to exert a downward bending force against ice located beneath the deck. Ballast may be continuously taken on and discharged to cyclically lower and raise the vessel when ice conditions are severe.

FIG. 1 shows a side elevational view of a semi-submersible vessel constructed in accordance with the present invention;

FIG. 2 shows a top plan view of the vessel of FIG. 1;

FIG. 3 shows an end elevational view of the vessel of FIG. 1, with a drilling rig;

FIG. 4 is a schematic side elevation view of a baseline vessel having vertical stability columns;

FIG. 5 is an end elevational view of the vessel of FIG. 4;

FIG. 6 is a top plan view of the vessel of FIG. 4;

FIG. 7 is an end elevational view of an embodiment of the present invention wherein the stability columns are angled 10°;

FIG. 8 is an end elevational view of an embodiment of the present invention wherein the stability columns are angled 15°;

FIG. 9 is an end elevational view of an embodiment of the present invention wherein the stability columns are angled 20°;

FIG. 10 is an end elevational view of an embodiment of the present invention wherein the stability columns are angled 30°;

FIG. 11 shows curves representing characteristics of vessels with differing stability column angularity;

FIGS. 12A-12F show curves of righting arm versus heel angle for the straight legged baseline vessel, and for the wide based semi-submersible vessel configurations in accordance with the instant invention; and

FIGS. 13-23 show examples of typical semi-submersible vessel configurations which are modifiable in accordance with the present invention to provide a wide buoyant base and thereby improve stability of such vessels.

With reference to FIGS. 1-3, there is shown a wide based semi-submersible vessel having a watertight buoyant deck 10 supported on three stability columns 20 which extend continuously downwardly and outwardly from the bottom of each outboard side of the deck 10. The three stability columns 20 on each side of the vessel are connected to a respective elongated pontoon 30 to provide a wide buoyant base for the vessel 30. As shown in FIG. 3, an example of a structural truss arrangement 40 is provided between each of the opposing three pairs of stability columns 20 and the bottom of the deck 10 to ensure structural integrity of the vessel. Each one of the three structural truss arrangements 40 has a transverse member 42 interconnecting an opposing respective pair of stability columns 20, a vertical member 44 extending upwardly from the center of the transverse member 42 to the bottom 46 of the deck 10, and a pair of diagonal members 48, 50 extending upwardly from the center of the transverse member 42 to the bottom 46 of the deck 10. The structural truss arrangements may take any form or shape so long as structural integrity of the vessel is maintained.

The deck 10 has a transverse center portion 52, a sponson portion 54, 56 extending downwardly from each side of the center portion 52 of the deck 10. The inner surface 58, 60 of each of the sponson 54, 56 extends downwardly and outwardly from the center portion 52 of the deck 10 at an angle which may correspond to the downwardly and outwardly extending three stability columns 20 on each side of the vessel.

The bottom 46 of the deck 10 is constructed to be structurally sufficient to withstand "wave-slap" loads from the sea, and the entire deck is constructed to be structurally watertight up to the level of the main or weather deck 62.

Sea water ballast, fuel oil, and drilling water are suitably located in tanks 64 located in each of the buoyancy pontoons 30 and in tanks 66 located in each of the stability columns 20. Spaces for propulsion motors and shafting, thrusters, are located in the lower portions of the buoyant pontoon 30. Dry bulk storage for drilling mud and cement may be located in the upper tanks 68 of the stability columns 20 and in the deck 10. Machinery spaces, storage spaces, workshops and living accommodations are also located in the deck 10. The main or weather deck 62 may be used for additional storage space, pipe racks drilling rig and other drill equipment and machinery, additional accommodations, dedicated or specialized shops and equipment, such as fire fighting.

The stability columns 20 are inclined away from the vertical at an angle specifically choosen to enhance the stability characteristics of the vessel, which can be in the range of greater than 0° to less than 90°. At the normal operational waterline 80, the effective beam of the vessel, and hence the stability of the vessel, is increased without increasing the span and weight of the deck structure, the increasing effective beam increases the stability of the vessel. When deeply ballasted, the low location of the ballast water in the ballast tanks 64 of the buoyancy pontoons 30 lowers the center of gravity of the vessel, and even though the effective beam of the vessel is reduced, the stability of the vessel is not impaired.

As shown in FIG. 3, the twin-sponson 54, 56 arrangement forms with the bottom 46 of the deck 10 with an inverted "V" shape between the sponsons 54, 56. Such configuration of the bottom 46 of the deck 10 improves the vessels capacity to resist the impact of "wave-slap" when deeply ballasted while minimizing detrimental interference of the deck 10 at operational draft. Further, because the deck 10 is watertight throughout, the buoyancy of the deck 10 will prevent capsizing in the event of catastrophic damage, flooding, or other accident.

Following are the results of a study performed to demonstrate the advantages of the present invention:

CONSTRAINTS

The semi-submersible hullform used to study the effect of the proposed configuration was based on the MSV "IOLAIR". The "IOLAIR" consists of twin pontoons supporting six stability columns under a buoyant deck. The pontoons are "ship-shape" in that they have a faired bow forward and a ship-form stern supporting a ducted propeller. The stability columns are rectangular in cross-section with radiused corners.

In order to highlight the effect of wide based semi-submersible vessel configuration, several simplifications were applied to the "IOLAIR" form as shown in FIGS. 4-6. Primarily, all elements, pontoons 92 and stability columns 94, were regarded as rectangular in section without radiuses, and all six stability columns 94 were given the same dimensions. Further, the forward and aft ends of the pontoons 92 were considered blunt without any fairing. The forward columns were considered flush against the forward perpendicular and the aft columns similarly located against the after perpendicular. The dimensions of both the pontoons 92 and the stability columns 94 were chosen to be thirty-six feet by twenty-four feet. The columns 94 were oriented with the long dimension fore and aft, and the pontoons 92 with the short dimension vertically. The centerline of the columns 94 were aligned with the center of the respective pontoon. The buoyancy of trusses (not shown) between the columns 94 was ignored. Around the top of the stability columns 94 ran a tight box beam 90, of the same width as the columns and depth as the deck structure of the "IOLAIR," forming a ring of reserve buoyancy. Though not sufficient to support the entire weight of the vessel, this minimum of reserve buoyancy was purposefully chosen to conservatively represent the effect of a buoyant deck without overpowering the contribution of the angular columns. In the final design, the entire deck is to be watertight.

The principal particulars of the baseline vessel of FIGS. 4-6 were adapted from the "IOLAIR" as well. The length of both the pontoons 92 and the main deck 90 (they are flush at each end) became 99.97m (328 feet) and the beam over the main deck 90 became 47.55m (156 feet). The depth of the vessel was held constant at 30.48m (100 feet) with the buoyant deck 90 occupying the top 4.88m (16 feet).

From the straight-legged baseline vessel of FIGS. 4-6, the study varied the angularity of the stability columns over the range of 0° to 30° by rotating the columns outboard from the bottom of the buoyant deck 14.63m (84 feet) above the baseline. Thus, the deck width and all other principal dimensions were held constant.

As the stability columns were angled outward, the offsets were adjusted to maintain a constant cross-section perpendicular to the axis of the column. Because the angularity increased the effective width of the column, the inboard offset was reduced keeping that outboard constant. The pontoons were not rotated with the stability columns but they were located further apart to preserve their orientation to the outboard edge of the columns.

A design displacement of 20,000 mt was chosen for the straight-legged baseline vessel resulting in a nominal 15.24m (50 feet) design draft. However, as the columns were angled outward, the displacement increased somewhat. In order to be consistent, the design displacement for the wide angled configurations was increased to maintain the design draft.

The vessel's VCG at the design displacement was held to be 13.71m (45 feet) above the baseline for all configurations studied. For the other drafts considered, the difference in displacement was attributed to the addition or removal of saltwater ballast. In all cases, the ballast was taken from or added to the volume within the pontoons; at a VCG of 3.66m (12 feet). Therefore, the vessel's VCG at each draft considered was calculated and incorporated into the evaluation. The resultant shifts in VCG were large over the range considered and thus important.

The effect of any consumption of stores and/or supplies would be to reduce the topside weight and thus improve the stability. Therefore, alternative loading conditions were not investigated. Consumption of fuel would either be compensated for by adding ballast within the pontoon, which would not change the stability, or by allowing the vessel to rise out of the water, which would be the same as the deballasting situations calculated.

HULLFORM

The wide based semi-submersible vessel configurations with stability columns angled 10°, 15°, 20° and 30°, are shown in FIGS. 7-9 and 10, respectively.

The exact angle of the stability columns correspond with the nominal figure for the 30° wide based semi-submersible, however, for the case of the configurations with intermediate angles, the actual angle is slightly different than the nominal. Because the characteristics of vessels with columns closer to the anticipated optimum were of importance, the offsets chosen were selected as more realistic, i.e. even numbers. The resulting column angle was rounded-off to become the nominal angle. In any case the difference is quite small, less than one degree.

The hydrostatics for the vessels with stability column angles of 0°, 20° and 30° are presented in Appendix I.

INITIAL STABILITY

FIG. 11 presents the initial stability of the wide based semi-submersible vessel. The figure shows the GM along the horizontal axis corresponding to any draft along the vertical axis. The different curves represent the characteristics of vessels with differing stability column angularity; ranging from 0° to 30°.

As can be seen at the design draft of fifty feet, the stability increases rapidly for increasing column angularity from 1.37m (4.5 feet) of GM with 0° to 9.45m (31 feet) with 30°.

At lighter drafts, the stability varies over a greater range. For vessels with less than about 10° column angularity, the stability actually diminishes; whereas vessels with greater angularity, the stability increases. In the very light condition before pontoons surface, the straight-legged baseline vessel experiences a negative GM, but the 30° wide based semi-submersible vessel has a GM exceeding 30.48m (100 feet).

The characteristics are less divergent at drafts deeper than 15.24 (50 feet). Because all the vessel configurations rotated the stability columns about the same point, the bottom of the buoyant deck, their waterplanes become more similar as the vessels ballast down. When the bottom of the buoyant deck is about to be immersed, the only differences in stability are due to the slight variations in ballast onboard giving slightly different VCGs. At these drafts, the GMs are about 4.57 to 5.18 (15 to 17 feet) for all configurations studied.

The GM was calculated using the drawings of FIGS. 4-10 and hydrostatics presented in Appendix I hereof at the 7.32m (24 feet) and 25.60m (84 feet) waterlines, the drafts just before the pontoon break the surface and just before the buoyant deck is immersed. At the other drafts calculated, the GM was obtained from the righting arm curves described in the next section for the vessels with column angles of 0°, 20° and 30°. For the intermediate angles of 10° and 15°, the GM was calculated using the drawings and hydrostatics at drafts of 7.62 and 15.24m (24 and 50 feet), and the balance of the curve was obtained by fairing the lines between the cases which were fully calculated.

FIG. 11 does not present the GM for the conditions with the pontoons exposed or with the buoyant deck immersed. The stability in these situations so far exceeds that in the draft range presented as to make comparison meaningless. However, Appendix II does present the calculations of the righting arms from which the GM may be ascertained in these regions.

The conclusion to be drawn from FIG. 11 is that judicious choice of stability column angularity will produce a wide based semi-submersible vessel with improved GM over the entire operating range of drafts. From this initial study, an angle of from about 10° to about 20° is preferable.

LARGE ANGLE STABILITY

The curves of righting arm (GZ) versus heel angle were calculated for the straight-legged baseline vessel and the wide based semi-submersible vessel configurations with the stability columns angled 20° and 30°. The details of the calculations are presented in Appendix II hereof. The results are presented in FIGS. 12A-12F. To aid the comparison of the different configurations considered, each of FIGS. 12A-12F presents the results for the three vessels at a particular draft. The drafts used vary from 24.1 feet, pontoons almost immerging, to eighty-four feet, buoyant deck almost awash. Each of FIGS. 12A-12F shows the GZ along the vertical axis corresponding to the vessel's heel angle along the horizontal axis.

In each case studied, the large angle stability increased with increasing stability column angularity. Additionally, one should note that the maximum righting arm and the area under the curve, righting energy, varied inversely with draft. All configurations possessed greater righting energy at shallower draft than when deeply ballasted.

From this portion of the study, one must conclude that any angularity of the stability columns is beneficial, and that the more angular they are, the more benefit derived.

Another important observation to be gleaned from this portion of the study concerns heeling due to wind. Egon P.D.

Bjerregaard, and Svenn Belschov, "Wind Overturning Effect on a Semi-Submersible", OTC paper 3063, 10th Annual Offshore Technology Conference, Houston, Texas, May 8-11, 1978, presents the wind heel moments and levers for the MSV "IOLAIR" as calculated by the ABS method. The information given was used to develop approximate wind heel curves for the configurations of this study. The resulting heeling arms are plotted on FIGS. 12A-12F. They reveal that the straight-legged baseline vessel will heel as much as 17° under a 51.44 m/s (100 knot) wind when at the design draft of 15.24m (50 feet). However, the wide based semi-submersible vessel configurations studied will heel less than 3° under the same circumstances. The great difference reveals the sensitivity of vessel performance to small differences in GM and configuration, and is attributable to the relationship between the angle of the righting arms and the heeling arms.

DAMAGED STABILITY

The study included a brief review of the damaged stability of the straight-legged baseline vessel and a wide based semi-submersible vessel with stability columns angled 30°. Two conditions were studied. The first, a flooding of one forward stability column between the top of the pontoon and the bottom of the buoyant deck; the second, the same column combined with the first 23.16m (76 feet) of its pontoon. The cases were chosen to represent catastrophic casualties and ignored the greater degree of subdivision actually expected in the final design.

The analysis reveals that for both extents of damage, the wide based semi-submersible vessel retains greater righting energy, and suffers less immersion than the baseline vessel.

For the purpose of this study, the relative performance of the two configurations considered and not the absolute numbers are important. Because the simplified hullform chosen had only a watertight ring around the main deck instead of a fully buoyant structure, the final measurement of heel and trim are exaggerated. The final design would have a fully buoyant deck structure. For the purposes of comparison therefore, the following table presents the results of the two conditions studied.

The details of the damaged stability calculation are presented in Appendix III.

DAMAGE STABILITY RESULTS

Vessel Compartment Flooded	Baseline Column	Baseline Column & Pontoon	WBSS 30° Column	WBSS 30° Column & Pontoon
Heel	18.0°	21.0°	12.2°	17.0°
Trim (m/ft)	10.36/34.0	15.54/51.0	11.89/39.0	13.87/45.5
Draft (m/ft)	17.62/57.8	19.81/65.0	18.41/60.4	20.42/67.0
Height of corner above final WL (m/ft)	-0.043/-0.14	-5.82/-19.1	0.96/3.16	-3.96/-13.0

CONCLUSIONS

The proposed concept of a wide based semi-submersible vessel does produce a vessel with superior characteristics in all areas of stability.

For the vessel size and proportions chosen as a baseline, a preferred angle for the stability column lies between 10° and 20°, but superior characteristics were shown for angles of the stability columns of greater than 0 to 30°. The exact configuration depends on the desired operational characteristics. A buoyant deck structure is beneficial at large angles of heel and in damaged conditions, and is preferably incorporated in the design.

Although the foregoing description and study were specific to a semi-submersible vessel having an elongated deck and parallel pontoons connected to the deck by stability columns such as shown in FIG. 13, the present invention contemplates any number of stability columns, and angling the stability columns outboard from the deck structure of any of the many semi-submersible vessel configurations such as shown in FIGS. 14-23.

FIG. 14 shows a pentagon arrangement of stability columns 96 and footings 97. Each of FIGS. 13 and 14 also show a drilling rig 100, 101 and means for propelling the respective vessels 102,

103. The present invention contemplates angling the stability columns 96 and footings 97 radially outwardly to improve the stability of the pentagon vessel shown.

Similarly, FIG. 15 shows a delta arrangement of stability columns 104 and footings 105 with such stability columns and footings angled radially outwardly as shown by the dashed lines. The semi-submersible vessel configurations of FIGS. 16-23 are known as FIG. 16 Ring, FIG. 17 A-Type, FIG. 18 Y-Type, FIG. 19 V-Type, FIG. 20 Catamaran, FIG. 21 Angle Catamaran, FIG. 22 Trimaran and FIG. 23 Grid.

A semi-submersible vessel constructed in accordance with the present invention is particularly suitable for operation in ice-infested waters. For example with reference to FIG. 3, the vessel is shown on station drilling a subsea borehole with a drilling rig 53 through a conduit or moonpool 55 through the deck 10. When it is desirable to break an outboard ice-mass such as shown at 61, seawater ballast in ballast tanks 66 is pumped overboard by pumps 57, 59 to raise the vessel such that the columns 20 exert an upward bending force on the mass 61 to break it.

Conversely, when it is desirable to break an ice mass below the deck 10 such as the mass shown at 63, ballast is pumped by means of pumps 57, 59 from the surrounding water to ballast tanks 56 to deep ballast or settle the vessel in the water such that the stability columns 20 exert a downward bending force on the mass 63 to break it.

A semi-submersible vessel such as those contemplated by the present invention find use not only in drilling as shown with respect to FIG. 3, but also in producing at offshore sites, and for general utility services at offshore facilities such as a rescue vessel. Thus, it is contemplated that a semi-submersible vessel used for utility purposes may serve as an ice breaker to protect offshore facilities.

APPENDIX I

HYDROSTATICS

i BASELINE CONFIGURATION

ii WBSS 20° CONFIGURATION

iii WBSS 30° CONFIGURATION

HYDROSTATICS
BASELINE 0 DEG

DATE

	UNITS AND DEFINITIONS
DISPLACEMENT	DISPLACEMENT(LONG TONS)
DRAFT	HEIGHT ABOVE BASELINE(FEET) AT AMIDSHIPS
KB	HEIGHT OF CENTER OF BUOYANCY(FEET) ABOVE BASELINE
LCB	LONG. CENTER OF BUOYANCY(FEET) FROM AMIDSHIPS (+ FWD)
LCF	LONG. CENTER OF FLOTATION(FEET) FROM AMIDSHIPS (+ FWD)
LONG KM	LONGITUDINAL METACENTRIC HEIGHT(FEET) ABOVE BASELINE
MT1	MOMENT TO CHANGE TRIM ONE INCH(FOOT-TONS,GML=BML)
TPI	TONS PER INCH IMMERSION
TRANS KM	TRANSVERSE METACENTRIC HEIGHT(FEET) ABOVE BASELINE
VOLUME	DISPLACED VOLUME(CUBIC FEET)
WPLANE AREA	AREA OF THE WATERPLANE(SQUARE FEET)

VESSEL LENGTH = 328.00 FEET MAXIMUM BEAM =168.00 FEET

VESSEL OFFSET FILE NAME MSV-A1
VESSEL OFFSET FILE CREATED 10/22/82

TRIM 0.00 FEET WATER DENSITY 35.0 CUBIC FEET/TON

DRAFT	VOLUME	DISPLACEMENT	LCB	KB	WPLANE AREA
20.000	472320	13494.85	0.000	10.000	23616.00
23.999	566760	16193.15	0.000	11.999	23616.00
24.001	566789	16193.97	0.000	12.000	5184.00
30.000	597888	17082.51	0.000	12.780	5184.00
40.000	649728	18563.65	0.000	14.553	5184.00
50.000	701568	20044.80	0.000	16.802	5184.00
60.000	753408	21525.94	0.000	19.431	5184.00
70.000	805248	23007.08	0.000	22.364	5184.00
83.999	877818	25080.53	0.000	26.881	5184.00
84.001	877847	25081.35	0.000	26.883	23520.00

DRAFT	LCF	TPI	LONG KM	TRANS KM	MT1
20.000	0.000	56.2	529.4	233.20	1780.9
23.999	0.000	56.2	444.8	198.00	1780.9
24.001	0.000	12.3	144.9	52.28	546.9
30.000	0.000	12.3	138.8	50.96	546.9
40.000	0.000	12.3	130.5	49.69	546.9
50.000	0.000	12.3	124.2	49.34	546.9
60.000	0.000	12.3	119.4	49.73	546.9
70.000	0.000	12.3	115.9	50.71	546.9
83.999	0.000	12.3	112.7	52.88	546.9
84.001	0.000	56.0	404.8	114.47	2408.8

HYDROSTATICS
20 DEG

DATE

	UNITS AND DEFINITIONS
DISPLACEMENT	DISPLACEMENT(LONG TONS)
DRAFT	HEIGHT ABOVE BASELINE(FEET) AT AMIDSHIPS
KB	HEIGHT OF CENTER OF BUOYANCY(FEET) ABOVE BASELINE
LCB	LONG. CENTER OF BUOYANCY(FEET) FROM AMIDSHIPS (+ FWD)
LCF	LONG. CENTER OF FLOTATION(FEET) FROM AMIDSHIPS (+ FWD)
LONG KM	LONGITUDINAL METACENTRIC HEIGHT(FEET) ABOVE BASELINE
MT1	MOMENT TO CHANGE TRIM ONE INCH(FOOT-TONS,GML=BML)
TPI	TONS PER INCH IMMERSION
TRANS KM	TRANSVERSE METACENTRIC HEIGHT(FEET) ABOVE BASELINE
VOLUME	DISPLACED VOLUME(CUBIC FEET)
WPLANE AREA	AREA OF THE WATERPLANE(SQUARE FEET)

VESSEL LENGTH = 328.00 FEET   MAXIMUM BEAM =212.00 FEET

VESSEL OFFSET FILE NAME   MSV-A7
VESSEL OFFSET FILE CREATED

TRIM 0.00 FEET   WATER DENSITY 35.0 CUBIC FEET/TON

DRAFT	VOLUME	DISPLACEMENT	LCB	KB	WPLANE AREA
20.000	472320	13494.85	0.000	10.000	23616.00
23.999	566760	16193.15	0.000	11.999	23616.00
24.001	566789	16193.98	0.000	12.000	5521.60
30.000	599913	17140.38	0.000	12.829	5521.60
40.000	655129	18717.99	-0.000	14.697	5521.60
50.000	710345	20295.59	0.000	17.052	5521.60
60.000	765561	21873.19	0.000	19.789	5521.60
70.000	820777	23450.79	0.000	22.830	5521.60
83.999	898074	25659.28	0.000	27.493	5521.60
84.001	898104	25660.13	0.000	27.495	24320.25

DRAFT	LCF	TPI	LONG KM	TRANS KM	MT1
20.000	0.000	56.2	529.4	402.60	1780.9
23.999	0.000	56.2	444.8	339.17	1780.9
24.001	0.000	13.1	153.5	86.63	582.5
30.000	0.000	13.1	146.6	79.85	582.5
40.000	0.000	13.1	137.1	70.93	582.5
50.000	0.000	13.1	130.0	64.38	582.5
60.000	0.000	13.1	124.6	59.69	582.5
70.000	0.000	13.1	120.6	56.49	582.5
83.999	0.000	13.1	116.8	53.97	582.5
84.001	0.000	57.9	403.4	115.63	2450.7

HYDROSTATICS
30 DEG

DATE

	UNITS AND DEFINITIONS
DISPLACEMENT	DISPLACEMENT(LONG TONS)
DRAFT	HEIGHT ABOVE BASELINE(FEET) AT AMIDSHIPS
KB	HEIGHT OF CENTER OF BUOYANCY(FEET) ABOVE BASELINE
LCB	LONG. CENTER OF BUOYANCY(FEET) FROM AMIDSHIPS (+ FWD)
LCF	LONG. CENTER OF FLOTATION(FEET) FROM AMIDSHIPS (+ FWD)
LONG KM	LONGITUDINAL METACENTRIC HEIGHT(FEET) ABOVE BASELINE
MT1	MOMENT TO CHANGE TRIM ONE INCH(FOOT-TONS,GML=BML)
TPI	TONS PER INCH IMMERSION
TRANS KM	TRANSVERSE METACENTRIC HEIGHT(FEET) ABOVE BASELINE
VOLUME	DISPLACED VOLUME(CUBIC FEET)
WPLANE AREA	AREA OF THE WATERPLANE(SQUARE FEET)

VESSEL LENGTH = 328.00 FEET   MAXIMUM BEAM =237.28 FEET

VESSEL OFFSET FILE NAME   MSV-A5
VESSEL OFFSET FILE CREATED 10/15/82

TRIM   0.00 FEET   WATER DENSITY 35.0 CUBIC FEET/TON

DRAFT	VOLUME	DISPLACEMENT	LCB	KB	WPLANE AREA
20.000	472320	13494.85	0.000	10.000	23616.00
23.999	566760	16193.15	0.000	11.999	23616.00
24.001	566789	16193.99	0.000	12.000	5985.36
30.000	602696	17219.89	0.000	12.893	5985.36
40.000	662549	18929.99	0.000	14.890	5985.36
50.000	722403	20640.09	0.000	17.385	5985.36
60.000	782256	22350.19	0.000	20.263	5985.36
70.000	842110	24060.30	0.000	23.443	5985.35
83.999	925899	26454.27	0.000	28.289	5985.36
84.001	925931	26455.17	0.000	28.291	25419.52

DRAFT	LCF	TPI	LONG KM	TRANS KM	MT1
20.000	0.000	56.2	529.4	521.82	1780.9
23.999	0.000	56.2	444.8	438.53	1780.9
24.001	0.000	14.2	165.4	115.72	631.4
30.000	0.000	14.2	157.2	103.76	631.4
40.000	0.000	14.2	146.1	87.90	631.4
50.000	0.000	14.2	137.8	76.06	631.4
60.000	0.000	14.2	131.4	67.30	631.4
70.000	0.000	14.2	126.7	60.97	631.4
83.999	0.000	14.2	122.2	55.30	631.4
84.001	0.000	60.5	401.4	116.91	2508.4

APPENDIX II

RIGHTING ARM CURVES

i BASELINE CONFIGURATION

ii WBSS 20° CONFIGURATION

iii WBSS 30° CONFIGURATION

iv VCG BASELINE CONFIGURATION

v VCG 20° CONFIGURATION

vi VCG 30° CONFIGURATION

i BASELINE CONFIGURATION

DYNAMIC STABILITY

VESSEL NAME BASELINE DATE 11/9/82

UNITS AND DEFINITIONS

DISPLACEMENT	DISPLACEMENT(LONG TONS)
DRAFT	HEIGHT ABOVE BASELINE AT CENTERLINE AMIDSHIPS(FEET)
KG	HEIGHT OF CENTER OF GRAVITY ABOVE BASELINE(FEET)
LCB	LONG.CENTER OF BUOYANCY(FEET) FROM AMIDSHIPS(+=FWD)
LCG	LONG.POSITION OF CENTER OF GRAVITY(FEET) FROM AMIDSHIPS(+=FWD)
TRIM	TRIM(FEET)(+= AFT)
RA	RIGHTING ARM(FEET)

OFFSET FILE NAME MSV-A1 DATE CREATED 10/22/82
VESSEL LENGTH = 328.00 FEET
WATER DENSITY = 35.00 CUBIC FEET/TON

DESIGN CONDITION 1

DRAFT	23.000
DISPLACEMENT	15,500.00
KG	54.580
LCG	0.000

HEEL ANGLE	RA	DISPLACEMENT	LCB	DRAFT	TRIM	ITERATIONS
0.00	0.0000	15,500.00	-0.000	22.971	0.000	2
0.57	1.5123	15,499.99	0.000	22.971	0.000	1
5.00	4.3271	15,499.99	-0.000	26.009	0.000	2
10.00	6.8747	15,499.99	0.000	29.761	0.000	2
15.00	9.6708	15,500.00	0.000	33.631	0.000	2
20.00	12.8780	15,500.00	0.000	37.687	0.000	2
25.00	16.7029	15,500.00	0.000	42.010	0.000	3
30.00	23.5259	15,500.00	0.000	45.929	0.000	4
35.00	35.3163	15,500.00	0.000	46.228	0.000	3
40.00	40.3638	15,500.00	-0.000	43.347	0.000	3

DESIGN CONDITION 2

DRAFT	23.900
DISPLACEMENT	16,000.00
KG	53.250
LCG	0.000

HEEL ANGLE	RA	DISPLACEMENT	LCB	DRAFT	TRIM	ITERATIONS
0.00	0.0000	16,000.00	0.000	23.712	0.000	2
0.57	0.7840	16,000.00	-0.000	23.951	0.000	2
5.00	2.9066	16,000.00	0.000	27.224	0.000	2
10.00	5.4191	15,999.99	-0.000	30.976	0.000	2
15.00	8.1817	15,999.99	0.000	34.847	0.000	2
20.00	11.3517	15,999.99	-0.000	38.902	0.000	2
25.00	15.1286	15,999.99	0.000	43.225	0.000	3
30.00	22.6365	16,000.00	-0.000	47.015	0.000	4
35.00	35.1556	16,000.00	0.000	47.529	0.000	3
40.00	40.8842	16,000.00	0.000	46.190	0.000	3

DESIGN CONDITION 3

DRAFT	24.100
DISPLACEMENT	16,200.00
KG	52.740
LCG	0.000

HEEL ANGLE	RA	DISPLACEMENT	LCB	DRAFT	TRIM	ITERATIONS
0.00	0.0000	16,200.00	0.000	24.041	0.000	2
0.57	0.2544	16,200.00	0.000	24.437	0.000	2
5.00	2.3639	16,200.00	0.000	27.710	0.000	2
10.00	4.8640	16,199.99	-0.000	31.463	0.000	2
15.00	7.6148	16,200.00	0.000	35.333	0.000	2
20.00	10.7715	16,200.00	0.000	39.389	0.000	2
25.00	14.5310	16,199.99	0.000	43.711	0.000	2
30.00	22.2991	16,200.00	0.000	47.431	0.000	4
35.00	35.0381	16,200.00	0.000	48.045	0.000	3
40.00	40.8731	16,200.00	0.000	47.297	0.000	3

DESIGN CONDITION 4

DRAFT	30.000
DISPLACEMENT	17,000.00
KG	50.820
LCG	0.000

HEEL ANGLE	RA	DISPLACEMENT	LCB	DRAFT	TRIM	ITERATIONS
0.00	0.0000	17,000.00	-0.000	29.442	0.000	2
0.57	0.0025	17,000.00	-0.000	29.442	0.000	1
5.00	0.4291	16,999.99	-0.000	30.011	0.000	4
10.00	2.7966	16,999.99	-0.000	33.473	0.000	4
15.00	5.4965	16,999.99	0.000	37.285	0.000	3
20.00	8.6067	16,999.99	0.000	41.333	0.000	2
25.00	12.3051	17,000.00	0.000	45.656	0.000	2
30.00	21.0474	17,000.00	0.000	49.011	0.000	4
35.00	34.2961	17,000.00	-0.000	50.091	0.000	3
40.00	39.8018	17,000.00	-0.000	51.568	0.000	3

DESIGN CONDITION 5

DRAFT	37.000
DISPLACEMENT	18,000.00
KG	48.670
LCG	0.000

HEEL ANGLE	RA	DISPLACEMENT	LCB	DRAFT	TRIM	ITERATIONS
0.00	0.0000	18,000.00	-0.000	36.194	0.000	2
0.57	0.0138	18,000.00	0.000	36.194	0.000	1
5.00	0.1327	17,999.99	-0.000	36.194	0.000	1
10.00	0.7730	17,999.99	-0.000	36.841	0.000	4
15.00	3.2345	17,999.99	0.000	40.121	0.000	4
20.00	6.2431	17,999.99	0.000	43.956	0.000	4
25.00	9.8762	17,999.99	0.000	48.159	0.000	4
30.00	19.8191	18,000.00	0.000	50.894	0.000	4
35.00	32.8419	18,000.00	0.000	52.606	0.000	3
40.00	36.7829	18,000.00	0.000	56.529	0.000	4

DESIGN CONDITION 6

DRAFT	44.000
DISPLACEMENT	19,000.00
KG	46.740
LCG	0.000

HEEL ANGLE	RA	DISPLACEMENT	LCB	DRAFT	TRIM	ITERATIONS
0.00	0.0000	19,000.00	0.000	42.945	0.000	2
0.57	0.0276	19,000.00	0.000	42.945	0.000	1
5.00	0.2522	18,999.99	0.000	42.945	0.000	1
10.00	0.5724	19,000.00	-0.000	42.945	0.000	1
15.00	1.5740	18,999.99	-0.000	43.777	0.000	4
20.00	4.3235	18,999.99	-0.000	47.049	0.000	4
25.00	8.2735	19,000.00	0.000	50.808	0.000	3
30.00	18.9554	18,999.99	0.000	52.723	0.000	3
35.00	30.9297	19,000.00	0.000	55.075	0.000	3
40.00	33.4672	19,000.00	-0.000	60.633	0.000	4

DESIGN CONDITION 7

DRAFT	50.000
DISPLACEMENT	20,000.00
KG	45.000
LCG	0.000

HEEL ANGLE	RA	DISPLACEMENT	LCB	DRAFT	TRIM	ITERATIONS
0.00	0.0000	20,000.00	0.000	49.697	0.000	2
0.57	0.0434	20,000.00	0.000	49.697	0.000	1
5.00	0.3894	19,999.99	-0.000	49.697	0.000	1
10.00	0.8423	20,000.00	0.000	49.697	0.000	1
15.00	1.4272	20,000.00	0.000	49.697	0.000	1
20.00	2.9469	19,999.99	0.000	50.840	0.000	4
25.00	7.5675	20,000.00	-0.000	53.467	0.000	2
30.00	18.4349	19,999.99	0.000	54.597	0.000	3
35.00	28.6557	20,000.00	-0.000	57.502	0.000	3
40.00	30.2853	20,000.00	-0.000	64.128	0.000	4

DESIGN CONDITION 8

DRAFT	70.000
DISPLACEMENT	23,000.00
KG	40.700
LCG	0.000

HEEL ANGLE	RA	DISPLACEMENT	LCB	DRAFT	TRIM	ITERATIONS
0.00	0.0000	22,999.99	0.000	69.952	0.000	2
0.57	0.1001	23,000.00	0.000	69.952	0.000	1
5.00	0.8819	23,000.00	0.000	69.952	0.000	1
10.00	1.8149	23,000.00	0.000	69.952	0.000	1
15.00	3.7678	23,000.00	0.000	68.028	0.000	4
20.00	6.4031	22,999.99	0.000	64.916	0.000	4
25.00	9.6097	22,999.99	0.000	61.545	0.000	4
30.00	17.1366	22,999.99	0.000	61.335	0.000	3
35.00	20.8969	22,999.99	0.000	66.217	0.000	4
40.00	21.7217	22,999.99	0.000	73.984	0.000	4

DESIGN CONDITION 9

DRAFT	83.900
DISPLACEMENT	25,000.00
KG	38.400
LCG	0.000

HEEL ANGLE	RA	DISPLACEMENT	LCB	DRAFT	TRIM	ITERATIONS
0.00	0.0000	25,000.00	0.000	83.455	0.000	2
0.57	0.1708	25,000.00	0.000	83.392	0.000	3
5.00	2.3355	25,000.00	0.000	80.732	0.000	4
10.00	4.8455	25,000.00	0.000	77.660	0.000	4
15.00	7.4870	25,000.00	0.000	74.490	0.000	4
20.00	10.3425	25,000.00	0.000	71.168	0.000	4
25.00	13.1418	24,999.99	0.000	68.265	0.000	4
30.00	15.5236	24,999.99	0.000	68.411	0.000	3
35.00	16.7176	24,999.99	0.000	74.118	0.000	4
40.00	17.2840	24,999.99	0.000	81.793	0.000	4

DESIGN CONDITION 10

DRAFT	84.100
DISPLACEMENT	25,200.00
KG	38.190
LCG	0.000

HEEL ANGLE	RA	DISPLACEMENT	LCB	DRAFT	TRIM	ITERATIONS
0.00	0.0000	25,200.00	0.000	84.177	0.000	2
0.57	0.4420	25,200.00	0.000	83.974	0.000	3
5.00	2.6403	25,200.00	0.000	81.320	0.000	4
10.00	5.1769	25,200.00	0.000	78.249	0.000	4
15.00	7.8409	25,200.00	0.000	75.080	0.000	4
20.00	10.7137	25,199.99	0.000	71.759	0.000	4
25.00	13.3906	25,199.99	0.000	69.095	0.000	4
30.00	15.2796	25,199.99	0.000	69.470	0.000	3
35.00	16.3713	25,199.99	0.000	75.055	0.000	4
40.00	16.9045	25,199.99	0.000	82.688	0.000	4

ii WBSS 20° CONFIGURATION

DYNAMIC STABILITY

VESSEL NAME 20DEG WIDE DATE 11/10/82

UNITS AND DEFINITIONS

DISPLACEMENT	DISPLACEMENT(LONG TONS)
DRAFT	HEIGHT ABOVE BASELINE AT CENTERLINE AMIDSHIPS(FEET)
KG	HEIGHT OF CENTER OF GRAVITY ABOVE BASELINE(FEET)
LCB	LONG.CENTER OF BUOYANCY(FEET) FROM AMIDSHIPS(+=FWD)
LCG	LONG.POSITION OF CENTER OF GRAVITY(FEET) FROM AMIDSHIPS(+=FWD)
TRIM	TRIM(FEET)(+= AFT)
RA	RIGHTING ARM(FEET)

OFFSET FILE NAME MSV-A7 DATE CREATED
VESSEL LENGTH = 328.00 FEET
WATER DENSITY = 35.00 CUBIC FEET/TON

DESIGN CONDITION 1

DRAFT	23.000
DISPLACEMENT	15,000.00
KG	55.110
LCG	0.000

HEEL ANGLE	RA	DISPLACEMENT	LCB	DRAFT	TRIM	ITERATIONS
0.00	0.000	14,999.99	0.000	22.230	0.000	5
0.57	3.092	15,000.00	0.000	22.230	0.000	1
5.00	11.891	15,000.00	0.000	25.982	0.000	2
10.00	18.759	14,999.99	-0.000	31.052	0.000	2
15.00	25.179	14,999.99	0.000	36.421	0.000	2
20.00	31.351	14,999.99	-0.000	42.190	0.000	3
25.00	37.492	15,000.00	0.000	48.450	0.000	5
30.00	50.626	15,000.00	0.000	51.266	0.000	4
35.00	56.157	14,999.99	0.000	47.519	0.000	3
40.00	50.624	14,999.99	0.000	38.708	0.000	4

DESIGN CONDITION 2

DRAFT	23.900
DISPLACEMENT	16,000.00
KG	53.760
LCG	0.000

HEEL ANGLE	RA	DISPLACEMENT	LCB	DRAFT	TRIM	ITERATIONS
0.00	0.000	16,000.00	-0.000	23.712	0.000	2
0.57	1.493	15,999.99	-0.000	24.082	0.000	2
5.00	7.578	16,000.00	-0.000	28.399	0.000	2
10.00	13.897	16,000.00	-0.000	33.482	0.000	2
15.00	19.828	16,000.00	-0.000	38.865	0.000	2
20.00	25.555	15,999.99	0.000	44.647	0.000	2
25.00	31.944	16,000.00	0.000	50.780	0.000	4
30.00	47.899	16,000.00	-0.000	53.647	0.000	4
35.00	57.120	16,000.00	0.000	52.471	0.000	3
40.00	52.746	15,999.99	0.000	44.869	0.000	5

DESIGN CONDITION 3

DRAFT	24.100
DISPLACEMENT	16,200.00
KG	53.250
LCG	0.000

HEEL ANGLE	RA	DISPLACEMENT	LCB	DRAFT	TRIM	ITERATIONS
0.00	0.000	16,199.99	-0.000	24.039	0.000	2
0.57	0.798	16,200.00	0.000	24.563	0.000	2
5.00	6.803	16,199.99	-0.000	28.882	0.000	2
10.00	13.044	16,200.00	0.000	33.968	0.000	2
15.00	18.908	16,200.00	-0.000	39.353	0.000	2
20.00	24.576	16,200.00	-0.000	45.138	0.000	2
25.00	31.101	16,200.00	-0.000	51.221	0.000	4
30.00	47.495	16,200.00	-0.000	54.083	0.000	4
35.00	57.081	16,200.00	-0.000	53.434	0.000	3
40.00	53.286	16,199.99	-0.000	46.414	0.000	5

DESIGN CONDITION 4

DRAFT	30.000
DISPLACEMENT	17,100.00
KG	51.080
LCG	0.000

HEEL ANGLE	RA	DISPLACEMENT	LCB	DRAFT	TRIM	ITERATIONS
0.00	0.000	17,100.00	0.000	29.743	0.000	2
0.57	0.290	17,099.99	0.000	29.747	0.000	2
5.00	3.592	17,099.99	-0.000	31.182	0.000	4
10.00	9.464	17,100.00	0.000	36.155	0.000	2
15.00	15.054	17,100.00	-0.000	41.553	0.000	2
20.00	20.481	17,100.00	0.000	47.350	0.000	2
25.00	27.834	17,100.00	0.000	53.134	0.000	4
30.00	45.607	17,100.00	0.000	55.970	0.000	4
35.00	55.582	17,100.00	0.000	57.617	0.000	3
40.00	55.307	17,100.00	0.000	59.126	0.000	3

DESIGN CONDITION 5

DRAFT	37.000
DISPLACEMENT	18,150.00
KG	48.820
LCG	0.000

HEEL ANGLE	RA	DISPLACEMENT	LCB	DRAFT	TRIM	ITERATIONS
0.00	0.000	18,150.00	0.000	36.399	0.000	2
0.57	0.250	18,150.00	-0.000	36.402	0.000	2
5.00	2.200	18,149.99	-0.000	36.631	0.000	2
10.00	5.904	18,149.99	0.000	39.113	0.000	4
15.00	11.093	18,149.99	-0.000	44.208	0.000	4
20.00	16.257	18,149.99	0.000	49.937	0.000	3
25.00	24.804	18,150.00	-0.000	55.236	0.000	4
30.00	43.018	18,150.00	-0.000	58.123	0.000	3
35.00	51.704	18,150.00	0.000	62.220	0.000	4
40.00	51.614	18,150.00	0.000	69.481	0.000	5

DESIGN CONDITION 6

DRAFT	44.000
DISPLACEMENT	19,200.00
KG	46.800
LCG	0.000

HEEL ANGLE	RA	DISPLACEMENT	LCB	DRAFT	TRIM	ITERATIONS
0.00	0.000	19,200.00	0.000	43.055	0.000	2
0.57	0.219	19,200.00	0.000	43.058	0.000	2
5.00	1.927	19,200.00	0.000	43.280	0.000	2
10.00	3.949	19,199.99	0.000	43.969	0.000	2
15.00	7.802	19,199.99	0.000	47.428	0.000	4
20.00	12.619	19,199.99	0.000	52.829	0.000	4
25.00	22.646	19,199.99	-0.000	57.227	0.000	4
30.00	40.070	19,200.00	0.000	60.243	0.000	3
35.00	46.662	19,200.00	0.000	66.371	0.000	4
40.00	46.837	19,200.00	0.000	75.005	0.000	5

DESIGN CONDITION 7

DRAFT	50.000
DISPLACEMENT	20,250.00
KG	45.000
LCG	0.000

HEEL ANGLE	RA	DISPLACEMENT	LCB	DRAFT	TRIM	ITERATIONS
0.00	0.000	20,250.00	0.000	49.710	0.000	2
0.57	0.195	20,250.00	-0.000	49.713	0.000	2
5.00	1.719	20,250.00	0.000	49.929	0.000	2
10.00	3.523	20,250.00	0.000	50.597	0.000	2
15.00	5.532	20,249.99	0.000	51.798	0.000	4
20.00	9.605	20,250.00	0.000	56.198	0.000	4
25.00	21.087	20,250.00	0.000	59.221	0.000	3
30.00	36.873	20,249.99	-0.000	62.353	0.000	3
35.00	41.772	20,250.00	0.000	69.842	0.000	4
40.00	42.165	20,250.00	0.000	79.293	0.000	5

DESIGN CONDITION 8

DRAFT	70.000
DISPLACEMENT	23,450.00
KG	40.500
LCG	0.000

HEEL ANGLE	RA	DISPLACEMENT	LCB	DRAFT	TRIM	ITERATIONS
0.00	-0.000	23,450.00	0.000	69.994	0.000	2
0.57	0.159	23,450.00	0.000	69.997	0.000	2
5.00	1.405	23,450.00	0.000	70.192	0.000	2
10.00	2.887	23,450.00	0.000	70.765	0.000	4
15.00	6.081	23,450.00	0.000	69.089	0.000	4
20.00	10.468	23,450.00	0.000	66.626	0.000	3
25.00	18.890	23,449.99	0.000	65.669	0.000	4
30.00	26.851	23,449.99	0.000	70.193	0.000	4
35.00	23.779	23,449.99	0.000	79.073	0.000	4
40.00	29.533	23,449.99	0.000	89.839	0.000	4

DESIGN CONDITION 9

DRAFT	83.900
DISPLACEMENT	25,600.00
KG	38.100
LCG	0.000

HEEL ANGLE	RA	DISPLACEMENT	LCB	DRAFT	TRIM	ITERATIONS
0.00	0.000	25,600.00	0.000	83.623	0.000	2
0.57	0.219	25,600.00	0.000	83.485	0.000	3
5.00	2.647	25,600.00	0.000	80.922	0.000	4
10.00	5.733	25,600.00	0.000	78.103	0.000	4
15.00	9.318	25,599.99	0.000	75.349	0.000	4
20.00	13.574	25,599.99	0.000	72.683	0.000	4
25.00	17.709	25,599.99	0.000	71.795	0.000	4
30.00	20.609	25,599.99	0.000	77.685	0.000	4
35.00	22.059	25,599.99	0.000	86.399	0.000	4
40.00	22.711	25,599.99	0.000	97.157	0.000	4

DESIGN CONDITION 10

DRAFT	84.100
DISPLACEMENT	26,000.00
KG	37.700
LCG	0.000

HEEL ANGLE	RA	DISPLACEMENT	LCB	DRAFT	TRIM	ITERATIONS
0.00	0.000	26,000.00	0.000	84.490	0.000	2
0.57	0.685	26,000.00	0.000	84.440	0.000	3
5.00	3.201	26,000.00	0.000	82.005	0.000	4
10.00	6.307	26,000.00	0.000	79.186	0.000	4
15.00	9.894	26,000.00	0.000	76.422	0.000	4
20.00	14.031	25,999.99	0.000	73.878	0.000	4
25.00	17.520	25,999.99	0.000	73.566	0.000	3
30.00	19.642	25,999.99	0.000	79.325	0.000	4
35.00	20.983	25,999.99	0.000	87.934	0.000	4
40.00	21.612	25,999.99	0.000	98.650	0.000	4

iii WBSS 30° CONFIGURATION

DYNAMIC STABILITY

VESSEL NAME 30DEG+39.20B WID DATE 11/10/82

UNITS AND DEFINITIONS

DISPLACEMENT	DISPLACEMENT(LONG TONS)
DRAFT	HEIGHT ABOVE BASELINE AT CENTERLINE AMIDSHIPS(FEET)
KG	HEIGHT OF CENTER OF GRAVITY ABOVE BASELINE(FEET)
LCB	LONG.CENTER OF BUOYANCY(FEET) FROM AMIDSHIPS(+=FWD)
LCG	LONG.POSITION OF CENTER OF GRAVITY(FEET) FROM AMIDSHIPS(+=FWD)
TRIM	TRIM(FEET)(+= AFT)
RA	RIGHTING ARM(FEET)

OFFSET FILE NAME MSV-A5 DATE CREATED 10/15/82
VESSEL LENGTH = 328.00 FEET
WATER DENSITY = 35.00 CUBIC FEET/TON

DESIGN CONDITION 1

DRAFT	23.000
DISPLACEMENT	15,500.00
KG	55.860
LCG	0.000

HEEL ANGLE	RA	DISPLACEMENT	LCB	DRAFT	TRIM	ITERATIONS
0.00	0.000	15,499.99	-0.000	22.971	0.000	2
0.57	3.920	15,499.99	0.000	22.990	0.000	3
5.00	13.624	15,500.00	0.000	27.756	0.000	2
10.00	23.140	15,500.00	0.000	33.497	0.000	2
15.00	31.602	15,499.99	0.000	39.662	0.000	2
20.00	39.292	15,500.00	-0.000	46.360	0.000	3
25.00	48.591	15,500.00	0.000	53.066	0.000	5
30.00	64.239	15,500.00	0.000	54.337	0.000	4
35.00	62.815	15,499.99	0.000	48.001	0.000	4
40.00	56.858	15,499.99	0.000	39.311	0.000	4

DESIGN CONDITION 2

DRAFT	23.900
DISPLACEMENT	16,000.00
KG	54.490
LCG	0.000

HEEL ANGLE	RA	DISPLACEMENT	LCB	DRAFT	TRIM	ITERATIONS
0.00	0.000	16,000.00	0.000	23.712	0.000	2
0.57	2.018	16,000.00	0.000	24.146	0.000	2
5.00	11.258	15,999.99	0.000	28.950	0.000	2
10.00	20.441	15,999.99	-0.000	34.702	0.000	2
15.00	28.624	16,000.00	0.000	40.877	0.000	2
20.00	36.077	15,999.99	0.000	47.585	0.000	3
25.00	46.182	16,000.00	0.000	54.154	0.000	5
30.00	63.466	15,999.99	-0.000	55.674	0.000	4
35.00	6E.861	15,999.99	0.000	50.395	0.000	4
40.00	58.146	16,000.00	0.000	42.068	0.000	5

DESIGN CONDITION 3

DRAFT	24.100
DISPLACEMENT	16,200.00
KG	53.960
LCG	0.000

HEEL ANGLE	RA	DISPLACEMENT	LCB	DRAFT	TRIM	ITERATIONS
0.00	-0.000	16,200.00	0.000	24.036	0.000	2
0.57	1.246	16,199.99	0.000	24.619	0.000	2
5.00	10.353	16,200.00	0.000	29.428	0.000	2
10.00	19.410	16,199.99	0.000	35.184	0.000	2
15.00	27.487	16,199.99	0.000	41.363	0.000	2
20.00	34.852	16,200.00	0.000	48.075	0.000	3
25.00	45.268	16,200.00	0.000	54.566	0.000	5
30.00	63.092	16,200.00	0.000	56.199	0.000	3
35.00	64.253	16,199.99	0.000	51.437	0.000	4
40.00	58.629	16,199.99	0.000	43.236	0.000	5

DESIGN CONDITION 4

DRAFT	30.000
DISPLACEMENT	17,300.00
KG	51.290
LCG	0.000

HEEL ANGLE	RA	DISPLACEMENT	LCB	DRAFT	TRIM	ITERATIONS
0.00	-0.000	17,299.99	0.000	30.468	0.000	2
0.57	0.516	17,299.99	-0.000	30.473	0.000	2
5.00	5.789	17,299.99	0.000	32.138	0.000	4
10.00	14.168	17,299.99	0.000	37.835	0.000	2
15.00	21.715	17,299.99	-0.000	44.037	0.000	2
20.00	28.634	17,299.99	0.000	50.771	0.000	2
25.00	40.732	17,300.00	-0.000	56.677	0.000	4
30.00	60.376	17,300.00	0.000	59.042	0.000	3
35.00	66.013	17,300.00	0.000	58.837	0.000	3
40.00	60.954	17,299.99	0.000	51.761	0.000	5

DESIGN CONDITION 5

DRAFT	37.000
DISPLACEMENT	18,400.00
KG	48.950
LCG	0.000

HEEL ANGLE	RA	DISPLACEMENT	LCB	DRAFT	TRIM	ITERATIONS
0.00	-0.000	18,400.00	0.000	36.900	0.000	2
0.57	0.433	18,400.00	-0.000	36.906	0.000	2
5.00	3.808	18,399.99	0.000	37.304	0.000	2
10.00	9.662	18,399.99	-0.000	40.707	0.000	4
15.00	16.662	18,399.99	-0.000	46.725	0.000	3
20.00	23.197	18,400.00	0.000	53.467	0.000	2
25.00	37.117	18,400.00	0.000	58.662	0.000	4
30.00	56.769	18,400.00	0.000	61.814	0.000	3
35.00	62.407	18,400.00	0.000	66.877	0.000	4
40.00	61.386	18,400.00	0.000	73.403	0.000	5

DESIGN CONDITION 6

DRAFT	44.000
DISPLACEMENT	19,500.00
KG	46.860
LCG	0.000

HEEL ANGLE	RA	DISPLACEMENT	LCB	DRAFT	TRIM	ITERATIONS
0.00	-0.000	19,500.00	0.000	43.333	0.000	2
0.57	0.367	19,499.99	0.000	43.338	0.000	2
5.00	3.222	19,499.99	0.000	43.720	0.000	2
10.00	6.559	19,499.99	0.000	44.906	0.000	4
15.00	12.360	19,499.99	-0.000	49.799	0.000	4
20.00	18.488	19,500.00	0.000	56.281	0.000	4
25.00	34.237	19,500.00	0.000	60.549	0.000	4
30.00	52.513	19,500.00	0.000	64.519	0.000	3
35.00	56.438	19,500.00	0.000	72.276	0.000	5
40.00	56.157	19,500.00	0.000	81.778	0.000	5

DESIGN CONDITION 7

DRAFT 50.000
DISPLACEMENT 20,600.00
KG 45.000
LCG 0.000

HEEL ANGLE	RA	DISPLACEMENT	LCB	DRAFT	TRIM	ITERATIONS
0.00	0.000	20,600.00	0.000	49.765	0.000	2
0.57	0.313	20,600.00	-0.000	49.770	0.000	2
5.00	2.748	20,600.00	0.000	50.136	0.000	2
10.00	5.596	20,599.99	0.000	51.271	0.000	2
15.00	9.001	20,599.99	0.000	53.678	0.000	4
20.00	15.259	20,600.00	0.000	59.146	0.000	4
25.00	31.848	20,599.99	0.000	62.379	0.000	4
30.00	47.767	20,600.00	0.000	67.162	0.000	4
35.00	50.548	20,600.00	0.000	76.389	0.000	5
40.00	50.580	20,600.00	0.000	87.075	0.000	5

DESIGN CONDITION 8

DRAFT 70.000
DISPLACEMENT 24,000.00
KG 40.330
LCG 0.000

HEEL ANGLE	RA	DISPLACEMENT	LCB	DRAFT	TRIM	ITERATIONS
0.00	0.000	24,000.00	0.000	69.647	0.000	2
0.57	0.208	24,000.00	0.000	69.651	0.000	2
5.00	1.828	23,999.99	0.000	69.967	0.000	2
10.00	3.752	24,000.00	0.000	70.901	0.000	4
15.00	7.859	24,000.00	0.000	69.618	0.000	4
20.00	13.762	24,000.00	0.000	67.689	0.000	3
25.00	25.944	24,000.00	0.000	68.721	0.000	4
30.00	32.592	23,999.99	0.000	75.860	0.000	4
35.00	34.506	23,999.99	0.000	86.275	0.000	4
40.00	35.177	23,999.99	0.000	98.716	0.000	5

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DESIGN CONDITION 9

DRAFT	83.900
DISPLACEMENT	26,200.00
KG	37.950
LCG	0.000

HEEL ANGLE	RA	DISPLACEMENT	LCB	DRAFT	TRIM	ITERATIONS
0.00	0.000	26,199.99	0.000	82.512	0.000	2
0.57	0.178	26,199.99	0.000	82.518	0.000	2
5.00	2.653	26,200.00	0.000	80.521	0.000	4
10.00	6.202	26,200.00	0.000	77.913	0.000	4
15.00	10.559	26,199.99	0.000	75.482	0.000	4
20.00	16.000	26,199.99	0.000	73.358	0.000	4
25.00	21.873	26,199.99	0.000	74.601	0.000	4
30.00	24.812	26,199.99	0.000	82.701	0.000	4
35.00	26.374	26,199.99	0.000	93.025	0.000	4
40.00	27.062	26,199.99	0.000	105.442	0.000	4

DESIGN CONDITION 10

DRAFT	84.100
DISPLACEMENT	26,700.00
KG	37.460
LCG	0.000

HEEL ANGLE	RA	DISPLACEMENT	LCB	DRAFT	TRIM	ITERATIONS
0.00	-0.000	26,700.00	0.000	84.338	0.000	2
0.57	0.603	26,700.00	0.000	84.228	0.000	3
5.00	3.296	26,700.00	0.000	81.818	0.000	4
10.00	6.839	26,700.00	0.000	79.181	0.000	4
15.00	11.160	26,700.00	0.000	76.720	0.000	3
20.00	16.337	26,699.99	0.000	74.775	0.000	4
25.00	20.789	26,699.99	0.000	76.446	0.000	4
30.00	23.298	26,699.99	0.000	84.447	0.000	4
35.00	24.774	26,699.99	0.000	94.688	0.000	4
40.00	26.468	26,699.99	0.000	107.051	0.000	4

iv VCG BASELINE CONFIGURATION

VCG = 45' @ 20,000 LT DESIGN DISPLACEMENT

DISP. LT	dBALLAST LT	dBALL MOM ft-LT	TOTAL MOM ft-LT	KG ft
25000	5000	60000	960000	38.40
23000	3000	36000	936000	40.70
20000	0	0	900000	45.00
19000	-1000	-12000	888000	46.74
18000	-2000	-24000	876000	48.67
17000	-3000	-36000	864000	50.82
16200	-3800	-45000	854400	52.74
16000	-4000	-48000	852000	53.25
15500	-45000	-54000	846000	54.58

∇ VCG 20° CONFIGURATION

VCG = 45' @ 20,250 LT DESIGN DISPLACEMENT

DISP. LT	dBALLAST LT	dBALL MOM ft-LT	TOTAL MOM ft-LT	KG ft
26000	5750	69000	980250	37.70
25600	5350	64200	975450	38.10
23450	3200	38400	949650	40.50
20250	0	0	911250	45.00
19200	-1050	-12600	898650	46.80
18150	-2100	-25200	886050	48.82
17100	-3150	-37800	873450	51.08
16200	-4050	-48600	862650	53.25
16000	-4250	-51000	860250	53.76
15500	-4750	-57000	854250	55.11

vi VCG 30° CONFIGURATION

VCG = 45' @ 20,000 LT DESIGN DISPLACEMENT

DISP. LT	dBALLAST LT	dBALL MOM ft-LT	TOTAL MOM ft-LT	KG ft
26700	6100	73200	1000200	37.46
26200	5600	67200	994200	37.95
24000	3400	40800	967800	40.33
20600	0	0	927000	45.00
19500	-1100	-13200	913800	46.86
18400	-2200	-26400	900600	48.95
17300	-3300	-39600	887400	51.29
16200	-4400	-52800	874200	53.96
16000	-4600	-55200	871800	54.49
15500	-5100	-61200	865800	55.86

APPENDIX III

DAMAGED STABILITY

i BASELINE CONFIGURATION

iii WBSS 30° CONFIGURATION

VESSEL NAME BASELINE DATE

DAMAGED CONDITION 2

DRAFT	50.00	FEET
DISPLACEMENT	20,000.00	TONS
VCG	45.00	FEET(ABOVE BASELINE)
LCG	0.00	FEET(+= FWD AMIDSHIPS)

DAMAGED COMPARTMENTS

ID NO.	COMPARTMENT	PERMEABILITY	TANK OUTFLOW DATA FILL DEPTH (FEET)	DENSITY (FT3/TON)	FREE SURFACE (FT-TONS)
1	COLUMN 1-S	1.00	24.00	35.00	0.0
3	PONTOON 1-S	1.00	0.00	35.00	0.0

DAMAGED SHIP PROPERTIES AFTER OUTFLOW

DISPLACEMENT = 19,999.90 TONS LCG = -0.00 FEET
VCG = 45.00 FEET
TCG = -0.00 FEET

TRANSVERSE METACENTER (ZERO DEGREES) = 78.55 FEET
METACENTRIC HEIGHT UPRIGHT (ZERO DEGREES) = 33.55 FEET

HEEL ANGLE	RIGHTING ARM	DISPLACEMENT	LCB	DRAFT	TRIM	ITERATION
0.000	-10.524	19,999.90	3.55	65.14	-55.98	26
10.000	-5.754	19,999.90	6.64	63.29	-59.75	11
20.000	-0.495	19,999.90	5.55	64.39	-53.42	7
30.000	8.749	19,999.90	4.18	66.10	-46.01	12
40.000	14.749	19,999.90	4.07	76.55	-58.02	10

DAMAGED STABILITY

VESSEL NAME BASELINE DATE

VESSEL OFFSET FILE NAME MSV-A1
DAMAGED COMPARTMENT FILE MSV-D1

DAMAGED CONDITION 1

DRAFT	50.00	FEET
DISPLACEMENT	20,000.00	TONS
VCG	45.00	FEET(ABOVE BASELINE)
LCG	0.00	FEET(+= FWD AMIDSHIPS)

DAMAGED COMPARTMENTS

ID NO.	COMPARTMENT	PERMEABILITY	TANK OUTFLOW DATA FILL DEPTH (FEET)	DENSITY (FT3/TON)	FREE SURFACE (FT-TONS)
1	COLUMN 1-S	1.00	24.00	35.00	0.0

DAMAGED SHIP PROPERTIES AFTER OUTFLOW

DISPLACEMENT = 19,999.97 TONS LCG = -0.00 FEET
VCG = 45.00 FEET
TCG = -0.00 FEET

TRANSVERSE METACENTER (ZERO DEGREES) = 45.05 FEET
METACENTRIC HEIGHT UPRIGHT (ZERO DEGREES) = 0.05 FEET

HEEL ANGLE	RIGHTING ARM	DISPLACEMENT	LCB	DRAFT	TRIM	ITERATION
0.000	-3.748	19,999.97	2.80	57.36	-33.86	19
10.000	-3.044	19,999.97	5.08	58.21	-43.46	9
20.000	0.408	19,999.97	3.22	57.66	-28.99	7
30.000	13.630	19,999.97	1.57	57.91	-15.93	9
40.000	22.241	19,999.97	1.71	68.69	-22.49	10

DAMAGED STABILITY

VESSEL NAME 30DEG WIDE DATE

VESSEL OFFSET FILE NAME MSV-A5
DAMAGED COMPARTMENT FILE MSV-D2

DAMAGED CONDITION 1

DRAFT	50.00	FEET
DISPLACEMENT	20,600.00	TONS
VCG	45.00	FEET(ABOVE BASELINE)
LCG	0.00	FEET(+= FWD AMIDSHIPS)

DAMAGED COMPARTMENTS

ID NO.	COMPARTMENT	PERMEABILITY	TANK OUTFLOW DATA FILL DEPTH (FEET)	DENSITY (FT3/TON)	FREE SURFACE (FT-TONS)
1	COLUMN 1-S	1.00	24.00	35.00	0.0

DAMAGED SHIP PROPERTIES AFTER OUTFLOW

DISPLACEMENT = 20,599.97 TONS LCG = -0.00 FEET
VCG = 45.00 FEET
TCG = -0.00 FEET

TRANSVERSE METACENTER (ZERO DEGREES) = 64.93 FEET
METACENTRIC HEIGHT UPRIGHT (ZERO DEGREES) = 19.93 FEET

HEEL ANGLE	RIGHTING ARM	DISPLACEMENT	LCB	DRAFT	TRIM	ITERATION
0.000	-5.301	20,599.97	2.57	57.27	-31.76	18
10.000	-0.971	20,599.97	4.76	59.77	-40.39	8
20.000	9.578	20,599.97	2.34	63.08	-20.50	7
30.000	35.501	20,599.97	1.92	71.28	-19.73	6
40.000	38.704	20,599.97	2.06	91.99	-27.35	14

VESSEL NAME 30DEG WIDE DATE

DAMAGED CONDITION 2

DRAFT	50.00	FEET
DISPLACEMENT	20,600.00	TONS
VCG	45.00	FEET(ABOVE BASELINE)
LCG	0.00	FEET(+= FWD AMIDSHIPS)

DAMAGED COMPARTMENTS

ID NO.	COMPARTMENT	PERMEABILITY	TANK OUTFLOW DATA FILL DEPTH (FEET)	DENSITY (FT3/TON)	FREE SURFACE (FT-TONS)
1	COLUMN 1-S	1.00	24.00	35.00	0.0
3	PONTOON 1-S	1.00	0.00	35.00	0.0

DAMAGED SHIP PROPERTIES AFTER OUTFLOW

DISPLACEMENT = 20,599.89 TONS LCG = -0.00 FEET
VCG = 45.00 FEET
TCG = -0.00 FEET

TRANSVERSE METACENTER (ZERO DEGREES) = 95.75 FEET
METACENTRIC HEIGHT UPRIGHT (ZERO DEGREES) = 50.75 FEET

HEEL ANGLE	RIGHTING ARM	DISPLACEMENT	LCB	DRAFT	TRIM	ITERATION
0.000	-15.131	20,599.89	3.41	65.08	-54.84	23
10.000	-6.888	20,599.89	6.21	64.49	-55.04	7
20.000	4.832	20,599.89	4.46	68.09	-41.49	10
30.000	22.156	20,599.89	3.91	77.10	-42.71	9
40.000	26.938	20,599.89	3.73	96.54	-52.33	16

CLAIMS:

1. A wide based semi-submersible vessel comprising a deck, a plurality of stability columns extending downwardly and outwardly from the deck, means connected to the lower ends of the stability columns for providing a wide buoyant base, and means for discharging and taking on ballast.

2. The vessel of claim 1 wherein the base-providing means comprises a pair of longitudinally elongated pontoons connected to the lower ends of the stability columns on each side of the vessel.

3. The vessel of claim 1 or 2 wherein the base-providing means comprises a footing connected to the lower end of each one of the stability columns.

4. The vessel of claim 2 wherein the deck is includes longitudinally extending sponsons extending downwardly from each of the port and starbord sides of the deck, the inner surface of each of the sponsons extending downwardly and outwardly from the bottom of the deck.

5. The vessel of claim 4 wherein the inner surface of each of the sponsons extends downwardly and outwardly from the bottom of the deck at the same angle as the columns extend downwardly and outwardly.

6. The vessel of claim 1 wherein the columns extend downwardly and outwardly at an angle of greater than 0° to less than 90°.

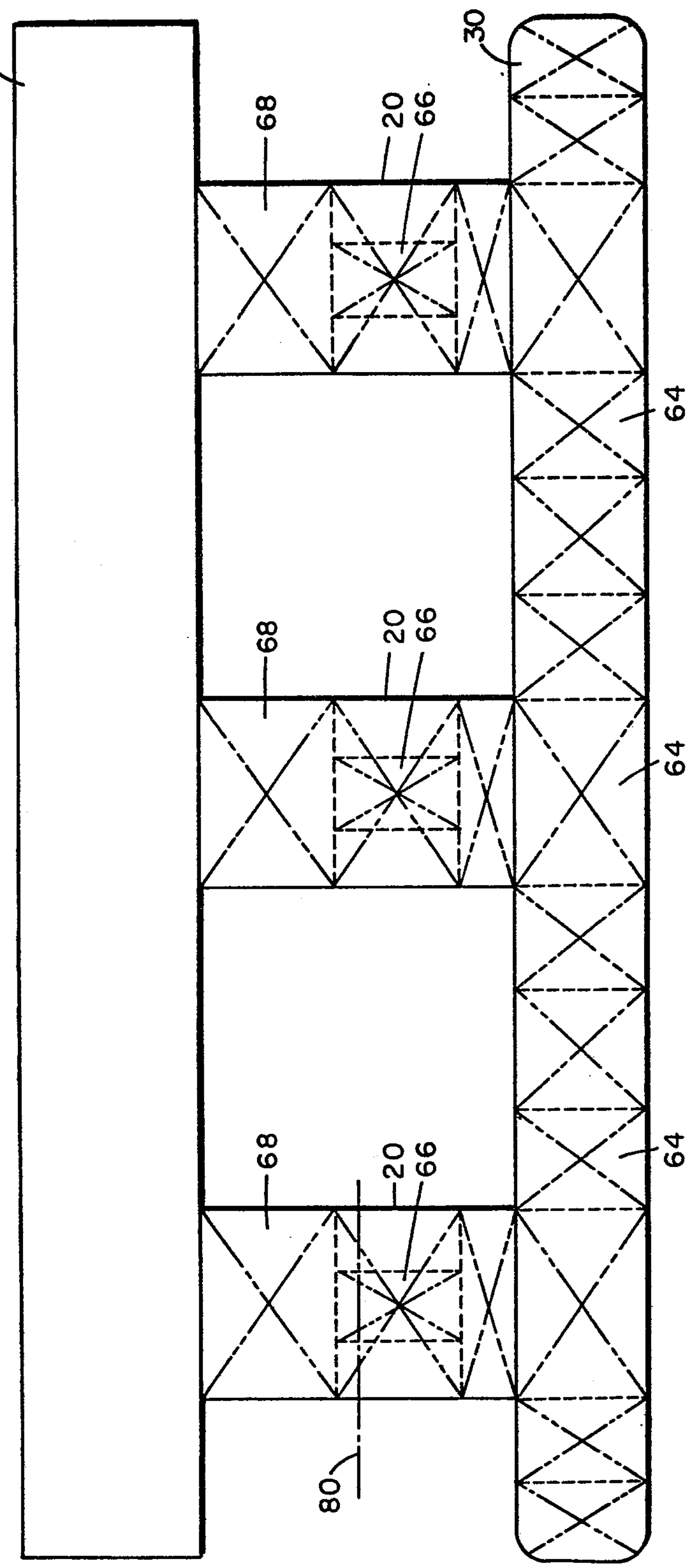
7. The vessel of claim 6 wherein said columns extend downwardly and outwardly at an angle of greater than 0° to about 30° from vertical.

8. A method of breaking an ice mass with a wide based semi-submersible vessel comprising a deck, a plurality of stability columns extending downwardly and outwardly from the deck, and means connected to the lower ends of the stability columns for providing a wide buoyant base, the method including the step of discharging and taking on ballast for the vessel to bring the stability columns into contact with the ice mass.

9. The method of claim 8 wherein the buoyancy of said vessel is continuously changed to have the vessel rise and settle.

3092H/0184H

FIG. 1



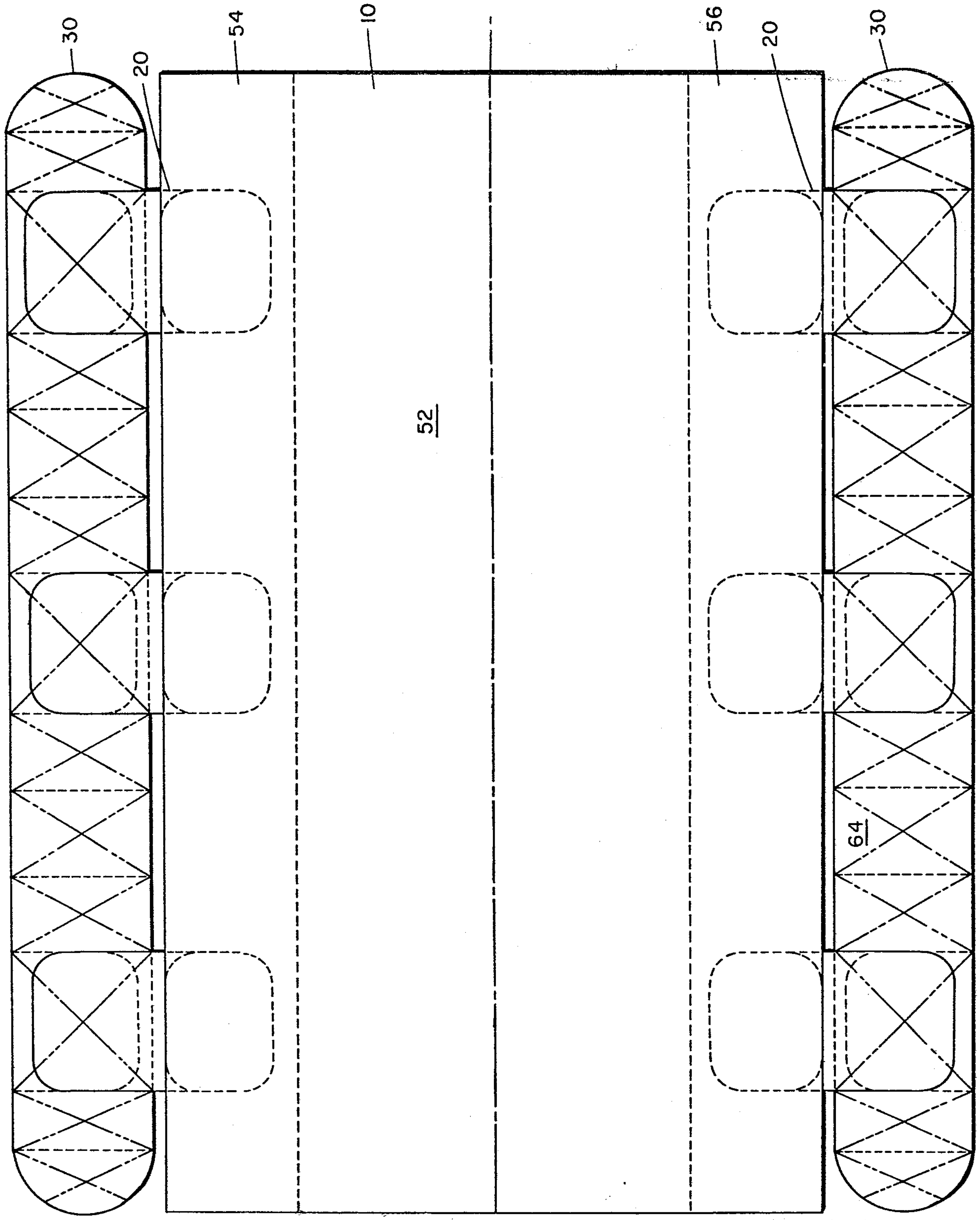


FIG. 2

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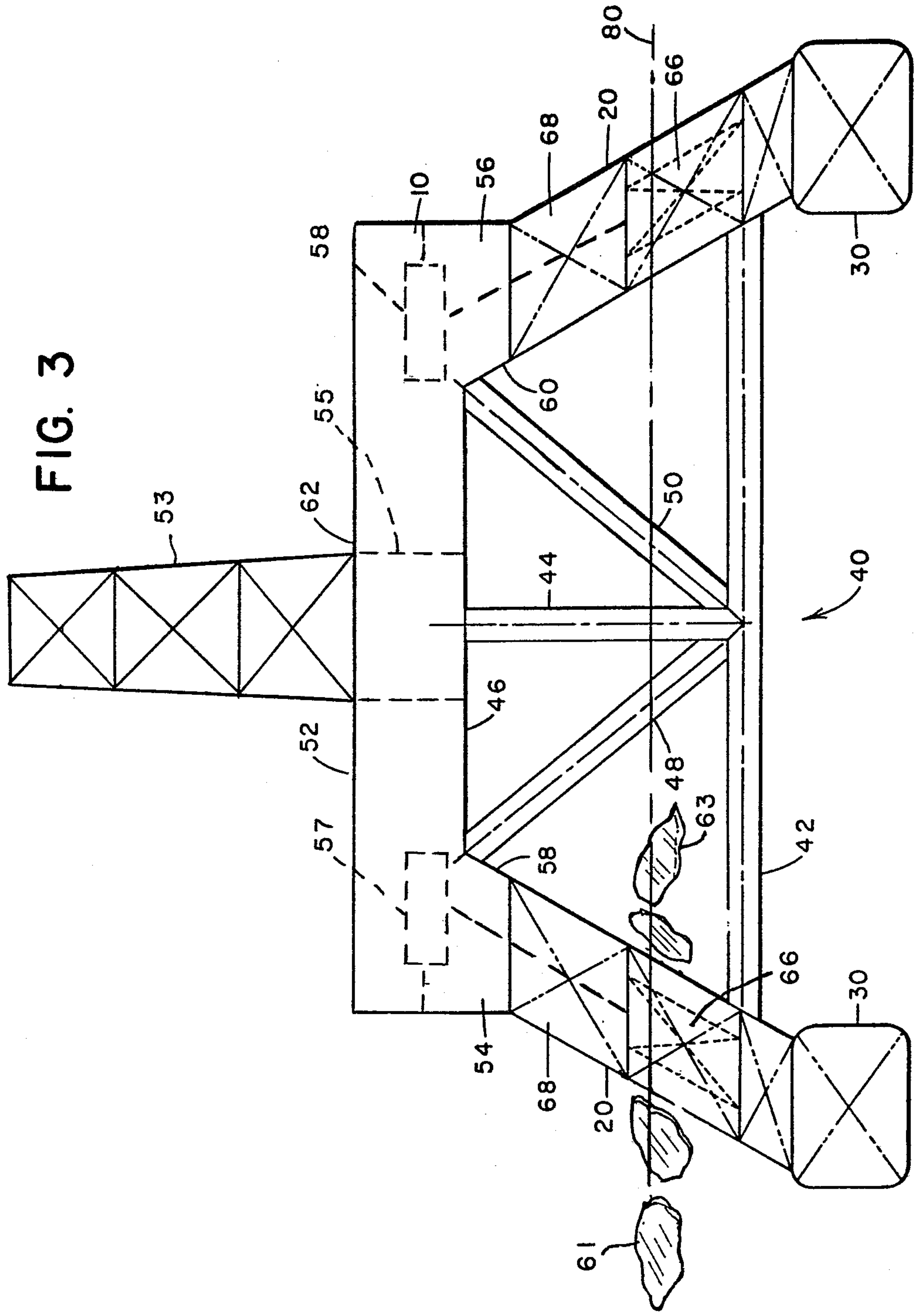

FIG. 3

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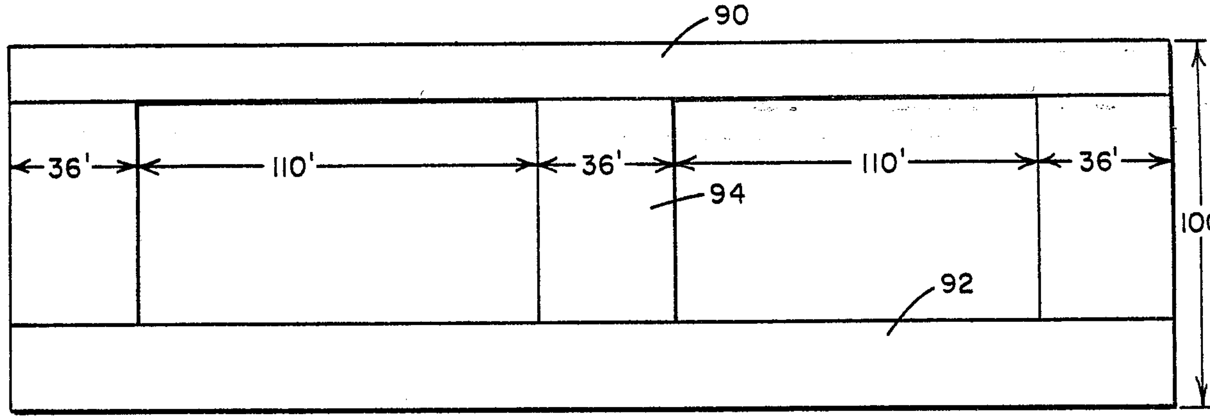

FIG. 4

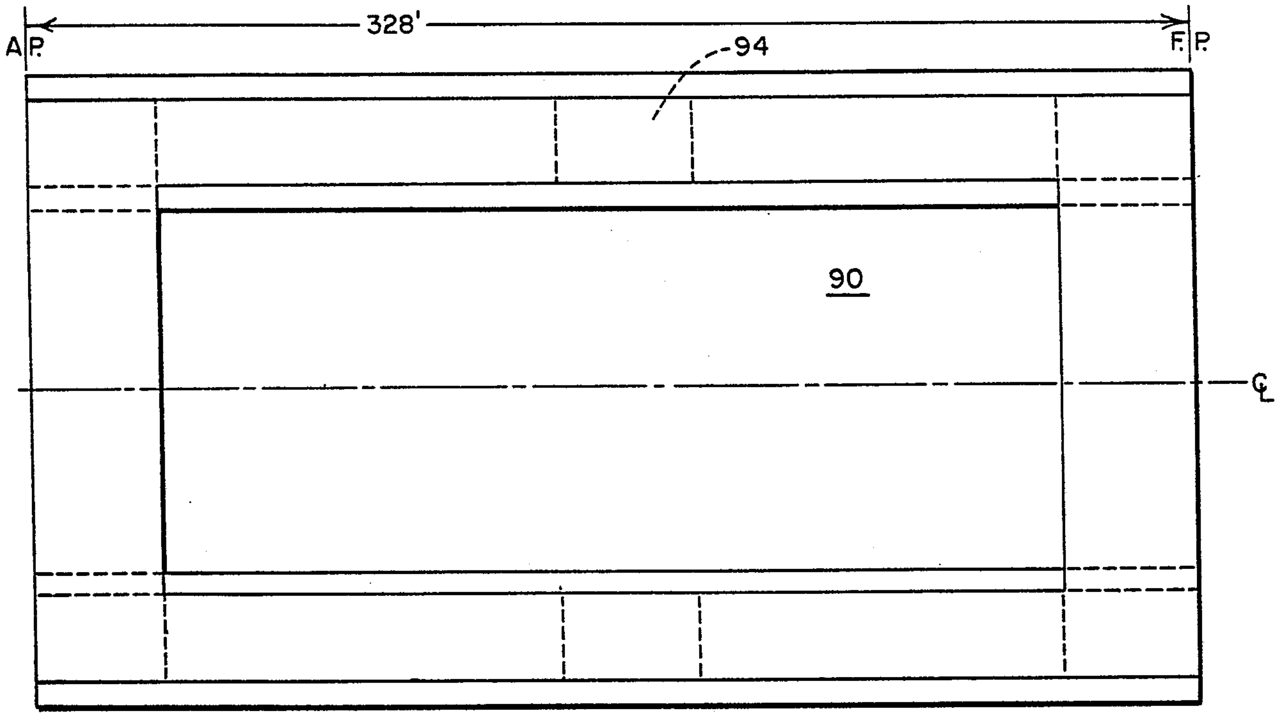

FIG. 6

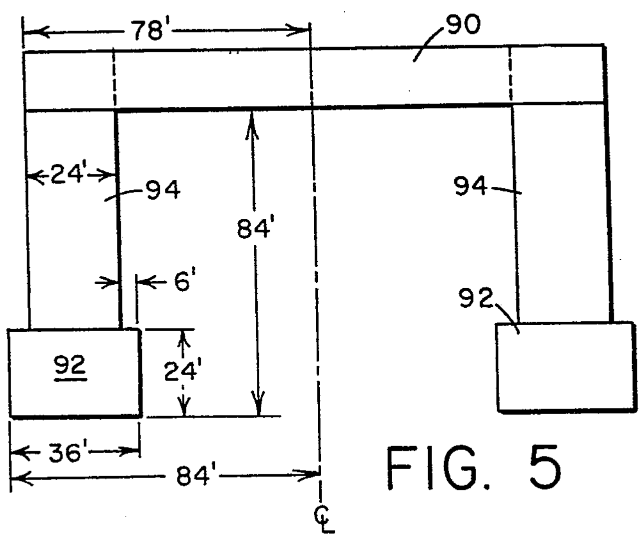

FIG. 5

FIG. 10

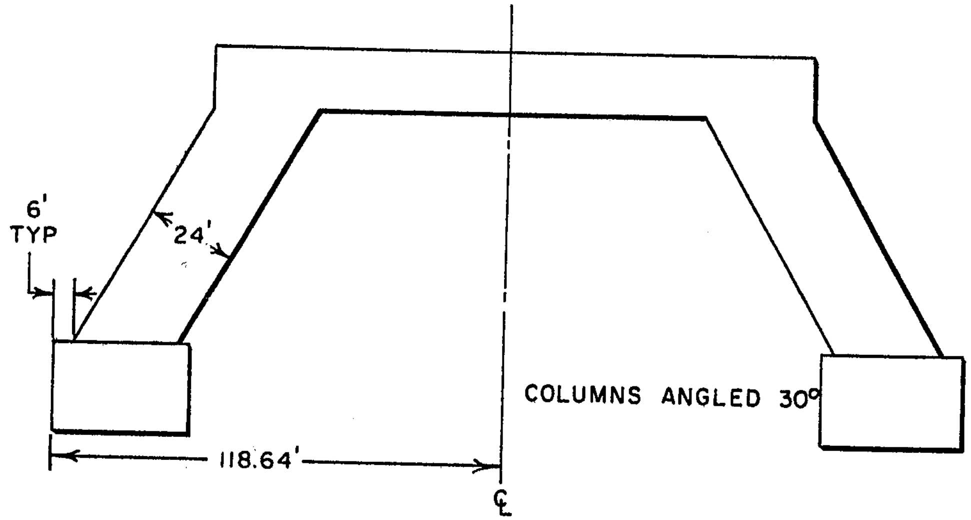

FIG. 9

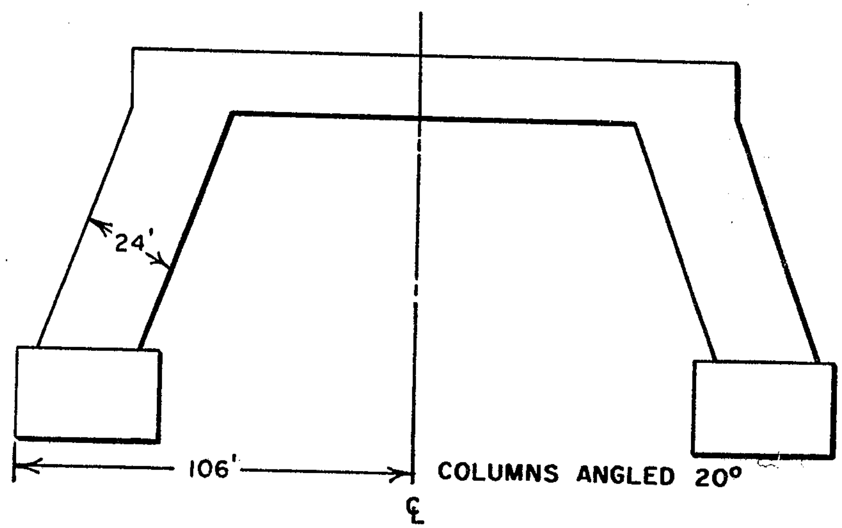

FIG. 8

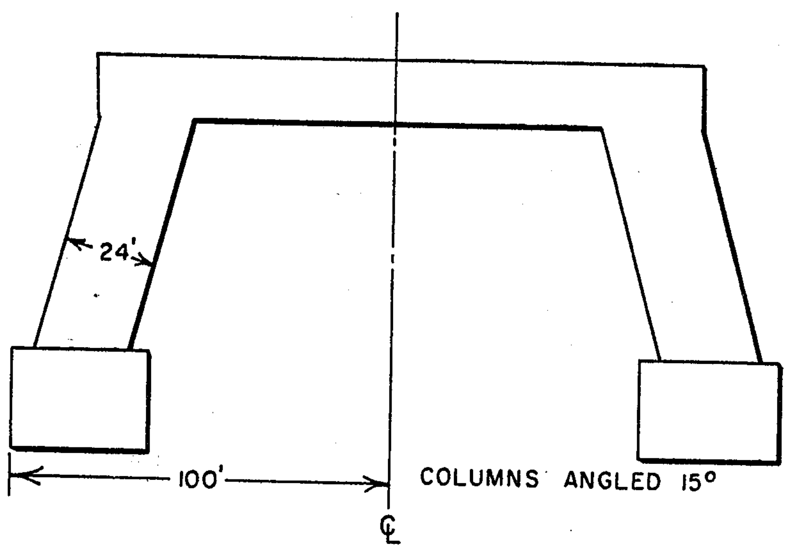

FIG. 7

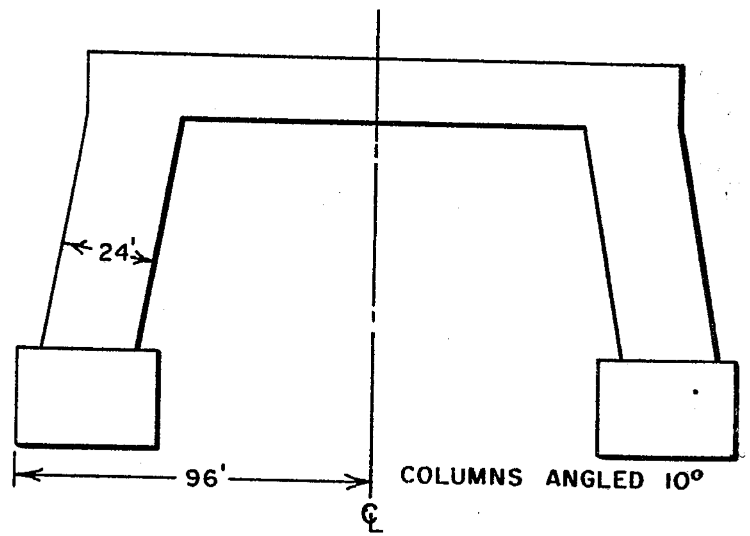

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FIG. 11

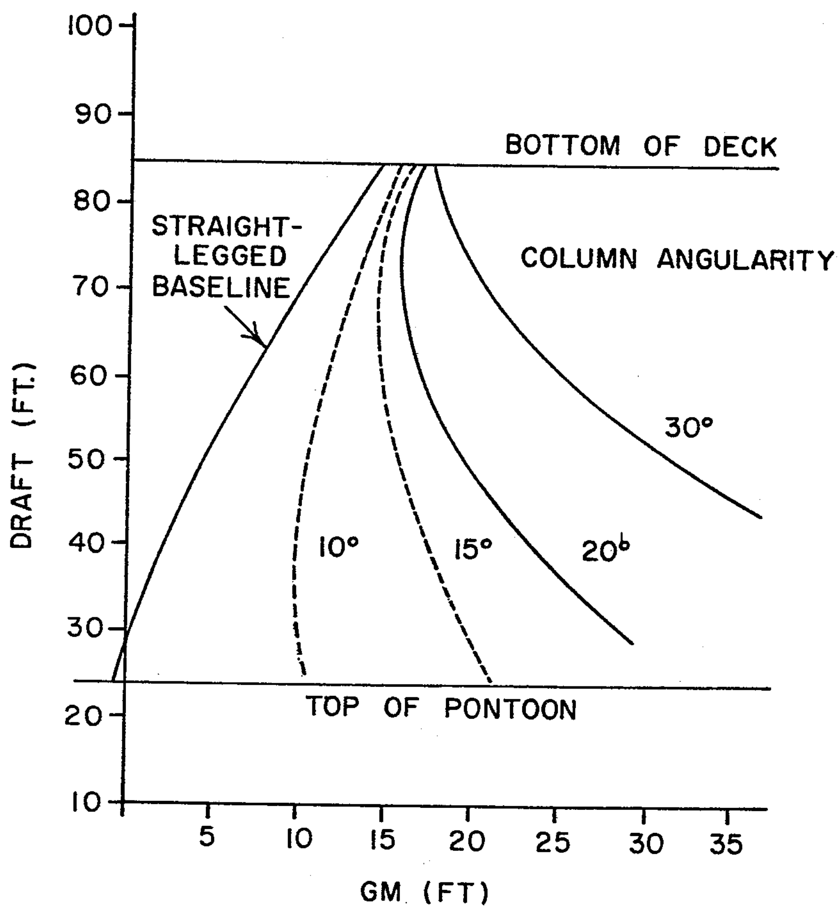


FIG. 12-A

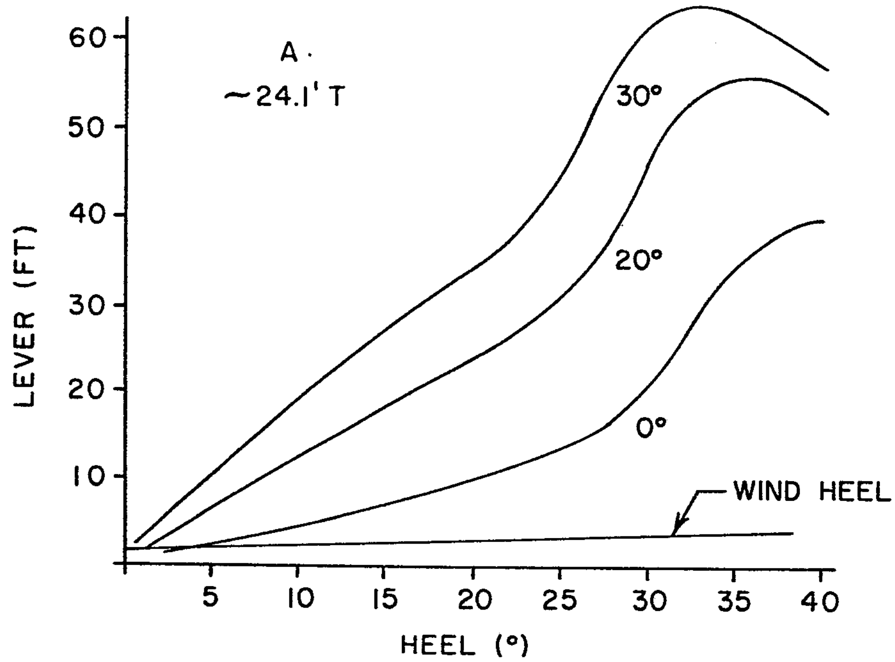


FIG. 12-B

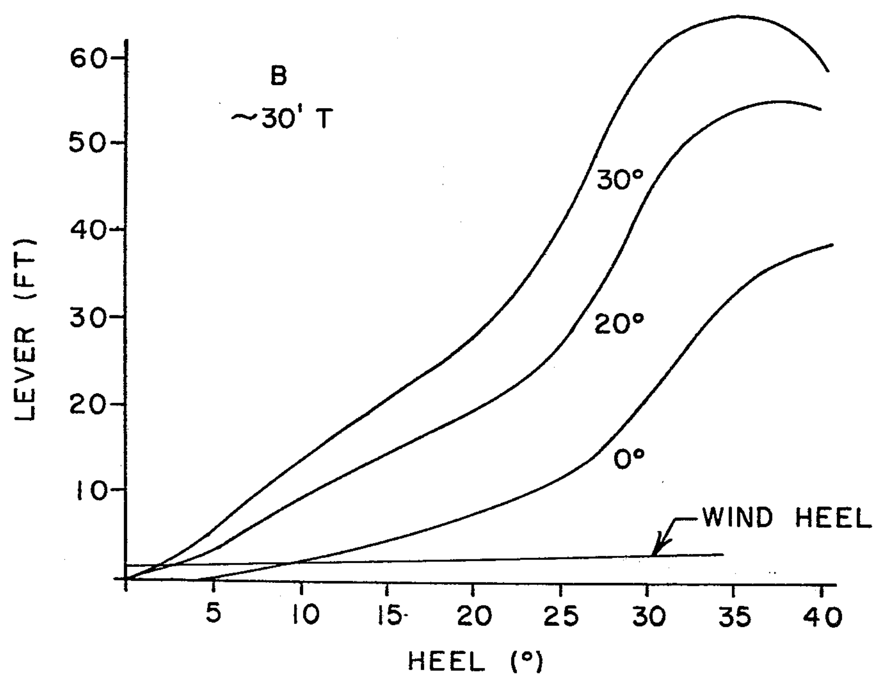


FIG. 12-C

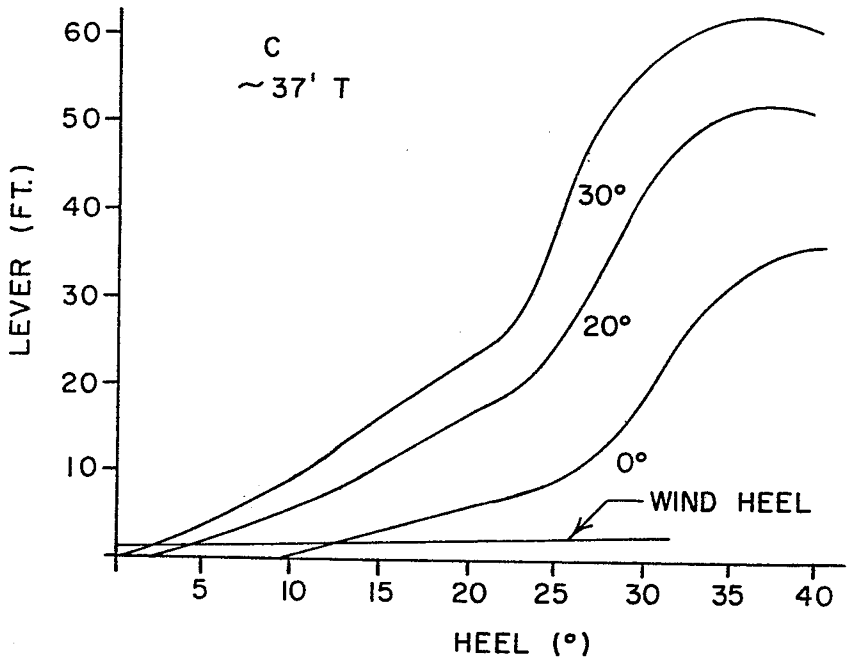


FIG. 12-D

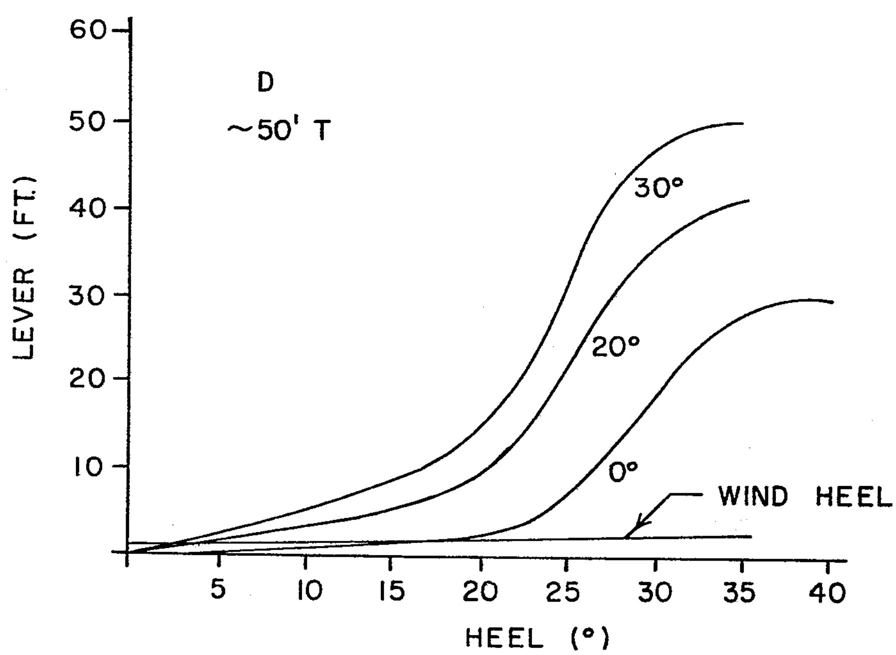


FIG. 12-E

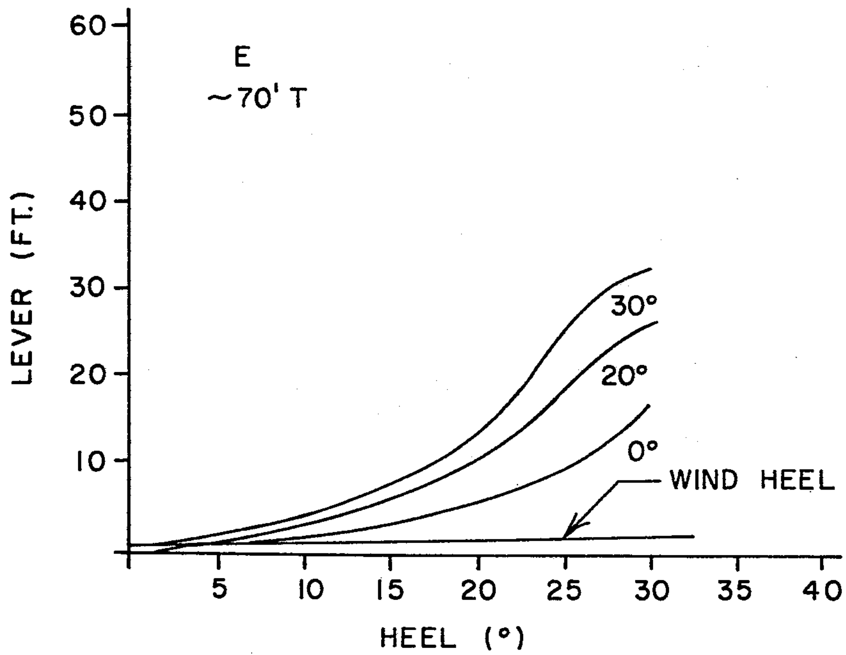


FIG. 12-F

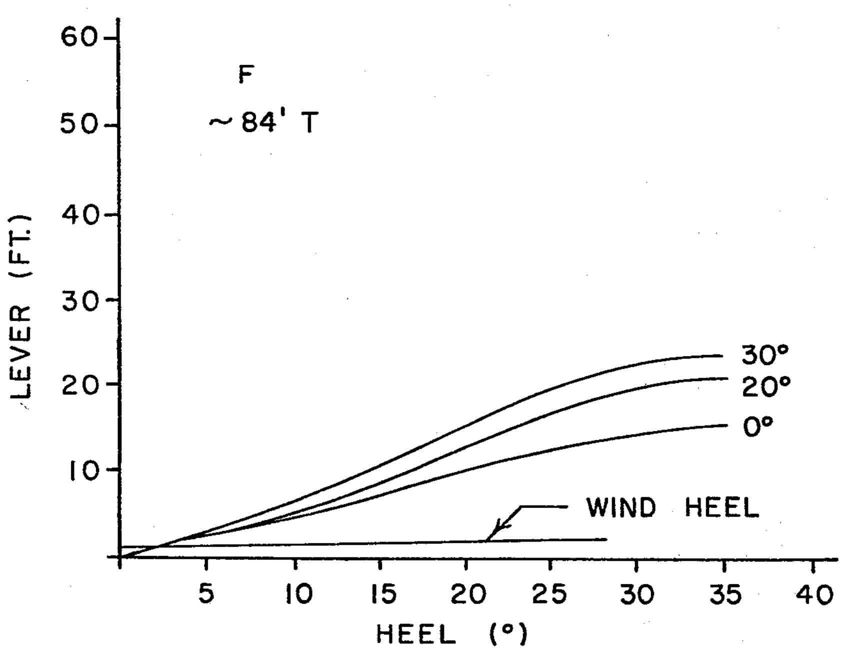


FIG. 13

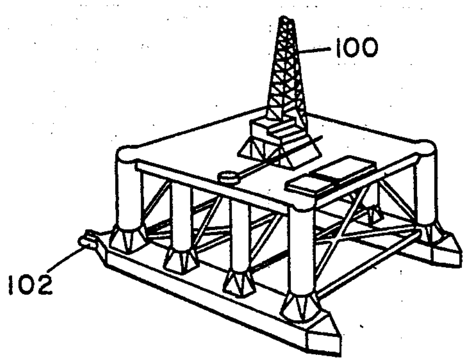


FIG. 14

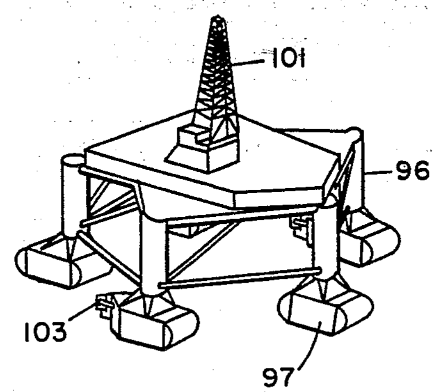


FIG. 15

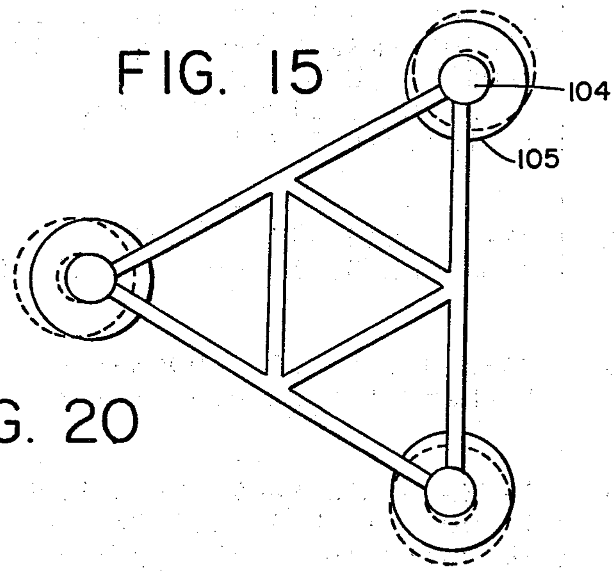


FIG. 16

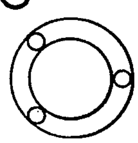


FIG. 20

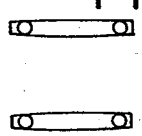


FIG. 17

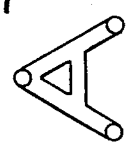


FIG. 21

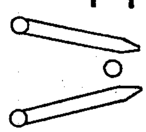


FIG. 18

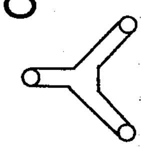


FIG. 22

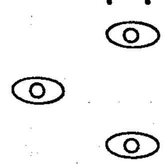


FIG. 19

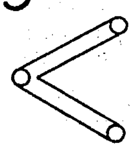
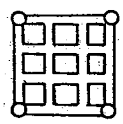


FIG. 23



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European Patent Office

EUROPEAN SEARCH REPORT

Application number

EP 84 30 2765

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl. 3)
X	FR-A-2 066 646 (DRESSER IND. INC.) * Page 7, lines 1-28; figures 6,7 *	1,6,7	B 63 B 35/44 B 63 B 35/08
Y		2,3,8, 9	

X	FR-A-2 137 154 (ENTREPRISE D'EQUIPEMENTS MECANIQUES ET HYDRAULIQUES E.M.H.) * Page 2, line 39 - page 3, line 1; figures 1-3 *	1,6,7	

Y	US-A-3 616 773 (LLOYD) * Column 5, lines 1-6; figure 6 *	2	
	---		TECHNICAL FIELDS SEARCHED (Int. Cl. 3)
Y	US-A-3 556 033 (BONNAFOUS) * Abstract; figures 1,2 *	3	B 63 B

Y	PATENTS ABSTRACTS OF JAPAN, vol. 7, no. 41 (M-194)(1186), February 18, 1983; & JP - A - 57 191188 (MITSUI ZOSEN K.K.) 24-11-1982	8,9	

A	FR-A-2 188 558 (GEORGE) * Page 1, line 36 - page 2, line 19; figure *	4,5	

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	27-07-1984	VOLLERING J.P.G.

CATEGORY OF CITED DOCUMENTS

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