Aug. 14, 1945. F. L. CORBIN 2,382,691

FORE AND AFT DRAFT INDICATOR

Filed July 4, 1942 2 Sheets-Sheet 1

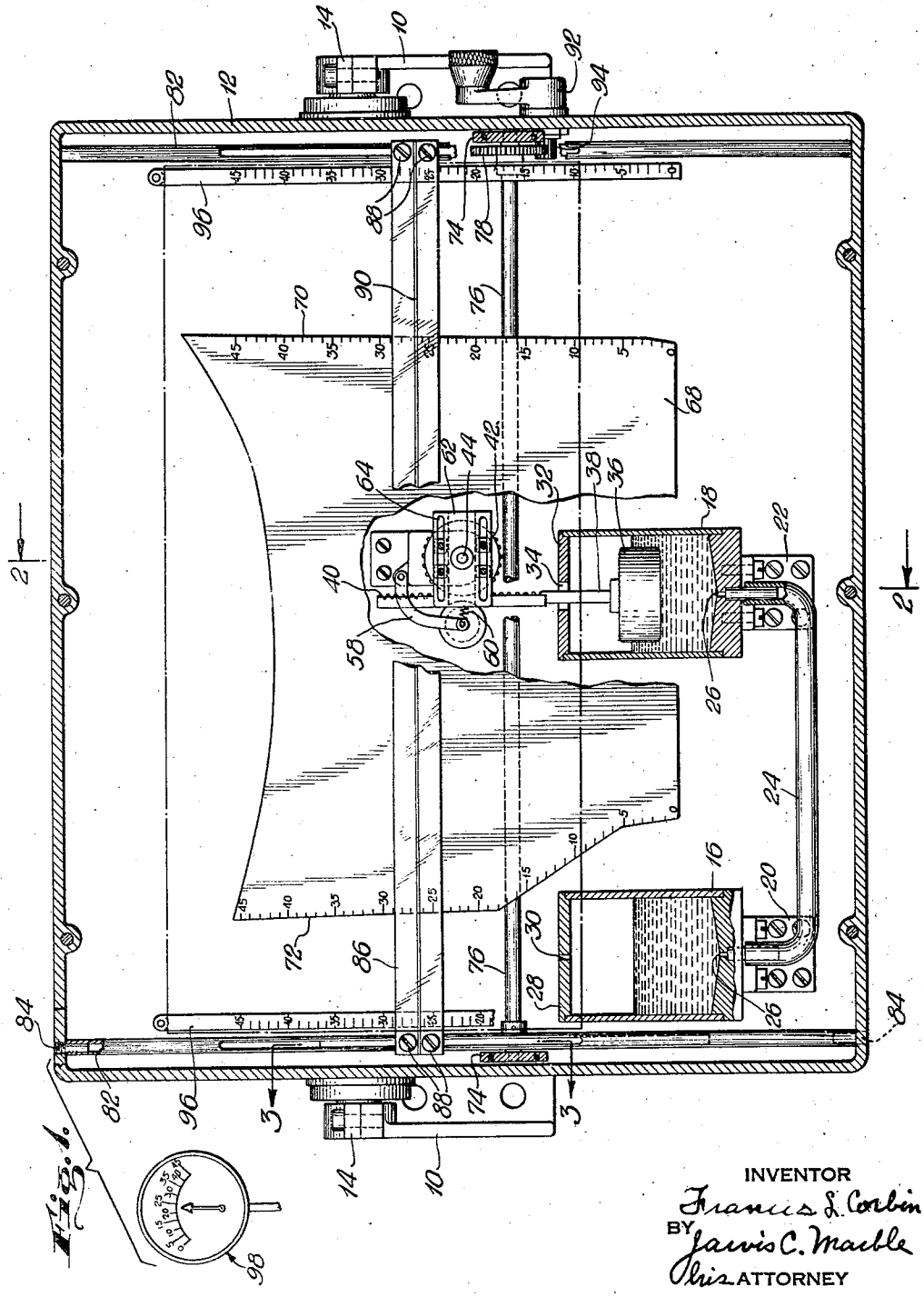


Fig. 1.

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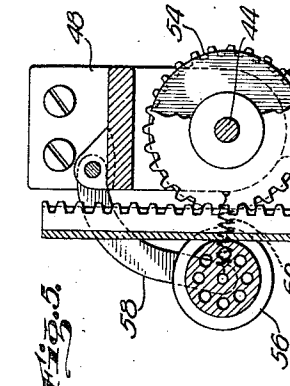


Fig. 5.

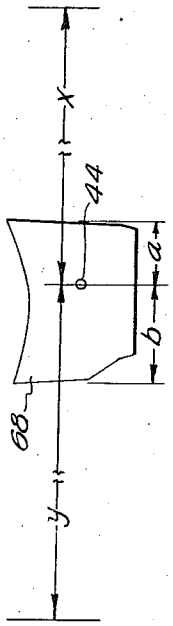


Fig. 6.

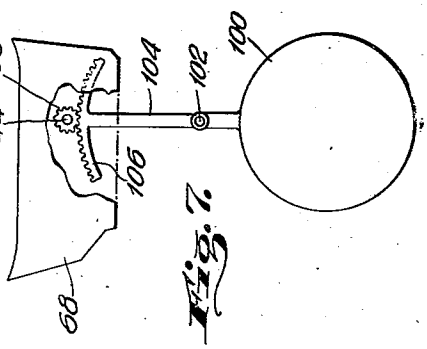


Fig. 7.

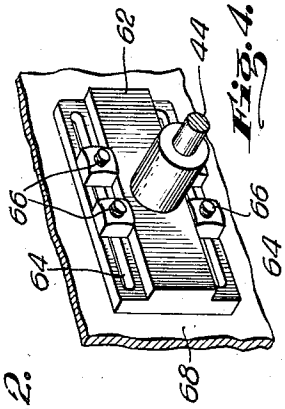


Fig. 4.

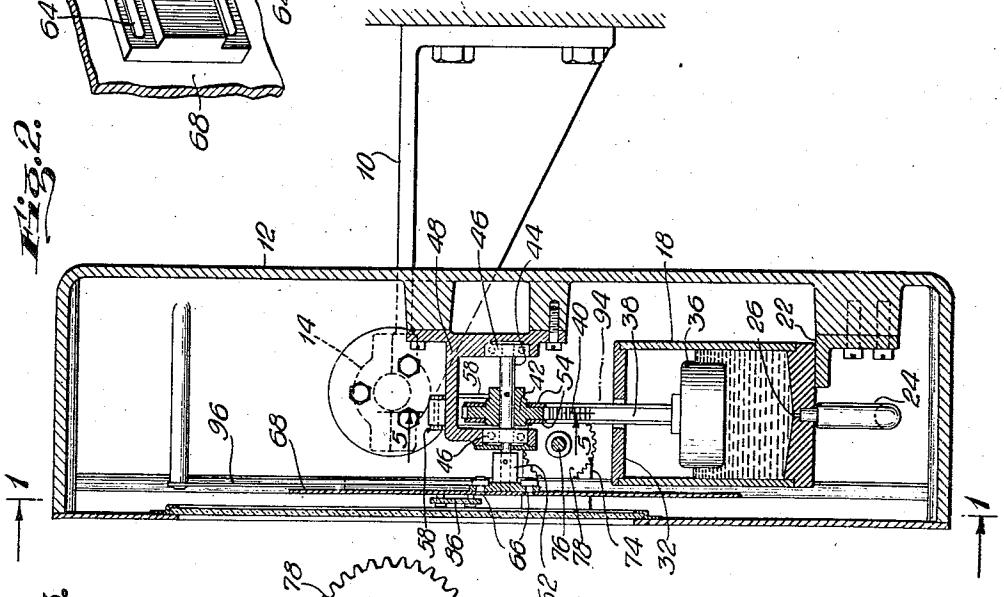


Fig. 2.

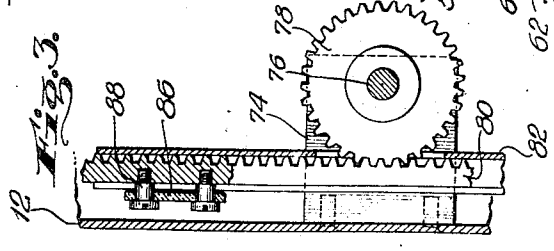


Fig. 3.

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2,382,691

FORE-AND-AFT DRAFT INDICATOR

Francis L. Corbin, Chatham, N. J., assignor to Pitometer Log Corporation, New York, N. Y., a corporation of New York

Application July 4, 1942, Serial No. 449,734

11 Claims. (Cl. 73—178)

My invention relates to a draft indicator system for ships and more particularly to an apparatus which will indicate at a glance and without the necessity for any computation the fore and aft draft of a ship at any instant. Heretofore, in order to determine the fore and aft draft of a ship, an inclinometer has been provided which indicates the angle at which the ship is out of trim fore and aft. From this information, if the actual draft at any point on the ship is also known, it is possible to compute the actual fore and aft draft of the ship. However, the necessary computation requires time, and, particularly on a warship in the midst of a battle, it is difficult to carry out. Moreover, repeated computations are necessary if the trim is changing.

In accordance with my invention the fore and aft draft is indicated directly by the apparatus. Thus, in the event of damage to the ship which causes it to take on water at one end or the other, thus bringing the ship out of trim fore and aft, the damage control officer may instantly know the extent of the out of trim and take the necessary steps to counteract it. Furthermore, he can immediately know the effect of these steps and thus be in a position to restore the trim of the vessel. In addition, in the event that it is impossible to completely restore the trim, the officer knows the actual fore and aft draft and hence knowns whether or not the ship in its out of trim condition can be safely navigated through shallow water.

Further objects and advantages will be apparent from the following description taken in conjunction with the accompanying drawings forming a part of this specification and in which:

Fig. 1 is a front cross-sectional view of a preferred embodiment of my invention;

Fig. 2 is a cross-sectional view taken on the line 2—2 of Fig. 1;

Fig. 3 is a cross-sectional view on an enlarged scale taken on the line 3—3 of Fig. 1;

Fig. 4 is a perspective view on an enlarged scale of a portion of the apparatus shown in Fig. 1;

Fig. 5 is a cross-sectional view on an enlarged scale taken on the line 5—5 of Fig. 2;

Fig. 6 is a diagram showing the proportions of certain distances; and

Fig. 7 is a front view of a second embodiment of my invention.

Referring more particularly to Figs. 1 through 5, reference character 10 designates a pair of brackets secured to any suitable structure on the ship. A housing 12 is pivotally supported in bearings 14 carried by the brackets. Within the housing there is mounted a pair of containers 16 and 18 by means of brackets 20 and 22.

The housing is so mounted that the containers 16 and 18 are spaced longitudinally of the ship, it being assumed that the container 18 is closer to the bow than is the container 16. The bottoms of the containers are connected by means of a conduit 24 which communicates with the containers through restricted openings 26. The upper end of container 16 is provided with a closure member 28 having a vent 30 to atmosphere. The upper end of container 18 is provided with a closure member 32 having a relatively large opening 34 through the central part thereof.

The containers 16 and 18 are partially filled with a suitable liquid, preferably mercury. Within the container 18 there is a float 36 to which is rigidly secured a bar 38, the upper portion of which is provided with teeth 40 to form a rack. These teeth are adapted to engage a pinion 42 fixed to a shaft 44 which is rotatably carried in suitable bearings 46 mounted in a bracket 48 supported from the rear wall of the housing 12. The rack portion of the rod 38 is received within a channel member 50. As is more clearly shown in Fig. 5 the flanges 52 of the channel extend to the pitch line of the teeth 40 and consequently the ends of the teeth project beyond the flanges. The pinion 42 is provided with a pair of circular discs 54, the peripheries of which coincide with the pitch circle of the pinion and consequently the pinion teeth project radially beyond the discs. The rack 38 and channel member 50 are held in engagement with the pinion 42 and discs 54 by means of a grooved wheel 56 rotatably carried at the free end of a pivoted arm 58. A spring 60 serves to urge the arm 58 in a counterclockwise direction as viewed in Figs. 1 and 5 so as to cause the wheel 56 to maintain the rack and pinion in engagement. The flanges 52 on the channel 50 contact the discs 54 on the pinion in order to prevent the teeth on the two members from becoming jammed by the force exerted by the spring.

A bracket 62 is rigidly secured to the shaft 44 and is provided with a pair of parallel slots 64. Bolts 66 pass through these slots and engage a thin sheet of material or card 68 so that the card will be rotated by the shaft and about the axis of the shaft.

Card 68 is given a configuration resembling roughly the outline of the particular ship on which the device is mounted. However, the hori-

zontal dimension of the card bears a ratio to the actual length of the hull of the ship which is greater than the ratio which the vertical dimension of the card bears to the height of the hull. In the example illustrated in Fig. 1 the horizontal dimension of the card bears a ratio of 1 to 600 with respect to the length of the hull, while the vertical dimension of the card bears a ratio of 1 to 60 with respect to the height of the hull. The forward end of the card is provided with a scale 70 which indicates the forward draft of the ship, while the other end of the card is provided with a scale 72 which indicates the aft draft of the ship, the ratios of these scales to the fore and aft drafts being 1 to 60.

From Fig. 6 it will be seen that the distance *a* from the center of shaft 44 to the forward end of card 68, is to the distance *b* from the shaft to the other end of the card, as the distance *x* from the shaft to the bow of the ship, is to the distance *y* from the shaft to the stern. The elongated slots 64 in the bracket 62 permit the card to be adjusted so that the above proportion obtains.

Rotatably mounted within suitable bearings 74 which are carried by the end walls of the casing 12 is a shaft 76. A pinion 78 is secured to the shaft adjacent to either end thereof. As is more clearly shown in Fig. 3 each pinion 78 engages a rack 80 which is slidably mounted within a channel 82 secured at opposite ends to the top and bottom of the housing 12 by means of bolts 84. A member 86 is secured at opposite ends to the respective racks 80 by means of bolts 88. Member 86 is preferably made of transparent rigid material and is provided with a reference line 90. A handcrank 92 is rotatably journalled in an end wall of the housing and is provided with a pinion 94 which engages one of the pinions 78 on the shaft 76.

Suitably supported within the casing and behind the member 86 is a pair of scales 96 which are calibrated in accordance with the draft of the ship at the point in line fore and aft with the axis of shaft 44. While a pair of scales 96 has been shown, one scale being located at each end of the member 86, only one such scale is necessary inasmuch as both scales read the same and the member 86 is always at right angles to the scales.

The above described device operates as follows:

With the ship in trim fore and aft the housing 12 will be level with the surface of the water in which the ship is floating. The float 36 occupies the position shown in which the card 68 mounted on the shaft 44 is horizontal and parallel to the surface of the water. Should, however, any condition arise, such as a hit below the water line near the bow of the ship, which would admit water to the forward part of the ship, the bow will sink lower in the water and the stern will be raised in the water, thus causing the ship to be out of trim fore and aft. This means that the housing 12 is no longer parallel with the surface of the water and consequently mercury will flow from the container 16 through the conduit 24 into the container 18 until the surfaces of the mercury in these containers are parallel with the surface of the water. This will cause the float 36 to rise relative to the container 18 and other fixed parts of the apparatus. This movement of the float causes the rack connected thereto to rotate the pinion 42 and consequently the card 68 will be turned through a certain angle. The diameter of the pinion 42 is so chosen with respect to the horizontal distance between the containers 16 and 18 that a 1° inclination of the ship will cause a 10° rotation of the pinion, this ratio being the same as the ratio between the horizontal and vertical dimensions of the card 68, which is 600 to 60 or 10 to 1.

In order to determine the actual fore and aft draft of the ship when it is out of trim, the officer reads the actual draft of the ship at a convenient point between the bow and the stern, which draft is directly indicated by means of any standard draft gage 98. In the foregoing description of Fig. 6 it has been assumed that the gauge 98 indicates the actual draft of the ship at a point in line fore and aft with the shaft 44, and consequently the distances *x* and *y* in Fig. 6 are stated to be measured from this shaft to the bow and stern, respectively. However, inasmuch as the ship is a substantially rigid structure, it is obvious that the angle of trim is the same at all places on the ship and consequently the fore and aft draft gauge will read the same regardless of its location on the ship. Hence, if it is more convenient to arrange the draft gauge 98 to indicate the actual draft of the ship at a point fore and aft different from the location of shaft 44, this may be done, but in this case, the distances *x* and *y* are measured from said point to the bow and stern, and not from the shaft 44.

When the officer has read the gauge 98, he turns the crank 92 so as to raise or lower the member 86 so that the reference line 90 thereon reads the same on the scales 96 as does the draft gage 98. When this adjustment of the reference line 90 has been made, the actual draft of the bow of the ship is indicated by the reference line 90 on the scale 70, while the draft at the stern is indicated directly by the reference line 90 on the scale 72.

The damage control officer then takes whatever steps he considers necessary in order to restore the fore and aft trim of the ship. As the ship comes back into trim he keeps the reference line 90 on the scales 96 in accordance with the reading of the draft gage 98 and when the reference line 90 reads the same on both scales 70 and 72 he knows that the ship is in trim. If the damage is so severe that it is impossible to completely trim the ship, the officer knows at a glance the actual draft at both the bow and the stern and hence knows the minimum depth of water in which the ship may be sailed without danger of grounding.

The restricted openings 26 tend to prevent rapid flow of the mercury from one container to the other and hence tend to damp out oscillation of the card 68 resulting from pitching of the ship in a rough sea. Due to the fact that the entire housing is pivotally mounted in the bearings 14, it tends to remain in a vertical position in spite of any list or rolling of the ship.

In the embodiment illustrated in Fig. 7 the containers 16 and 18 and the float 36 are replaced by means of a heavy pendulum 100 having an arm 104 pivoted at 102. The upper end of the arm 104 carries a gear segment 106 which meshes with a pinion 108 which corresponds to the pinion 42 in the embodiment illustrated in the previous embodiments. This pinion is mounted on the shaft 44 which carries the card 68. The ratio between the gears 106 and 108 is the same as the ratio between the horizontal and vertical scales of the card 68. Thus, when the ship comes out

of trim fore and aft, the pendulum 100 remains in a vertical position and consequently pivots about the axis 102. This causes the gear 106 to rotate pinion 108 and the sheet is given an inclination in the same manner as described in connection with Fig. 1. Otherwise than as above described, this embodiment operates in the same manner as the one previously described, but, while simpler in construction, it is much more susceptible to the effect of pitching of the ship in a rough sea and hence under such conditions does not give as accurate an indication of the fore and aft draft.

While I have shown and described two more or less specific embodiments of my invention, it is to be understood that this has been done for purposes of illustration only and that the scope of my invention is not to be limited thereto but is to be determined by the appended claims.

What is claimed is:

1. In a fore and aft draft gage for a ship, a pivotally mounted member having fore and aft draft scales adjacent to opposite ends thereof, the horizontal distance between said scales bearing a ratio to the actual length of the ship which is greater than the ratio which the height of the respective scales bears to the fore and aft draft of said ship, means for pivoting said member in response to variations in the inclination of the ship, the pivoting of said member being amplified with respect to the inclination of the ship in the same proportion as the first mentioned ratio bears to the second mentioned ratio, and a member having a reference line cooperating with said scales for indicating directly thereon the fore and aft draft of the ship.

2. In a fore and aft draft gage for a ship, means for indicating the actual draft of the ship at a point between the bow and stern, a card having fore and aft draft scales adjacent to opposite ends thereof, means for mounting said card to pivot about an axis located between said ends, the distance from said axis to the fore draft scale being to the distance from the axis to the aft draft scale as the distance from said point to the bow of the ship is to the distance from said point to the stern of the ship, means for pivoting said card in response to variations in the inclination of the ship, and a member having a reference line cooperating with said scales for indicating directly thereon the fore and aft draft of the ship.

3. In a fore and aft draft gage for a ship means for indicating the actual draft of the ship at a point between the bow and the stern, a turnably mounted shaft, a card having fore and aft draft scales adjacent to opposite ends thereof, means for adjustably mounting said card on said shaft so that the distance from said shaft to the fore draft scale is to the distance from the shaft to the aft draft scale as the distance from said point to the bow of the ship is to the distance from said point to the stern of the ship, means for turning said shaft in response to variations in the inclination of the ship, and a member having a reference line cooperating with said scales for indicating directly the fore and aft draft of the ship.

4. In a fore and aft draft gage for a ship means for indicating the actual draft of the ship at a point between the bow and the stern, a card having fore and aft draft scales adjacent to opposite ends thereof, means for mounting said card to pivot about an axis located between said ends, the distance from said axis to the fore draft scale being to the distance from the axis to the aft draft scale as the distance from said point to the bow of the ship is to the distance from said point to the stern of the ship, means for pivoting said card in response to variations in the inclination of the ship, a member having a reference line parallel to the ship, and means for raising and lowering said member in accordance with variations in the actual draft of the ship at said point, said reference line cooperating with said scales for indicating directly thereon the fore and aft draft of the ship.

5. In a fore and aft draft gage, a turnably mounted shaft, a card having fore and aft draft scales adjacent to opposite ends thereof, means for mounting said card on said shaft so as to be turned thereby, a pair of liquid containers placed longitudinally of the ship, a conduit connecting the lower parts of said containers, a float disposed in one of said containers, a toothed rack rigidly secured to said float, a pinion on said shaft, means to maintain said rack in engagement with said pinion, whereby rising and falling of said float in response to variations in the liquid level in said containers turns said shaft, and a member having a reference line cooperating with said scales for indicating directly thereon the fore and aft draft of the ship.

6. In a fore and aft draft gage, a turnably mounted shaft, a card having fore and aft draft scales adjacent to opposite ends thereof, means for mounting said card on said shaft so as to be turned thereby, a pair of liquid containers spaced longitudinally of the ship, a conduit connecting the lower parts of said containers, a float disposed in one of said containers, a rack rigidly secured to said float, said rack having teeth on one side and being smooth on the opposite side, a pinion on said shaft, a spring pressed guide roller contacting the smooth side of said rack for maintaining said teeth in engagement with said pinion, and a member having a reference line cooperating with said scales for indicating directly thereon the fore and aft draft of the ship.

7. In a fore and aft draft gage, a turnably mounted shaft, a card having fore and aft draft scales adjacent to opposite ends thereof, means for mounting said card on said shaft so as to be turned thereby, a pair of liquid containers spaced longitudinally of the ship, a conduit connecting the lower parts of said containers, a float disposed in one of said containers, a rack rigidly secured to said float, said rack having teeth on one side and being smooth on the opposite side, members on the other two sides of said rack having smooth edges coinciding with the pitch line of said teeth, a pinion on said shaft, a circular disc on each side of said pinion having its circumference coinciding with the pitch circle of the pinion, a spring pressed guide roller contacting the smooth side of said rack for maintaining said smooth edges in contact with said discs and said teeth in engagement with said discs, and a member having a reference line cooperating with said scales for indicating directly thereon the fore and aft draft of the ship.

8. In a fore and aft draft gage for a ship means for indicating the actual draft of the ship at a point between the bow and the stern, a card having fore and aft draft scales adjacent to opposite ends thereof, means for mounting said card to pivot about an axis located between said ends, the distance from said axis to the fore draft scale being to the distance from the axis to the aft draft scale as the distance from said point to the

bow of the ship is to the distance from said point to the stern of the ship, means for pivoting said card in response to variations in the inclination of the ship, a member having a reference line parallel to the ship, a stationary scale calibrated to indicate the draft of the ship at said point, and means for adjusting said member vertically to cause the reference line to indicate on said stationary scale the actual draft of the ship at said point, said reference line cooperating with the scales on said card for indicating directly thereon the fore and aft draft of the ship.

9. In a fore and aft draft gage for a ship, a supporting structure, a card pivotally mounted on said structure, said card having fore and aft draft scales adjacent to opposite ends thereof, means carried by said structure for pivoting said card in response to variations in the inclination of said ship, a member mounted on said structure and having a reference line cooperating with said scales for indicating directly thereon the fore and aft draft of said ship, and means for pivotally mounting said structure on said ship about an axis extending in a fore and aft direction, whereby said structure substantially remains in a vertical plane regardless of any list of the ship.

10. In a fore and aft draft gage for a ship, a pivotally mounted shaft, a card secured to said shaft and having fore and aft draft scales adjacent to opposite ends thereof, a pivotally mounted pendulum, gear means connected to said shaft and said pendulum for turning the former in accordance with pivoting of the latter, and a member having a reference line cooperating with said scales for indicating directly thereon the fore and aft draft of the ship.

11. In a fore and aft draft gage for a ship, a pivotally mounted member having fore and aft draft scales adjacent to opposite ends thereof, means for pivoting said member in response to variations in the inclination of the ship, a member having a reference line parallel to the ship, and means for raising and lowering the last-mentioned member, in accordance with variations in the draft of the ship at a point between the bow and the stern, the distance said last-mentioned member is moved for a given variation in draft being equal to the distance on said fore and aft draft scales indicating a like difference in draft, whereby said reference line cooperates with said scales for indicating directly thereon the fore and aft draft of the ship.

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