United States Patent

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[54] **MOVING WEIGHT SHIP STABILIZER**
11 Claims, 9 Drawing Figs.

[52] **U.S. Cl.** **114/124**
[51] **Int. Cl.** **B63b 39/02,**
B63b 43/08
[50] **Field of Search** 114/121,
122, 124, 125

[56] **References Cited**

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ABSTRACT: A roll stabilization system for ships including a rolling cylindrical weight guided to roll athwartships in response to the rolling motion of the ship. Liquid means may be provided to dissipate kinetic energy from the rolling weight to assure proper phasing. Further means are provided to slow or dampen the movement of the weight near the extremities of travel.

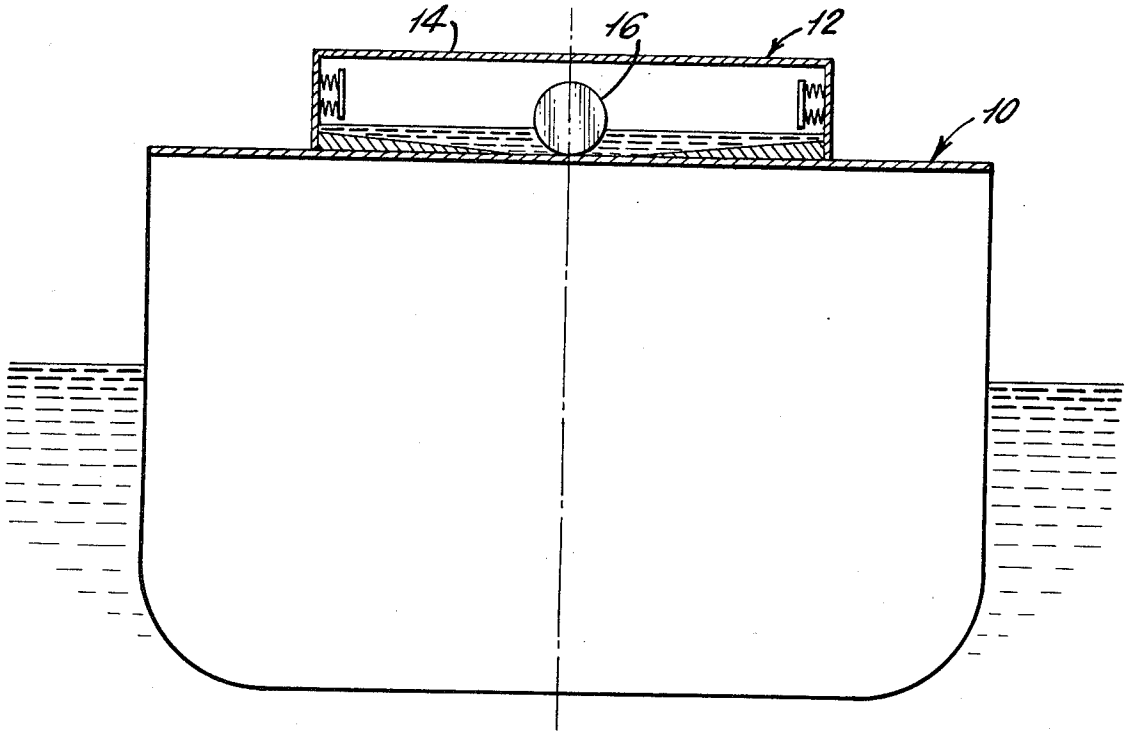

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Fig. 1.

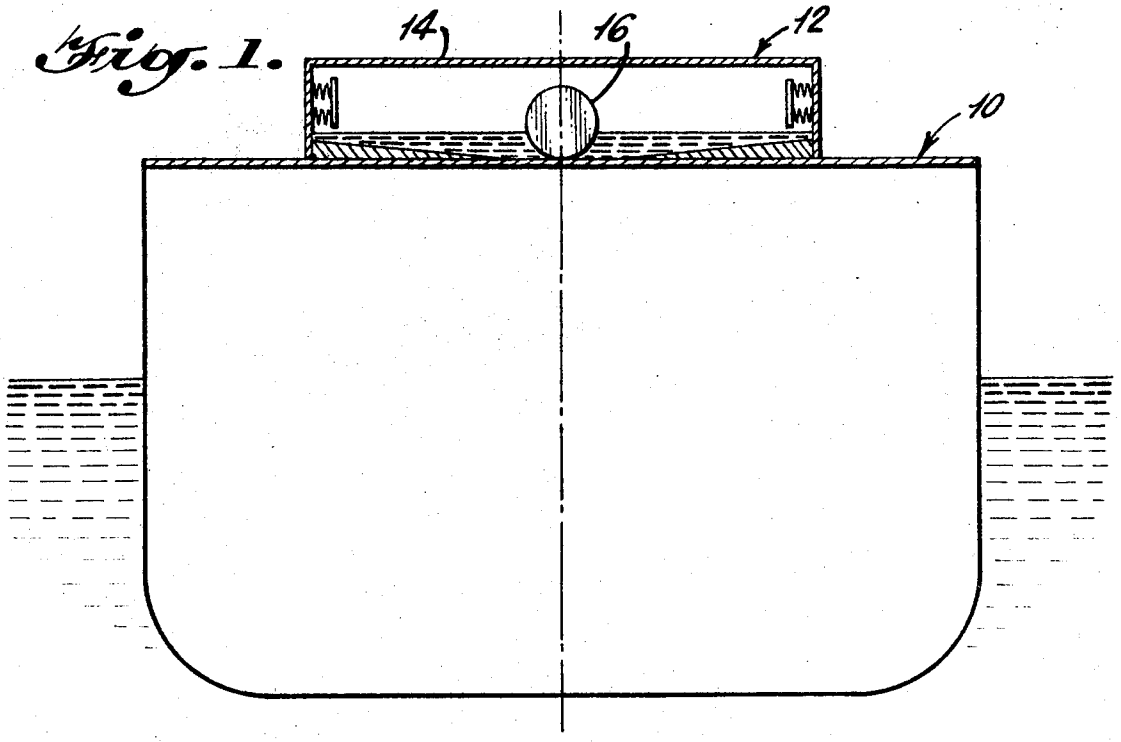
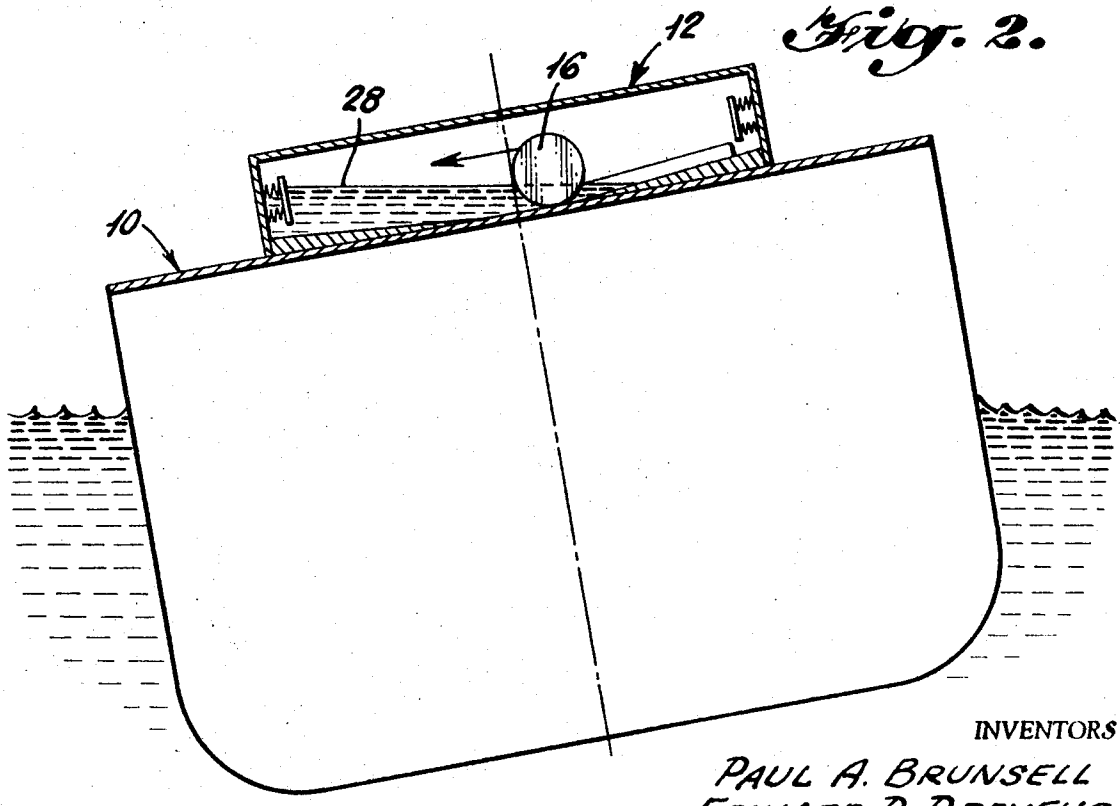


Fig. 2.



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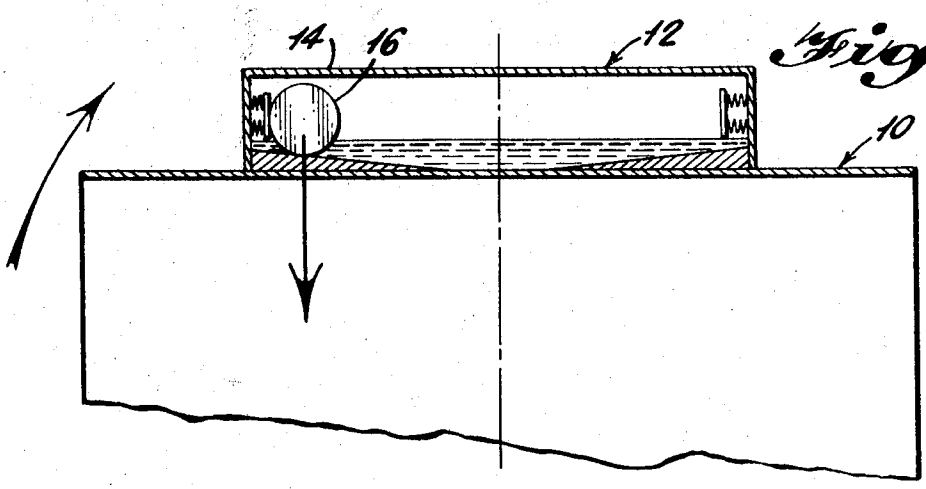

Fig. 3.

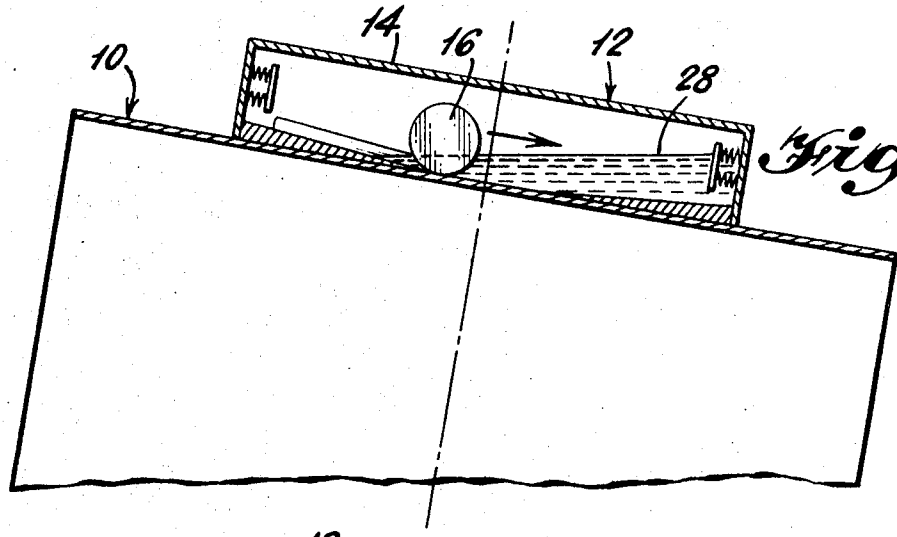

Fig. 4.

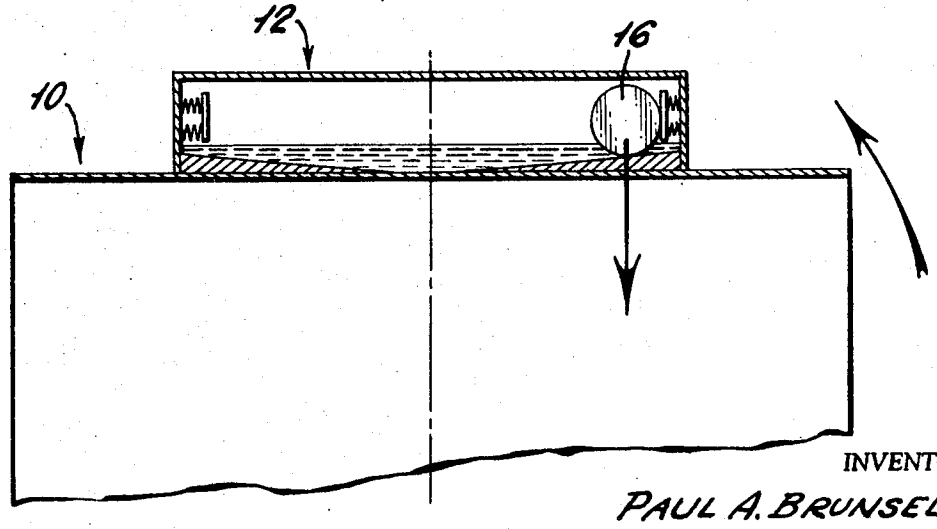

Fig. 5.

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Fig. 8.

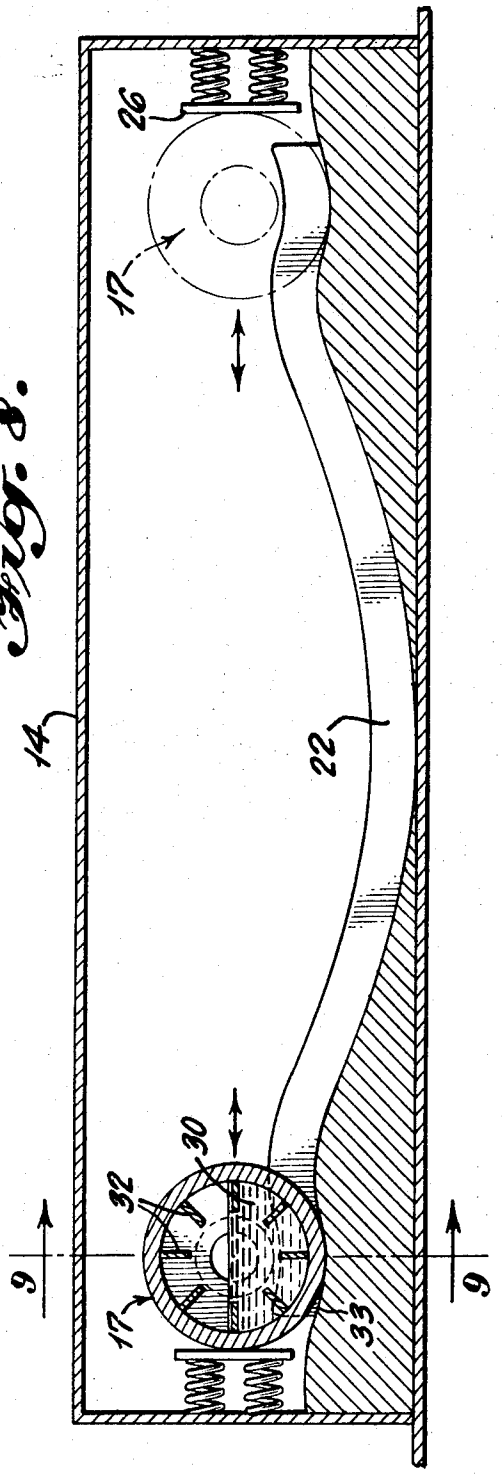

Fig. 6.

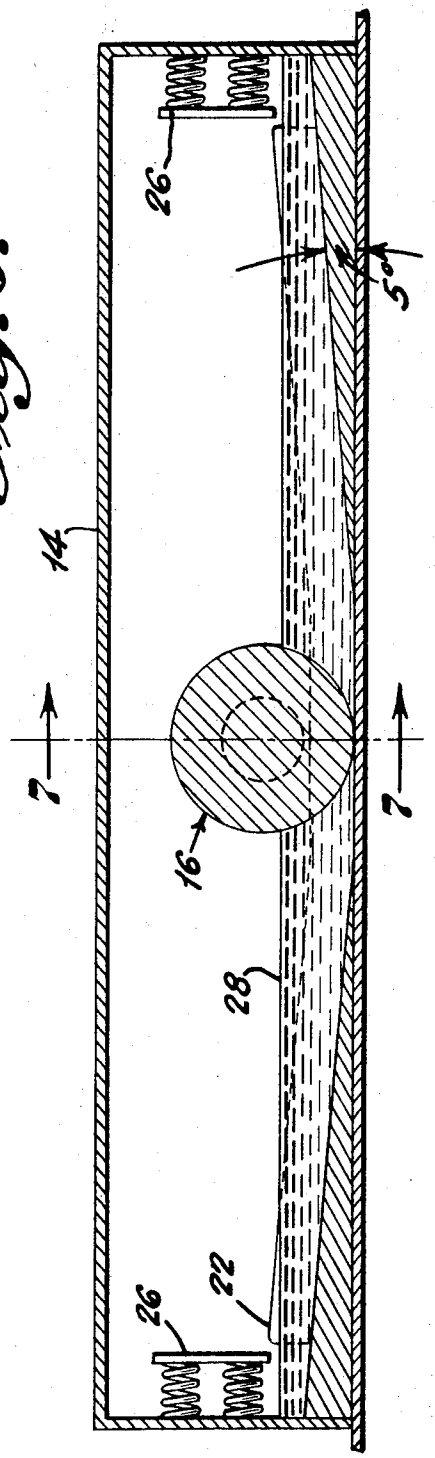

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Fig. 9.

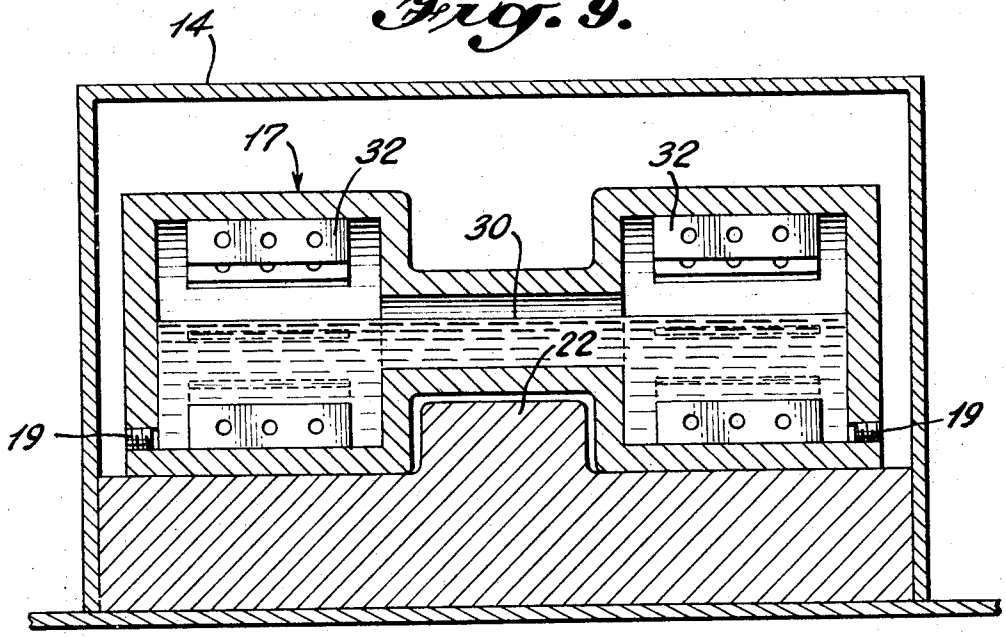
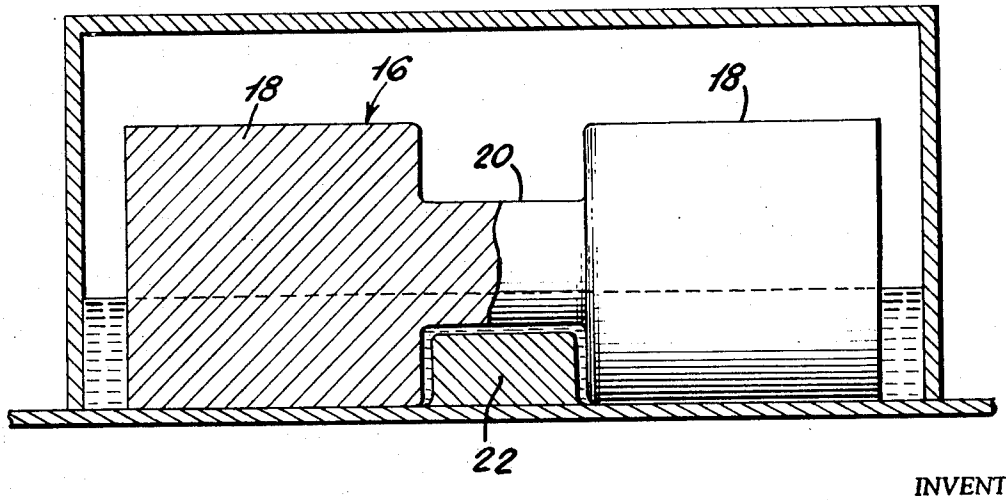


Fig. 7.



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MOVING WEIGHT SHIP STABILIZER

BACKGROUND

The present invention relates to moving weight stabilization systems for ships and more particularly to such a system including a moving weight in the form of rolling cylindrical member guided to roll athwartship in response to the rolling motion of the ship.

Moving weight stabilizers are known which include a track mounted carriage including a significant weight or mass block, for example 25 tons or more, arranged on wheels which in response to the roll of the ship translates from one side of the ship toward the other. In addition to maintenance and guiding problems, these conventional systems usually experience a serious phasing problem the solution of which, in one example, includes a complicated braking mechanism requiring an electronic roll sensing brake actuation device.

It is a primary object of the present invention to provide a new and improved passive moving weight system which embodies a rolling cylindrical weight dimensioned so that its position due to rolling lags the relative motion of the ship.

The weight is guided by a rail and travels on a floor which is preferably inclined upward from the center region of the tank to diminish the kenetic energy of the weight as it travels outboard. In one embodiment preferably including a solid cylinder, liquid is contained within the path through which the cylinder rolls to dampen and dissipate kinetic energy during operation.

In another embodiment the weight cylinder is of hollow construction and incorporates a liquid body filled to a level to effectively determine the mass and consequently the timing or amplitude of the weight movement. If further energy dissipation is required, members may be formed within the hollow cylinder that rotate through the liquid body in order to dampen rotation and translation of the cylinder weight.

It is, therefore, the primary object of the present invention to provide a new and improved rolling weight system of the type described which solves the problems and avoids the disadvantages outlined above. Other and further objects of the invention will become apparent with the following detailed description when taken in view of the appended drawings in which:

FIG. 1 is a diagrammatic illustration of a transverse section through a ship embodying the stabilizing system according to the invention. The ship and system is depicted in a steady state stabilized condition.

FIGS. 2—5 are illustrations similar to FIG. 1 in which the ship and system are illustrated in various parts of the roll cycle.

FIG. 6 is a transverse section relative to the ship illustrating the stabilization system according to the invention.

FIG. 7 is a longitudinal section relative to the ship taken along line 7–7 of FIG. 6.

FIG. 8 is similar to FIG. 6 illustrating a second embodiment of the invention.

FIG. 9 is a longitudinal sectional relative to the ship taken along line 9–9 of FIG. 8.

DETAILED DESCRIPTION OF EMBODIMENTS

With reference to FIGS. 1 through 5, there is depicted a typical ship 10 on which the stabilization system 12 according to the invention is arranged to impart stabilizing moments to the vessel in opposition to roll. The moving weight system 12 may be arranged on the main deck as shown or in the double bottom or between any decks of the ship 12 to suit the space and stability characteristics of the ship.

System 12 includes an enclosed and elongated enclosure or housing 14 extending athwartships and arranged symmetrically with the longitudinal center line of the ship. According to the invention the moving weight is in the form of a rolling cylindrical member 16 guided within housing 14 to roll athwartships in response to the rolling action of ship 10. Cylinder 16 is designed such that its radius of gyration is related to the cylinder mass to cause a cylinder translation of a predetermined distance when the ship rolls at its natural frequency. As more fully described below, the bottom surface on which cylinder 16 travels is flat near the center and is inclined outboard at least near the extremities of housing 14 and means are provided within the housing to dampen the rolling action of cylinder 16 or dissipate the kinetic energy therefrom.

The athwartship travel distance provided cylinder 16 and the radius of gyration of cylinder 16 and amount of damping imparted thereto during each ship rolling cycle should be related to each other so that the weight generally assumes the positions indicated in FIGS. 2 through 5 during the steady state rolling condition of the ship. Specifically, the cylinder position should lag approximately 90° behind the rolling of the ship, that is, when the ship is at its maximum roll amplitude cylinder 16 should be at or near the center line of the ship and when the ship is approximately horizontal rolling with maximum velocity, cylinder 16 should be near the system end wall imparting a moment to the ship in opposition to the roll.

With reference to FIGS. 6 and 7 one embodiment of the system 12 includes a solid cylinder 16 having a pair of enlarged cylindrical parts 18 connected by a center shaft 20 of smaller diameter. Parts 18 straddle a reinforced guide rail 22 which extends the athwartship dimension of housing 14. Guide rail 22 maintains the direction of roll of the cylinders 16 in the transverse plane notwithstanding pitching, yawing, or other motions of the ship. It should be understood that the cylindrical member may have any one of a number of suitable configurations to determine the desired parameters of the system and that the configuration illustrated is by way of example.

The cylinder 16 rolls on the bottom surface of housing 14 which is inclined upward at the outboard extremities to an angle of approximately 5 to 10°. The end walls 24 of housing 14 should be sufficiently reinforced to withstand undesirable impact imparted by cylinder 16. To lessen any shock forces experienced thereby a suitable energy absorber is provided such as a spring biased bumper plate 26.

In order to dampen movement of weight 16 and create a net loss of energy per cycle of roll (usually required for long period ships with roll period in excess of 20 seconds), housing 14 is partially filled with a body of liquid 28 through which cylinder 16 rolls in response to the rolling of the ship. Liquid 28 does not appreciably change the metacentric height of the ship due to the shallow liquid level which may be in the order of 1 to 3 feet. For this reason also, liquid 28 does not appreciably destabilize the ship. Any suitable liquid may be selected such as fresh water, sea water, bunker oil, or the like. In the case of oil or other lubricants, cylinder slipping may be encountered but this may be beneficial to the operational efficiency.

In operation, cylinder 16 rolls within housing 14 in response to the rolling of the ship to impart a stabilizing moment as indicated in FIGS. 2 through 5. The rolling action of cylinder 16 is dampened as the weight transfers through the liquid body 28. The amount of damping imparted to weight 16 may be varied by changing the liquid level within housing 14 to maintain the desired cylinder phase lag. In some cases, particularly in short period ships, it is anticipated that no damping liquid in the housing will be preferable.

Another embodiment of the invention is illustrated in FIGS. 8 and 9 wherein cylinder 17 includes a hollow body partially filled with liquid 30 and including a plurality of internal fins 32 which continuously pass through and churn liquid 30 as cylinder 17 rolls on track 22. In this way, sufficient damping is imparted and the level of the liquid body 30 is adjustable to vary the mass of cylinder 16 and accordingly introduce a frequency tuning capability to the system. The liquid may be added or drained via normally closed ports 19. Again, liquid 30 may be of any suitable type and heavy liquids such as mercury or solid-liquid suspensions may be preferred.

The cylinder supporting floor of housing **14** upon which cylinder **16** rolls should be inclined towards the outboard extremities. In one example the rolling surface levels off at the outboard end as indicated at **33**.

The operation of the embodiment of FIGS. **8** and **9** is essentially the same as that of the first described embodiment with the exception that the cylinder **16** carries the damping liquid within. If desired, the surface upon which cylinder **16** rolls may be the same as that depicted in FIG. **6**.

In one example of the invention including a solid cylinder without the inclusion of damping liquid in the housing the system has the following approximate parameters at resonance for a ship of 16,000 tons displacement, beam 78.0 ft. rolling period of 20 seconds, gm of 2.50 ft.:

Cylinder gross weight	tons	55
Rolling diameter	feet	5. 0
Out to out length of travel	feet	40
Moment (maximum)	foot-tons	1, 050
Percent roll reduction		[1] 75

[1] Percent at a 5 degree stabilized roll with an unstabilized roll amplification factor of 10.

It will be appreciated that other and further modifications can be made to the invention without departing from the spirit and scope thereof.

I claim:

1. A passive moving weight roll stabilizer for ships comprising a freely rolling cylindrical member of sufficient mass to impart a significant stabilization moment or force to the ship, a guide track rigidly secured to a deck of the ship, said cylinder arranged on the guide track to roll athwartship in direct response to the rolling action of the ship, and means to slow or impede the lateral movement of the cylinder at least at a predetermined distance on either side of the ship's centerline in order to maintain a proper stabilizing phase lag between the roll of the ship and the roll of the cylinder.

2. The stabilizer of claim **1** wherein the surface upon which the cylinder rolls near the outboard limits of travel is inclined upward and outboard.

3. The stabilizer of claim **1** wherein guide means are provided to maintain the cylindrical member movement athwartships.

4. The stabilizer of claim **1** wherein the cylindrical supporting surface extending in both directions from the ship's center line is flat.

5. The stabilizer of claim **1** wherein said stabilizer includes a housing about the cylindrical member and said last mentioned means includes a body of liquid at least partially filling the housing and through which the cylinder rolls.

6. The stabilizer of claim **5** wherein the surface supporting the cylindrical member is inclined upward and outboard from points spaced on opposite sides of the ship's centerline.

7. The stabilizer of claim **6** wherein impact shock absorbers are provided on the inside near the housing end walls.

8. A moving weight roll stabilizer for ships comprising a cylindrical member of sufficient mass to impart a significant stabilization moment or force to the ship, said cylinder arranged on the ship to roll athwartship in response to the rolling action of the ship, means to slow or impede the lateral movement of the cylinder at least at a predetermined distance on either side of the ship's center line, and guide means to maintain the cylindrical member movement athwartships, wherein the guide means comprises the cylindrical member having a part with a reduced diameter and a transverse guide rail mounted to the ship and cooperating with said part.

9. A moving weight roll stabilizer for ships comprising a cylindrical member of sufficient mass to impart a significant stabilization moment or force to the ship, said cylinder arranged on the ship to roll athwartship in response to the rolling action of the ship, and means to slow or impede the lateral movement of the cylinder at least at a predetermined distance on either side of the ship's center line, wherein the cylinder is hollow and its internal cavity is partially filled with liquid.

10. The stabilizer of claim **9**, wherein fins are arranged in said internal cavity connected to the cylindrical member so as to rotate through the liquid body during operation.

11. The stabilizer of claim **9**, wherein the cylindrical member is provided with normally sealed ports to permit the addition of, or draining of, the liquid internal thereto.