June 22, 1954 W. J. SMITH 2,681,783

SELF-LEVELING DEVICE

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Fig. 1

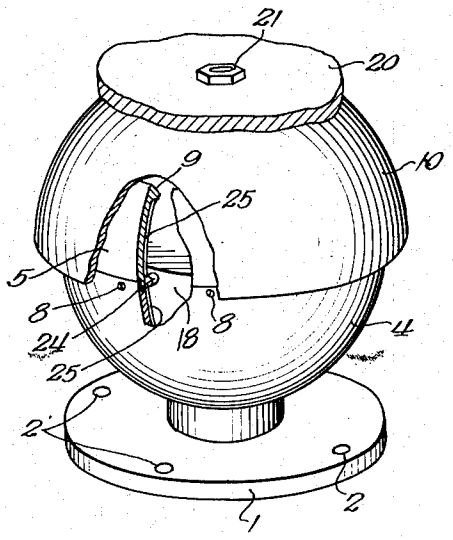


Fig. 4

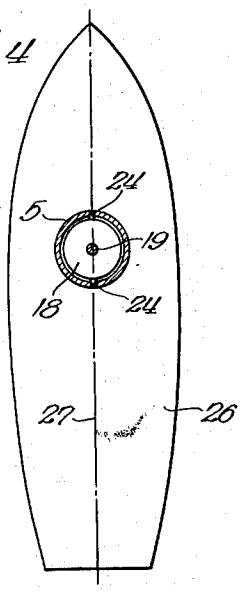


Fig. 3

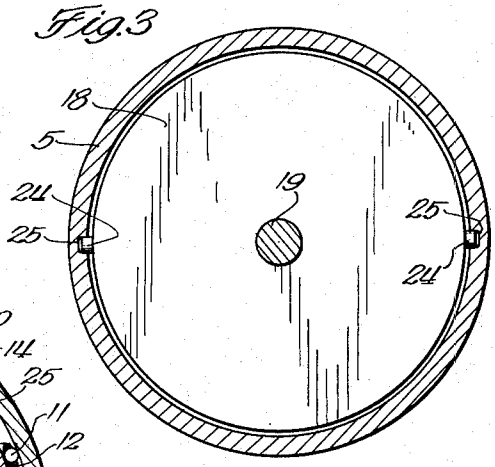
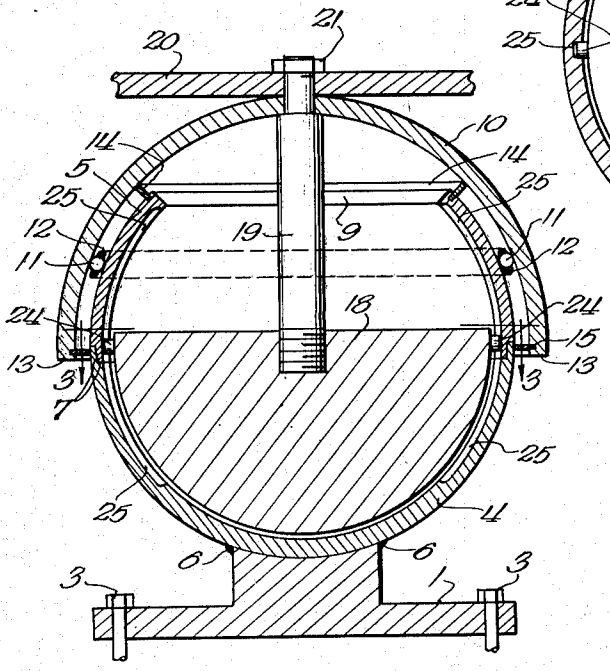


Fig. 2



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Fig. 6

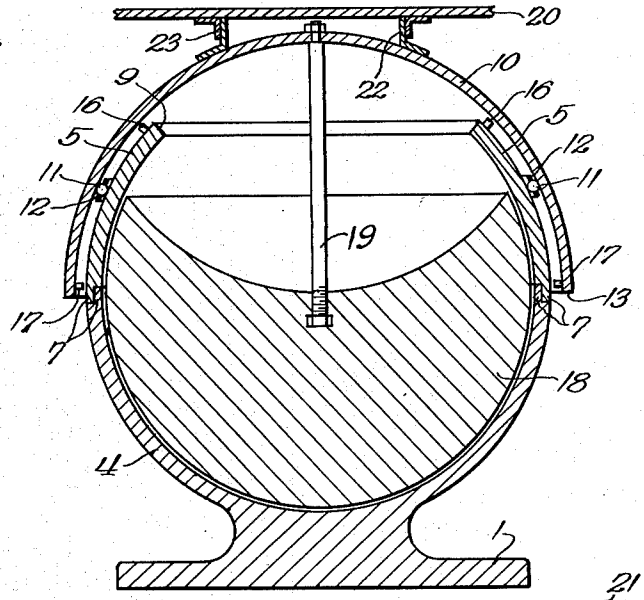


Fig. 5

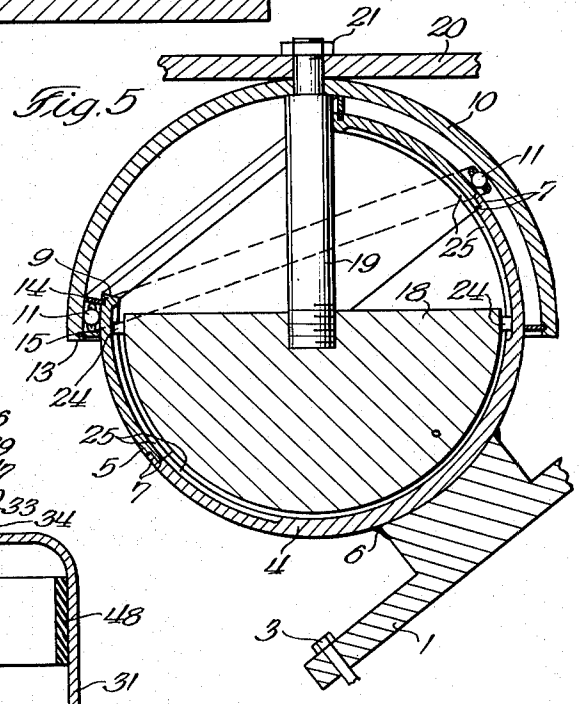
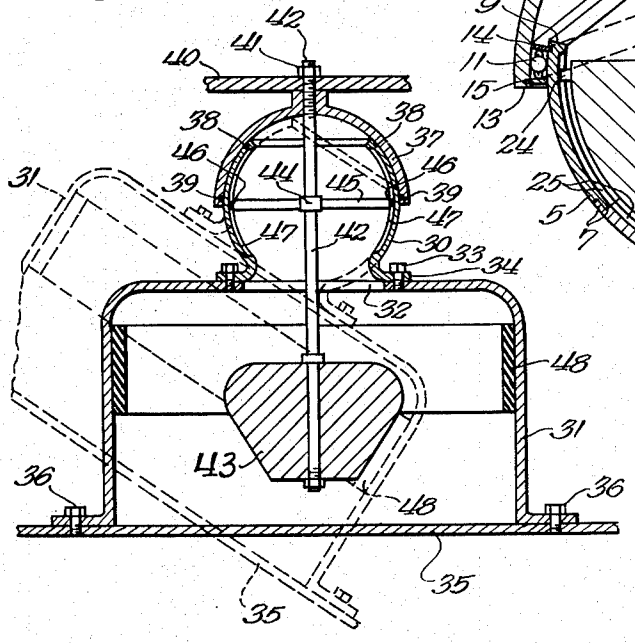


Fig. 7



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SELF-LEVELING DEVICE

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4 Claims. (Cl. 248—182)

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This invention pertains to self-leveling devices, and relates particularly to the novel construction of a device by which to maintain objects mounted thereon in a horizontal plane when the device is mounted upon an unstable support.

It is a principal object of the present invention to provide a self-leveling device which is essentially a self-contained unit of but three cooperating parts which are caused to move freely with relation to each other in response to forces of gravity.

Another important object of this invention is the provision of a self-leveling device which operates to maintain an object mounted thereon in a horizontal plane but prevents horizontal rotation of the object.

A further object of this invention is to provide a self-leveling device of simplified and therefore economical construction and which is sturdily built yet delicately responsive to forces of gravity.

These and other objects and advantages of the present invention will appear from the following detailed description taken in connection with the accompanying drawings, in which:

Figure 1 is a perspective view of a self-leveling device embodying features of this invention, parts thereof being broken away to disclose details of construction;

Figure 2 is a sectional view taken through the center of the device shown in Figure 1;

Figure 3 is a sectional view taken along the line 3—3 on Figure 2;

Figure 4 is a sectional view of the self-leveling device similar to Figure 3 and showing the same mounted upon a boat;

Figure 5 is a sectional view similar to Figure 2 and showing the self-leveling device in operation upon an angularly disposed support;

Figure 6 is a sectional view similar to Figure 2 showing a modified form of self-leveling device embodying features of this invention; and

Figure 7 is a sectional view showing a still further modified form of self-leveling device embodying features of this invention, the same being shown in tilted position by dotted lines.

Stated briefly, the self-leveling device of the present invention comprises a hollow ball, a socket freely overriding the ball, and a counterweight suspended from the socket.

Referring particularly to Figures 1 to 6, inclusive, the self-leveling device is shown to comprise a pedestal-type base 1 provided with spaced holes 2 for receiving bolts 3 or other fastening means by which the base may be secured to an unstable

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support. Examples of the latter may include the deck or other structural member of a boat or airplane.

Mounted upon the central column of the base 1 is a hollow ball which is formed of the lower semi-spherical section 4 and the upper complementary segment 5. Section 4 may be secured to the base by any of various conventional means well-known in the art, such as by the welding 6 shown in Figure 2. Alternatively, the base and section 4 may be formed as an integral unit, as shown in Figure 6. Section 4 and segment 5 are provided with complementary interengaging shoulders 7 along their abutting edges, as illustrated, and are there preferably secured together detachably by means of set screws 8 for purposes explained in detail hereinafter. Thus, the section 4 and segment 5 cooperate to form a hollow ball which is provided with a circular opening defined by the circumferential edge 9 disposed diametrically opposite the base 1.

A substantially semi-spherical hollow socket 10 is arranged to override the hollow ball. In the embodiments illustrated in Figures 1 to 6, inclusive, the inner diameter of the socket is somewhat greater than the outer diameter of the ball in order to provide sufficient space therebetween for the ball bearings 11 and their retainer ring 12. The diameter of the bearing ring 12 is chosen, in the embodiments illustrated, so that the bearings are disposed substantially midway between the circumferential edge 13 of the socket 10 and the circumferential edge 9 of the ball segment 5, as best shown in Figures 2 and 6. In this manner the bearings may roll upon the adjacent surfaces of the segment 5 and socket 10 within the limits of said edges as the self-leveling device is actuated by movement of the unstable support.

Flexible circular washers 14 and 15 are secured in circumferential grooves adjacent the edges 9 and 13, respectively, for sliding contact with the adjacent surfaces of the socket 10 and segment 5, respectively. These washers function to prevent displacement of the bearing ring 12 and also to prevent entrance of dirt into the bearing area. If desired, the washers may be replaced by lugs 16 and 17, as illustrated in Figure 6. These lugs are disposed at spaced intervals about the circumference of segment 5 and project from the outer surface of the latter adjacent edge 9 and from the inner surface of the socket 10 adjacent edge 13, respectively. The lugs function in manner similar to washers 14 and 15 to prevent displacement of the bearing ring 12.

It is to be noted here, with reference to Figures 2 and 5 of the drawings, that by the illustrated use of the single ball bearing ring 12, only the outer surface of the ball segment 5 and the complementary inner surface area of the socket 10, i. e., the area disposed between the washers 14 and 15 in Figure 2, need be machined to provide smooth rolling surfaces for the ball bearings 11. However, those skilled in the art will recognize that various other means and methods may be employed in substitution for the ball bearing arrangement described hereinbefore to promote maximum freedom of movement between the ball and socket. One alternative is described hereinafter with reference to Figure 7. Another alternative, not illustrated, is to provide a plurality of ball bearings mounted in circumferential grooves formed in the inner face of the socket 10 adjacent the edge 13 and in the outer face of segment 5 adjacent the edge 9.

Referring now particularly to Figures 2 and 6 of the drawings, a counterweight 18, preferably of solid construction and of heavy mass, is suspended within the hollow ball by means of a rod 19 secured at its lower end to the counterweight and at its upper end to the socket 10. In Figure 2 the upper end of rod 19 is reduced in diameter and projects through holes provided in the socket 10 and a platform 20. The socket and platform are thus secured together by means of nut 21. In Figure 6 the rod 19 is secured at its upper end only to the socket 10. The platform 20 is mounted detachably upon the socket by means of interengaging cylindrical flanges 22 and 23 secured to the socket and platform, respectively. In both cases the platform functions as a base upon which to mount an object which is to be maintained level, as explained in detail hereinafter.

It is to be observed that the counterweight is of substantially semi-spherical shape having a diameter slightly smaller than the inner diameter of the hollow ball. The counterweight is installed within the ball section 4 before segment 5 is attached. The latter is then mounted upon the section 4 and secured in place by set screws 8. The counterweight may be of any other shape desired, it being necessary only that it be contained within the ball. The shape and size illustrated is preferred, however, in order to prevent undesirable movement of the counterweight within the ball.

In the embodiment illustrated in Figures 1 to 5, inclusive, provision is made to prevent axial rotation of the platform 20 relative to the base 1 and hence relative to the unstable support upon which the base 1 is mounted. This provision is afforded by the following means: A pair of pins 24 are arranged to extend radially outward from diametrically opposite sides of the counterweight 18. These pins project along a line extending through the point which defines the center of rotation of the hollow ball and socket. The pins extend into guide slots 25 which are formed in the inner surfaces of the section 4 and segment 5. The width of these slots is substantially equal to the diameter of the pins 24, whereby to receive the latter freely for sliding and pivotal contact without permitting excessive lateral displacement of said pins. The slots 25 extend in a plane normal to the plane of the base 1 and are arranged at diametrically opposite sides of the hollow ball.

The length of slots 25 is determined by the maximum angle through which the device is

to operate effectively to maintain the platform 20 upon a horizontal plane. In the illustration, the device is constructed to operate effectively through approximately 88°, i. e. to maintain the platform in a horizontal plane during tilting of the base 1 to approximately 44° in any direction from a vertical line. Accordingly, the arcuate length of slots 25 shown in the drawing is at least 88°, measured radially from the center of the hollow ball.

It will be apparent to those skilled in the art that the effective maximum angle of operation of the present device is also determined by the size of the opening in the ball defined by the circumferential edge 9. Thus, in the foregoing illustration, the diameter of said opening is greater than about 88° by the diameter of the supporting rod 19.

The device illustrated in Figures 1 to 5, inclusive, operates to maintain the platform 20 in a horizontal plane and to prevent horizontal rotation of the platform, as follows: Let it be assumed that the base 1 is tilted in the plane of the drawings from the position shown in Figure 2 to the position shown in Figure 5. During this tilting of the base, the pins 24 merely slide along the guide slots 25 because the latter are disposed in the same plane in which the base 1 is being moved. Let it now be assumed that the base 1 is tilted in a plane perpendicular to the plane of the drawing from either of the positions shown in Figures 2 and 5. During such tilting the pins 24 pivot axially within the guide slots 25 because said pins are positioned in line with the center of rotation of the hollow ball and the socket 10. Thus, it is apparent that the tilting of base 1 in any direction within the limits defined by the opening in the hollow ball and by the length of slots 25 may be accommodated by the simultaneous axial rotation and longitudinal movement of pins 24 within the guide slots 25.

The interengagement of the pins and slots operates additionally to prevent horizontal rotation of the platform 20. This feature affords particular utility of the device aboard a ship or boat for mounting a compass upon the platform 20. Referring to Figure 4 of the drawings, the cooperating guide slots 25 and pins 24 permit the boat 26 to roll and pitch in any direction without disturbing the horizontal position of a compass mounted upon the platform 20. The slots and pins prevent horizontal rotation of the platform, however, and thus the compass is maintained in its required position relative to the longitudinal center line 27 of the boat. It will be understood that the pins 24 need not be arranged in line with the center line 27, as shown, but may be disposed in any other position desired. It is preferred, in any case, to position the pins 24 and slot 25 in the line of direction in which abrupt movements of the unstable support most frequently occur. In this manner the shearing strains exerted upon the pins 24 are reduced to a minimum.

The modification illustrated in Figure 6 of the drawing differs in general construction from the device of Figures 1–5, inclusive, in the absence of the pins 24 and guide slots 25. Incidental differences reside in the manner of detachably mounting the platform 20, as explained hereinbefore, and in the shape of the counterweight 18. In the latter instance, the counterweight comprises a substantially greater portion of a sphere than does the counterweight previously described. The

shapes illustrated are merely suggestive of several, it being understood that the counterweight may comprise a complete sphere if desired.

The device shown in Figure 6 not only provides for the maintenance of the platform **20** in a horizontal plane during movement of the base **1**, but also permits horizontal rotation of the platform. This latter motion is permitted because rotation of the counterweight about a vertical axis is not restricted by the pins **24** and registering slots **25** provided in the structure previously described. This feature affords utility of the device for various purposes such, for example, as a mounting for a deck chair, whereby to maintain the chair level during motion of the boat and also to permit the chair to swivel in a horizontal plane. On the other hand, if it is desired to restrict horizontal rotation of the chair, the device shown in Figures 1–5 of the drawings may be employed.

The modification shown in Figure 7 of the drawings differs primarily from the structures described hereinbefore in the arrangement of the counterweight. The device comprises a hollow spherical ball **30** which is open at both upper and lower ends. The ball is mounted upon an enlarged cylindrical housing **31**, with the lower opening of the ball registering with a hole **32** provided in the housing. The ball is secured in place by such means as bolts **33** extending through the out-turned flange **34** defining the periphery of the lower opening of the ball. The housing **31** is in turn secured to a base **35** by means of bolts **36**.

A substantially semi-spherical socket **37** having an inner diameter substantially equal to the outer diameter of the hollow ball **30** is arranged over the upper opening of the ball for sliding contact with the latter. The contacting surfaces of the ball and socket may be greased or otherwise treated to reduce friction and promote freedom of motion. Grease seals **38** and **39** may be provided adjacent the upper opening of the ball **30** and the circumferential edge of the socket **37**, respectively, to retain the grease therebetween. Alternatively, the anti-friction ball bearing arrangment described hereinbefore may be employed if desired.

The socket **37** supports a platform **40** which is secured thereto by means of the nut **41** which is threaded onto the upper end of rod **42**. This rod is secured to the socket **37** and depends therefrom through the hollow ball **30** and into the housing **31**. A counterweight **43** of substantial size and weight is mounted upon the lower end of rod **42**. Thus, the counterweight is displaced a greater distance from the center **44** of the hollow ball than are the counterweights of the structures described hereinbefore. This latter construction is used to advantage for supporting objects of considerably greater weight upon the platform **40** than can be supported effectively upon the platform **20** of the previously described devices.

In order to prevent horizontal rotation of the platform **40** with respect to the housing **31**, means similar to the pins **24** and guide slots **25** previously described may be provided, as follows: An arm **45** is secured to rod **42** at the center **44** of the hollow ball **30**. The arm extends perpendicularly to rod **42** and terminates at its ends adjacent the inner surface of the ball **30**. Pins **46** are provided on the opposite ends of the arm **45** and they extend into the guide slots **47** formed at diametrically opposite sides of the hollow ball **30**. The slots extend in a plane normal to the plane of base **35**, in manner similar to slots

25 described hereinbefore. The length of slots **47** and the openings in the hollow ball **30** determine the angle through which the device will operate to maintain the platform **40** in a horizontal plane, as previously described.

It is to be understood that the arm **45**, pins **46** and slots **47** need not be provided if restriction of horizontal rotation of the platform **40** is not desired. By elimination of these elements, the device operates in the manner of the device illustrated in Figure 6.

A ring of rubber **48** or other resilient material is preferably secured to the inner surface of the housing **31** in proper position for engaging the counterweight **43** when the housing is tilted to its maximum limits, as illustrated in dotted lines in Figure 7. This ring forms a cushion to absorb the shock of impact of the counterweight, whereby to decrease the sound of impact and to prevent damage to the housing.

It will be apparent to those skilled in the art that the ball **30** may be mounted directly upon an elevated base without the necessity of housing **31**, in which case the flange **34** constitutes a base for the device. For example, the ball may be secured to a floor and the rod and counterweight suspended below the floor to any distance. This may be desirable when a large object such as a table or bed is to be supported upon the socket **37**.

It will be further apparent to those skilled in the art that various changes may be made in the structural details described hereinbefore and illustrated in the drawings without departing from the scope and spirit of the present invention. For example, the pins **24** or **46** may be formed as integral parts of the counterweight **18** or arm **45**, respectively. In either case a ring of ball or roller bearings may be mounted upon the pins, if desired, to promote freedom of movement of the latter. Alternatively, each of the pins may comprise a roller or ball bearing mounted for rotation in a bracket or other support provided at the proper positions previously described. It will be apparent that the pins **24** may alternatively be secured to and project radially from diametrically opposite sides of the inner surface of socket **10** to engage guide slots formed in the outer surface of the ball sections **4** and **5**. The illustrated arrangement is preferred, however, because the parts are enclosed within the ball. In any case the pins function with the cooperating slots to interengage the ball and socket at points extending through the center of rotation of said ball and socket in such manner as to prevent relative rotation of said parts about a vertical axis.

These and other modifications may be made as desired. Accordingly, the foregoing description is intended merely as exemplifying and illustrating the features of the invention and is not to be considered in a limiting sense.

Having now described my invention and the manner in which the same may be used, what I claim as new and desire to secure by Letters Patent is:

1. A self-leveling device comprising, in combination, a hollow ball having an enlarged opening therein, a base connected to the ball opposite said opening, a hollow socket overlying the ball for movement relative thereto, a counterweight suspended freely from the socket, said ball having guide means formed at diametrically opposite sides and extending in one plane only normal to the plane of the base, pin means mounted in

fixed relation to the socket and projecting in diametrically opposite directions along one line only extending through the center of rotation of the ball and socket, said pin means slidably engaging the guide means for movement longitudinally along and for rotation axially with respect to the guide means, and means on the socket for mounting an object to be supported.

2. A self-leveling device comprising, in combination, a hollow ball having an enlarged opening therein, a base connected to the ball opposite said opening, a hollow socket overlying the ball for movement relative thereto, a counterweight suspended freely from the socket and contained within the hollow ball, said ball having guide means extending in one plane only normal to the plane of the base, pin means mounted in fixed relation to the socket and projecting along one line only extending through the center of rotation of the ball and socket, said pin means slidably engaging the guide means for movement longitudinally along and for rotation axially with respect to the guide means, and means on the socket for mounting an object to be supported.

3. A self-leveling device comprising, in combination, a supported hollow ball having an enlarged opening therein, a hollow socket overlying the ball for movement relative thereto, the ball and socket having a common center of rotation, a counterweight suspended from the socket, interengaging pin and guide means disposed in fixed relation to the ball and socket, the guide means extending radially about the said common center of rotation in one vertical plane only, the pin means projecting along one line only extending through said common center of rotation and

slidably engaging the guide means, whereby the pin means may move longitudinally along and rotate axially with respect to the guide means.

4. A self-leveling device for supporting an article, comprising a supported hollow ball having an enlarged top opening therein, guide means within the ball extending radially about the center of the ball in one vertical plane only, transverse support means within the ball, pin means on the ends of the transverse support means and projecting along one line only extending through the center of the ball and slidably engaging the guide means, whereby the pin means may move longitudinally along and rotate axially with respect to the guide means, vertical support means secured to the transverse support means and extending upwardly therefrom through the opening in the ball for supporting an article, and counterweight means extending downwardly from the transverse support means below the line axis of the pin means.

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