United States Patent

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[54] **ATTITUDE CONTROLLED FLOTATION SYSTEM**
11 Claims, 8 Drawing Figs.

[52] **U.S. Cl.** **4/172.13**
[51] **Int. Cl.** **E04h 3/19**
[50] **Field of Search** 4/172.13, 172.12, 172.11, 172.14

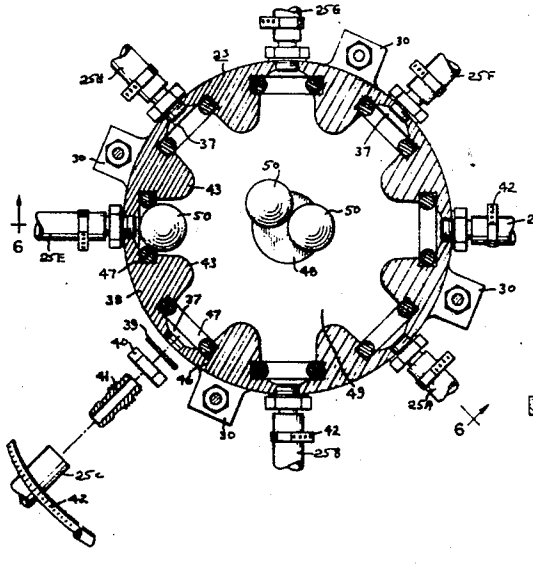
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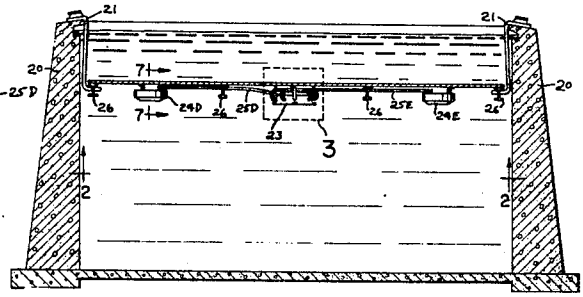
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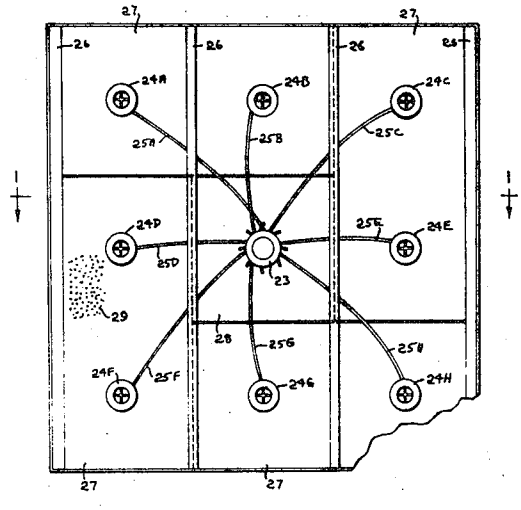
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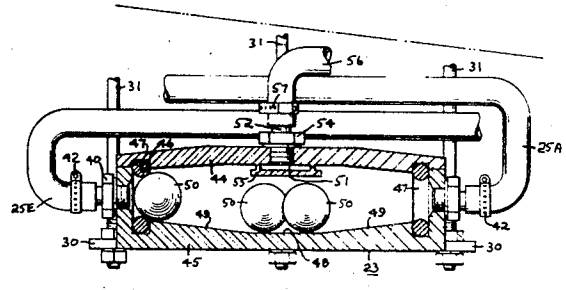
Primary Examiner—Henry K. Artis
Attorney—Edelson and Udell

ABSTRACT: A flotation system including a plurality of gas/liquid ballast tanks secured to the underside of a platform and all connected to a novel gas distribution valve also secured to the platform which selectively delivers gas to the ballast tanks in such manner as to maintain the desired attitude of the platform within the liquid medium. The ballast tanks are open bottomed and function as air traps, the degree of flotation afforded to the platform being controlled by injecting or withdrawing air or other gas to respectively force water out from and take water in through the bottom of the tank and thereby control the displacement. The open bottom construction of the ballast tanks provides a self-limiting tilt feature to each tank because inclination of a tank above a predetermined critical angle causes air to spill out through the bottom and limit the flotation. The valve is a novel type of ball check valve and provides attitude control by automatically selectively controlling the ratio of gas to liquid within each ballast tank through the check ball feature, while elevation control is effected by simultaneously changing the ratio of gas to liquid in all ballast tanks. The control valve is formed with a plurality of ports spaced peripherally about the sidewall of the valve body. The upper surface of the valve body bottom wall is provided with a central horizontal platform region disposed at a level below that of each of the ports, from which the floor extends radially outward and slopes upward toward the ports. A plurality of spherical balls are seated on the central platform when the latter is in a horizontal position, and when the valve body is tilted are free to roll outward and block any of the ports disposed at a lower elevation than the central platform. The mechanism may be adjusted to provide a slope to the platform or other controlled device where such an arrangement is desired.









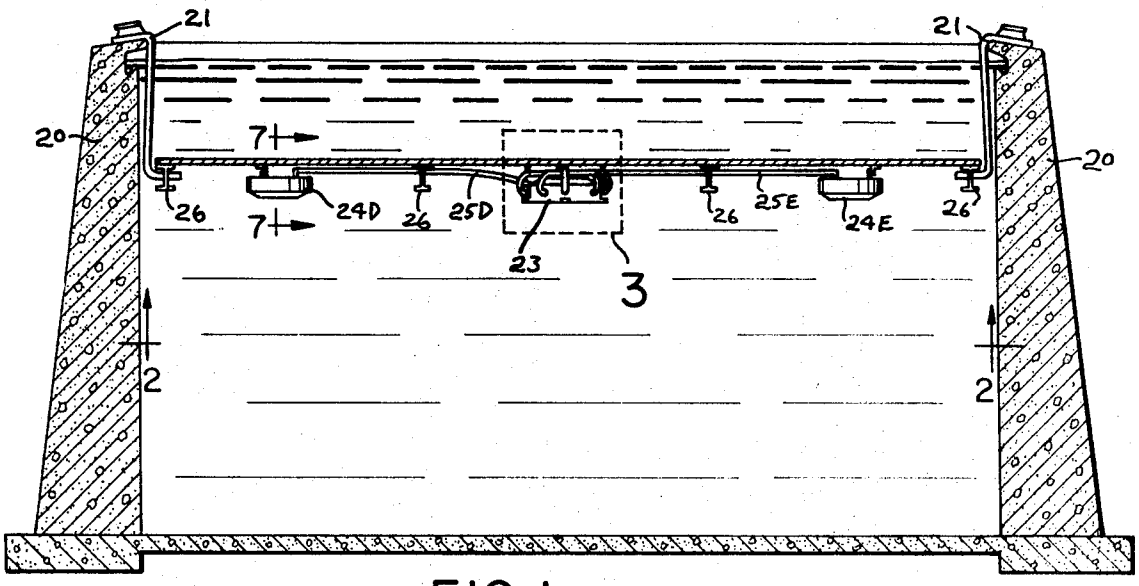


FIG. 1

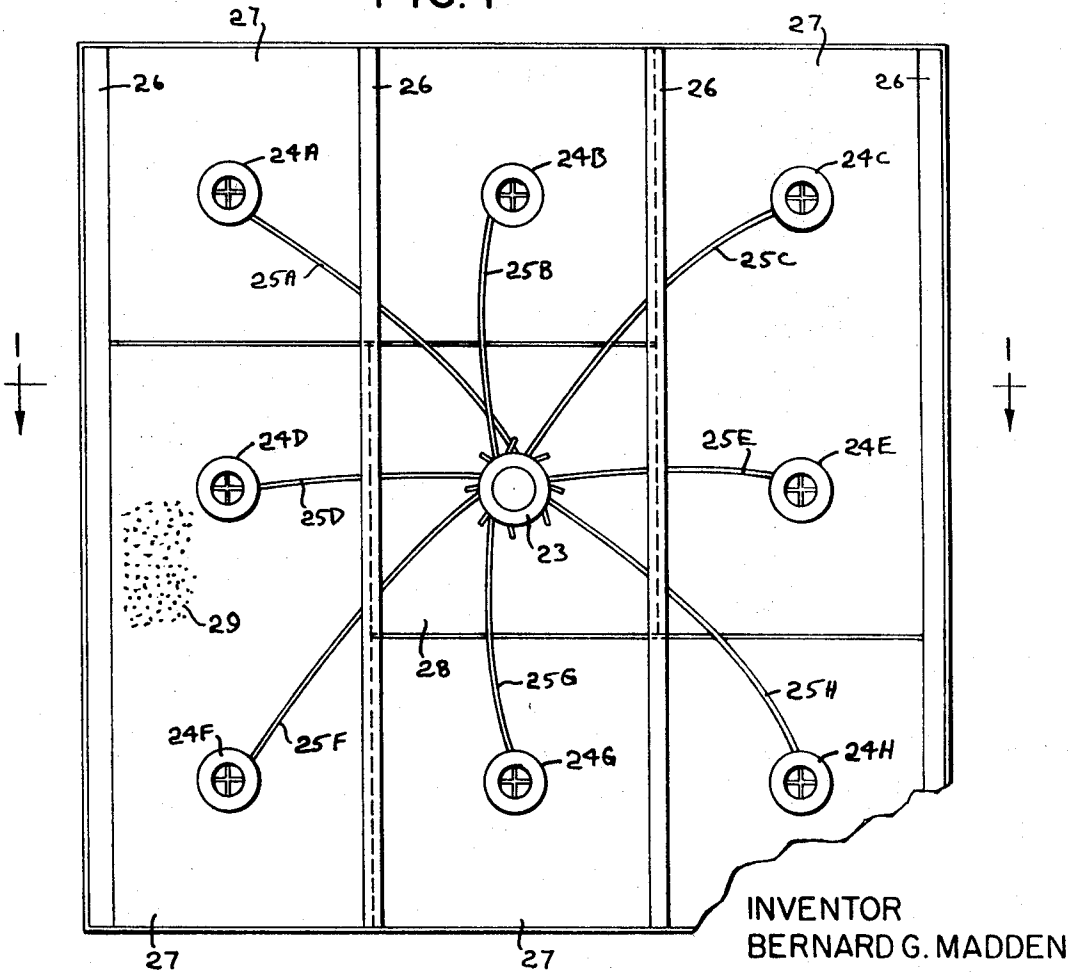


FIG. 2

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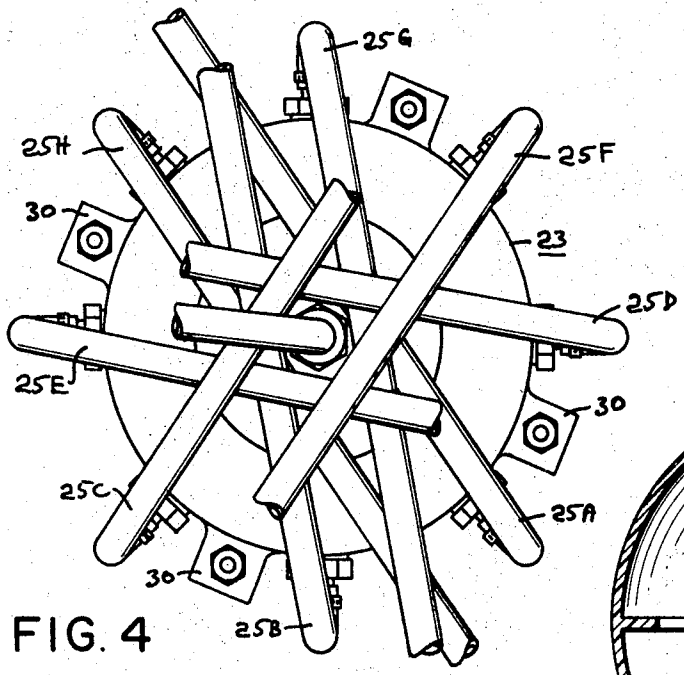


FIG. 4

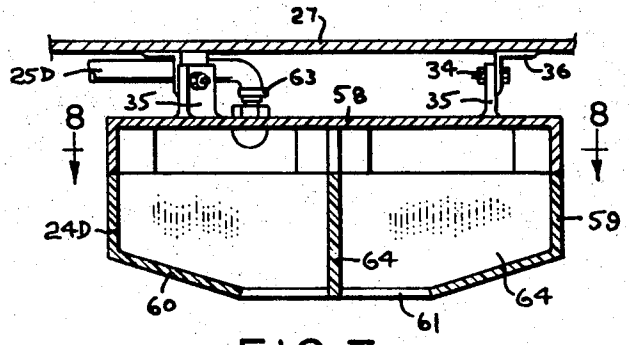


FIG. 7

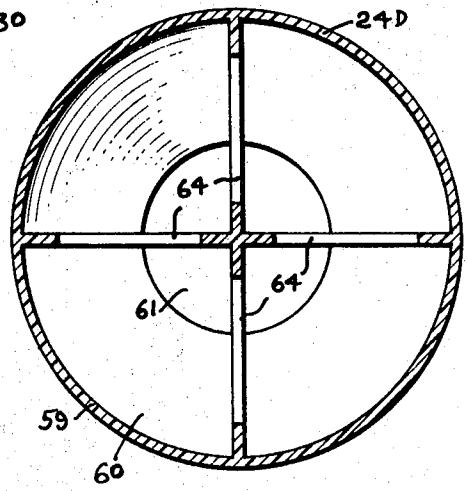


FIG. 8

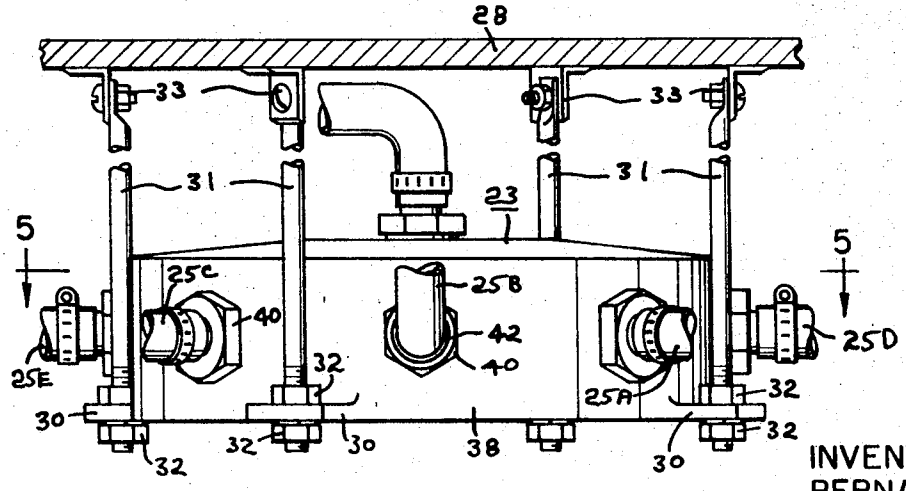


FIG. 3

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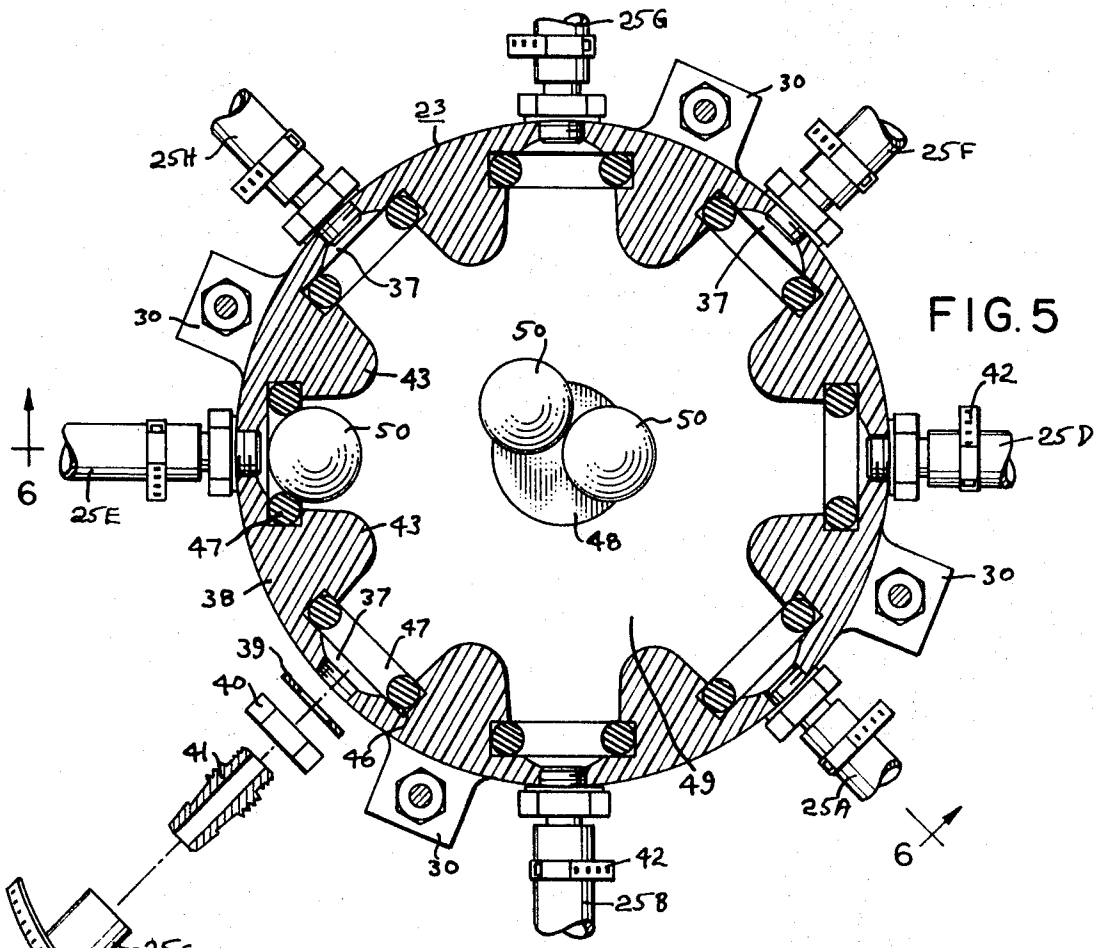


FIG. 5

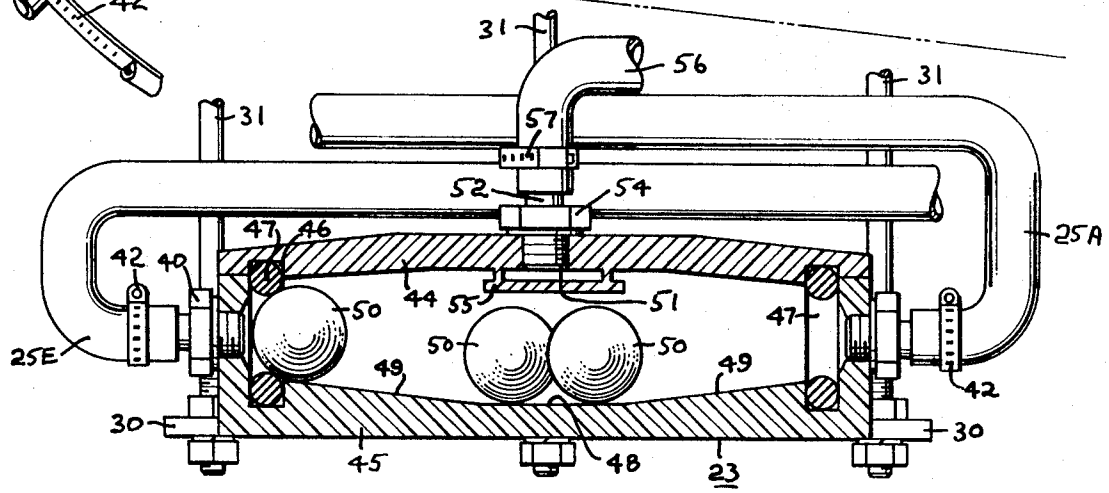


FIG. 6

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ATTITUDE CONTROLLED FLOTATION SYSTEM

This invention relates generally to an attitude controlled flotation system, and more particularly the invention contemplates control of a device which it is desired to maintain at a given attitude within a fluid medium such as water while also having the capability of vertically shifting the device and stabilizing it at any desired level. For illustrative purposes the invention is described herein as incorporated with a movable floor or platform of the same size and shape as the interior periphery of a swimming pool, which floor may be raised or lowered to any desired level within the pool and thereby function to control the effective water depth of the pool.

Vertically adjustable pool floors are not per se new. However, in the past, vertically adjustable pool floor mechanism have usually had to be installed when the pool was built, or have required rather extensive work and expense thereafter because of the nature of the mechanisms involved. For example, some vertically adjustable pool floors have been operated by a central piston lift requiring the construction of a piston shaft and hydraulic system beneath the level of the pool itself. Another system utilizes cable lifts, also operated from the basic structure of the pool. Yet another mechanisms employ jack screws at the various corners of the pool to provide an adjustable positioning mechanism. Devices of the foregoing types require the use of substantial mechanical and electrical equipment, and by their nature are subject to corrosion due to immersion in the pool water. Such systems require extensive maintenance and are, accordingly, not only expensive to install but expensive to keep in functioning condition.

The apparatus according to the invention is not subjected to these drawbacks and can in fact be installed into any existing pool with no modification of the pool structure whatever, and can be removed from the pool whenever desired leaving no evidence of its former use or existence. The cost of the system is relatively small by comparison with the mechanical systems aforedescribed, is relatively inexpensive to maintain, and includes in the illustrated embodiment a novel valve structure and a plurality of ballast tanks as part of the operating system, the valve automatically controlling the attitude and elevation of the vertically shiftable platform or floor to which it and the ballast tanks are secured to maintain the floor substantially horizontal regardless of its elevated position.

In the apparatus to be described, the ballast tanks are open bottomed and function as air traps, the degree of flotation afforded being controlled by injecting or withdrawing air to respectively force water out from and take water in through the bottom of the tank and thereby control the displacement. The valve provides attitude control by automatically selectively controlling the ratio of gas to liquid within each ballast tank, while elevation control is effected by simultaneously changing the ratio of gas to liquid in all ballast tanks. The mechanism according to the invention may be adjusted to provide a slope to the platform where such an arrangement is desired. Accordingly, it is a primary object of the invention to provide an attitude controlled flotation system for a platform to enable the latter to be moved vertically within a fluid medium throughout a continuous range between desired limits.

Another object of the invention is to provide a novel flotation system as aforesaid including a plurality of gas/liquid ballast tanks secured to the underside of a platform and all connected to a novel gas distribution valve device which selectively delivers gas to the ballast tanks in such manner as to maintain the desired attitude of the platform within the liquid medium.

A further object of the invention is to provide a novel flotation system as aforesaid in which the ballast tanks are so constructed as to automatically allow entry of the fluid medium within which they are submerged when gas is withdrawn from the tanks through the valve device, and to expel the fluid medium from the tanks when gas is forced thereinto through the novel control valve.

A still further object of the invention is to provide a novel flotation system as aforedescribed which may be fabricated relatively simply and inexpensively from molded plastic parts and thereby avoid problems of corrosion and maintenance.

The foregoing and other objects of the invention will become clear from a reading of the following specification in conjunction with an examination of the appended drawings, wherein:

FIG. 1 is a vertical sectional view through a typical swimming pool structure illustrating the flotation system according to the invention in place within the swimming pool and supported at a predetermined depth below the water surface;

FIG. 2 is a bottom plan view of the flotation system and supported platform as would be seen when viewed along the lines 2–2 of FIG. 1;

FIG. 3 is an enlarged side elevational view of the exterior of the novel attitude controlled valve according to the invention as shown in the phantom box designated as 3 in FIG. 1;

FIG. 4 is a top plan view of the attitude controlled valve shown in side elevation in FIG. 3, on a somewhat reduced scale;

FIG. 5 is a horizontal sectional view through the valve of FIG. 3 as would be seen when viewed along the line 5–5 thereof;

FIG. 6 is a vertical section through the novel control valve as would be seen when viewed along the lines 6–6 of FIG. 5;

FIG. 7 is a vertical sectional view through one of the ballast tanks of the flotation system as would be seen when viewed along the line 7–7 of FIG. 1; and

FIG. 8 is a horizontal sectional view through the ballast tank shown in vertical section in FIG. 7, as would be seen when viewed along the line 8–8 of FIG. 7.

In the several figures, like elements are denoted by like reference characters.

Turning now to the drawings and considering first FIGS. 1 through 4, there are seen the masonry sidewalls 20 of a swimming pool within the confines of which are close fittingly suspended by a plurality of peripherally spaced hangers 21 a platform designated generally as 22 to the underside of which is centrally secured a hydraulic control valve 23 and a plurality of peripherally disposed ballast tanks 24A through 24H, the ballast tanks being respectively connected to the control valve 23 by hydraulic hose lines 25A to 25H.

As best seen in FIG. 2, the platform 22 is typically formed of four parallel spaced apart longitudinally extending I-beams 26, which may suitably be made of aluminum, to which are fixedly secured four rectangular pieces of sheet aluminum 27 and a central square 28 which may also be of aluminum. All of the sheet aluminum pieces 27 and 28 may be perforated with holes such as show illustratively at 29 to permit the easy flow of water through the pieces of sheet aluminum which compose the flooring surface, quarter inch holes being suitable.

The particular composition of the platform 22 is not critical provided that the specific gravity of the composite platform structure is somewhat greater than the specific gravity of the fluid medium within which it is disposed so that the platform is not free floating but will of its own weight move toward the bottom of the pool. In this regard, a composite wood and metal platform can provide a very closely controlled desired specific gravity. In any event, a foraminous platform surface of some type is preferred, although not mandatory, in order to provide relatively easy movement of fluid through the platform surface between the volumes of fluid above and below the platform.

As best seen in FIGS. 3 and 4, the body of the control valve is provided with four external radially outwardly projecting ears 30 by means of which the valve is rigidly secured in fixed position to the underside of platform section 28 by the spacer rods 31, nuts 32, and the nut and bolt upper angle securements 33. Similarly, as best seen in FIG. 7, the ballast tanks 24A through 24H are fixedly rigidly secured to the underside of the platform section 27 by nut and bolt securements 34 pro-

jected through ears 35 extending upward from the tank top wall and angles 36 extending downward from the platform sections 27.

As best seen in FIGS. 3 through 6, the control valve 23 is generally circular shape in horizontal cross section and is formed with eight equiangularly spaced ballast tank ports 37 formed in the sidewall 38 of the valve body. Threaded into the ports 37 and hermetically sealed against the valve body by means of a compression washer 39 and nut 40 is a hose fitting 41 upon the outer end of which is forced the end of one of the hose lines 25A through 25H. The end of each hose line is hermetically contracted about the hose fitting 41 by a conventional hose clamp 42. The valve body sidewall 38 between each pair of adjacent ports 37 is formed with a generally triangularly shaped radially inwardly extending wedge or projection 43, and the facing sides of these wedges 43 proximate to the ports 37 together with the respectively above-lying and below-lying valve body top wall 44 and valve body bottom wall 45 are circularly recessed as at 46 to receive and hold captive therein a resilient O-ring 47.

The upper surface of the valve body bottom wall 45 is provided with a central horizontal platform region 48 disposed at a level below that of each of the ports 37. Extending radially outward from the central platform 48 and sloping upward toward the ports 37 is the attitude-control-angle floor 49. It is the angular inclination of the floor 49 which determines the angular control action of the valve 23, as will be seen. A plurality of spherical balls 50 disposed within the valve body 23 are normally seated on the central platform 48 when the latter is in a horizontal position, and are free to roll outward across the floor 49 when the valve body becomes inclined so that any portion of the floor 49 assumes an inclination other than horizontal with on or more ports 37 being at least partially disposed at a lower elevation than the central platform 48. This can of course only occur when the inclination of the valve body exceeds the inclination of the floor 49. Consequently, the angle at which the floor portion 49 is formed determines the attitude of the valve body which must be achieved in order to cause movement of the spherical balls 50 away from the central platform 48 and against the resilient O-ring 47 surrounding the inside of each port 37, and to thereby of course block off such port.

The valve body top wall 44 is provided with a central distributor port 51 into which is threaded a hose fitting 52 of the same type as the previously described hose fitting 41, the hose fitting 52 being hermetically sealed to the valve body top wall 44 by means of a compression washer 53 and nut 54. Spaced downward from and secured to the undersurface of the valve body top wall 44 below the central port 51 and above the valve body bottom wall platform 48 is a deflector disc 55 which causes pressurized gas moving inward through the central port 51 to be deflected radially outward through the interior of the valve body in a uniform manner while at the same time preventing the inflow of pressurized gas from driving the spherical balls 50 off of the platform region 48. A hydraulic hose line 56 is projected onto the end of the hose fitting 52 and hermetically contracted thereon by the hose clamp 57.

The valve 23 is a two-way device permitting flow in two directions as determined by the relative pressure differences. During operation of the system according to the invention, when the line 56 is connected to a high pressure source of gas, such as compressed air, it acts as an inlet line causing the gas to flow inward through the central port 51 and be distributed outward through the sidewall ports 37 to the ballast tanks 24, such gas distribution being generally uniform unless an unbalanced condition should occur as a consequence of tipping or inclination of the platform 22.

If tipping should occur, the control valve body 23 will be also inclined and the spherical balls 50 will roll off of the platform 48 and seal off the outlet ports 37 which are in the low position, thus preventing airflow outward through such ports 37 to the ballast tanks which they supply. From FIGS. 1, 4, and 6, however it is observed that each port 37 feeds a ballast tank positioned diametrically across the valve body from that port so that the ballast tanks which have their gas supply shut off are precisely those tanks which are located on the high side of the platform 22. As a consequence, these high tanks receive no more gas until the tanks of the low side of the platform 22 have been sufficiently pressurized to cause the low side of the platform to rise upward into substantial horizontal alignment with the formerly high side ballast tanks and thereby shift the attitude of the control valve 23 back toward the horizontal and cause the spherical balls 50 to roll away from the ports 37 and again allow the outflow of gas therethrough.

Gas pressurization of the ballast tanks 24A through 24H continues a long as gas is being forced inward through hose line 56. When the platform 22 has risen to the desired elevation, further pressurization is stopped but the pressure must be maintained in the line either by compressor action or by blocking the line 56, as with a shutoff valve in order to prevent backflow through the line. When it is desired to lower the platform 22, the gas in the ballast tanks 24A through 24H is bled off by opening the line 56 so that the central port 51 then becomes an exhaust port while all of the sidewall ports 37 become inlet ports feeding gas inward from the ballast tanks to the port 51. When the platform 22 has descended to the desired depth, the line 56 may again be blocked to prevent further air bleed and stabilize the platform at the desired elevation. Of course, the platform 22 may be allowed to settle entirely to the bottom if this is desired, in which event there is no need to block off line 56 since hose lines 25A to 25H will be blocked off from liquid backflow at the ballast tanks in the manner now to be described.

As best seen in FIGS. 7 and 8, each of the ballast tanks in the manner now to be described.

As best seen in FIGS. 7 and 8, each of the ballast tanks 24A through 24H, and as shown by representative tank 24D, is formed with a circular top wall 58 from which depends a cylindrical sidewall 58, the tank bottom being partially closed by a radially inwardly and downwardly extending frustoconical bottom wall 60 provided with a central circular bottom opening 61. Each of the hoses 25A through 25H is secured to an inlet float valve 62 by means of a hose clamp 63. The valve 62 is secured in the top wall 58 of the ballast tank 24D and permits the two-way flow of gas into and out of the tank but prevents the backflow of water or other liquid into the hose lines 25A through 25H when the liquid level within the ballast tank rises sufficiently to close the float check valve. The ballast tanks are internally reinforced by the cross-partitions 64 which extend partially upward from the bottom wall 60 but stop short of the top wall 58 to provide intercommunication of all four quadrants of the ballast tank to equalize the water level in the quadrants. The ballast tanks of open bottom construction are provided with a self-limiting tilt feature since inclination of a tank above a predetermined critical angle causes air to spill out through the bottom. The critical angle is determined by the depth of sidewall 59 and the radial extent of the bottom wall 60.

If desired, the platform may stabilized at an angle inclined to the horizontal by securing the control valve 23 and ballast tanks 24A to 24H to the platform so that they are in their horizontally disposed positions, as shown in FIG. 1, when the platform in inclined at the desired angle. In the case of the control valve 23, two of the rods 31 may be made shorter than the remaining two to incline the valve, and a similar expedient could be adopted for the ballast tanks.

The flotation system is intended only as a means for positioning the platform and is not intended to carry large or suddenly shifting mass loads such as are encountered when numerous people might be using a swimming pool, and of course walking upon the platform. Mechanical support is provided by the hangers 21, previously described, which may be provided in sets of various lengths. In use, the platform is moved to the desired position by the flotation system, the hangers are placed in position, and the flotation is reduced or completely discharged so that the platform settles its weight downward upon the hangers and is mechanically stabilized.

Having now described my invention in connection with a particularly illustrated embodiment thereof, it will be appreciated that modifications and variations of the invention may now occur from time to time to those persons normally skilled in the art without departing from the essential scope or spirit of the invention, and accordingly it is intended to claim the same broadly as well as specifically as indicated by the appended claims.

What I claim to be new and useful is:

1. A flotation system for coupling to a device which it is desired to controllably vertically shift and stabilize at a given attitude within a liquid medium, comprising in combination,

a. a control valve having a valve body, at least three approximately horizontally coplanar ballast ports spaced peripherally about the valve body, a distributor port communicating with said ballast ports within the valve body, means for coupling said distributor port to a source of pressurized gas, and ballast ports closing means operative to close any ballast ports disposed at a predetermined level lower than any other ballast port as a consequence of predetermined angular inclination of said valve body,

b. at least three ballast tanks and hydraulic coupling means connecting the same singly respectively to said at least three ballast ports to permit the passage between each said connected tank and port of pressurized gas, each said tank having vent means for placing the tank interior in communication with the ambient atmosphere.

c. support means for fixedly securing at a predetermined attitude to the controlled device said control valve and said ballast tanks,

said ballast tanks being spaced radially outward from said control valve with each ballast port being so positioned with respect to the ballast tank to which it is connected that tilting movement of the controlled device causes the ballast port and its associated ballast tank to move in opposite sense with respect to any point therebetween.

2. A flotation system as described in claim 1 wherein said ballast tanks vent means is an opening at the bottom to permit entry and exit of the liquid medium within which said controlled device is shiftable, and wherein said hydraulic coupling means communicates with the interior of said ballast tanks proximate to the top thereof.

3. A flotation system as described in claim 1 wherein said ballast tanks vent means is an opening at the bottom to permit entry and exit of the liquid medium within which said controlled device is shiftable, and wherein said hydraulic coupling means communicates with the interior of said ballast tanks proximate to the top thereof, the width and depth of said tank and the size of said bottom opening being so proportioned that no tank can rise more than a predetermined amount above any other tank without automatically spilling pressurizing gas out through the bottom opening to thereby limit the angle of inclination of the controlled device.

4. A flotation system as described in claim 1 wherein said ballast tanks vent means is an opening at the bottom to permit entry and exit of the liquid medium within which said controlled device is shiftable, and wherein said hydraulic coupling means communicates with the interior of said ballast tanks proximate to the top thereof through a valve which permits gas flow into and out of said tank through said hydraulic coupling means to prevents the flow of liquid medium in said tank into said control valve.

5. A flotation system as described in claim 1 further including a platform to the underside of which said control valve and ballast tanks are secured, said platform being of a size and shape to close-fittingly be disposed within the confines of a walled pool, and a plurality of hanger devices detachably connectable to said platform at their lower ends and adapted to overlie the walls of the pool or engage therewith at their upper ends to support the weight of said platform.

6. A flotation system as described in claim 1 wherein said control valve body comprises a top wall, a bottom wall, and a sidewall extending between said top and bottom walls and peripherally thereabout to form a chamber, said ballast ports being spaced equiangularly about and located in said sidewall, one side of each ballast port communicating with the inside of said chamber while the other side of each such port communicates with the outside of said chamber and is connected to said hydraulic coupling means, said distributor port being located in said top wall with one side communicating with the inside of said chamber, while the other side communicates with said means for coupling said distributor port to a source of pressurized gas.

7. A flotation system as described in claim 1 wherein said control valve body comprises a top wall, a bottom wall, and a sidewall extending between said top and bottom walls and peripherally thereabout to form a chamber, said ballast ports being spaced equiangularly about and located in said sidewall, one side of each ballast port communicating with the inside of said chamber while the other side of each such port communicates with the outside of said chamber and is connected to said hydraulic coupling means, said distributor port being located in said top wall with one side communicating with the inside of said chamber, while the other side communicates with said means for coupling said distributor port to a source of pressurized gas, said ballast ports closing means being a plurality of gravity actuated devices contained within said valve body chamber.

8. A flotation system as described in claim 1 wherein said control valve body comprises a top wall, a bottom wall, and a sidewall extending between said top and bottom walls and peripherally thereabout to form a chamber, said ballast ports being spaced equiangularly about and located in said sidewall, one side of each ballast port communicating with the inside of said chamber while the other side of each such port communicates with the outside of said chamber and is connected to said hydraulic coupling means, said distributor port being located in said top wall with one side communicating with the inside of said chamber, while the other side communicates with said means for coupling said distributor port to a source of pressurized gas, said ballast ports closing means being a plurality of gravity actuated devices contained within said valve body chamber and fewer in number than the number of said ballast ports.

9. A flotation system as described in claim 1 wherein said control valve body comprises a top wall, a bottom wall, and a sidewall extending between said top and bottom walls and peripherally thereabout to form a chamber, said ballast ports being spaced equiangularly about and located in said sidewall, one side of each ballast port communicating with the inside of said chamber while the other side of each such port communicates with the outside of said chamber and is connected to said hydraulic coupling means, said distributor port being located in said top wall with one side communicating with the inside of said chamber, while the other side communicates with said means for coupling said distributor port to a source of pressurized gas, said bottom wall comprising a depressed region disposed at a level below that of each of said ballast ports when the plane of the latter is approximately horizontal and a sloping region sloping upward toward each of said ballast ports at predetermined inclination, and said ballast ports closing means comprising a plurality of free rolling balls seated in said depressed region, said balls being free to roll outward when said valve body is tilted and block any of said ballast ports disposed at a predetermined lower elevation than said depressed region.

10. A flotation system as described in claim 2 wherein said control valve body comprises a top wall, a bottom wall, and a sidewall extending between said top and bottom walls and peripherally thereabout to form a chamber, said ballast ports being spaced equiangularly about and located in said sidewall, one side of each ballast port communicating with the inside of said chamber while the other side of each such port communicates with the outside of said chamber and is connected to said hydraulic coupling means, said distributor port being located in said top wall with one side communicating with the inside of said chamber, while the other side communicates

with said means for coupling said distributor port to a source of pressurized gas.

11. A flotation system as described in claim 3 wherein said control valve body comprises a top wall, a bottom wall, and a sidewall extending between said top and bottom walls and peripherally thereabout to form a chamber, said ballast ports being spaced equiangularly about and located in said sidewall, one side of each ballast port communicating with the inside of said chamber while the other side of each such port communicates with the outside of said chamber and is connected to said hydraulic coupling means, said distributor port being located in said top wall with one side communicating with the inside of said chamber, while the other side communicates with said means for coupling said distributor port to a source of pressurized gas, said bottom wall comprising a depressed region disposed at a level below that of each of said ballast ports when the plane of the latter is approximately horizontal and a sloping region sloping upward toward each of said ballast ports at predetermined inclination, and said ballast ports closing means comprising a plurality of free rolling balls seated in said depressed region, said balls being free to roll outward when said valve body is tilted and block any of said ballast ports disposed at a predetermined lower elevation than said depressed region.