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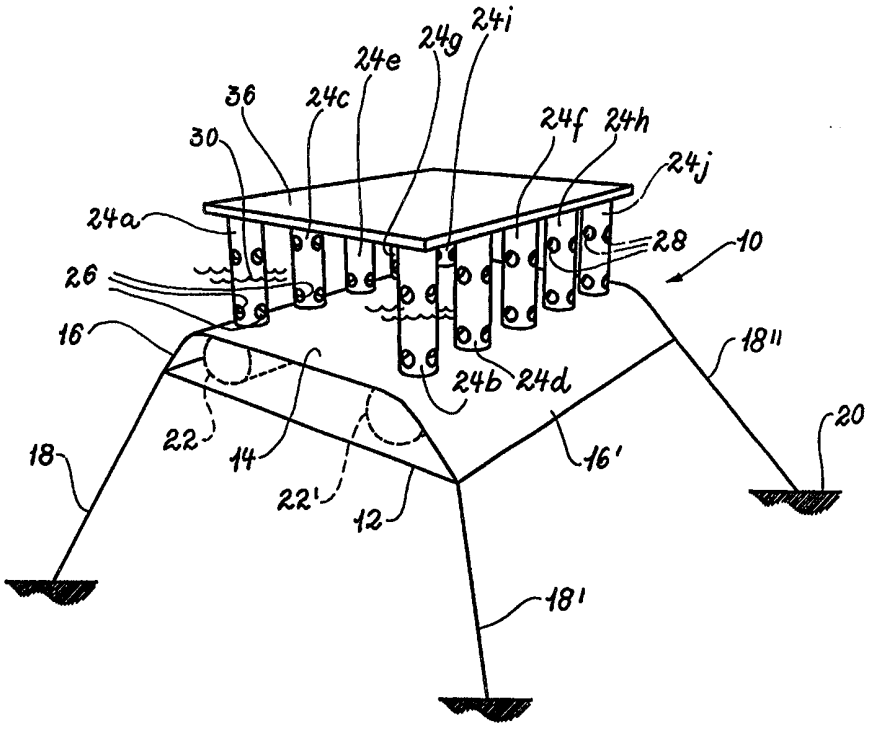
(54) Title: SEA–WAVE POWER PLANT

(57) Abstract

A sea–wave power plant comprises one or more channels, each externally defined by a hollow column (24a–24j), which internally can be supplied with water from below through at least one opening (26), and where, within the hollow column or each hollow column (24a–24j), a piston is disposed, preferably a float piston (32), adapted to rise upon water influx from below and sink upon outgoing water flow from the respective hollow column (24a–24j). The upward and downward displacement movement of the piston or each piston (32), respectively, can be converted into a rotational movement in one and the same direction, and this mechanical rotation energy may, possibly, be converted into electric energy through a generator. Said hollow column(s) (24a–24j) are mounted in upright positions on a submersible, moorable, ballastable/unballastable buoyancy body (10), the hollow column(s) (24a–24j) thereof having at least one first, through–going port (26) communicating with the hollow column cavity and lying at a level below the underside of the piston (32) when the piston (32) occupies the lowermost position thereof.



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SEA-WAVE POWER PLANT

The present invention relates to a sea-wave power plant comprising at least one channel, bore or similar passage defined by a hollow column or other hollow body extending upwardly from a lower, submerged, open end, and wherein wave movements in water are utilized for lifting and lowering a float piston disposed within said hollow column, and wherein to the float piston or to each float piston, respectively, is connected a transmission member for forwarding and utilizing the upward and downward, linear displacement movement, possibly for converting this movement to a rotational movement in one and the same direction. The rotational movement can be utilized for the operation of an electric generator for the generation of electric current or for operating a pump station for the conversion of seawater to fresh water (inverted osmosis).

A sea-wave power plant and especially a transmission mechanism for converting the seaway-conditioned, upward and downward displacement movement of the float piston/ pistons to a rotational movement in one and the same rotational direction, is known from Norwegian patent specification No. 163,544, wherein a fly wheel operating an electric generator at all times is allotted a rotation in one rotational

direction, irrespective of the direction of the sea-wave-conditioned, linear movement of the float piston.

Such a transmission mechanism is not the subject matter of the present invention; transmission devices of the kind disclosed in U.S. patent specifications Nos. 1,177,126 or 2,440,674 might as well be utilized. On the contrary, the present invention is occupied with the sea-wave power plant as such and provides, in a well known way per se, upward and downward, possibly slopingly upward and downward displacement movements of one or, preferably, more float pistons, each disposed in a hollow cylinder having inlet/outlet for seawater, seawater flow-in occuring when crest of a wave registers with said inlet and flow-out occuring when trough of the waves registers with said outlet, wherein said inlet/outlet or, alternatively, one single opening may act alternately as inlet and outlet.

Norwegian patent No. 163,544 teaches the use of a vertical channel portion in which a float piston rises and lowers dependent on the distance from a laterally directed channel portion outlet to the overlying water surface at crest/trough of a wave. This prior art sea-wave power plant has, maybe apart from the transmission mechanism converting linear displacement movement backwards and forwards into rotation having one and the same rotational direction, no adjust-ability. Nor other known sea-wave power plant structures exhibit any considerable adjustment possibilities.

Therefore, the object of the present invention has primarily been to provide a sea-wave power plant of the kind defined introductorily, wherein control and regulation possibilities are present, in order to achieve optimal working conditions at the sea-wave power plant. Simultaneously, it is preferred that a combined adjusting and safety device at all times secures that the float piston or the float pistons

individually are restricted in their upward displacement movement upon the occurence of extreme waves.

This object is realized by means of a sea-wave power plant distinguishing itself through the features appearing from the characterizing clause of claim 1 to follow.

Preferred, advantageous features are defined in claims 2-5.

The sea-wave power plant according to the invention is built up on a ballastable/deballastable, hollow buoyancy body adapted for submersion in water and for mooring to the seabed and, further, adapted to be placed at such an adjustable depth that the hollow body acts as an artificial sunken rock across which the waves will break and which is temporarily pressed down. Correct submersion depth is reached when the perforated hollow columns carried by the buoyancy body, during pressed down buoyancy body, are allotted correct amounts of inflowing water at the passage of a crest of a wave, so that the float piston in each hollow column is given a corresponding raising movement up to the upper boundary position.

Each hollow column has, preferably, two sets of through-going, radially or approximately radially directed ports, of which a lower set of ports serve as inlet ports, the upper port set serving as outlet ports, the primary task thereof being as safety valves, preventing the float piston from being subjected to unnecessary pressure load due to the passage of crests having extreme heights, when the float piston occupies its absolutely uppermost boundary poition.

The invention is further explained in the following in connection with an exemplary embodiment of a sea-wave power plant shaped and designed in accordance with the invention, reference being made to accompanying drawings, where:

Figure 1 shows a diagrammatical perspective view of a sea-wave power plant, moored to the seabed with mooring lines;

Figure 2 shows a diagrammatical partial view in perspective, corresponding to about half of the sea-wave power plant in figure 1;

Figures 3A - 3C show a side elevational view of the sea-wave power plant, with a vertical axial section through one hollow column, in order to illustrate the float piston's various positions in relation to a wave passing the cut-through hollow column;

Figure 4 shows a diagrammatical perspective view corresponding to figure 1, in which the hollow buoyancy body is shaped and designed differently from the body shown in figures 1 and 2;

Figure 5 is a perspective partial view of the embodiment of figure 4.

First, reference is made to the embodiment of figures 1 and 2 and figures 3A-3C.

Figure 1 shows diagrammatically a sea-wave power plant substantially comprising a buoyancy body 10 which, in accordance with this exemplary embodiment, is formed with a flat, substantially horizontal bottom 12 and a parallel, somewhat smaller, overlying mounting face 14, as well as intermediate, inclined, opposite side walls 16, 16' extending divergingly in a downward direction from above. The two remaining, opposite side walls may have an upright course.

The buoyancy body 10 is moored by means of anchor lines 18, 18', 18'' anchored to the seabed 20 and each attached to one

of the corners of the buoyancy body 10. The anchors are used for the positioning only.

Cylindrical ballast tanks 22, 22' e.g. containing seawater, may be further ballasted or unballasted, respectively. The buoyancy body 10 is unballasted when the wave height is tall; the opposite is done when the waves are smaller.

According to the exemplary embodiment, on the buoyancy body's 10 upper face, the mounting face 14, of the sea-wave power plant, eight hollow columns 24a-24j have been mounted, each hollow column having two sets of radial ports, lower inlet ports 26 and upper outlet ports 28.

When the submerged buoyancy body 10 is positioned at the right depth in relation to the seabed 20 (or to the sea surface 30) as well as to wave height, the buoyancy body 10 of the sea-wave power plant will be capable of acting as an artificial sunken rock against which the waves will break.

According to figure 2, in each hollow column 24a-24j, is disposed a float piston 32 to which is connected an upright guidance rod 34 transmitting the upward and downward displacement movements of the float piston; said movements may be converted into a rotational motion in one and the same direction of a fly wheel (not shown) which, again, may operate an electric generator (not shown) generating electric current. According to the present invention which does not directly deal with conversion of one type of movement to another type of movement, the upper ends are covered with an upper deck on which generators and other necessary equipment may be placed.

When the buoyancy body 10 is pressed down by the waves which (from the right hand side to the left hand side in figures 3a-3c) break against the artificial sunken rock in the form

of the submerged, moored buoyancy body 10, water will flow in through the lower ports, the inlet ports 26, and cause the float piston 32 to rise within the hollow column 24b assigned thereto, and the underside of the float piston 32 will be aligned with the crest level outside the column 24b, figure 3B.

Figure 3C shows the float piston 32 at the uppermost limit position thereof, in which the outlet ports 28 ensure to get rid of excess water 36. The pressure on the piston 32 and parts connected thereto is, thus, relieved.

When the buoyancy body 10 thereupon is given the opportunity of rising again within the limits allowed by the anchor lines 18, 18', 18'', the float pistons 32 lower themselves and bring along with them the guidance rods 34, the downward movement thereof being utilized by the transmission mechanism (not shown), converting linear upward and downward movement into rotational movement in one and the same direction.

The submersion depth for the buoyancy body 10 is established, adapting the ballasting/unballasting in relation to the length and gradient of the anchor lines 18, 18', 18''. A sea-wave power plant according to the invention may, preferably, be disposed at places where the wave movements are constant and have the same or approximately the same direction of motion, at least seasonally, but it may also be installed on other locations having a more accidental seaway and changing wave directions. It is easy to adapt and adjust to varying wave height through ballasting/unballasting and, possibly, adjustments of the anchor lines 18, 18', 18''.

In figures 4 and 5, a modified design of the buoyancy body 10 has been shown, here exhibiting circular or oval top and bottom limitation faces 14 and 12, respectively, the circumferential edges thereof being interconnected by means of an upwardly conically tapering side face 16. In this

embodiment, the waves will hit a side face having the same inclination when they meet the buoyancy body 10, irrespective of where they come from.

Claims

1. A sea-wave power plant comprising one or more channels each externally defined by e.g. a hollow column (24a-24j) which internally can be supplied with water from below through at least one opening (26), where within the hollow column or each hollow column, respectively, a piston, preferably a float piston, is disposed, said piston being adapted to rise upon water influx from below and to sink upon outgoing water flow from a respective hollow column (24a-24j), and wherein the upward and downward displacement movement of the piston or each piston (32), respectively, preferably can be converted into a rotational movement in one and the same direction, and wherein this mechanical rotational energy possibly may be converted to electric energy through the intermediary of a generator, the hollow column(s) (24a-24j) in upright position(s) being disposed in connection with a submersible, moorable buoyancy body (10), characterized in that said hollow column(s) (24a-24j) is (are) mounted on top of the submerged buoyancy body (10), the hollow column(s) (24a-24j) thereof having at least one first, through-going, lateral port (26) communicating with the hollow column cavity, said first, lateral port (26) lying at a level below the underside of the piston (32) in the lowermost position of said piston (32).

2. A sea-wave power plant as set forth in claim 1, characterized in that the hollow column or each hollow column (24a-24j), respectively, at a higher positioned level than said first port(s) (26), is provided with one or more second lateral ports (28) acting as outlet ports when the piston (32) is occupying its absolutely uppermost position and said first port(s) (26) thereof simultaneously is (are) situated at a depth causing continued water influx to the hollow column's (24a-24j) cavity.

3. A sea-wave power plant as set forth in claim 1 or 2, c h a r a c t e r i z e d i n that the buoyancy body (10) has a plane underside (12) and a top face (14) which, preferably, is parallel to said underside (12).

4. A sea-wave power plant as set forth in claim 3, c h a r a c t e r i z e d i n that the top and bottom, substantially horizontal, rectangular faces (14, 12) are interconnected through two outward-downwardly sloping side walls (16, 16') at two opposite sides of the circumference of the buoyancy body (10).

5. A sea-wave power plant as set forth in claim 3, c h a r a c t e r i z e d i n that the top and bottom, substantially horizontal faces (14, 12) of the buoyancy body (10) each has a circular/oval circumferential shape and that they, along the circumferences thereof, are interconnected through a side wall (16) sloping outward-downwardly from above or tapering conically outward-downwardly, respectively.

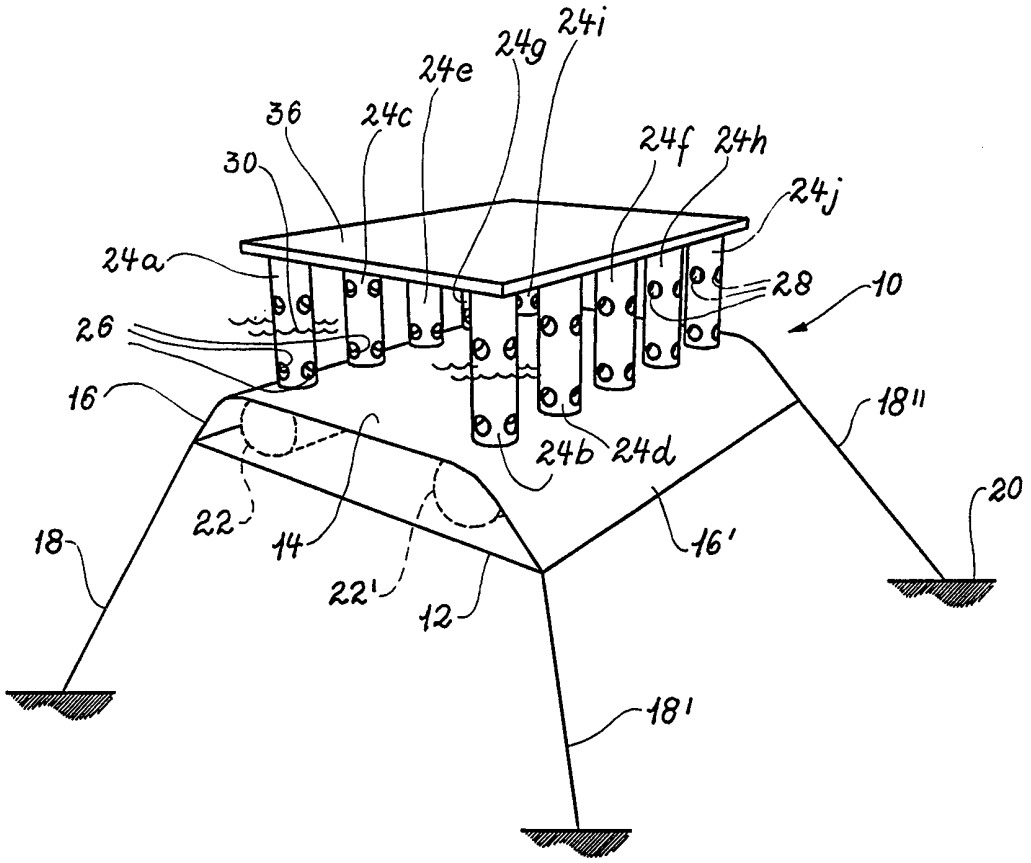
24i
24g
24e
36
24c
24f
24h
30
24j
24a
28
10
26
16
18II
24b
24d
20
22
14
16'
18
22'
12
18I

Fig. 1

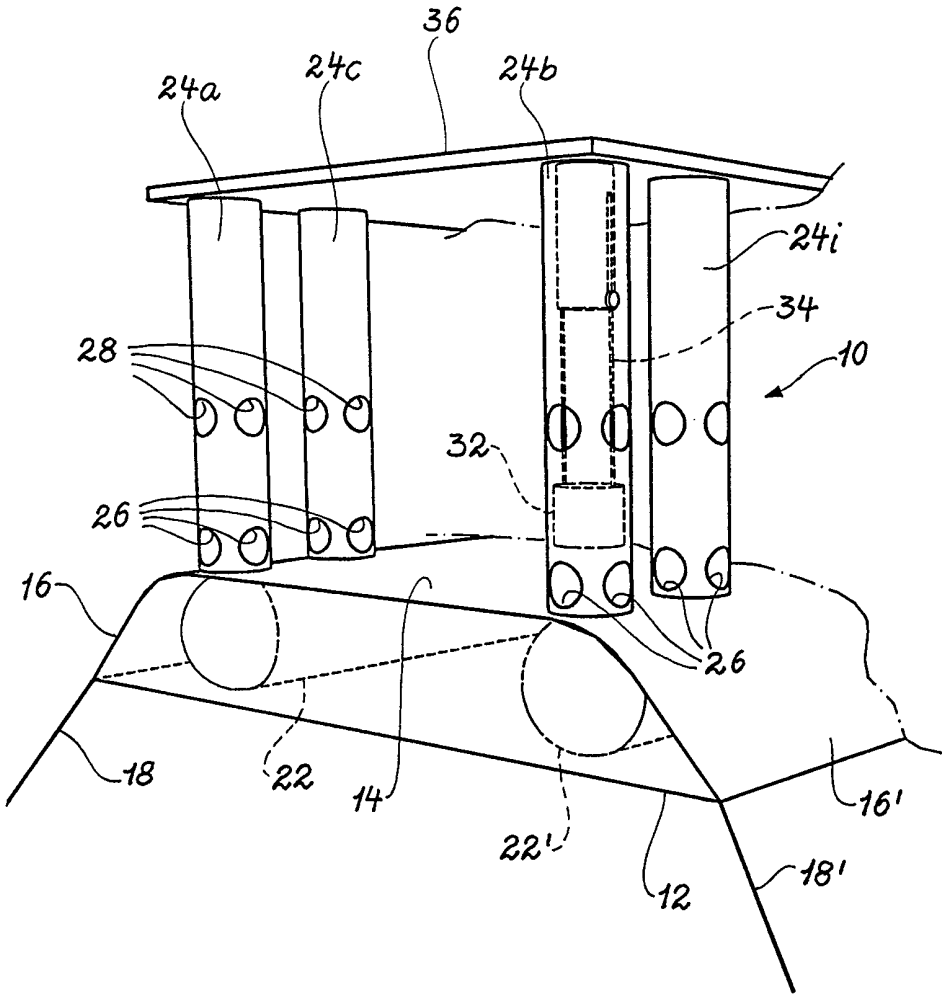

Fig. 2

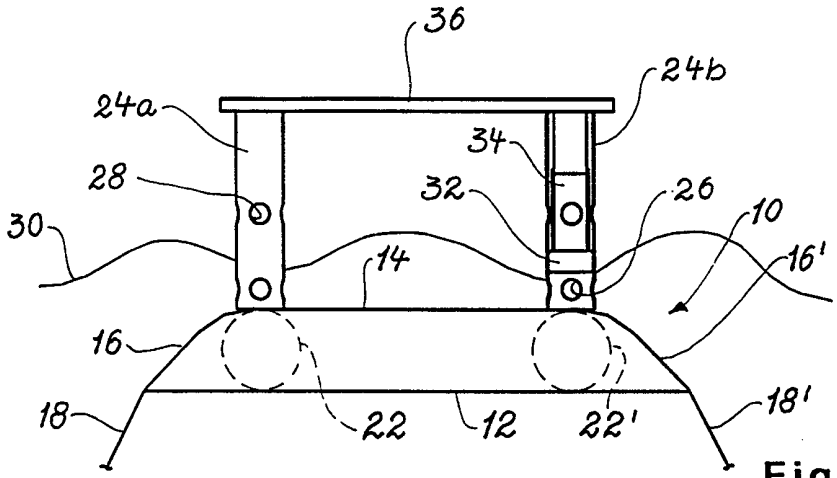

Fig. 3A

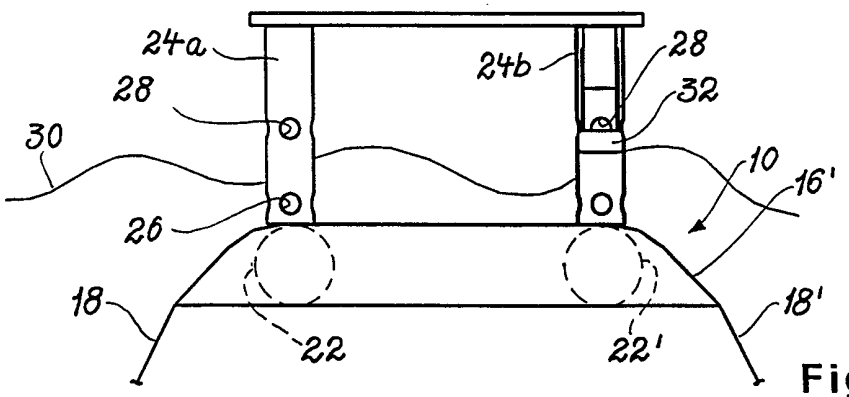

Fig. 3B

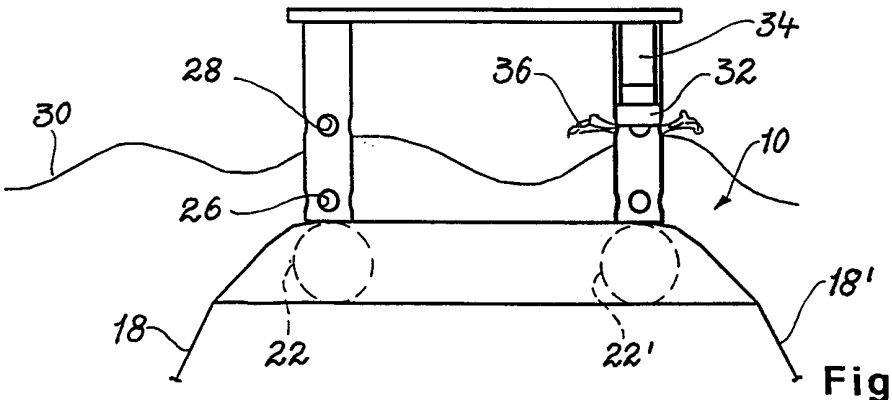

Fig. 3C

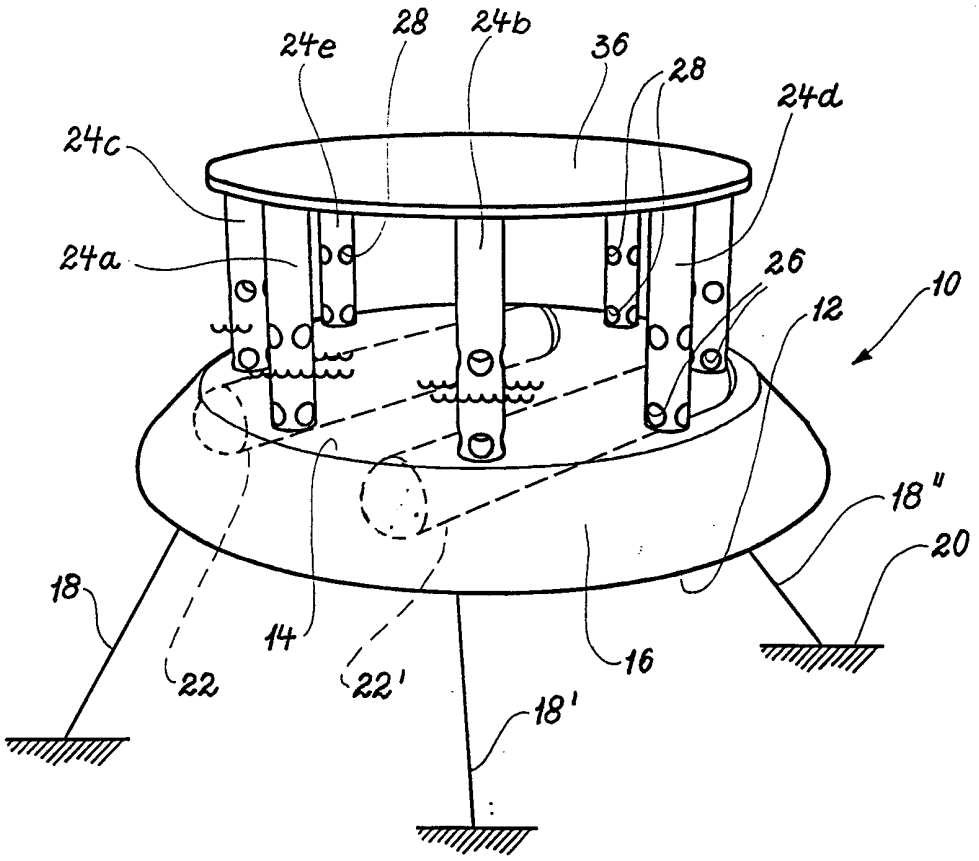

FIG. 4

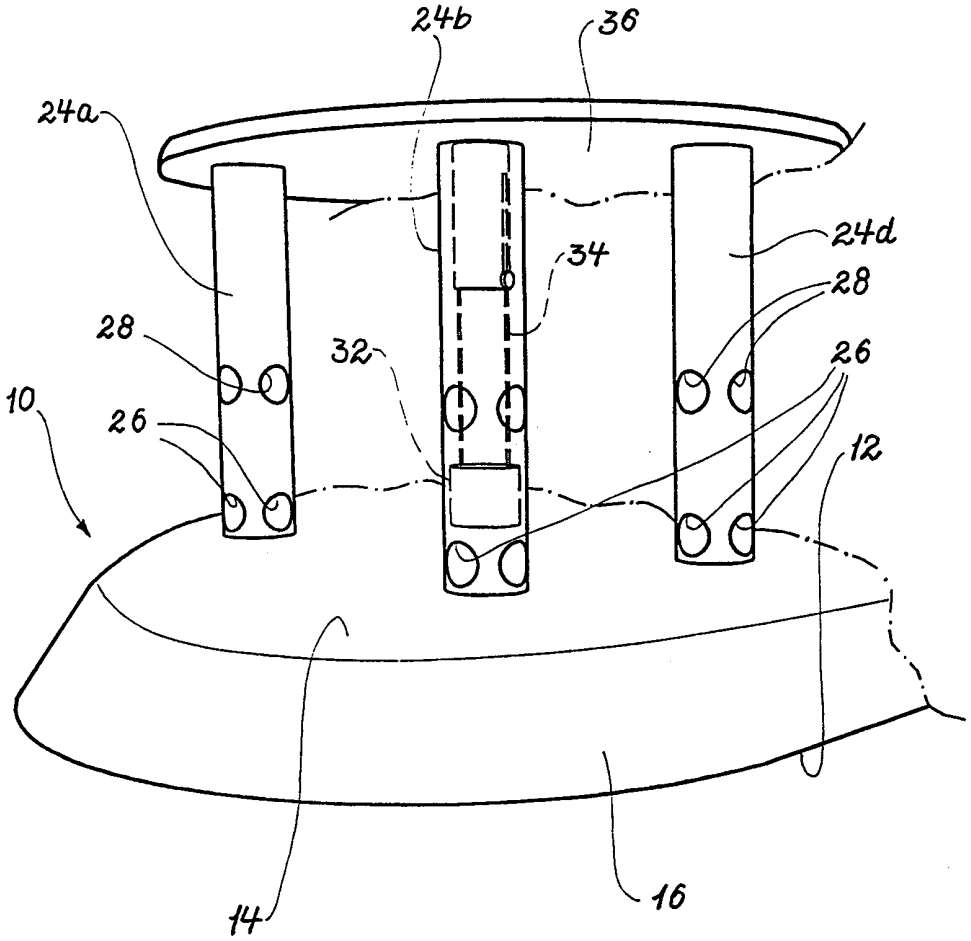

FIG. 5

INTERNATIONAL SEARCH REPORT

International application No.
PCT/NO 98/00255

A. CLASSIFICATION OF SUBJECT MATTER

IPC6: F03B 13/20
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC6: F03B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

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C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 4773221 A (S.A. NOREN), 27 Sept 1988 (27.09.88) --	1-5
A	DE 4134692 A1 (EHLKE, F.), 21 May 1992 (21.05.92) --	1-5
A	DE 2901856 A1 (WAGENER, K.), 24 July 1980 (24.07.80) --	1-5
A	Derwent's abstract, No 92-148925/18, week 9218, ABSTRACT OF SU, 1665066 (ELTSOV V M), 23 July 1991 (23.07.91) --	1-5

☐ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

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INTERNATIONAL SEARCH REPORT

Information on patent family members

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