

April 23, 1963

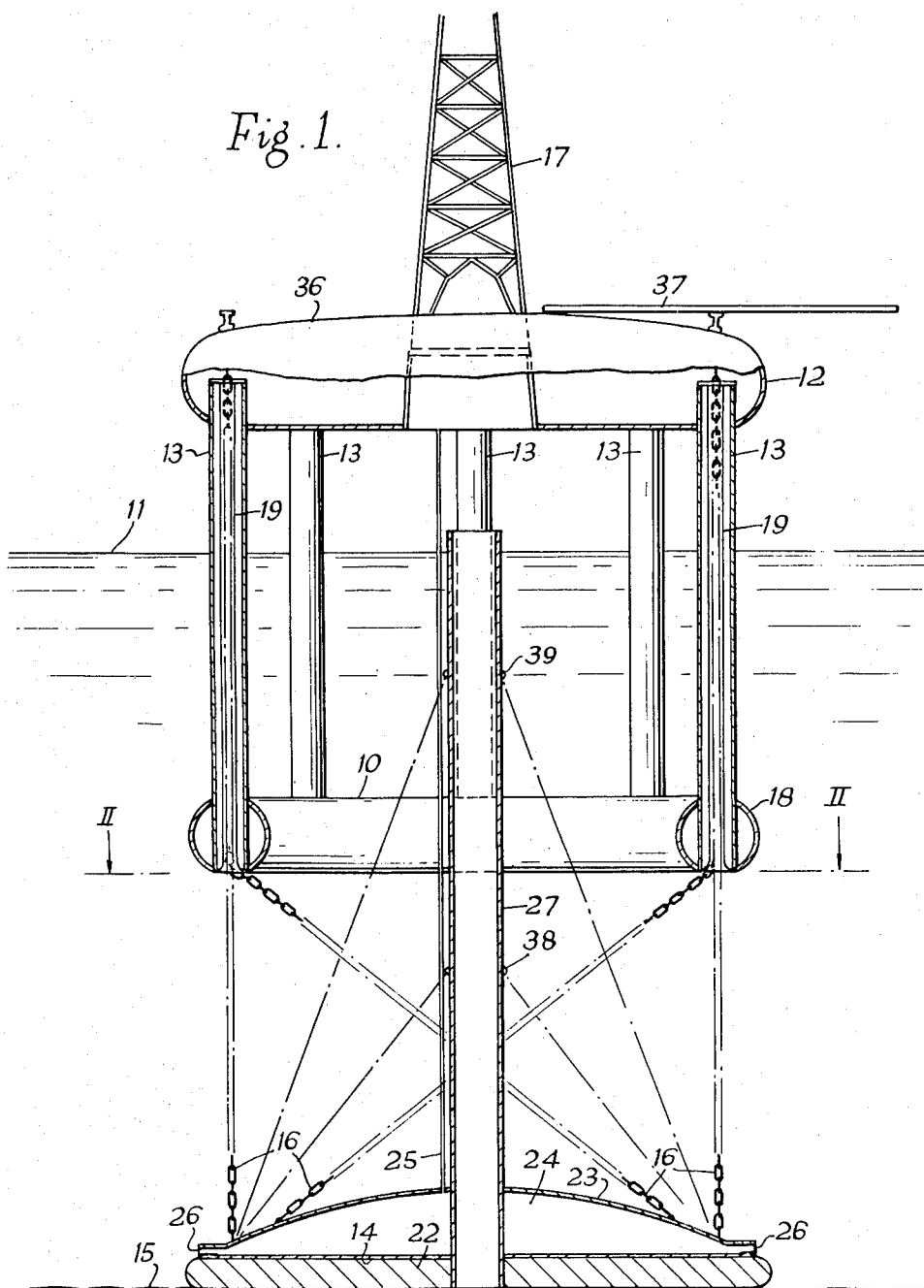
O. POPPER
CHAINS AND MARINE APPARATUS MOORED OR
ANCHORED BY CHAINS TO THE SEA BED

3,086,368

Filed Oct. 6, 1959

4 Sheets-Sheet 1

Fig. 1.



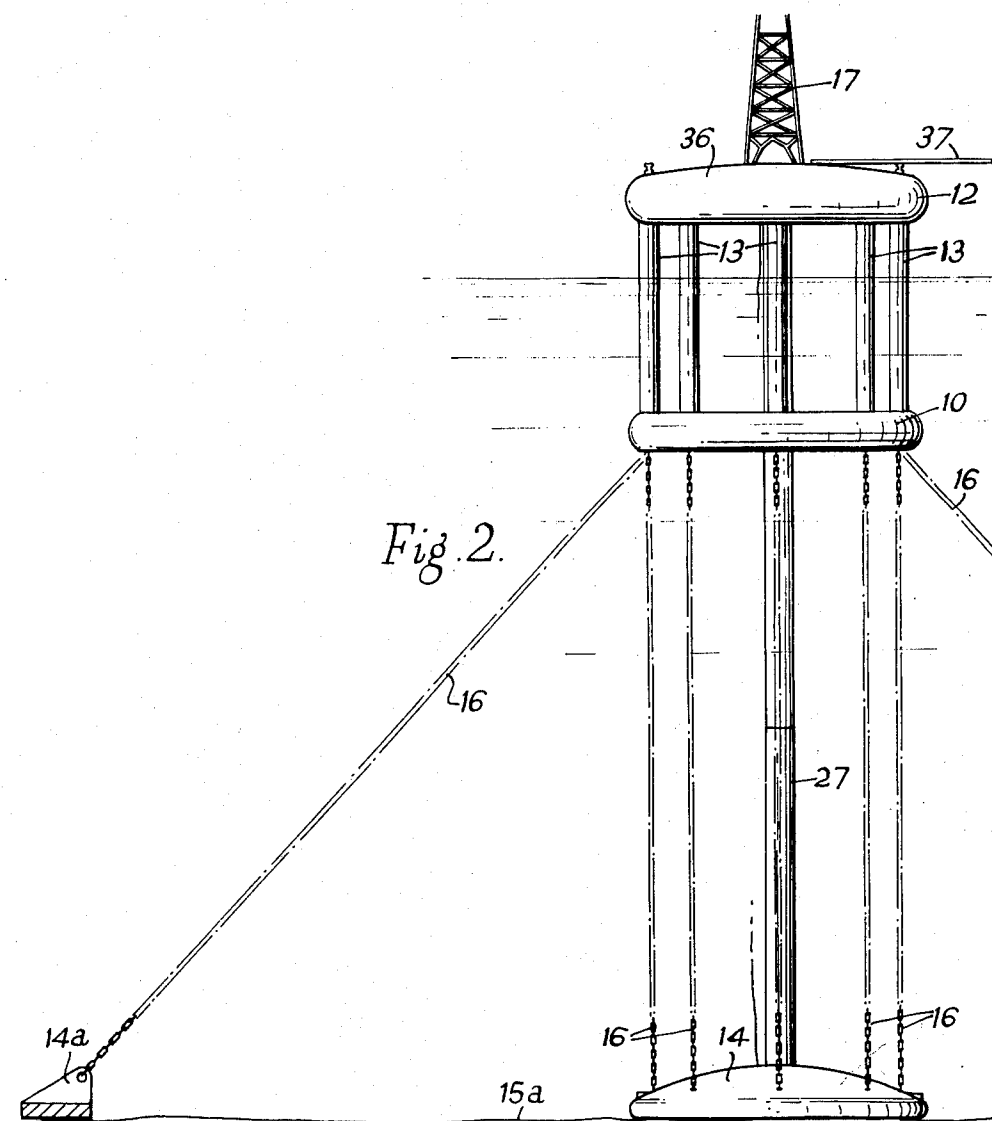
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Fig. 4.

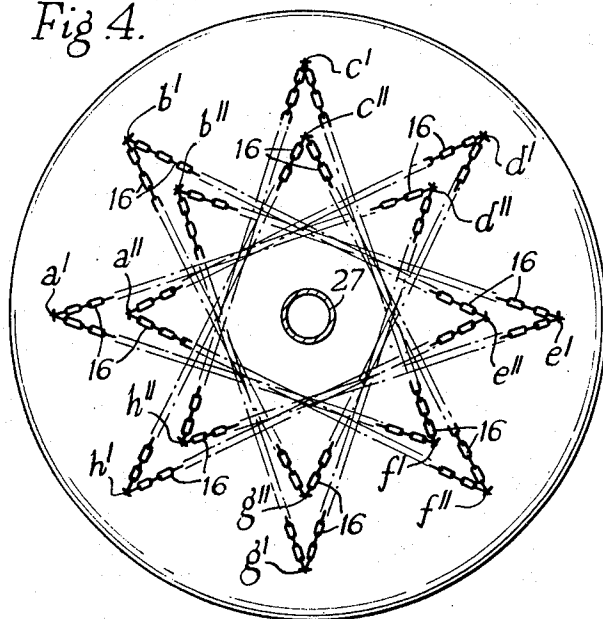
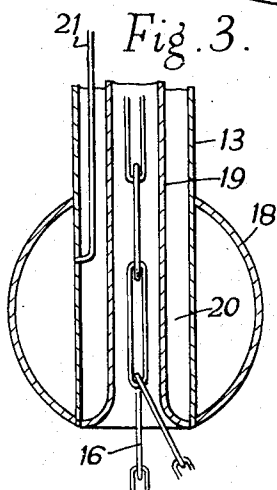


Fig. 3.



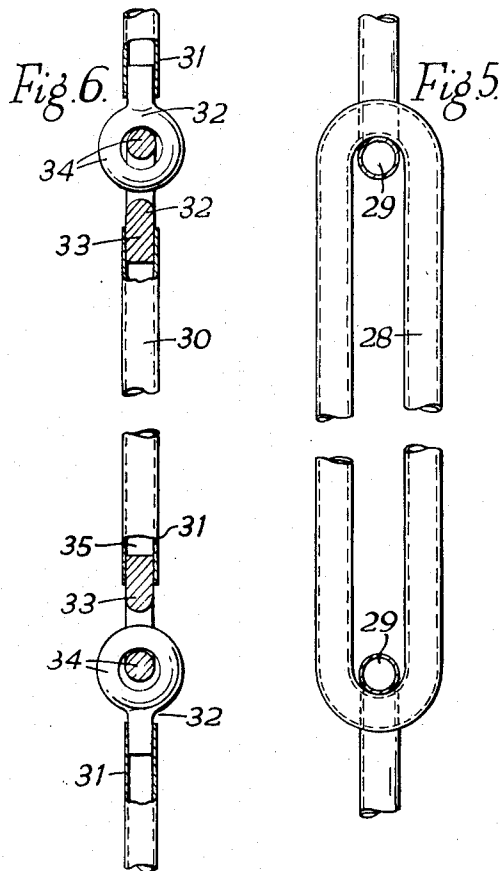
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CHAINS AND MARINE APPARATUS MOORED OR ANCHORED BY CHAINS TO THE SEA BED

Otto Popper, Flat 5, Tudor House, Parson St.,
London, England

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3 Claims. (Cl. 61—46.5)

This invention relates to chains for use in supporting marine apparatus in water, or in anchoring marine apparatus to an underwater bed, such as the sea bed, and the invention also relates to marine apparatus anchored by chains to an underwater bed.

According to the invention there is provided a chain comprising a plurality of metal links coupled together, wherein at least some of said links, including links at spaced intervals along the chain, are provided with internal cavities having such a volume, that, upon immersion of the chain in water, the weight of water displaced by the chain is approximately equal to the weight of the chain in air.

The chain may be slightly heavier or slightly lighter than the water which it displaces, that is the specific gravity of the chain is approximately 1, and this physical property is advantageous, in circumstances where long lengths of chain are required. The chain is particularly suitable for use in suspending heavy objects such as bathyspheres or sounding leads in deep water, since the loading on the chain at the surface of the water will only be equal to the weight of the object in water irrespective of the depth to which the object is lowered.

An important advantage of the chain according to the present invention is the absence of any catenary when the chain is positioned in water at an angle to the vertical, due to the above mentioned physical property of the chain in water, which permits the construction of marine apparatus anchored by chains to the sea bed and having, for all practical purposes, the hitherto unknown characteristic of being rigidly fixed relative to the sea bed.

Thus according to the invention there is further provided marine apparatus comprising a buoyant vessel and a plurality of chains anchoring the apparatus to an underwater bed, the said vessel displacing a volume of water having a weight in excess of the weight of the apparatus in air and at least some of said chains being arranged at an angle to the vertical, each chain comprising a plurality of metal links coupled together and at least some of said links, including links at spaced intervals along the chain, being provided with internal cavities having such a volume that, upon immersion of the chain in water, the weight of water displaced by the chain is approximately equal to the weight of the chain in air.

The vessel is thus provided with an excess buoyancy which is resisted by a pull on the chains. Since however the chains are substantially weightless in water and form no catenary, the pull on the chains straightens them out so that each chain lies along a direct line between its point of attachment or engagement with the apparatus and its point of anchorage to the sea bed.

The chains therefore form in effect rigid tie rods and the apparatus is thus rigidly secured in a fixed position relative to the sea bed. It is to be noted however that the chains only function as rigid rods when they are in tension, and consequently the amount of upward thrust acting on the vessel and the distance of the points of attachment of the chains to the apparatus from a vertical line through the centre of buoyancy must be sufficient to provide restoring couples in excess of any tilting couples that may act upon the apparatus due to the action of wind, waves, water currents or any other horizontal force. The tension in the chains are thus at a maximum when

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there are no horizontal forces acting on the apparatus, and any tilting moment on the apparatus due to a horizontal force acting on one side of the apparatus merely reduces the tension in the chains at the other side of the apparatus.

The vessel may protrude above the surface of the water, but it is preferably completely submerged to provide the maximum upward thrust consistent with its volume and weight. The vessel can then conveniently serve as a base for mounting a superstructure extending above the surface of the water and housing for example oil drilling equipment, a radar and weather station, or serving as a support for a bridge.

The vessel is preferably provided with compartments and with means for filling the compartments with water in order to sink the vessel and for expelling water from the compartments in order to adjust the buoyancy of the vessel.

Marine apparatus anchored to the sea bed by chains according to the invention will now be described, by way of example, with reference to the accompanying drawings, in which:

FIG. 1 is a sectional elevation view of the apparatus anchored by the chains in relatively shallow water,

FIG. 2 is an elevation view, on a reduced scale, of the apparatus anchored by the chains in relatively deep water,

FIG. 3 is an enlarged view of a detail of the apparatus,

FIG. 4 is a view of the chain network of the apparatus when anchored in relatively shallow water, the view of FIG. 4 being taken along the line II—II of FIG. 1,

FIG. 5 is an enlarged part-sectional view of a length of one form of chain suitable for anchoring the apparatus, and

FIG. 6 is an enlarged part-sectional view of a length of another form of chain suitable for anchoring the apparatus.

Referring to FIG. 1, the apparatus comprises an annular vessel 10 arranged in a horizontal attitude below the surface 11 of the water, a platform 12 supported above the surface of the water on the upper ends of eight tubular stanchions 13 secured to the vessel and extending upwards above the surface of the water, and a circular anchor 14 resting on the sea bed 15 beneath the vessel 10 and secured to the platform 12 by chains 16. A drilling derrick 17 and other ancillary drilling equipment for prospecting for oil and gas are mounted on the platform 12.

The annular vessel 10 comprises a large circular tube 18, and the tubular stanchions 13 are arranged symmetrically around the vessel with their lower ends extending through the circular tube 18. The tube 18 is subdivided into separate water compartments, and the water may be expelled from the compartments through openings (not shown), in order to adjust the buoyancy of the vessel, by compressed air supplied through an airline 21 (FIG. 3) extending downwards from the platform within a stanchion 13. The chains 16 extend through tubes 19 in the stanchions 13, and the lower end of each tube 19 is outwardly flared and welded to the lower end of its associated stanchion, as shown in detail in FIG. 3. The clearance between each tube 19 and its associated stanchion thus provides a watertight passageway 20 giving access from the platform to the interior of the vessel 10, through an opening (not shown) in the portion of the stanchion extending through the vessel, and the passageways 20 in addition increase the buoyancy of the apparatus.

Three chains 16 extend through each tube 19, and when the apparatus is anchored in relatively shallow water as shown in FIG. 1 all the chains are secured at their lower ends to the anchor 14. As shown in FIG. 4 the anchor is provided with eight outer anchorage points *a'*, *b'*, *c'*,

d' , e' , f' , g' , h' positioned one below each of the eight stanchions, and with eight inner anchorage points a'' , b'' , c'' , d'' , e'' , f'' , g'' , h'' positioned radially inwards of the anchor with respect to the corresponding outer anchorage points, and the anchorage points for the chains are so selected that the chains do not intersect the vertical centre line of the apparatus. For example, the three chains extending through the tube 19 in the stanchion positioned immediately above the anchorage point a' are secured one to each of the anchorage points a' , d'' , f'' .

When the apparatus is anchored in relatively deep water as shown in FIG. 2, only one chain from each tube 19 is connected to the anchor 14 at the anchorage point positioned immediately below the associated stanchion, the remaining chains being connected to additional anchors 14a positioned on the sea bed 15a around the anchor 14. The chains connected to the additional anchors will thus be at an angle sufficient to ensure stability of the apparatus.

The main anchor 14 comprises a large heavy base 22 and a hull 23 mounted on the base and providing a compartment 24 connected by an air line 25 to a source of compressed air on the platform. The compartment 24 is normally filled with water when the anchor 14 is resting on the sea bed, but the water may be expelled through openings 26 in the wall of the hull adjacent the base by compressed air supplied through the air line 25 when it is desired to lift the anchor. A hollow vertical column 27, which serves as a guide for the drill, is secured in a central aperture in the anchor 14 and extends upwards through the annular vessel 10, with its upper end projecting above the surface of the water.

Each of the chains 16 comprises a series of interconnected links 28 (FIG. 5). Each link is made from a length of tubular steel which is first passed through the eye of an adjacent link and then bent into the shape of an elongated loop with the ends of the length of tubular steel arranged coaxial in closely spaced relationship, these ends then being welded together to form a watertight cavity 29 extending around the link within the tubular wall thereof. Each link is so designed that, upon immersion in water, the weight of water displaced by the link is approximately equal to the weight of the link in air. The whole chain will therefore have substantially no weight when immersed in water and will stretch out straight when subjected to a tensile load.

FIG. 6 shows another construction of chain suitable for anchoring the apparatus. The chain of FIG. 6 comprises a series of links 30 each consisting of a hollow steel tube 31 sealed at each end by plugs 32. Each plug comprises a solid stem 33 secured as a watertight fit in one end of the associated tube 31 and a ring shaped head 34 which is interlinked with the head of the plug secured in the opposing end of the adjoining tube 31. Each link is thus provided with a watertight cavity 35 within the tube 31, and the volume of the cavity is adjusted, by appropriate positioning of the plugs in the ends of the tube 31, to such a value that each link will displace its own weight of water.

The vessel 10 is designed to displace considerably more than its own weight of water when the compartments in the tube 18 are filled with air, and the buoyancy of the vessel 10, together with the buoyancy provided by the stanchions 13, supports the weight of the vessel 10, stanchions 13, platform 12 and drilling equipment, and in addition provides an upward thrust on the chains 16 which then extend in straight lines between the apparatus and the anchor and function as rigid tie rods. When the apparatus is in position with the anchor resting on the sea bed the weight of the anchor in water must of course exceed the upward thrust due to the excess buoyancy of the vessel, and this upward thrust must be sufficient to prevent tilting of the apparatus under the action of any horizontal force acting on the platform or stanchion, such

as for example the force of the wind, waves, or water currents.

The platform 12, which is positioned well above the reach of the highest waves at high tide, is circular, with the drilling derrick 17 mounted centrally on the platform to prevent the apparatus pivoting around its vertical axis under the action of wind or waves. The lower part of the platform body is watertight so that the platform is capable of floating in water and the floor of the platform is covered by a stream-lined roof 36 fitted with a landing stage 37 for helicopters.

When it is desired to move the apparatus to another location, the buoyancy of the vessel 10 is reduced by flooding one or more of the compartments in the tube 18 until the platform 12 is floating on the water, and the water in the compartment 24 of the anchor 14 is expelled by compressed air so that the anchor becomes buoyant and rises from the sea bed to engage the underside of the vessel 10. Alternatively, the anchor 14 may be designed so that it is not quite buoyant when the water is expelled from the compartment 24 and the anchor then raised by means of the chains. The platform 12 is then released from the stanchions 13 and the buoyancy of the vessel 10 is increased by expelling water from the compartments in the tube 18 so that the vessel 10 and anchor 14 rise to engage the underside of the platform 12, the stanchions 13 and the column 27 rising through vertical passageways (not shown) in the platform 12. The platform, vessel and anchor are then in close superimposed relationship with the stanchions and the column extending upwards above the platform, and the apparatus can be conveniently towed to another location. The stanchions and the column may of course be dismantled in sections as they rise above the platform, if they are of exceptional length or if they should affect the stability of the apparatus.

When the drill on the marine apparatus strikes oil or gas the vessel 10 and platform 12 are preferably removed from the anchor 14, a part of the vessel 10 being removable to provide a slot permitting the passage of the column 27 which extends up through the centre of the vessel 10. The anchor 14 then remains on the sea bed with the column extending above the surface of the water and the oil or gas can be extracted through the column. The upper ends of the chains which have been detached from the platform are then secured to spaced lugs 38, 39 on the column 27 to provide additional support to the column.

I claim:

1. Marine apparatus comprising a buoyant vessel, a plurality of chains anchoring the apparatus to an underwater bed, at least some of said chains being arranged at an angle to the vertical, hollow stanchions secured to the vessel, a platform mounted on the upper ends of said stanchions and tubes mounted in said stanchions, the outside diameter of said tubes being substantially smaller than the inside diameter of said stanchions and the lower ends of the tubes being welded to the walls of the associated stanchions to provide buoyant water-tight annular chambers therein, wherein at least some of said chains extend downwards through said tubes and the vessel and at least the lower end portions of the stanchions are submerged and displace a volume of water having a weight in excess of the weight of the vessel, stanchions and platform in air, and each chain comprises a plurality of metal links coupled together, at least some of said links, including links at spaced intervals along the chain, being provided with internal cavities having such a volume that, upon immersion of the chain in water, the weight of the water displaced by the chain is approximately equal to the weight of the chain in air so that said chains are substantially weightless in the water and when subjected to the upward thrust produced by the buoyancy of said vessel and said water-tight annular chambers the chains stretch out straight and form no catenary.

2. Marine apparatus as claimed in claim 1 wherein

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said platform is watertight at the lower part thereof so that said platform is buoyant and capable of floating in water to serve as a vessel capable of supporting the apparatus on the water.

3. Marine apparatus as claimed in claim 1, wherein 5 said chains are secured to an anchor having a water compartment, means for expelling water from said compartment to reduce the weight of the anchor in water, a hollow vertical column secured at its lower end to said

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anchor and said column having its upper end extending upwards through said vessel.

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