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(54) **METHOD AND APPARATUS FOR CAPTURING OIL LEAKING FROM AN UNDERWATER WELL**

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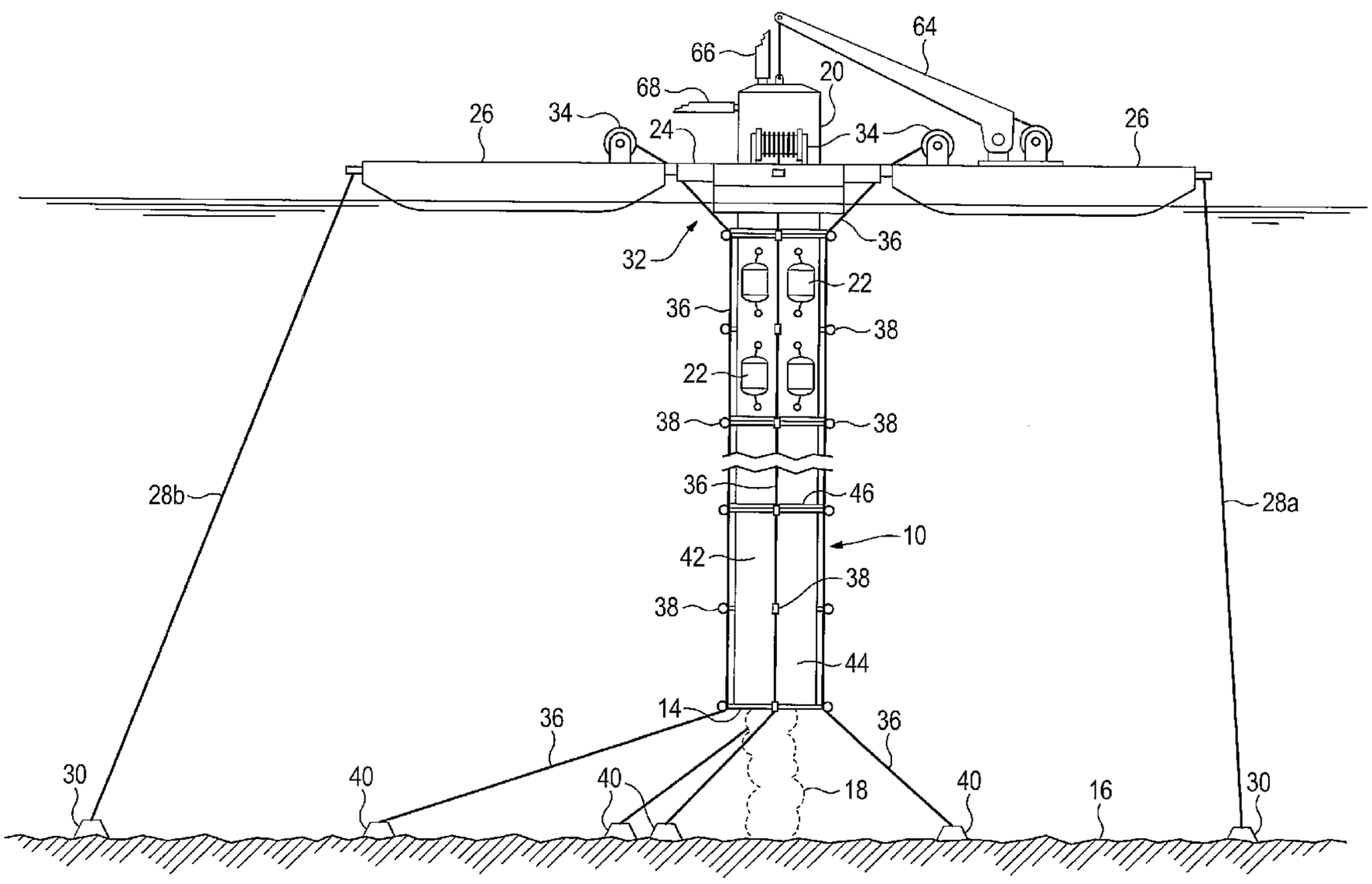
(57) **ABSTRACT**

A system for capturing oil leaking from an underground well includes an elongate hollow tube which is deployed vertically in the water with its open lower end located above the oil well. A system for securing the tube in the desired location where it captures the maximum amount of leaking oil includes an adjustment system which allows the tube to be moved transversely once it is in place. A method is provided for erecting the tube and anchoring it at the desired location above the leaking well.



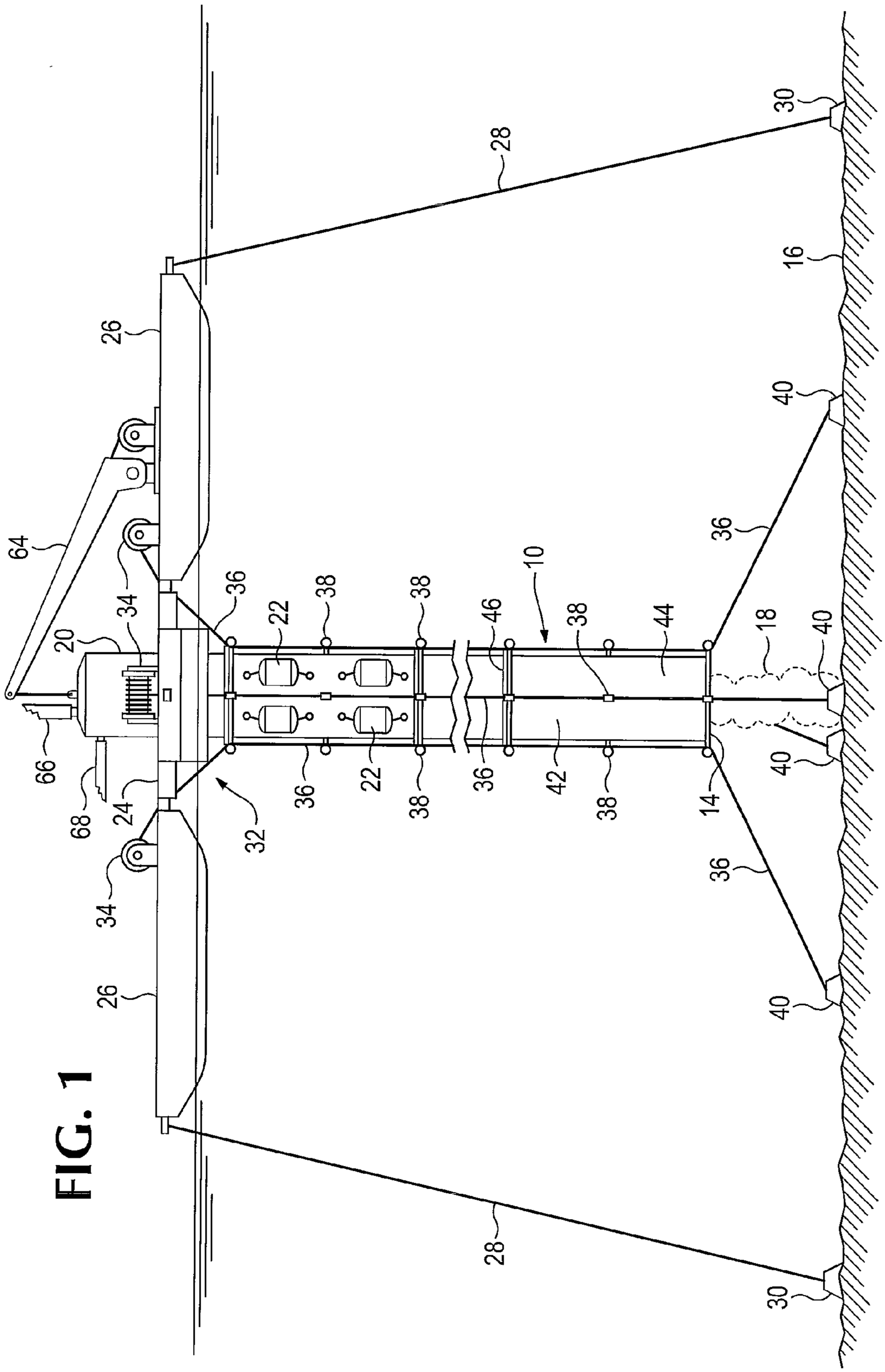

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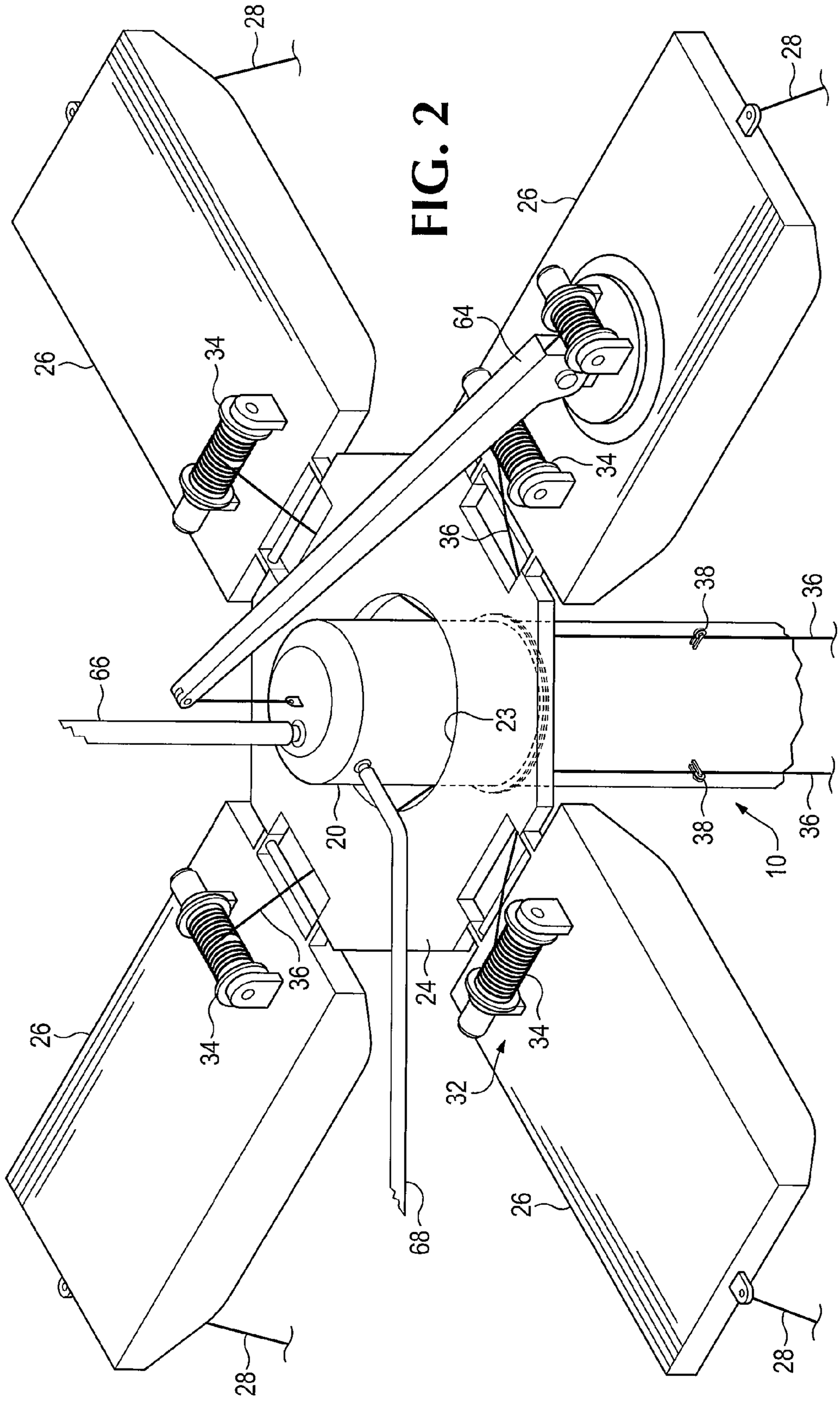
FIG. 1

FIG. 2



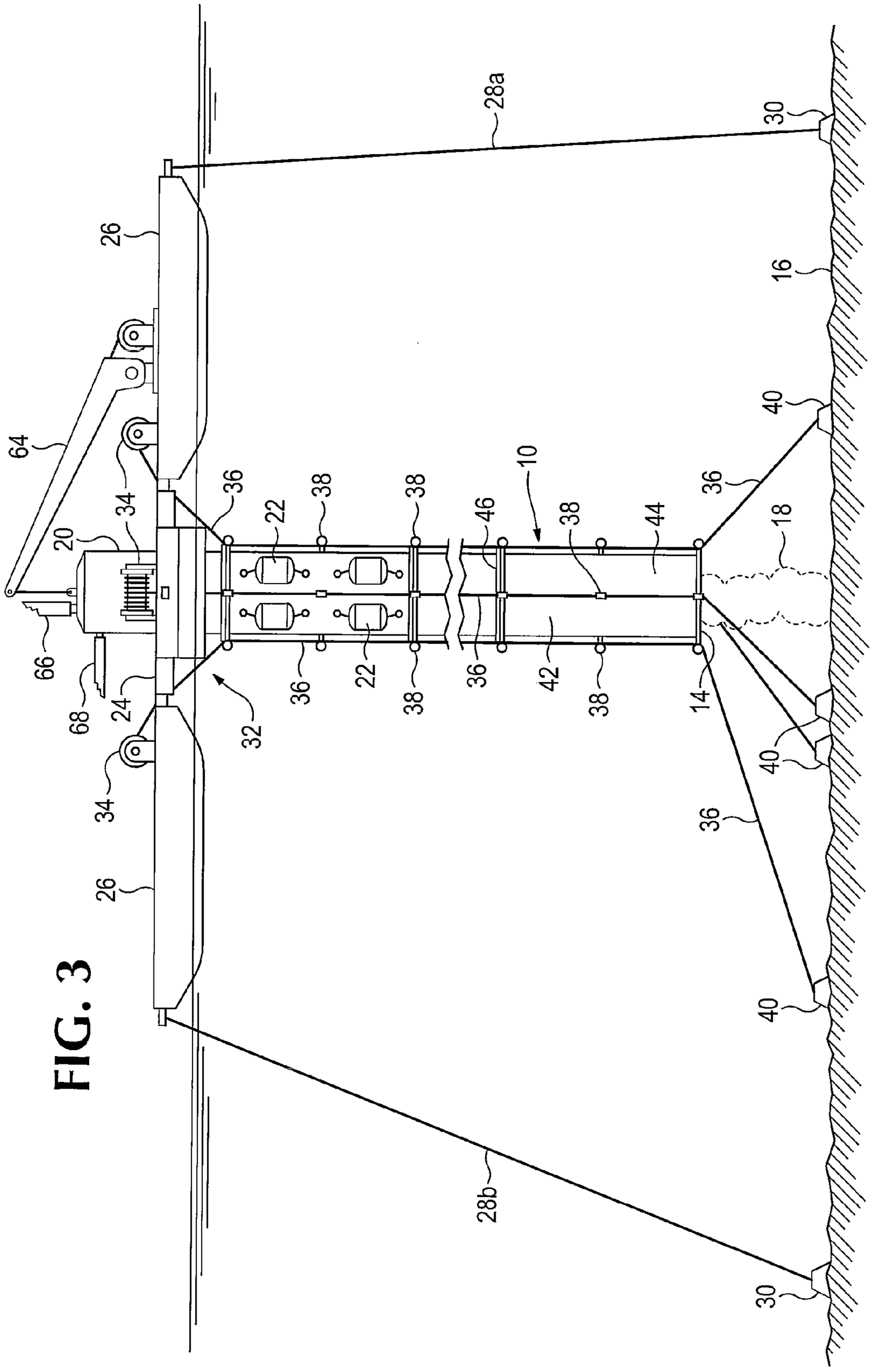

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FIG. 3

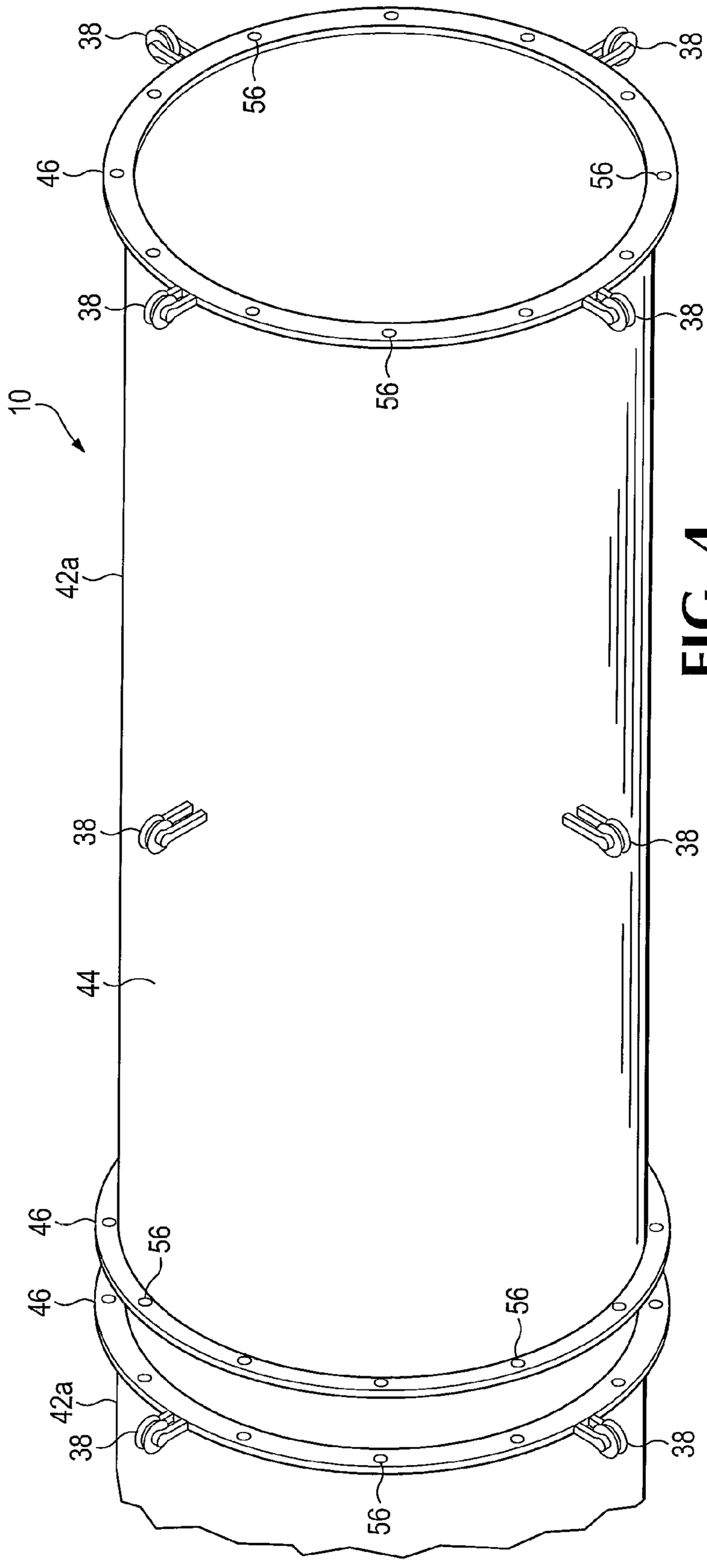


FIG. 4

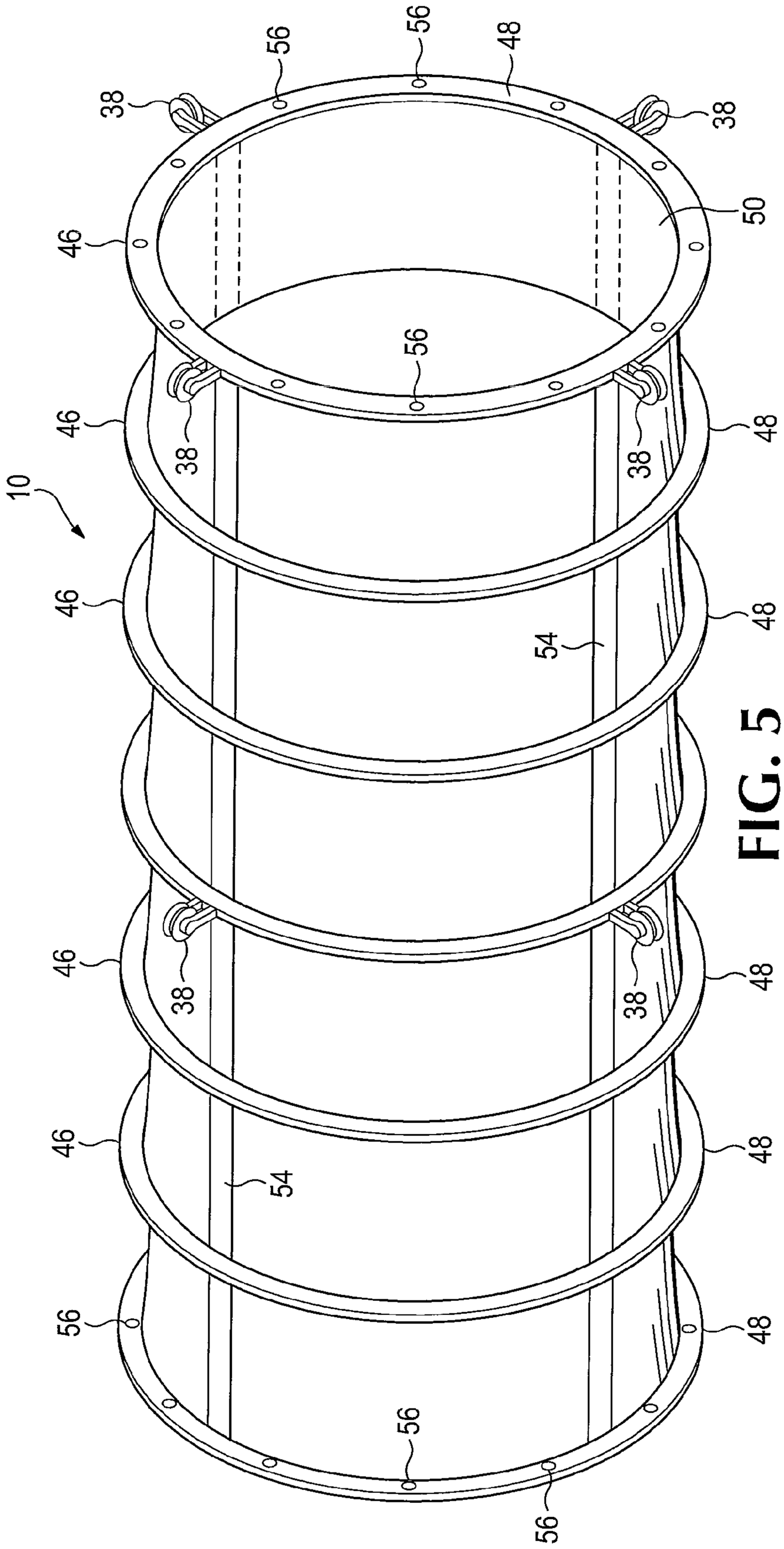
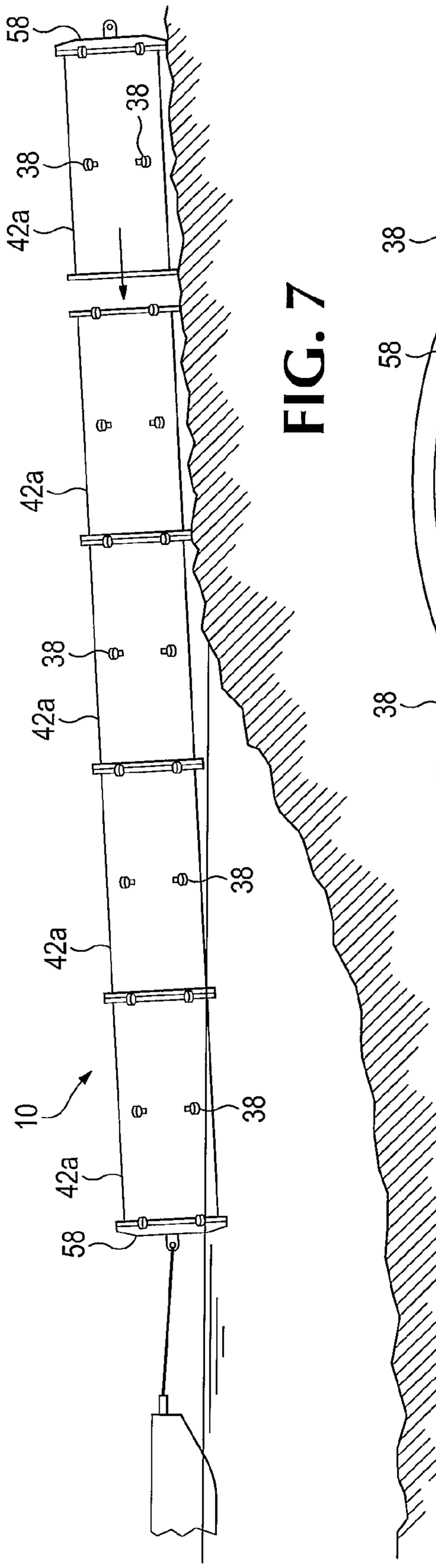


FIG. 5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42a
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FIG. 7

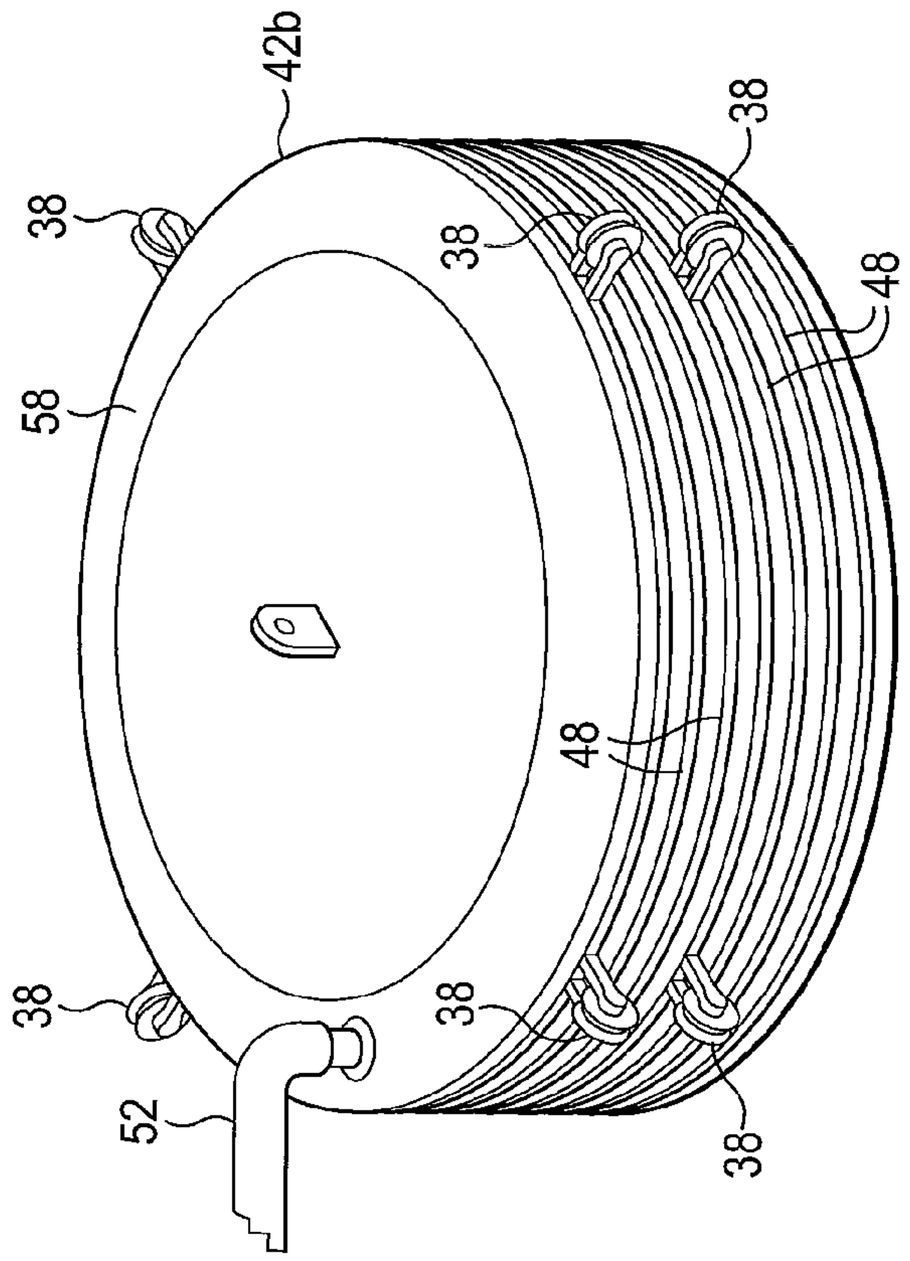
42b
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FIG. 6

FIG. 8

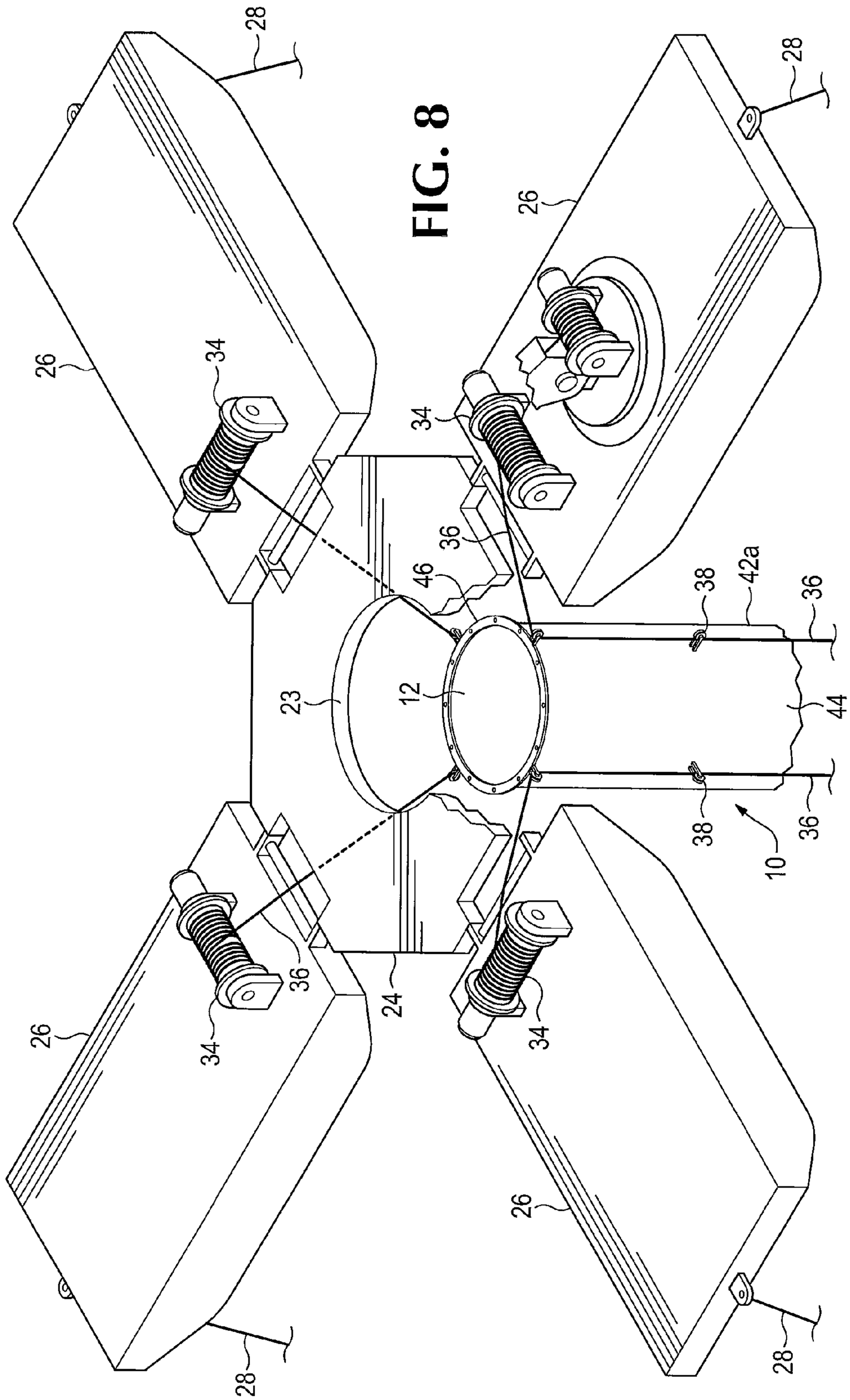
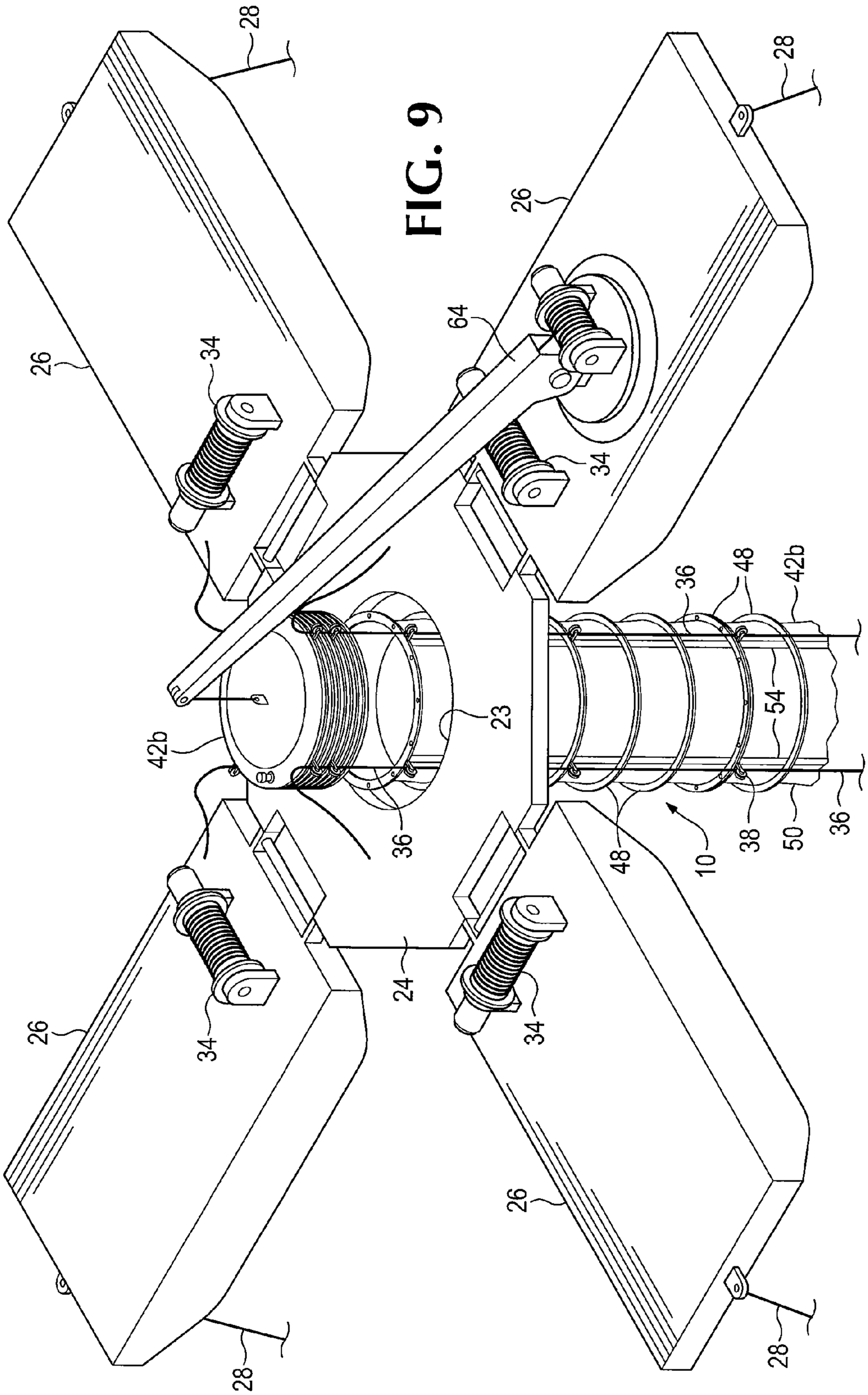


FIG. 9



METHOD AND APPARATUS FOR CAPTURING OIL LEAKING FROM AN UNDERWATER WELL

BACKGROUND OF THE INVENTION

[0001] When oil wells are located under water, it can be difficult and time consuming to cap them if an accident occurs and there is uncontrolled leakage of oil from the well. While there are procedures for capping or otherwise plugging underwater wells, a considerable amount of oil can flow out of the well before it can be capped. This leakage can cause extensive environmental damage and there can be considerable costs involved in attempting to capture the oil that is discharged from the well before the well is capped.

BRIEF SUMMARY OF THE INVENTION

[0002] A system for capturing oil leaking from an underwater well includes an elongate hollow tube which is deployed vertically in the water above the well. An anchoring system which anchors the tube to the floor beneath the body of water includes an adjustment system which allows moving the tube transversely to a location where it captures the maximum amount of oil. A method is provided for constructing the tube from a plurality of tube segments, and erecting it above a leaking oil well.

[0003] The foregoing and other objectives, features, and advantages of the invention will be more readily understood upon consideration of the following detailed description of the invention, taken in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWINGS

[0004] FIG. **1** is a side elevation view of a system for capturing oil from a leaking well embodying the subject invention.

[0005] FIG. **2** is a perspective view, looking from above, of the system of FIG. **1**.

[0006] FIG. **3** is a side elevation view similar to FIG. **1**, showing how the tube that is used to capture the oil can be moved transversely.

[0007] FIG. **4** is a partial perspective view showing a first embodiment of a tube segment, which is an element of the subject invention.

[0008] FIG. **5** is a partial perspective view showing another embodiment of a tube segment.

[0009] FIG. **6** is a perspective view of the tube segment shown in FIG. **5** in a collapsed position.

[0010] FIG. **7** is a side elevation view illustrating one method of constructing the system.

[0011] FIGS. **8** and **9** are perspective views, similar to FIG. **2**, showing methods for constructing the system.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENT

[0012] Referring now to FIG. **1** of the drawings, an elongate hollow tube **10** is deployed in a vertical orientation over a leaking underwater oil well. The tube **10** has an upper end **12**, FIG. **8**, which is located proximate the surface of the water, and a lower end **14**, which is located substantially below the surface of the water, but above the floor **16** of the body of water. How far the lower end is above the floor depends upon the diameter of the tube, the velocity which the leaking oil exits the floor **16**, and the extent of water currents between the floor and the lower end **14**. However, it preferably is located close enough to the floor so that a large portion of the oil **18** escaping from the well is still traveling substantially vertically upwardly and has not dispersed substantially to where a significant portion of it flows into the lower end of the tube. The tube is open at both ends, but a domed shape collection chamber **20** covers its upper end **12**. A plurality of flotation devices **22** are attached to the tube around its outer surface to support the tube vertically at the appropriate depth. Providing this neutral buoyancy could be achieved by other means. Referring now also to FIG. **2**, the collection chamber **20** and upper end **12** of the tube project through an opening **23** in a flotation platform **24** which is shown schematically. Flotation platforms of this type are well known in the offshore oil well technology. Attached to the platform **24** at generally equally spaced locations around the tube are a plurality of floats **26**. In the embodiment illustrated, there are four floats, but there could be any number of floats. The floats **26** are attached to the platform **24** to form an integral floating unit. Each float is anchored to the floor **16** by means of a cable **28** which extends between the float and a platform anchor **30** located on the floor **16**. The platform anchors **30** are located around a circle circumscribed on the floor **16** having a diameter which is much larger than the diameter of the tube **10**, in order to maintain the tube in generally the same location.

[0013] An anchoring system anchors the lower end of the tube **10** to the floor **16**. The platform **24** and the anchoring system work together to maintain the tube **10** in its vertical orientation. The anchoring system includes an adjustment system **32** which permits the tube to be moved laterally in order to initially locate it above the escaping oil **18** and to keep it in the optimal location to capture the maximum amount of the oil. Located on each float **26** is a take-up device **34** having a cable **36** attached to it. In the embodiment shown in the drawings, the take-up device is a winch, but it could be another type of device. The cables **36** are directed downwardly along the length of the tube by passing them through guides **38** located on the outer surface of the tube. The guides could be rollers such as shown, or any other device which will allow a cable to movably extend along the longitudinal length of the tube. The bottoms of the cables **36** are attached to tube anchors **40** located on the floor **16**. In the embodiment, the tube anchors **40** are located on a circle circumscribed on the floor **16** having a diameter which is greater than the diameter of the tube **16** and less than the diameter of the circle the float anchors are located around. Referring now also to FIG. **4**, by using the take-up devices **34** to shorten a cable **38***a* onto its associated take-up device **34** and lengthening the cable **28***b* on the opposite take-up device **34**. The tube **10**, platform **24**, and floats **26** will be moved laterally.

[0014] In order to facilitate erection of the tube **10**, it is constructed from a plurality of tube segments **42** which are joined end-to-end, FIGS. **4** and **5**. In the embodiment shown in FIG. **4**, the tube segments **42***a* have a solid wall **44** with flanges **46** at each end. The wall **44** could be constructed from metal or another rigid material.

[0015] The tube segments **42***b*, shown in FIGS. **5** and **6**, are collapsible. The collapsible tube segments **42***b* have a plurality of annular rings **48** which support a flexible wall **50**. The wall **50** could be a fabric material, such as rubberized canvas, or any other flexible material which can function in this environment. The rings **48** are made from metal or other suitable rigid material. The rings at each end of each tube

segment **42***b* serve as the flanges which are used to attach adjacent tube segments to one another. The flexible tube segments **42***b* collapse by their own weight when placed on a solid surface, FIG. **6**, but by covering the ends of the tube segment and drawing a vacuum through a line **52**, the wall **50** will be pulled inwardly when the tube segment is collapsed so that it is out of the way. In order to strengthen the collapsible tube segments and facilitate hanging them vertically, longitudinal straps **54** may be attached to the rings **48** at selected intervals around the periphery of the tube segment. The tube segments **42** can be attached to one another by bolting, riveting, installing collars, or by other known means. Holes **56** are shown in the flanges to facilitate this. The tube **10** can either be assembled remote from the leaking well and towed to the site of the well, FIG. **7**, or erected at the site of the well, FIGS. **8** and **9**. One way of accomplishing the former is to assemble the tube segments **42** onshore and pull them into the water as additional tube segments are attached, FIG. **7**. Covers **58** cover both ends of the tube so that air trapped in the tube causes it to float. When the tube has been towed to the site, the cables **36** from the take-up devices **34** are fed through the guides **38** and attached to the tube anchors **40**. Appropriate flotation devices **22** are attached to the tube to provide neutral buoyancy and the cover **58** is removed from what will be the lower end of the tube. This will allow water to flow into the tube and the tube will sink lower end first. The filling of the tube with water and the flotation devices cause the tube to become vertical with its upper end adjacent to the surface of the water. The cover **58** at the upper end of the tube is removed and a crane **16** located on one of the floats **26** then places the collection chamber **20** on top of the tube and the collection chamber and tube are joined, FIG. **2**. While this erection method could be used with either solid tube segments **42***a* or collapsible tube segments **42***b*, it is shown in the drawings with solid tube segments **42***a* because this method would more commonly be used for erecting the tube **10** from solid tube segments **42***a*.

[0016] Erecting the tube **10** on the site would most commonly be used for erecting the tube from collapsible tube segments **42***b*. Referring now to FIG. **9**, the crane **62** is used to lift collapsible tube segments off of a barge or similar floating storage structure (not shown). The crane then lowers the tube segment through the opening **23** in the platform **24** into the water, and the tube segment is allowed to expand. Flotation devices **22** are attached to this tube segment so that it floats with its upper end **12** near the surface of the water. The crane **62** is then disconnected from this tube segment and is attached to another collapsed tube segment **42***b*. The new tube segment is then placed over and lowered against the previous tube segment. The two tube segments are then attached and additional flotation devices are attached so that the combined tube segments have neutral buoyancy. The process is then repeated until the tube has reached the desired length. Cables **36** are then fed through guides **38** and attached to the tube anchors **40**. Finally, the crane is used to place the collection chamber **20** on top of the tube. Regardless of which erection method is used, after the tube is erected, oil **18** from the leaking well rises through the water in the tube, due to its lower density, until it reaches the collection chamber **20**. Any natural gas contained in the oil raises to the top of the collection chamber where it is removed through a natural gas line **64**. The natural gas is collected for use or is burned. Oil is removed from the collection chamber **20** by means of oil lines **64** and its pumped to a tanker or barge for transportation.

[0017] The tube **10** can be erected either before the well is drilled or after it is drilled, including after a leak has occurred.

[0018] The terms and expressions which have been employed in the foregoing specification are used therein as terms of description and not of limitation, and there is no intention, in the use of such terms and expressions, of excluding equivalents of the features shown and described or portions thereof, it being recognized that the scope of the invention is defined and limited only by the claims which follow.

I/We claim:

1. A system for capturing oil leaking from an underwater well comprising:

(a) an elongate hollow tube deployed in a vertical orientation above a leaking well, said tube having an upper end which is proximate the surface of the water and a lower end which is substantially below the surface of the water; and

(b) an anchoring system for anchoring the lower end of said tube to the floor below the water.

2. The system of claim **1** including an adjustment system associated with said anchoring system which allows said tube to be moved to an optimum location where it captures the maximum amount of oil leaking from said well.

3. The system of claim **1** including buoyancy devices attached to said tube in order to support said tube with its upper end proximate the surface of the water.

4. The system of claim **1** wherein said tube comprises a series of tube segments joined to one another end-to-end.

5. The system of claim **4** wherein said tube segments have a solid metal wall.

6. The system of claim **4** wherein said tube segments are collapsible.

7. The system of claim **6** wherein said tube segments comprise two or more rigid rings and a flexible wall made from a fabric material, which is supported by said rings.

8. The system of claim **7** wherein said fabric material is rubberized canvas.

9. The system of claim **7** including straps which are attached to and extend between adjacent rings at spaced apart locations around the periphery of said rings.

10. The system of claim **4** wherein said tube segments have outwardly projecting flanges at each end thereof and said tube segments are joined to one another by attaching flanges from adjacent tube segments to one another.

11. The system of claim **10** wherein said adjacent tube segments are welded to one another.

12. The system of claim **10** wherein said adjacent tube segments are bolted to one another.

13. The system of claim **10** including a clamp ring which clamps flanges of adjacent tube sections to one another.

14. The system of claim **1** including a collection chamber which is connected to the upper end of said tube.

15. The system of claim **14** including one or more conduits for removing oil from said collection chamber.

16. The system of claim **14** including one or more conduits for removing natural gas from said collection chamber.

17. The system of claim **1** wherein the lower end of said tube has a sufficiently large diameter and is located sufficiently close to the floor of the body of water that a large portion of the oil leaking from the well flows into said tube as it rises to the surface.

18. The system of claim **2** wherein said anchoring system includes at least three cables having lower ends which are attached to the floor below the water at generally evenly

spaced intervals around a circle circumcised on said floor, said circle having a diameter which is greater than the diameter of said tube.

19. The system of claim **17** wherein said adjustment system comprises:

(a) guides located on said tube which allow said cables to extend moveably along the linear extent of said tube;

(b) a take-up device associated with each of said cables located at the surface of said body of water; and

(c) said take-up devices being capable of lengthening or shortening the amount of the associated cable which is located in the water.

20. The system of claim **19** where said take-up devices are winches.

21. The system of claim **18** wherein said cables are located in pairs which are diametrically opposed from one another around the periphery of said tube.

22. The system of claim **21** wherein said take-up devices are synchronized so that when one of said cables is shortened, the opposed cable is lengthened like a mount.

23. A method of constructing the system of claim **4** comprising:

(a) placing a first one of said tube segments on its side adjacent to the water with the end facing the water covered with a first removable cap;

(b) attaching the end of said first tube segment to a towing vessel located in the water;

(c) attaching another tube segment to the existing tube segment;

(d) using said vessel to pull said first tube segment into the water;

(e) repeating steps (c) and (d) until the resulting tube has the desired length;

(f) covering the unattached end of the resulting tube with a second removable cap; and

(g) using said vessel to tow said tube to an underwater well.

24. The method of claim **23** including the following additional steps:

(a) attaching an anchoring system to said tube to anchor said tube to the floor below the water; and

(b) removing the second removable cap from said tube allowing said tube to submerge.

25. The method of claim **24** including attaching buoyancy devices to said tube such that when submerged it is oriented vertically with an upper end located proximate the surface of the water and a lower end which is substantially below the surface of the water.

26. The method of claim **25** including providing an adjustment system to said tube which allows said tube to be moved transversely in the water.

27. A method of constructing the system of claim **6**, comprising:

(a) providing a plurality of collapsed tube segments at a location above said oil well;

(b) expanding one of said collapsed tube segments and suspending it above the water;

(c) expanding another collapsed tube segment and attaching it to the top of said one of said tube segments; and

(d) repeating steps (b) and (c) until the resulting tube has the desired length.

28. The method of claim **27** including attaching buoyancy devices to said tube such that when submerged said tube is oriented substantially vertically with an upper end located proximate the surface of the water.

29. The method of claim **28** including attaching an anchoring system to said tube to anchor said tube to the floor below the water.

30. The method of claim **29** including providing an adjustment system which allows said tube to be moved transversely in the water.

* * * * *