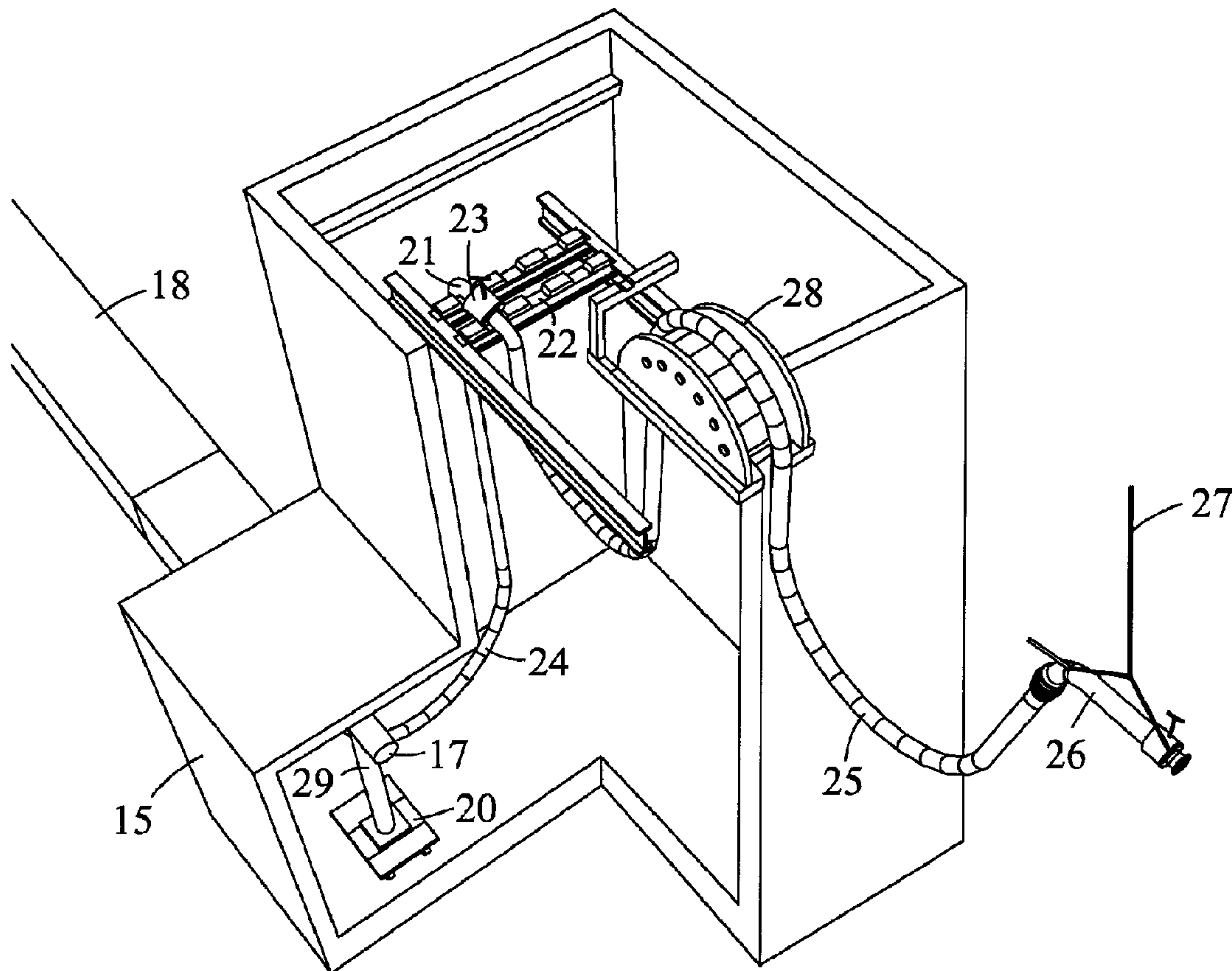




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(54) **Titre : SYSTEME ET PROCEDE POUR TRANSFERT DE FLUIDES ENTRE UN NAVIRE ET UN RESERVOIR DE STOCKAGE**
(54) **Title: A SYSTEM AND METHOD FOR FLUIDS TRANSFER BETWEEN SHIP AND STORAGE TANK**



(57) **Abrégé/Abstract:**

The present invention provides a system and a method for loading/unloading cryogenic fluids between a free end of a transfer pipeline (17) and a ship. The system comprises a shaft (15) extended upwards to above the sea level (36), at least one dolly (20) to



(57) Abrégé(suite)/Abstract(continued):

bear the weight of the transfer pipeline at the free end, an internal hose (39), and a loading arm (25) for connection with a ship manifold (32). The loading arm further comprises an external hose (40) as well as an elbow spool (45), a valve (46), an end flange (47) at its mobile end (26). A crane (19, 27) is used to lift the mobile end (26) of the loading arm between a loading position and storing position. Internal and external hoses are hung in a catenary for accommodating end displacements of a transfer pipeline and ship motions, respectively.

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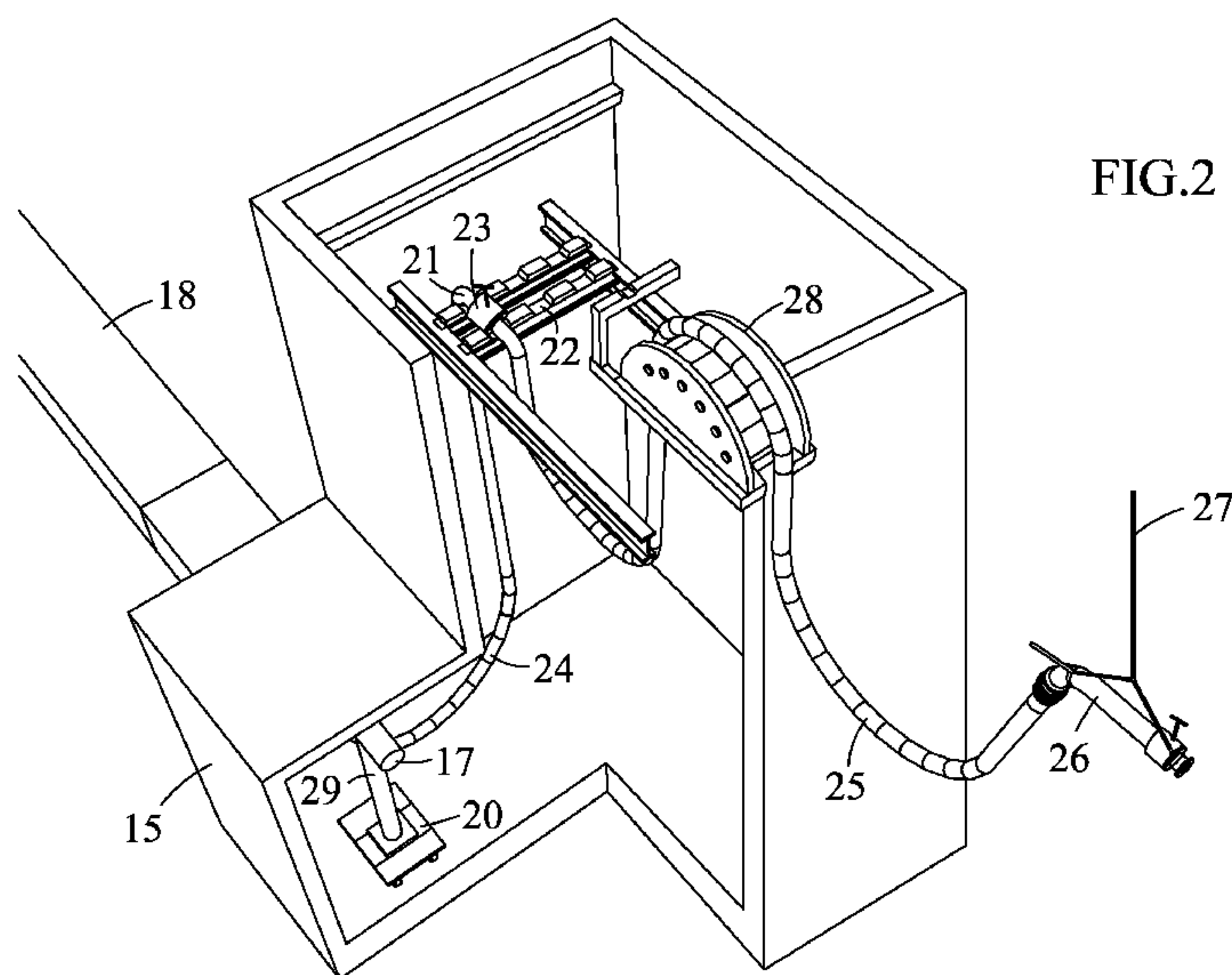
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(54) Title: A SYSTEM AND METHOD FOR FLUIDS TRANSFER BETWEEN SHIP AND SHORE



(57) Abstract: The present invention provides a system and a method for loading/unloading cryogenic fluids between a free end of a transfer pipeline (17) and a ship. The system comprises a shaft (15) extended upwards to above the sea level (36), at least one dolly (20) to bear the weight of the transfer pipeline at the free end, an internal hose (39), and a loading arm (25) for connection with a ship manifold (32). The loading arm further comprises an external hose (40) as well as an elbow spool (45), a valve (46), an end flange (47) at its mobile end (26). A crane (19, 27) is used to lift the mobile end (26) of the loading arm between a loading position and storing position. Internal and external hoses are hung in a catenary for accommodating end displacements of a transfer pipeline and ship motions, respectively.



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A SYSTEM AND METHOD FOR FLUIDS TRANSFER BETWEEN SHIP AND STORAGE TANK

Technical Field

The present invention relates generally to loading/unloading cryogenic fluids between a
5 ship and storage tanks. Specifically, the present invention provides a loading system that
extends from a free end of a transfer pipeline to a ship manifold.

Background Art

Typical LNG terminals have storage tanks onshore and a transfer system extending from
the storage tanks to a loading/unloading platform where a ship is docked. The loading
10 platform is located on a coast, a river bank, or offshore. At most terminals the transfer
pipelines are supported on trestles (i.e., above the sea level), and terminate at a loading
header on a loading platform. Articulated loading arms extend from the loading header to a
ship manifold for fluid transfer.

In these conventional systems, the transfer pipelines are fixed at the platform with
15 expansion loops or bellows to accommodate temperature changes, and articulated loading
arms accommodate ship motions. These conventional hard arms are made of rigid pipe and
swivel joints. They are mounted on a supporting structure/ frame with balancing weight to
extend arms toward a ship manifold as disclosed in US3434491 to Bily.

Some improvements have been developed for the hard arms. For example, US7857001
20 to Kristensen et al discloses a loading system with a spiral and rigid pipe attached to a boom
with trolleys to compensate longitudinal movements. US8176938 to Queau and Maurel
discloses a loading system with a movable supporting frame that allows end displacements
of a transfer pipeline. US8181662 to Pollack et al discloses a loading system with a
supporting metal shaft pivotable at its base. Regardless of these improvements, all the
25 systems above have the followings in common: rigid pipes and a number of swivel joints,

and a large supporting structure. These arms are not only costly, but also require maintenance with leakage potential from the swivel joints.

At a few terminals where LNG transfer pipelines are inside an underground tunnel, a vertical shaft is used at a loading station near the ship to host a rigid riser and support a loading header on the top. The rigid riser extends from the transfer line below to the loading header above. The same hard arms discussed above are then fluidly connected to the loading header. US2010/0287957 to Liu discloses a similar transfer system with a vertical shaft and a rigid riser inside. The difference is that the Liu's system allows end displacement of a transfer pipeline. However, stresses could develop at rigid riser ends under thermal expansion/contraction of the subsea transfer pipeline.

Flexible hoses for cryogenic fluids have been developed. These cryogenic hoses typically consist of multiple layers of polyester fabric and polymeric film as well as inner and outer spiral wound stainless steel wires as disclosed in US4417603 to Argy. Flexible hoses have been disclosed as loading arms for example in US8286678 to Adkins et al, and used for ship to ship transfer of cryogenic fluids by Excelerate Energy.

For ship-to-shore transfer, several systems have been proposed using flexible hoses. US6886611 to Dupont and Paquet discloses a loading system between a LNG ship and a termination point of a transfer pipeline that is fixed on a gantry above a main platform. The loading system comprises flexible loading arm(s) with one end permanently hung at the termination point and a free end hung under another gantry with a winch and cable near a LNG ship. During a loading operation, a connection module is lifted over with a crane and tied in with a ship manifold (first connection). The free end of the flexible arm is then pulled over with another winch and cable, and fluidly connected with the connection module (second connection). This system avoids swivel joints, and provides a mean to break a free fall of the flexible arm in case of emergency. However, the system cannot

accommodate end displacements of a transfer pipeline. Moreover, the system doubles the number of flange connection/disconnection for each loading arm that is time-consuming.

US 7,299,835 to Dupont et al discloses a flexible loading system comprising flexible hoses with one end hung at a reel attached to a station and another end extended to a ship manifold. The flexible hoses can be stored by rotating the reel after loading operations. Again, swivel joints are needed at the reel axis or at the rotatable connection.

A single point mooring system has also been proposed for subsea LNG transfer. The system comprises a cryogenic riser connecting subsea pipelines and a turret or the like, and loading arm(s) extended from the turret to a LNG ship. For example, US7438617 to Poldervaart et al discloses a system comprising a floating buoy, turntable reel as well as rotatable connection between flexible hoses and transfer risers. US7836840 to Ehrhardt et al discloses a system comprising a floating buoy, a flexible riser and a flexible arm with a submersible turret (i.e., rotatable) connection between the flexible arm end and socket at the ship bottom.

Other systems have a vertical post anchored at the seabed. US3379027 to Mowell discloses a fixed tower, a rigid riser, a rigid loading arm partially submerged in water. US7147021 to Dupont and Paquet discloses a system that has a riser attached to a vertical post with a rotatable connection, and piping along the boom that extends from the riser to a LNG ship. EP 1462358 to De Baan uses a vertical post as a riser, and flexible arms extend from the riser top to a ship for fluid transfer.

The drawback of these systems is the need for rotatable connection at an end of a loading arm as well as the difficulty to access underwater components.

In summary, there is a need to develop a loading system that not only allows end displacements of a transfer pipeline, but also overcomes the drawbacks discussed above.

Disclosure of Invention

The present invention provides a loading/unloading system for cryogenic fluids in which a transfer pipeline has a free end. The system comprises a shaft extended upwards to above the sea level, a transfer pipeline extended from storage tanks to the shaft, a header fluidly connected to the free end inside the shaft, at least one downward pipe branch extended from the header, one internal hose with one end hung under the downward pipe branch, and a loading arm that is fluidly connected to the internal hose and extended to a ship manifold for fluid transfer. In addition, at least one dolly supports the loading header in the vertical direction so that the header moves along with the free end inside the shaft as the transfer pipeline expand/contract axially. As such, the internal hose accommodates end displacements of the transfer pipeline while the loading arm accommodates ship motions.

Accordingly, it is a principal object of the invention to provide a flexible but robust loading/unloading system that can accommodate both the ship motions and thermal expansion/ contraction of a transfer pipeline.

It is another object of the invention to protect a loading system from environmental impacts (e.g., corrosive sea-water, ocean wave, wind, and sunlight).

It is another object of the invention to provide easy access for equipment that is below the sea level around a loading platform.

It is another object of the invention to provide a loading system applicable for a ship docked at a water front or offshore.

Thus, in an aspect, there is provided a loading system for transferring cryogenic fluids between storage tanks and a ship with at least one ship manifold on a manifold platform, said loading system comprising: a) a shaft extending upwards to above the sea level; b) at least one hose coupler with a first end and a second end, said first end is located inside said

shaft and facing downward; c) a transfer pipeline extended from said storage tanks to said shaft with a free end that is free to expand/contract axially; d) a header fluidly connected to said free end of said transfer pipeline; e) at least one downward pipe branch extended from said header; f) at least one internal hose freely hung inside said shaft between said downward pipe branch and said first end of said hose coupler; g) at least one loading arm with a connected end fluidly connected to said second end of said hose coupler and a mobile end that has an end flange for connection with said ship manifold and is movable to accommodate ship motions during fluid transfer; h) at least one vertical support to support said header in the vertical direction; wherein said internal hose accommodates end displacements of said free end of shaft as said transfer pipeline expands and contracts axially.

In another aspect, there is provided a loading system for transferring cryogenic fluids between a pipeline with a free end and a vessel with at least one ship manifold, said free end is supported in the vertical direction and free to expand/contract axially at a vertical shaft and said vessel is docked with said ship manifold near said vertical shaft, said loading system comprising: a) a downward pipe branch fluidly connected to said transfer pipeline around said free end; b) an internal hose with a first end and a second end, said first end freely hung under said downward pipe branch; and c) an external hose with a connected end fluidly connected to said second end of said internal hose and a mobile end that has an end flange for connection with said ship manifold; wherein said internal hose is freely suspended inside said shaft and said first end of said internal hose is free to move along with said free end of said transfer pipeline.

In another aspect, there is provided a method for transferring a cryogenic fluid between a transfer pipeline with a free end and a vessel floating in water through a loading system, said loading system comprising a shaft extending upwards to above the sea level, a convex

saddle sitting on said shaft, a downward pipe branch fluidly connected to said pipeline, an internal hose with a first end hung below said downward pipe branch, an external hose having one end coupled with a second end of said internal hose and one mobile end, said method comprising the steps of: relocating said mobile end of said external hose from a storing position resting at a convex saddle to a ship manifold on said vessel; securing a fluid tight connection between an end flange at said mobile end and a presentation flange of said ship manifold; wherein said vessel is docked with said manifold near said shaft, said pipeline is supported in the vertical direction at said free end, and said internal hose is freely suspended inside said shaft, and said first end of said internal hose is free to move along with said free end as said pipeline expands/contracts axially.

Brief Descriptions of Drawings

The loading system, method and advantages of the present invention will be better understood by referring to the drawings, in which:

FIG.1 is a perspective view of a first embodiment of the system along with other components at a loading /unloading terminal;

FIG. 2 is a perspective view of the first embodiment;

FIG.3 is an elevation view of a second embodiment of the system in a loading position;

FIG.4 is an enlarged view taken along 4-4 line in FIG.3;

FIG.5 is a sectional view taken along 5-5 line in FIG.4;

FIG.6 is a sectional view taken along 6-6 line in FIG.4;

FIG.7 is an elevation view of a third embodiment of the system in a stored position;

FIG.8 is an enlarged view taken along 8-8 line in FIG.7;

FIG.9 is an enlarged view taken along 9-9 line in FIG.7;

FIG.10 is an elevation view of a convex saddle and motor;

FIG.11 is an elevation view of a fourth embodiment of present invention;

FIG.12 is a perspective view of a surge drum and flexible connection with a transfer pipeline and a vapor return line;

FIG.13 is an elevation view of flexible connection between two transfer pipelines;

5 FIGS.14A to 14C are simplified configurations at the free end of a transfer pipeline;

FIG.15 is a variation of the mobile end of the loading arms according to the invention.

Best Mode for Carrying out the Invention

FIG.1 is an overview of a first embodiment of the present invention at a loading or
10 unloading (i.e., receiving) terminal. A ship 12 is docked at a dolphin 13 with a ship manifold near a shaft 15 that is located around a coast line 16. A transfer pipeline 10 extends from onshore storage tanks 14 to the shaft 15 with an anchor at a vault 11, and is encased with an underground reinforced concrete conduit 18. A crane 19 is located at the top of the shaft 15.

15 FIG.2 shows a perspective view of this embodiment. A transfer pipeline 10 enters the shaft 15 and ended with a header 17. A dolly 20 and a vertical bar 29 support the header 17. A rigid n-shaped coupler 21 is supported on a beam 22 inside shaft 15 with two openings facing down and a valve 23 in the middle. An internal hose 24 is fluidly connected with the header 17 and is freely hung between the header and the n-shaped coupler 21. A
20 flexible arm 25 is fluidly connected with the n-shaped coupler 21 at one end, and lifted at a mobile end 26 with a rope 27 of a crane (refer to 19 in FIG.1). A convex saddle 28 is anchored to a wall of the shaft 15 providing a convex surface for the flexible arm 25. In this embodiment, the internal hose 24 and flexible arm 25 are freely hung in two planes perpendicular to each other. As the mobile end of the flexible arm is dragged from the
25 convex saddle to a ship manifold with the rope, the flexible arm is pulled out of the shaft

FIG.3 shows a second embodiment while the internal hose 24 and flexible arm 25 are freely hung in two planes parallel to each other. The transfer pipeline enters the shaft 15 at an entrance 31. The internal hose 24 is fluidly connected with the transfer pipeline at the header 17 and freely hung from the n-shaped coupler 21 at the other end. The flexible arm 5 25 comprises an internal hose 39 and external hose 40 extending from the n-shaped coupler 21 to a ship manifold 32 on a ship platform 33. Both a dolphin 34 and shaft 15 are anchored to a seabed 35, and extends upwards to above the sea level 36. Between the internal hose 39 and external hose 40, there is a stop flange 37 that is not allowed to pass through a restraint 38 so that the internal hose 39 is not bent excessively. In addition, the internal hose 24 and 10 flexible arm 25 can be freely hung in two planes with an intersectional angle varying from 0 to 90 degree to fit a site condition.

FIG.4 shows details for connection at a ship manifold during loading operations. The ship manifold 32 is supported on the manifold platform 33 with a stand 41. The mobile end 26 of the flexible arm 25 sits on the manifold platform 33 with a main leg 42 and an 15 assistant leg 43. The mobile end 26 comprises a powered emergency release coupler (PERC) 44, an elbow spool 45 (i.e., a bend in this case), a valve 46, and an end flange 47. The mobile end 26 is fluidly connected with the ship manifold 32 and an external hose 40 is hung below the PERC 44. . At the elbow spool 45, there is a handle 48. Alternatively, a two-way splitter can be fluidly connected with the elbow spool 45 and a smaller-size hose 20 can be fluidly connected with each way of the two-way splitter (e.g., two 10-inch size hoses can replace a 16-in hose for a 16-in size manifold flange). Using a smaller size of hoses can reduce the size of the convex saddle 28 and shaft 15.

FIG.5 shows a cross-section view from line 5-5 in FIG.4. The assistant leg 43 has a bottom plate 51, a column 52, and a top plate 53. A roller 54 is supported with springs 55 at 25 both ends. A pipe 56 sits on the roller 54 and two alignment guides 57 extend upward with

a widen opening. At the bottom, a male bar 58 is inserted into a hole 59 in the manifold platform 33.

FIG.6 shows a cross-section view of the main leg 42 along line 6-6 in FIG.4. A pipe 56 sits on a concave saddle 61. Alternatively, the main leg 42 has a combination of a roller (54 in FIG.5) and concave saddle (61 in FIG.6) sharing weight of the pipe 56 above. The height of both legs can be made adjustable with means such as leveling pins, rotating a threaded column, hydraulic jacking, etc. Those means are not shown for simplicity.

FIG.7 shows an elevation view of a third embodiment with the flexible arm 25 in a stored position. A transfer pipeline enters a shaft 72 near the top and ended with a header 71. The flexible arm 25 comprises an internal hose 73 and external hose 74 freely hung from the header 71 at one end and from a convex saddle 75 at the mobile end. Both internal and external hoses are stored inside the shaft 72, and protected from sea-water, wind and sunlight.

FIG.8 shows details around hanging off point inside the shaft along line 8-8 in FIG. 7. The header 71 is hung below a dolly 89 with a pipe hanger comprising a clamp 81, vertical bar 82 and a nut 85. The dolly 89 has at least two wheels 83 rolling along a metal track 84 (for example a box beam). Below the header 71, there are a branch 86, a valve 87, a flange connection 88 and an internal hose 73.

FIG.9 shows details taken along line 9-9 in FIG.7. The mobile end 26 sits on a storing seat that comprises a side bar 91 and a top roller bar 92 of the convex saddle 75. The convex saddle 75 is anchored to a shaft wall 93 at a bottom plate 97 along with a bracing strut 94. An external hose 95 goes through a hole on a roof 96 of the shaft. The mobile end 26 has an end flange 98 and a quick connecting/disconnecting (QC/DC) device 99.

FIG.10 shows details of a convex saddle 101 which comprises two semicircle guides 103, and seven roller bars 104 in-between. These rollers are arranged along a smooth convex

curve, supporting external hose on top. (refer also to 28 in FIG.2). In this variation, a round belt 105 is wrapped around the roller bars 104, and driven by a motor 106 that is attached to a bottom roller bar and anchored to a base plate 102. . This motor controls the movement of the external hose that travels on the convex saddle.

5 FIG.11 shows a fourth embodiment of this invention intended for docking and loading two ships simultaneously. For simplicity, FIG.11 shows both loading arms at a stored position on a storing seat 117. In this case, a shaft 113 is located offshore and a header 111 is located inside the shaft 113 around the seabed 35. A n-shaped coupler 112 is hung on a wall of the shaft 113. An internal hose 114 extends from the header 111 to the n-shaped
10 coupler 112. Outside the shaft 113, an external hose 115 is freely hung from the n-shaped coupler 112 at one end with a mobile end 116 on the storing seat 117. The storing seat 117 has two concave saddles at a distance 1.5 to 3m apart on the top, and is mounted on piers of a dolphin 118. A strap can be used to secure the mobile end in the seat (not shown). Alternatively, the storing seat 117 can be attached to a structure such as a passageway, or be
15 anchored directly into the seabed. Crane 119 is located at the top of the shaft 113.

FIG.12 shows a surge drum 121 anchored to a wall 122 of a shaft 123. A gooseneck spool 124 is fluidly connected to the top of the drum 121. A vapor hose 125 extends from the gooseneck spool 124 to a vapor return line 127. A fluid hose 126 extends from the bottom of drum 121 to a transfer line 128. The drum 121 regulates any pressure surge.

20 FIG.13 shows flexible connection between two transfer pipelines. Inside a shaft 131, a first transfer pipeline 132 and second transfer pipeline 133 are fluidly connected with two flexible hoses 134 and a u-shaped coupler 135 at the bottom. Both the flexible hoses 134 and u-shaped coupler 135 are in a freely hanging position.

FIGS.14A to 14C show variations at the free end of a transfer pipeline 141. There are a
25 header 145, branches 143 and at least one valve 144. Dolly 142 supports the header 145 in

the vertical direction, allowing the transfer pipeline to expand/contract axially at the free end.

FIG.15 shows a variation on the mobile end 26 of the loading arms. A presentation flange of a ship manifold 151 is facing up near the edge of a manifold platform 152. With
5 an elbow spool 153 (i.e., gooseneck spool in this case), an end flange 154 is facing down.

One embodiment of the invention includes a method of transporting a cryogenic fluid between a transfer pipeline and a vessel floating in water using the systems described above. The method includes: a) relocating the mobile end of the external hose from a storing position resting at a convex saddle to a manifold on the vessel and pulling the
10 external hose out of the shaft through the convex saddle as shown in Fig.2; b) securing a fluid tight connection between an end flange at said mobile end and a presentation flange of said ship manifold as shown in Figs. 3, 4 and 15. During fluid transfer, the external hose is adapted to accommodate vessel motions. After fluid transfer, the method further includes retrieving the mobile end back to the storing position at the convex saddle. Both the
15 internal hose and external hose are freely suspended inside the shaft during non-transfer periods as shown in Fig.7.

Industry Applicability

Cryogenic fluids such as liquefied natural gas (LNG), liquefied petroleum gas (LPG) and
20 ethylene have been carried and transported for over four decades with sea-going vessels. Loading systems are needed at loading terminals near a gas resource to loading a vessel or at receiving terminals near markets to unload a vessel. Cryogenic flexible hoses have been developed and used for fluid transfer between two ships. A reinforced concrete shaft is easy to build in shallow water and can provide strong protection. To reduce thermal stress and
25 avoid expansion loops or bellows in a transfer pipeline, it is feasible to allow the offshore

end to expand/contract freely inside a shaft. Taking advantage of the cryogenic hoses and shaft, the system provides a flexible and robust solution, and is needed especially for terminals located at sites prone to natural disaster (e.g., ice gouging, storm surges, seawater level rising, earthquake/ tsunami) and man-made disaster (e.g., ship collision, attack).

Claims

1. A loading system for transferring cryogenic fluids between storage tanks and a ship with at least one ship manifold on a manifold platform, said loading system comprising:
 - a) a shaft extending upwards to above the sea level;
 - b) at least one hose coupler with a first end and a second end, said first end is located inside said shaft and facing downward;
 - c) a transfer pipeline extended from said storage tanks to said shaft with a free end that is free to expand/contract axially;
 - d) a header fluidly connected to said free end of said transfer pipeline;
 - e) at least one downward pipe branch extended from said header;
 - f) at least one internal hose freely hung inside said shaft between said downward pipe branch and said first end of said hose coupler;
 - g) at least one loading arm with a connected end fluidly connected to said second end of said hose coupler and a mobile end that has an end flange for connection with said ship manifold and is movable to accommodate ship motions during fluid transfer;
 - h) at least one vertical support to support said header in the vertical direction;wherein said internal hose accommodates end displacements of said free end of shaft as said transfer pipeline expands and contracts axially.
2. The loading system of claim 1, wherein said vertical support is a pipe hanger.
3. The loading system of claim 1, wherein said loading arm is a flexible hose.
4. The loading system of claim 3 further comprising a convex saddle to support said flexible hose with a first portion inside said shaft and a second portion extended to said ship manifold for fluid transfer, wherein said second end of said hose coupler is located inside said shaft.

5. The loading system of claim 4, wherein said convex saddle comprising a group of roller bars.
6. The loading system of claim 5, wherein said convex saddle further comprises a belt that is wrapped around said roller bars and driven by a motor.
7. The loading system of claim 2, wherein said vertical support further comprising a metal track and a dolly, and said dolly ties said pipe hanger to said metal track.
8. The loading system of claim 1, wherein said loading arm further comprises an emergency release coupler (ERC).
9. The loading system of claim 1, wherein said loading arm further comprising a quick connecting and disconnecting device that can hold said end flange onto said ship manifold.
10. The loading system of claim 1, wherein said mobile end is supported by a main leg on said loading platform during transfer operations.
11. The loading system of claim 10, wherein said main leg comprises a plate at the bottom, a column in the middle, a concave top, and two alignment guides.
12. The loading system of claim 11, wherein said concave top is formed with at least one roller.
13. The loading system of claim 11, wherein said concave top is a concave saddle.
14. The loading system of claim 1, wherein said second end of said hose coupler is located outside of said shaft.
15. The loading system of claim 1 further comprises a storing seat above the sea level and away from said ship to store said mobile end.
16. The loading system of claim 1 further comprises a surge drum inside said shaft with a hose freely hung between said surge drum and said transfer pipeline.
17. The loading system of claim 1 further comprises a second transfer pipeline and a hose freely hung between said two transfer pipelines.

18. The loading system of claim 1, wherein said loading arm further comprising an elbow spool.
19. The loading system of claim 18, wherein said end flange has an opening facing downward.
20. The loading system of claim 1, wherein said mobile end further comprising an end valve near said end flange.
21. The loading system of claim 15 further comprising a crane for relocating said mobile end of said loading arm between a transfer position connected to said ship manifold and a storage position on said storing seat.
22. The loading system of claim 1, wherein said header is in alignment with said transfer pipeline.
23. A loading system for transferring cryogenic fluids between a pipeline with a free end and a vessel with at least one ship manifold, said free end is supported in the vertical direction and free to expand/contract axially at a vertical shaft and said vessel is docked with said ship manifold near said vertical shaft, said loading system comprising:
 - a) a downward pipe branch fluidly connected to said transfer pipeline around said free end;
 - b) an internal hose with a first end and a second end, said first end freely hung under said downward pipe branch; and
 - c) an external hose with a connected end fluidly connected to said second end of said internal hose and a mobile end that has an end flange for connection with said ship manifold;wherein said internal hose is freely suspended inside said shaft and said first end of said internal hose is free to move along with said free end of said transfer pipeline.
24. The loading system of claim 23, wherein said transfer pipeline is fluidly connected to a storage tank..

25. The loading system of claim 23 further comprises a convex saddle atop said shaft for supporting said external hose.

26. The loading system of claim 25 further comprising a restraining device attached to said shaft and located below said convex saddle, wherein said restraining device restrains said external hose from excessive movement.

27. A method for transferring a cryogenic fluid between a transfer pipeline with a free end and a vessel floating in water through a loading system, said loading system comprising a shaft extending upwards to above the sea level, a convex saddle sitting on said shaft, a downward pipe branch fluidly connected to said pipeline, an internal hose with a first end hung below said downward pipe branch, an external hose having one end coupled with a second end of said internal hose and one mobile end, said method comprising the steps of:

- a) relocating said mobile end of said external hose from a storing position resting at a convex saddle to a ship manifold on said vessel;
- b) securing a fluid tight connection between an end flange at said mobile end and a presentation flange of said ship manifold;

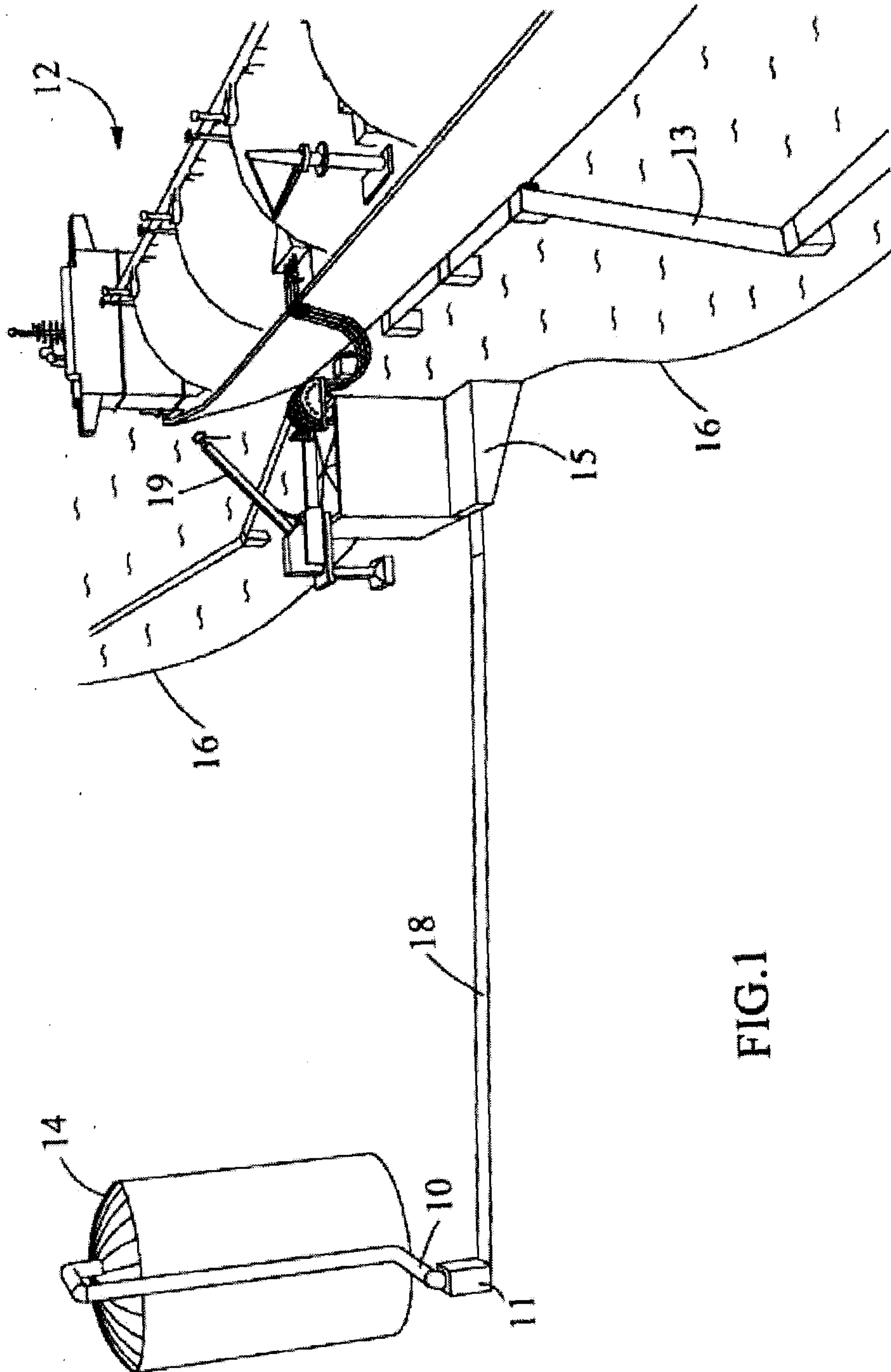
wherein said vessel is docked with said manifold near said shaft, said pipeline is supported in the vertical direction at said free end, and said internal hose is freely suspended inside said shaft, and said first end of said internal hose is free to move along with said free end as said pipeline expands/contracts axially.

28. The method in claim 27 further comprising retrieving said mobile end of said external hose back to said shaft after fluid transfer, wherein both said internal hose and external hose are freely suspended inside said shaft.

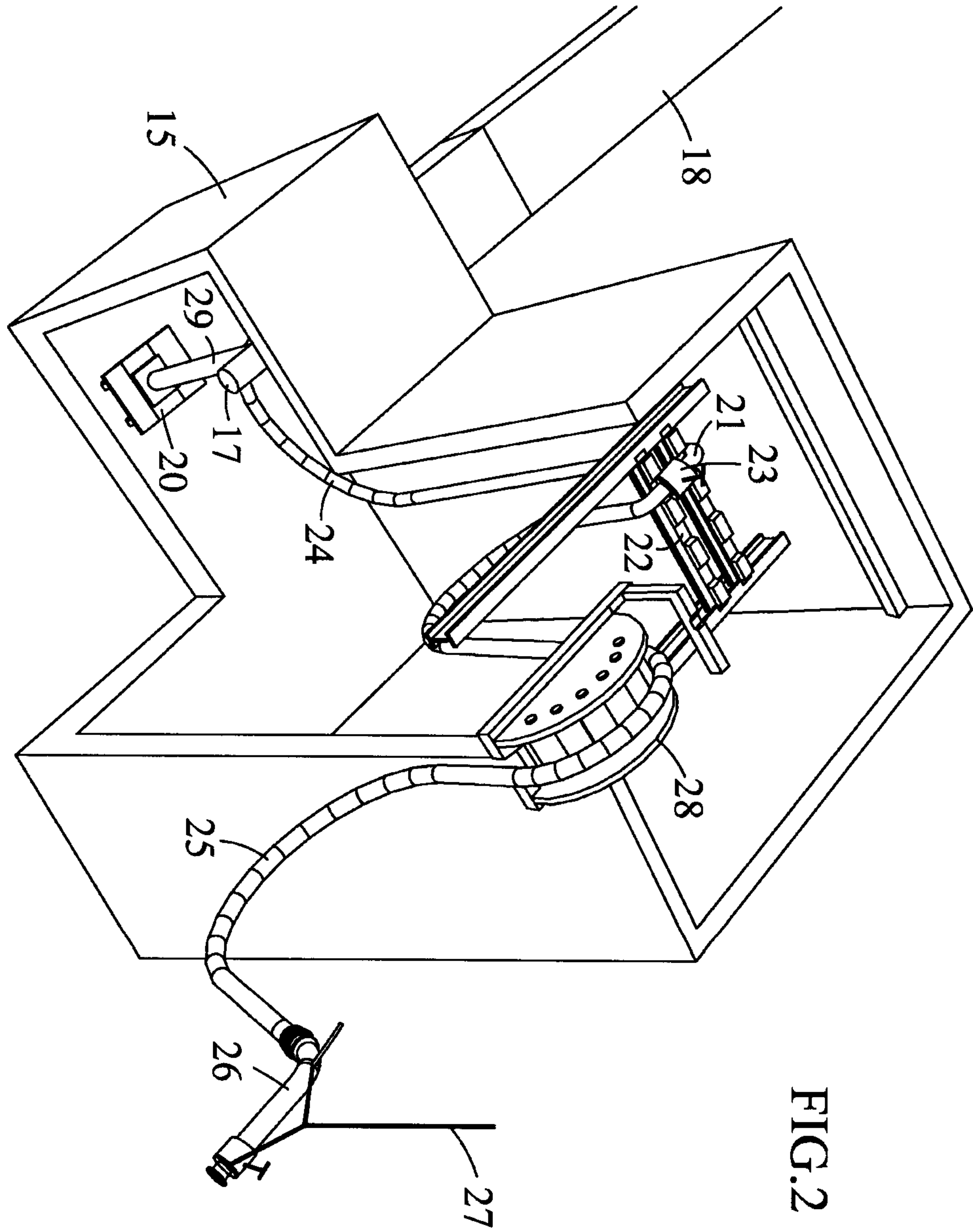
29. The method in claim 27, wherein said transfer pipeline is fluidly connected to a storage tank.

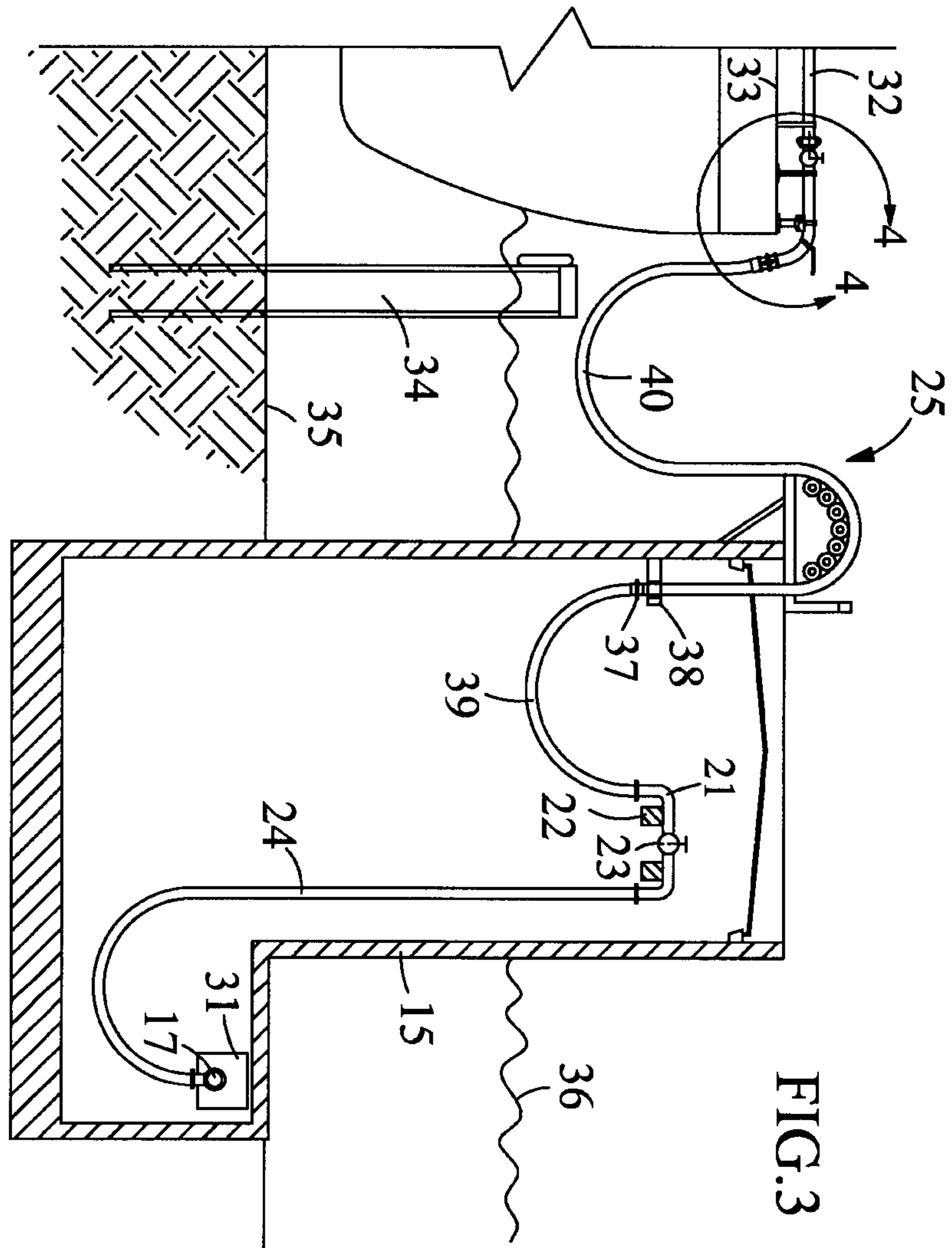
- 30. The method in claim 27, wherein said vessel is a sea-going tanker.
- 31. The method in claim 27, wherein said presentation flange onboard said vessel is facing up.
- 32. The method in claim 27, wherein said convex saddle comprising a plurality of rollers arranged along a smooth convex curve.
- 33. The method in claim 27, wherein said system further comprising a motor at said convex saddle for controlling the movement of said external hose.
- 34. The method in claim 27, where said system further comprising a hose coupler and another internal hose fluidly connected to said transfer pipeline located at a distance below, said hose coupler is attached to said shaft.
- 35. The method in claim 27, wherein said mobile end further comprises an emergency release coupler (ERC).
- 36. The method in claim 27, wherein said mobile end is supported on a manifold platform onboard said vessel.

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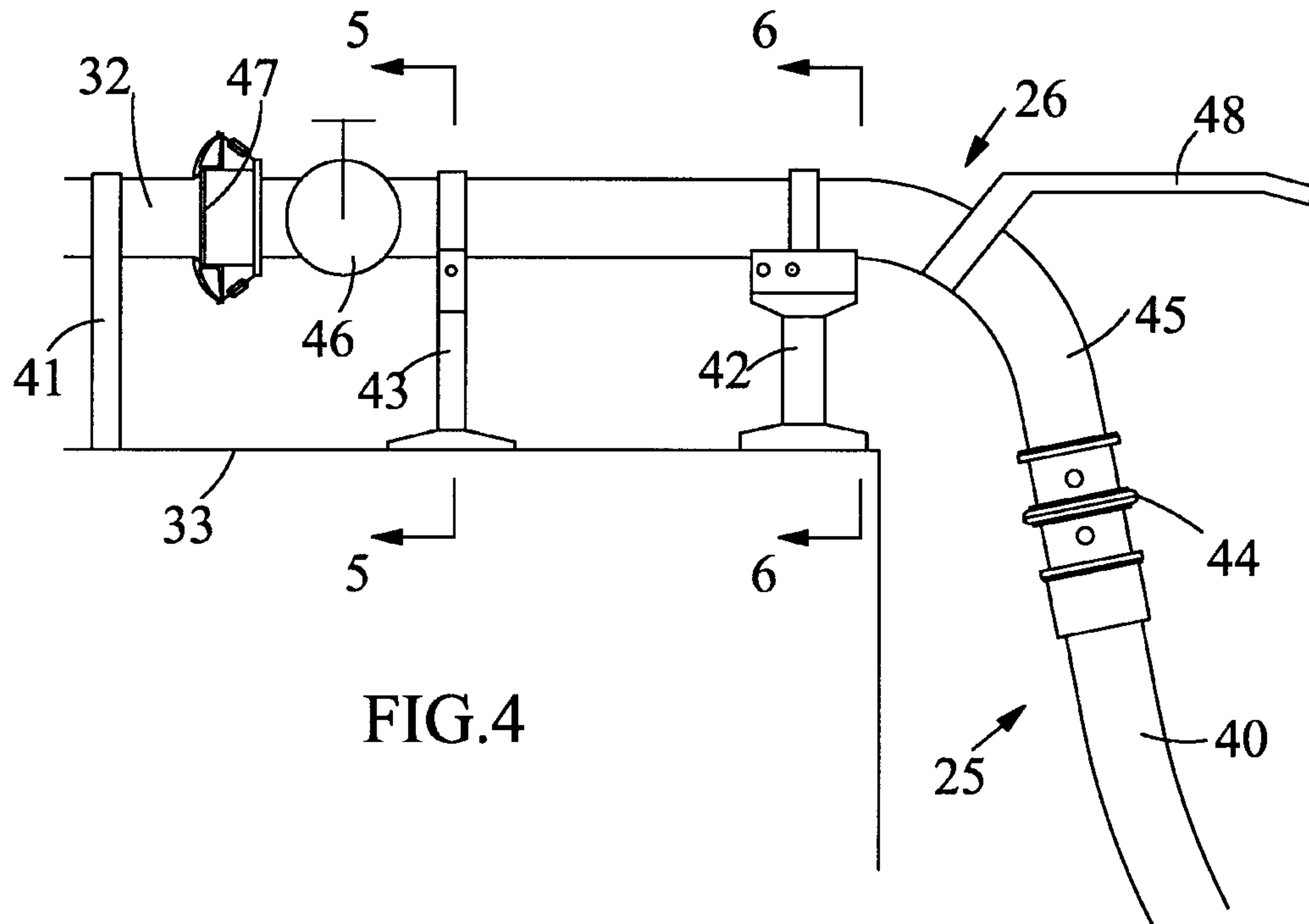


FIG. 4

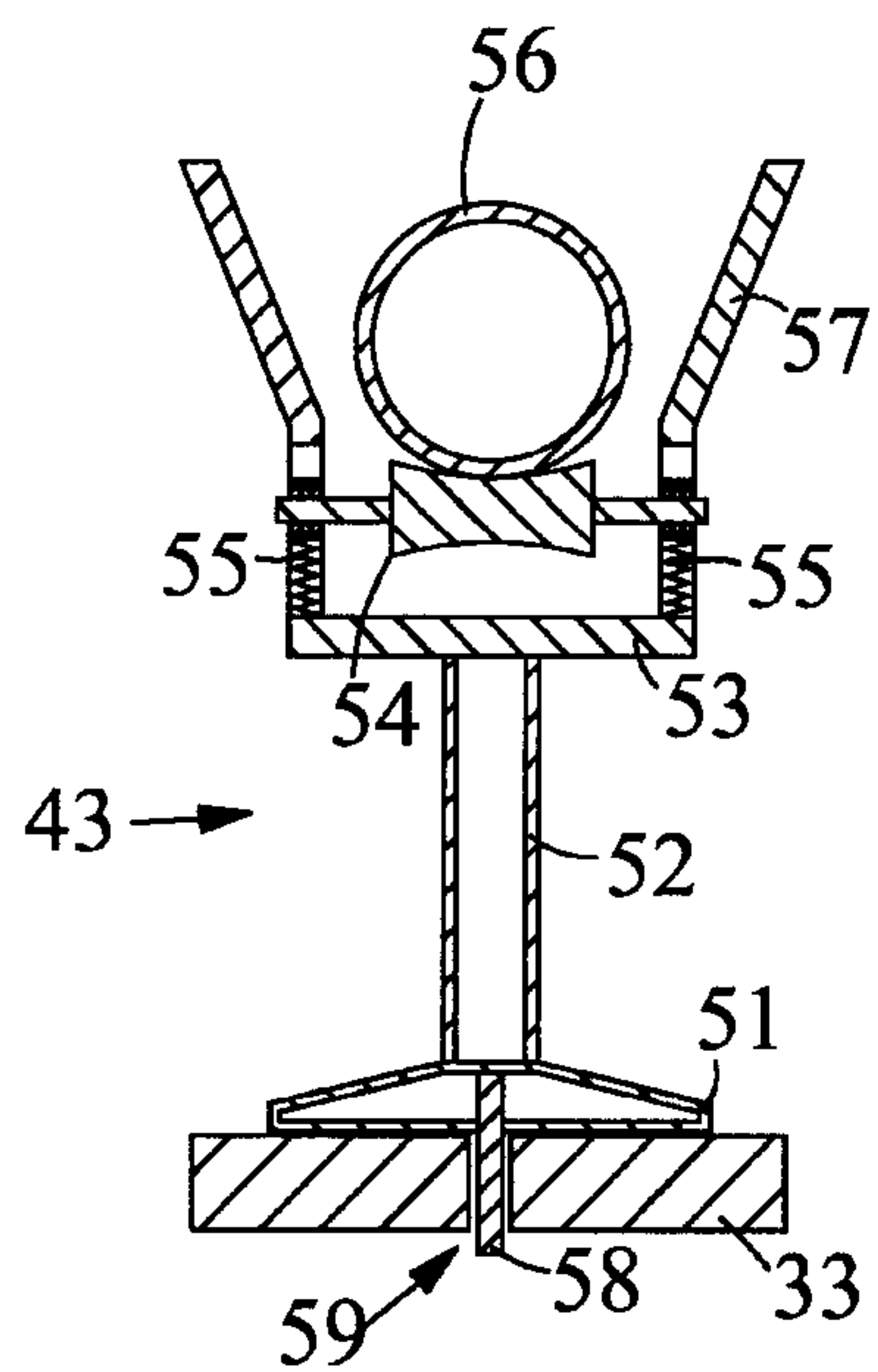


FIG. 5

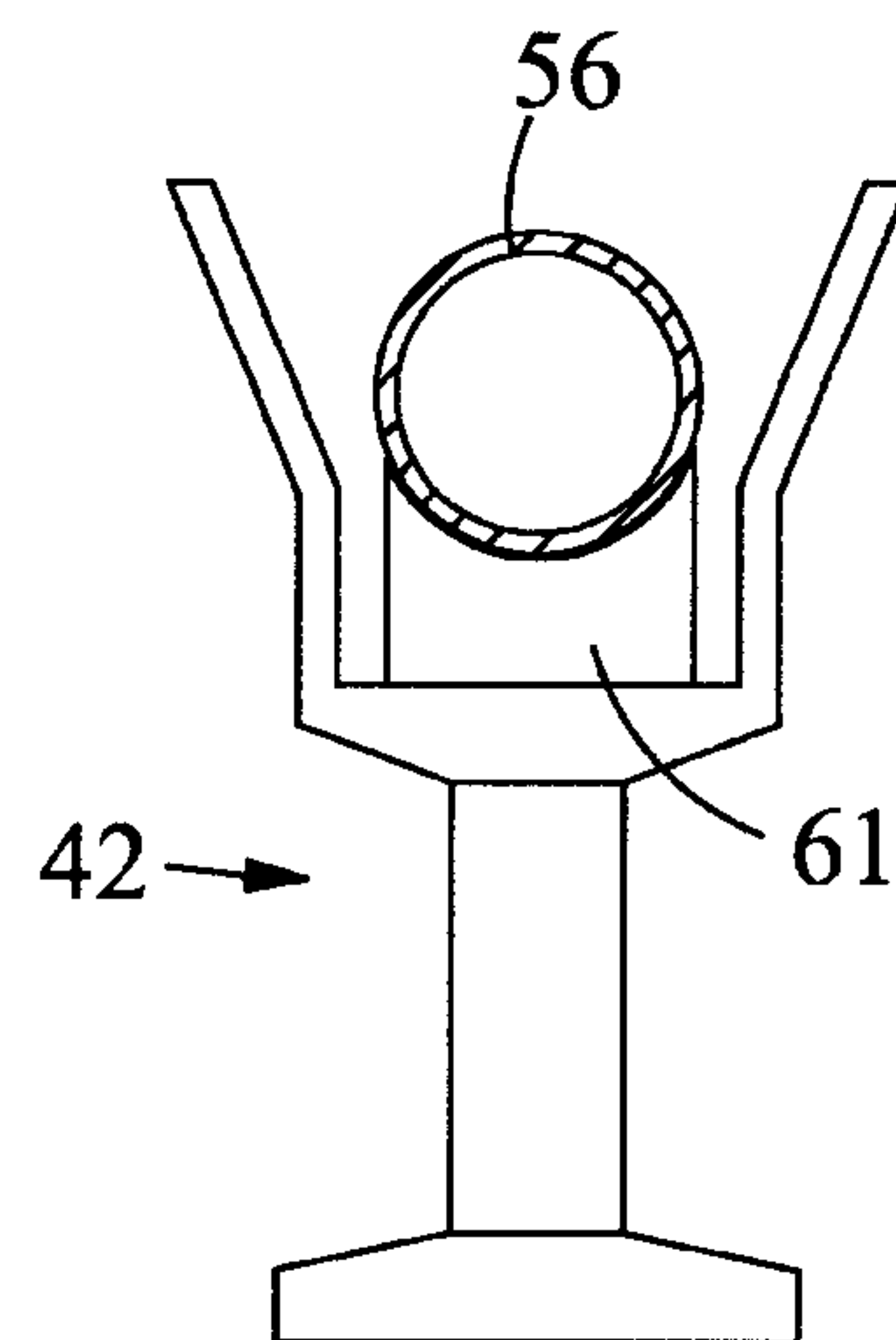


FIG. 6

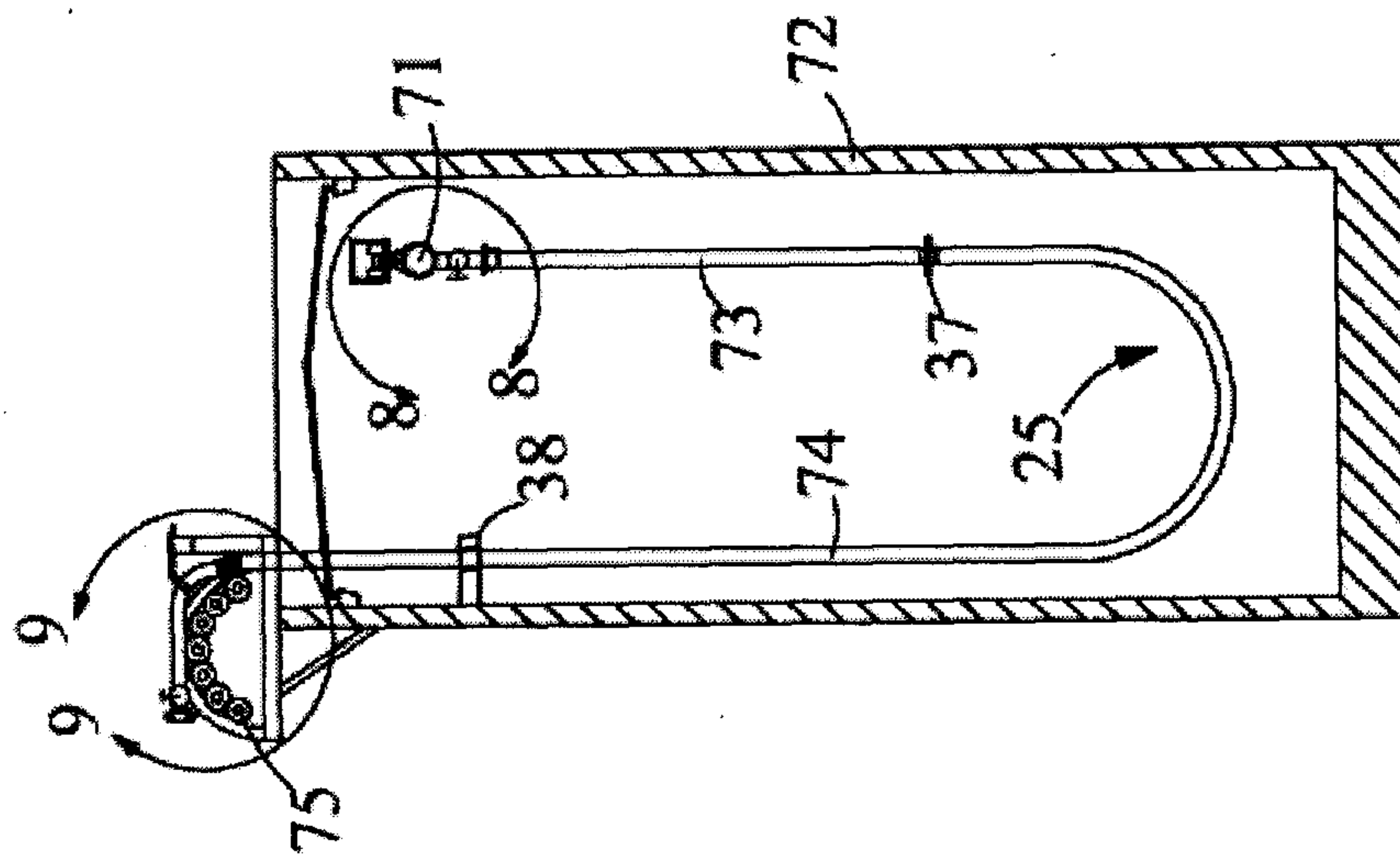


FIG. 7

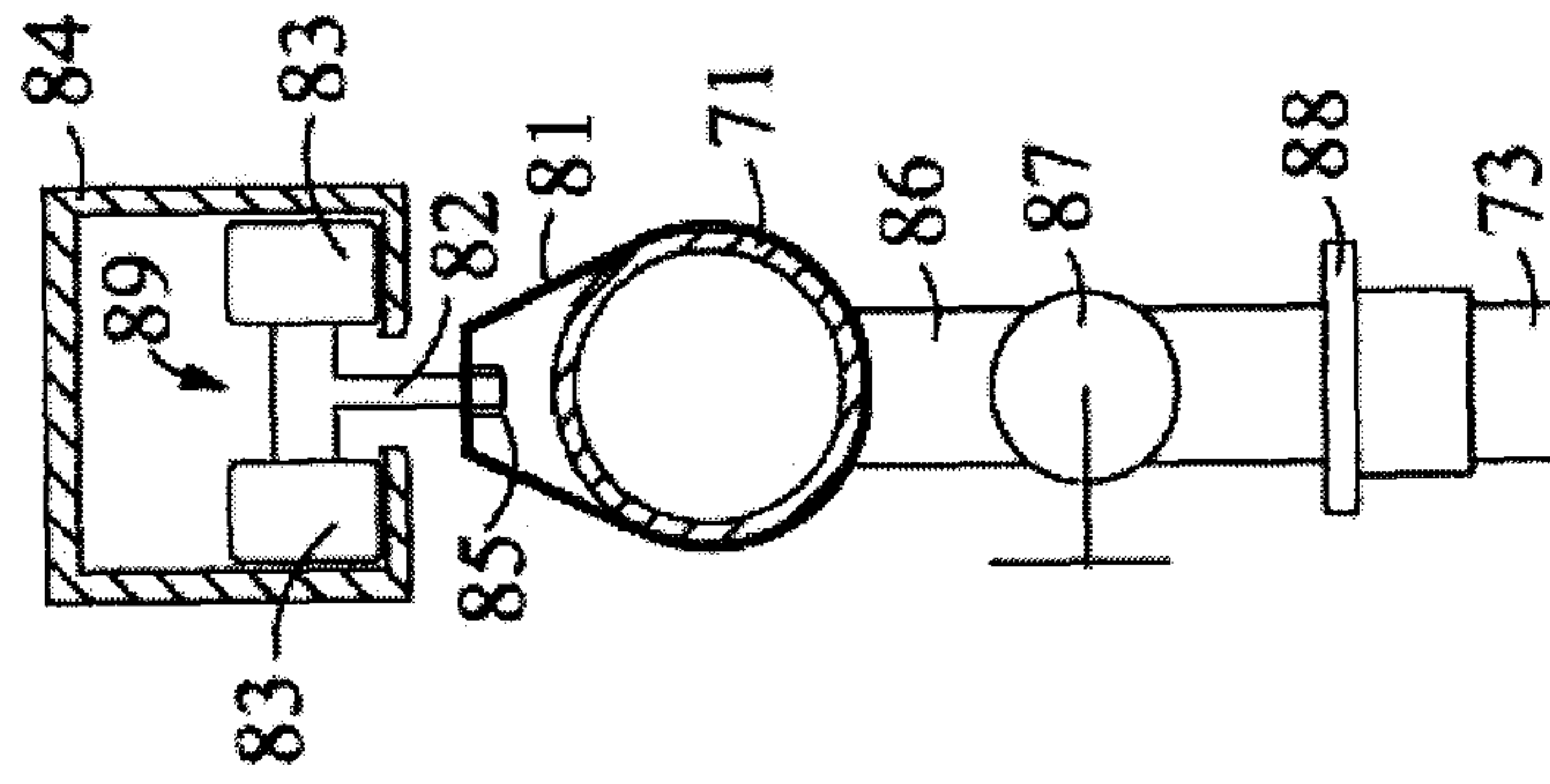


FIG. 8

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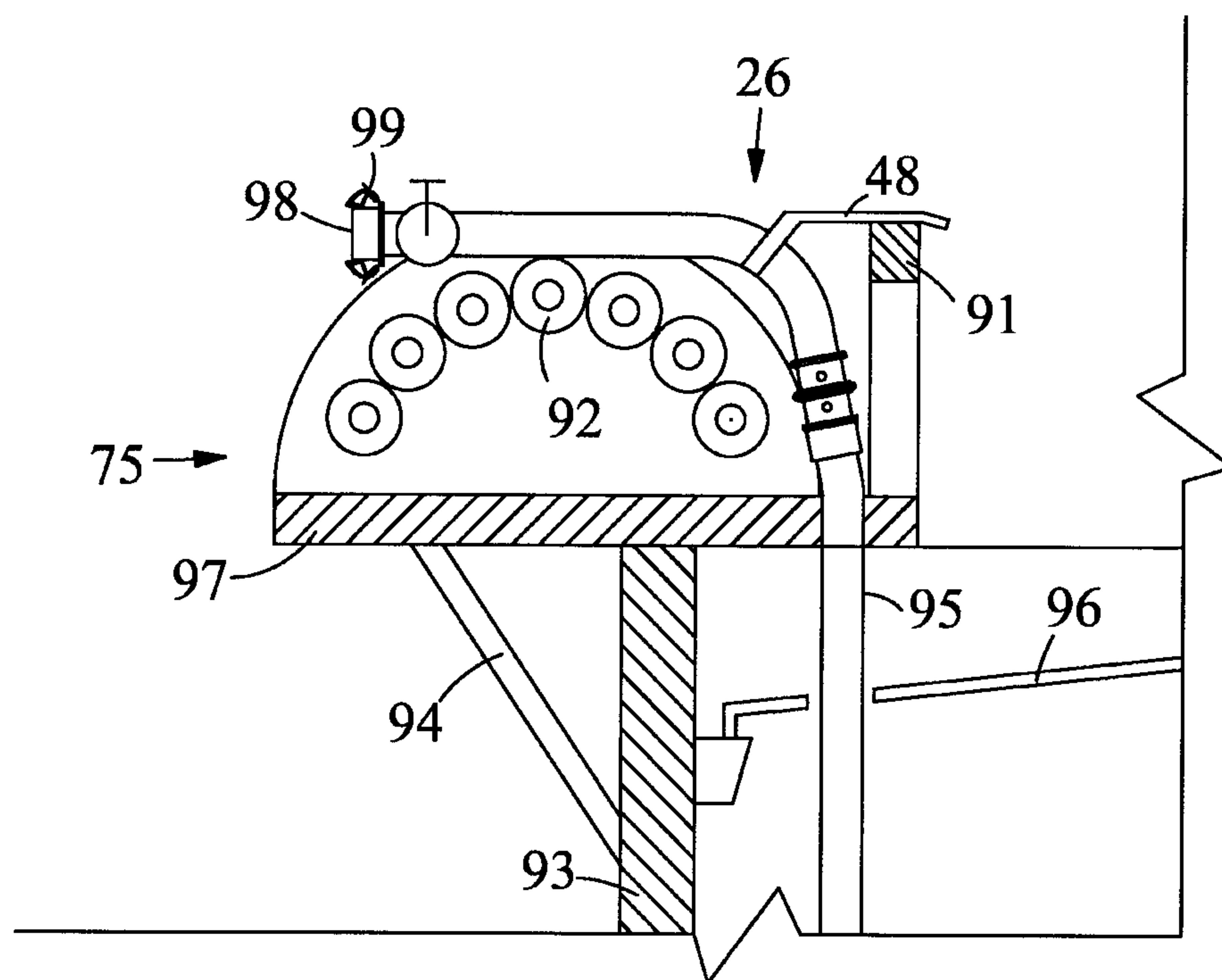


FIG.9

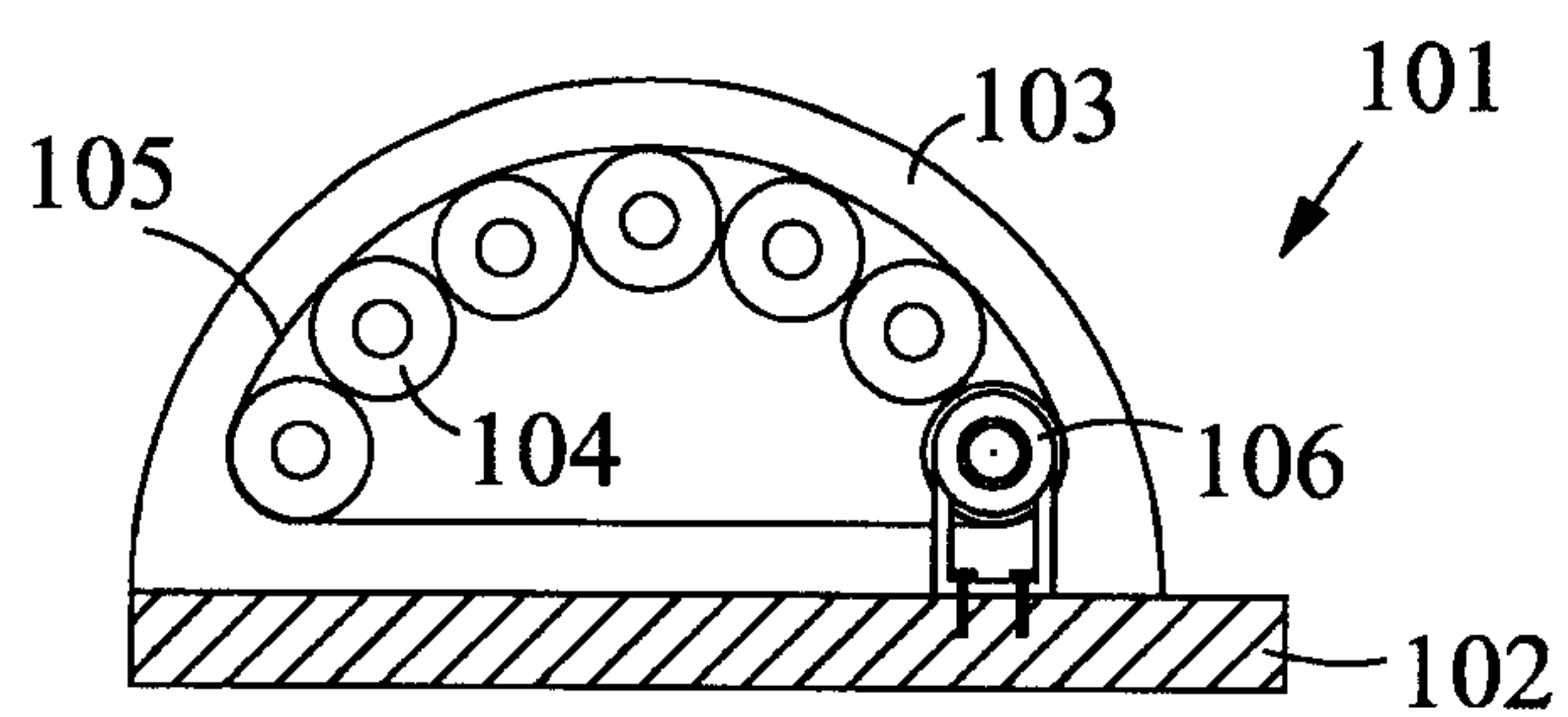


FIG.10

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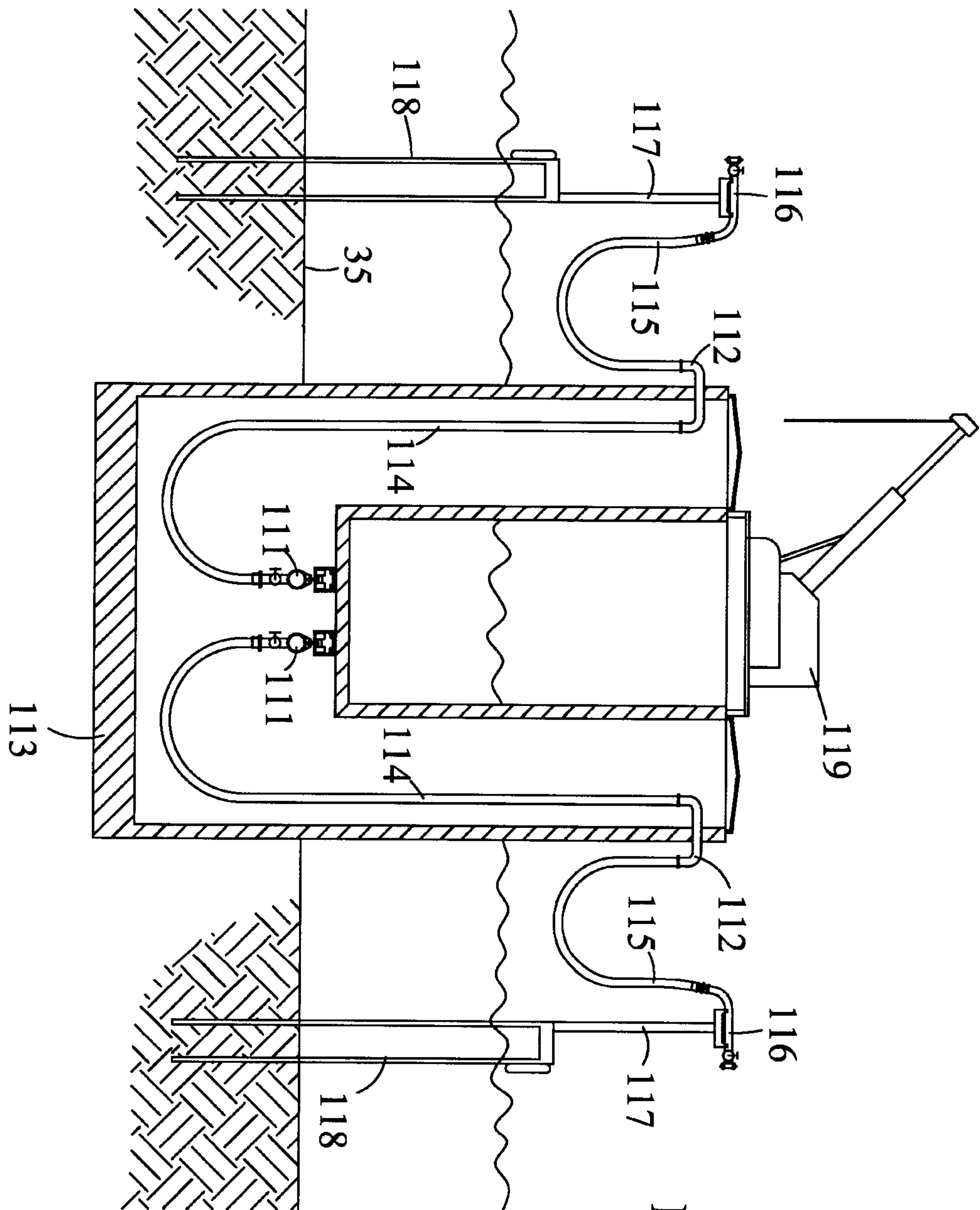


FIG. 11

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FIG.12

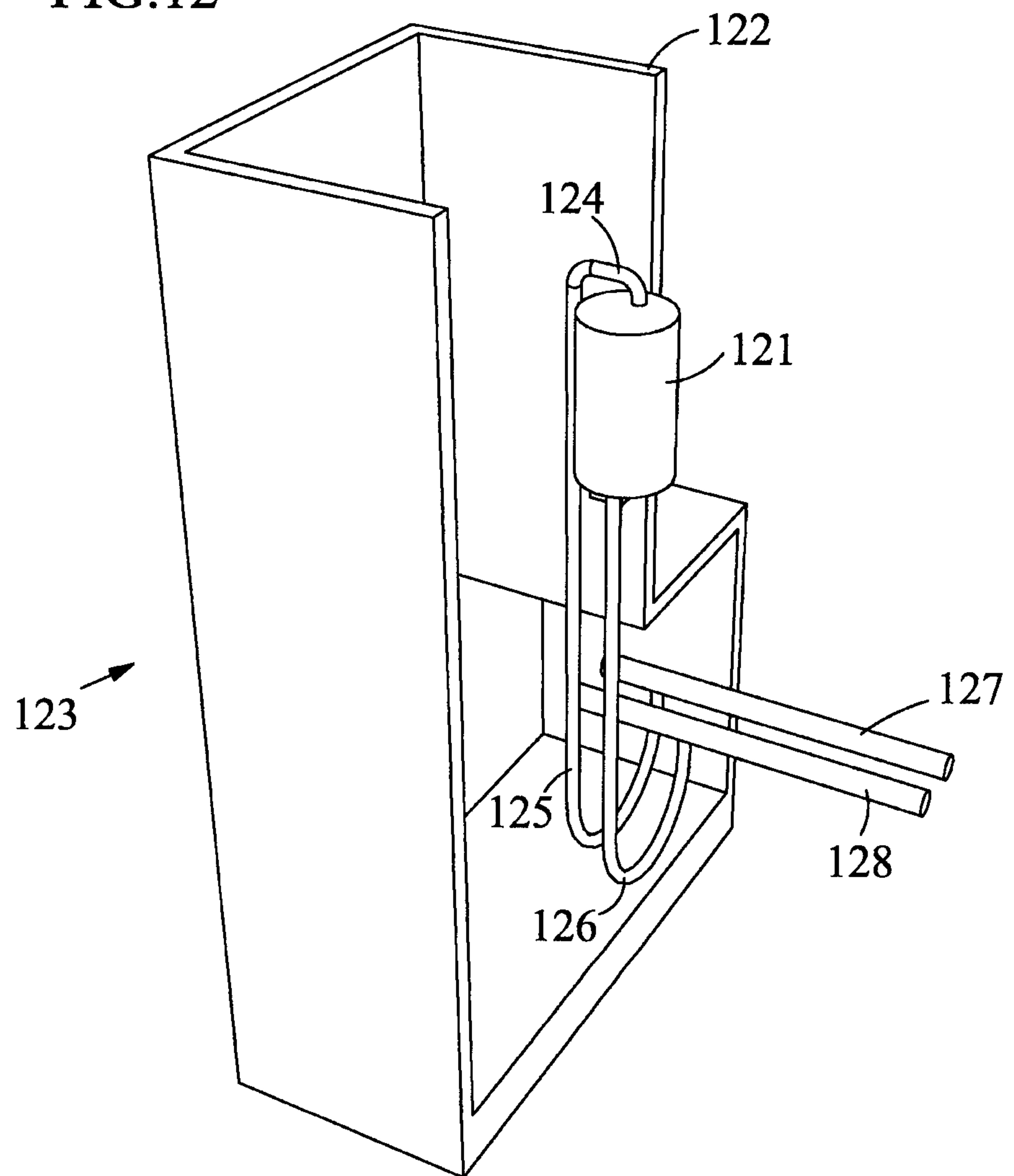


FIG.13

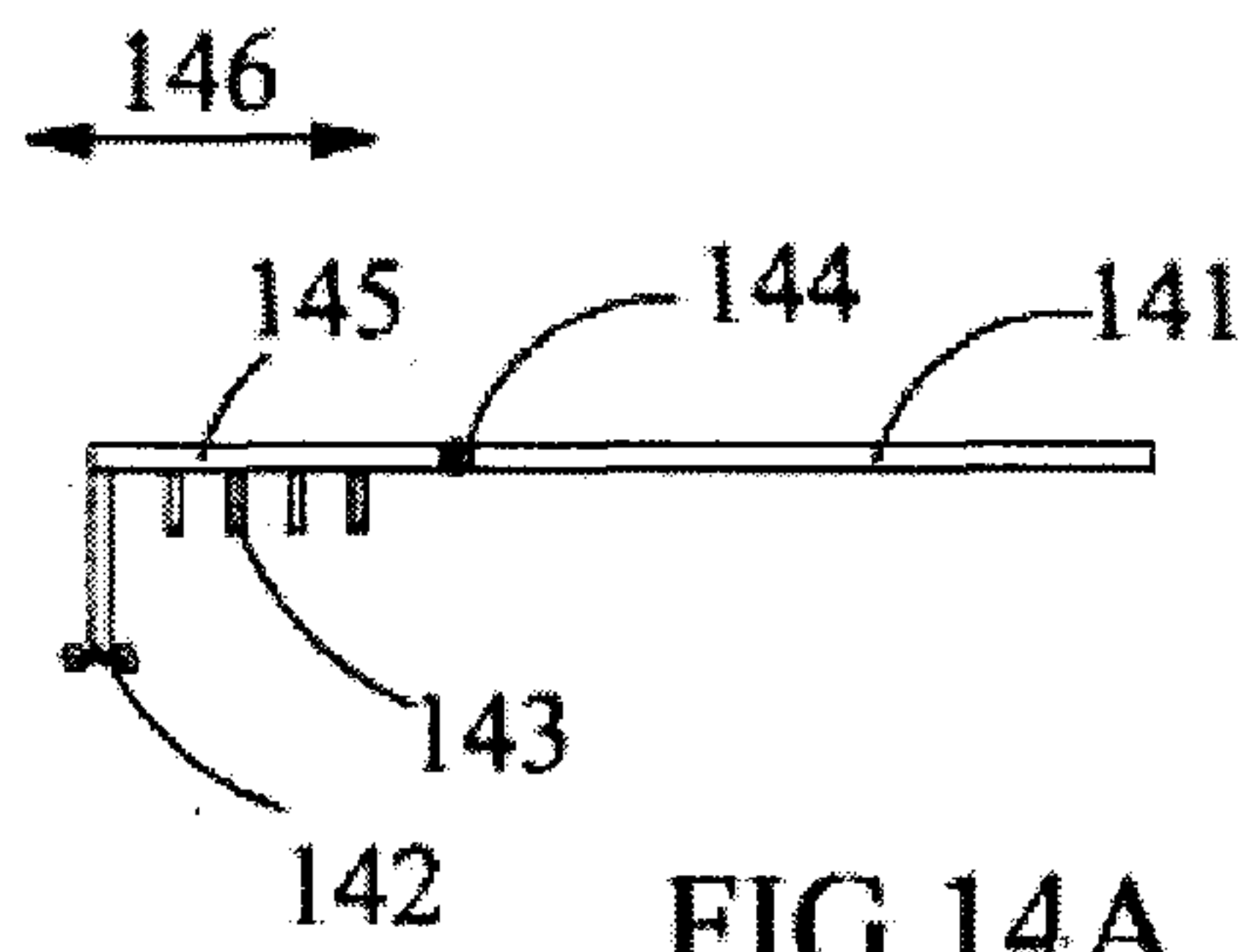
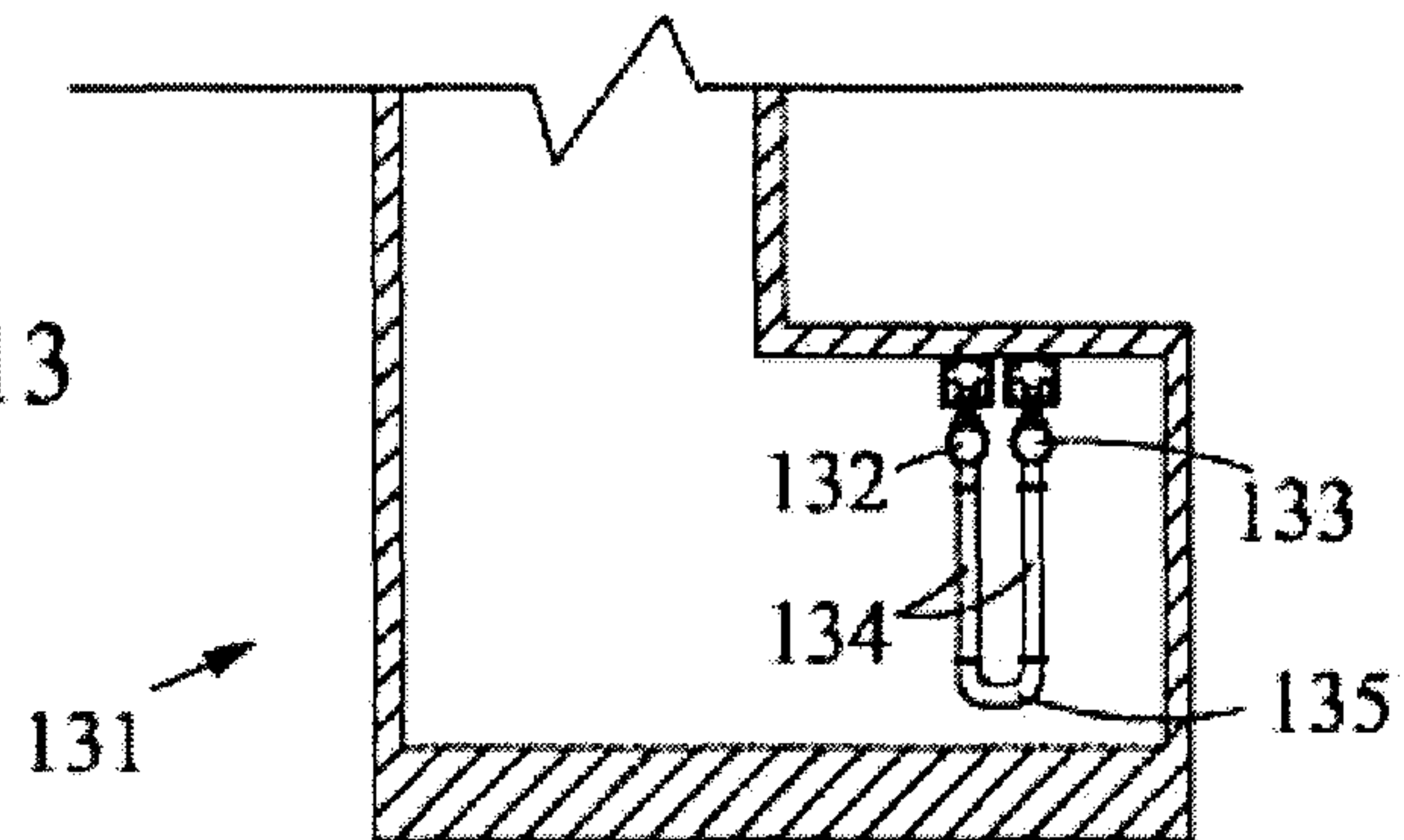


FIG.14A

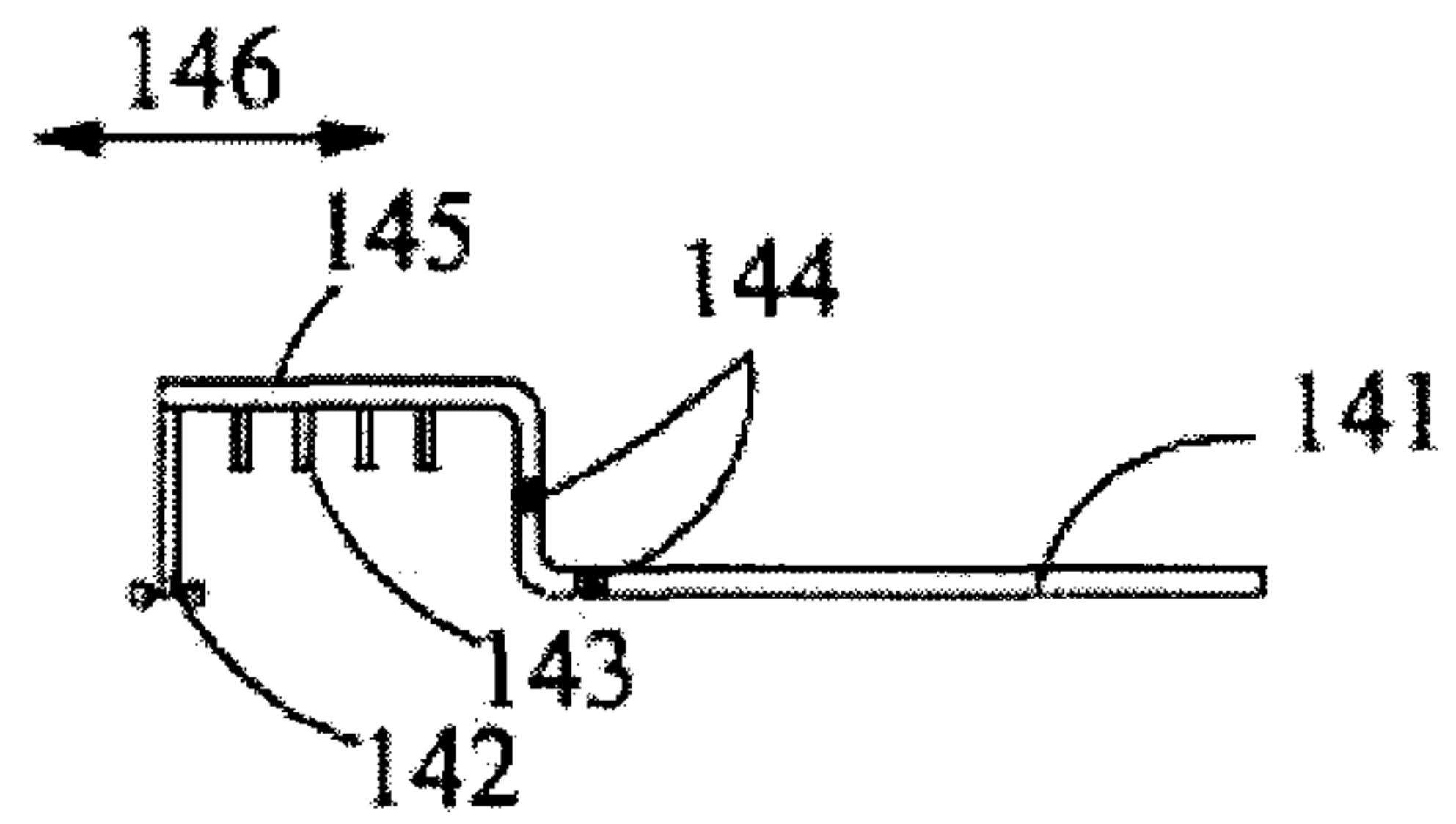


FIG.14B

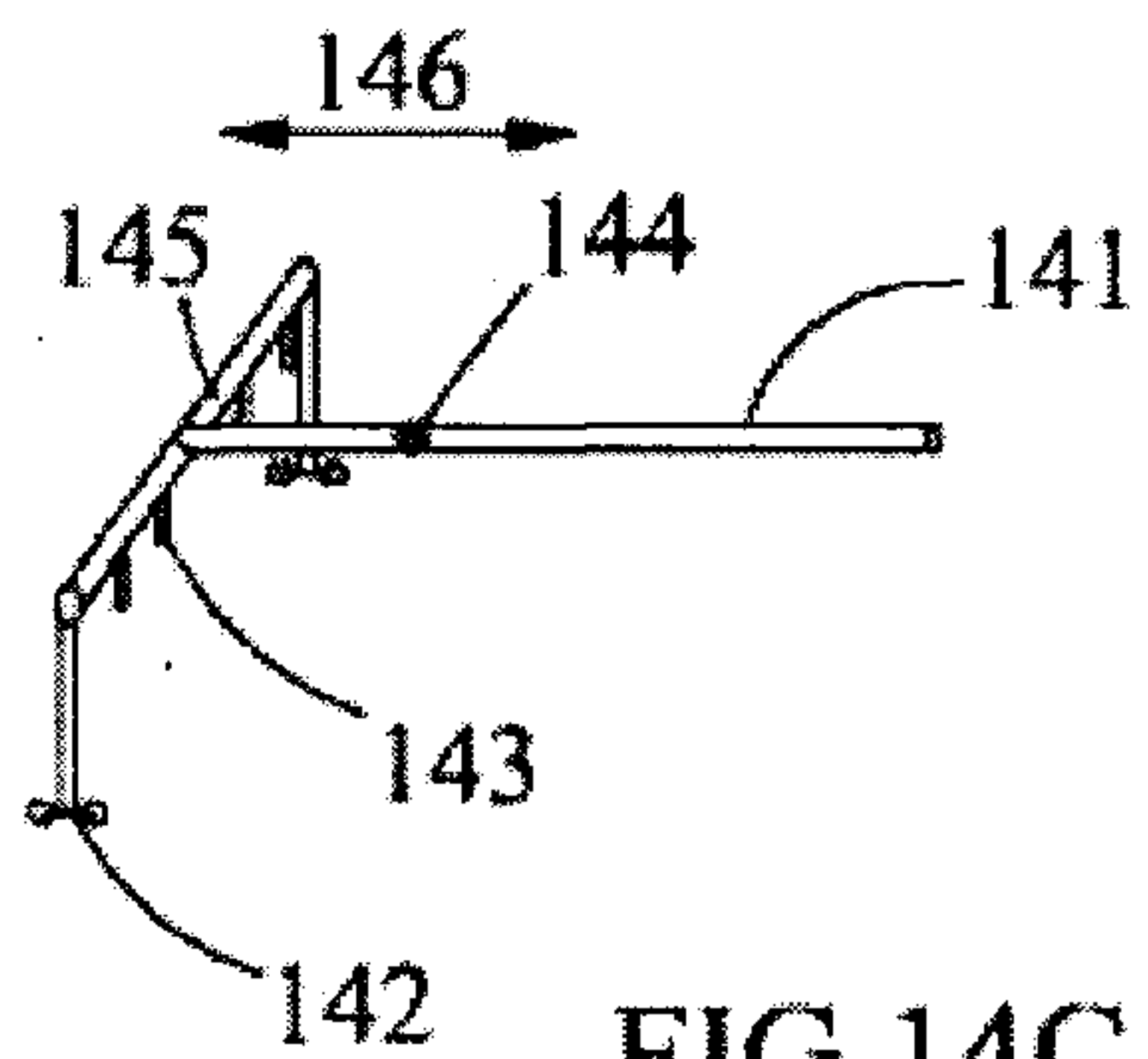


FIG.14C

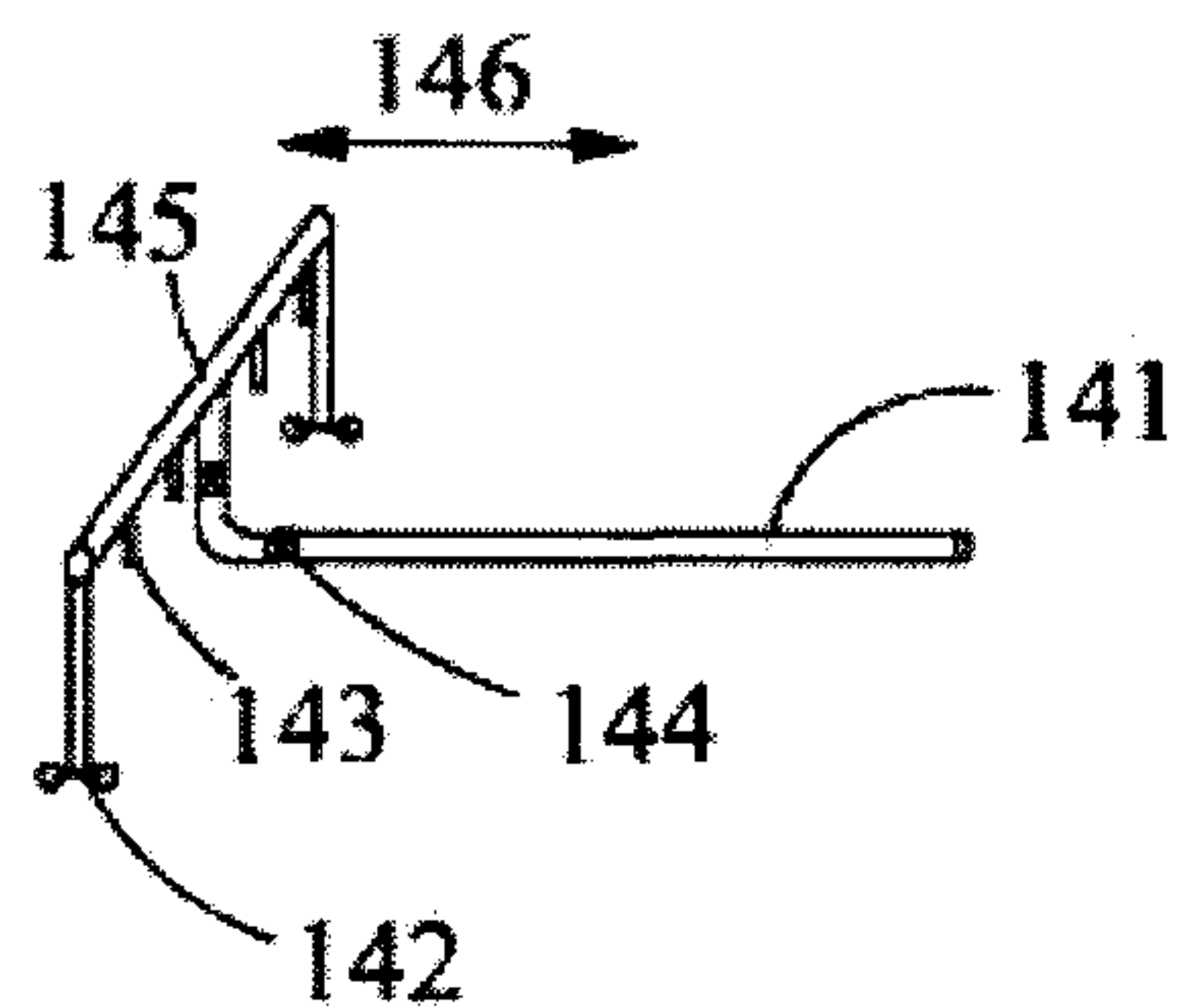


FIG.14D

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