(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) Publication number: **0 275 690**
A1

(12) EUROPEAN PATENT APPLICATION

(21) Application number: **87311281.7**

(51) Int. Cl.4: **B08B 9/08** , B63B 57/00

(22) Date of filing: **22.12.87**

(30) Priority: **30.12.86 US 947646**

(43) Date of publication of application:
27.07.88 Bulletin 88/30

(84) Designated Contracting States:
AT DE FR GB IT NL SE

(71) Applicant: **WEATHERFORD U.S. Inc.**
1360 Post Oak Boulevard
Houston Texas 77056(US)

(72) Inventor: **Taylor, Sidney Ashton**
10410 Willowisp
Houston Texas 77035(US)
Inventor: **Lambert, Paul Lee**
807 Gateside Drive
Houston Texas 77032(US)

(74) Representative: **Lucas, Brian Ronald et al**
Lucas, George & Co. 135 Westhall Road
Warlingham Surrey CR3 9HJ(GB)

(54) A method of tank cleaning and a tractor for use therein.

(57) Apparatuses and methods for cleaning storage tanks, (especially oil tanks) disclosed include methods and apparatus for degassing, sediment and sludge removal, interior surface cleaning and finishing, and coating. An in-tank tractor (12 or 54) is provided which can have pneumatically powered components. The tractor (12 or 54) is useful for moving sludge and sediment, for conveying personnel within the tank (111), and for blasting the tank's interior walls and floor with high pressure liquid or high pressure liquid with abrasives. A water blasting unit (40) is provided which can be vertically, horizontally or angularly mounted to the tractor. A sediment removal unit (15) is provided which extends into the tank (111) and has an auger (24) for removing freed sediment and sludge from the tank (111).*

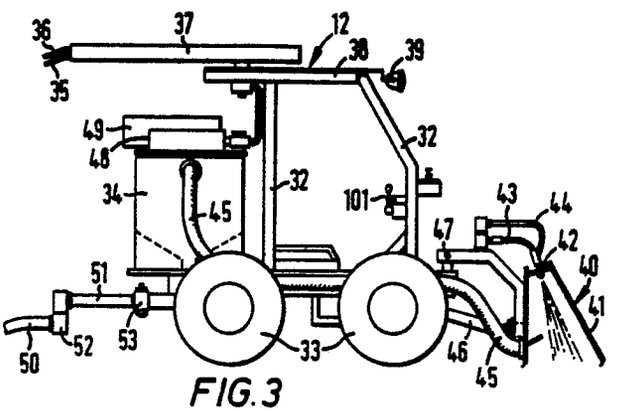

FIG.3

EP 0 275 690 A1

A METHOD OF TANK CLEANING AND A TRACTOR FOR USE THEREIN

BACKGROUND OF THE INVENTION

This invention relates to a method of tank cleaning and a tractor for use therein. The method and tractor of specific embodiments are especially concerned with cleaning and maintaining oil storage tanks.

Routine maintenance and cleaning of crude oil storage tanks includes several labour intensive operations. Crude oil storage tanks develop a sediment accumulation which must be removed prior to cleaning. Sediment deposits can vary in depth from 100 mm up to one metre. The sediment consistency can vary from a viscous grease/paraffin residue to a relative solidified bituminous/asphalt residue. Following sediment removal, the tank must be cleaned and degreased for inspection and repair work. During cleaning, personnel remove the remaining sediment from the tank bottom and they remove hard and encrusted sediments from the tank walls and floors. Degreasing requires removal of hydrocarbons from tank walls and floors to permit complete inspection of the tank and any necessary repair work. Following the repair work, the tank walls and bottom must be sandblasted to leave a white metal surface finish prior to application of a tank coating. During these operations, gases need to be exhausted from the tank.

Hitherto cleaning and degreasing operations have usually been performed using manual labour and the simplest of tools. Sediment removal is currently done by manually digging out the material, transporting it across the tank in wheel barrows and dumping it outside the tank through a hole in the tank wall. A typical tank can require up to 4000 manhours to remove material. Traditional cleaning and degreasing is done using fire hoses and squeegees. This also is manual work and can require up to 1000 manhours per tank. Sandblasting is done using conventional sandblast equipment with the typical rates associated with this work. Manual labour is required to remove all of the spent sand from the tank and to vacuum down the walls and tank bottom prior to painting. This step can require an additional 1000 manhours.

There has been a long-felt need for a method and apparatus for tank cleaning, for example for cleaning crude oil storage tanks, which facilitates cleaning in less time and with less manual labour than are required by traditional methods.

According to the present invention there is provided an in-tank tractor for use in cleaning the interior of storage tanks, the tractor comprising

a chassis,

a body means mounted on the chassis, the body means having a top and bottom,

wheels mounted to the chassis,

motor means for rotating the wheels,

boom means rotatably mounted to the top of the body means, the boom means having inlet means for receiving hose means which convey power fluid to the tractor including power fluid for the motor means, one end of the boom means extending beyond the chassis and beyond the body means, and

conduit means for conveying power fluid from the boom means to the motor means.

According to the present invention there is also provided a method for cleaning sludge from a storage tank, the method including the steps of

emplacing sludge removal means partially within the tank said sludge removal means having an inlet within the tank and an outlet outside the tank,

passing the components of an in-tank tractor through an opening in the tank,

assembling the in-tank tractor within the tank, and

using the tractor to push the sludge to the inlet of the sludge removal means.

In embodiments the system for crude oil storage tank cleaning and maintenance includes methods and apparatus for degassing, sediment removal, cleaning, and coating the interior surfaces of a tank. The equipment used for sediment and sludge removal includes: an in-tank tractor unit; a sediment transfer unit; a sediment removal pump; a power unit; and a water blasting device. The equipment used for cleaning, degreasing, and sandblasting includes: the in-tank tractor unit; the water blasting device; cleaning and surface preparation accessories; the sediment transfer unit; and the power unit. In a preferred embodiment this equipment is constructed to allow for easy entry into tanks through a manway 750 mm in diameter. Tanks that have manways of smaller than 750 mm rarely have diameters in excess of 10-15 m and are more efficiently cleaned using less automated in-tank equipment. Equipment required for cleaning smaller tanks is designed to pass through 500 mm diameter manways. Gas exhaust equipment may be used in tanks in which dangerous gases are present.

The in-tank mobile tractor has a variety of uses. It can be used to partially emulsify sediments; to break up solidified sediment; and to push sediment to a sediment transfer unit. The tractor can be constructed completely of aluminium and brass to eliminate sparking and combustion and it can be comprised of elements small enough so that it can be passed through a 750 mm wide

manway. The tractor can be made so that it is completely hydraulically operable for its mechanical functions and it may have pneumatically powered lights. A solid blade disposed preferably on the front of the tractor can be used to push material and it can be raised as needed. By employing a swivel boom for supporting the tractor's hydraulic power hoses and other lines such as compressed air lines, the tractor can turn on its own axis without becoming entangled in the hoses or damaging them. The tractor can support and transport the water and sand blasting equipment within the tank.

The tractor's components can be passed through the tank's manway and reassembled inside the tank. Each component can be a maximum weight of 100 kilograms making it possible for two persons to lift and manipulate each component. A hydraulic motor can be provided for each of the four wheels to facilitate the driving of the tractor and to enhance its ability to drive in sludge or sediment.

The tractor can be steered by differential speed of the driving wheels. The tractor operator sits on the tractor for visibility and safety. The operator's controls include forward and reverse motion and steering controls. A forward/reverse selector can be employed which requires that the operator maintain a constant force on it so that the tractor's motion will cease when the selector is released by the operator. The tractor's speed is controlled by a flow control valve. Communication equipment can be used to link the tractor operator to personnel outside the tank.

The sediment transfer unit is useful for the emulsifying and breaking up of sludge or sediment and for transferring it outside the tank. The unit has an auger-type conveyor and is mounted on a trailer. Part of the unit is insertable through a 750 mm manway in a tank. An hydraulic power unit is used with the sediment transfer unit. Pumps can be used to pump sludge or sediment from the sediment transfer unit to a container, to a sludge pit, or to a vacuum tanker; or sediment can be conveyed from the end of the sediment transfer unit outside of the tank into a container or hopper.

The water blasting unit is useful for supplying liquid to break up sediment and for partially emulsifying sediment. Also, it is useful for cleaning and descaling the walls and floor of a tank. A non-foaming degreaser or surfactant can be injected into blast water to assist in degreasing. Sand can be injected with water to sand blast surfaces. A rust inhibitor can be injected with blast water. Water, other components, and freed material and sediment can be vacuumed up and transferred to a storage container or vacuum tank. Water blasting devices in both horizontal and vertical configurations can be employed on the in-tank tractor.

When one area of a tank has been cleaned or has had a certain amount of sludge removed from it, that area can be isolated with barriers (e.g., sand bags, boards, planks, etc.). Further operations can be carried on in the isolated area while initial sludge or sediment removal (or some other operation) is done in other areas of the tank.

Conventional power units, hoses, pumps, high pressure water generating systems, blowers, air compressors, suction tanks, trucks, corrosion inhibitors, hydraulic fluids, couplings, and fittings, can be used in combination with the various units described above.

The present invention seeks to provide, at least in preferred embodiments, novel and efficient apparatuses and methods for cleaning and maintaining storage tanks, e.g., crude oil storage tanks.

The present invention seeks to provide in an embodiment a system for cleaning crude oil storage tanks in which the system components used inside the tank can be passed through an opening 750 mm in diameter.

The present invention further seeks to provide in embodiments a system which can be used to remove sediment or sludge from a tank and to clean or degrease the tank's interior.

The present invention seeks to provide an embodiment of such a system which can deal with sediment or sludge varying in depth from one hundred millimetres to one metre and which can work effectively with viscous residues as well as solidified residues.

The present invention further seeks to provide an embodiment of a tractor which can be used with: vertical or horizontal water or sand blasting units; pneumatically powered lights; individual power drives for each wheel; a swivel boom for keeping power and control lines out of the way of the tractor; and a blade for pushing sediment. Tractor components can be made of non-sparking material.

The present invention seeks to provide embodiments of a tank cleaning system which significantly reduces the amount of manual labour required to clean a tank.

The present invention seeks to provide embodiments of such a system which permits certain operations (e.g., the cleaning of a specific area or zone) within portions of a tank and provides barriers for demarcating and separating different zones or areas within the tank.

Embodiments of the invention will now be described, by way of example only, with reference to the accompanying drawings, in which:-

Fig. 1 shows a side view of an in-tank tractor according to an embodiment;

Fig. 2 shows in a side view, and partially in cross-section, a sediment transfer unit partially in a tank;

Fig. 3 shows a side view of an in-tank tractor;

Fig. 4 shows a perspective view of the front portion and controls of the tractor of Fig. 3;

Fig. 5 shows a top plan schematic view of a tank sediment removal system;

Fig. 6 shows a top plan schematic view of a tank cleaning system;

Fig. 7 shows a top plan schematic view of a tank cleaning system;

Fig. 8 shows a top plan schematic view of a tank wall cleaning system;

Fig. 9 shows a top plan schematic view of a tank preparation system; and

Fig. 10 shows a top plan schematic view of a tank coating system.

As shown in Fig. 5, a tank sediment removal system 2 for removing sediment from a tank 111 includes a sediment transfer unit 15, a gas exhaust device 75, an hydraulic power unit 14, air compressors 76 and 77, an in-tank tractor 54, and high pressure water generating apparatuses 78. In this embodiment five water generating apparatuses 78a-78e are connected in series and each is capable of delivering water at the rate of 1.26 l/s (20 gallons per minute) and collectively they are able to deliver 6.3 l/s (100 gallons per minute). A handheld spray gun 79, which is supplied with high pressure water through hose 82, can be used within the tank 111. Barriers 80 and 81, e.g., formed of sand bags, are positioned to isolate an area in which the tractor 54 operates. Tractor 54 is provided with a front-mounted blade 55 which blade 55 is used to push sediment or sludge to the sediment transfer unit 15. An air filter 83 can be used to provide filtered air as needed to various apparatuses or operators.

As shown in Fig. 2, the sediment transfer unit has an inlet portion 21 formed by conduits 25c to f and extending within the tank 111 and an outlet portion 22 formed by conduits 25a to w, which is exterior to the tank 111. One inlet conduit 25f is formed with side recess 23 into which sludge or sediment can be pushed or inserted. An auger 24 conveys material, which has been inserted into the side recess 23, through the conduits 25 to the outlet portion 22 of the unit 15. The auger 24 extends within the conduits 25a to f from the side recess 23 to an outlet channel 26 in the outlet portion 22 at conduit 25a. A removable cover 27 is emplaced on conduit 25c within the tank 111 for permitting access to a hanger bearing (not shown in Fig. 2) located within the conduit 25c. This hanger bearing holds and supports the auger 24 so that it does not rub against the interior of the conduit 25c. Likewise, hanger bearings (not shown) are used in each conduit section 25a to f to support the auger 24. The portion of the auger 24 in the conduit 25d has a U-joint connection in order to accommodate the bend between conduits 25c and 25d and 25e. Thus, the conduit 25 is composed of inlet conduit 25f, bottom conduits 25e, bend conduit 25d, bearing conduit 25c, exterior conduits 25b, and outlet conduit 25a. Any number of conduits can be used so as to extend or reduce in length either the exterior or interior portion of the conduit. Segments can also be added to the auger 24. In this way, the auger 24 can access any part of the tank 111.

A manway 28 in the embodiment shown in Fig. 2 is 750 mm (30 inches) wide. Of course, the system herein described, is not restricted to use in a tank 111 with manways 28 of any particular size. However, it is a preferred feature herein that the components of the system (or easily disassembleable parts thereof) be passable through a 750 mm wide manway.

The sludge or sediment dumped through the outlet channel 26 is introduced into a hopper 29. A slide valve 30 disposed at the bottom of the hopper 29. By opening this valve 30, material is introduced into the pumping unit 31. The material is pumped through a pipe 107 (Fig. 6) to suction tankers such as the tank 13 shown in Fig. 6 or to other containers.

As shown in Fig. 1, a tractor 54 has a solid blade 55 (made of metal, e.g., aluminium) movably mounted to the front of the tractor 54. A wear strip 55a ("squeegee"), which is preferably made of a material such as neoprene, is mounted to the blade 55. An hydraulic cylinder 56 is rotatably mounted to the tractor 54 at the pivot point 57 and to a blade support member 58 at the pivot point 59. Activation of cylinder 56 effects the raising of the blade 55 by causing a support member 58 to pivot upwardly about a farther pivot point 60. The support member 58 is rotatably mounted at the pivot point 60 to a top member 61 which itself is connected to the tractor 54.

The tractor 54 is comprised of components such as structural members 85, tyres 86, and a boom 88. Boom 88 is swivelly mounted for swivel movement on the top of the tractor 54 by means of a swivel 89. In this embodiment of an in-tank tractor, a sand distribution system 87 is provided which conveys sand to a blast unit (not shown) mounted on the tractor. A suction hose 90 is used to suck water, sand, and blasted material from such a blast unit. (A connecting hose which is not shown will connect the hose 90 to a blast unit mounted to the tractor). It is preferred that all of these components (or easily disassembleable parts thereof) be able to be passed through a 750 mm manway and that each part weight no more than 100 kilograms.

As shown in Fig. 6, both hydraulic and pneumatic power lines 104, 105 and 106 are coupled to

the tractor 54. As indicated in Fig. 1, a separate hydraulic motor is provided for each wheel 92. In this manner the tractor 54 is adapted to make very sharp turns. In use, if it is necessary, the tractor 54 is able to turn about its own vertical axis. The hydraulic power fluid is conveyed through hoses 104, 150 from the hydraulic power unit 14. At the tractor 54 these hoses are coupled to the hydraulic inlets 93, 94 on a boom 88. Within the tractor structure, conventional hydraulic fluid conduits (not shown) are used to convey the fluid to hydraulically operable equipment on the tractor 54. The compressed air from compressors 76 and 77 is conveyed through hoses 106 and is received by the tractor 54 at the air inlets 95, 96 on the boom 88. On the tractor 54, the compressed air is then conducted to pneumatically operable equipment on the tractor 54 through conventional conduits.

Breatheable air can be conveyed from either inlet 95 or 96 via a suitable conduit to outlets 97, 98, 99 and 100 for use by the tractor operator and by tank cleaning personnel with suitable umbilical hoses. Each of such personnel can also carry a small supply of air so that in the event of an emergency each will have sufficient air to exit from a tank.

The rotatable boom 88 keeps the hoses (pneumatic and hydraulic) out of the way of the tractor 54 during cleaning operations. (Of course for environments in which he use of electricity is permitted, electrical power may be used with the tractor).

In Fig. 3 a tractor 12 comprises components such as structural members 32, tyres 33, and vacuum tank 34 all of which, when disassembled, are able to be passes through a 750 mm wide manway. Also, it is a preferred feature of the embodiment that the components not exceed about 100 kilograms in weight so that two persons can handle, lift, and manipulate them easily.

This tractor 12 is hydraulically powered via hydraulic power lines (not shown) each of which is connected to a hydraulic line input 35 which communicates with the additional hydraulic means and motors on the tractor 12. An air inlet 36 is provided for receiving a compressed air hose (not shown) and for conveying compressed air to the various means and apparatuses of the tractor 12 which require compressed air for operation.

A rotatable boom 37 is rotatably mounted to a top beam 38 of the tractor 12. The inlets 35 and 36 are disposed on this boom 37 so that the tractor's motion is not impeded by the air hose, hydraulic power line, or other members connected to the inlets. When a separate hydraulic motor is used for each of the tractor's four wheels 33, the tractor can turn on its own central vertical axis or otherwise manoeuvre within a very small area, since the boom 37 keeps the power lines and air hoses out of the tractor's way.

A pneumatically operated light (or lights) such as the light 39 can be mounted to the tractor 12 as shown in Fig. 3. These lights 39 may be employed for cleaning operations in the darkened interior of a storage tank or other vessel which has no light or is poorly lit.

A water blasting device 40 is mounted in a horizontal configuration to the front of the tractor 12. A shroud 41 has one or more blast nozzles 42 disposed therethrough. Hose 43 is connected to nozzles 42 and conveys water under pressure thereto. Hose 44 conveys air or air with abrasive particles such as sand to the nozzle 42. A suction or vacuum hose 45 sucks up the liquid, abrasives, and/or blasted material from a blasting zone defined by the shroud 41 and conveys them to a suction tank 34. Alternatively the hose 45 may be extended to a receptacle at the exterior of the tank 111. As shown in Fig. 3, the water blasting device 40 is mounted for cleaning the floor of a tank. It is also possible to mount the water blasting device 40 to the tractor 12 in a position in which device 40 is arranged at an angle or vertically for cleaning the walls of a tank. An hydraulic cylinder 46 is provided which, when actuated, is adapted to pivot the device 40 upwardly about a pivot point 47. This actuation of cylinder 46 is employed to displace the device 40 from its position adjacent a tank floor. A venturi 48 provides a suction in the suction tank 35 and a silencer 49 silences the venturi noise. Material is conveyed from the tank 34 through a pipe 51, a connection 52 and a hose 50. A check valve 53 prevents backflow.

Controls 101 for an in-tank tractor such as tractor 12 (Fig. 3) or tractor 54 (Fig. 5) are shown in Fig. 4. A control lever 62 controls the hydraulic motors on the two left wheels and a control lever 63 controls the hydraulic motors on the two right wheels. By pulling back on both levers 62 and 63, the tractor will go in reverse. Conversely, by pushing forward on both levers 62 and 63, the tractor will go forward. A control lever 65 controls the hydraulic cylinder (either cylinder 46 or cylinder 56) which raises and lowers a member (either blasting device 40 or blade 55, respectively) mounted on the front of the tractor. Additional levers 66, 67, and 68 can be used to control other items on the tractor. A centre speed control lever 64 is used to control the distribution of hydraulic power between the wheel motors and other functions. When the lever 64 is in the vertical position, substantially all of the hydraulic power flows to the function controls; but when the lever 64 is in the horizontal position, substantially all power is directed to the wheel motors 91 (Fig. 5). An intermediate position permits power fluid to flow both to the wheel mo-

tors and to the other functions.

In Fig. 6 a tank cleaning system is being used to clean a tank 111 by removing the sludge and/or sediment in the tank 111. Thereafter the tank 111 may be inspected for the purpose of detecting holes or breaks which may require welding or other repair. A degassing blower/exhauster 75 is connected to tank manway 103 and is for removing gases and fumes from the interior of the tank 111. Various ingoing power lines and outgoing suction lines pass through a manway 102. Hydraulic power lines 104, 105 extend from the hydraulic power unit 14, through the manway 102, and to the in-tank tractor 12. A compressed air line 106 extends from the air compressor 76 to the tractor 12 and a suction line 107 extends from the tractor 12 to the suction tank 13. The water blaster high pressure water generators 78a-e are manifolded at the manifold 108 and high pressure water is conveyed through the hose 109 to the tractor 12.

In Figs. 7 and 8, the preparation of the walls and floor of the tank 111 for painting or coating is illustrated. Sand in a compressed air stream is fed from a sand distribution device 110 ("sand pot"), through a hose 112 which passes through the manway 102 and to the blast device 40 in the tractor 12 within the tank 111. Of course if the tractor 54 is used (Fig. 1), there is no need for a sand pot outside of the tank. As shown in Fig. 8 the blast device 40 is mounted vertically on the tractor for cleaning the tank walls.

Fig. 9 illustrates the use of a hand-held high pressure water gun 113, a foot-operated hand-held gun 114, and a manually manoeuvrable water blaster 115 for treating any sludge or sediment missed by the in-tank tractor. These devices are operated manually. The water blaster 115 may be of the type known as "grate blaster", which is very useful for the operation depicted in Fig. 9 and which has multiple nozzles for water blasting. In such a grate blaster the nozzles are disposed within a blast shroud and traverse from one side to the other within the shroud.

As shown in Fig. 10, once the interior of a tank has been cleaned and degreased to a desired finish, the walls and floor of the tank can be painted or coated as needed. The coating system 116 shown in Fig. 10 includes a pneumatically powered automatic coating unit 117. Unit 117 is a pneumatically powered unit which includes a small tractor having two rear mounted downwardly directed nozzles for coating the tank floor, which nozzles can be re-oriented to coat the tank walls. Other coating units including manual coating systems can be used, although not as efficiently as an automatic coating unit.

A cleaning system as described herein is adapted to accomplish the following operations:

1. Cleaning and Descaling --Remove sludge or sediment from the tank bottom.

--Remove all hard and encrusted sediments from the tank walls and floors.

2. Degreasing --Removal of hydrocarbons from tank walls and floors to permit complete inspection of the tank and any necessary repair work.

3. Abrasive Water Blasting --Remove rust and scale up to an ISO surface preparation grade between SA2 to 2 1/2.

4. Coating --Apply a reasonably uniform 150 micron coating to tank floor and walls.

A cleaning system according to the preferred embodiments is designed to achieve the following production rates:

Sediment Removal

1. Removal rate: up to approximately 75 m^3/hr.

2. Removal to a depth of 3 cm.

3. Actual hours required to remove sludge will depend on quantity of sediment and amount of water required to emulsify the material.

Cleaning and Degreasing

1. Rate for cleaning and degreasing: up to approximately 250 m^2/hr; cleaning path 1.2 metres wide; horizontal or vertical.

2. Cleaning and degreasing occur in same operation.

3. Degreasing is adequate to permit inspection and repair.

4. Actual hours required for an 80 m wide tank estimated to be 48 hours.

Sandblasting

1. Rate for surface preparation prior to coating: up to approximately 250 m^2/hr.

2. Surface preparation including removal of rust and scale up to an ISO Standard 2 to 2 1/2 finish.

3. Actual hours required for an 80 m wide tank estimated to be 48 hours.

4. Cleaning operation automatically removes spent sand requiring only minimal clean up prior to coating.

Degassing

1. Replace volume of air in tank every five to six minutes during sludge removal and initial cleaning.

2. Replacement rates in excess of eight minutes for inspection, surface preparation or coating.

Coating

1. A reasonably uniform 150 micron thick coating to tank floor and walls.

2. Coating unit remotely operable.

Further disclosure pertinent to, and illustrative of, the system described herein is made in Applicants' co-pending Applications, the disclosures of which are incorporated herein by reference as follows:-Title: PUMP HEAD (Case WEAA,017)
DUMP CONTROL AND VALVE (Case WEAA,018)
LIQUID BLASTING SYSTEM (Case WEAA,020)
GRATE BLASTER (Case WEAA
AUTOMATIC COATING UNIT (Case WEAA

Claims

1. An in-tank tractor for use in cleaning the interior of storage tanks, the tractor comprising

a chassis (85),

a body means (85) mounted on the chassis (85), the body means (85) having a top and bottom,

wheels (92) mounted to the chassis (85),

motor means (91) for rotating the wheels (92),

boom means (88) rotatably mounted to the top of the body means (85), the boom means (88) having inlet means (93 to 96) for receiving hose means (104, 106) which convey power fluid to the tractor (12 or 54) including power fluid for the motor means (91), one end of the boom means (88) extending beyond the chassis (85) and beyond the body means (85), and conduit means for conveying power fluid from the boom means to the motor means.

2. A tractor as claimed in Claim 1, wherein individual motor means (91) are provided for each wheel (92), and control means (62, 63) are provided for each wheel (92) so that differential speeds can be imparted to the wheels (92) for turning and manoeuvring the tractor (12 or 54).

3. A tractor as claimed in either of Claim 1 or Claim 2, wherein a blade (55) is secured to the tractor (12 or 54) for pushing the material.

4. A tractor as claimed in either of Claim 1 or Claim 2, wherein a fluid blast unit (40) is secured to the tractor (54) for blasting material from a wall, ceiling or floor surface of a tank (111) with pressurized fluid.

5. A tractor as claimed in Claim 4, wherein the blast unit (40) has shroud means (41) for enclosing a surface to be blasted and defining a blasting zone, and suction means (46) communicating with the blasting zone defined by the shroud means (41) for removing blasted material from within the blasting zone.

6. A tractor as claimed in any one of Claims 1 to 5, further comprising pneumatically powered lighting means (39) mounted on the tractor (12 or 54).

7. A tractor as claimed in any one of Claims 1 to 6, wherein each component of the tractor (12 or 54) weighs less than 100 kilograms and is adapted to be passed through a circular opening (102, 103) of 750 millimetre diameter, or each component is disassembleable into sub-components which each weighs less than 100 kilograms and is adapted to be passed through a circular opening (102, 103) of 750 millimetre diameter.

8. A method for cleaning sludge from a storage tank, the method including the steps of

emplacing sludge removal means (15) partially within the tank (111), said sludge removal means (15) having an inlet (23) within the tank (111) and an outlet (26) outside the tank (111),

passing the components of an in-tank tractor (12 or 54) through an opening (102) in the tank (111),

assembling the in-tank tractor (12 or 54) within the tank (111), and

using the tractor (54) to push the sludge to the inlet (23) of the sludge removal means (15).

9. A method according to Claim 8, including also the step of exhausting gases from the interior of the tank (111).

10. A method according to either Claim 8 or Claim 9, including also the step of isolating a particular area within the tank (111) for cleaning by employing barrier means (79, 80) about that area.

11. A method according to any one of Claims 8 to 10, further including the step of fluid blasting an area of the tank from which sludge has been removed to further clean that area.

12. A method according to any one of Claims 8 to 11, wherein breatheable air is supplied to the tractor for breathing by a tractor operator.

13. A method according to any one of Claims 8 to 12, wherein the components of the tractor (12 or 54) each weight 100 kilograms or less, and each component is adapted to be passed through a circular opening (102) in the tank (111) of 750 millimetre diameter.

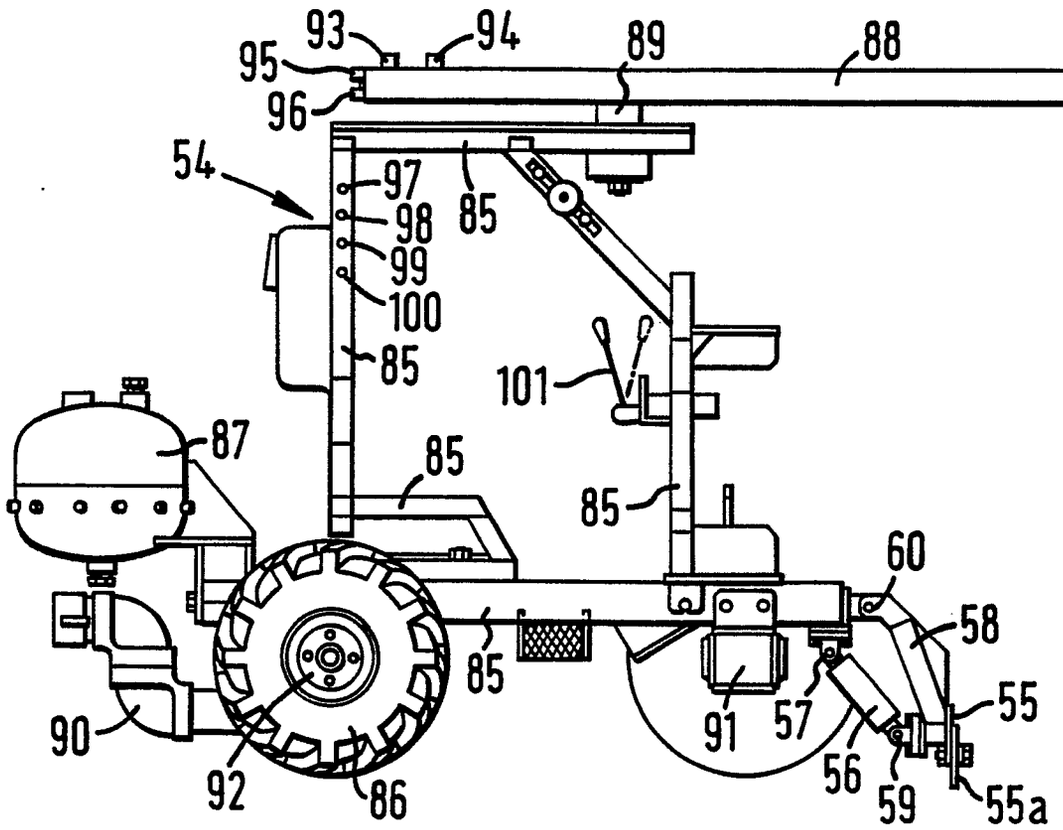
93
94
89
88
95
96
54
97
98
99
100
85
85
101
87
85
85
60
58
85
90
92
86
91
57
56
59
55
55a

FIG.1

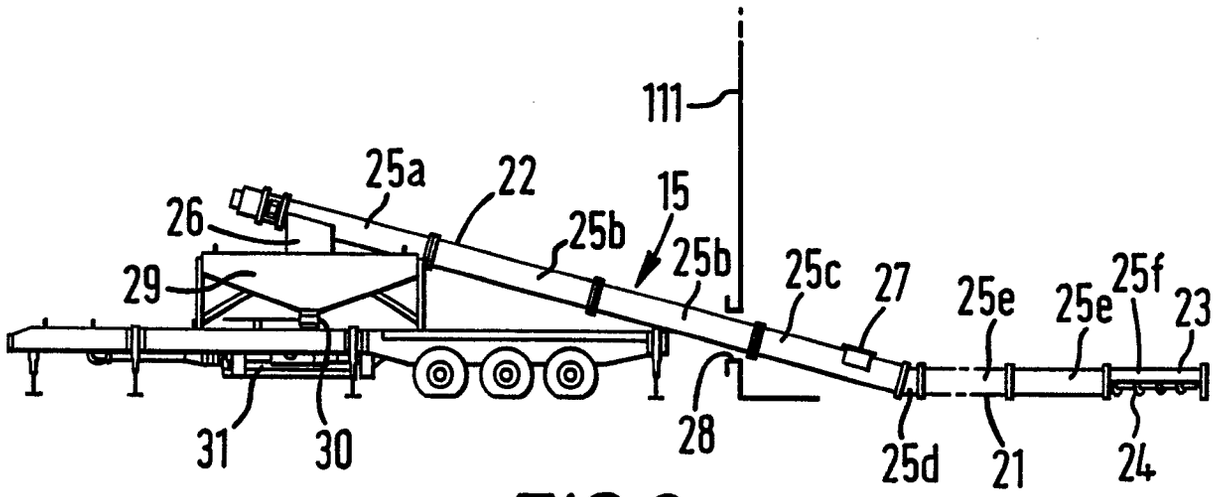
111
25a
22
15
26
25b
25b
25c
27
25e
25e
25f
23
29
31
30
28
25d
21
24

FIG.2

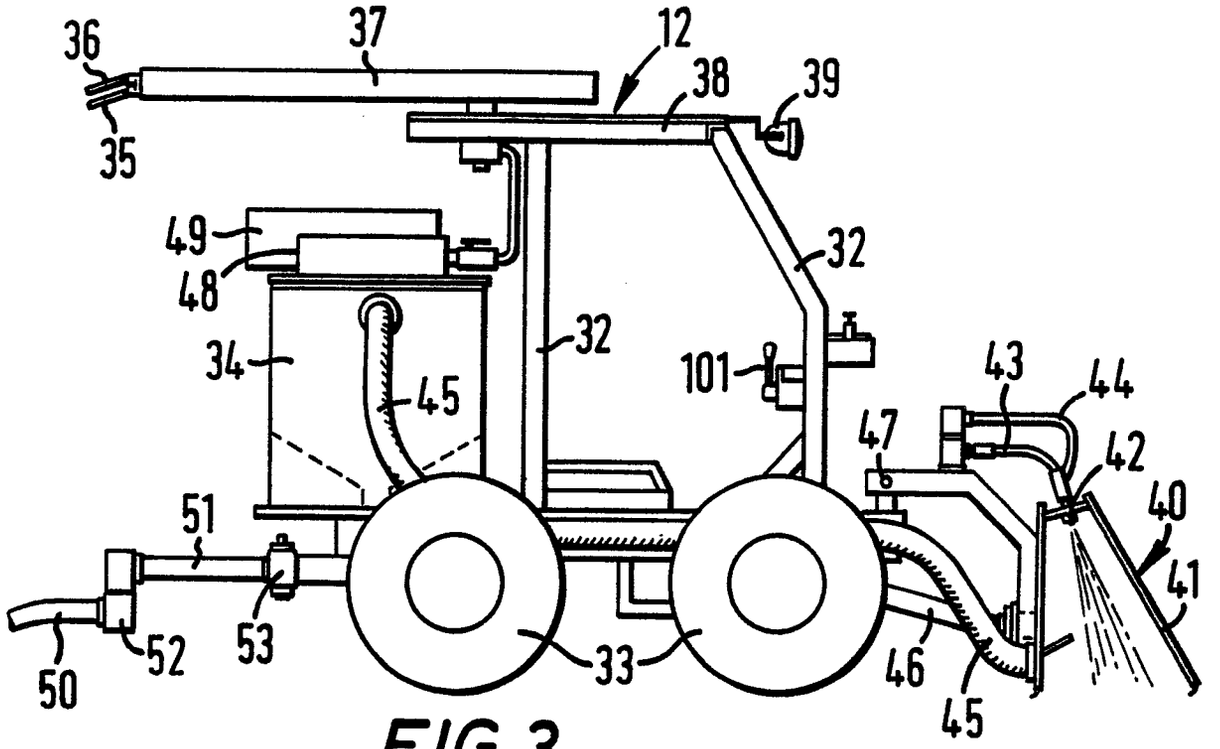
36
37
12
38
39
35
49
48
32
34
45
32
101
43
44
47
42
40
51
41
50
52
53
33
46
45

FIG. 3

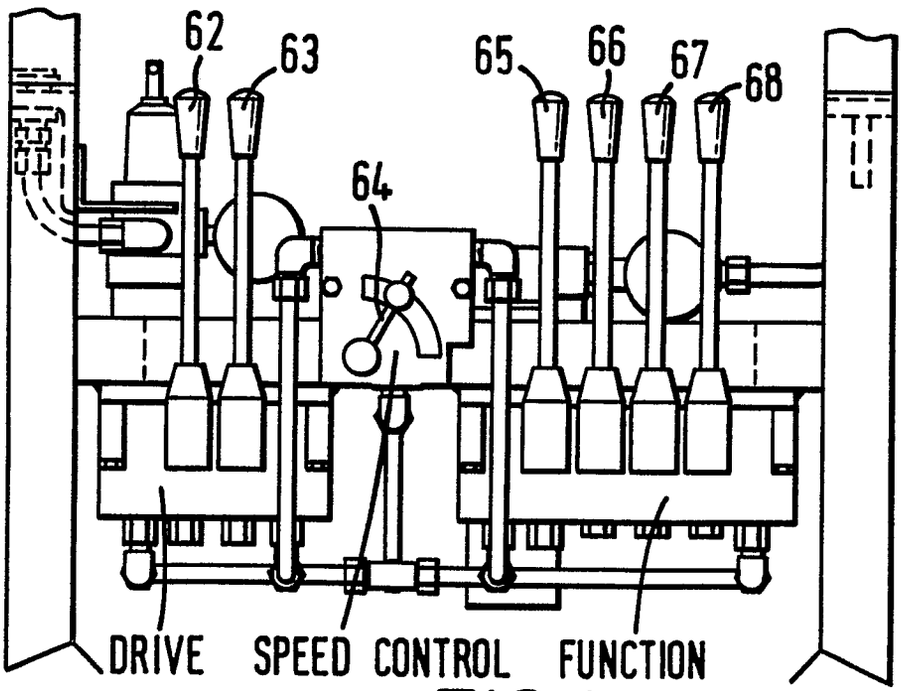
62
63
65
66
67
68
64
DRIVE
SPEED CONTROL
FUNCTION

FIG. 4

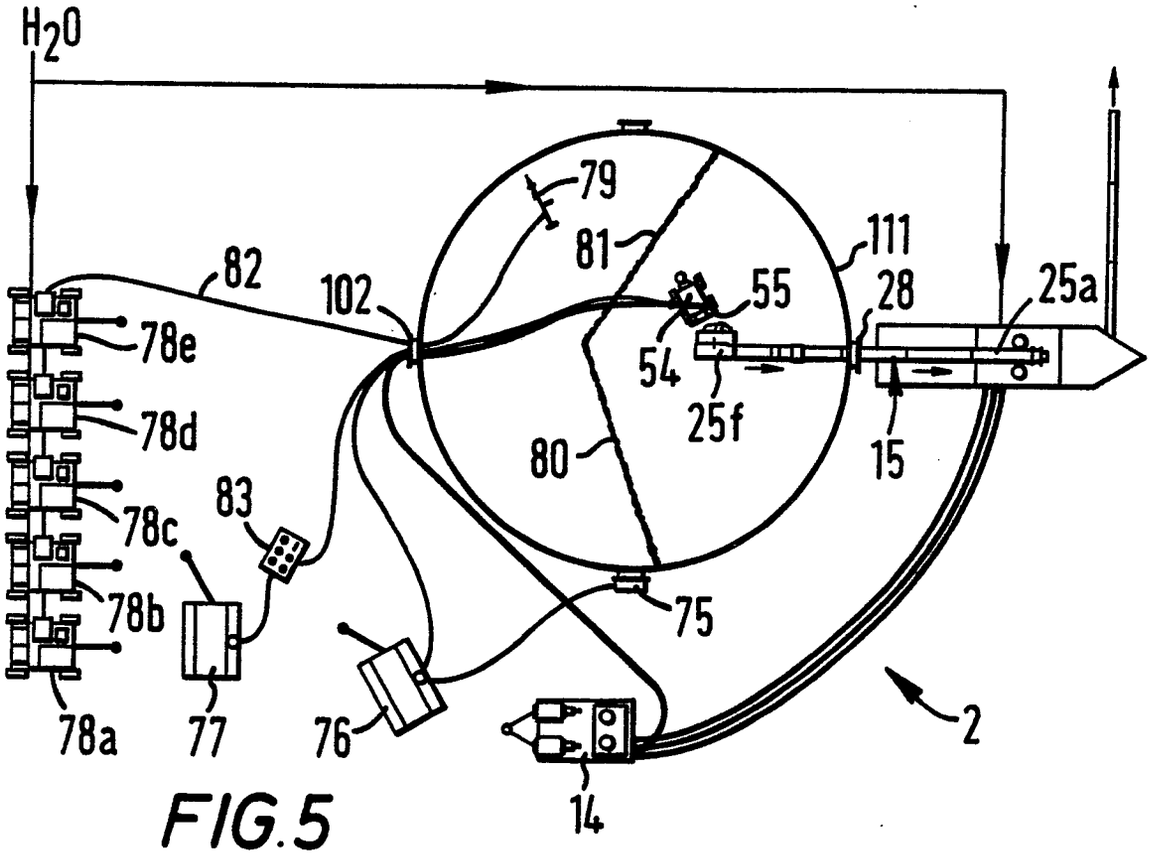
H2O
79
81
111
82
102
55
28
25a
78e
54
25f
78d
80
15
83
78c
78b
75
78a
77
76
2
14

FIG.5

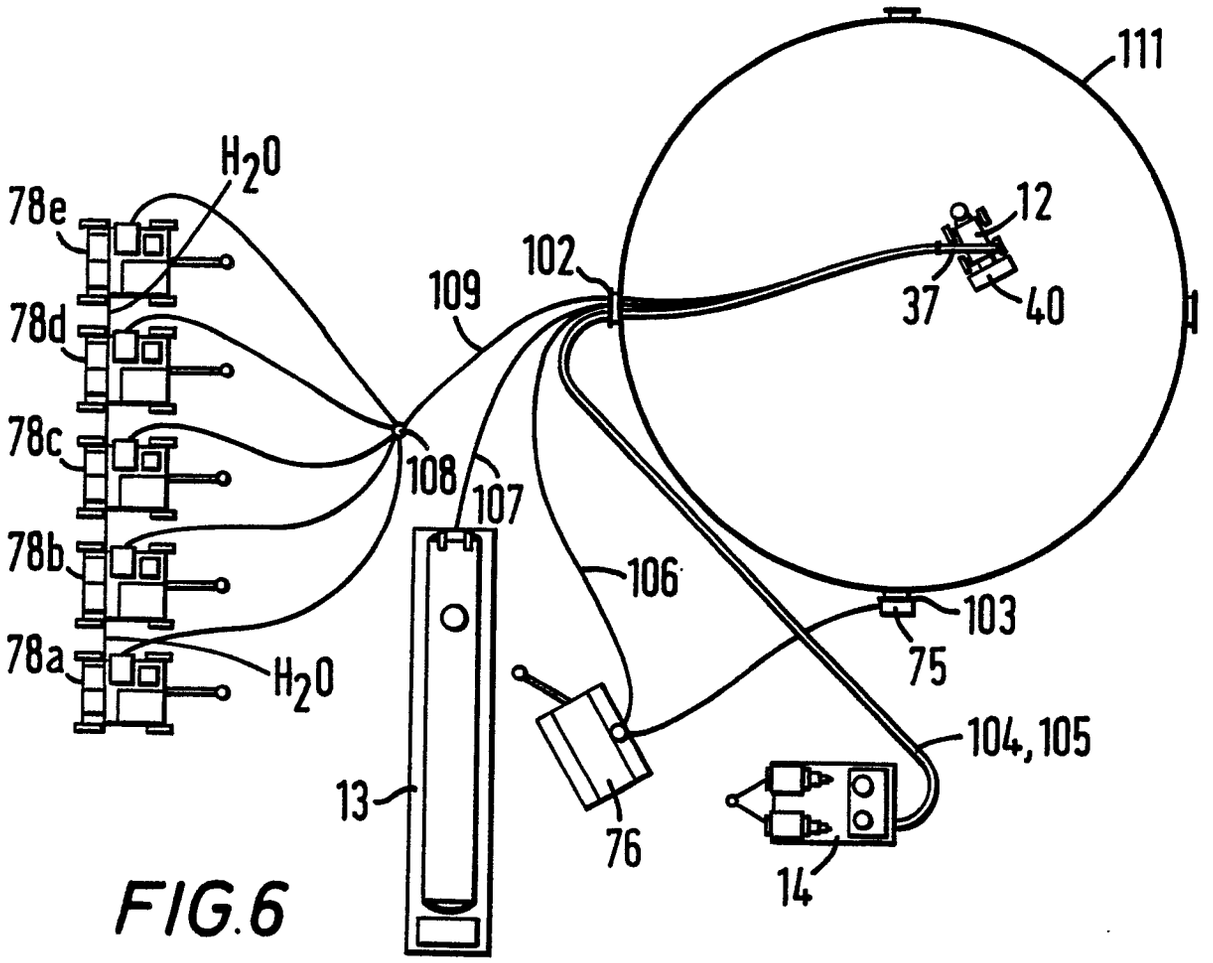
111
H2O
12
78e
102
109
37
40
78d
78c
108
107
106
78b
103
75
78a
H2O
104,105
13
76
14

FIG.6

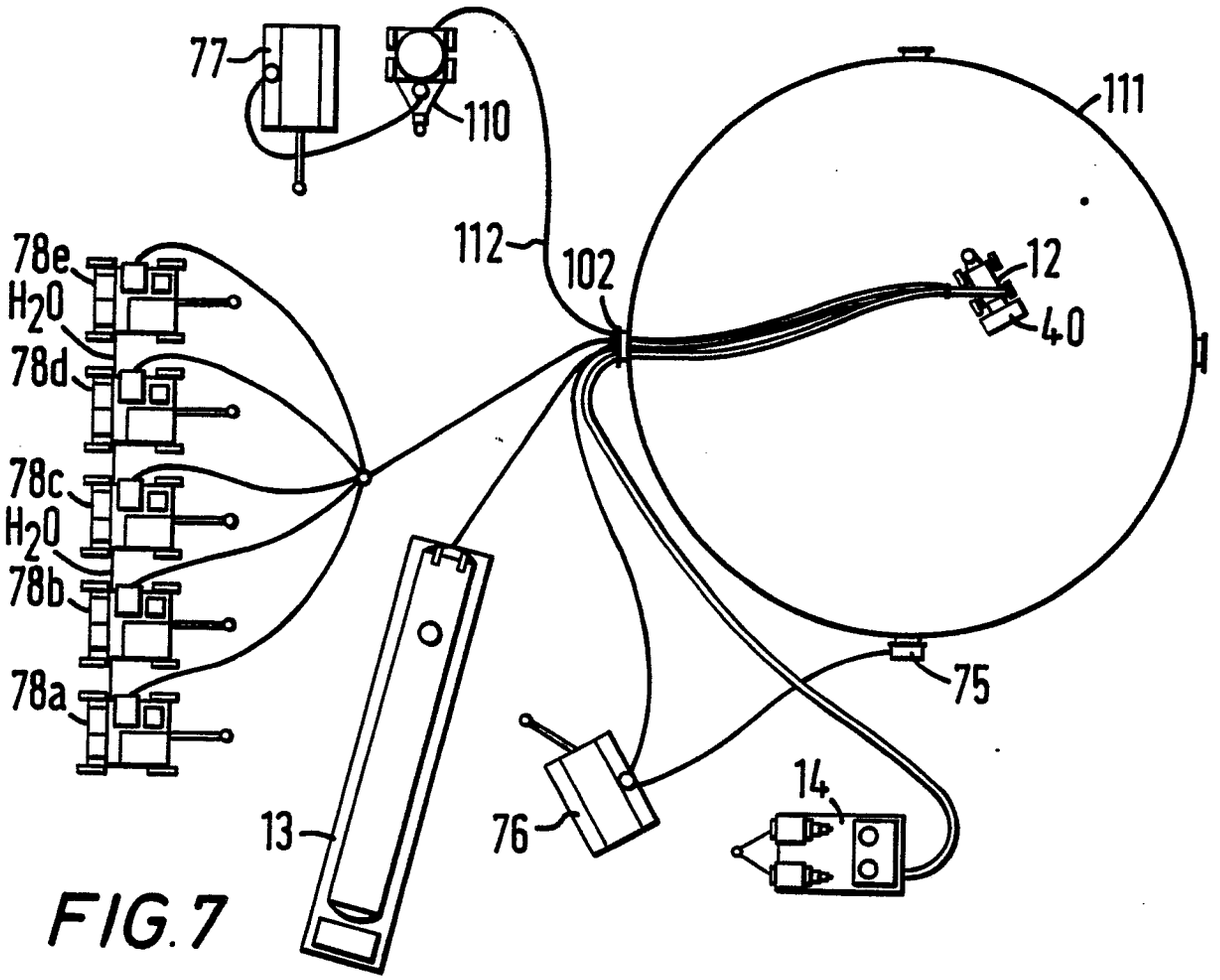
77
110
111
112
102
12
40
78e
H_2O
78d
78c
H_2O
78b
78a
75
13
76
14

FIG.7

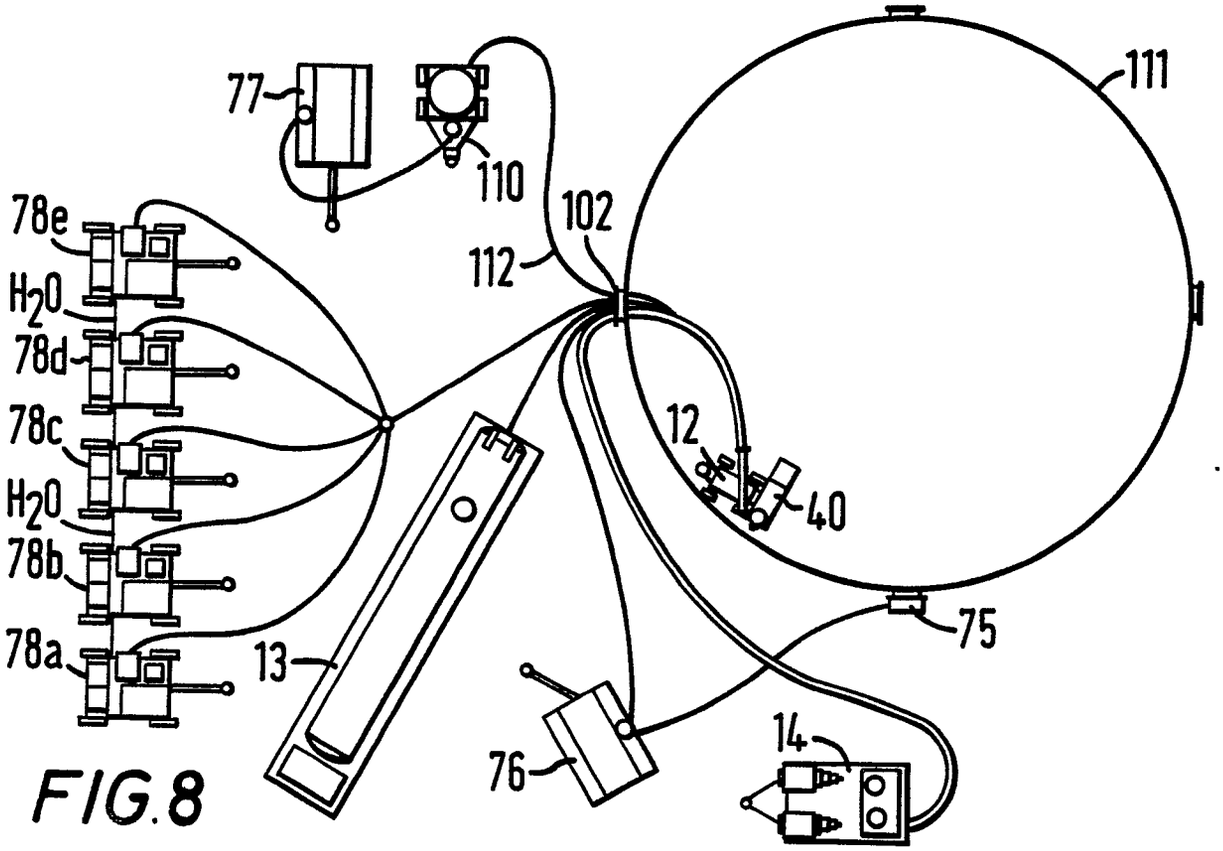
77
110
111
102
112
78e
H_2O
78d
78c
H_2O
78b
78a
12
40
75
13
76
14

FIG.8

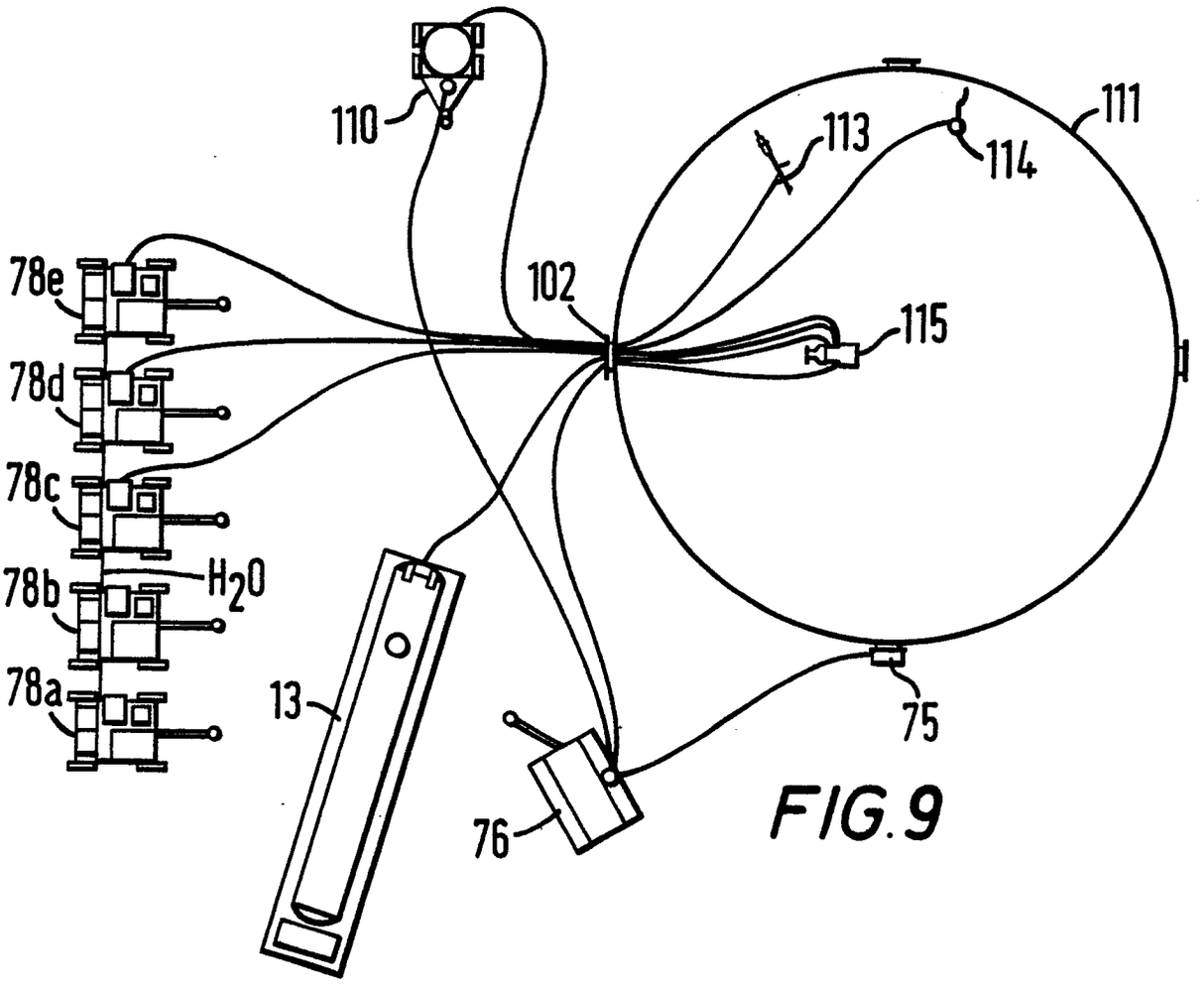
110
111
113
114
78e
102
115
78d
78c
78b
H_2O
78a
13
75
76

FIG.9

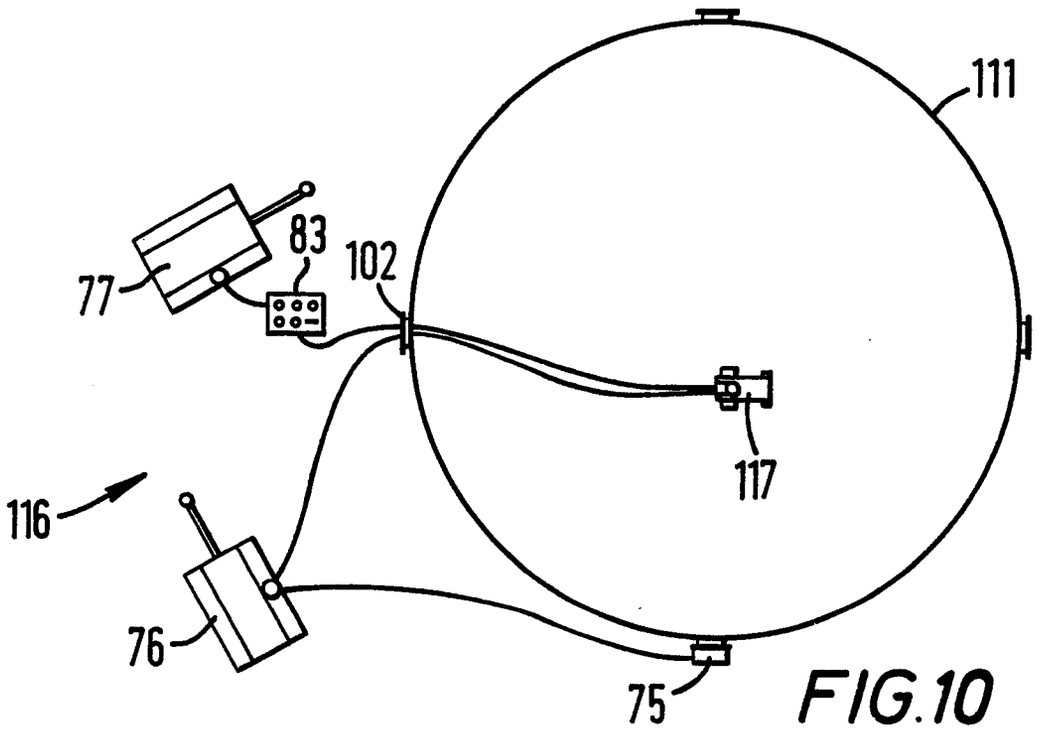
111
83
77
102
117
116
76
75

FIG.10

European Patent Office

EUROPEAN SEARCH REPORT

Application Number

EP 87 31 1281

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.4)
X	NL-A-8 300 142 (MOURIK SERVICES B.V.) * Pages 2-4; figure *	1,3,8	B 08 B 9/08 B 63 B 57/00
Y		5,12	
A		7,13	
Y	US-A-4 407 035 (LINDQVIST) * Column 2, line 18 - column 4, line 2; figures 1-6 *	5,12	
A		1,3,4,7,8,11,13	
A	EP-A-0 043 888 (BUSEMANN)		

TECHNICAL FIELDS SEARCHED (Int. Cl.4)

B 08 B
B 63 B

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	07-04-1988	VOLLERING J.P.G.

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

EPO FORM 1503 03.82 (P0401)