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(54) **DEVICE FOR THE MAINTENANCE OF TANKS AND CISTERNS DESIGNED TO CONTAIN DANGEROUS PRODUCTS**

VORRICHTUNG ZUR WARTUNG VON TANKS UND ZISTERNEN FÜR GEFÄHRLICHE STOFFE
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Description

TECHNICAL FIELD

[0001] This invention relates to a device designed to perform maintenance operations on the inside surfaces of tanks used to hold hazardous and non-hazardous products.

[0002] More specifically, this invention relates to a device designed to perform maintenance operations on tanks which extends the operation of the maintenance carriages used up to now to allow the operation to be adapted to the increased dimensions of the spaces involved in the operation.

[0003] The device according to the invention defined in appended claim 1 is mounted on a self-propelled carriage and comprises a system of articulated telescopic and rotary elements hinged to each other, carrying one or more tools, which allows movement towards the surfaces to be treated by the tool, in such a way as to always operate at the optimum distance.

[0004] The assembly of elements is moved by the same console used for moving the self-propelled support carriage and it becomes to all intents and purposes an integral part.

[0005] The device according to the invention aims, on the one hand, to increase the effectiveness of the traditional carriages for the treatment of tanks, especially those with a large capacity, and, on the other hand, to increase the versatility of use, adopting a system of interchangeable tools which allow, for example, washing, spraying of paint or gelcoats, measurement of thicknesses or sandblasting, all at a distance close to the surface to be treated.

[0006] This invention is applicable and finds its main use in all the applications which require maintenance, inspection and, in general, control operations for the inside walls of tanks and structures containing fuels and other solid or liquid products.

[0007] More specifically, this invention can be applied for the maintenance of tanks where for reasons of safety the access of personnel inside is not allowed (no man entry), and where access normally consists of an opening of very limited dimensions, such as, for example, a manhole.

BACKGROUND ART

[0008] It is known that tanks in general and more specifically those for holding fuels are subject over time to deterioration, which implies regular maintenance activities on the inside walls, such as cleaning, restoring and painting, and the implementation of non-destructive investigations by means of suitable tests, in order to check the condition.

[0009] These activities involve the use of equipment for cleaning by, for example, pressure washing and wet sandblasting, airless paint spraying, or instruments for

non-destructive investigations such as visual inspections, thickness measurement, etc., performed on metal products in confined spaces, such as tanks and metal containers in general, either fixed or mobile.

5 [0010] In the past, the maintenance operations for tanks holding fuels or other liquids were carried out manually using specifically trained personnel equipped with suitable personal protective equipment, operating inside the confined space, being lowered inside the tank with suitable equipment for inspecting and treating the walls.

10 [0011] These operations were immediately found to be extremely dangerous and solutions were subsequently introduced using mechanical means designed to automate the operations which were initially performed manually with all the resulting potential risks.

15 [0012] In effect, for some of the activities mentioned above, mechanical or automatic systems are still used which prevent these dangerous operations from being performed by specialised personnel operating inside the confined space, with the limit that, until now, these systems have been designed with a predetermined geometrical configuration which, whilst guaranteeing good operational efficiency, result in the need to reach compromises if the spaces to be treated are particularly large.

20 [0013] Document US 2002/179123A1 discloses an apparatus and method for fluidized cleaning or scarification of a surface, wherein the apparatus comprises a movable carriage for mounting an assembly which conveys an adjustable pressurized treatment fluid, preferably water, that contacts the treated surface.

25 [0014] Document US 2004/0099288A1 discloses an apparatus for scarifying the interior surface of a sewer pipe. The apparatus consists of a chassis, with an outer frame coupled to the chassis and an inner frame slidably coupled to the outer frame. Two extendable arms are attached to opposite sides of the inner frame. Each arm has a nozzle assembly mounted on the end, each nozzle assembly having a plurality of fluid jets for spray water onto the interior surface of the pipeline. The nozzle assembly may be pivotally mounted to allow for greater control of the fluid jets. The apparatus further includes a propulsion system for movement of the apparatus along the pipeline.

30 [0015] These documents describe carriages of significant size and are used exclusively for cleaning pipes but not tanks.

35 [0016] Document DE G9307652.5 U1 also describes a movable device for cleaning tanks for the sprouting or drying of grain or fruit or vegetables.

40 [0017] Document DE 29603291 U1 relates to a vehicle for performing inspections (and it is for this reason provided with a video camera) inside pipes equipped with a worm screw mechanism for moving the movable arm of the carriage.

45 [0018] None of these vehicles are designed to be inserted through a tank opening of limited size, in particular a manhole, for access which is not recommended for personnel for safety reasons, and they are not designed

to perform different operations inside the tank, placing one or more tools or heads immediately next to the inside wall of the tank.

[0019] US 5 081 800 A discloses a vehicle with a manipulator arm provided with a blasting nozzle at its end and proximity detectors placed close to it in order to allow automatic control of the movements of the nozzle.

DESCRIPTION OF THE INVENTION

[0020] The aim of this invention is to provide a device to perform maintenance operations on tanks, in particular for holding hazardous products, which is able to overcome or at least reduce the above-mentioned drawbacks.

[0021] The invention also aims to provide a device designed for maintenance operations on tanks which is simple to produce but extremely practical and functional to use, having components which are able to move the tools towards the walls to be treated irrespective of the dimensions of the tank itself.

[0022] This is achieved by a device designed to perform maintenance operations on tanks, the features of which are described in claim 1.

[0023] The dependent claims of the solution according to this invention describe advantageous embodiments of the invention.

[0024] The main advantages of this solution, as well as all those deriving from the simple and efficient concept, concern above all the use of an articulated system of telescopic and rotary elements hinged to each other which form a mechanical arm, which allows a carriage, that movable on a single working surface located far from the portions to be treated, to move the tool towards the surfaces so as to always operate at the optimum working distance.

[0025] The operational elements of the apparatus are moved by the same console used for moving the carriage and it becomes it to all intents and purposes an integral part.

[0026] Use is also made of at least one feeler device fixed on the end point of the arm, which allows the tool to be always located in the optimum working position.

[0027] The extreme adaptability of this mechanical arm allows particularly effective operations to be performed, even in zones which are difficult to treat, such as, for example, the ceiling of tanks, even large ones, as it is able to move the tools towards the inner walls of the areas to be treated.

DESCRIPTION OF THE DRAWINGS

[0028] Other features and advantages of the invention will become clear on reading the description given below of one embodiment, provided as a non-limiting example, with the help of the accompanying drawings, in which:

- Figure 1 shows the device according to the invention

mounted on a carriage operative inside a tank;

- Figure 2 is a schematic view of a first embodiment of the device in its entirety according to the invention;
- Figure 3 shows the view of a detail of the kinematic unit of movement of the articulation;
- Figures 4 to 7 illustrate in sequence the opening movement of the arm during the operation inside a tank;
- Figures 8 to 10 illustrate tanks of various diameters in which is inserted the carriage according to the invention, which may be configured to optimise the various working distances from the surfaces to be treated on the basis of the various volumes of the container;
- Figure 11 shows a schematic view of a device according to a further embodiment mounted on a carriage operating inside a tank;
- Figure 12 is a schematic view of a second embodiment of the device in its entirety according to the invention;
- Figures 13 to 17 illustrate in sequence the opening movement of the arm according to the second embodiment during the operation inside a tank;
- Figures 18 to 20 illustrate tanks of various diameters in which is inserted the carriage according to the second embodiment, which may be configured to optimise the various working distances from the surfaces to be treated on the basis of the various volumes of the container.

DESCRIPTION OF ONE EMBODIMENT OF THE INVENTION

[0029] With reference initially to Figure 1, a device 10 according to this invention is positioned inside a cylindrical tank 20 with a horizontal axis provided with a manhole opening 11, and it substantially consists of an articulated arm 31 applied on a carriage 32 driven by a pneumatic or hydraulic motor, and generally moved by tracks or the like, which can be connected by suitable wiring 33 to a control panel 34 located outside the tank.

[0030] The arm 31 consists of a series of elements which will be described in more detail below, and it can be operated by means of the same control panel 34 of the carriage 32 and it is in fact an integral part of it.

[0031] Figure 2 highlights the constructional features of the articulated arm 31.

[0032] The arm 31 comprises a tower 35 hinged on the carriage 32. The tower 35 is able to rotate by 90° to the horizontal and move at right angles to it, adopting a substantially vertical position, using a piston 36.

[0033] The tower 35 is equipped with a telescopic device 37 which by means of pistons 38 is able to raise up to twice its height. In the case of use inside cylindrical tanks with a horizontal axis the telescopic device 37 allows a gear unit 39 to reach the centre of the tank.

[0034] The above-mentioned gear unit 39 is mounted on the telescopic device 37, and on the axes of rotation

40, 41 of the unit are mounted telescopic rods 42, 43 which can rotate on the axis of the gears by means of a motor 44 which places the rods 42, 43 in counter-rotation respectively about the pivots formed by the axes 40, 41.

[0035] Each telescopic rod 42, 43 is provided with respective telescopic devices 45, 46 at the top of each of which is applied a tool 47, which in the case illustrated in Figure 2 is represented by a series of nozzles for performing high pressure washing.

[0036] It should be noted that the sliding members 45 and 46 make it possible to increase the operating distance covered by the articulated arms 42 and 43.

[0037] Figure 3 shows a detail of the kinematic unit 39 comprising gears for rotating the telescopic rods 42 and 43 applied on the rotational pins 40 and 41.

[0038] As illustrated in Figures 4 to 7 the arm 31 and carriage 32 assembly is on the bottom of the tank 10. Figure 4 shows the articulated arm 31 in the closed position immediately after having been lowered through the manhole 11, Figure 5 shows the arm with the tower 35 in the vertical position and Figure 6 shows the tower 35 raised and the telescopic device 37 lifted. Lastly, in Figure 7, the rods 42, 43 are rotated and the telescopic devices are open, allowing the tools to move close to the walls to be treated.

[0039] Figures 8 to 10 show all the movements which can be performed by the articulated arm 31 and, as may be noted, all the telescopic devices of the same articulated arm may be extended to the distance necessary for the size of the tank to be treated, and the set of mutual translational and rotational movements which the various components of the arm 31 can perform in combination with each other allows an increase in operational efficiency, guaranteeing the optimum working distance with variations in the diameter of the tank.

[0040] These drawings show tanks of various diameters comprising the carriage 32 and the articulated arm 31, which may be configured to optimise the working distance of the respective tool from the surfaces to be treated.

[0041] In Figures 11 to 20 the device according to this invention is shown in a further embodiment, and in this case the articulated arm is denoted in its entirety by the numeral 50 and is located on a carriage 51.

[0042] Also in this case the set of elements which constitute the invention, that is to say, the arm 50 mounted on the carriage 51, can be operated by the same control panel 52 connected to the carriage 51 by wiring 53.

[0043] Figure 12 highlights the distinctive constructional feature of the invention, and it may be noted that in this second embodiment the arm 50 is installed on a base 54 which may rotate through 360° relative to a vertical axis, the base 54 being fixed by a rack 55 to the carriage 51.

[0044] The tower 57 is in this case hinged on the base 54 and, by means of a motor 59 connected to a worm screw 60, rotates relative to the pivot 58 through 90° to move to a vertical position.

[0045] Installed on the tower 57 is a telescopic device 61 which by means of a motor 62 rises to twice the height of the tower 57 moving, in the case of cylindrical tanks with a horizontal axis, the box gear 63 close to the centre of the tank.

[0046] Moreover, on top of the telescopic device 61 there is a gear box 63 similar to the box 39 described above, which, by means of a motor 64 rotates a rod 65 equipped with the telescopic device 66 at the top of which is fixed a tool 67.

[0047] At the end of the arm which supports the tool 67 there is also a feeler device 68 connected to the control panel which makes it possible to automatically adjust the length of the telescopic device 66 for moving the tool 67 to the optimum working distance or in contact with the surfaces to be treated.

[0048] The feeler device is also present in all embodiments of the device according to the invention.

[0049] Figures 13 to 17 show in sequence the opening movements of the arm 50 during its operation.

[0050] More specifically, Figure 13 shows the assembly made up of the arm 50 and carriage 51 located on the bottom of the tank 30 in a closed position immediately after having been lowered into the tank through the manhole.

[0051] Figure 14 shows the arm with the tower 57 in the vertical position and Figure 15 shows the arm rotated by 90° with respect to the carriage 51.

[0052] In Figure 16 the tower is raised and the telescopic device is lifted and in Figure 17 the rods are rotated and the telescopic devices are open with the tool in contact with the inside surface of the walls of the tank.

[0053] Lastly, Figures 18 to 20 show tanks of various diameters comprising inside them the carriage 51 comprising the articulated movable arm 50 according to the second embodiment of the invention, and again in this case it may be noted that the articulated arm 50 of the carriage unit according to the invention may be configured in various ways according to the dimensions of the tank so as to optimise the working distance of the respective tool from the surfaces to be treated.

[0054] The invention as described above refers to a preferred embodiment. It is nevertheless clear that the invention is susceptible to numerous variations which lie within the scope of the appended claims.

Claims

1. A device configured to be insertable through an access manhole opening (11) of a tank (10) designed to contain fuels or other hazardous liquids, the device being configured to carry out maintenance operations, the device comprising a carriage (32, 51) of self-propelled type driven by at least one pneumatic or hydraulic motor, connected by suitable wiring (33, 53) to a remote control panel (34, 52) suitable to be located outside the tank, wherein an articulated arm

(31, 50) is rotatably connected by one end thereof to the carriage (32,51), said arm comprising a tower (35, 57) hinged on the carriage (32, 51), said tower having a telescopic device (37) which, through pneumatic pistons or pneumatic or hydraulic motors (38, 62), is able to raise up to two times the height of said tower (35, 57), wherein the articulated arm (31, 50) further comprises a gear unit (39, 63) having at least one gear axis of rotation (40, 41) located at the distal end of said telescopic device (37), as well as at least an articulated telescopic rod (42, 43, 65) equipped with a telescopic device (45, 46, 66) and located on said gear unit (39, 63) in such a way as to be driven by the latter, wherein at least one tool (47, 67) is applied in an interchangeable fashion at the top free end of the at least one articulated telescopic rod (42, 43, 65), wherein the at least one articulated telescopic rod (42, 43, 65) is configured to be rotated on the axis (40, 41) of the gears of the gear unit (39, 63) by means of a pneumatic or hydraulic piston (44, 64) and wherein the device further comprises a feeler device (68) fixed close to said at least one tool (47) on the end point of the articulated arm (31, 50) and connected to the control panel, the feeler device (68) being configured to automatically adjust the length of the telescopic device (66) of the articulated telescopic rod (42, 43, 65) to control the working distance of said at least one tool from the inside wall of the tank during use of the device.

2. A device according to claim 1, **characterised in that** said at least one tool (47) consists of a series of nozzles configured to carry out high pressure washing.
3. A device according to claim 1, **characterised in that** said at least one tool (47) consists of a series of nozzles configured to spray paints or gelcoats.
4. A device according to claim 1, **characterised in that** said at least one tool (47) consists of a device configured to measure the thickness of a metal sheet constituting the wall of the tank.
5. A device according to claim 1, **characterised in that** said at least one tool (47) consists of a head configured to sandblast the inside wall of the tank.
6. A device according to any one of the preceding claims, **characterised in that** the articulated arm (50) is mounted on a base (54) which is configured to be rotated through 360° relative to a vertical axis, the base (54) being fixed by a rack (55) to the carriage.
7. A device according to claim 6, **characterised in that** the tower (57) is hinged on the base (54) and is configured to be rotated between a horizontal position and a vertical position by means of a pneumatic or

hydraulic motor (59).

Patentansprüche

1. Gerät, das dazu konfiguriert ist, durch eine Zugangsschachttöffnung (11) eines Tanks (10) einführbar zu sein, welcher zum Enthalten von Brennstoffen oder anderen gefährlichen Flüssigkeiten gestaltet ist, wobei das Gerät zum Ausführen von Wartungsvorgängen konfiguriert ist, wobei das Gerät einen Schlitten (32, 51) der selbstfahrenden Art umfasst, der durch zumindest einen Pneumatik- oder Hydraulikmotor angetrieben wird und durch geeignete Verdrahtung (33, 53) mit einer Fernbedienungstafel (34, 52) verbunden ist, welche außerhalb des Tanks angeordnet ist, wobei ein Gelenkarm (31, 50) drehbar durch ein Ende davon mit dem Schlitten (32, 51) verbunden ist, wobei der Arm einen Turm (35, 57) umfasst, der am Schlitten (32, 51) angelenkt ist, wobei der Turm ein teleskopisches Gerät (37) aufweist, das durch pneumatische Kolben oder Pneumatik- oder Hydraulikmotoren (38, 62) dazu imstande ist, sich bis zum Zweifachen der Höhe des Turms (35, 57) zu erheben, wobei der Gelenkarm (31, 50) ferner eine Getriebereinheit (39, 63) mit zumindest einer Getriebebedrehachse (40, 41), die sich am distalen Ende des teleskopischen Geräts (37) befindet, sowie zumindest eine teleskopische Stange (42, 43, 65) umfasst, die mit einem teleskopischen Gerät (45, 46, 66) ausgestattet ist und derart an der Getriebereinheit (39, 63) angeordnet ist, dass sie durch die Letztere angetrieben wird, wobei zumindest ein Werkzeug (47, 67) austauschbar am oberen freien Ende der zumindest einen gelenkigen teleskopischen Stange (42, 43, 65) angebracht ist, wobei die zumindest eine gelenkige teleskopische Stange (42, 43, 65) dazu konfiguriert ist, auf der Achse (40, 41) der Zahnräder der Getriebereinheit (39, 63) mittels eines pneumatischen oder hydraulischen Kolbens (44, 64) gedreht zu werden, und wobei das Gerät ferner ein Fühlergerät (68) umfasst, das nahe an dem zumindest einen Werkzeug (47) am Endpunkt des Gelenkarms (31, 50) befestigt ist und mit der Bedienungstafel verbunden ist, wobei das Fühlergerät (68) zum automatischen Anpassen der Länge des teleskopischen Geräts (66) der gelenkigen teleskopischen Stange (42, 43, 65) konfiguriert ist, um den Arbeitsabstand des zumindest einen Werkzeugs zur Innenwand des Tanks während der Benutzung des Geräts zu steuern.
2. Gerät nach Anspruch 1, **dadurch gekennzeichnet, dass** das zumindest eine Werkzeug (47) aus einer Reihe von Düsen besteht, die zum Ausführen von Hochdruckwäsche konfiguriert sind.
3. Gerät nach Anspruch 1, **dadurch gekennzeichnet,**

dass das zumindest eine Werkzeug (47) aus einer Reihe von Düsen besteht, die zum Versprühen von Farben oder Gelschichten konfiguriert sind.

4. Gerät nach Anspruch 1, **dadurch gekennzeichnet, dass** das zumindest eine Werkzeug (47) aus einem Gerät besteht, das zum Messen der Stärke eines Metallblechs konfiguriert ist, welches die Wand des Tanks bildet. 5
5. Gerät nach Anspruch 1, **dadurch gekennzeichnet, dass** das zumindest eine Werkzeug (47) aus einem Kopf besteht, der zum Sandstrahlen der Innenseitenwand des Tanks konfiguriert ist. 10
6. Gerät nach einem der vorhergehenden Ansprüche, **dadurch gekennzeichnet, dass** der Gelenkarm (50) an einer Basis (54) angebracht ist, die dazu konfiguriert ist, um 360° bezüglich einer vertikalen Achse gedreht zu werden, wobei die Basis (54) durch ein Gestell (55) am Schlitten befestigt ist. 15 20
7. Gerät nach Anspruch 6, **dadurch gekennzeichnet, dass** der Turm (57) an die Basis (54) angelenkt ist und dazu konfiguriert ist, mittels eines Pneumatik- oder Hydraulikmotors (59) zwischen einer horizontalen Position und einer vertikalen Position gedreht zu werden. 25

Revendications

1. Dispositif configuré pour être insérable à travers une ouverture de trou d'homme d'accès (11) d'un réservoir (10) conçu pour contenir des carburants ou d'autres liquides dangereux, le dispositif étant configuré pour effectuer des opérations de maintenance, le dispositif comprenant un chariot (32, 51) de type automate entraîné par au moins un moteur pneumatique ou hydraulique, relié par un câblage approprié (33, 53) à un panneau de commande à distance (34, 52) apte à être situé à l'extérieur du réservoir, dans lequel un bras articulé (31, 50) est relié de manière rotative par une de ses extrémités au chariot (32, 51), ledit bras comprenant une tour (35, 57) articulée sur le chariot (32, 51), ladite tour comportant un dispositif télescopique (37) qui, par l'intermédiaire de pistons pneumatiques ou de moteurs pneumatiques ou hydrauliques (38, 62), peut s'élever jusqu'à deux fois la hauteur de ladite tour (35, 57), dans lequel le bras articulé (31, 50) comporte en outre un réducteur (39, 63) ayant au moins un axe de rotation d'engrenage (40, 41) situé à l'extrémité distale dudit dispositif télescopique (37), ainsi qu'au moins une tige télescopique articulée (42, 43, 65) équipée d'un dispositif télescopique (45, 46, 66) et située sur ledit réducteur (39, 63) de manière à être entraînée par ce dernier, 35 40 45 50 55

dans lequel au moins un outil (47, 67) est appliqué de manière interchangeable à l'extrémité supérieure libre de la au moins une tige télescopique articulée (42, 43, 65),

dans lequel la au moins une tige télescopique articulée (42, 43, 65) est configurée pour être mise en rotation sur l'axe (40, 41) des engrenages du réducteur (39, 63) au moyen d'un piston pneumatique ou hydraulique (44, 64) et dans lequel le dispositif comprend en outre un dispositif palpeur (68) fixé à proximité dudit au moins un outil (47) sur le point d'extrémité du bras articulé (31, 50) et relié au panneau de commande, le dispositif palpeur (68) étant configuré pour ajuster automatiquement la longueur du dispositif télescopique (66) de la tige télescopique articulée (42, 43, 65) afin de contrôler la distance de travail dudit au moins un outil par rapport à la paroi intérieure du réservoir pendant l'utilisation du dispositif.

2. Dispositif selon la revendication 1, **caractérisé en ce que** ledit au moins un outil (47) consiste en une série de buses configurées pour effectuer un lavage à haute pression.
3. Dispositif selon la revendication 1, **caractérisé en ce que** ledit au moins un outil (47) consiste en une série de buses configurées pour pulvériser des peintures ou des gelcoats. 30
4. Dispositif selon la revendication 1, **caractérisé en ce que** ledit au moins un outil (47) consiste en un dispositif configuré pour mesurer l'épaisseur d'une tôle constituant la paroi du réservoir. 35
5. Dispositif selon la revendication 1, **caractérisé en ce que** ledit au moins un outil (47) est constitué d'une tête configurée pour sabler la paroi intérieure du réservoir. 40
6. Dispositif selon l'une quelconque des revendications précédentes, **caractérisé en ce que** le bras articulé (50) est monté sur une base (54) configurée pour être tournée de 360° par rapport à un axe vertical, la base (54) étant fixée par une crémaillère (55) au chariot. 45
7. Dispositif selon la revendication 6, **caractérisé en ce que** la tour (57) est articulée sur la base (54) et est configurée pour être tournée entre une position horizontale et une position verticale au moyen d'un moteur pneumatique ou hydraulique (59). 50

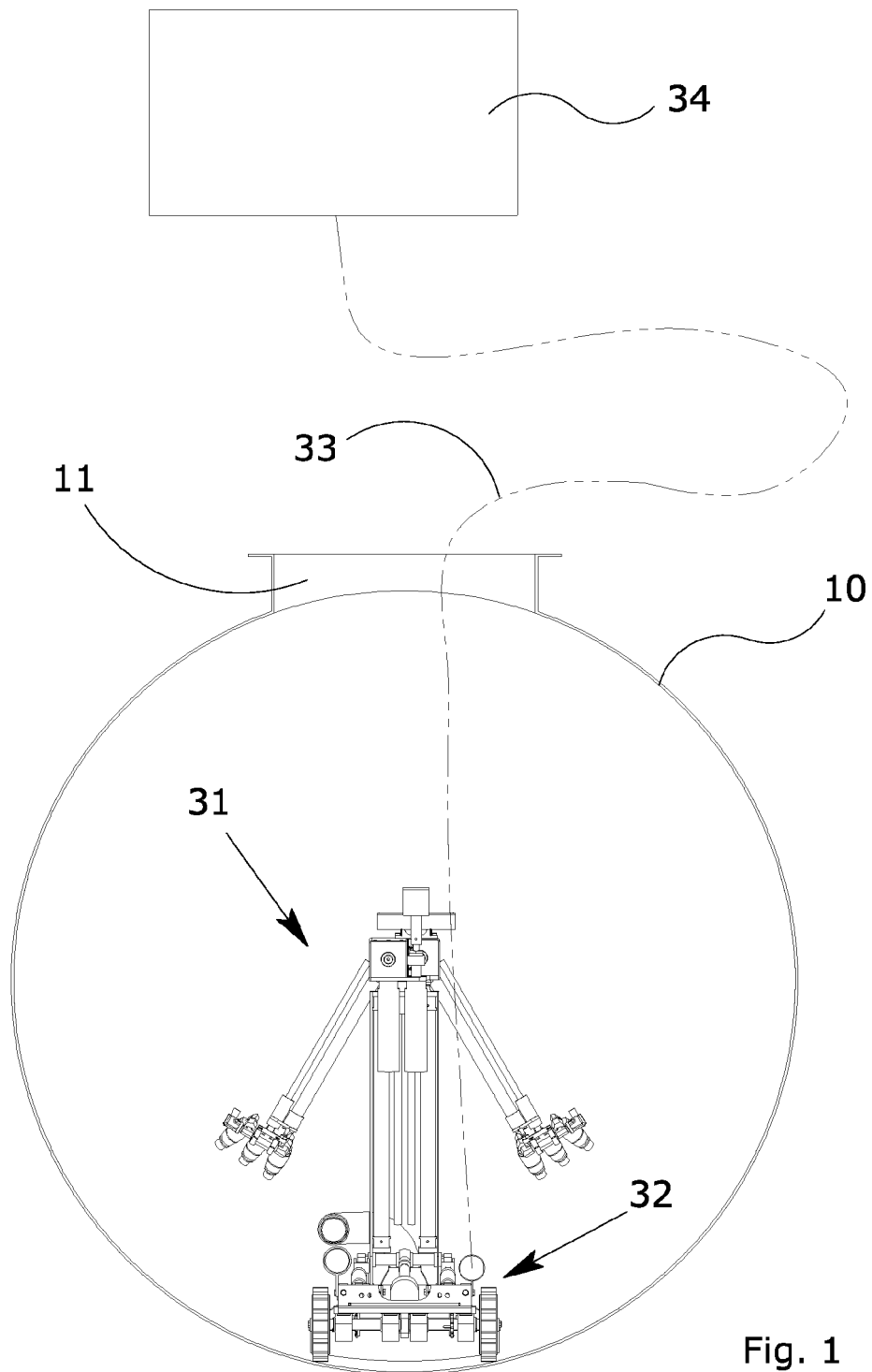


Fig. 1

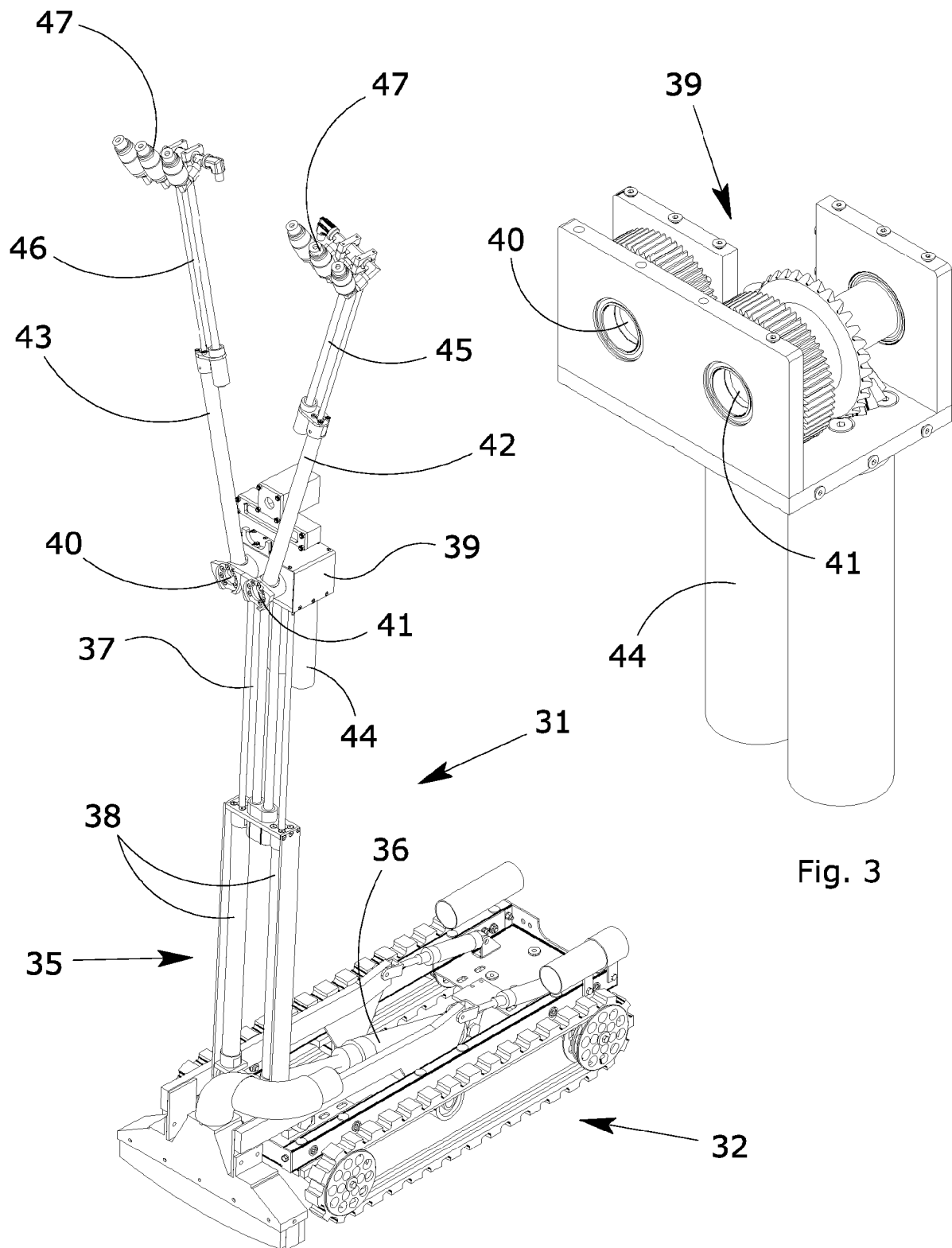
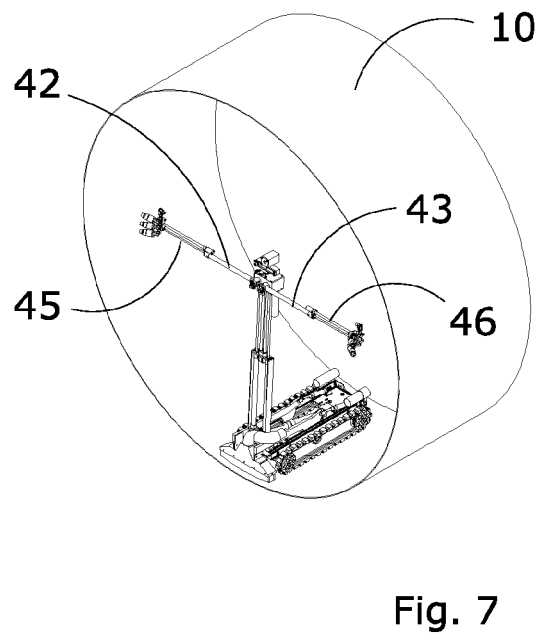
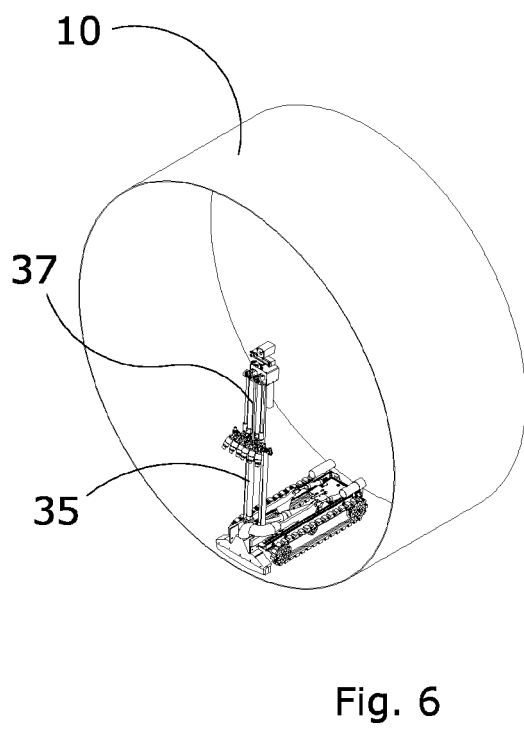
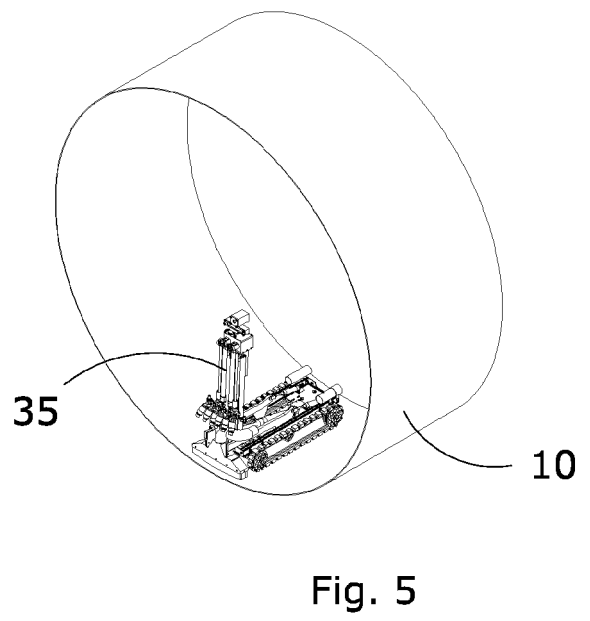
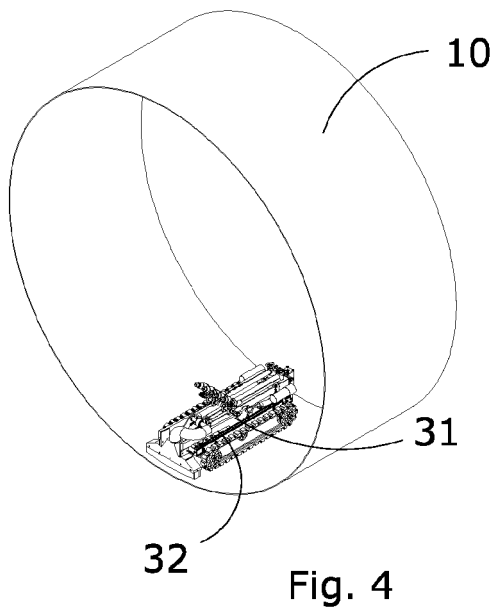


Fig. 3

Fig. 2



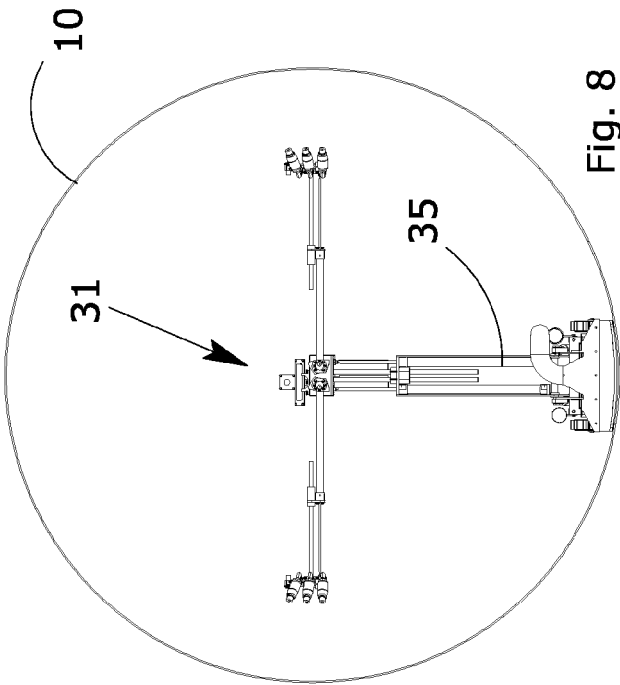


Fig. 8

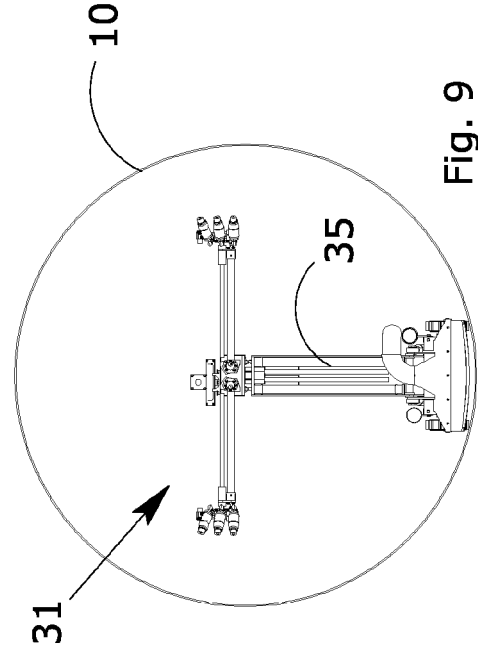


Fig. 9

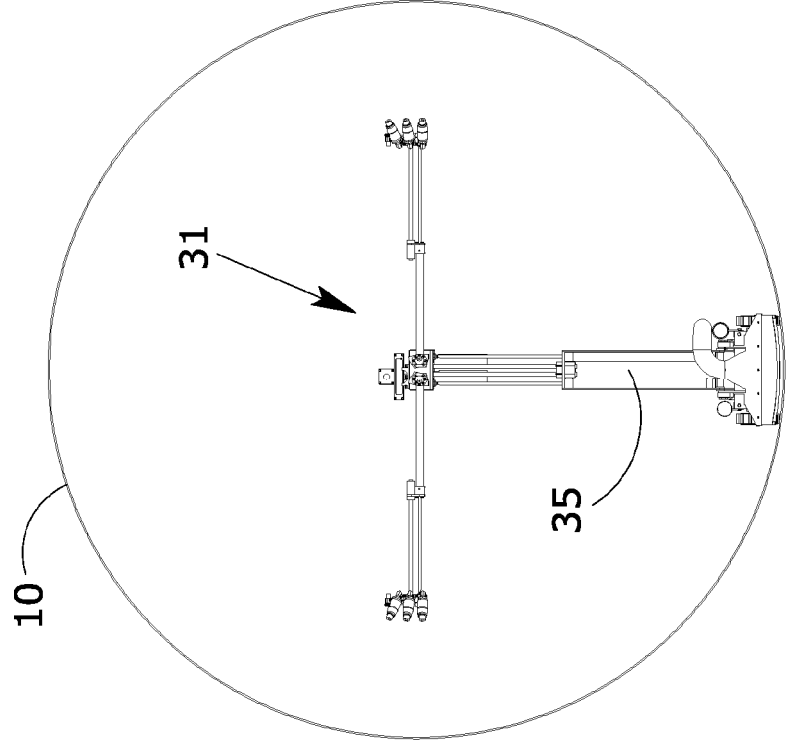


Fig. 10

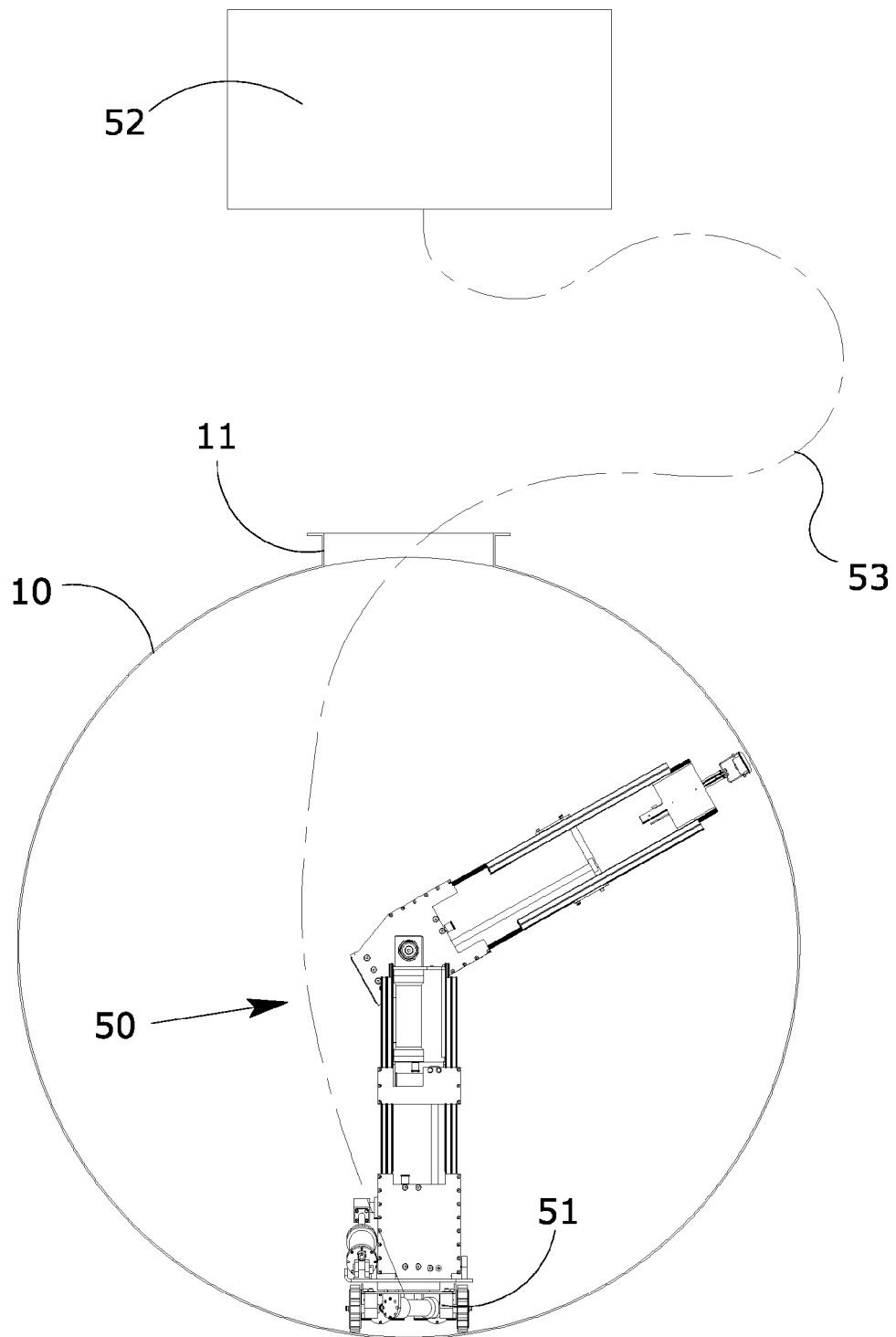


Fig. 11

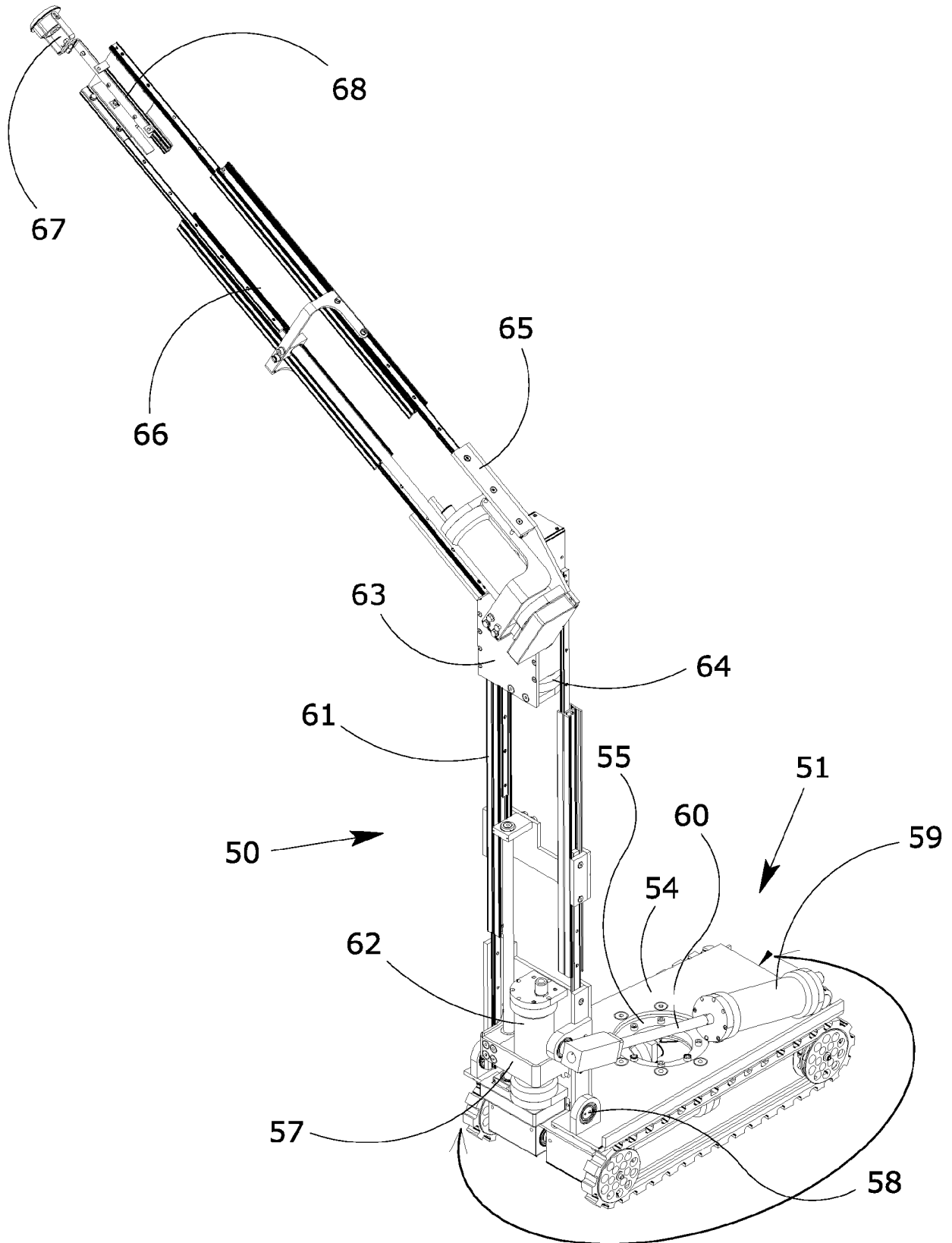
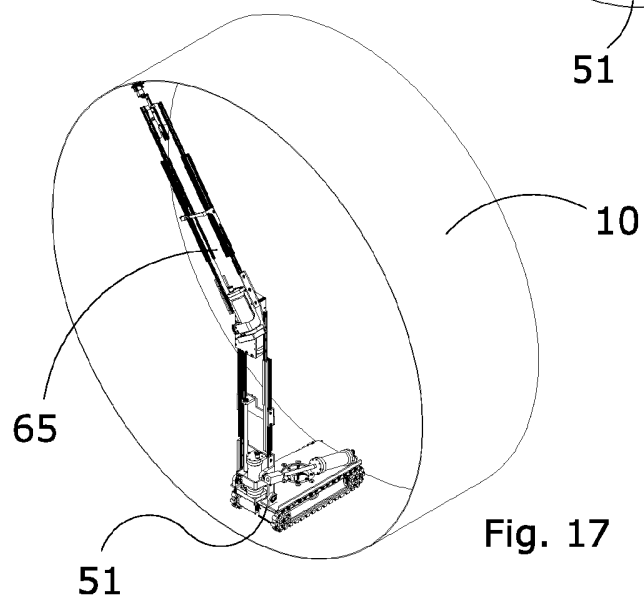
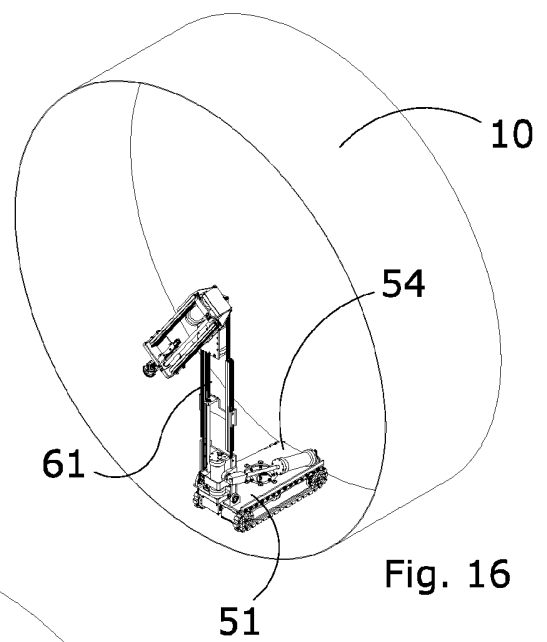
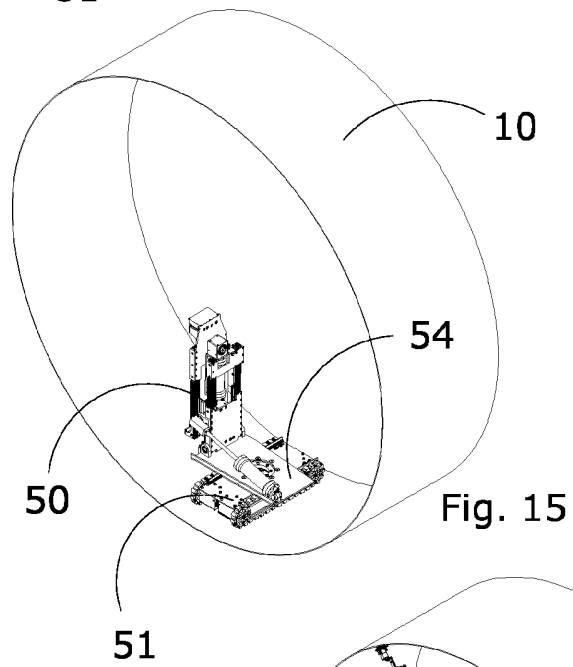
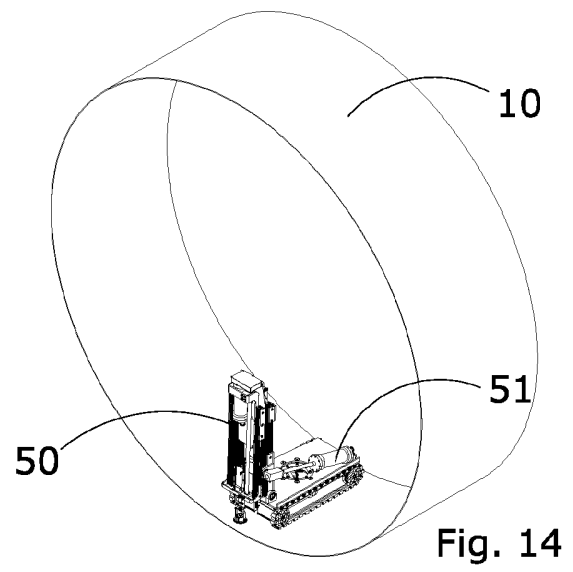
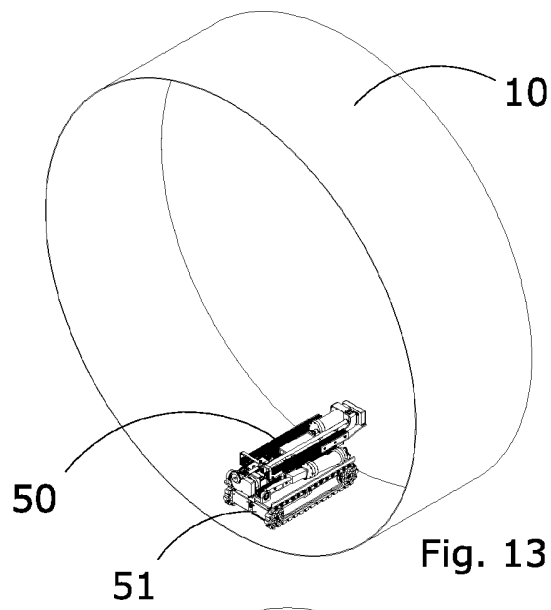
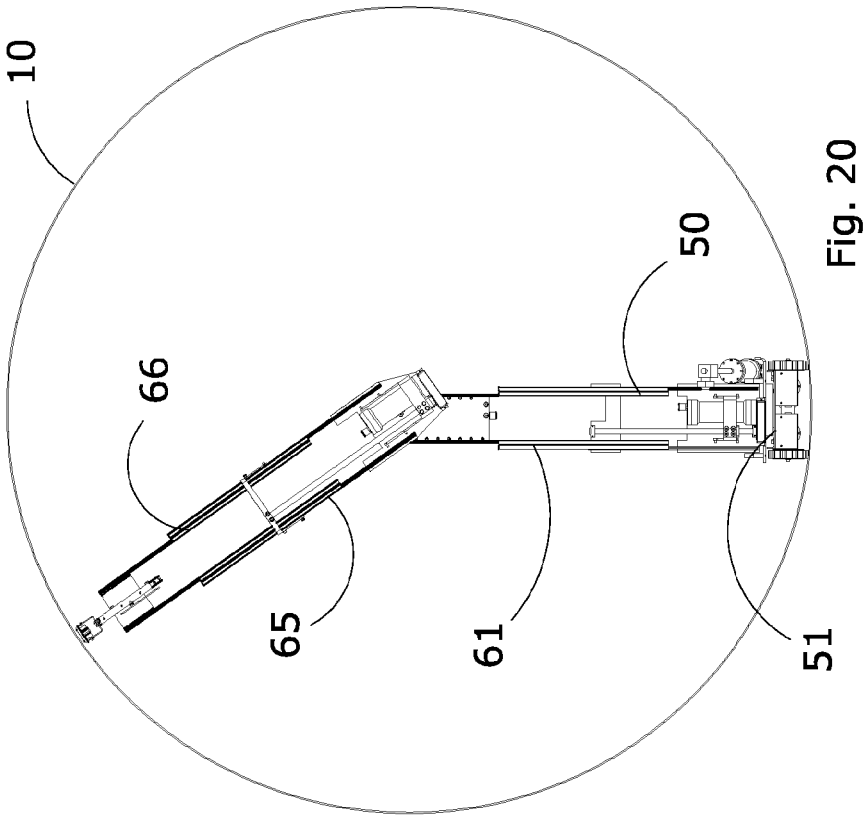
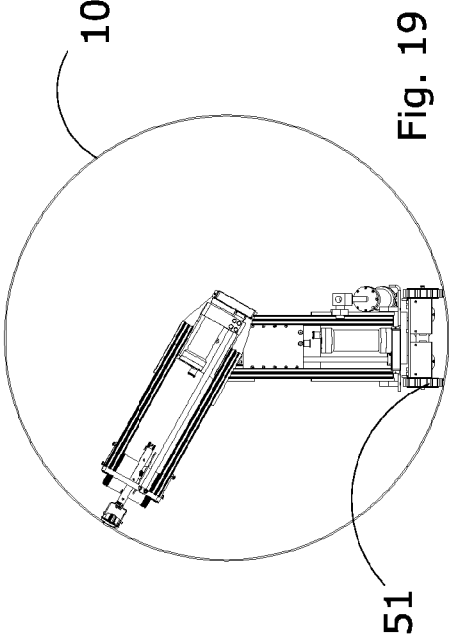
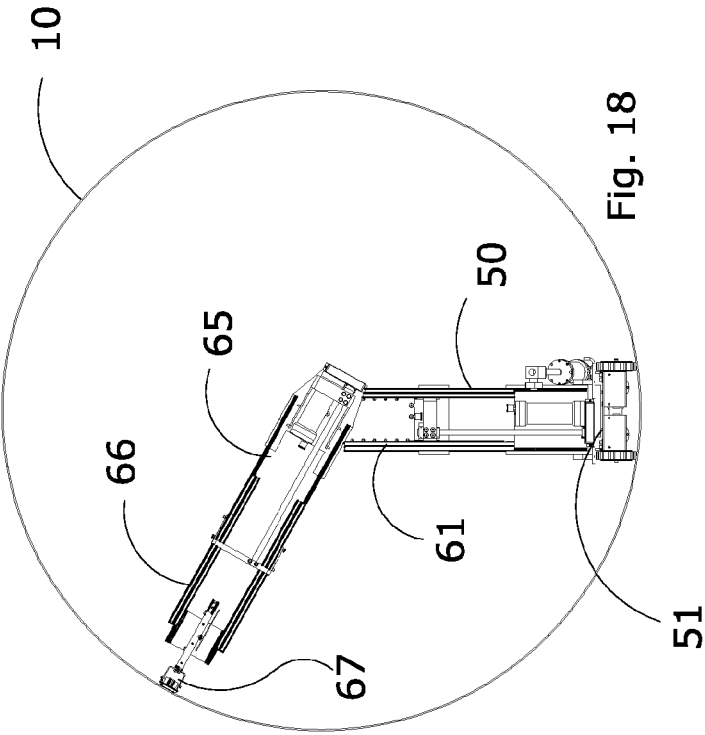


Fig. 12





REFERENCES CITED IN THE DESCRIPTION

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