



INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification ⁶ : G21C 17/013	A1	(11) International Publication Number: WO 95/18452 (43) International Publication Date: 6 July 1995 (06.07.95)
(21) International Application Number: PCT/SE94/01249 (22) International Filing Date: 23 December 1994 (23.12.94) (30) Priority Data: 9304295-0 28 December 1993 (28.12.93) SE (71) Applicant (for all designated States except US): ABB TEKNISKA RÖNTGECENTRALEN AB [SE/SE]; P.O. Box 121, S-183 22 Täby (SE). (72) Inventor; and (75) Inventor/Applicant (for US only): LANDER, Lars [SE/SE]; Lomvägen 435, S-191 56 Sollentuna (SE). (74) Agents: LUNDBLAD VANNESJÖ, Katarina et al.; Asea Brown Boveri AB, Patent, S-721 78 Västerås (SE).		(81) Designated States: AM, AT, AU, BB, BG, BR, BY, CA, CH, CN, CZ, DE, DK, EE, ES, FI, GB, GE, HU, JP, KE, KG, KP, KR, KZ, LK, LT, LU, LV, MD, MG, MN, MW, NL, NO, NZ, PL, PT, RO, RU, SD, SE, SI, SK, TJ, TT, UA, US, UZ, VN, European patent (AT, BE, CH, DE, DK, ES, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, ML, MR, NE, SN, TD, TG), ARIPO patent (KE, MW, SD, SZ). Published <i>With international search report.</i> <i>Before the expiration of the time limit for amending the</i> <i>claims and to be republished in the event of the receipt of</i> <i>amendments.</i>
(54) Title: DEVICE FOR INSPECTION OF A REACTOR VESSEL AND A METHOD FOR INSPECTION BY MEANS OF THE DEVICE (57) Abstract A device for inspection of a reactor vessel (1), for example a vessel for a pressurized-water reactor and a method for inspection by means of the device. The device comprises a manipulator (12) for inspection equipment (19), said manipulator being adapted to be anchored, by means of adhesion devices (24a, 24b, 24c, 24d) to the vessel wall during the inspection. The manipulator comprises a curved track (14) and a horizontal trolley (15) movable along the track for transfer of the inspection equipment, the extent of the track in the tangential direction of the vessel corresponding to an arc of the vessel's circumference. A rigid rod is attached to the device and to a lifting device. The manipulator is lowered into the vessel and moved towards the vessel wall.		

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Device for inspection of a reactor vessel and a method for inspection by means of the device

TECHNICAL FIELD

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The present invention relates to a device for inspection of a reactor vessel, for example a vessel for a pressurized-water reactor, comprising a manipulator for inspection equipment, the manipulator being adapted to be secured, by means of an adhesion device, to the wall of the vessel during the inspection, and to a method for inspection by means of the device.

BACKGROUND ART

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Complete inspections of reactor vessels of the kind mentioned in the introductory paragraph are carried out at certain time intervals. On these occasions, weld joints in vessel walls and in pipe sockets, known or suspected defects in the vessel and other areas of interest are inspected from the inside of the vessel by means of, for example, ultrasonic technique and/or eddy current technique. The inspections are carried out with the cover of the vessel and usually also all internal parts removed and with the vessel and the space thereabove filled with water as radiation protection.

For the above purpose, it is known to use devices of a so-called center mast type, a manipulator for the inspection equipment being arranged at a mast which is placed centrally in the vessel, resting on the upper flange thereof or on a service bridge at the opening of the vessel. The inspection equipment may comprise probes of ultrasonic type, of eddy current type, TV cameras, etc. US Patent US 5,193,405 illustrates a device of this type. It is also known, for the purpose in question, to use devices comprising a frame, movable along a circular track arranged at the vessel flange. A horizontal trolley movable in the horizontal

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direction is arranged at the frame, the horizontal trolley supporting a vertical mast along which the inspection equipment can be moved.

- 5 The above known devices are heavy and space-demanding, which means that it is complicated and time-consuming to mount and dismantle them at the site of inspection. In addition, the volumes of material which have to be decontaminated after completed inspection are large.

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In addition to the complete inspections, intermediate inspections are also carried out when especially certain regions of the vessel are inspected, for example known surface cracks and/or repaired regions on the inner wall of the vessel and in pipe sockets. Otherwise, these inspections are carried out under conditions similar to those described above. On the occasions of these inspections, the need of an appropriate, more compact and lighter device for carrying out the inspection becomes even more apparent.

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US 5,193,405 discloses a device comprising a base plate on which is mounted a platform which is rotatable in relation to the base plate and which supports a robot, obviously of a general industrial type, with six degrees of freedom. In the hand of the robot, inspection equipment in the form of an ultrasonic probe is placed and the device thus constitutes a manipulator for the inspection equipment. Further, it is designed such that its weight shall correspond to the displaced liquid volume, the displacement, when located in the reactor vessel which is filled with water during the inspection. When the device is immersed in the water, it moves to a desired region at the wall of the vessel by means of four propulsion devices, each one in the form of propellers mounted in tubes and arranged on the rotatable platform. When the device makes contact with the vessel wall, it is moved by means of four wheels resiliently fixed to the base plate, each wheel being provided with a control and drive device. By means of the wheels, the base plate is

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fine-positioned to a desired region on the vessel wall. When the desired position has been reached, the base plate is anchored to the vessel wall by means of an adhesion device, comprising four suction cups which are arranged at the base plate and which by means of pistons may be brought towards the vessel wall and be activated by means of a vacuum device. After that, the inspection is carried out by controlling the hand of the robot to a predetermined region on the vessel wall where the ultrasonic probe is activated. To determine the position of the device relative to the vessel, a laser beam is transmitted from a rotatable transmitter placed on a mast at the upper part of the vessel. The laser beam is reflected in a reflector arranged on the rotatable platform and the position is determined indirectly by calculations based on read-off values of the position of the rotatable transmitter upon reflection. All the operations are remotely controlled from a control device placed outside the radiation shield of the reactor.

The device described above has a complicated design, comprising drive devices for both freefloating movement in the water and mechanically complicated control and drive systems for movement on the vessel wall. In addition to the actual inspection method, it is the task of the control equipment to control all the movements, the movement of the rotatable platform, the six degrees of freedom of the robot and, for determining the position of the reflector in the vessel, the direction of the laser transmitter in space. To prevent the device from capsizing when it is moved floating in the water, it must be designed such that the center of gravity of the displacement is located above the center of gravity of the device, independently of the position of the robot arm. The forces which influence the adhesion device are dependent on the position of the robot, and the counter-weight which is proposed to be arranged on the robot to reduce this effect entails an increase of the weight of the device.

SUMMARY OF THE INVENTION

The invention aims to provide an improved and simplified device of the kind described in the introductory part of the description, which comprises a manipulator for the inspection equipment especially designed for its purpose and which utilizes devices, present at the site of inspection, for transfer to that region in the vessel which is to be inspected, and a method for inspection by means of the device.

What characterizes a device and a method according to the invention will become clear from the appended claims.

Advantageous improvements of the invention will become clear from the following description and claims.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention will be described in greater detail in the following with reference to the accompanying drawings, wherein

Figure 1 shows a section of a reactor vessel with a manipulator according to the invention for inspection of the wall of the vessel,

Figure 2 shows an embodiment of a manipulator according to the invention,

Figure 3 shows a track for a horizontal trolley according to the invention,

Figure 4 shows a horizontal trolley for a manipulator according to the invention,

Figure 5 shows a section of a reactor vessel with a manipulator according to the invention for inspection of a pipe socket in the vessel,

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Figure 6 shows another embodiment of a manipulator according to the invention,

Figure 7 shows still another embodiment of a manipulator according to the invention,

Figure 8 shows inspection devices which are movable along a track arranged at the flange of a reactor vessel, and

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Figure 9 shows a section of a reactor vessel with inspection devices according to Figure 8.

The majority of the drawings are produced by means of CAD equipment. The tubes 14a, 14b described below exhibit in the figures, in certain cases, a number of lines inside the contour lines of the tubes and extending in the axial direction of the tubes. These lines are auxiliary lines, not erasable by means of the CAD equipment, for construction of the figure and thus do not illustrate any physical feature of the tubes. The same is true also of the arm 20 in Figure 6 described below.

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DESCRIPTION OF THE PREFERRED EMBODIMENTS

The following description relates both to the method and to the device.

Figure 1 shows a section of a substantially cylindrical reactor vessel 1 for a pressurized-water reactor with the cover and internal parts removed. The upper part of the vessel accommodates pipe sockets 2 and 3 for supplying and removing water to/from the fuel core (not shown), and the flange 4 of the vessel is provided with supports 5 for guiding during mounting and dismantling of internal parts. The vessel is surrounded by a concrete structure 6 and is disposed immersed in a cavity 7 therein. At the upper part of the concrete structure, which constitutes a floor 8, fuel

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handling equipment 9 with a service bridge is arranged on a rail track 10 which is only roughly indicated. At the upper part of the fuel handling equipment, a telpher 11 with a lifting rope 111 and a lifting hook (not shown) is arranged.

5 The telpher may be moved in a horizontal direction above the vessel, which is indicated in the figure by showing the telpher dashed in three alternative positions.

When an inspection is to be carried out, the vessel 1 and
10 the cavity 7 are filled with water.

Figure 2 shows an embodiment according to the invention of a manipulator 12 for inspection equipment. The manipulator comprises a curved track 14, consisting of an upper tube 14a and a lower tube 14b, both of stainless steel. A horizontal
15 trolley 15 is movable along the track and supports a mast 16 with slots 161, 162 formed at the edges thereof. A vertical trolley 17 is movable along the mast, guided by the slots therein, in a direction perpendicular to the direction of
20 movement of the horizontal trolley. The vertical trolley comprises a rotary unit 18, rotatable around an axis perpendicular to the direction of movement of the vertical trolley. An arm 20, which is fixed to the rotary unit and rotatable by means of this, supports inspection equipment
25 19, comprising a probe holder 19a and an ultrasonic probe 19b. As indicated in the figure, the probe 19b is movable in the axial direction of the arm by means of brackets 19c, the supporting points of which against the probe holder are displaceable along the probe holder. The horizontal trolley,
30 the vertical trolley, the rotary unit and the probe are movable in a manner known per se, but not shown in detail in the figure, to the desired positions by means of drive devices controlled from control equipment (not shown) placed
35 outside the radiation shield of the reactor. The control equipment is also adapted to activate the inspection equipment, in a manner known per se, and to receive and record measured signals, including positional information, delivered by the inspection equipment.

The curved track is shown in detail in Figure 3. The upper and lower tubes are kept together by two frames 21a and 21b, respectively. At each of the frames, two suction cups 24a, 24b and 24c, 24d, respectively, are arranged. When the suction cups have been caused to make contact with the vessel wall, they can be activated, in a manner known per se, by means of a vacuum pump (not shown) such that negative pressure arises between the respective suction cup and the wall. Each one of the suction cups comprises a sensor, arranged in the central part thereof but not shown in the figure, to sense and supply to the control equipment a signal indicating that the suction cup makes contact with the wall with a negative pressure between the wall and the suction cup. Thus, the suction cups form adhesion members by means of which the manipulator may be anchored to the vessel wall.

As shown in Figure 2, a lifting yoke 22 is fixed to the frames 21a, 21b. A lifting attachment 23 is resiliently attached to the lifting yoke in the direction of movement of the vertical trolley. A lifting rod 23a, running in a tube 22a fixed to the lifting yoke, is formed at the lifting attachment. The lifting rod terminates in a cross-pin 23b (only slightly indicated in the figure) which is movable in the longitudinal direction of the tube 22a by running in two diametrically opposite, longitudinal slits 22b, one of which is shown in Figure 2. Between the cross-pin and a counter support (not shown) in the tube 22a, a compression spring (not shown) is arranged such that the lifting yoke may be suspended from the lifting attachment supported by the spring force and movable relative to the lifting attachment 23 in the direction of the lifting rod.

The horizontal trolley 15 is shown in detail in Figure 4. It comprises a frame, in the figure designated 15a, 15b, 15c, 15d, a drive unit 25, and three guide units 26a, 26b, 26c. The drive unit comprises a drive wheel 251, formed with a flange, and a support wheel 252, the guide unit 26a a support wheel 261a, formed with a flange, and a support

wheel 262a, and the guide units 26b and 26c each comprise two support wheels 261b, 262b and 261c, 262c, respectively. With the horizontal trolley mounted on the track, as shown in Figure 2, the drive and support wheels extend over the tubes 14a and 14b, respectively, and lock the horizontal trolley to the track 14 such that, when the drive unit 25 is activated, the horizontal trolley is able to move along the track and be guided thereby in its movement. A position transducer 27 with an indicating wheel 271, making contact with the tube 14a, delivers to the control equipment a signal indicating the position of the horizontal trolley along the path 14.

The embodiment of the manipulator shown in Figure 2 is particularly advantageous when a region on the inner wall of the vessel is to be inspected. This is indicated in Figure 1 by a manipulator 12 placed in the vessel in a position marked by 'C'. In this case it is advantageous to design the track 14 such that the tubes 14a, 14b have a radius of curvature substantially corresponding to the radius of curvature of the reactor vessel wall and, in addition, the manipulator such that the centers of curvature of the tubes and the wall substantially coincide when carrying out the inspection. The extent of the track in the tangential direction of the vessel corresponds to an arc of the circumference of the vessel. Thus, the horizontal trolley may be moved along a circular arc along the circumference of the vessel and the vertical trolley in a direction essentially parallel to the vertical axis of the vessel such that a region of the vessel wall may be inspected by means of the inspection equipment.

Figure 5 shows a section of a reactor vessel of the same kind as that mentioned with reference to the description of Figure 1. In this case the manipulator 12 is placed at the wall of the vessel in a position 'C' above and in immediate proximity to a pipe socket 3 for the purpose of carrying out inspection thereof.

- An advantageous embodiment of a manipulator for inspection of, for example, a repaired weld in a pipe socket is shown in Figure 6. The difference in relation to the manipulator shown in Figure 2 is essentially that the arm 20 in this case is extended and that the probe holder 19a, which is fixed to the arm, is designed as a guide 19d in which the probe may be moved in a manner known per se in the axial direction of the arm, that is, of the pipe socket 3.
- To effectively carry out a complete internal inspection of a pipe socket, the manipulator may advantageously be designed as shown in Figure 7. A sleeve 19e is mounted on the arm, movable in the axial direction thereof, by means of a drive screw and nut of ball type, four probe holders 19a being arranged on the movable sleeve. To increase the rigidity of the design with respect to flexural stresses in the arm, the arm is in this case rotatable via a separate rotary unit mounted at the vertical trolley with a frame 28.
- In the initial position for an inspection, the manipulator 12 is placed on the floor 8 in a position in Figure 1 designated 'A'. With the aid of the telfer of the fuel handling equipment, a detachable revolving crane may be mounted on the fuel handling equipment whereupon the manipulator with the aid of the revolving crane and a lifting tool designed for this purpose, arranged in the lifting hook thereof, is lifted in the lifting attachment 23 and moved to a position, designated B in Figure 1, over the opening of the reactor vessel in order to be suspended there in a manner known per se, with the lifting attachment detachable, from the fuel handling equipment in an attachment (not shown) provided for this purpose on the fuel handling equipment. Thereafter, a magazine 13 is moved in similar manner by means of the revolving crane from a position on the floor, to be suspended from the fuel handling equipment in a position designated B. In the magazine, a number of stiff extension rods of a known length are placed, commonly designated 131. At their ends the rods are formed such that

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they can be rigidly joined to the lifting attachment 23 and to each other, both with respect to bending and torsion, and be suspended from the attachment of the fuel handling equipment.

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Thereafter, an extension rod is fetched from the magazine 13 by means of the telpher of the fuel handling equipment, which telpher is provided with a lifting tool designed for the purpose in the lifting hook thereof, and the extension
10 rod is then fixed to the lifting attachment 23 in a manner known per se. The lifting attachment is then detached from the attachment in the fuel handling equipment and with the telpher of the fuel handling equipment the manipulator is lowered to be suspended from the attachment in the fuel
15 handling equipment at the upper end of that extension rod which was last fetched from the magazine. The lifting tool of the telpher is detached from the extension rod, whereupon additional extension rods are fetched from the magazine, and the joining operation is repeated as described above. In
20 this way, the manipulator may be successively lowered down into the vessel until, suspended from the lifting hook of the telpher, it reaches a predetermined level, designated C in Figure 1, corresponding to a region which is to be inspected and determined by means of calculations based on
25 the positions of the fuel handling equipment and the telpher and the lengths of the rods. In the horizontal direction, the manipulator is moved to the predetermined region by moving the telpher in this direction. By connecting the extension rods to each other such that they are able to
30 transmit to the manipulator bending and torsional forces, the manipulator can now be brought towards the wall of the vessel with the aid of the telpher such that all four suction cups will make contact with the vessel wall. That this is the case is verified by observing the procedure by means
35 of, for example, a TV camera. When it is determined that the suction cups make contact with the vessel wall, their vacuum pumps are activated such that the manipulator is secured to the vessel wall. Starting from this position, the inspection

equipment may be moved by moving the horizontal trolley and the vertical trolley and by rotating the arm and moving the probe holder and/or the probe. By using a detachable revolving crane for lifting the manipulator, the crane which is
5 normally present at the inspection site is released for other activities in the reactor hall.

For identifying the region of interest to the inspection, an initial sensing of the available region of inspection may be
10 made, either with the aid of specially designed detecting probes or with the probes which are intended to be used during the actual inspection. The respective probes are thereby activated from the control equipment whereupon the available region is systematically detected and measured
15 data and their coordinates are recorded. Thereafter, the actual inspection of the region can be carried out in a manner known per se. When it is terminated, the adhesion members are deactivated, whereupon the manipulator is either brought directly to a new region of inspection or back to
20 the fuel handling equipment where it is suspended to change the number of extension rods in the manner described above. When all the regions in question have been inspected, the manipulator is again brought to the fuel handling equipment in order to be dismantled by reversing the process described
25 above.

It may be advantageous to allow the manipulator to remain suspended from the extension rods in the telpher also during those stages when it is secured to the vessel wall. The
30 changes in the length of the extension rods which arise as a result of temperature variations, as well as any changes in height of the lifting hook of the telpher, are thus taken up by resiliently attaching the lifting attachment 23 to the lifting yoke.

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With a manipulator according to the invention, which is specifically designed to carry out the movements of the inspection equipment which occur during the inspections, and

which is only using simple transport devices, which are normally available at the inspection site, for its location at the regions in question in the reactor vessel, a very simple, light and compact design is obtained which, during transport to and from the inspection site, takes up a very small volume and which is simple to mount in a space which is often narrow and difficult to reach. This entails considerable advantages in that the time from the point where the device has been brought to the inspection site and until it can leave the site again after completed inspection may be made very short. One consequence of this is that the time during which the reactor is blocked for other activities because of the inspection may be minimized. The method of bringing the manipulator to the region in question in the reactor vessel using simple transport devices also means that the cost of the manipulator may be kept low. The volumes of material which are contaminated during the inspection also become very small.

It has also proved advantageous to utilize parts of the manipulator according to the invention for designing an inspection device which, in a manner known per se, rests on an annular track arranged at the upper flange of the reactor vessel. Figure 8 illustrates this in the form of an oblique view of an annular track 29 and a manipulator 30 for inspection of pipe sockets and a manipulator 31 for inspection of a vessel wall. In order not to obscure the manipulator 30, the track is not shown as a closed loop in Figure 8 but it may, of course, be designed as such. The track is composed of tubes of the same kinds as the tubes 14a, 14b which form the track for the manipulator according to the invention described above. The track 29 rests with supports 32 against the flange (not shown) on the reactor vessel. A vertical mast 33 of the same kind as the vertical mast 16 described above is carried by a trolley 34, which is arranged to be movable along the track 29. A mast support 35 is arranged during the inspection to support, by means of rollers 351, 352, against the vessel wall.

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The manipulator 30 comprises a cross-beam 303, arranged at the mast, of the same kind as the mast. An arm 301 with a sleeve 302 movable thereon is arranged on the cross-beam, the arm and sleeve being of the same kind as the arm 20 and the sleeve 19e described above with reference to Figure 7. The arm 301 is movable along the cross-beam in similar manner as the vertical trolley 17, described with reference to Figure 2, is movable along the vertical mast 16. The arm 301 is also rotatable around its axis by a rotary unit (not shown). Inspection equipment may be arranged at the sleeve 302 in the same way as described above with reference to Figure 7.

The manipulator 31 comprises a vertical trolley 36 with a rotary unit 37, both of the same kind as the vertical trolley 17 with the rotary unit 18 described above with reference to Figure 2. An arm with inspection equipment, preferably of the same kind as described above with reference to Figure 2, may be arranged at the rotary unit 37.

Figure 9 shows the two manipulators 30 and 31 immersed into the reactor vessel 1 in positions for initiating an inspection of, respectively, a pipe socket 2 and a region on the vessel wall by means of inspection equipment 19 (only roughly indicated in the figure). To carry out an inspection of the pipe socket by means of the manipulator 30, the arm 301 is first moved along the cross-beam 303 to a position where the arm is at least partially located in the pipe socket. The mast 33 of the manipulator 31 has a curved portion 331 at its lower part. The mast support 35 and the vertical trolley 36 are so designed that the vertical trolley may pass between the vessel wall and past the mast support in a direction towards the bottom portion 38 of the vessel such that the vertical trolley may be moved along the curved portion of the mast. This enables inspection also of regions at the bottom portion of the vessel, for example the welds which are marked 381, 382, 383 in the figure. By

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designing devices for inspection as described with reference to Figures 8 and 9, inspections of the vessel wall and of pipe sockets may be carried out simultaneously, possibly also simultaneously with a device according to the invention
5 anchored to the vessel wall.

The embodiment described above relates to inspection of a reactor vessel for a pressurized-water reactor, but the invention may of course also be applied to inspection of
10 other types of reactor vessels.

CLAIMS

1. A device for inspection of a predetermined region in a reactor vessel (1), for example a vessel for a pressurized-
5 water reactor, comprising a manipulator (12) for inspection equipment (19), said manipulator being adapted to be anchored to the vessel wall, by means of adhesion devices (24a, 24b, 24c, 24d), during the inspection, **characterized**
10 in that the manipulator comprises a curved track (14), a horizontal trolley (15) movable along the track for transfer of the inspection equipment and a lifting attachment (23) arranged at the track, the extent of said track in the tangential direction of the vessel corresponding to an arc of the vessel's circumference and the adhesion devices being
15 attached to the track to anchor said track to the region predetermined for the inspection.

2. A device according to claim 1, **characterized** in that it further comprises a rod (131) for connection to the lifting
20 attachment, said rod being able to transmit forces in its bending and torsional direction to the manipulator to transfer the manipulator to the region predetermined for the inspection.

25 3. A device according to any of the preceding claims, **characterized** in that the manipulator comprises a mast (16) which is movable by means of the horizontal trolley and which is arranged substantially perpendicularly to the direction of movement of the horizontal trolley, and a
30 vertical trolley (17), movable along the mast, for transfer of the inspection equipment.

4. A device according to claim 3, **characterized** in that the vertical trolley comprises a rotatable arm (20) which
35 supports the inspection equipment.

5. A device according to claim 4, **characterized** in that the inspection equipment is movable along the arm.

6. A device according to any of the preceding claims, **characterized** in that the lifting attachment is resiliently attached to the track in a direction perpendicularly to the direction of movement of the horizontal trolley.

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7. A method for inspection of a predetermined region in a reactor vessel (1), for example a vessel for a pressurized-water reactor, with a device comprising a manipulator (12) for inspection equipment (19), said manipulator being adapted, during the inspection, to be anchored to the reactor vessel by means of adhesion devices (24a, 24b, 24c, 24d) and said manipulator comprising a curved track (14), a horizontal trolley (15) movable along the track for transfer of the inspection equipment, and a lifting attachment (23) arranged at the track, **characterized** in that it comprises the following steps:

a flexurally and torsionally rigid rod (131) is attached to the lifting attachment,
by means of a lifting device (11) present at the site of inspection, the manipulator is lowered down into the reactor vessel suspended from the rod and is moved with the lifting device towards the vessel wall at the region predetermined for the inspection, and

when it has been determined that the manipulator makes contact with the vessel wall with its adhesion devices, the adhesion devices are activated to anchor the track to the wall.

8. A method according to claim 7, whereby at least one of a fuel handling device (9) and a service bridge is arranged at the reactor vessel and a magazine (13) for additional rods (131) is placed at the reactor vessel, **characterized** in that the lowering of the manipulator into the reactor vessel comprises the following steps:

with the lifting device the manipulator is placed suspended from the rod in an attachment in the at least one of the fuel handling equipment and the service bridge, respectively,

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with the lifting device an additional rod is fetched from the magazine for rods and is brought to the rod from which the manipulator is suspended,

5 the rod last fetched from the magazine is attached in a flexurally and torsionally rigid manner to the rod from which the manipulator is suspended, whereupon this rod loosens from the attachment, and

the manipulator is lowered down into the reactor vessel suspended from the rod last fetched from the magazine.

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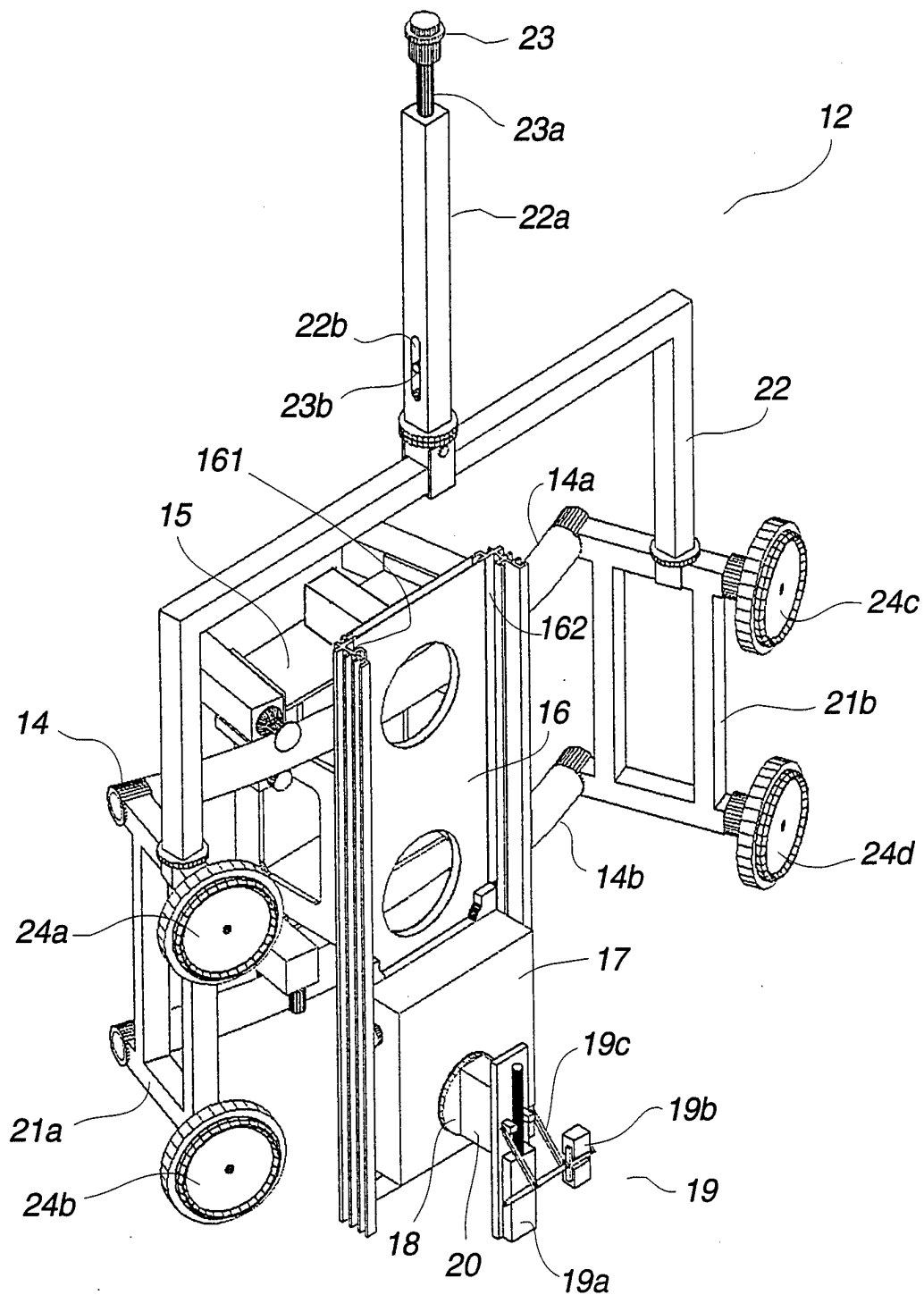
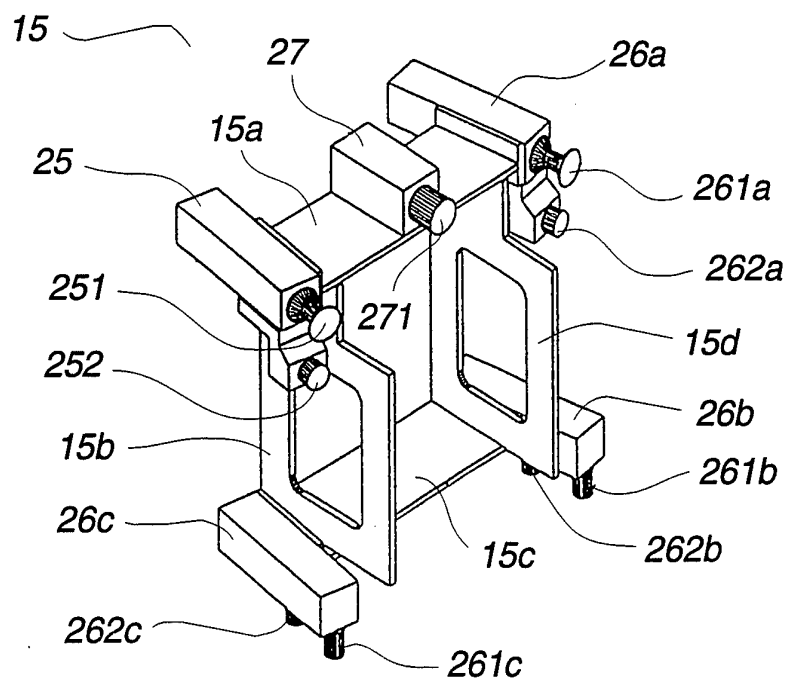
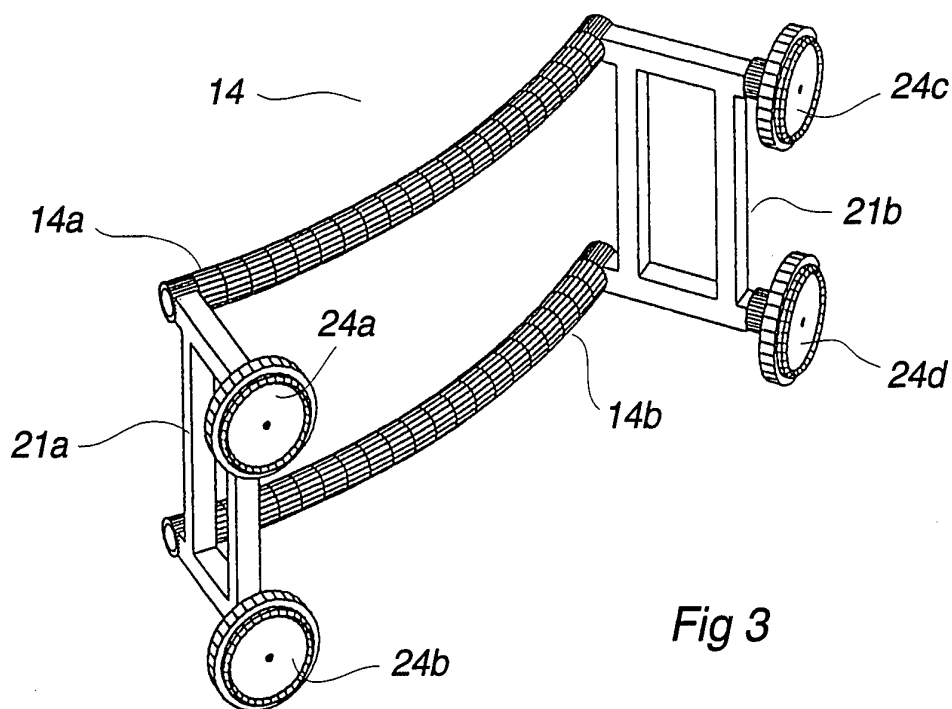


Fig 2

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SUBSTITUTE SHEET

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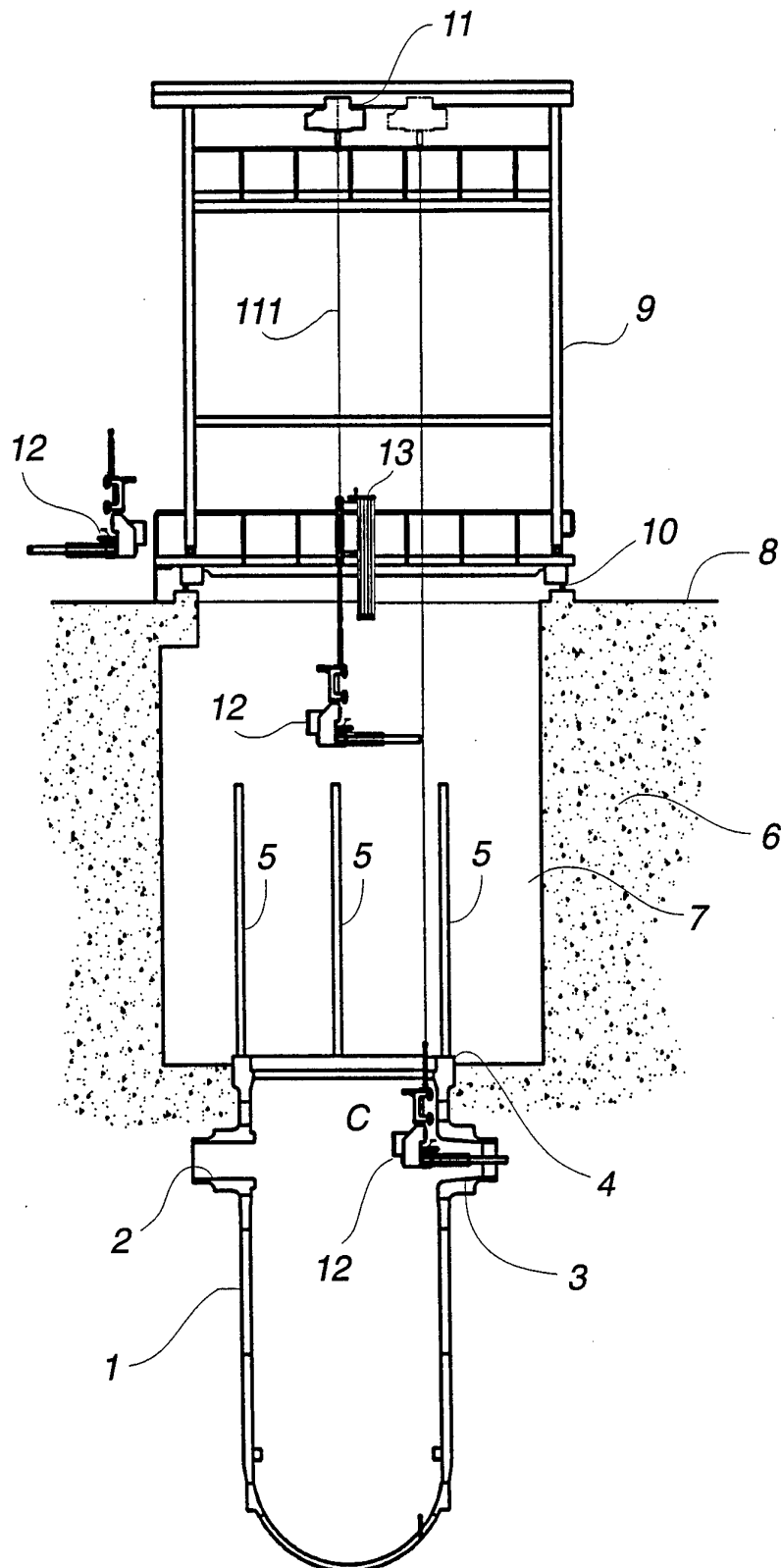


Fig 5

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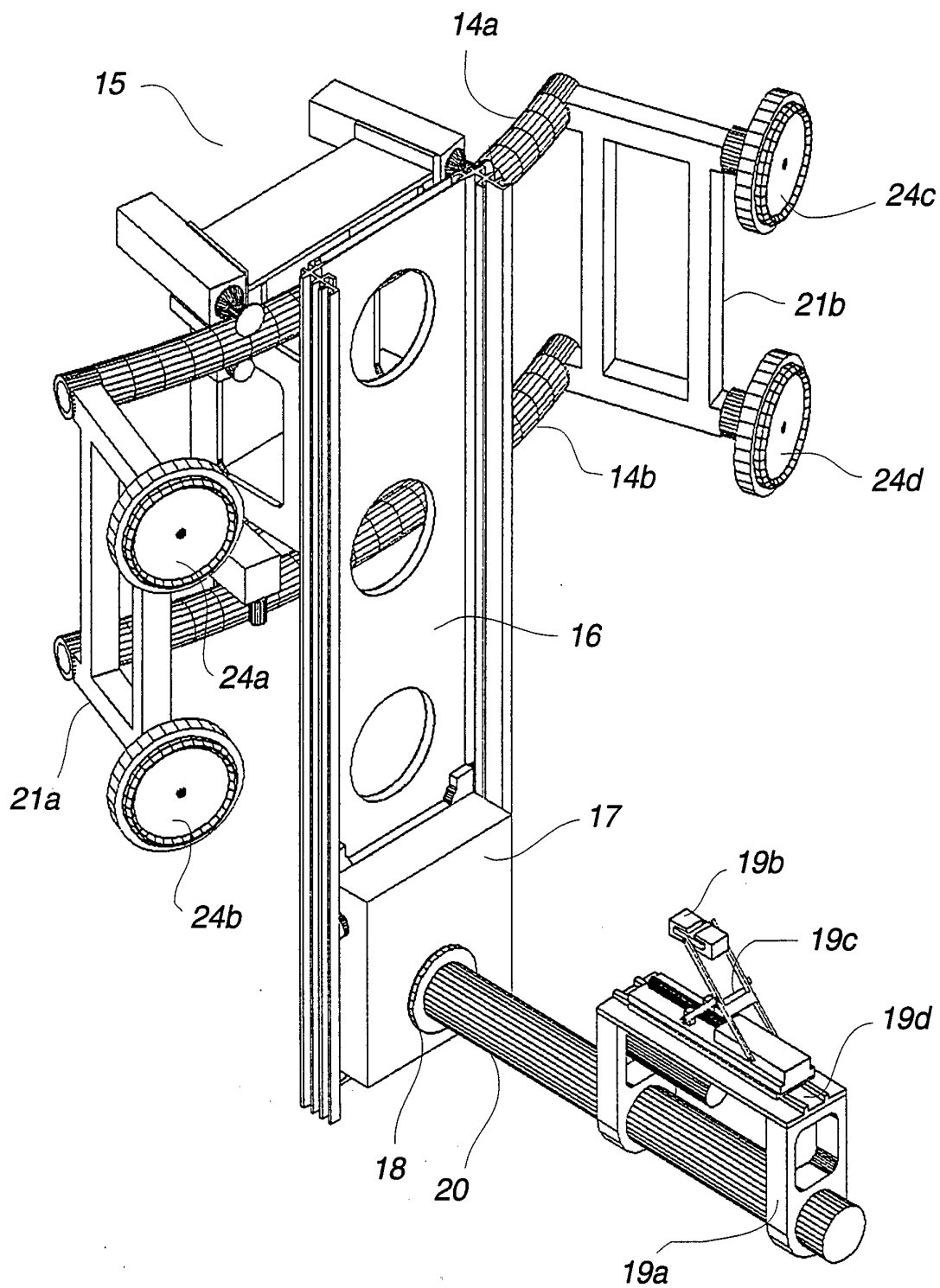


Fig 6

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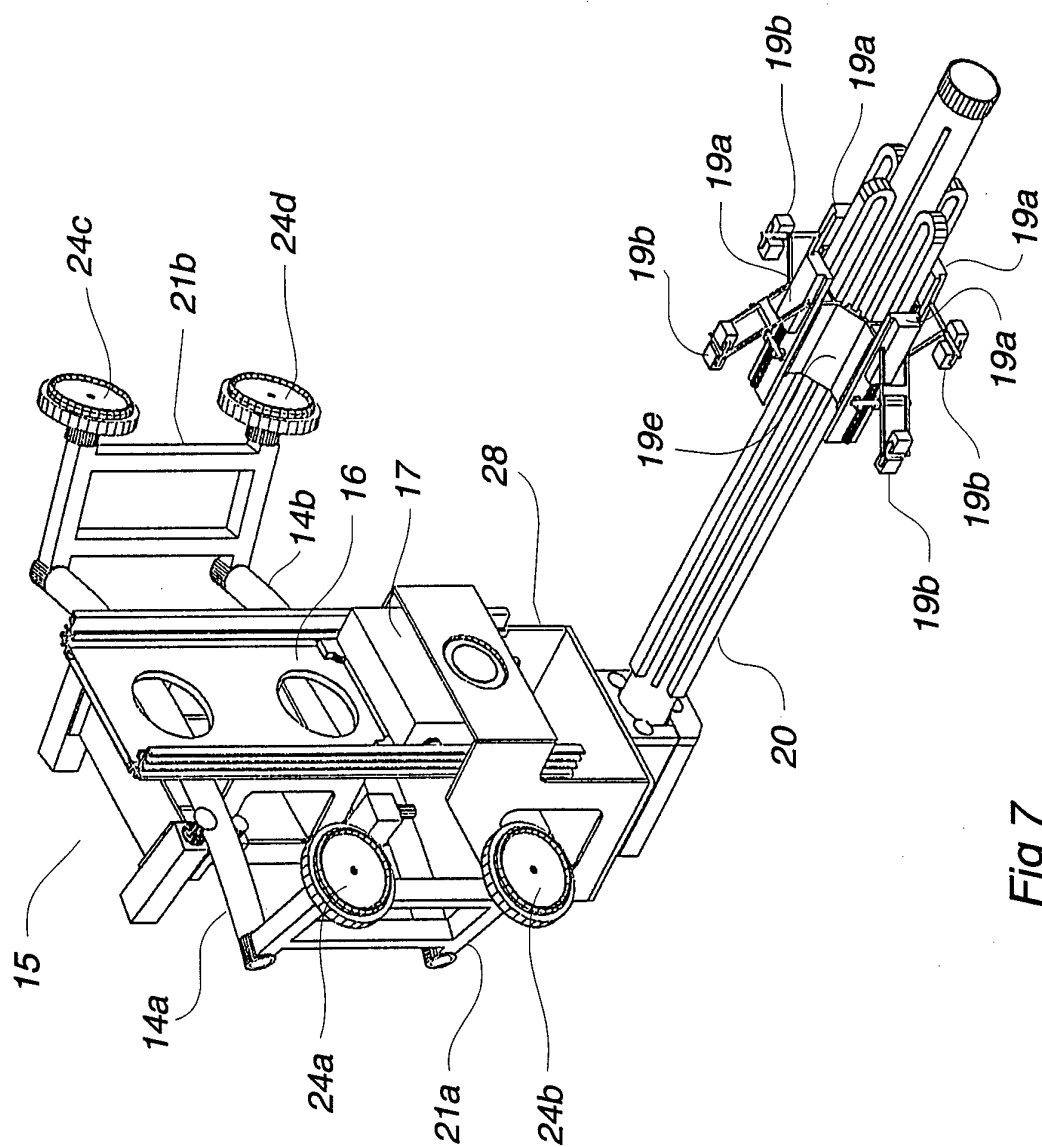


Fig 7

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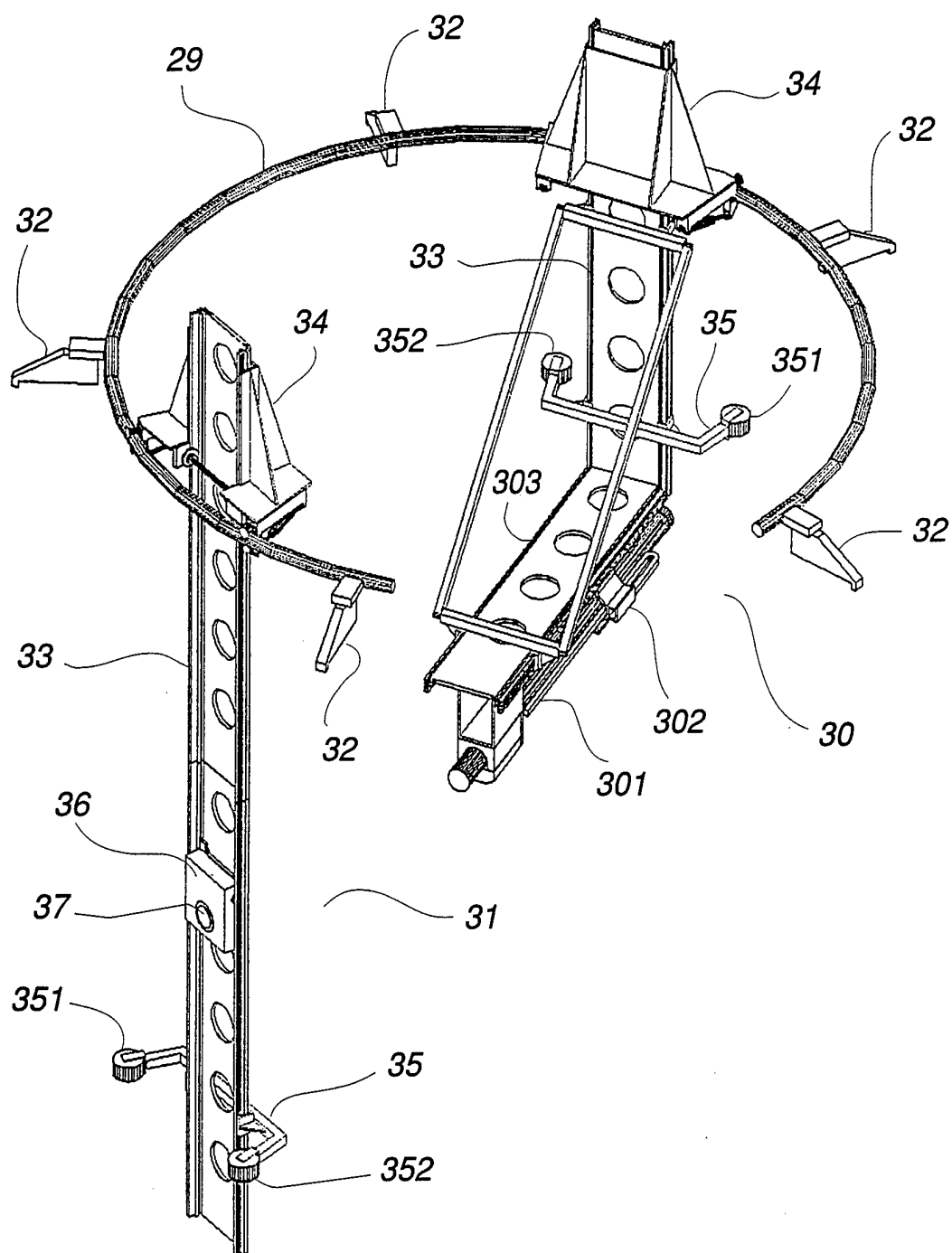


Fig 8
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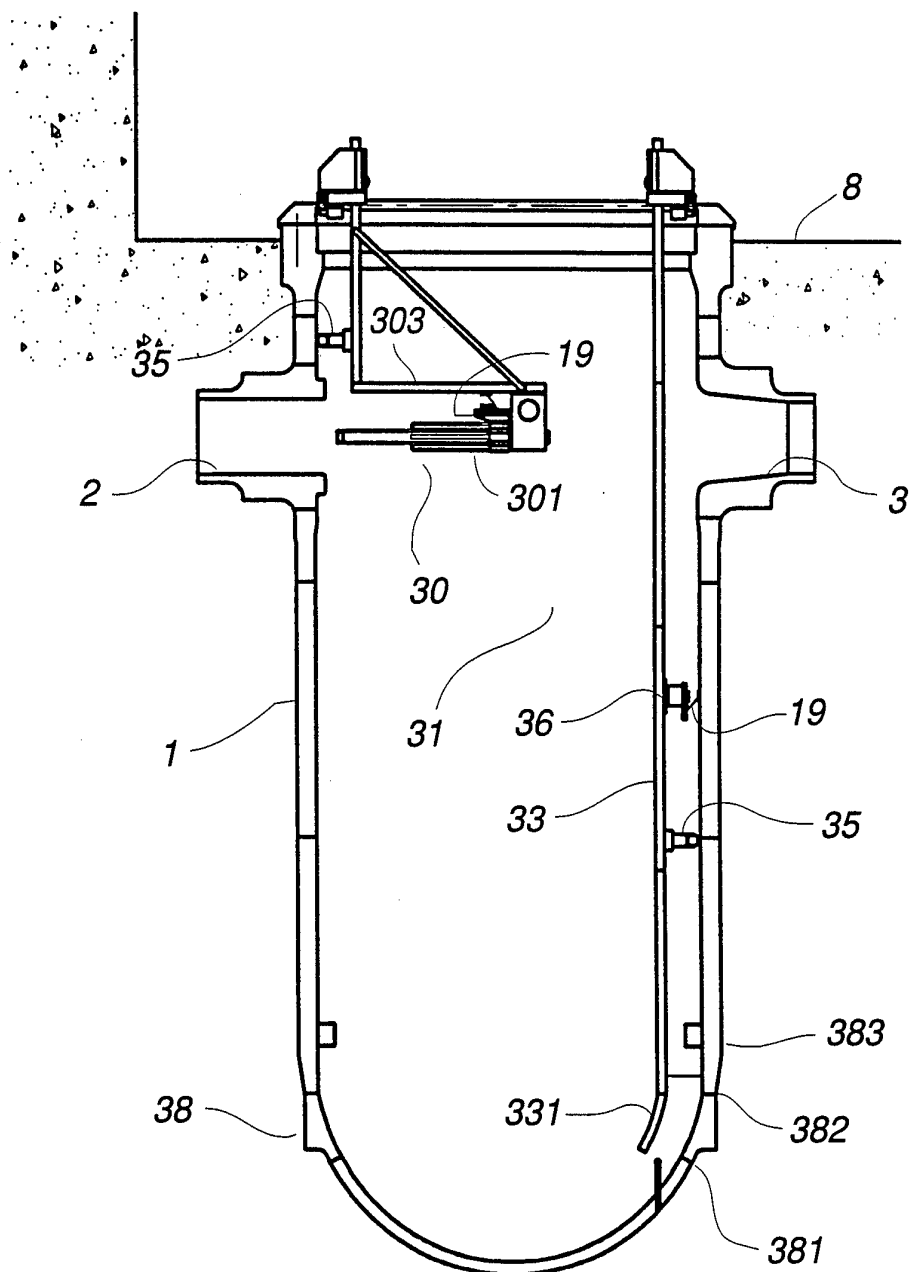


Fig 9
SUBSTITUTE SHEET

INTERNATIONAL SEARCH REPORT

International application No.

PCT/SE 94/01249

A. CLASSIFICATION OF SUBJECT MATTER		
IPC6: G21C 17/013 According to International Patent Classification (IPC) or to both national classification and IPC		
B. FIELDS SEARCHED		
Minimum documentation searched (classification system followed by classification symbols)		
IPC6: G21C, G01N		
Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched		
SE,DK,FI,NO classes as above		
Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)		
C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US, A, 4883576 (A. GEMMA), 28 November 1989 (28.11.89), column 3, line 3 - line 61 --	1,2
A	EP, A1, 0155375 (KRAFTWERK UNION AKTIENGESELLSCHAFT), 25 Sept 1985 (25.09.85) --	
A	SE, B, 438219 (TEKNISKA RÖNTGENTRALEN AB), 1 April 1985 (01.04.85) --	
A	US, A, 4196049 (D.C. BURNS ET AL), 1 April 1980 (01.04.80) --	
☒ Further documents are listed in the continuation of Box C. ☒ See patent family annex.		
* Special categories of cited documents: "A" document defining the general state of the art which is not considered to be of particular relevance "E" earlier document but published on or after the international filing date "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) "O" document referring to an oral disclosure, use, exhibition or other means "P" document published prior to the international filing date but later than the priority date claimed "T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention "X" document of particular relevance: the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone "Y" document of particular relevance: the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art "&" document member of the same patent family		
Date of the actual completion of the international search		Date of mailing of the international search report
19 April 1995		27 -04- 1995
Name and mailing address of the ISA/ Swedish Patent Office Box 5055, S-102 42 STOCKHOLM Facsimile No. +46 8 666 02 86		Authorized officer Anette Hall Telephone No. +46 8 782 25 00

INTERNATIONAL SEARCH REPORT

International application No.

PCT/SE 94/01249

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US, A, 4645637 (R. BAUER ET AL), 24 February 1987 (24.02.87) --	
A	US, A, 5128094 (G. MÜLLER ET AL), 7 July 1992 (07.07.92) -- -----	

INTERNATIONAL SEARCH REPORT

Information on patent family members

25/02/95

International application No.

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