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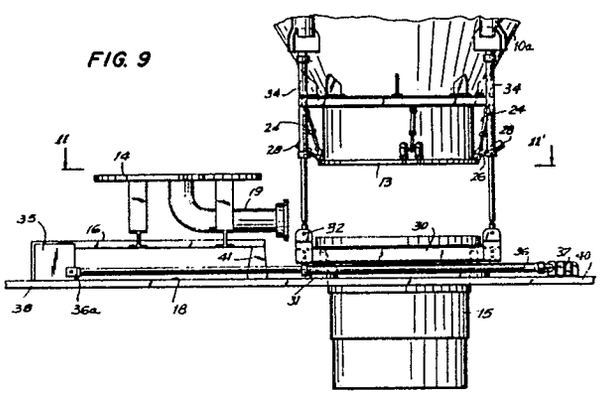
(54) Bottom unheading device and method for vertical vessels.

(57) The unheading device includes a cover unit (14) for attachment to a lower flange of a coking drum (10), fastening means (20) by which a plurality of swing bolts are disconnected by remotely operated detensioning equipment, and a frame device (16) which can lower the cover unit and moves it on a carriage unit laterally to one side. A chute (15) attached to the frame can be raised into engagement with the coking drum lower flange for removal of coke from the drum. Following such coke removal, the chute is lowered and the cover unit is moved laterally and remotely reconnected to the coking drum lower flange.

FIG. 9



EP 0 330 295 A1

BOTTOM UNHEADING DEVICE AND METHOD FOR VERTICAL VESSELS

This invention relates to a bottom unheading device for vertical vessels, such as coking drums which are adapted for remote operation. It particularly relates to such a bottom unheading device for removing and replacing a lower cover unit for coking drums and to a method for remote operation of the unheading device.

During the operation of delayed coking drums or units for coking various heavy hydrocarbon materials in petroleum refinery operations, the resulting coke is deposited progressively on the inner walls of the drum and when full must be removed, usually at 36-48 hour intervals. A typical decoking apparatus for such coking drums is disclosed by U.S. Patent No. 4,611,613 to Kaplan. Such coke removal from coking drums is accomplished through an opening in the lower end of the vertically-oriented drum, and is usually accomplished by manually removing a lower flange cover and installing a chute to direct the coke removed to a desired location, such as to a happer or rail car. Because the coking drum operates at relatively high temperatures of 800-900° F, such removal of the hot coking drum lower cover by manual means is slow and hazardous and is therefore undesirable.

A useful remotely operated unheading device for coking drums is disclosed by co-pending patent application Serial No. 917,443 to Malsbury et al. However, this device has been found to have some deficiencies, which have been overcome by this invention. Accordingly, the invention advantageously provides an improved bottom unheading device for coking drums for remote safe and reliable removal and replacement of coking drum lower cover unit, and enables more convenient and rapid removal of coke from the drum during decoking operations.

The present invention provides an improved unheading device for the bottom flange of vertically oriented vessels such as coking drums. This device is adapted for remote unfastening and removal of a lower cover unit, moving it transversely to one side to permit coke removal from the drum, and subsequent replacement of the cover unit onto the coking drum. The unheading device according to the invention includes a cover unit adapted for being fastened pressure-tightly to a lower flange of a coking drum bolt detensioning and pivotable clamping means adapted for unfastening a plurality of bolts in the cover unit and swinging the bolts radially outward and upward so as to permit downward removal of the cover unit, a vertically movable lifting frame means adapted for supporting and lowering the cover unit from the drum lower flange, and a carriage unit supported by said lifting frame and adapted for lateral movement of the cover unit relative to the lifting frame and coking drum by dual horizontal piston actuator means for moving the cover unit laterally to a side position. The unheading device also includes a chute attached to the lifting frame, so that the chute can be raised to contact the coking drum lower flange for conveying the coke removed from the drum. The unheading device also provides for the cover unit to be returned laterally so as to be in vertical alignment with the coking vessel lower flange, lifted up into engagement with the lower flange, after which the cover unit fasteners can be rotated downwardly and refastened to reclamp the cover unit into place on the coking drum lower flange.

The multiple bolt fasteners of the unheading device are pivotally attached to the coking vessel lower flange, so they can be swung radially outward and upward by vertically-oriented piston actuators attached to the vessel, thus permitting lowering of the cover unit. Preferably, two adjacent pivotable bolts are attached to a single piston actuator. The lifting frame means is rectangular-shaped and is supported and moved vertically by four equally-spaced hydraulic piston actuators, which are attached at their lower ends to the frame outer corners and attached at their upper ends to the coking vessel.

A chute is attached to the frame for use in removing the deposited coke from the vessel. After the cover unit mating flanges are unfastened, the frame means can lower the cover unit by operation of the four vertically-oriented piston actuators, after which the cover unit can be moved laterally from beneath the coker drum by dual horizontal piston actuators located along opposite sides of the cover unit. The frame means four piston actuators then raise the coke chute into contact with the coking drum lower flange into the decoking position, so that the accumulated coke can be removed from the vessel through the chute..

After decoking of the vessel is completed, the four piston actuators then lower the frame means and the attached coke chute, after which the cover unit is then moved laterally back to a position below the drum lower flange by action of the dual horizontal piston actuators. The frame member then raises the cover unit into mating position for rebolting it to the coking drum lower flange. The bolt detensioning and lift mechanisms for the cover unit and coke chute are advantageously operated by hydraulic pistons operated by remote control. This unheading device and chute arrangement can be advantageously applied to either new or existing delayed coking drums, for decoking the drums

much more rapidly and with increased reliability and safety at intervals of 36-48 hours operation.

The present invention also provides a method for removing a lower cover unit from vertically oriented vessels such as coking drums for coke removal, and replacing the cover unit on the vessel or coking drum. The method includes the steps of unfastening a flanged joint provided between a lower flange of the delayed coking vessel and a removable cover unit by detensioning a plurality of bolt fasteners using remotely operated hydraulic devices for detensioning the fastener bolts, and swinging the bolts radially outwardly and upwardly, then lowering the cover unit and moving it laterally to a side position. Next, a coke chute is raised and connected to the coking vessel lower flange for removing the coke contents from the vessel. Following such coke removal, the chute is lowered and the cover unit is moved laterally so as to be in vertical alignment with the coking vessel lower flange, and then raised back into its original position against the coking vessel flange. The fastener bolts are then swung downwardly into position and retensioned to reconnect the cover unit onto the coking vessel lower flange.

It is an advantage to have a vessel or coking drum lower cover unit that can be conveniently and safely removed from the coking drum, using a remotely-operated unheading device, which loosens the plurality of bolt fasteners and pivots the fasteners outwardly, then lowers the cover unit and moves it laterally aside. Such unheading device and method permits more rapid and reliable removal of coke deposited in a coking drum, so as to increase the available operating time for the drum, and also improves personal safety by avoiding undesirably exposure of personnel to hot hydrocarbons, steam and water during such unheading operations. Vertically oriented vessels on which this unheading device and method can be advantageously used include coking drums, reactors, or any vessel of a similar configuration, where danger to personnel exits during an unheading operation.

This invention will be further described with reference to the following drawings, in which:

Fig. 1 shows a vertically-oriented delayed coking drum having a structural support means and a removable lower cover unit provided at the drum lower end;

Fig. 2 shows an enlarged perspective view of the bottom unheader device removably attached to the coking drum lower flange and supported by a frame member according to the present invention, with the cover unit and fastening bolts connected in place;

Fig. 3 is an enlarged elevational view showing the cover unit removably attached to the coking vessel lower flange, and the supporting frame and a coke chute provided below the cover unit;

Fig. 4 is an enlarged cross-sectional plan view taken at line 4-4′ of Fig. 3, showing location of detensioning and actuator means for removing the multiple fasteners in the coking drum lower flange;

Fig. 5 shows a detail plan view of a flange clamp taken at line 5-5′ of Fig. 3;

Figs. 6 and 7 show sectional elevation views taken at lines 6-6′ and 7-7′ of Fig. 5;

Fig. 8 shows an enlarged elevation view similar to Fig. 3, but with the flange fastener bolts swung outwardly and the cover unit lowered away from the coking drum lower flange;

Fig. 9 is an elevation view showing the frame lowered onto location pins and the cover and cradle unit moved aside;

Fig. 10 is an elevation view per Fig. 9, showing cover unit moved aside and the frame and coke chute moved upwardly to contact the coking drum lower flange for removal of coke from the drum; and

Fig. 11 shows a plan view of the unheader device taken at line 11-11′ of Fig. 9.

As generally shown by the Fig. 1 drawing, a delayed coking drum or vessel 10 is vertically-oriented and supported by an adjacent support structure 11 and also by a lower platform stucture 12 provided below the drum 10. Such a delayed coking drum 10 for use in petroleum refineries are usually 20-25 ft. diameter and 75-100 ft. tall, and have a conical lower portion 10a attached to a lower flange 13 which is usually 5-7 ft. diameter. A removable lower cover unit 14 is pressure-tightly attached to the lower flange 13 by a plurality of clamp fastener means 20. The coke deposited progressively in coking drum vessel 10 is removed from the drum periodically as needed by removing the lower cover unit 14 and hydraulically cutting the coke from within the vessel, so that the coke falls through a chute 15 into a storage pit or a rail car (not shown) for further use.

The cover unit 14 is fastened onto the lower flange 13 of vessel 10 by multiple pivotable clamp fastener means 20, as shown in greater detail by Figs. 2 and 3. Cover unit 14 includes a cradle support structure 16 having dual horizontal skid members 18 extending along opposite sides of the cradle, and which are supported by a rectangular-shaped frame member 30. It will be noted that cover unit 14 also includes a lateral conduit 19 used for feeding hydrocarbon, steam and water materials into the coke drum 10 and to drain water from the drum. As is shown in Figs. 2 and 3 and further shown in Fig. 4, 16-48 swing type fasteners

20 (depending on the flange diameter and pressure rating) are provided evenly spaced around the periphery of flange 13 for pressure-tightly clamping the cover unit 14 onto the lower flange 13 of vessel 10.

As shown in greater detail by Figs. 5-7, each clamp fastener device 20 is constructed and operated similarly, and includes a clamp arm 21 which is pivotably attached at its upper end 21a to flange 13 by a pivot pin 22 pivotably secured to the upper surface of flange 13 at near the outer perimeter of the flange. The other or lower end 21b of clamp arm 21 is pivotally attached to a lower end of a piston actuator 24, and the upper end of actuator 24 is pivotably attached at 25 to the outer wall portion 10a of coker drum 10. The lower end 21b of each clamp 21 is also rigidly connected via pivot pin 22 to the upper end of a fastener bolt 26, which is provided in a vertical slot 27 provided in both the lower flange 13 of vessel 10 and in the mating cover unit 14. Also, a remotely operated tensioning unit 28 is provided attached to each bolt 26 below the cover unit 14. The bolt tensioning device 28 may be similar to that described in U.S. Patent 3,015,975 to Biach, which is incorporated herein by reference to the extent necessary to adequately disclose the present invention. The tensioning units 28 are usually operated by a suitable hydraulic pressure source connected to each tensioning unit. Preferably, each two adjacent pivotable bolts 26 are attached to a single piston actuator 24 attached to an elongated pivot pin 23.

When it is desired to open the flanged joint between the drum lower flange 13 and cover unit 14, the bolt tensioning unit 28 are first remotely actuated to detension the bolts 26 thereby lowering the cover unit 14 and cradle 16 by a distance of 0.25-1 inch by the lift frame support device 30. Then, the swing actuator pistons 24 are actuated, so as to swing the bolts 26 radially outwardly and upwardly to a disconnected or unfastened position as shown in Fig. 8.

For supporting and lowering the cover unit 14 from the coker vessel lower flange 13, the lift frame support device 30 is provided below and in supporting engagement with skid member 18, as is shown by Figs. 2, 3 and 8. The frame device 30 is adapted for contacting the lower surface of cradle support carriage 16 and skid member 18 of the cover unit 14. The frame device 30 includes four vertically-extending brackets 32 located at its four corners, and each pivotally attached to a vertically-oriented piston actuator 34 adapted for controllably lifting and lowering the frame unit 30. The upper end of each piston actuator 34 is pivotably attached to the conical portion 10a of coking drum 10. After the fastener bolts 26 have been detensioned and the cover unit 14 initially lowered by 0.25-1 inch and is being supported by frame device 30, the bolts 26 are then swung radially outwardly and upwardly from flange 13. Then the cover unit 14 is further lowered by frame unit 30 as shown by Fig. 8, and is then moved laterally aside as shown by Figs. 9 and 10. The vertical movements for cover unit 14 are accomplished by it being vertically movable by the four vertically-oriented piston actuators 34. The frame device 30 is lowered onto at least two and usually four alignment pins 31, as shown in Fig 3, so that the frame 30 remains in a fixed horizontal position relative to the flange 13 of coking drum 10.

After the cover unit 14 has been lowered by action of frame 30 vertical piston actuators 34 as shown by Fig. 8, the cover unit 14 is then moved side laterally by dual horizontal piston actuators 36, which extend substantially horizontally along each side of cover unit 14. The actuators 36 are each connected at their forward end 36a to cover unit 14 by lug 35, and are each connected at their rearward end to anchor means 37. The orientation and relative position of the parts of lifting frame device 30 is additionally shown in plane view of platform support device by Fig. 11.

While the cover unit 14 is moved aside laterally to an offset position as shown by Figs. 9 and 10, by extension action of the piston actuators 36, the lower skid member 18 is retained by dual guide surfaces 33a and 33b which are provided extending along opposite sides of the frame unit 30. The forward end portion of cradle support 16 is preferably partially supported by dual rollers 38 running along parallel tracks 39 provided in deck 40. The rear end of cradle support 16 rests on a chair member 41 attached to deck 40. Then, after the cover unit has been moved laterally to one side, collapsible chute 15 which is attached to lower portion 30a of the frame device 30, is simultaneously raised by action of the four piston actuators 34 so that chute 15 contacts the lower flange 13 of the coker vessel 10. An enlarged partial view of the chute 15 being in contact with the lower flange 13 of the coker vessel 10 is shown by Fig. 12. The coke is removed from within the coking drum 10 and falls through the chute 15 to a storage pit or rail car (not shown) for further processing or use.

After the decoking operation for the coker drum 10 is completed, the frame unit 30 and attached chute 15 are lowered, and then cover unit 14 is returned to its original position and reconnected onto the drum flange 13, as was shown by Figs. 2 and 3. This return movement for cover unit 14 is accomplished by first lowering frame 30 and coke chute 15 by the four actuator pistons 34, then retracting dual piston actuators 36 to move the cover unit 14 laterally to a position in vertical

alignment below flange 13, then raising frame 30 so that cover unit 14 is again placed against and in alignment with lower flange 13. Next, the swing actuators 24 are extended so as to pivot the bolts 26 downwardly into the slots 27, as shown by Figs. 3 and 4. Then the multiple tensioning units 28 are actuated so as to clamp the mating flange 13 and cover unit 14 tightly together again.

This invention will be further described by the following example of operations, which should not be construed as limiting the scope of the invention.

EXAMPLE

In a coking drum used for delayed coking of petroleum feedstocks, after 36-48 hours of operation sufficient coke is deposited progressively on the inner wall of the drum that removal of the coke is required before continued operation. The coking drum, which is equipped with a lower flange cover unit constructed and operated in accordance with this invention, is shut down, depressurized and the lower head cover unit is removed. Important characteristics of the coker drum lower cover unit and unheading device are as follows: Coker lower flange diameter, inc. 72
Cover unit flange diameter, in. 72
Cover unit length, in. 18
Number of fastener swing bolts 36
Swing bolt diameter, in. 1.25
Bolt slot width in flange, in. 1.5
Vertical movement of lift frame, in. 12
Lateral movement of cover unit, in. 105
Lift actuator hydraulic pressure, psig 1500

Following switch out of the heavy hydrocarbon feed, steam, water quench and draining of the coking drum, the lower cover unit is removed and replaced using the following procedure:

a) Detension the fastener swing bolts clamping the cover unit to the coking drum lower flange by pressurizing the hydraulically-operated bolt tension units to sufficiently loosen the bolts to lower the cover unit 0.25 - 1 inch onto a lifting frame and to permit the bolts to swing outwardly from the flange periphery.

b) Pressurize the swing piston actuators to retract and swing fastener bolts outwardly and upwardly, thus freeing the cover unit flange from the coking drum flange.

c) Pressurize the lift frame actuators and lower the cover unit, then move it aside by pressurizing and extending the dual lateral piston actuators.

d) Reverse pressurize four lift actuators to move coke chute upwardly to mate with the coking drum lower flange to permit removal of the coke.

e) Following removal of accumulated coke from the coking drum, lower the coke chute, move the cover unit laterally to be back in vertical alignment with the coking drum flange, and then lift the cover unit to mate with the coking drum flange.

f) Reverse pressurize swing piston actuator to extend swing a bolts downward into the bolt slots of the cover flange, then actuate the tensioning units to retension the flange bolts to securely reclamp the cover unit onto the lower flange of the coking drum.

Although this invention has been disclosed broadly and in terms of a preferred embodiment, it will be understood that modifications and variations can be made within the scope of the invention, which is defined by the following claims.

Claims

1. An improved unheading device adapted for removal and replacement of a lower cover unit of a vertical vessel, comprising:

(a) a cover unit adapted for being sealably attached by bolts to a lower flange of a vertical vessel, said cover unit including a supporting cradle means;

(b) at least eight pivotable clamping devices each including a detensioning means equally spaced around the perimeter of said cover unit and adapted for detensioning and pivotably removing the bolts located in said cover unit and the lower flange of the vessel to unfasten said cover unit from the vessel;

(c) a lifting frame located below said cover unit and cradle means, said frame being supported from said vessel by four equally-spaced vertically-oriented piston actuator means; and

(d) a carriage unit supported by said lifting frame and adapted for lateral movement of the cover unit relative to the lifting frame by dual horizontal piston actuator means, said carriage unit being at least partly supported by said lifting frame, whereby the cover can be lowered from the vessel lower flange and moved aside laterally to permit coke removal through the lower opening in the vessel.

2. The unheading device of claim 1, wherein each said clamping device is pivotally attached to said vessel lower flange and multiple sets of two adjacent clamping devices are attached to a hy-

draulic piston actuator, whereby the clamping device bolts can be swung radially outwardly and upwardly to unfasten the flanged joint.

3. The unheading device of claim 1, wherein said bolt detensioning means are provided at a lower end of each bolt and are each adapted to be operated by hydraulic pressure means.

4. The unheading device of claim 1, wherein said lifting frame when lowered is retained in a horizontal position by a plurality of vertically-oriented pegs which interfit with openings in the frame.

5. The unheading device of claim 1, including a chute attached to said lifting frame means and adapted for contact with the vessel lower head flange for removing material from the vessel.

6. The unheading device of claim 1, wherein 16-48 pivotable clamping devices with attached bolt detensioning means are provided equally-spaced around the periphery of said cover unit.

7. An improved unheading device adapted for removal and replacement of a lower cover unit of a vertically-oriented coking drum, comprising:

(a) a cover unit adapted for being sealably attached by bolts to a lower flange of a coking drum, said cover unit being attached to a supporting cradle means;

(b) at least eight pivotable clamping devices each including a detensioning means equally-spaced around the perimeter of said cover unit, each detensioning means being adapted for connecting onto a lower nut for detensioning and removing the fastening bolts pivotably outward and upward so as to unfasten said cover unit from the coking drum lower flange;

(c) a lifting frame located below said cover unit and cradle means, said lifting frame being supported from said coking drum by four equally-spaced vertically-oriented piston actuator means; and

(d) a carriage unit resting on said lifting platform, said carriage unit adapted for lateral movement relative to the lifting frame by dual horizontally oriented piston actuators each attached to the carriage unit forward end, said carriage unit being supported at its forward end by a guide surface sliding on a support rail, whereby said cover unit can be lowered from the coking drum lower flange and moved laterally aside to permit coke removal through the lower opening in the coking drum.

8. A method for removing and replacing a lower cover unit for a vessel the method comprising:

(a) unfastening a flanged joint between a lower head flange of a vessel and a removable cover unit attached thereto by detensioning a plurality of pivotable bolts and swinging the bolts outwardly and upwardly relative to the flange joint;

(b) lowing the cover unit away from the vessel lower flange and moving it laterally to a position at one side of the coking drum opening; then

(c) raising a chute to contact said vessel lower flange for removal of material from the vessel;

(d) lowering said chute, then moving the cover unit laterally into position in vertical alignment with the vessel lower flange, and raising the cover unit into position against the lower flange of the vessel; and

(e) refastening said pivotable bolts of the flanged joint between the cover unit and the vessel.

9. The method of claim 8, wherein the bolts in the flange joint are refastened by remotely swinging the bolts downwardly to enter slots in the flanged joint, and including retensioning the bolts in the flange joint between the cover unit and the vessel flange.

10. A method for removing and replacing a lower cover unit for a coking drum, the method comprising:

(a) unfastening a flanged joint between a lower head flange of a coking drum and a removable cover unit attached thereto, by detensioning a plurality of pivotable bolts and swinging the bolts radially outwardly and upwardly relative to the flange joint;

(b) lowering the cover unit away from the coking drum lower flange by a hydraulically actuated frame member and moving the cover unit laterally to a position at one side of the coking drum opening; then

(c) raising the frame and chute to contact said lower head flange for removal of coke from the coking drum;

(d) lowering said frame and chute, then moving the cover unit laterally into position in vertical alignment with the coking drum lower flange, and raising the cover unit into position against the lower flange of the coking drum; and

(e) refastening said pivotable bolts of the flanged joint between the cover unit and the coking drum.

11. The unheading device of claim 1, wherein said carriage unit is at least partially supported by roller means located at the carriage unit forward end.

12. The unheading device of claim 11, wherein said carriage unit roller means slides on dual rails located below a deck surface.

13. The unheading device of claim 1, wherein said vessel is a vertically oriented coking drum.

14. The unheading device of claim 1, wherein said vessel is a vertically oriented reactor.

15. The method of claim 8, wherein the bolts of the flange joint are each detensioned by remotely-operated hydraulic devices attached to each bolt.

16. The method of claim 8, wherein the cover unit is lowered by a hydraulically actuated frame member and is moved laterally to one side by carriage unit by dual horizontal piston actuator means attached to the cover unit.

FIG. 2

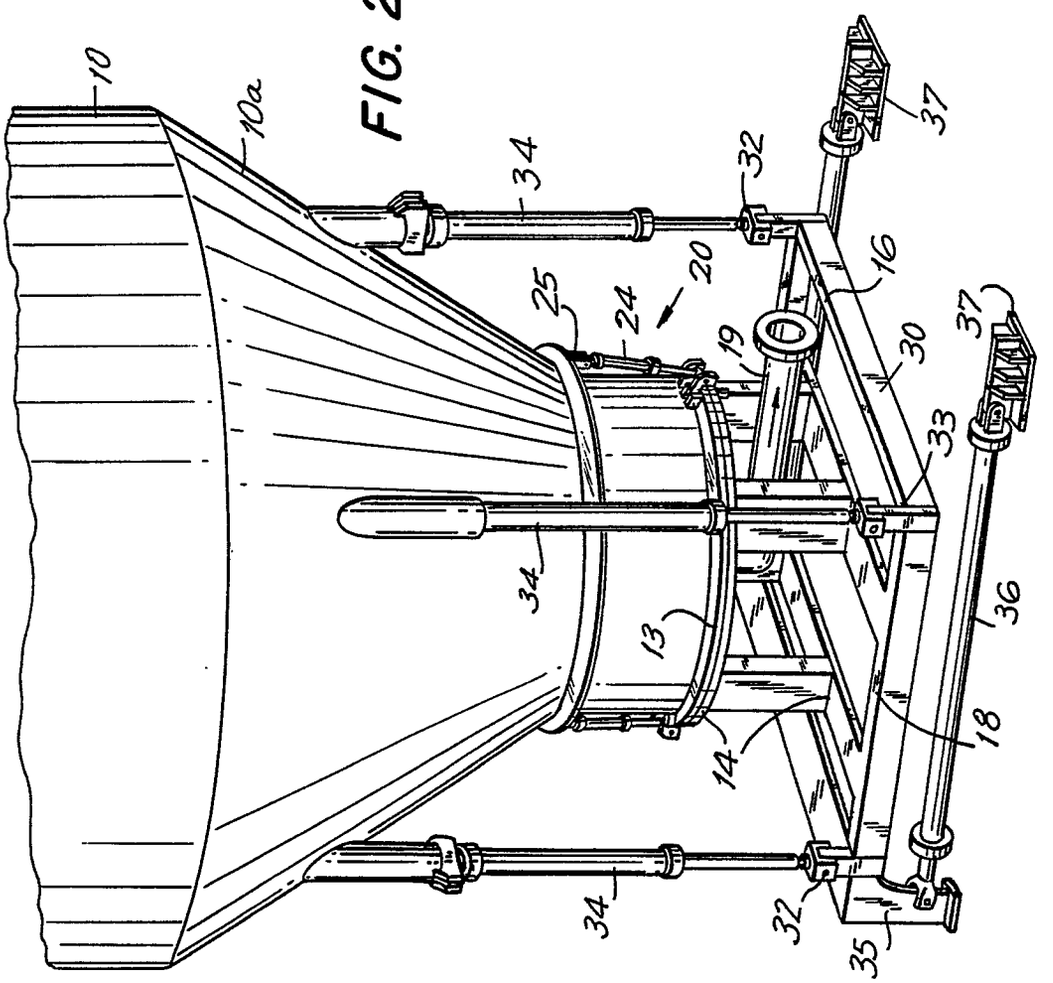

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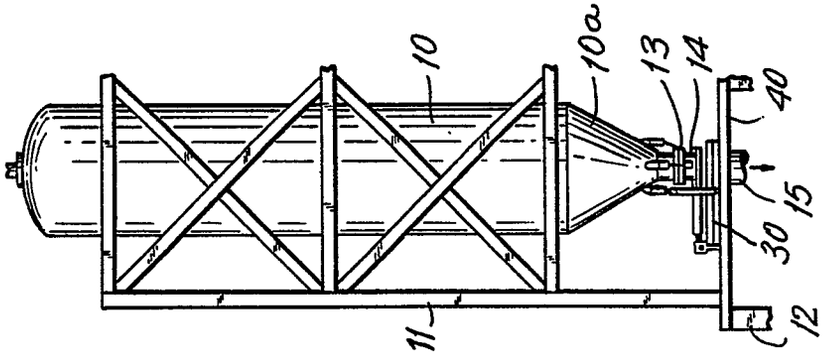
FIG. 1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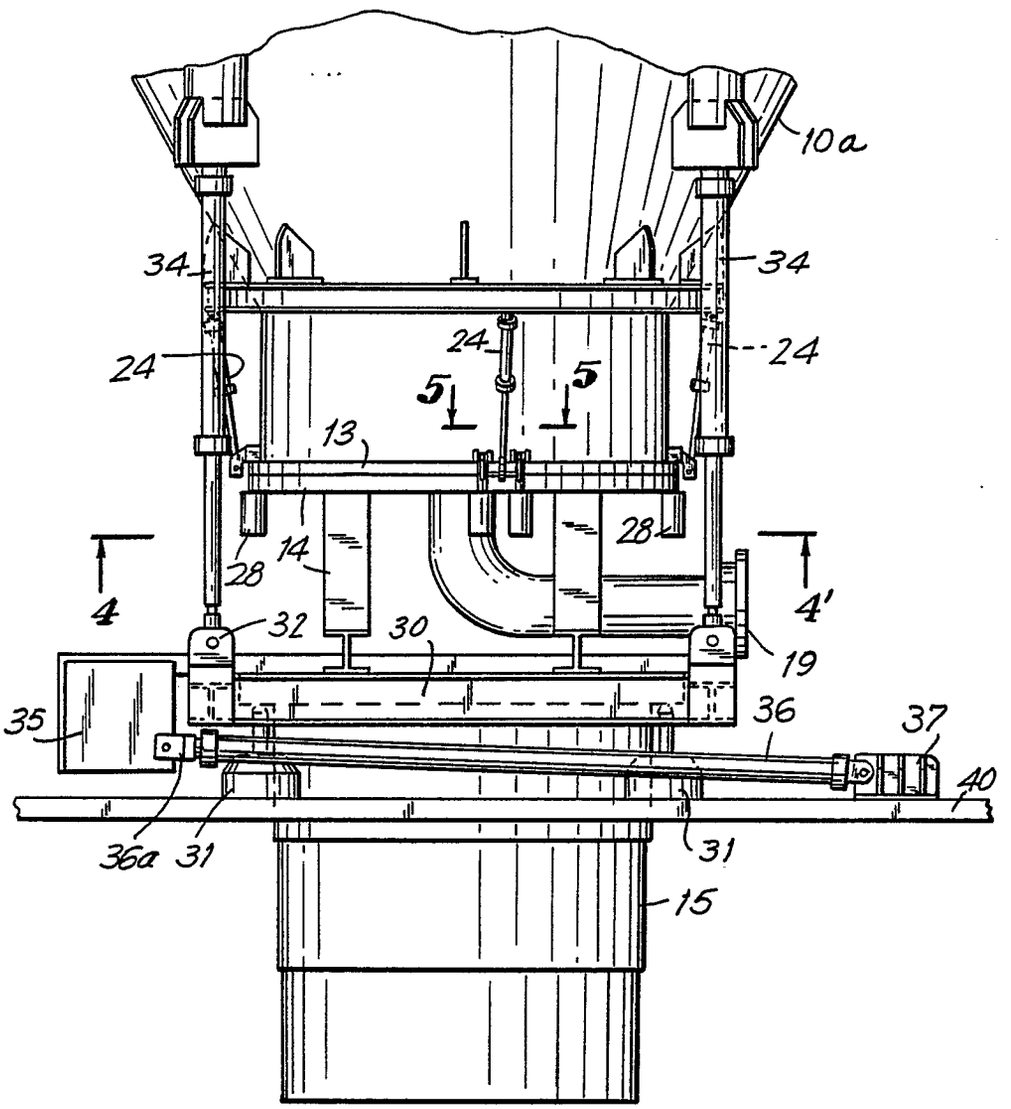


FIG. 3

FIG. 4

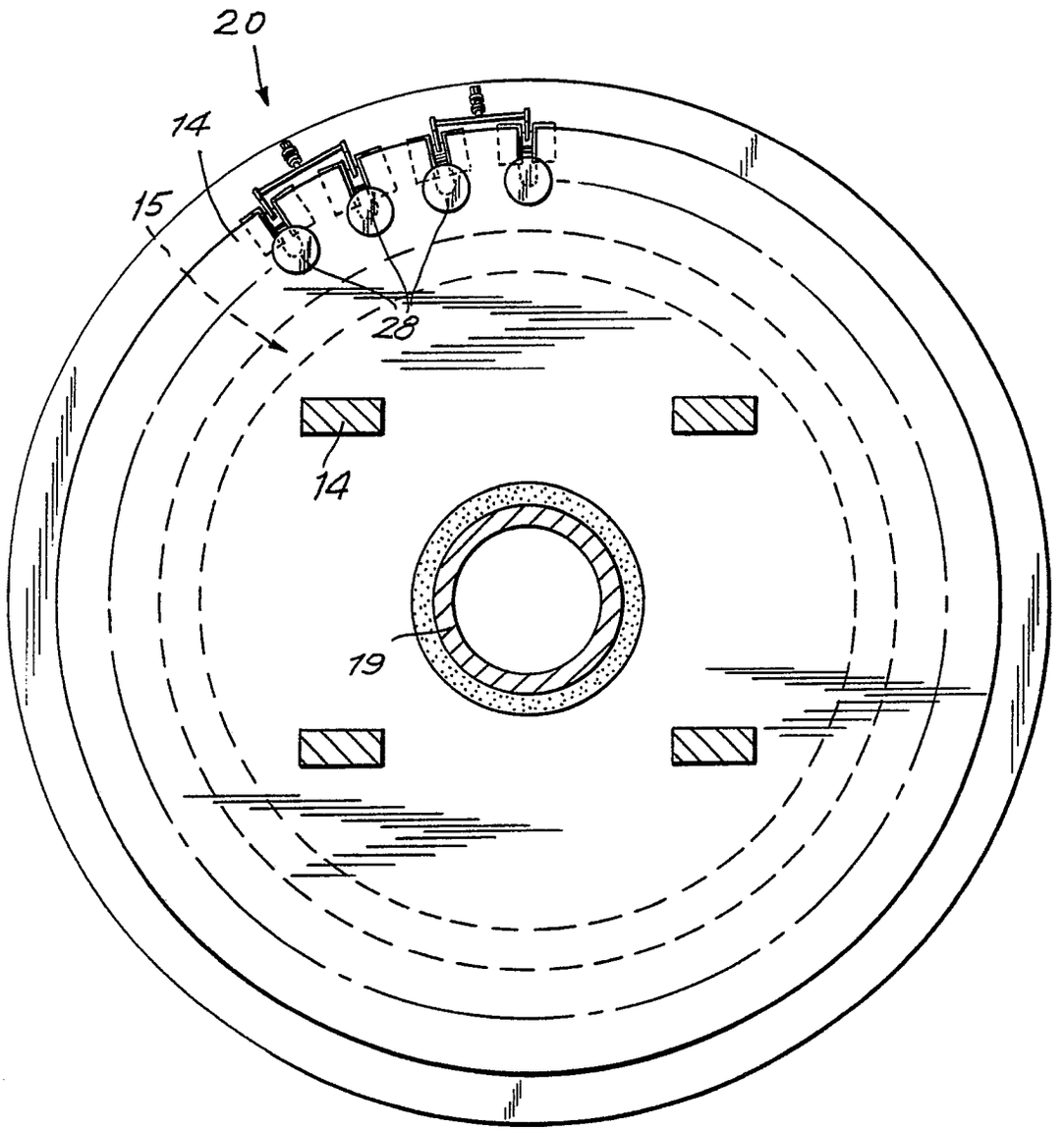


FIG. 5

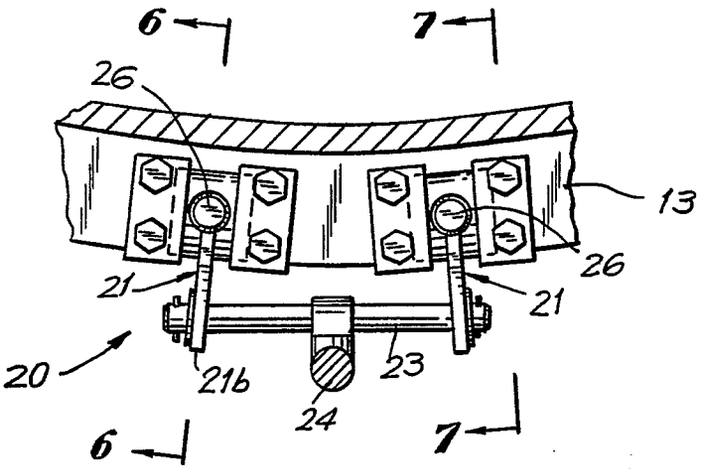


FIG. 6

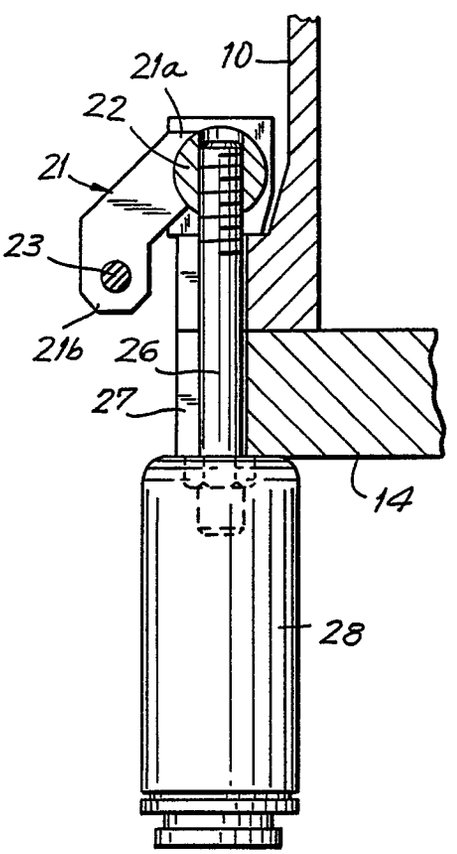


FIG. 7

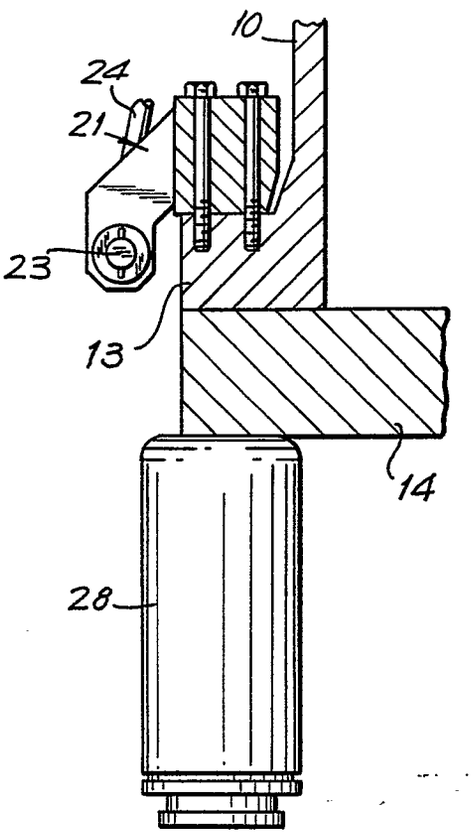
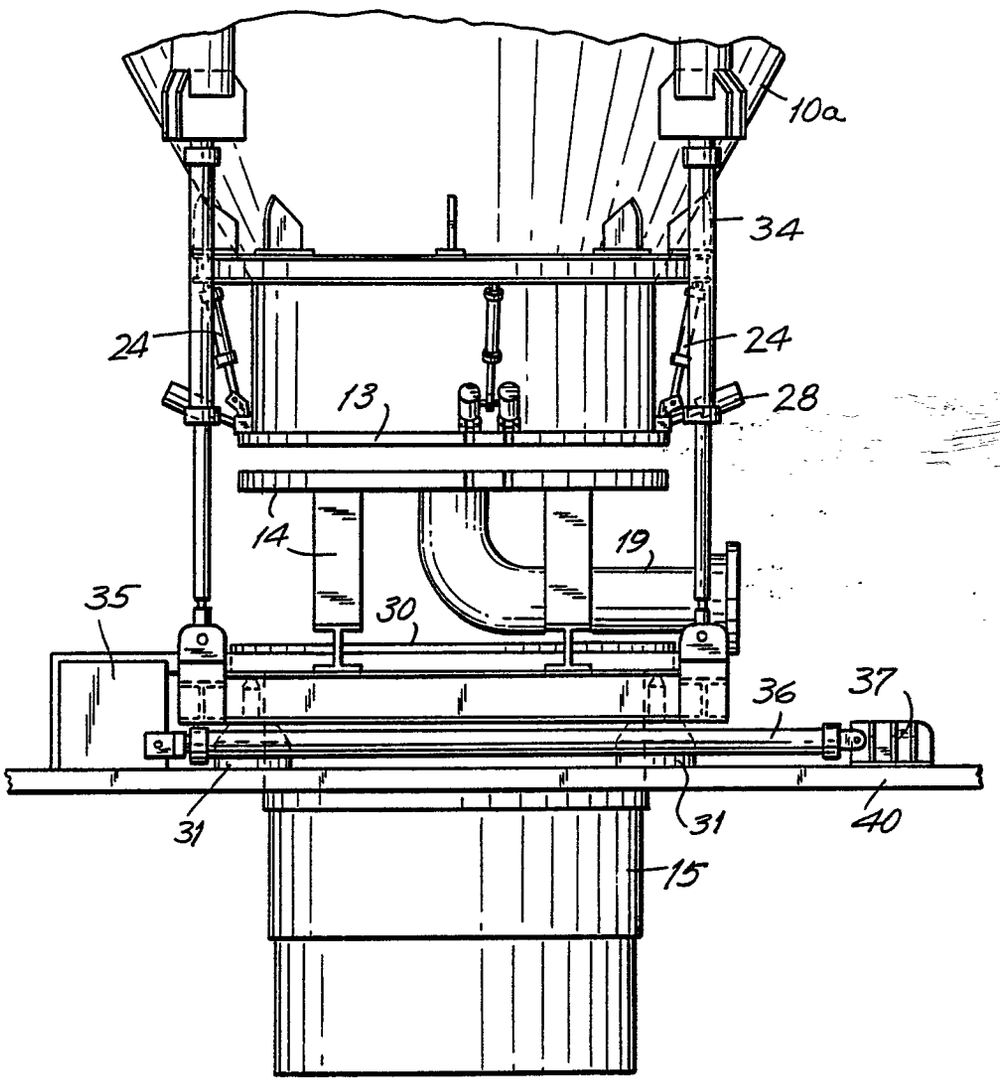


FIG. 8



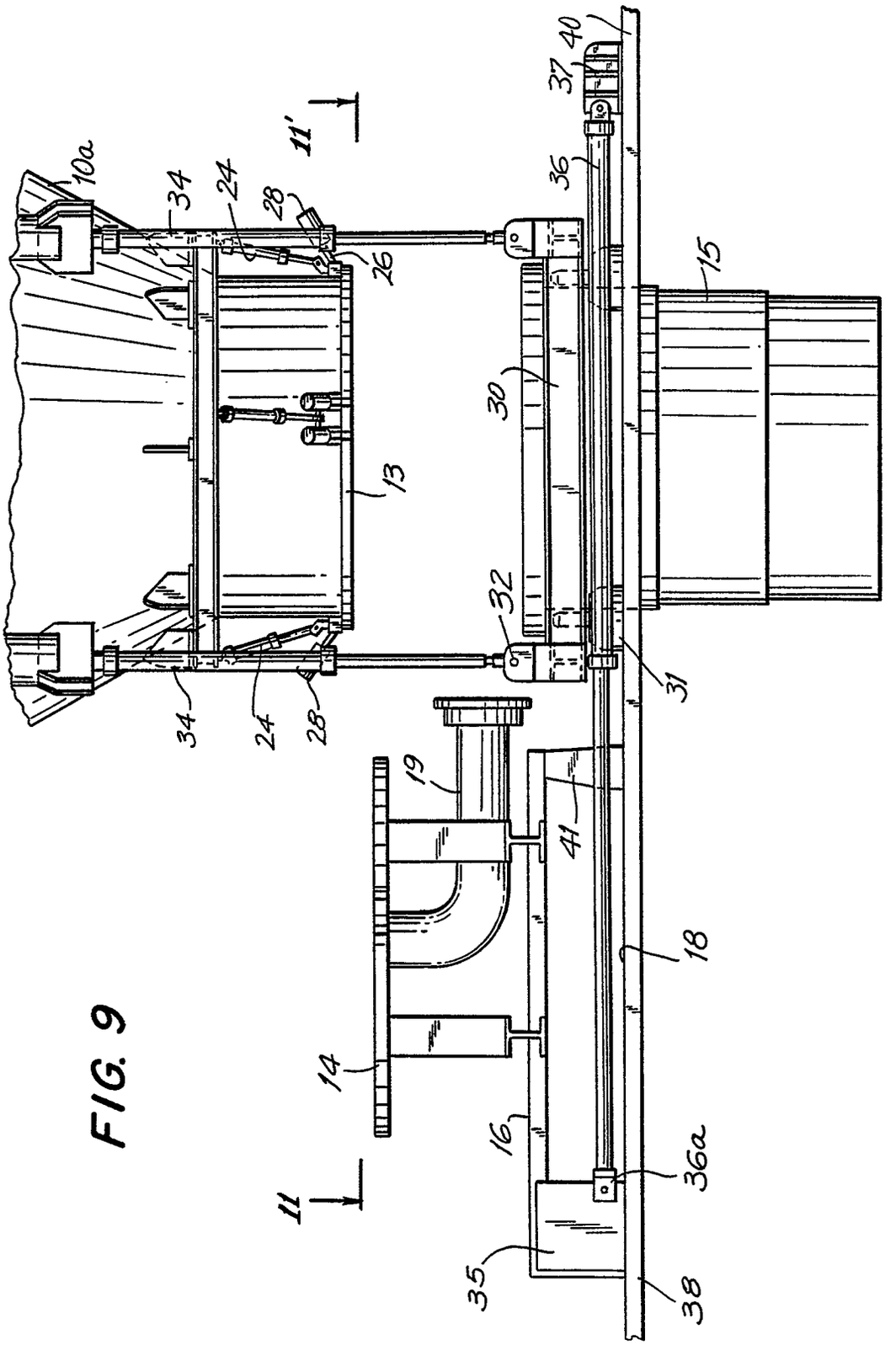

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FIG. 9

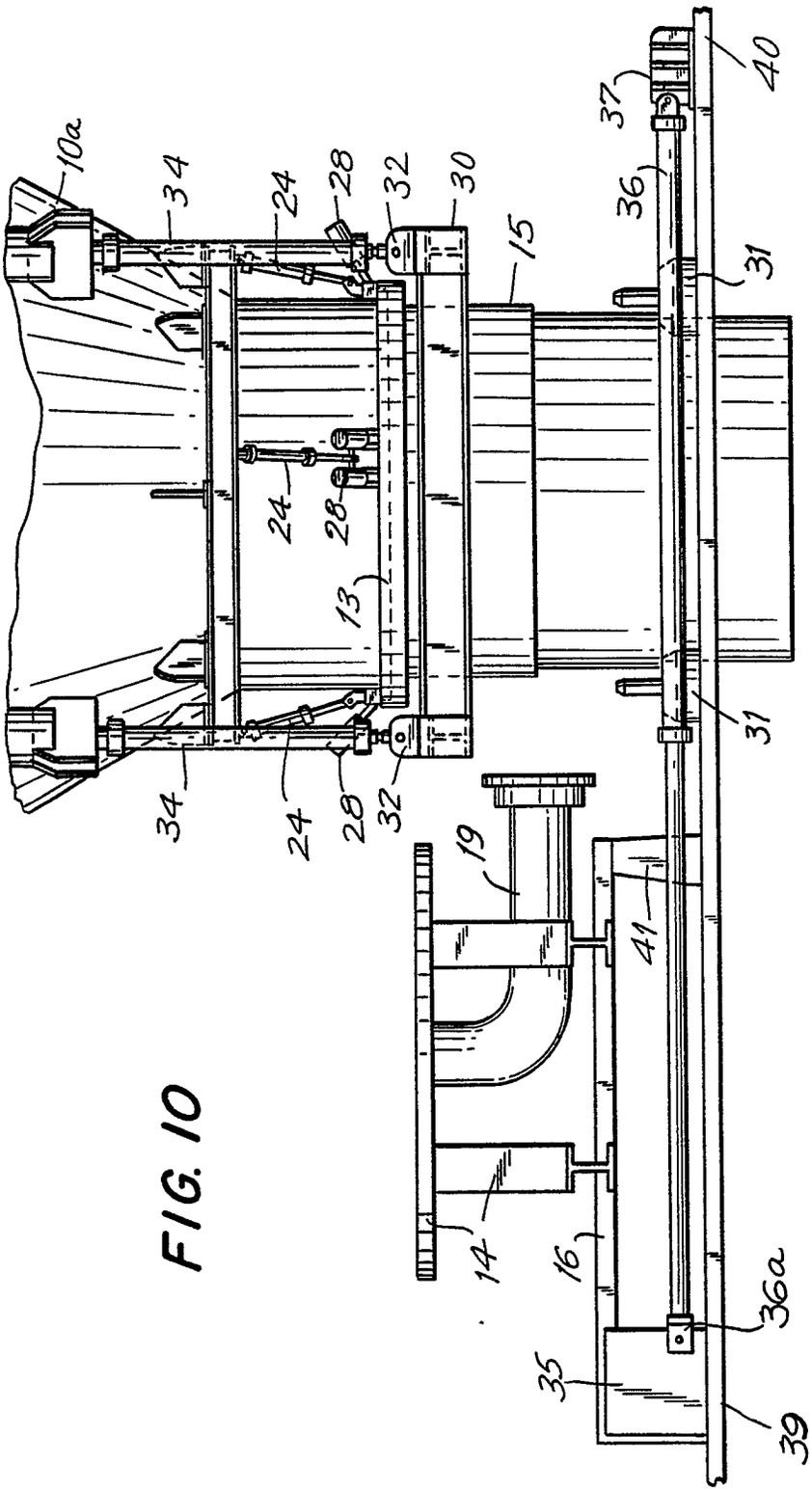
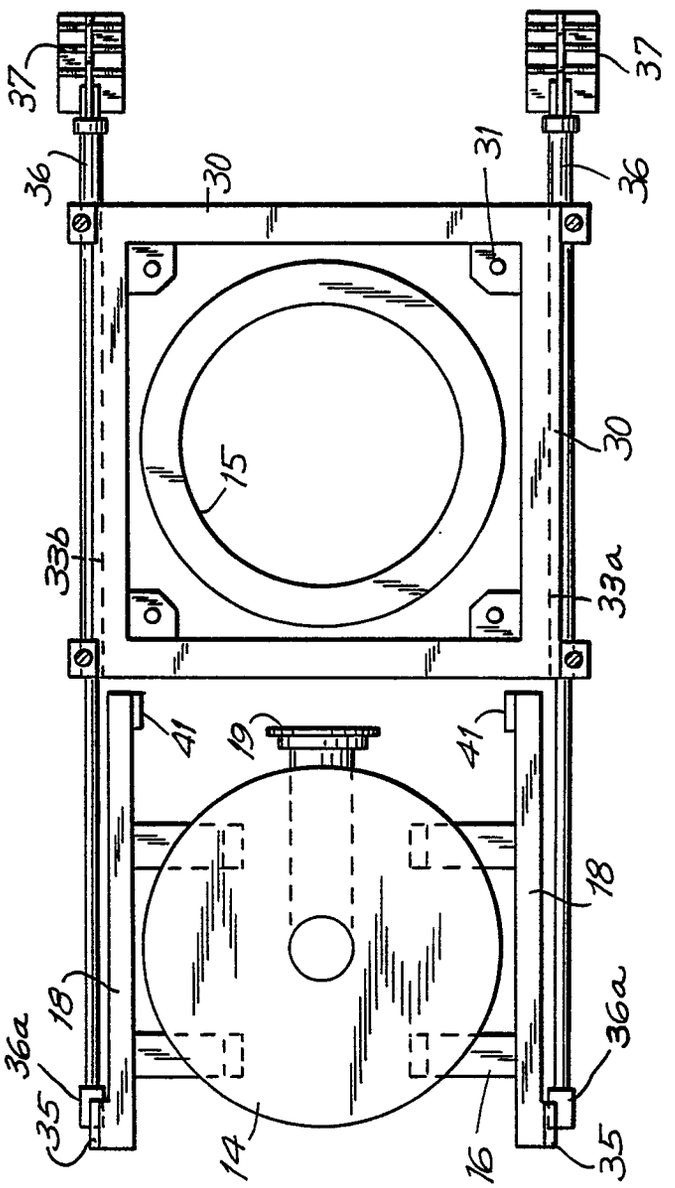


FIG. 10

FIG. 11



European Patent Office

EUROPEAN SEARCH REPORT

Application Number

EP 89 30 0068

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)
A	US-A-2 595 245 (GRANDINETTI et al.) * Claims 1-8; figures 1-6 *	1-10	C 10 B 25/14 C 10 B 25/10 C 10 B 33/00
A	US-A-2 529 046 (PADGETT) * Claims 1-8; figures 1-9 *	1-10	
A	US-A-3 379 623 (FORSYTH) * Claims 1,2,6,7,10-13; figures 1-6 *	1-10	
A,P D	EP-A-0 265 096 (FOSTER WHEELER ENERGY) * Claims 1-15; figures 1-15 *	1-10	

TECHNICAL FIELDS SEARCHED (Int. Cl.4)

C 10 B

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	11-05-1989	MEERTENS J.

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

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