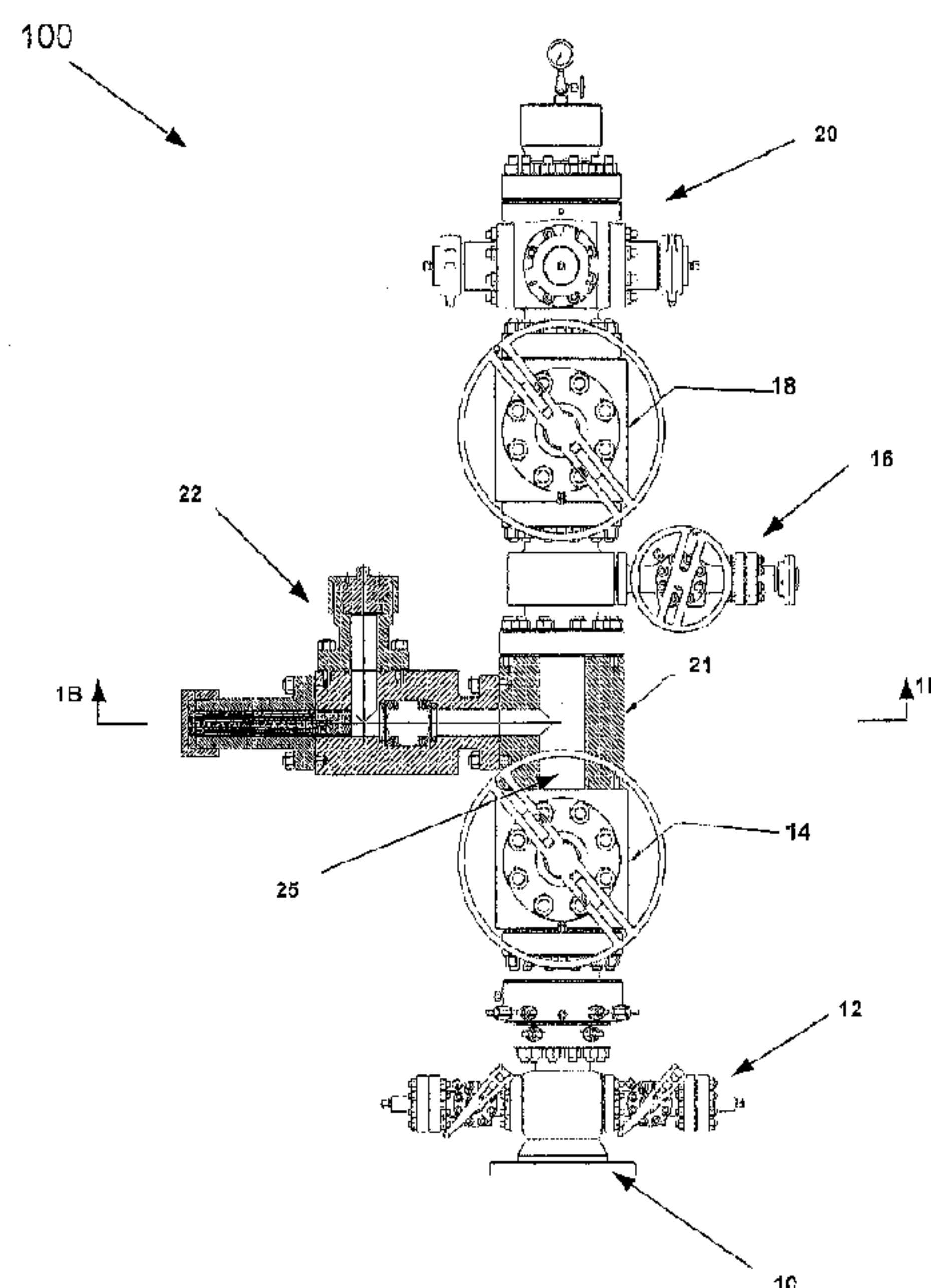




(86) Date de dépôt PCT/PCT Filing Date: 2016/07/20
(87) Date publication PCT/PCT Publication Date: 2017/02/20
(45) Date de délivrance/Issue Date: 2017/11/21
(85) Entrée phase nationale/National Entry: 2017/01/05
(86) N° demande PCT/PCT Application No.: CA 2016/050851
(30) Priorité/Priority: 2015/08/20 (US14/830,825)

(51) Cl.Int./Int.Cl. *E21B 33/068* (2006.01),
E21B 23/08 (2006.01), *E21B 33/12* (2006.01)
(72) Inventeurs/Inventors:
PENNY, BRADLEY ERIC, CA;
HOLMES, CURTIS BERNARD, CA;
GALLAGHER, PATRICK JOHN, CA
(73) Propriétaire/Owner:
FMC TECHNOLOGIES CANADA LTD., CA
(74) Agent: KIRBY EADES GALE BAKER

(54) Titre : DISPOSITIF D'INSERTION DE BALLE DESTINE AUX PUITS DE PETROLE ET DE GAZ
(54) Title: BALL INSERTION DEVICE FOR USE IN OIL AND GAS WELLS



(57) Abrégé/Abstract:

In one illustrative embodiment, the ball inserter device comprises, among other things, a body having a ball insertion opening and a ball drop opening, wherein the ball drop opening intersects the ball insertion opening, a ball inserter piston that is attached to the body and an inserter cavity isolation valve coupled to the body wherein the valve element, when closed, blocks the ball insertion opening and partially defines an insertion cavity between the inserter cavity isolation valve and the ball inserter piston and a pressure relief valve coupled to the body that is in fluid communication with the insertion cavity. In this example, the device also comprises a ball input device coupled to the body that includes a plug, a removable cap and an opening that is axially aligned with the ball drop opening.



ABSTRACT

In one illustrative embodiment, the ball inserter device comprises, among other things, a body having a ball insertion opening and a ball drop opening, wherein the ball drop opening intersects the ball insertion opening, a ball inserter piston that is attached to
5 the body and an inserter cavity isolation valve coupled to the body wherein the valve element, when closed, blocks the ball insertion opening and partially defines an insertion cavity between the inserter cavity isolation valve and the ball inserter piston and a pressure relief valve coupled to the body that is in fluid communication with the insertion cavity. In this example, the device also comprises a ball input device coupled to the body
10 that includes a plug, a removable cap and an opening that is axially aligned with the ball drop opening.

BALL INSERTION DEVICE FOR USE IN OIL AND GAS WELLS

FIELD OF INVENTION

5 The present invention relates to a ball insertion device for use in oil and gas wells.

BACKGROUND OF THE INVENTION

Oil and gas wells are typically subjected to fracturing or other stimulation procedures by isolating zones of interest in the wellbore by use of packers and the like.

10 Thereafter, a treatment fluid or fracturing fluid is forced into the isolated zone at an elevated treatment pressure. In a typical fracturing procedure for a cased wellbore, for example, the casing of the well is first perforated to allow oil and/or gas to flow into the wellbore. Thereafter, a fracturing fluid is then pumped into the wellbore and through the perforations into the formation. Such treatment opens and/or enlarges drainage channels

15 in the formation, enhancing the producing ability of the well. For open holes that are not cased, stimulation is carried out directly in the zone intervals without the need for perforating casing.

Frequently, a series of packers in a packer arrangement may be inserted into the

20 wellbore, wherein the packers are located at intervals for isolating one zone from an adjacent zone. To selectively engage a packer, a ball ("frac ball") is typically introduced into the wellbore so as to block fluid flow through the packer, which creates an isolated zone up-hole from the blocked packer so that a fluid treatment or stimulation may be performed on that isolated interval. Once the previously isolated (lower) zone has been

25 stimulated, a subsequent ball is dropped to block off a subsequent packer that is positioned up-hole from the previously blocked packer, so as to create another isolated

zone up-hole of the second blocked packer. This isolated zone is then fractured or treated. The process is continued until all of the desired zones have been stimulated and/or fractured. Typically the balls range in diameter from a smallest diameter ball, which is suitable for blocking fluid flow through the most downhole packer, to the largest
5 diameter ball, which is suitable for blocking fluid flow through the most up-hole packer.

Equipment for fracturing, such as a “frac head,” is typically provided at the surface of a well so that fracturing operations may be conducted. The frac head includes fluid connections for introducing fracturing fluids, which may include proppants and like,
10 into the wellbore, and ultimately into the formation during the fracturing process. There are various prior art systems that have been employed for introducing the frac balls into a wellbore. Some are very complex and involve a complex arrangement of various valves and fittings that are operated so as to introduce the frac balls into the wellbore. Such complexity may lead to additional costs, operator errors, down time due to maintenance
15 of the complex arrangement of valves and fittings and/or failure of one or more of the pieces of equipment.

The present application is directed to a novel ball insertion device for use in oil and gas wells that may eliminate or at least minimize some of the problems noted above.

20

BRIEF DESCRIPTION OF THE INVENTION

The following presents a simplified summary of the invention in order to provide a basic understanding of some aspects of the invention. This summary is not an exhaustive overview of the invention. It is not intended to identify key or critical
25 elements of the invention or to delineate the scope of the invention. Its sole purpose is to

present some concepts in a simplified form as a prelude to the more detailed description that is discussed later.

The present application is directed to a novel ball insertion device for use in oil
5 and gas wells. In one illustrative embodiment, the ball inserter device comprises, among other things, a body having a ball insertion opening and a ball drop opening defined in the body, wherein the ball drop opening intersects the ball insertion opening, a ball inserter piston that is attached to the body and an inserter cavity isolation valve coupled to the body wherein the valve element, when closed, blocks the ball insertion opening and
10 partially defines an inserter cavity between the inserter isolation valve and the ball inserter piston and a pressure relief valve coupled to the body that is in fluid communication with the inserter cavity. In this example, the device also comprises a ball input device coupled to the body that includes a plug, a removable cap and an opening that is axially aligned with the ball drop opening.

15

One illustrative method disclosed herein includes, among other things, closing at least a lower master valve so as to isolate a ball inserter device positioned vertically between an upper master valve and a lower master valve from pressure within a well bore, opening a relief valve so as to relieve pressure within an inserter cavity that is
20 located in a body of the ball inserter device between a closed inserter cavity isolation valve and a ball inserter piston that is coupled to the body, after relieving the pressure within the inserter cavity, removing a plug from a ball input device so as to allow communication with a ball drop opening defined in the body, wherein the ball drop opening intersects a ball insertion opening defined in the body and inserting a ball
25 through the ball input device so as to position the ball within the inserter cavity between

the ball inserter piston and the closed inserter cavity isolation valve. In this example, the method further comprises, with the inserter cavity isolation valve in its closed position, coupling the removable plug to the ball input device, after coupling the removable plug to the ball input device, opening the inserter cavity isolation valve so as to allow the inserted
5 ball to be moved through the open inserter cavity isolation valve and the ball insertion opening defined in the body, actuating the ball inserter piston from a retracted position to an extended position so as to move the ball through the open inserter cavity isolation valve and the ball insertion opening and into the well bore, after inserting the ball into the well bore, actuating the ball inserter piston so as to cause it to return toward the retracted
10 position, closing the inserter isolation valve so as to block the ball insertion opening and, after closing the inserter isolation valve so as to block the ball insertion opening, opening the upper master valve and the lower master valve.

BRIEF DESCRIPTION OF THE DRAWINGS

15 The present invention will be described with the accompanying drawings, which represent a schematic but not limiting its scope:

Figures 1A-1C depict one illustrative example of a novel ball insertion device for use in oil and gas wells disclosed herein; and

20

Figures 2A-2H depict one illustrative operational sequence of an illustrative ball insertion device for use in oil and gas wells disclosed herein.

While the subject matter disclosed herein is susceptible to various modifications
25 and alternative forms, specific embodiments thereof have been shown by way of example

in the drawings and are herein described in detail. It should be understood, however, that the description herein of specific embodiments is not intended to limit the invention to the particular forms disclosed, but on the contrary, the intention is to cover all modifications, equivalents, and alternatives falling within the spirit and scope of the invention as defined
5 by the appended claims.

DETAILED DESCRIPTION OF THE INVENTION

Various illustrative embodiments of the invention are described below. In the interest of clarity, not all features of an actual implementation are described in this
10 specification. It will of course be appreciated that in the development of any such actual embodiment, numerous implementation-specific decisions must be made to achieve the developers' specific goals, such as compliance with system-related and business-related constraints, which will vary from one implementation to another. Moreover, it will be appreciated that such a development effort might be complex and time-consuming, but
15 would nevertheless be a routine undertaking for those of ordinary skill in the art having the benefit of this disclosure.

The present subject matter will now be described with reference to the attached figures. Various structures, systems and devices are schematically depicted in the
20 drawings for purposes of explanation only and so as to not obscure the present disclosure with details that are well known to those skilled in the art. Nevertheless, the attached drawings are included to describe and explain illustrative examples of the present disclosure. The words and phrases used herein should be understood and interpreted to have a meaning consistent with the understanding of those words and phrases by those
25 skilled in the relevant art. No special definition of a term or phrase, *i.e.*, a definition that

is different from the ordinary and customary meaning as understood by those skilled in the art, is intended to be implied by consistent usage of the term or phrase herein. To the extent that a term or phrase is intended to have a special meaning, *i.e.*, a meaning other than that understood by skilled artisans, such a special definition will be expressly set forth in the specification in a definitional manner that directly and unequivocally provides the special definition for the term or phrase.

One illustrative system 100 that includes an illustrative example of a ball insertion device 22 for use in oil and gas wells disclosed herein is depicted in Figures 1A-1C. The ball insertion device 22 will be disclosed in the context of using the ball insertion device 22 for a well fracturing application. However, as will be appreciated by those skilled in the art after a complete reading of the present application, the novel ball insertion device 22 disclosed herein may be employed in a variety of applications as it relates to operations performed on oil and gas wells.

15

Figure 1A is a partial cross-sectional elevation view depicting one illustrative example of a system 100 where one embodiment of an illustrative ball insertion device 22 may be employed. As shown therein, the system 100 is comprised of a plurality of pieces of equipment positioned above an illustrative wellhead 10. The wellhead 10 provides access to a wellbore (not shown) (cased or un-cased) in an earthen formation. In the depicted example, the system is comprised of several items of equipment positioned above the wellhead 10: a tubing head 12, a lower master valve 14, a flow outlet valve 16, an upper master valve 18 and a frac head 20. In the depicted example, a spool (*e.g.*, a tee) 21 is positioned between the lower and upper master valves 14, 18, and one illustrative example of a ball inserter device 22 disclosed herein is removably coupled to the spool 21

by a plurality of bolts. A bore 25 is defined in the spool 21 and it is axially aligned with other bores (not shown) in the various pieces of equipment above and below the spool 21, and the bore 25 is in fluid communication with the wellbore that extends into the formation. In the depicted example, the ball inserter device 22 is coupled to the spool 21.

5 However, in other applications, the spool 21 may be omitted and the ball inserter device 22 may be coupled to or formed integrally with another item of equipment positioned above the wellhead 10. Different sized spools 21 may also be provided with different bores 25 therein for different sized wells, wherein the same ball inserter device 22 is a universal device that may be used with each of the different sized spools.

10

Figure 1B is a cross-sectional plan view taken through the ball inserter device 22 and the spool 21 where indicated in Figure 1A. Figure 1C is a cross-sectional elevation view taken through the ball inserter device 22, the spool 21, and the lower/upper master valves 14, 18. As shown in Figures 1B-1C, the illustrative example of the ball inserter
15 device 22 disclosed herein is generally comprised of an inserter body 30 having an inserter cavity 33 defined therein, an inserter cavity isolation valve 26, a ball inserter piston 28, an inserter cavity relief valve 31 and a ball input device 32 (see Figure 1C). In the depicted example, each of the inserter cavity isolation valve 26, the ball inserter piston 28, the inserter cavity relief valve 31 and the ball input device 32 are removably coupled
20 to the inserter body 30 via bolted connections. However, as noted above, in some applications, the inserter body 30 may be formed integral with the spool 21 or the spool 21 may be omitted and the inserter body 30 may be attached to or formed integral with another item of equipment positioned above the wellhead 10.

In the depicted example, a plurality of drilled openings are formed in the inserter body 30: a ball insertion opening 41, a pressure relief opening 43, and a ball drop opening 45 (see Figure 1C). As described more fully below, an inserter cavity 33 is defined, at least in part, by a portion of the ball insertion opening 41 between the inserter cavity isolation valve 26 and the ball inserter piston 28. The ball insertion opening 41 is in fluid communication with the bore 25 defined in the spool 21 and defines a constant diameter opening from the piston 28 to the bore 25. The pressure relief opening 43 provides fluid communication between the inserter cavity 33 and the inserter cavity relief valve 31. The ball drop opening 45 is in fluid communication with the inserter cavity 33 (*i.e.*, the ball insertion opening 41). The ball drop opening 45 provides the conduit by which frac balls (not shown) will be inserted into the inserter cavity 33. In general, the size of the openings 41, 43, 45 may vary depending upon the particular application. The ball insertion opening 41 and the ball drop opening 45 will normally have the same internal diameter and they may be sized to accommodate the largest ball that will be inserted into a range of wells where the ball inserter device 22 is expected to be deployed, *e.g.*, they may have an internal diameter of about 4 inches in one illustrative embodiment. Of course, balls having a lesser diameter than the inside diameter of the ball insertion opening 41 and ball drop opening 45 may be inserted into a well using the novel ball inserter device 22 disclosed herein, *e.g.*, 2 inch diameter balls may be inserted using a ball inserter device 22 with a ball insertion opening 41 having a diameter of 4 inches. In one example, with the ball insertion opening 41 and the ball drop opening 45 both having an internal diameter of 4 inches, the ball inserter device 22 disclosed herein may be employed to insert frac balls having diameters that fall within the range of about 0.5 – 4 inches. The pressure relief opening 43 may be of any diameter sufficient for performing its pressure relief function as frac balls will not be inserted through the pressure relief

opening 43. In the depicted example, an opening 21A is defined in the spool 21. The opening 21A is in fluid communication with the bore 25 in the spool 21. The opening 21A in the spool 21 has a diameter that is equal to a diameter of the ball insertion opening 41 formed in the body 30.

5

The inserter cavity isolation valve 26 may be any type of valve suitable for performing its isolation function when it is in a closed position and allowing a frac ball to pass through the ball insertion opening 41 and the inserter cavity isolation valve 26 when it is in an open position. In one illustrative example, the inserter cavity isolation valve 26 may be a gate valve or a ball valve. The inserter cavity isolation valve 26 may be actuated in any desired manner, *e.g.*, manually, hydraulically or electrically. In the example depicted in the drawings, the inserter cavity isolation valve 26 is a gate valve that may be manually actuated by turning a wheel 39. In the depicted example, the inserter cavity isolation valve 26 is provided with pressure balancing means 34 for reducing the actuating forces needed to open or close the inserter cavity isolation valve 26. Such pressure balancing means are well known to those skilled in the art. As depicted in Figure 1B, the gate 47 of the inserter cavity isolation valve 26 is in a closed position where, in combination with the seats 48, the gate 47 acts to block the ball insertion opening 41 and isolate the inserter cavity 33 from pressure within the wellbore 25. However, the inserter cavity isolation valve 26 is also adapted to be actuated such that an opening 47A in the gate 47 is aligned with the ball insertion opening 41 so as to thereby allow a frac ball to pass from the ball inserter cavity 33 through the opening 47A in the gate 47 and down the ball insertion opening 41 into the well bore 25, as described more fully below.

25

The ball inserter piston 28 may be a pneumatic or hydraulic double-acting piston. The ball inserter piston 28 has a ball engagement attachment 38 that is removably coupled to the rod of the piston 28. The piston 28 is coupled to the body 30 such that the rod of the piston 28 is axially aligned with the ball insertion opening 41. In one example, the ball engagement attachment 38 may be made of a relatively hard material, such as steel, and it may have a substantially planar engagement face 38A that is adapted to engage a frac ball during the ball insertion process. The ball inserter piston 28 should have a sufficient stroke such the engagement face 38A of the engagement attachment 38 may be positioned at least a portion of the way into the bore 25 to insure that the ball has been properly inserted. Of course, stroke of the ball inserter piston 28 (in absolute length terms) may vary depending upon the particular application and the size of the components of the system 100.

With reference to Figure 1B, the illustrative inserter cavity relief valve 31 disclosed herein may be any type of valve suitable for performing its venting function as described herein. In one illustrative example, the inserter cavity relief valve 31 may be a plug valve. The inserter cavity relief valve 31 is removably coupled to an adapter 35 via a coupling 36. A seal 37 is provided between the inserter cavity relief valve 31 and the adapter 35. The adapter 35 is coupled to the inserter body 30 by a plurality of bolts. A coupling 47 is also coupled to the inserter cavity relief valve 31 so as to provide connection to piping (not shown). In the depicted example, the inserter cavity relief valve 31 is oriented such that an opening 35A in the adapter 35 is substantially horizontal. The inserter cavity relief valve 31 is in fluid communication with the inserter cavity 33 via the pressure relief opening 43 and the opening 35A. In general, with the inserter cavity

isolation valve 26 in the closed position, the inserter cavity relief valve 31 may be opened to vent and relieve pressure within the inserter cavity 33.

With reference to Figure 1C, the illustrative ball input device 32 disclosed herein is comprised of a removable plug 42, a removable cap 44 and an adapter 40. The cap 44 is removably coupled to the adapter 40. The adapter 40 is coupled to the inserter body 30 by a plurality of bolts. A seal 43 is provided between the plug 42 and the adapter 40. In the depicted example, the ball inserter device 22 is oriented such that the opening 40A in the adapter 40 is substantially vertical and axially aligned with the ball drop opening 45. In one embodiment, the size of the opening 40A should at least be equal to the size of the ball insertion opening 41 and the ball drop opening 45. With the inserter cavity isolation valve 26 in the closed position, and after venting the inserter cavity 33 (by actuating the inserter cavity relief valve 31), the cap 42 may be removed and the plug 42 may then be removed. With the plug 42 removed, a frac ball may be inserted or dropped through the opening 40A into the ball drop opening 45 and thus the inserter cavity 33 in front of the engagement face 38A of the engagement attachment 38 attached to the ball inserter piston 28. The overall height of the ball input device 32 (from the top of the plug 42 to the body 30) should be kept to a minimum so as to avoid damage to frac balls as they are dropped into the inserter cavity 33.

20

Figures 2A-2H depict one illustrative operational sequence of the illustrative ball insertion device 22 disclosed herein for use during fracturing operations performed on an oil/gas well. Each of the Figures 2A-2H contain a plan view of the device disclosed herein in the top portion of the drawing and an elevation view of the device disclosed herein in the bottom portion of the drawing.

25

As shown in Figure 2A, the first major operation is to insure that inserter cavity 33 is isolated from well bore pressure. As depicted in Figure 2A, the inserter cavity isolation valve 26 and the inserter cavity relief valve 31 will normally both be in the closed position during normal wellbore operations and only opened as described below as part of the frac ball insertion process. After insuring that the inserter cavity isolation valve 26 and the inserter cavity relief valve 31 are both closed, and as depicted in Figure 2A, at least the lower master valve 14 is closed. In some applications, both of the lower and upper master valves 14, 18 will be closed. The ball inserter piston 28 will also be in its fully retracted position as this process begins.

Next, as shown in Figure 2B, with the inserter cavity isolation valve 26 in its closed position, the inserter cavity relief valve 31 is opened to vent or relieve pressure within the inserter cavity 33 (behind the closed inserter cavity isolation valve 26). This insures that the inserter cavity 33 is at atmospheric pressure.

Next, as shown in Figure 2C, with the ball inserter piston 28 in its fully retracted position, and the inserter cavity isolation valve 26 in its closed position, the plug 42 of the ball input device 32 is removed. Thereafter, a frac ball 50 is dropped or inserted into the inserter cavity 33 (via the opening 40A and the ball drop opening 45) to a position in front of the ball engagement attachment 38 of the piston 28.

Next, as shown in Figure 2D, with the inserter cavity isolation valve 26 in its closed position, the plug 42 of the ball input device 32 is replaced and the inserter cavity relief valve 31 is closed.

Next, as shown in Figures 2E-2F, the inserter cavity isolation valve 26 is opened, and the piston 28 is actuated so as to force the ball 50 down the ball insertion opening 41 toward the bore 25. Figure 2F depicts the device after the piston 28 has been fully
5 extended so as to position the ball 50 within the bore 25. The ball 50 initially falls within the bore 25 due to the force of gravity. At some point later, pressure may be applied to force the ball 50 down into the well.

Figure 2G depicts the device after the piston 28 was fully retracted and after the
10 inserter cavity isolation valve 26 was moved to its closed position. Note that at this point the ball 50 is positioned on the closed lower master valve 14.

Figure 2H depicts the device after the lower and upper master valves 14, 18 have been opened. At this point normal wellbore operations may proceed.

15

As will be appreciated by one skilled in the art after a complete reading of the present application, the novel system and method disclosed herein may provide several distinct advantages. For example, using the system disclosed herein, the frac balls 50 are isolated from the fracking fluid until such time as they are deployed into the wellbore.
20 Additionally, using the system disclosed herein, the frac balls 50 are inserted into the frac fluid at a location below the flow tee or frac head 20 that is positioned above the upper master valve 18 during fracking operations. By inserting the frac balls 50 at this location, the reliability of the frac ball deployment process is increased.

The particular embodiments disclosed above are illustrative only, as the invention may be modified and practiced in different but equivalent manners apparent to those skilled in the art having the benefit of the teachings herein. For example, the process steps set forth above may be performed in a different order. Furthermore, no limitations are intended to the
5 details of construction or design herein shown, other than as described in the claims below. It is therefore evident that the particular embodiments disclosed above may be altered or modified and all such variations are considered within the scope and spirit of the invention. Note that the use of terms, such as “first,” “second,” “third” or “fourth” to describe various processes or structures in this specification and in the attached claims is only used as a
10 shorthand reference to such steps/structures and does not necessarily imply that such steps/structures are performed/formed in that ordered sequence. Of course, depending upon the exact claim language, an ordered sequence of such processes may or may not be required.

CLAIMS**WHAT IS CLAIMED IS:**

1. A ball inserter device for inserting a ball into a well, comprising:
 - 5 a body;
 - a ball insertion opening defined in the body;
 - a ball drop opening, wherein the ball drop opening intersects the ball insertion opening;
 - a ball inserter piston that is attached to the body, wherein a rod of the piston is
 - 10 axially aligned with the ball insertion opening;
 - an inserter cavity isolation valve coupled to the body, the inserter cavity isolation valve having a valve element that, when closed, blocks the ball insertion opening and partially defines an inserter cavity between the inserter cavity isolation valve and the piston;
 - 15 a pressure relief opening defined in the body, the pressure relief opening being in fluid communication with the inserter cavity;
 - a pressure relief valve coupled to the body, the pressure relief valve being in fluid communication with the pressure relief opening; and
 - a ball input device coupled to the body, the ball input device comprising a
 - 20 removable plug, a removable cap and an opening that is axially aligned with the ball drop opening.
2. The device of claim 1, wherein the ball insertion opening and the ball drop opening have the same diameter.

3. The device of claim 2, wherein the pressure relief opening has a diameter that is less than the diameter of the ball insertion opening and the ball drop opening.

4. The device of claim 1, wherein the inserter cavity isolation valve is one of
5 a gate valve or a ball valve.

5. The device of claim 1, further comprising a ball engagement device coupled to an end of the rod of the ball inserter piston, the ball engagement device having an engagement face that is adapted to engage a ball when a ball is positioned within the
10 inserter cavity.

6. The device of claim 5, wherein the engagement face is a substantially planar face.

15 7. The device of claim 1, wherein the body is removably coupled to a spool and wherein the ball insertion opening is in fluid communication with a bore defined in the spool.

8. The device of claim 7, further comprising an opening in the spool that is in
20 fluid communication with the bore in the spool, wherein the opening in the spool has a diameter that is equal to a diameter of the ball insertion opening in the body.

9. The device of claim 1, wherein the ball is a ball that is adapted to be used in fracturing operations.

25

10. The device of claim 7, wherein the spool is a tee.

11. A ball inserter device for inserting a ball into a well, comprising:

a tee having a bore defined therein and an opening in the spool that is in fluid

5 communication with the bore;

a body removably coupled to the tee;

a ball insertion opening defined in the body, the ball insertion opening being in
fluid communication with the opening in the tee;

10 a ball drop opening defined in the body, wherein the ball drop opening intersects
the ball insertion opening;

a ball inserter piston that is attached to the body, wherein a rod of the piston is
axially aligned with the ball insertion opening;

15 an inserter cavity isolation valve coupled to the body, the inserter cavity isolation
valve having a valve element that, when closed, blocks the ball insertion
opening and partially defines an inserter cavity between the inserter cavity
isolation valve and the piston;

a ball engagement device coupled to an end of the rod of the ball inserter piston,
the ball engagement device having an engagement face that is adapted to
engage a ball when a ball is positioned within the inserter cavity;

20 a pressure relief opening defined in the body, the pressure relief opening being in
fluid communication with the inserter cavity;

a pressure relief valve coupled to the body, the pressure relief valve being in fluid
communication with the pressure relief opening; and

a ball input device coupled to the body, the ball input device having a removable plug and a removable cap and an opening that is axially aligned with the ball drop opening.

5 12. The device of claim 11, wherein the ball insertion opening and the ball drop opening have the same diameter.

10 13. The device of claim 12, wherein the pressure relief opening has a diameter that is less than the diameter of the ball insertion opening and the ball drop opening.

14. The device of claim 13, wherein the inserter cavity isolation valve is one of a gate valve or a ball valve.

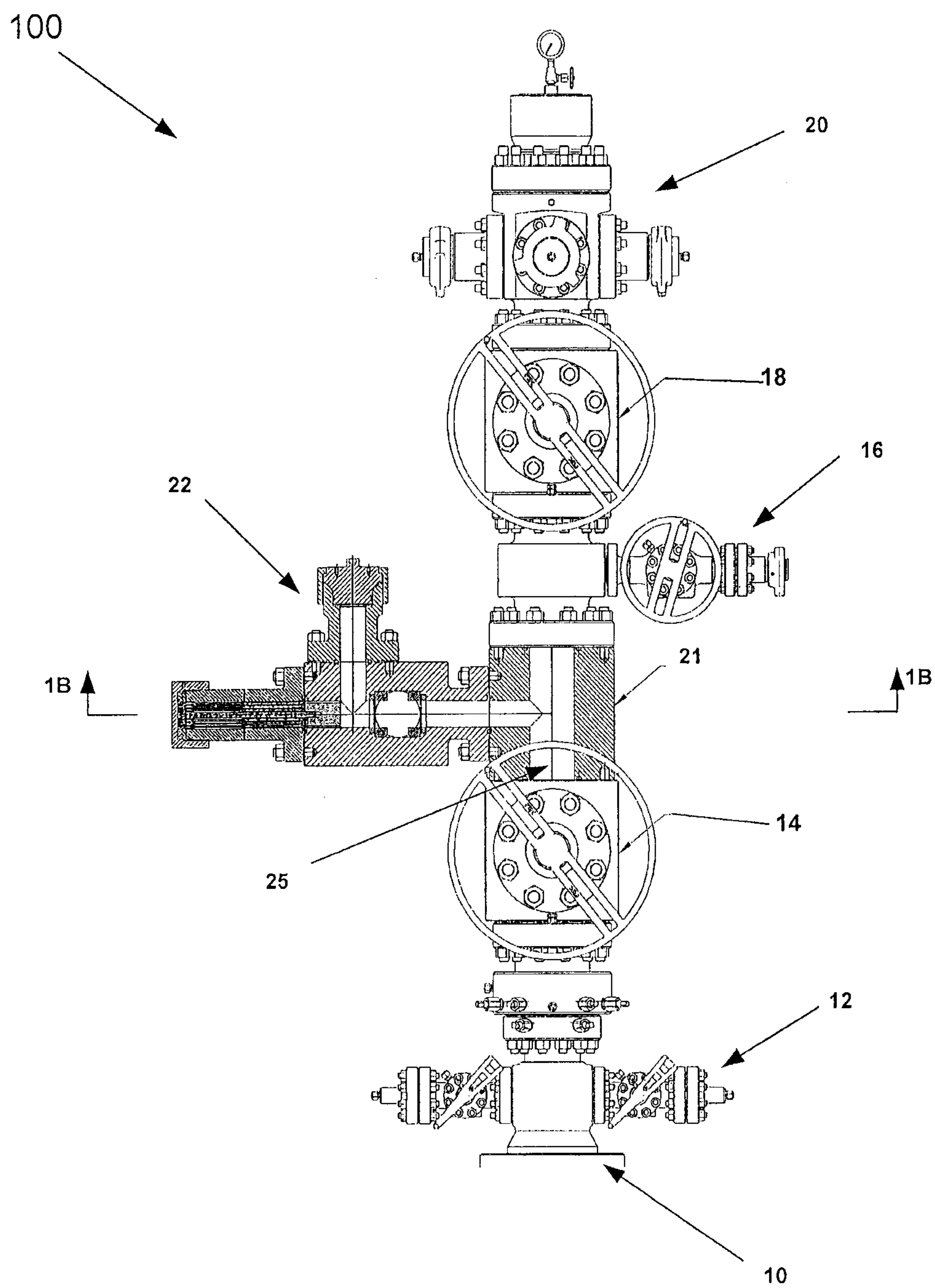
15 15. The device of claim 13, wherein the engagement face is a substantially planar face.

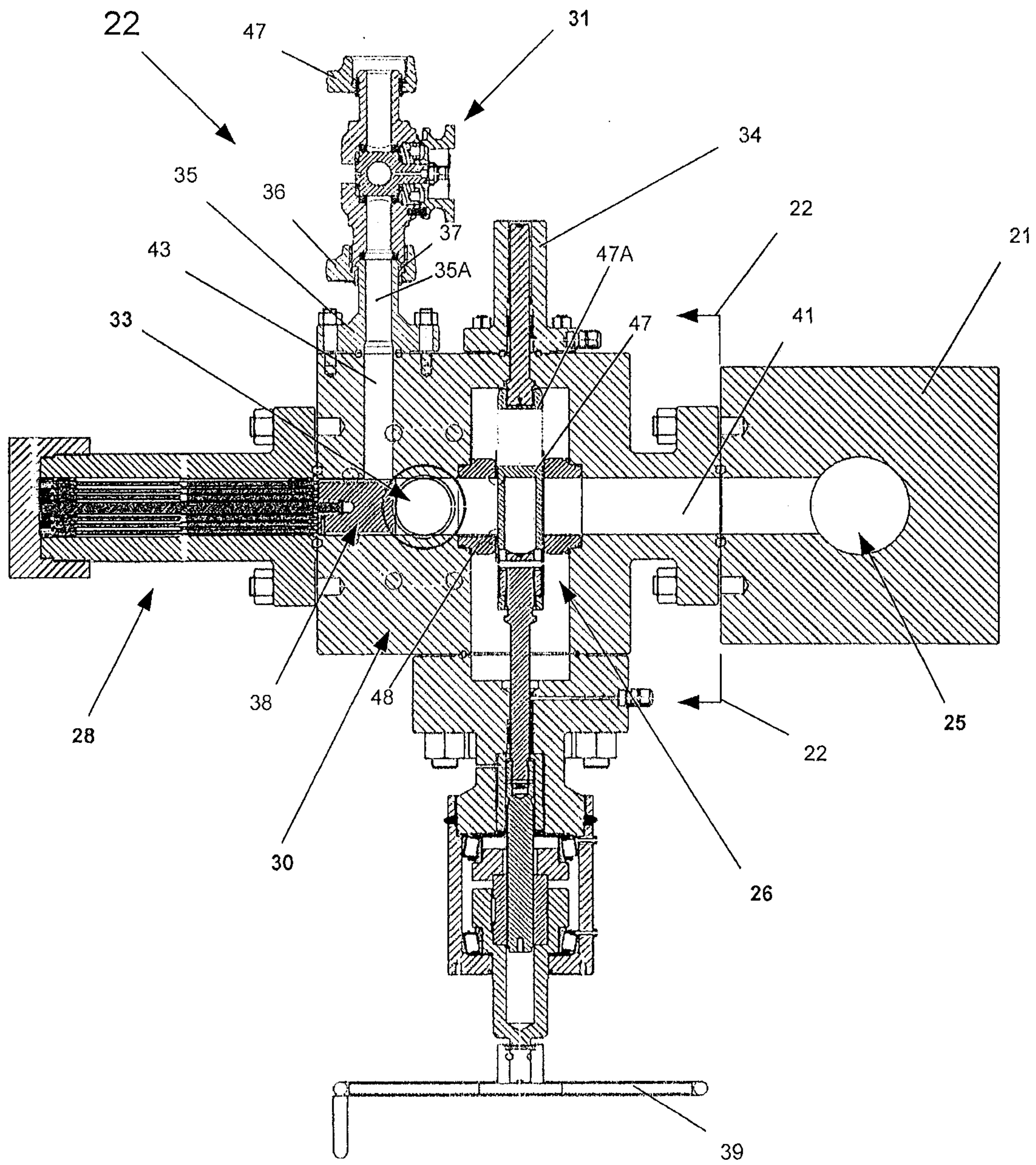
16. The device of claim 13, wherein the opening in the tee has a diameter that is equal to a diameter of the ball insertion opening in the body.

20 17. A method of inserting a ball into a well bore, the method comprising:
closing at least a lower master valve so as to isolate a ball inserter device
positioned vertically between an upper master valve and the lower master
valve from pressure within the well bore;

opening a relief valve so as to relieve pressure within an inserter cavity that is
located in a body of the ball inserter device between a closed inserter
cavity isolation valve and a ball inserter piston that is coupled to the body;
after relieving the pressure within the inserter cavity, removing a removable plug
5 from a ball input device so as to allow communication with a ball drop
opening defined in the body, wherein the ball drop opening intersects a
ball insertion opening defined in the body;
inserting a ball through the ball input device so as to position the ball within the
inserter cavity between the ball inserter piston and the closed inserter
10 cavity isolation valve;
with the inserter cavity isolation valve in its closed position, coupling the
removable plug to the ball input device;
after coupling the removable plug to the ball input device, opening the inserter
cavity isolation valve;
15 actuating the ball inserter piston from a retracted position to an extended position
so as to move the ball through the open inserter cavity isolation valve and
the ball insertion opening and into the well bore;
after inserting the ball into the well bore, actuating the ball inserter piston so as to
cause it to return toward the retracted position;
20 closing the inserter cavity isolation valve so as to block the ball insertion opening;
and
after closing the inserter cavity isolation valve so as to block the ball insertion
opening, opening at least the lower master valve.

18. The method of claim 17, wherein closing at least a lower master valve comprises closing both the lower master valve and the upper master valve so as to isolate a ball inserter device.



**Figure 1B**

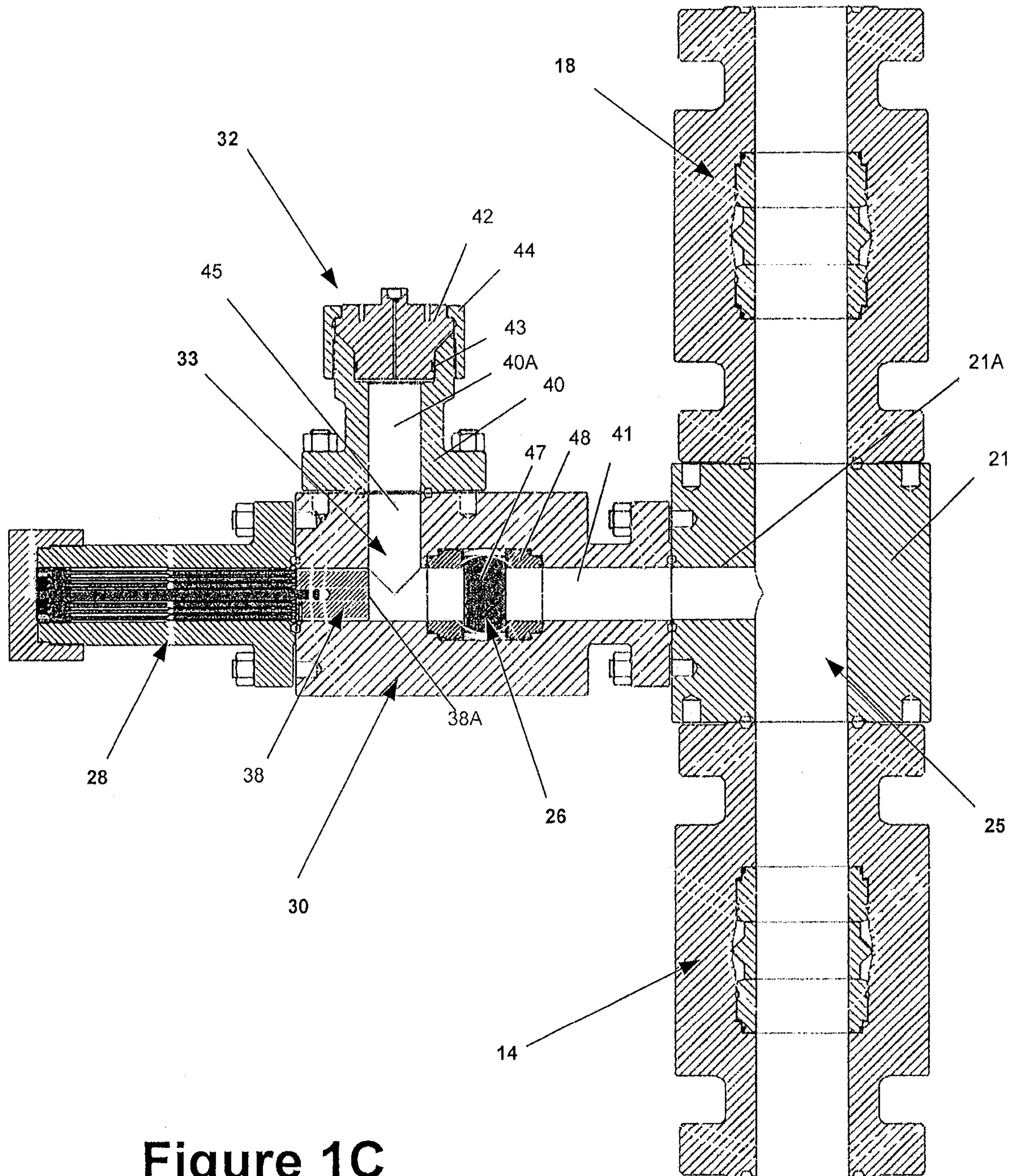


Figure 1C

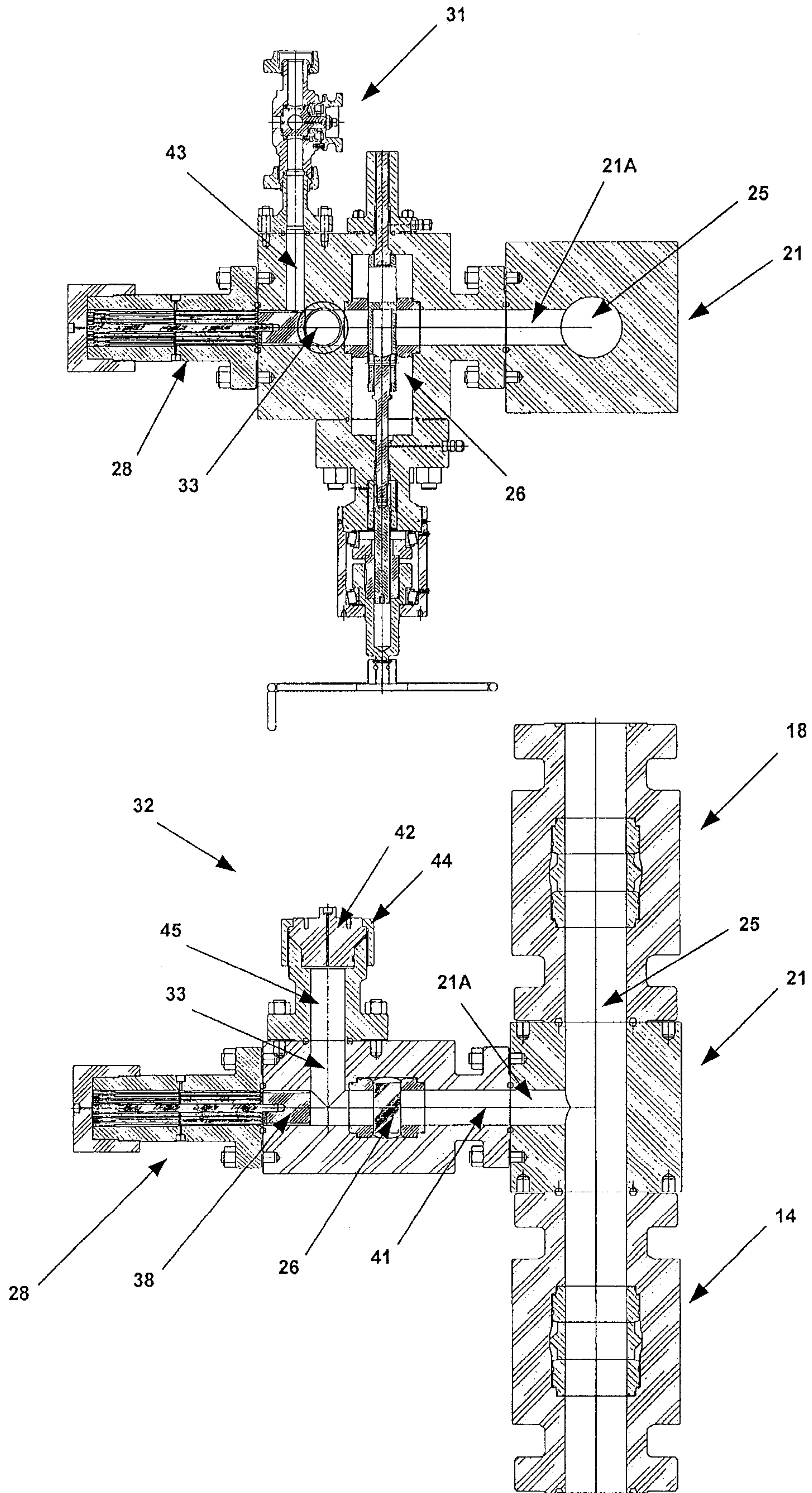


Figure 2A

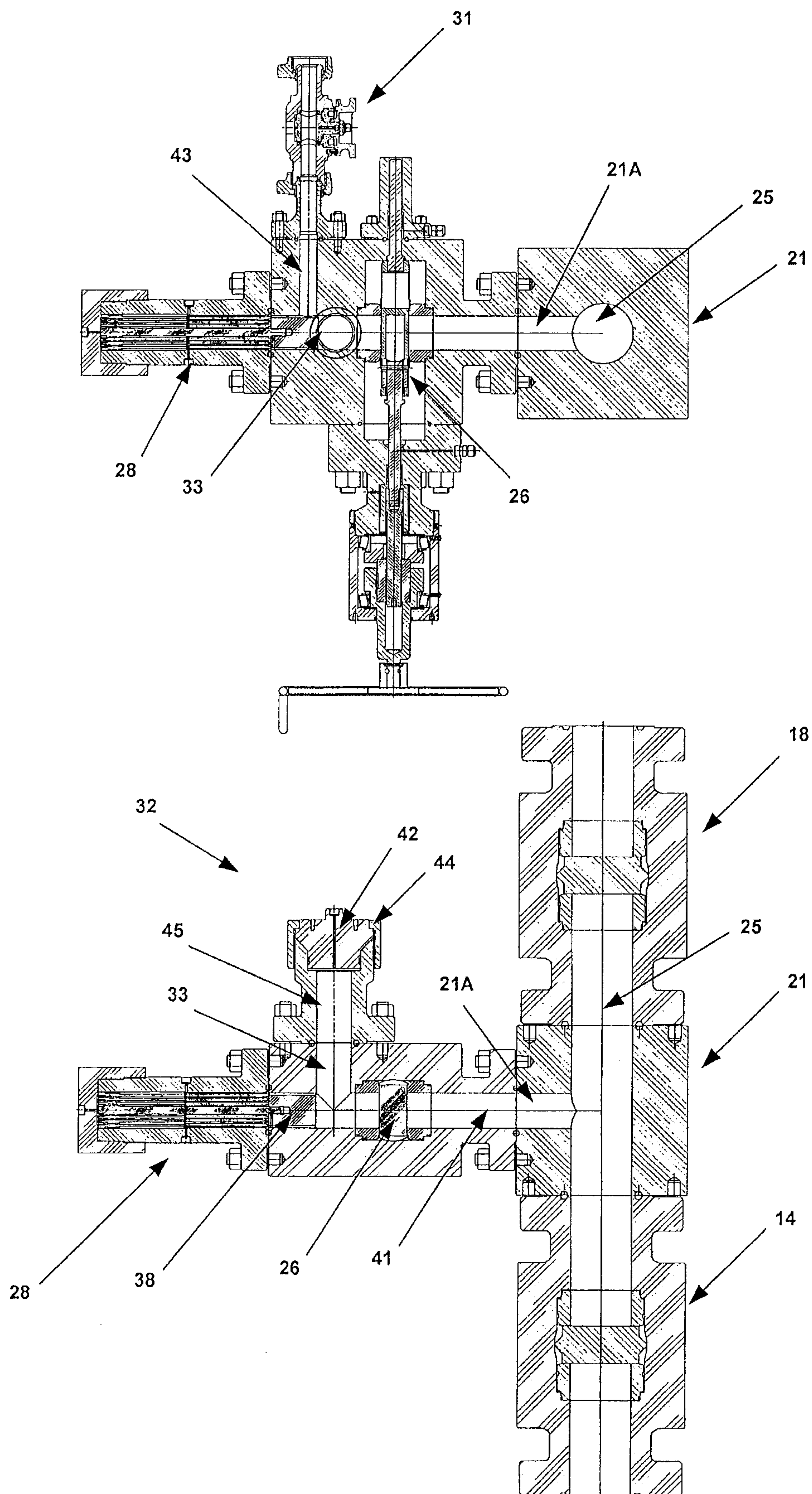


Figure 2B

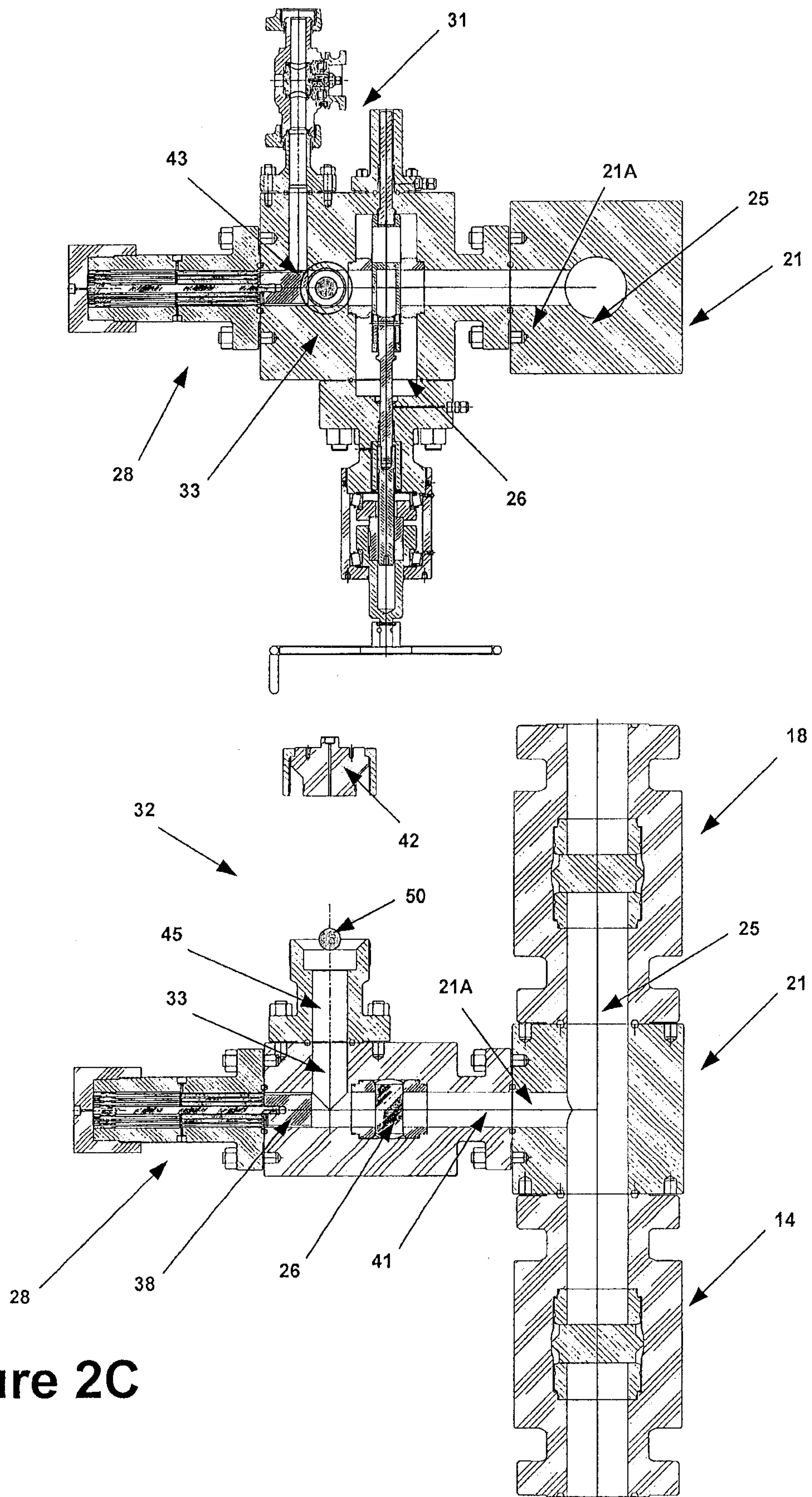


Figure 2C

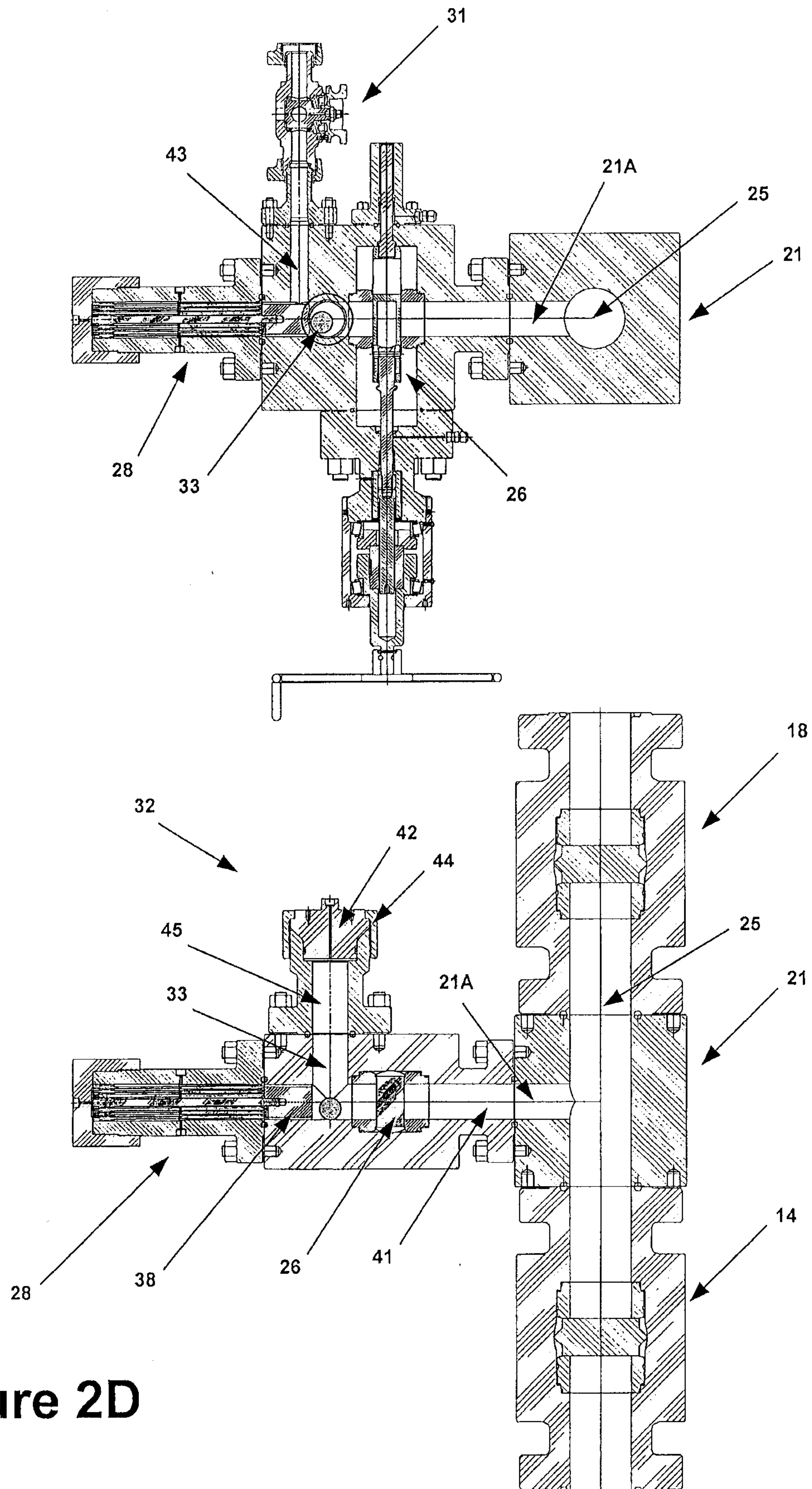


Figure 2D

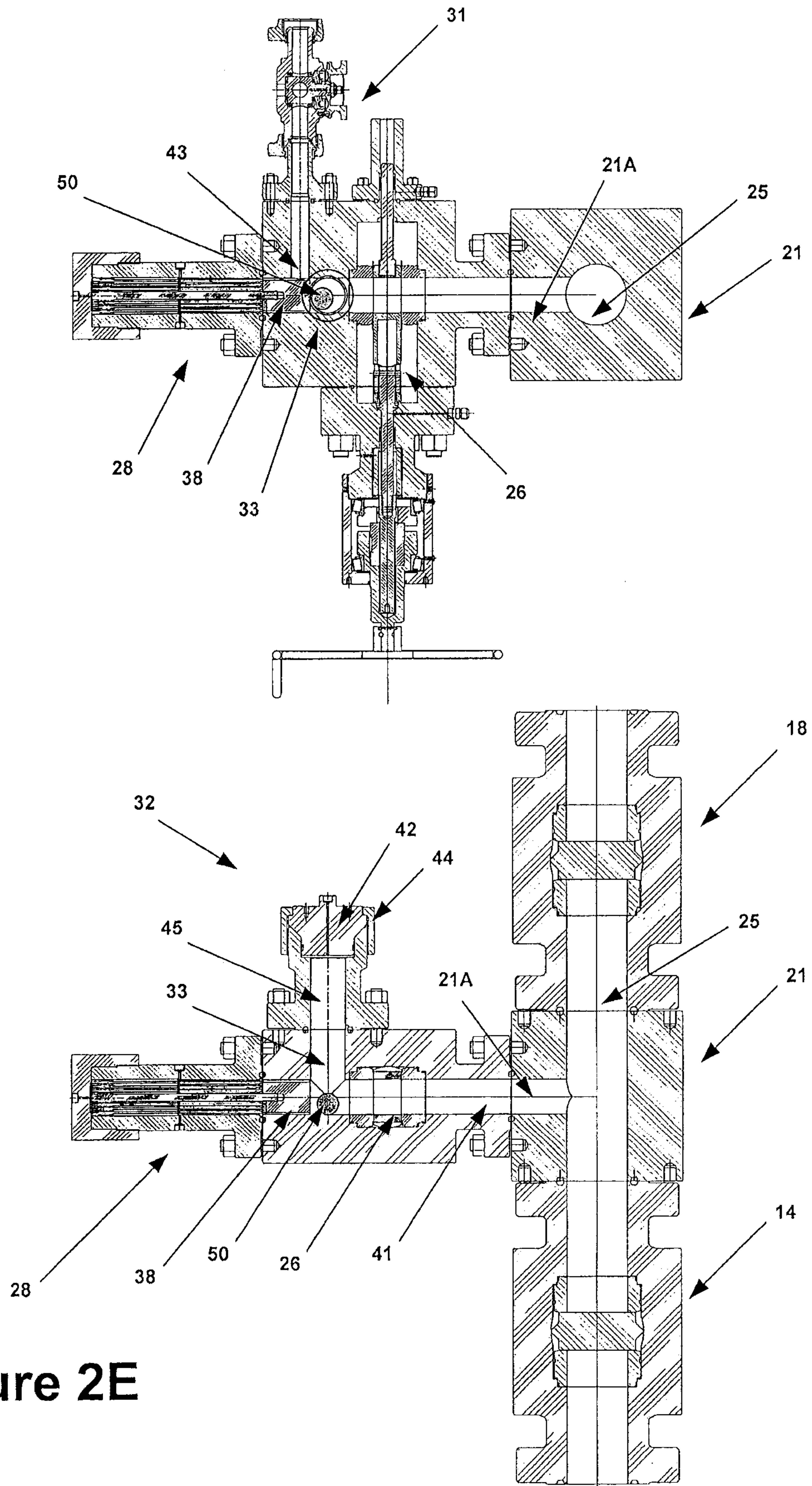


Figure 2E

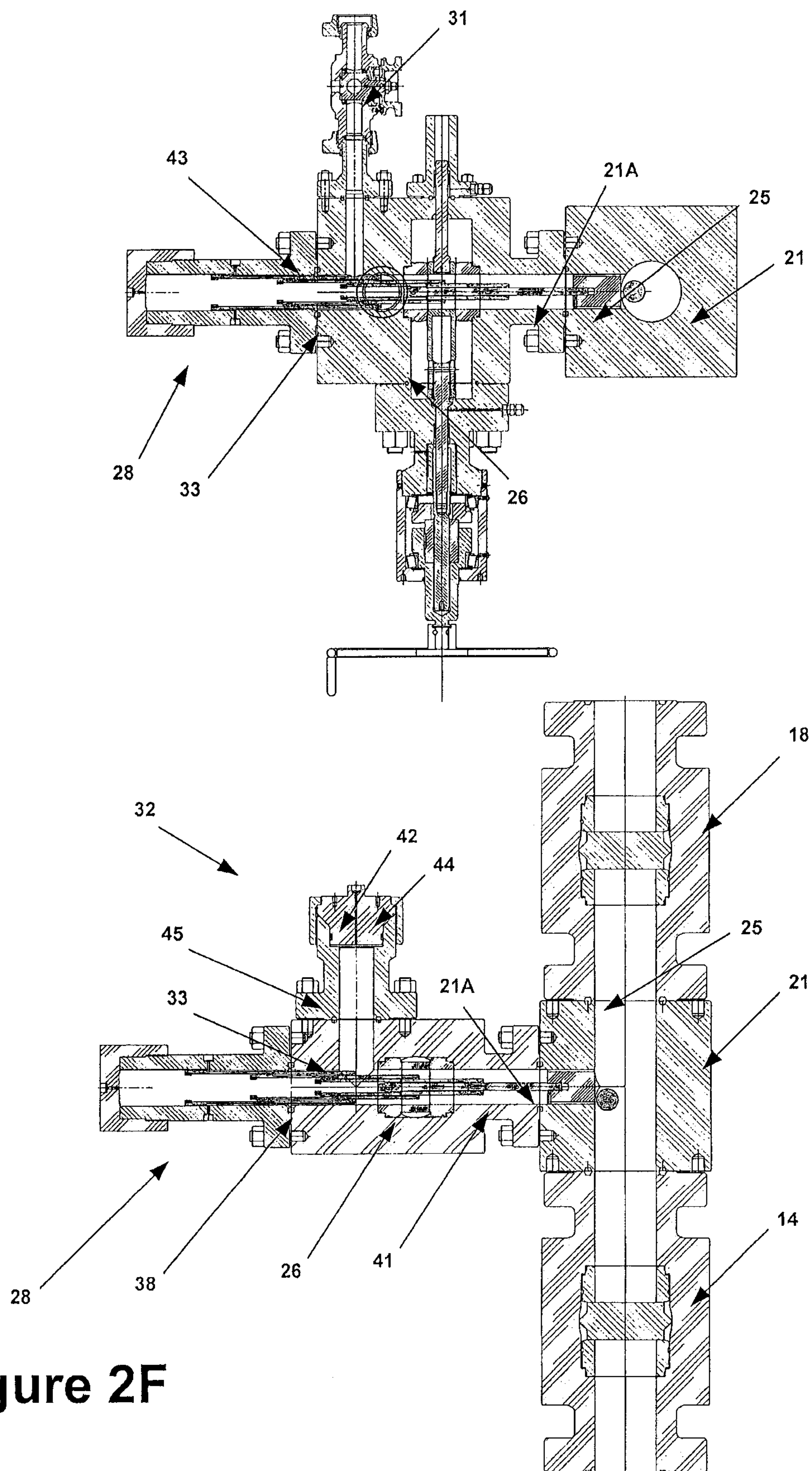


Figure 2F

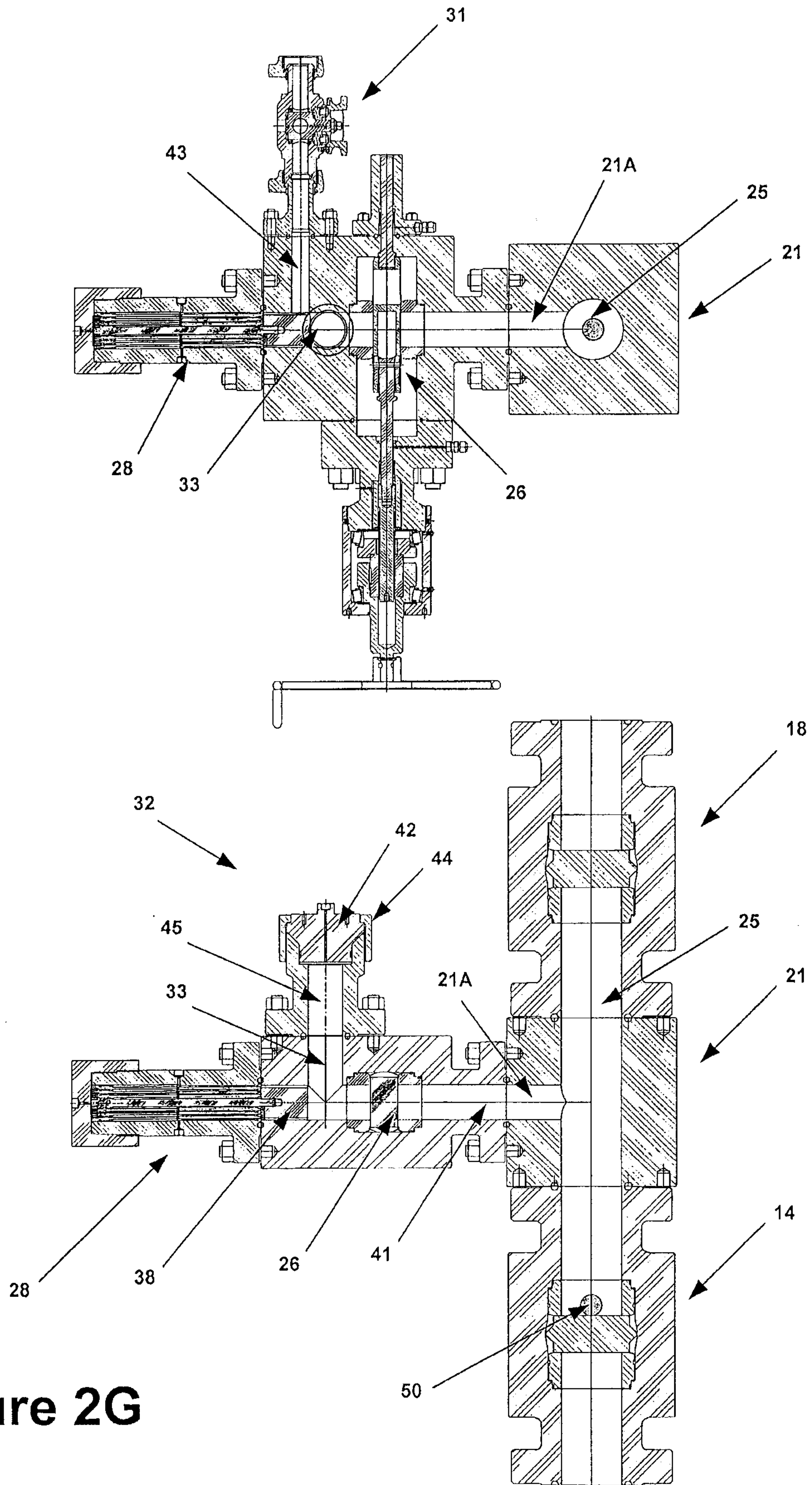
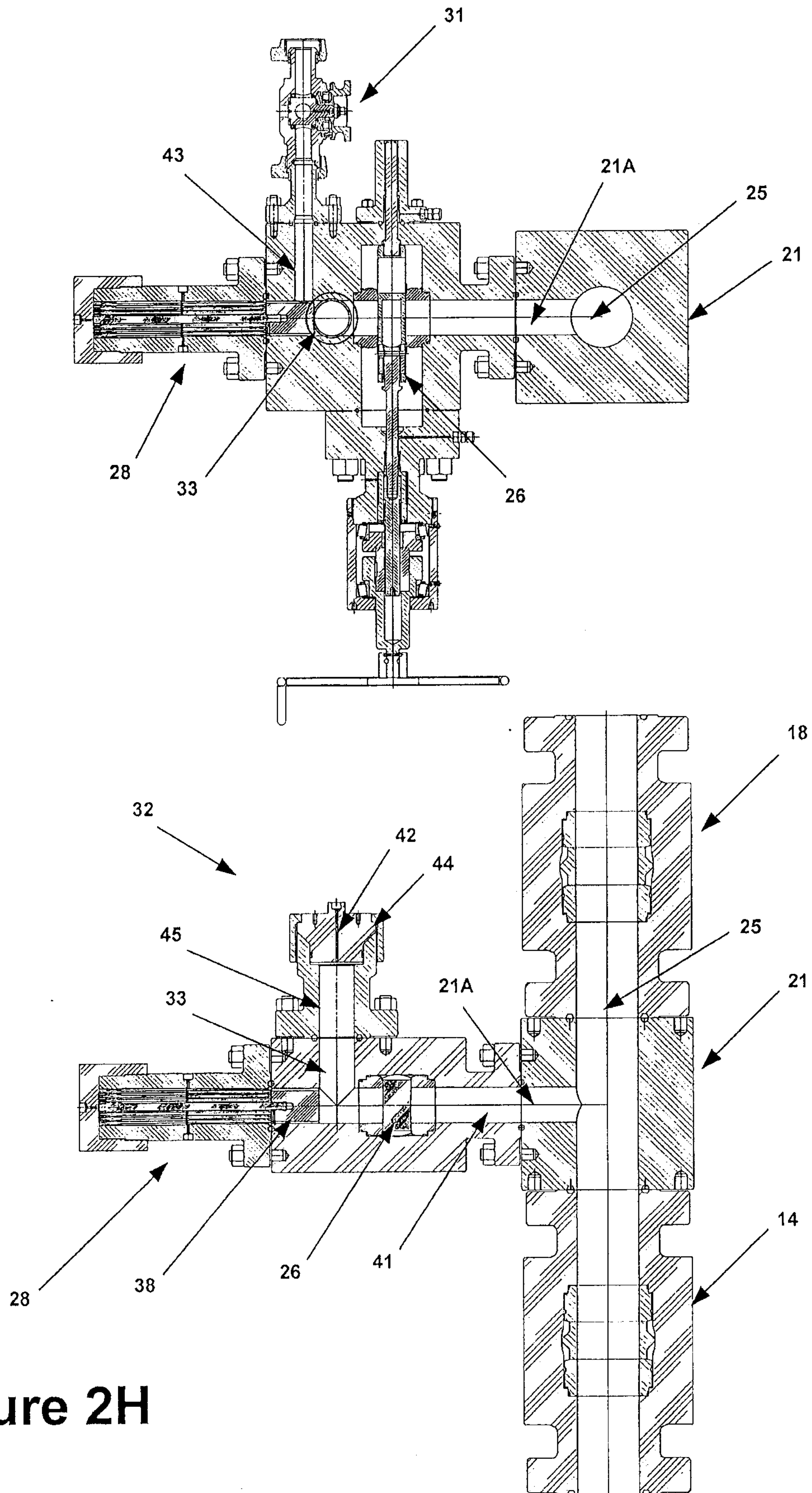
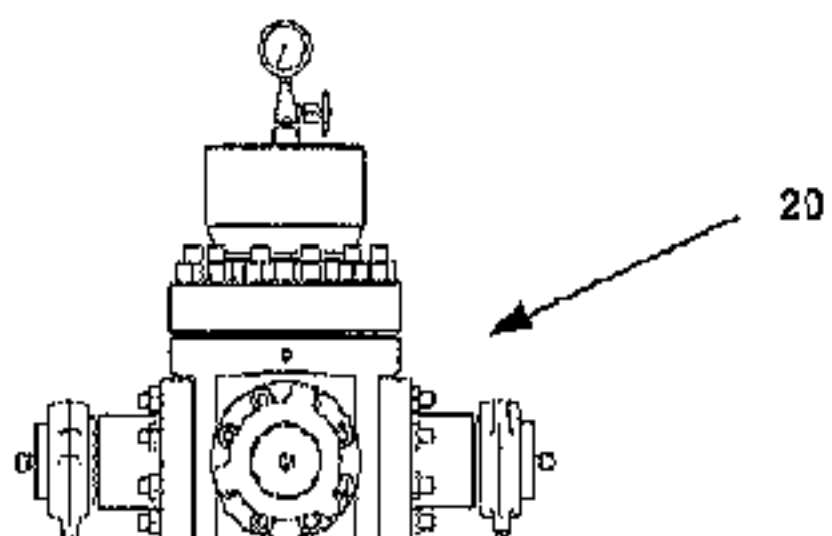
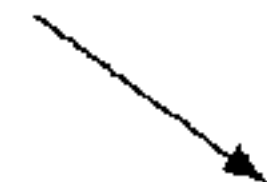


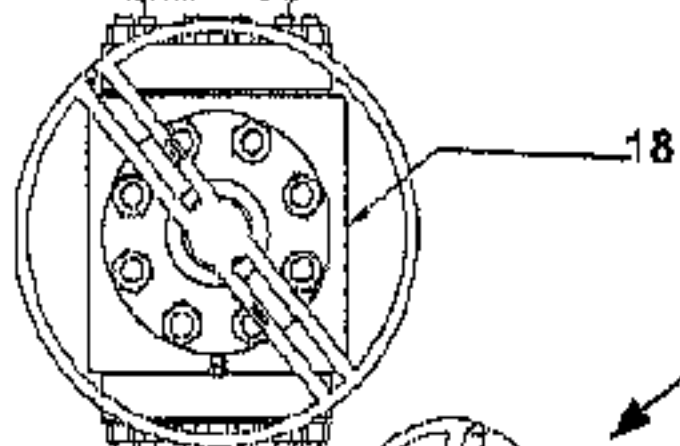
Figure 2G

**Figure 2H**

100



20



18

22

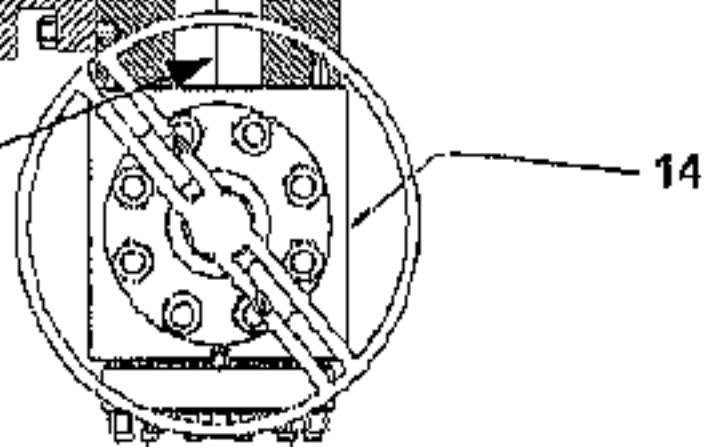


16



21

1B

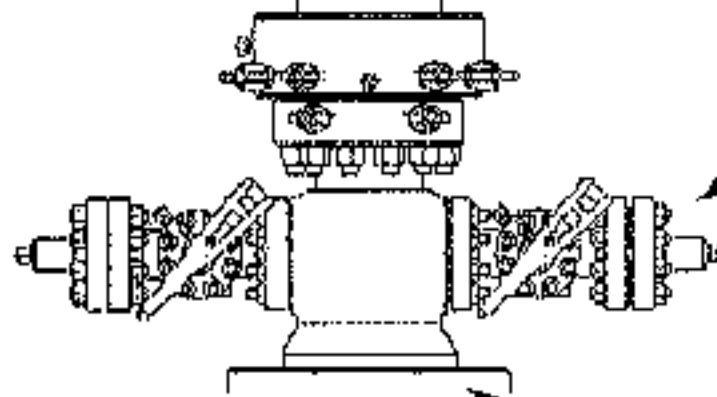


14

25



12



10