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An agency of Industry Canada

CA 2203091 C 2004/11/02

(11)(21) 2 203 091

(12) BREVET CANADIEN
CANADIAN PATENT

(13) C

(22) Date de dépôt/Filing Date: 1997/04/18

(41) Mise à la disp. pub./Open to Public Insp.: 1998/10/18

(45) Date de délivrance/Issue Date: 2004/11/02

(51) Cl.Int.^{6}/Int.Cl.^{6} E21B 33/06

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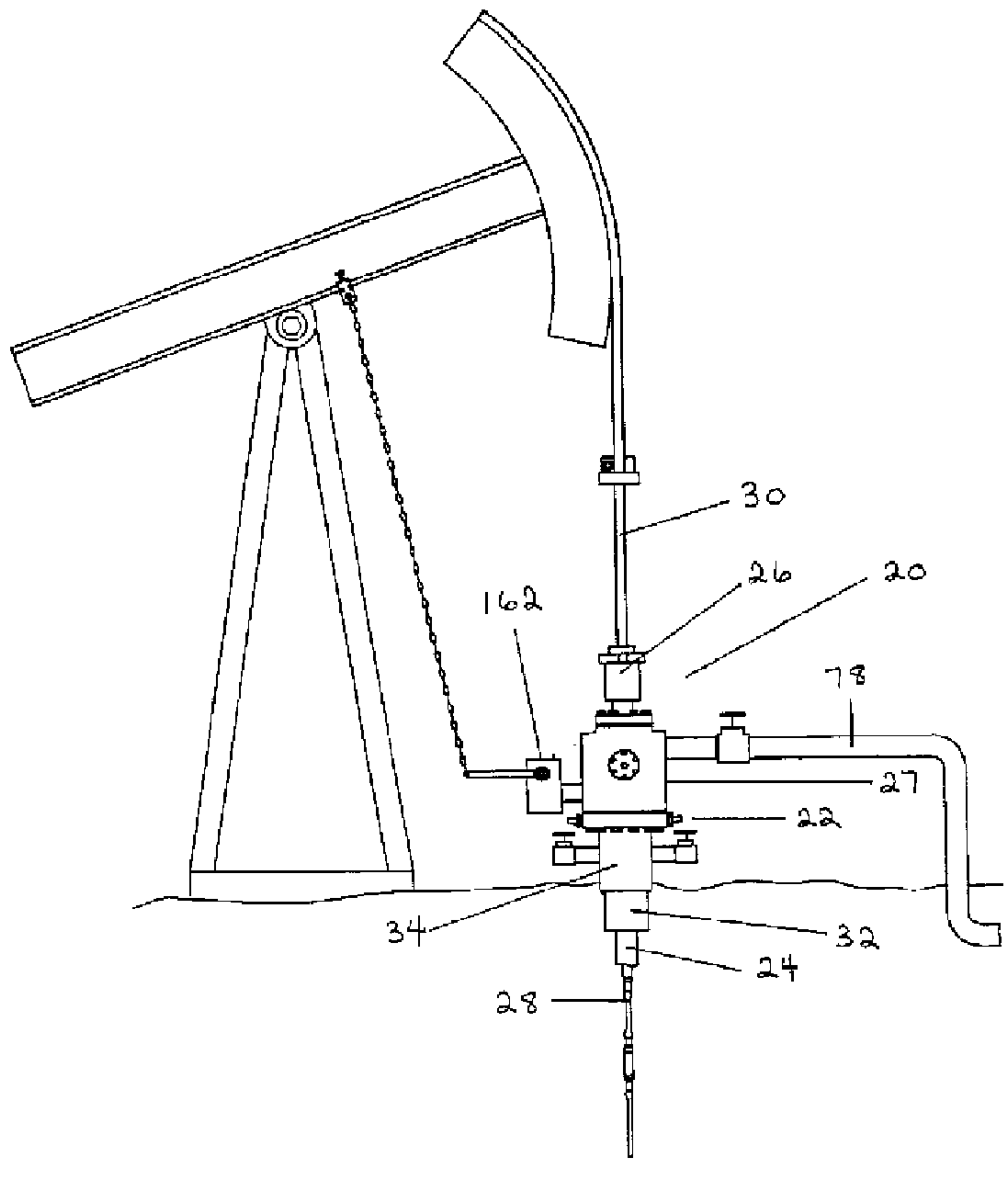
(54) Titre : TE DE POMPAGE, BLOC D'OBTURATION DE PUITS ET ROTATEUR DE TUBE INTEGRES
(54) Title: INTEGRAL PUMPING TEE, BLOWOUT PREVENTER AND TUBING ROTATOR



(57) Abrégé/Abstract:
An improved assembly of wellhead equipment consisting of a flow tee having an upper end and a lower end, a blowout preventer having an upper end and a lower end and a tubing rotator having an upper end and a lower end, wherein the improvement comprises combining the flow tee, the blowout preventer and the tubing rotator in a single apparatus so that the lower end of the flow tee is permanently connected to the upper end of the blowout preventer and the lower end of the blowout preventer is permanently connected to the upper end of the tubing rotator.

ABSTRACT OF INVENTION

An improved assembly of wellhead equipment consisting of a flow tee having an upper end and a lower end, a blowout preventer having an upper end and a lower end and a tubing rotator having an upper end and a lower end, wherein the improvement comprises combining the flow tee, the blowout preventer and the tubing rotator in a single apparatus so that the lower end of the flow tee is permanently connected to the upper end of the blowout preventer and the lower end of the blowout preventer is permanently connected to the upper end of the tubing rotator.

INTEGRAL PUMPING TEE, BLOWOUT PREVENTER AND TUBING ROTATOR

TECHNICAL FIELD

The present invention relates to an apparatus for attachment to a wellhead. More specifically, the invention relates to an assembly of wellhead equipment comprising a flow or pumping tee, a blowout preventer and a tubing rotator, wherein the flow tee, the blowout preventer and the tubing rotator are combined and permanently connected to form a single, integral apparatus.

BACKGROUND ART

A typical wellhead is often comprised of a pumping tee or flow tee connection, a blowout preventer and a tubing rotator. These individual components are typically joined to each other and to the wellhead by way of temporary connections between two of the components or between one of the components and the wellhead. The tubing rotator is typically mounted to the wellhead adjacent the upper end of the casing string at the ground surface by bolting a flanged surface on the lower end of the tubing rotator to a flanged surface on the wellhead. The blowout preventer is then typically mounted on top of the tubing rotator by bolting together flanged surfaces on the upper end of the tubing rotator and the lower end of the blowout preventer respectively, and the flow tee is then typically mounted on top of the blowout preventer by bolting together flanged surfaces on the upper end of the blowout preventer and the lower end of the flow tee respectively. The remainder of the wellhead structure is then typically mounted on top of the flow tee by being bolted to a flanged surface on the upper end of the flow tee. Other forms of temporary connections amongst the wellhead and the individual components are also possible. These connections are designed to be temporary in order to facilitate the dismantling of all or a portion of the wellhead structure for the purpose of servicing the well.

Tubing rotators are used in the industry to suspend and rotate the tubing string within the wellbore. By rotating the tubing string, typical wear occurring within the internal surface of the tubing string, by either a reciprocating or rotating rod string, is distributed over the entire internal surface. As a result, the tubing rotator may prolong the life of the tubing string. Further, the constant movement of the inner surface of the tubing string relative to the rod string may inhibit or reduce buildup of wax and other materials within the tubing string.

The pumping tee or flow tee provides a connection between one or more production flow lines and the wellhead such that the wellbore fluid may be directed through the wellhead and into the production flow lines. The blowout preventer provides a mechanism for sealing off the production tubing about the rod string within the wellhead. In particular, the blowout preventer provides means for sealing off the annulus between the rod string and the production tubing in order to inhibit the release of pressure or fluid from the wellbore through the wellhead.

The combined use of a conventional flow tee, blowout preventer and tubing rotator connected in series on a wellhead results in the wellhead having multiple connections and significant height. It has been found that excessive wellhead height may cause weakening and instability of the wellhead and present servicing difficulties. The temporary connections between the components may also contribute to this weakening and instability. Canadian Patent Application No. 2,153,612 describes an "Integral Blowout Preventer and Flow Tee" combining the functions of a flow tee and a blowout preventer in a single apparatus, thus reducing the number of temporary connections and the overall height of the wellhead, but does not contemplate combining the functions of a flow tee, a blowout preventer and a tubing rotator in a single apparatus, which provides even fewer temporary connections and the possibility of even more sturdiness, stability and further reduced wellhead height.

There is therefore a need in the industry for an apparatus which provides for the functions of a flow tee, blowout preventer and tubing rotator in an integral unit. Specifically, there is a need for an apparatus which combines the functional elements of the flow tee, the blowout preventer and the tubing rotator in a single apparatus which is sturdier and more stable in comparison with a flow tee, blowout preventer and tubing rotator as separate or individual units mounted together. There is also a need in the industry for such an integral apparatus that will still facilitate servicing of the well.

DISCLOSURE OF INVENTION

The present invention combines the functions of a flow tee, a blowout preventer and a tubing rotator in a single integral apparatus, thus reducing the number of temporary connections that must be made to a wellhead in comparison with a flow tee, blowout preventer and tubing rotator which are mounted on a wellhead separately. This reduced number of temporary connections in turn may result in a more sturdy and stable wellhead, and may also result in reduced overall wellhead height.

In one aspect, the present invention presents an improvement in an assembly of wellhead equipment comprising a flow tee having an upper end and a lower end, a blowout preventer having an upper end and a lower end and a tubing rotator, for suspending and rotating a tubing string contained within a wellbore, having an upper end and a lower end, and wherein the lower end of the flow tee is connectable to the upper end of the blowout preventer and the lower end of the blowout preventer is connectable to the upper end of the tubing rotator, wherein the improvement comprises combining the flow tee, the blowout preventer and the tubing rotator in a single apparatus so that the lower end of the flow tee is permanently connected to the upper end of the blowout preventer and the lower end of the blowout preventer is permanently connected to the upper end of the tubing rotator.

By combining the flow tee, the blowout preventer and the tubing rotator in a single apparatus, the temporary connection between the lower end of the flow tee and the upper end of the blowout preventer and the temporary connection between the lower end of the blowout preventer and the upper end of the tubing rotator can be eliminated. Preferably, the overall height of the apparatus is less than that of a flow tee, blowout preventer and tubing rotator when mounted separately on a wellhead. This reduced height may be realized by eliminating connecting flanges between the flow tee and the blowout preventer and eliminating connecting flanges between the blowout preventer and the tubing rotator.

In a preferred embodiment of the invention, the apparatus comprises a housing having an upper end, an upper section, a middle section, a lower section, a lower end and a fluid path extending therethrough between the upper and lower ends and wherein the flow tee is comprised of the upper section of the housing, the blowout preventer is comprised of the middle section of the housing and the tubing rotator is comprised of the lower section of the housing. Preferably, the upper, middle and lower sections of the housing comprise a continuous housing which is integrally formed as one piece, but the housing may be comprised of several pieces permanently connected together, such as by welding.

Preferably, the apparatus has a lower end and an upper end, and further comprises temporary connection means located at the upper and lower ends of the apparatus which may be comprised of any means which are compatible with the wellhead and with other wellhead equipment. Where the apparatus comprises a housing, these temporary connection means comprise respectively means for connecting the upper end of the housing to other wellhead equipment and means for mounting the lower end of the housing on a wellhead. The upper end connecting means may be comprised of the housing, which housing may comprise an upper surface on the upper end of the housing or a connecting flange located at the upper end of the housing. The mounting means may be comprised of the housing, which housing may comprise a lower surface on the lower end of the housing, a mounting flange located at the lower end of the housing, or a base plate connected to the lower end of the housing.

The tubing rotator may be further comprised of a supported member for connecting to the tubing string and a supporting structure for rotatably supporting the supported member so that the tubing string is rotatably supported within the wellbore. Any combination of supported member and supporting structure which performs this basic function may be used in the invention. Preferably, however, the supporting structure engages the wellhead, and may comprise a support flange for mounting on the wellhead, or may comprise the lower section of the housing, including the base plate in circumstances where the housing comprises a base plate. In circumstances where the wellhead is comprised of a casing bowl having a tapered inner surface, the supporting structure may include a tapered outer surface which is compatible with the inner surface of the casing bowl.

As can be seen, the servicing of wells which include the apparatus of the present invention may be simplified, in that the apparatus can be removed from and installed upon the wellhead as one unit, rather than as three separate components, as is the case where the flow tee, blowout preventer and tubing rotator are not combined in one integral apparatus. In addition, in the preferred embodiment of the invention, the apparatus may be removed from the wellhead to facilitate servicing without compromising the safety of the well, since the tubing string can remain anchored in the wellbore while most of the apparatus is removed and is replaced with a service blowout preventer.

BRIEF DESCRIPTION OF DRAWINGS

Embodiments of the invention will now be described with reference to the accompanying drawings, in which:

Figure 1 is a side view of a wellhead having a reciprocating rod and walking beam, in which the apparatus is mounted for operation;

Figure 2 is a side view of a wellhead having a rotating rod in which the apparatus is mounted for operation;

Figure 3 is a top view of a preferred embodiment of the apparatus connected to a gear box;

Figure 4 is a longitudinal sectional view of the preferred embodiment of the apparatus taken along line 4-4 of Figure 3 showing a preferred embodiment of the tubing rotator;

Figure 5 is a longitudinal sectional view of the apparatus taken along line 5-5 of Figure 3;

Figure 6 is a longitudinal sectional view of the apparatus taken along line 6-6 of Figure 3 including a polished rod ram and a polished rod ram rubber backer;

Figure 7 is a pictorial view of the polished rod ram shown in Figure 6;

Figure 8 is a pictorial view of the polished rod ram packer shown in Figure 6;

Figure 9 is an outer end view of the polished rod ram shown in Figure 7;

Figure 10 is a cross-sectional view of the polished rod ram taken along line 10-10 of Figure 9;

Figure 11 is a longitudinal sectional view a first alternate embodiment of the apparatus taken along a line similar to that of Figure 4, showing a first alternate embodiment of the tubing rotator;

Figure 12 is a longitudinal sectional view of a second alternate embodiment of the apparatus taken along a line similar to that of Figure 4, showing a second alternate embodiment of the tubing rotator;

Figure 13 is a longitudinal sectional view of a third alternate embodiment of the apparatus taken along a line similar to that of Figure 4, showing a third alternate embodiment of the tubing rotator;

Figure 14 is a top view of a drive ring shown in the tubing rotator of Figures 12 and 13;

Figure 15 is a cross-sectional view of the drive ring taken along line 15-15 of Figure 14;

Figure 16 is a top view of a lower supported member shown in Figures 12 and 13; and

Figure 17 is a longitudinal sectional view of the lower supported member taken along line 17-17 of Figure 16.

BEST MODE OF CARRYING OUT INVENTION

Referring to Figures 1 and 2, the within invention is directed at an improvement of an assembly of wellhead equipment. A typical wellhead (20) is comprised of plurality of components mounted at the ground surface above a wellbore, including a wellhead flange (22) and wellhead equipment such as a tubing rotator for suspending and rotating a tubing string (24) contained within the wellbore, a blowout preventer, a flow tee or pumping tee and a rod stuffing box (26). Typically, the wellhead equipment is mounted above the wellhead flange (22).

Further, typically, a lower end of the tubing rotator is directly or indirectly mounted, or otherwise connected, to the wellhead flange (22). As well, the upper end of the tubing rotator is directly or indirectly mounted or connected to the lower end of the blowout preventer. The upper end of the blowout preventer is then mounted or connected to the lower end of the flow tee. Finally, the upper end of the flow tee is typically mounted or connected to the lower of the rod stuffing box (26). The wellhead equipment may be interconnected in this manner by any suitable means, structure, apparatus or mechanism. However, typically, each of the flow tee, blowout preventer and tubing rotator includes a flange located at each of its upper and lower ends. Thus, the equipment is mounted together or interconnected by joining or fastening the adjacent flanges on the lower end of the flow tee and the upper end of the blowout preventer and by joining or fastening the adjacent flanges on the lower end of the blowout preventer and the upper end of the tubing rotator.

Further, a rod or rod string (28) is run through the wellhead (20) and into the wellbore through a continuous fluid passage or pathway which extends through each of the flow tee, the blowout preventer and the tubing rotator. The well may be produced by a reciprocating rod (28), reciprocated by a pump jack or walking beam at the surface as shown in Figure 1. Alternately, the well may be produced by a rotating rod (28), driven by a rotary pump drive at the surface as shown in Figure 2. In either case, the upper end of the rod (28) includes a polished rod (30) that extends through the entire wellhead (20). The polished rod (30) provides a smooth sealable surface between the reciprocating or rotating rod (28) and the rod stuffing box (26) or the rod blowout preventer when it is closed or sealed against the polished rod (30). The upper end of the polished rod (30) is held by a rod clamp such that the rod (28) is suspended in the wellhead (20) and the wellbore. The rod clamp is supported either by the walking beam, as shown in Figure 1, or from a thrust bearing plate forming part of the rotary pump drive, as shown in Figure 2.

The wellbore of the well is typically completed by cementing a casing string (32) in at least the upper portion of the wellbore. Typically, the wellhead flange (22) is comprised of a casing bowl (34), welded or screwed to the top of the casing string (32), having a flange at its uppermost surface. The casing bowl (34) may include an inwardly tapered inner surface (36).

The within invention is comprised of an improvement in the above described wellhead equipment. In particular, the improvement is comprised of combining the flow tee, blowout preventer and tubing rotator in a single, integral or continuous unit or apparatus (27). Thus, an apparatus (27) is provided which combines the functions of each of these three components. The apparatus (27) combines the flow tee, blowout preventer and tubing rotator, and is configured or arranged such that a lower end of the flow tee is permanently connected to, or associated with, an upper end of the blowout preventer and a lower end of the blowout preventer is permanently connected to, or associated with, an upper end of the tubing rotator.

The permanent connections between the flow tee, blowout preventer and tubing rotator may be made by any means, method, process, device, mechanism or apparatus suitable for permanently connecting or affixing together the adjacent ends or surfaces of the various components such that a single apparatus (27) is formed therefrom. More particularly, connecting flanges, fastened together by bolts, screws or the like, or other interconnecting members, such as nipples and the like, are not located between the flow tee and the blowout preventer and between the blowout preventer and the tubing rotator. For instance, the adjacent ends or surfaces may be welded together. However, in the preferred embodiment, the flow tee, blowout preventer and tubing rotator are permanently connected together by casting, machining or otherwise forming the components of the apparatus (27), being the flow tee, blowout preventer and tubing rotator, as a continuous or integral unit. Specifically, in the preferred embodiment, the apparatus (27) is comprised of a housing (38) which is preferably cast, machined or otherwise formed as a continuous unit or piece. The flow tee, blowout preventer and tubing rotator are each comprised of a section of the housing (38) as described further below.

Referring to Figures 4 and 11-13, the apparatus (27) is comprised of a housing (38) having an upper end (40), an opposing lower end (42), a longitudinal axis extending therebetween and an outer surface or wall (43). The housing (40) may be of any shape or configuration suitable for its intended function or purpose, as described herein. However, the housing (38) is preferably circular on cross-section, as shown in Figure 3, such that the circumference of the housing (38) defines the outer wall (43).

A primary fluid passage (44) or pathway is defined by the apparatus (27) and extends longitudinally therethrough such that the primary fluid passage (44) permits the wellbore fluids from the tubing string (24) to pass through the apparatus (27). The primary fluid passage (44) extends through the housing (38) between the upper and lower ends (40, 42) and is preferably aligned such that the primary fluid passage (44) is substantially parallel to the longitudinal axis of the housing (38). Further, a longitudinal axis of the primary fluid passage (44) is preferably concurrent or coincident with the longitudinal axis of the housing (38) such that the primary fluid passage (44) is substantially centrally located within the housing (38). In operation, the polished rod (30) passes through the apparatus (27) within the primary fluid passage

(44). The primary fluid passage (44) may be of any shape or size suitable for its intended function and which permits the reciprocation or rotation of the polished rod (30) therein. However, in the preferred embodiment, the primary fluid passage (44) is circular on cross-section in order to facilitate the passage of the wellbore fluid therethrough and to facilitate the movement of the polished rod (30) therein.

The upper end (40) of the housing (38) is preferably connectable to other wellhead equipment by any fastening or connecting means, mechanism, structure or device suitable for temporarily fastening or connecting the apparatus (27) to such other wellhead equipment. Thus, further wellhead equipment may be mounted upon the apparatus (27). In the preferred embodiment, the housing (38) further comprises a connecting flange (46) located at the upper end (40) of the housing (38) for connecting the apparatus (27) to the other wellhead equipment. As a result, the connecting flange (46) forms the uppermost surface of the apparatus (27).

In the preferred embodiment, the connecting flange (46) is integral or continuous with the remainder or balance of the housing (38). Preferably, the housing (38) is cast, machined or otherwise formed such that the connecting flange (46) is incorporated into or comprises the housing (38). However, alternately, the connecting flange (46) may comprise a separate or distinct portion of the housing (38), which is connected to the upper end (40) of the housing (38) by any fastening or connecting means, device, apparatus or mechanism suitable for fastening or connecting the adjacent surfaces of the connecting flange (46) and the housing (38). In this instance, the connection is preferably permanent, however, the connecting flange (46) may be removably attached or connected to the upper end (40) of the housing (38) where preferred or otherwise desirable to permit versatility or flexibility with respect to the specific wellhead equipment which may be mounted upon the connecting flange (46).

As shown in Figures 3-5, in the preferred embodiment, the connecting flange (46) is comprised of an upper surface (47) on the upper end (40) of the housing (38), which upper surface (47) is adapted for connection to the other wellhead equipment. Any manner of adapting, or any structure, device or mechanism for adapting, the upper surface (47) for connection to the other wellhead equipment may be used. However, in the preferred embodiment, the connecting flange (46) is comprised of the upper surface (47) defining at least two apertures (48), and preferably a plurality of apertures (48), spaced circumferentially about the primary fluid passage (44). The apertures (48) are for receiving fasteners, such as bolts, screws or the like, therein such that the other wellhead equipment may be fastened to the connecting flange (46). Thus, the arrangement or configuration of the apertures (48) must be compatible with the adjacent wellhead equipment to be mounted upon the apparatus (27), and in particular, must be compatible with a flange or lowermost surface of such equipment. Further, the upper surface (47) of the housing (38) comprising the connecting flange (46) preferably defines an annular groove (50) about the circumference of the primary fluid passage (44), for receiving an O-ring or other seal, for sealing between the adjacent surfaces of the connecting flange (46) and the other wellhead equipment.

Similarly, the lower end (42) of the housing (38) is preferably connectable to the components of the wellhead, or wellhead equipment, which are located in the wellhead beneath the apparatus (27). Preferably, the lower end (42) of the housing (38) is directly connected to the wellhead flange (22). However, the lower end (42) may be indirectly connected to the wellhead flange (22) where other wellhead equipment is located between the apparatus (27) and the wellhead flange (22). Thus, in the preferred embodiment, the apparatus (27) is further comprised of means for mounting the lower end of the housing (38) on the wellhead (20), and preferably, on the wellhead flange (22). The lower end (42) may be connected to the wellhead flange (22) by any fastening or connecting means, mechanism, structure or device suitable for temporarily fastening or connecting the lower end (42) of the housing (38) to the wellhead (20). For instance, the mounting means may be comprised of a mounting flange permanently or temporarily connected at the lower end (42) of the housing (38).

In the preferred embodiment, the mounting means is comprised of a lower surface (51) on the lower end (42) of the housing (38), which lower surface (51) is adapted for connection to the wellhead, and preferably, the wellhead flange (22). However, as stated above, the lower surface (51) may be adapted for connection to further wellhead equipment located between the apparatus (27) and the wellhead flange (22). Any manner of adapting, or any structure, device or mechanism for adapting, the lower surface (51) for connection to the wellhead flange (22) may be used. However, in the preferred embodiment, the lower surface (51) defines at least two apertures (52), and preferably a plurality of apertures (52), circumferentially spaced about the lower surface (51). The apertures are for receiving fasteners (54), such as bolts, screws or the like, therein. The apertures (52) are arranged or configured on the lower surface (51) to be compatible with the wellhead flange (22). In the preferred embodiment, the fastener (54), being a stud bolt, is screwed into the apertures (52) in the lower surface (51) of the housing (38). When the apparatus (27) is mounted upon the wellhead (20), the fasteners (54) extend from the apertures (52) in the lower surface (51) of the housing (38), through compatible apertures defined by the wellhead flange (22). A nut (56) is then screwed onto the end of the fastener (54) to secure the housing (38), and thus the apparatus (27), upon the wellhead flange (22).

In the preferred embodiment, the lower surface (51) of the housing (38) is immediately adjacent or proximal to the wellhead flange (22) when the apparatus (27) is mounted thereon. In particular, the lower surface (51) is supported by the upper surface of the wellhead flange (22) and the lower surface (51) directly engages the wellhead flange (22). However, alternately, the lower surface of the housing (38) may be a spaced distance from the wellhead flange (22) such that the lower surface (51) does not directly engage the wellhead flange (22). For instance, one or more further elements or components of the apparatus (27) may be located between the lower surface (51) and the wellhead flange (22). Thus, the lower surface (51) of the housing (38) engages the further element or elements and the further elements, in turn, engage the wellhead flange (22). In addition, depending upon the specific mounting means of the lower surface (51), and depending upon the specific manner of engagement of the lower surface (51) with the wellhead (20), the lower surface (51) of the housing (38) may include a seal for sealing the lower surface (51) to the adjacent surface of the wellhead flange (22) or other elements of the apparatus (27). For instance, the lower surface (51) may define an annular groove for receiving an O-ring or other sealing device.

Further, the housing (38) may be further comprised of a base plate (60) connected to the lower end (42) of the housing (38) In this instance, the mounting means, for mounting the lower end (42) of the housing (38) on the wellhead (20), is comprised of the base plate (60), as shown in the Figures 11-13 of the first, second and third alternate embodiments of the apparatus (27) respectively. The housing (38) is connected or affixed to the base plate (60), and the base plate (60) is, in turn, connected to the wellhead by any fastening or connecting means, mechanism, structure or device suitable for temporarily fastening or connecting the base plate (60) to the wellhead (20). Preferably, in these alternate embodiments, the mounting means is particularly comprised of the base plate (60) having an upper surface (61) for connection or attachment to the lower surface (51) of the housing (38) and a lower surface (62) adapted for connection to the wellhead, and preferably, the wellhead flange (22). Thus, the mounting means is particularly comprised of the lower surface (62) of the base plate (60). However, as stated above, the lower surface (62) may be adapted for connection to further wellhead equipment located between the apparatus (27) and the wellhead flange (22).

Any manner of adapting, or any structure, device or mechanism for adapting, the lower surface (62) for a temporary connection to the wellhead flange (22) may be used. However, preferably, the lower surface (62) defines at least two apertures (63), and preferably a plurality of apertures (63), circumferentially spaced about the lower surface (62). The apertures (63) are substantially identical to the apertures (52), as described above, in the lower surface (51) of the housing (38). The apertures (63) are for receiving the fasteners (54) therein. The apertures (63) are arranged or configured on the lower surface (62) to be compatible with the wellhead flange (22). In the preferred embodiment, the fastener (54) is screwed into the apertures (63) in the lower surface (62) of the base plate (60). When the apparatus (27) is mounted upon the wellhead (20), the fasteners (54) extend from the apertures (63) in the lower surface (62) of the base plate (60), through compatible apertures defined by the wellhead flange (22). The nut (56) is then screwed onto the end of the fastener (54) to secure the base plate (60), and thus the housing (38), upon the wellhead flange (22).

In the first and third alternate embodiments shown in Figures 11 and 13 respectively, the lower surface (62) of the base plate (60) is immediately adjacent or proximal to the wellhead flange (22) when the apparatus (27) is mounted thereon. In particular, the lower surface (62) is supported by the upper surface of the wellhead flange (22) and the lower surface (62) directly engages the wellhead flange (22). However, alternately, the lower surface (62) of the base plate (60) may be a spaced distance from the wellhead flange (22) such that the lower surface (62) does not directly engage the wellhead flange (22) as shown in Figure 12 of the second alternate embodiment. In this alternate embodiment, one or more further elements or components of the apparatus (27) may be located between the lower surface (62) and the wellhead flange (22). Thus, the lower surface (62) of the base plate (60) engages the further element or elements and the further elements, in turn, engage the wellhead flange (22).

In the alternate embodiments, depending upon the specific mounting means of the lower surface (62), and depending upon the specific manner of engagement of the lower surface (62) of the base plate (60) with the wellhead (20), the lower surface (62) of the base plate (60) preferably includes a seal for sealing the lower surface (62) to the adjacent surface of the wellhead flange (22) or other elements of the apparatus (27). For instance, the lower surface (62) may define an annular groove for receiving an O-ring (58) or other sealing device therein.

In the alternate embodiments, as indicated above, the base plate (60) may be permanently connected or affixed to the lower end (42) of the housing (38). However, preferably, the base plate (60) is preferably removably connected or affixed to the lower end (42) of the housing (38). The base plate (60) may be removably connected or affixed by any means, mechanism or structure suitable for temporarily connecting the base plate (60) to the lower end (42) of the housing (38). However, preferably, as shown in Figures 11-13, the lower surface (51) of the housing (38) is comprised of an externally threaded extension (64) extending axially away from the housing (38). The extension (64) is received within an internally threaded recess (65) defined by the upper surface (61) of the base plate (60). One or more seals, as required, may be located between the lower surface (51) of the housing (38) and the adjacent upper surface (61) of the base plate (60) when the extension (64) is threaded into the recess (65).

Although the housing (38) in the preferred embodiment of the apparatus (27), as shown in Figure 4, is not comprised of the base plate (60). the use of a removable base plate (60) may be preferred in some circumstances. Specifically, a removable base plate (60) may be preferred where the apparatus (27) is intended to be mounted upon varying configurations or sizes of the wellhead flange (22). In particular, as the diameter and configuration of the apertures for receiving the fasteners, or the bolt ring, in the wellhead flange (22) varies between different wellheads (20), the base plate (60) may be changed to suit, and be compatible with, the particular wellhead flange (22).

Further, in the preferred and alternate embodiments, the housing (38) is preferably further comprised of an upper section (68), a lower section (70) and a middle section (72) located therebetween. Preferably, the flow tee of the apparatus (27) is comprised of the upper section (68) of the housing (38), the blowout preventer of the apparatus (27) is comprised of the middle section (72) of the housing (38) and the tubing rotator of the apparatus (27) is comprised of the lower section (70) of the housing (38). Preferably, the sections (68, 70, 72) are permanently connected together by any means, method, device, apparatus or mechanism suitable for permanently connecting or fastening the adjacent surfaces of the sections (68, 70, 72) of the housing (38). For instance, the sections (68, 70, 72) of the housing (38) may be permanently connected or joined together by welding the sections together at their points of contact with each other.

However, preferably, the upper, middle and lower sections (68, 72, 70) are permanently connected together by casting, machining or otherwise forming the housing (38) as a continuous, integral unit or single piece or component of the apparatus (27). Thus, in the preferred embodiment, the sections (68, 70, 72) comprise a continuous housing (38). As indicated above, the primary fluid passage (44) extends through the housing (38) through each of the upper, middle and lower sections (68, 72, 70). Thus, preferably, the continuous housing (38) is comprised of the connecting flange (46), the upper section (68), the middle section (72) and the lower section (70). In the alternate embodiments, the base plate (60), which further comprises the housing (38), is then removably or temporarily connected to the lower surface (51) of the housing (38).

As indicated, the flow tee portion of the apparatus (27), or the portion of the apparatus (27) performing the flow tee function, is comprised of the upper section (68) of the housing (38). Referring to Figures 3 and 5, the upper section (68) of the housing (38) defines a portion of the primary fluid passage (44) therein. Further, the upper section (68) defines at least one secondary fluid passage (76) having a longitudinal axis intersecting, or extending transversely to, to the primary fluid passage (44) such that each secondary fluid passage (76) extends from the primary fluid passage (44) to the outer wall (43) of the housing (38) within the upper section (68) of the housing (38). As a result, the wellbore fluids are permitted to flow from the tubing string (24) through the primary fluid passage (44) in the apparatus (27) and into, and subsequently through, each secondary fluid passage (76). The end of each secondary fluid passage (76), when in use, is preferably connected to an external production pipe (78), as shown in Figures 1 and 2, which does not form part of the apparatus (27).

Any feasible number of secondary fluid passages (76) which does not unduly weaken the overall structure of the apparatus (27) may be defined by the upper section (68) of the housing (38). However, in the preferred embodiment, as shown in Figures 3 and 5, the upper section (68) defines two secondary fluid passages (76). In this case, the longitudinal axes of the two secondary fluid passages (76) are aligned such that the longitudinal axes are substantially concurrent or coincident with each other and the secondary fluid passages (76) exit the outer wall (43) of the housing (38) at opposing sides of the housing (38). However, the specific location and configuration of each secondary fluid passage (76) may be varied as desired for any particular application.

Further, each secondary fluid passage (76) is preferably circular on cross-section. However, any other suitable shape may be used. As well, each secondary fluid passage (76) may be of any diameter and the diameters of each secondary fluid passage (76) comprising the flow tee need not be the same. Finally, as stated above, the portion of each secondary fluid passage (76) adjacent the outer wall (43) of the housing (38) preferably includes means for connecting an external production pipe (78) to the secondary fluid passage (76). The connecting means may be comprised of any device, structure or mechanism suitable for performing this connection function. However, in the preferred embodiment, the portion of the secondary fluid passage (76) adjacent the outer wall (43) is comprised of a threaded inner surface for engagement with a compatible threaded outer surface of the external production pipe (78).

Referring to Figures 3 and 6, the blowout preventer portion of the apparatus (27), or the portion of the apparatus (27) performing the blowout preventer function, is comprised of the middle section (72) of the housing (38). As stated previously, the primary fluid passage (44) is defined centrally within the middle section (72) of the housing (38) and the polished rod (30) extends therethrough. Further, the middle section (72) of the housing (38) defines two rod ram passages (80) having a longitudinal axis extending through both passages (80) which intersects the longitudinal axis of the primary fluid passage (44) such that the rod ram passages (80) extend from the primary fluid passage (44) to opposing locations on the outer wall (43) of the housing (38) within the middle section (72). As a result, the rod ram passages (80) are aligned on opposing sides of the primary fluid passage (44), and thus the polished rod (30). Specifically, in the preferred embodiment, the longitudinal axis of the rod ram passages (80) is substantially perpendicular to the longitudinal axis of the primary fluid passage (44) and the polished rod (30).

A polished rod ram (82) is movably mounted within each rod ram passage (80) such that each polished rod ram (82) may be selectively moved within the passage (80) into and out of engagement with the polished rod (30). Preferably, an outer surface (84) of the polished rod ram (82) seals with the adjacent surface of the housing (38) defining the rod ram passage (80). In the preferred embodiment, the outer surface (84) defines an aperture (86) about its entire outer surface (84) for receiving an O-ring (88) or similar sealing device therein such that the seal is provided between the outer surface (84) and the adjacent surface of the housing (38).

Further, each polished rod ram (82) is comprised of an inner end (90) facing the primary fluid passage (44) and an opposing outer end (92). Preferably, as shown in Figures 6-8, a polished rod ram packer (94) is mounted to the inner end (90) of the polished rod ram (82) for sealingly engaging the polished rod (30) when the polished rod ram (82) and polished rod ram packer (94) are moved into engagement therewith. In this manner, the polished rod ram (82) and polished rod ram packer (94) provide a seal with the polished rod (30) to prevent or inhibit the passage of wellbore fluids and pressure from the tubing string (24) through the apparatus (27) via the primary fluid passage (44).

To facilitate the sealing between the polished rod ram (82), including the packer (94), and the polished rod (30), the inner end (90) of the polished rod ram (82) and the corresponding packer (94) define a groove (96) for receiving the polished rod therein. When the two polished rod rams (82) are moved into engagement with the polished rod (30), the groove (96) of each rod ram (82) and packer (94) contacts and seals with one half of the outer diameter of the polished rod (30). Thus, both rod rams (82) and packers (94) together contact and seal with the entire outer diameter of the polished rod (30).

The polished rod ram packer (94) may be comprised of any resilient, elastic material capable of providing a seal with the polished rod (30), such as rubber. Further, although the packer (94), as shown in Figure 8, is preferably used for sealing with the polished rod (30), any mechanism, structure, device or apparatus suitable for providing a seal between the polished rod ram (82) and the polished rod (30) may be used.

The polished rod ram (82) may be of any shape suitable for performing its intended purpose and function as described herein. Further, any means, mechanism, structure or device may be used for moving the polished rod ram (82) within the rod ram passage (80) such that the polished rod ram (82) is movable into and out of engagement with the polished rod (30). For instance, conventionally, the outer portion of each rod ram passage (80) adjacent the outer wall (43) of the housing (38) may be internally threaded for receiving an externally threaded end cap (98) therein. Each end cap (98) defines an internally threaded aperture (99) therethrough for receiving an externally threaded feed screw (100). When inserted, the feed screw (100) extends from an outer end (102) of the end cap (98) adjacent the outer wall (43) of the middle section (72) of the housing (38), through the end cap (98) towards the polished rod ram (82) for engagement with the outer end (92) of the polished rod ram (82). Thus, feeding of the feed screw (100) into the end cap (98) moves the polished rod ram (82) into engagement with the polished rod (30), while feeding of the feed screw (100) out of the end cap (98) moves the polished rod ram (82) out of engagement with the polished rod (30).

In this conventional polished rod ram (82) and end cap (98) structure, the end of the feed screw (100) may engage the polished rod ram (82) at substantially a central location on the outer end (92) of the rod ram (82). Further, in such conventional apparatus, the rod ram (82) may be round or square on cross-section. In the event the rod ram (82) is round or circular on cross-section, operation of the feed screw (100) may cause turning or rotation of the polished rod ram (82) within the rod ram passage (80). When the polished rod ram (82) is square on cross-section, operation of the feed screw (100) does not typically result in the movement or rotation of the rod ram (82) within the rod ram passage (80).

In the preferred embodiment of the apparatus (27), as shown in Figures 6, 9 and 10, the end cap (98) is not externally threaded, but rather, is maintained or mounted within the rod ram passage (80) by one or more fasteners (108), such as bolts, screws or the like. Further, the end of the feed screw (100) which engages the rod ram (82) includes a plunger portion (104). The plunger portion (104) is loosely received within a plunger recess (106) defined by the outer end (92) of the rod ram (82), which plunger recess (106) is not centrally located within the outer end (92). In particular, the plunger recess (106) is preferably positioned below a central axis passing between the inner and outer ends (90, 84) of the rod ram (82). The specific manner of mounting the end cap (98) and the non-axial plunger recess (106) permit the use of a rod ram (82) having a round or circular configuration on cross-section, while inhibiting the rotation of the rod ram (82) within the rod ram passage (80) upon operation of the feed screw (100). Thus, the grooves (96) in the rod ram (82) and the packer (94) tend to stay aligned with the polished rod (30) such that the polished rod (30) may be easily received therein.

Referring to Figure 3, in the preferred embodiment, the longitudinal axis of the rod ram passages (80) is located in a first vertical plane and the longitudinal axis of the secondary fluid passages (76) is located in a second vertical plane. Preferably, the first vertical plane is substantially perpendicular to the second vertical. This orientation permits or facilitates relatively easy access to the secondary fluid passages (76) for connection of external production pipes (78) and to the feed screws (100) for operation of the rod rams (82). However, any desired angle may be formed between the first and second vertical planes.

Finally, as stated, the tubing rotator portion of the apparatus (27), or the portion of the apparatus (27) performing the tubing rotator function, is comprised of the lower section (70) of the housing (38). Further, the tubing rotator is comprised of a supported member (110) having an upper end (112) and a lower end (114) for connecting, either directly or indirectly, to the tubing string (24). Further, the tubing rotator is comprised of a supporting structure for rotatably supporting the supported member (110) such that the tubing string (24) is rotatably suspended within the wellbore. Thus, the supporting structure permits the rotation of the supported member (110), while supporting the supported member (110) such that at least the upper end (112) of the supported member (110) is contained within the lower section (70) of the housing (38).

Preferably, the supported member (110) is tubular such that a bore (116) of the supported member (110) forms a portion of the primary fluid passage (44) extending through the apparatus (27). Thus, the polished rod (30) is passed through the bore (116) of the supported member (110). Further, preferably, an outer surface (118) of the supported member (110) at its upper end (112) sealingly engages the adjacent surface of the lower section (70) of the housing (38). Further, a spaced distance is preferably provided between the upper end (112) of the supported member (110) and the adjacent surface of the housing (38) in order to provide a relatively loose fit between the housing (38) and upper end (112) of the supported member (110).

The supporting structure preferably engages the wellhead (20), and more preferably, the uppermost surface of the wellhead flange (22). However, the supporting structure may engage further wellhead equipment located between the apparatus (27) and the wellhead (20). The supporting structure may be comprised of any members, elements, structure, device, apparatus or mechanism suitable for rotatably supporting the supported member (110) such that the tubing string (24) connected to the supported member (110) is rotatably supported within the wellbore. Further, the supporting structure, as indicated above, may engage the wellhead (20), and in particular the wellhead flange (22), in any suitable manner permitting the supporting structure to perform its intended function. As well, the supporting structure may rotatably support the supported member (110) in any manner or by any means or mechanism suitable for performing this intended function. In other words, any known tubing rotators and tubing rotator structures comprising a supported member (110) and a supporting structure, as described herein, may comprise the tubing rotator of the apparatus (27).

However, in the preferred embodiment, the supporting structure is comprised of a support flange (120) for mounting on the wellhead (20). Preferably, the support flange (120) is mounted upon the uppermost surface of the wellhead flange (22). Thus, in the preferred embodiment, as shown in Figure 4, the support flange (120) rests upon and is supported by the wellhead flange (22). A seal ring (122) is preferably located between the lowermost surface of the support flange (120) and the uppermost surface of the wellhead flange (22) to prevent the passage of wellbore annulus fluids therebetween.

The support flange (120) may directly support the supported member (110), however, in the preferred embodiment, the support flange (120) indirectly supports the supported member (110) by an outer member (124). Thus, in the preferred embodiment, the supporting structure is comprised of the support flange (120) and the outer member (124). Preferably, the support flange (120) and the outer member are completely or partially contained within the lower section (70) of the housing (38), although they need not be. Further, the support flange (120) is preferably sized and shaped such that when it is supported by, or resting upon, the wellhead flange (22), the support flange (120) is contained within the circumference of the apertures in the wellhead flange (22) comprising the bolt ring.

In the preferred embodiment, the support flange (120) is tubular in shape and is detachably engaged with the outer member (124) such that the outer member (124) may be disengaged from the support flange (120) as desired. Specifically, an inner surface of the support flange (120) engages an outer surface of the outer member (124). The inner surface of the support flange (120) is shaped to be compatible with the outer surface of the outer member (124) in order to facilitate sealing of the surfaces and so that the outer member (124) may be seated upon and supported by the support flange (120). The specific shape of the seating arrangement between the surfaces may vary from a gradual angled slope of the outer surface of the outer member (124) to a vertical slope containing a protruding horizontal shoulder at any point along the outer surface of the outer member (124). Preferably, the outer surface of the outer member (124) and the inner surface of the support flange (120) are sealingly engaged. Specifically, in the preferred embodiment, the two surfaces are sealingly engaged by a sealing assembly comprised of two O-rings mounted within O-ring grooves on the outer surface of the outer member (124).

In the preferred embodiment, a lower end (128) of the outer member (124) extends downward inside the wellhead flange (22) when the outer member (124) is mounted on the support flange (120). Preferably, the shape of the lower end (128) of the outer member (124) is not dependent upon the shape of the inner surface of the wellhead flange (22). Although the shapes of the outer surface of the lower end (128) of the outer member (124) and the inner surface of the wellhead flange (22) may be compatible to engage each other, this is neither necessary nor preferred in the preferred embodiment. The two surfaces are not required to be sealingly engaged for operation of the apparatus (27). Further, in the preferred embodiment, the lower end (128) of the outer member (124) extends downward from the wellhead flange (22) and specifically into the casing bowl (34) without conforming to its shape in order that the apparatus (27) may be more easily retrofit to varying shapes and sizes of casing bowls (34) in existing wellheads.

Referring to Figure 4, the wellhead flange (22) preferably includes two holddown screws (130) which extend through the wellhead flange (22) through a bore from its outer surface to its inner surface. A nose (136) of each holddown screw (130) is engagable with the outer surface of the outer member (124) when the outer member (124) is suspended from the support flange (120). The outer surface of the outer member (124) includes a compatible engagement surface (138) for receiving the nose (136) of each holddown screw (130). The holddown screws (130) are moveable within the bore of the wellhead flange (22) such that the holddown screws (130) are adjustable in order that the nose (136) may be moved into and out of engagement with the engagement surface (138) as desired for operation or servicing of the wellhead (20). When the holddown screws (130) are loosened or moved away from the engagement surface (138), the outer member (124) may be removed from the wellhead flange (22). Conversely, when the holddown screws (130) are tightened and moved into engagement with the engagement surface (138), longitudinal movement of the outer member (124) relative to the wellhead flange (22) is prevented.

In the preferred embodiment, the inner surface of the outer member (124) includes a shoulder (140) which extends towards the polished rod (30). A bearing (142) is seated on the shoulder (140). The bearing (142) may be any bearing suitable for its intended purpose, however, preferably the bearing (142) is comprised of a thrust bearing. A compatible shoulder (144) on the outer surface of the supported member (110) is then seated on the bearing (142) such that the supported member (110) is rotatably supported upon the outer member (124). In this manner, the downward longitudinal movement of the supported member (110) relative to the outer member (124) is inhibited.

Further, the outer surface of the supported member (110) preferably sealingly engages the inner surface of the outer member (124). The two surfaces may be sealingly engaged by any sealing assembly, such as one or more O-rings mounted in O-ring grooves on the outer surface of the supported member (110). Further, a bushing (146), preferably a radial bushing, is also located between the supported member (110) and the outer member (124).

In the preferred embodiment, the apparatus (27) further includes means for securing the supported member (110) to the outer member (124) such that upward longitudinal movement of the supported member (110) relative to the outer member (124) is inhibited. The securing means are preferably comprised of a retaining ring (148) secured to the supported member (110) adjacent to the lower end (128) of the outer member (124). The retaining ring (148) is preferably removable in order to permit upward longitudinal movement of the supported member (110) as necessary for servicing.

Finally, the tubing rotator is further comprised of means for rotating the supported member (110) within the supporting structure while the supporting structure remains stationary in order that the tubing string (24) is rotated within the wellbore. Any rotating means, mechanism, device, apparatus or gear system suitable for and capable of performing this function or purpose may be used. In the preferred embodiment, the supported member (110) includes a crown gear (150), and the rotating means are comprised of a rotatable pinion (152), releasably engaged with the crown gear (150), and means for driving the pinion (152) such that rotation of the pinion (152) rotates the supported member (110) within the supporting structure.

The driving means for the pinion (152) is preferably comprised of a pinion shaft (154), connected to the pinion (152), and means for driving the pinion shaft (154). The lower section (70) of the housing (38) defines a pinion passage (156) for passage of the pinion shaft (154) therethrough for engagement of the pinion (152) with the crown gear (150). Thus, the pinion shaft (154) has a first end (158) extending into the housing (38) through the pinion passage (156) for connection to the pinion (152) and a second end (160) outside of the housing (38) for connection to the driving means of the pinion shaft (154). The pinion (152) and the crown gear (150) are contained within the lower section (70) of the housing (38). The pinion shaft (154) may be rotatably supported within the pinion passage (156) by any means, structure, mechanism or device suitable for its intended purpose.

As stated, the second end (160) of the pinion shaft (154) is adapted to be connected to the driving means. The driving means is comprised of a gear box (162) in the preferred embodiment. The gear box (162) may be operated manually or may be driven automatically by the reciprocating action of a walking beam as shown in Figure 1, or by the rotation of a rotating polished rod (30) as shown in Figure 2. In all modes of operation, the gear box (162) provides means for creating a mechanical advantage which facilitates the generation of sufficient torque to turn the pinion shaft (154) in order to rotate the supported member (110).

In the preferred embodiment as shown in Figure 3, a longitudinal axis of the pinion passage (156) is preferably located in a third vertical plane. The third vertical plane preferably forms about a 45 degree angle with the second vertical plane including the secondary fluid passage (76) and the first vertical plane including the rod ram passages (80). In this manner, each of the elements of the tubing rotator, flow tee and blowout preventer are readily accessible by the operator of the apparatus (27). However, the first, second and third vertical planes may intersect at any angle.

In a first alternate embodiment of the apparatus (27) as shown in Figure 11, the supporting structure comprising the tubing hanger is comprised of the lower section (70) of the housing (38). In particular, the lower surface (62) of the base plate (60) comprising the housing (38) includes an inwardly projecting shoulder (164). The shoulder (164) preferably sealingly engages the outer surface of the supported member (110). Specifically, the shoulder (164) includes one or more apertures for containing an O-ring, or like sealing means, for sealing against the outer surface of the supported member (110). Further, a bearing (142) is preferably located between the shoulder (144) on the outer surface of the supported member (110) and the shoulder (164) of the base plate (60). The bearing (42) may be comprised of any bearing suitable for its intended purpose, however, the bearing (142) is preferably a radial bearing or a tapered roller bearing.

Referring to a third alternate embodiment of the invention, as shown in Figure 13, where the casing bowl (34) includes a tapered inner surface (36), the supporting structure may be comprised of an outer member (166) having a tapered outer surface compatible with the tapered inner surface (36) of the casing bowl (34). In this manner, the outer surface (168) of the outer member (166) engages the inner surface (36) of the casing bowl (34) such that the downward longitudinal movement of the outer member (166) relative to the casing bowl (34) is prevented. In this instance, as with the preferred embodiment of the apparatus (27), the outer member (166) includes an inwardly projecting shoulder (170) which engages and supports thereon an outwardly directed shoulder (144) on the supported member (110). A bearing (142) is located between the shoulder (144) of the supported member (110) and the shoulder (170) of the outer member (166).

Further, referring to the third alternate embodiment of the apparatus (27), the supported member (110) may be comprised of an upper supported member (172) and a lower supported member (174). The supporting structure for the upper supported member (172) is comprised of the base plate (60). The supporting structure of the lower supported member (174) is comprised of the tapered outer surface (168) of the outer member (166) which engages the inner surface (36) of the casing bowl (34). In this particular embodiment, use of one of the supporting structures alone may be sufficient to support the entire supported member (110), including both the upper supported member (172) and the lower supported member (174). However, in the third alternate embodiment, both supporting structures are preferably used.

Referring to Figure 12, in a second alternate embodiment of the invention, the supported member (110) is similarly comprised of an upper supported member (172) and a lower supported member (174). Again, the upper supported member (172) is rotatably supported by a supporting structure comprising the base plate (60). The supporting structure for the lower supported member (174) is comprised of a support flange (120) for mounting on the wellhead (20). More particularly, the supporting structure for the lower supported member (174) is comprised of a support flange (120) and an outer member (124) similar to those provided for in the preferred embodiment shown in Figure 4. Again, use of both of the supporting structures may not be required. However, in the preferred second alternate embodiment, both of the supporting structures are used to rotatably support the complete supported member (110).

In each of the second and third alternate embodiments, as shown in Figures 12 and 13 respectively, the upper supported member (172) and the lower supported member (174) are preferably connected or engaged with each other such that the upper and lower supported members (172, 174) rotate concurrently as a single supported member (110) unit. Any mechanism, structure, device or apparatus suitable for engaging a lower end (176) of the upper supported member (172) with the upper end (178) of the lower supported member (174) may be used. For instance, the lower end (176) of the upper supported member (172) may include splines compatible with splines located on the upper end (178) of the lower supported member (174).

However, in the preferred second and third alternate embodiments, the connection or engagement between the upper and lower supported members (172, 174) is comprised of a dowel pin connection (180). The dowel pin connection (180) is comprised of one or more holes (182) defined about the circumference of the upper end (178) of the lower supported member (174). The dowel pin connection (180) is further comprised of a dowel pin (184) associated with each hole (182) in the lower supported member (174). Each dowel pin (184) includes a first end (186) mounted or otherwise affixed within the hole (182) and a second end (188) extending from the hole (182) towards the lower end (176) of the upper supported member (172). Finally, the dowel pin connection (180) is comprised of a drive ring (190) mounted about the lower end (176) of the upper supported member (172). The drive ring (190) defines a hole (192) for receiving each of the second ends (188) of the dowel pin (184). Each of the holes (192) in the drive ring (190) is preferably tapered at both the top and bottom surfaces to guide the dowel pin (184) within the hole (192) as shown in Figure 15.

The drive ring (190) may be rigidly affixed to the lower end (176) of the upper supported member (172) by any suitable fastening means, device or mechanism. However, in the preferred embodiment, the drive ring (190) defines at least two threaded holes (194) extending from the outer circumference of the drive ring (190) to the inner circumference of the drive ring (190) such that set screws or like fasteners may be passed therethrough. Thus, the set screws (not shown) extend from the outer circumference of the drive ring (190) through the drive ring (190) for engagement with the lower end (176) of the upper supported member (172).

The dowel pin connection (180) may be comprised of any number of dowel pins (184) sufficient to provide a relatively strong connection between the upper and lower supported members (172, 174). In the preferred embodiment, the dowel pin connection (180) is comprised of ten dowel pins (184) arranged within ten holes (182) in the upper end (178) of the lower supported member (174), which holes (182) are arranged circumferentially about the upper end (178) of the lower supported member (174). The drive ring (190) is comprised of at least one hole (192) for receiving each of the dowel pins (184). However, a greater number of holes (192) may be provided by the drive ring (190). In the preferred embodiment, the drive ring (190) defines twenty holes (192) for receiving the dowel pins (184) therein.

Finally, as shown in Figure 16, the upper end (178) of the lower supported member (174) preferably defines a plurality of keyways (196) about its outer circumference. The adjacent inner circumference of the outer member (124) defines at least one matching keyway (198). When servicing the apparatus (27), removal of the lower supported member (174) and the adjacent outer member (124) may be achieved in the following manner. First, one of the keyways (196) defined by the outer circumference of the upper end (178) of the lower supported member (174) is aligned with the keyway (198) on the inner circumference of the outer member (124). A key (not shown) is then inserted into the aligned keyways (196, 198) in order to lock the lower supported member (174) and the outer member (124) in position such that relative rotation is no longer permitted. The housing (38) of the apparatus (27) is then removed and a servicing blowout preventer is installed on the wellhead (20). A pup joint (not shown) or other structure may then be screwed into an internal threaded surface of the lower supported member (174) such that the lower supported member (174) and the outer member (124) may be removed through the servicing blowout preventer.

The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:

1. In an assembly of wellhead equipment comprising a flow tee having an upper end and a lower end, a blowout preventer having an upper end and a lower end and a tubing rotator, for suspending and rotating a tubing string contained within a wellbore, having an upper end and a lower end, and wherein the lower end of the flow tee is connectable to the upper end of the blowout preventer and the lower end of the blowout preventer is connectable to the upper end of the tubing rotator, the improvement which comprises combining the flow tee, the blowout preventer and the tubing rotator in a single apparatus so that the lower end of the flow tee is permanently connected to the upper end of the blowout preventer and the lower end of the blowout preventer is permanently connected to the upper end of the tubing rotator.

2. The apparatus as claimed in claim 1, wherein the apparatus has a lower end, and wherein the apparatus further comprises means for mounting the lower end of the apparatus on a wellhead.

3. The apparatus as claimed in claim 2, wherein the apparatus has an upper end, and wherein the apparatus further comprises means for connecting the upper end of the apparatus to other wellhead equipment.

4. The apparatus as claimed in claim 3, wherein the flow tee is connected to the blowout preventer without connecting flanges therebetween and wherein the blowout preventer is connected to the tubing rotator without connecting flanges therebetween.

5. The apparatus as claimed in claim 4, wherein the apparatus comprises a housing having an upper end, an upper section, a middle section, a lower section, a lower end and a fluid path extending therethrough between the upper and lower ends and wherein the flow tee is comprised of the upper section of the housing, the blowout preventer is comprised of the middle section of the housing and the tubing rotator is comprised of the lower section of the housing.

6. The apparatus as claimed in claim 5, wherein the upper, middle and lower sections of the housing comprise a continuous housing.

7. The apparatus as claimed in claim 5, wherein the mounting means comprise a lower surface on the lower end of the housing, which lower surface is adapted for connection to the wellhead.

8. The apparatus as claimed in claim 5, wherein the mounting means comprise a mounting flange located at the upper end of the housing.

9. The apparatus as claimed in claim 5, wherein the housing further comprises a base plate connected to the lower end of the housing, and wherein the mounting means comprise the base plate, which base plate is adapted for connection to the wellhead.

10. The apparatus as claimed in claim 5, wherein the upper end connecting means comprise an upper surface on the upper end of the housing, which upper surface is adapted for connection to other wellhead equipment.

11. The apparatus as claimed in claim 5, wherein the upper end connecting means comprise a connecting flange located at the upper end of the housing.

12. The apparatus as claimed in claim 5, wherein the tubing rotator is further comprised of a supported member for connecting to the tubing string and a supporting structure for rotatably supporting the supported member such that the tubing string is rotatably suspended within the wellbore.

13. The apparatus as claimed in claim 12, wherein the supporting structure engages the wellhead.

14. The apparatus as claimed in claim 13, wherein the supporting structure is comprised of a support flange for mounting on the wellhead.

15. The apparatus as claimed in claim 13, wherein the wellhead is comprised of a casing bowl having a tapered inner surface and wherein the supporting structure has a tapered outer surface compatible with the inner surface of the casing bowl for engagement therewith.

16. The apparatus as claimed in claim 13, wherein the supporting structure is comprised of the lower section of the housing.

17. The apparatus as claimed in claim 9, wherein the tubing rotator is further comprised of a supported member for connecting to the tubing string and a supporting structure for rotatably supporting the supported member such that the tubing string is rotatably suspended within the wellbore.

18. The apparatus as claimed in claim 17, wherein the supporting structure is comprised of the base plate.

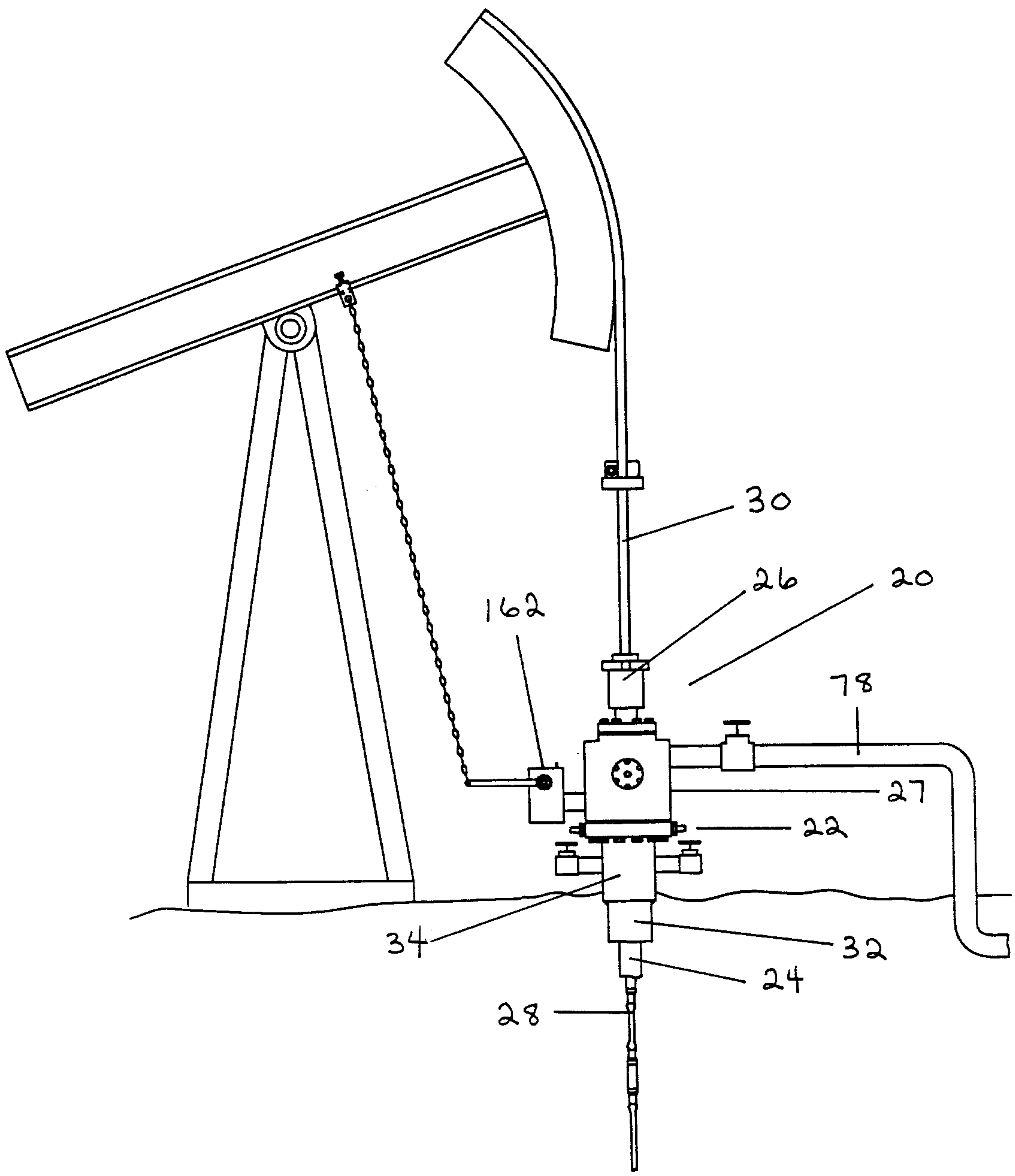


FIGURE 1

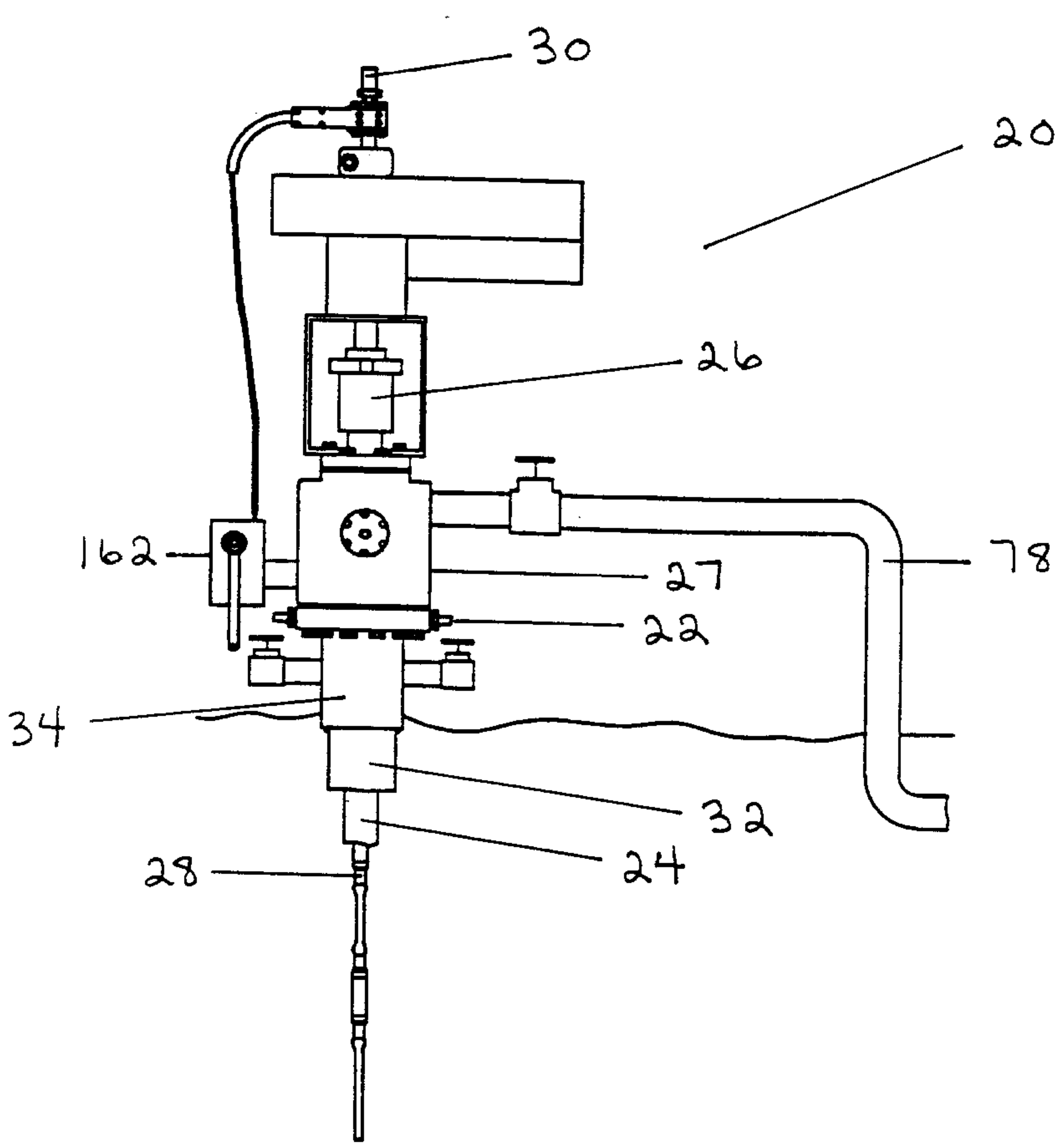
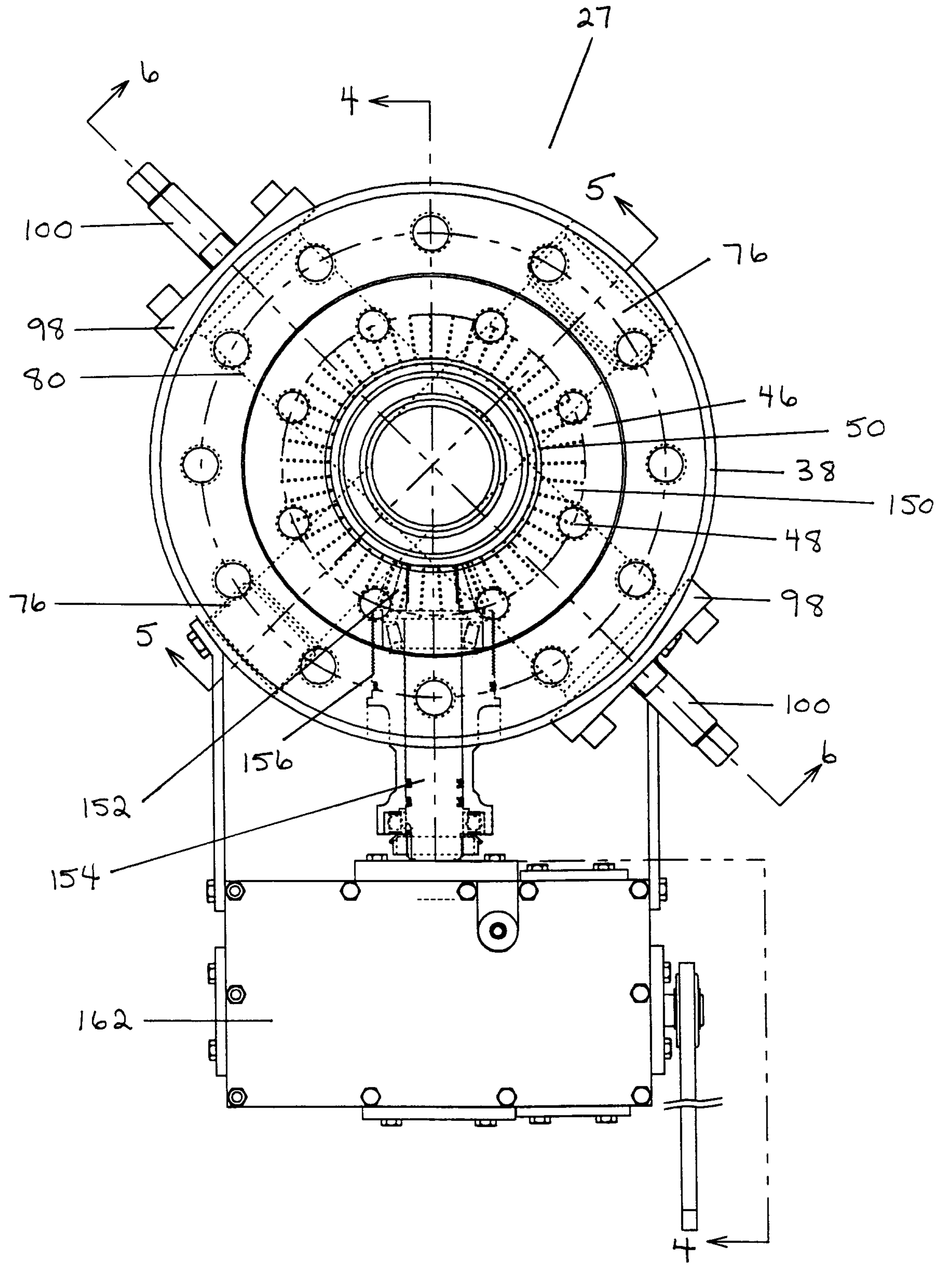


FIGURE 2

FIGURE 3



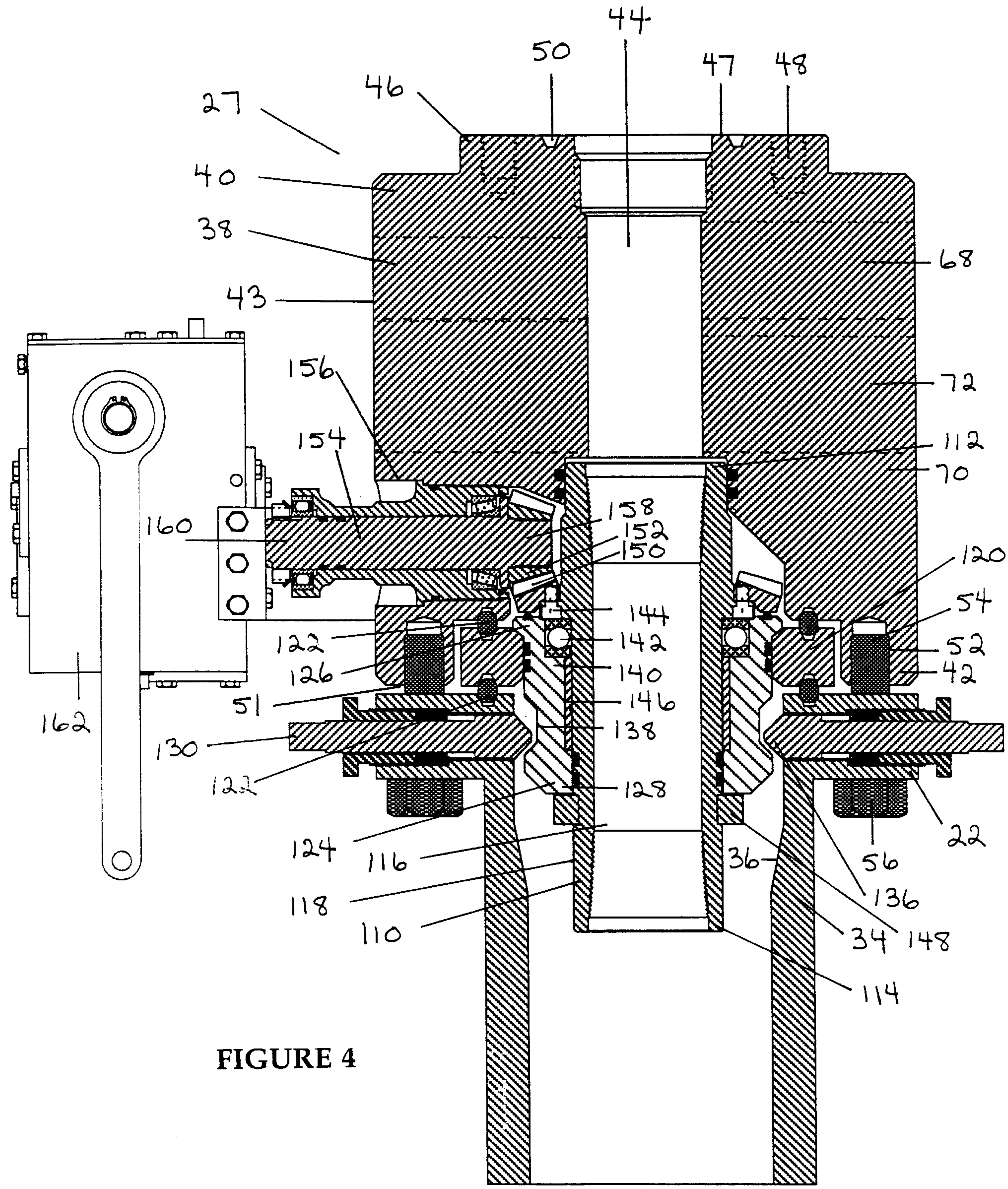

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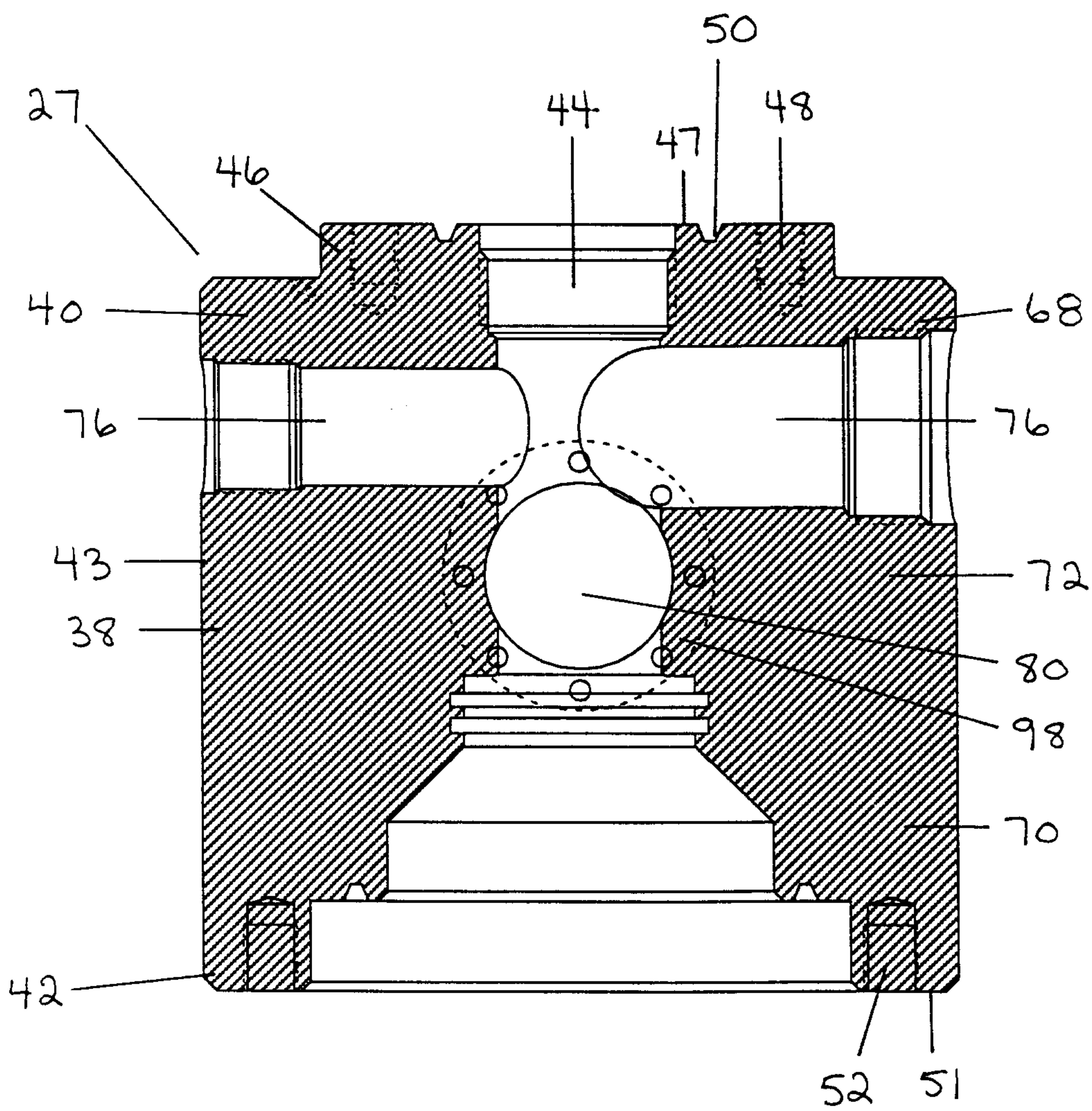
FIGURE 4



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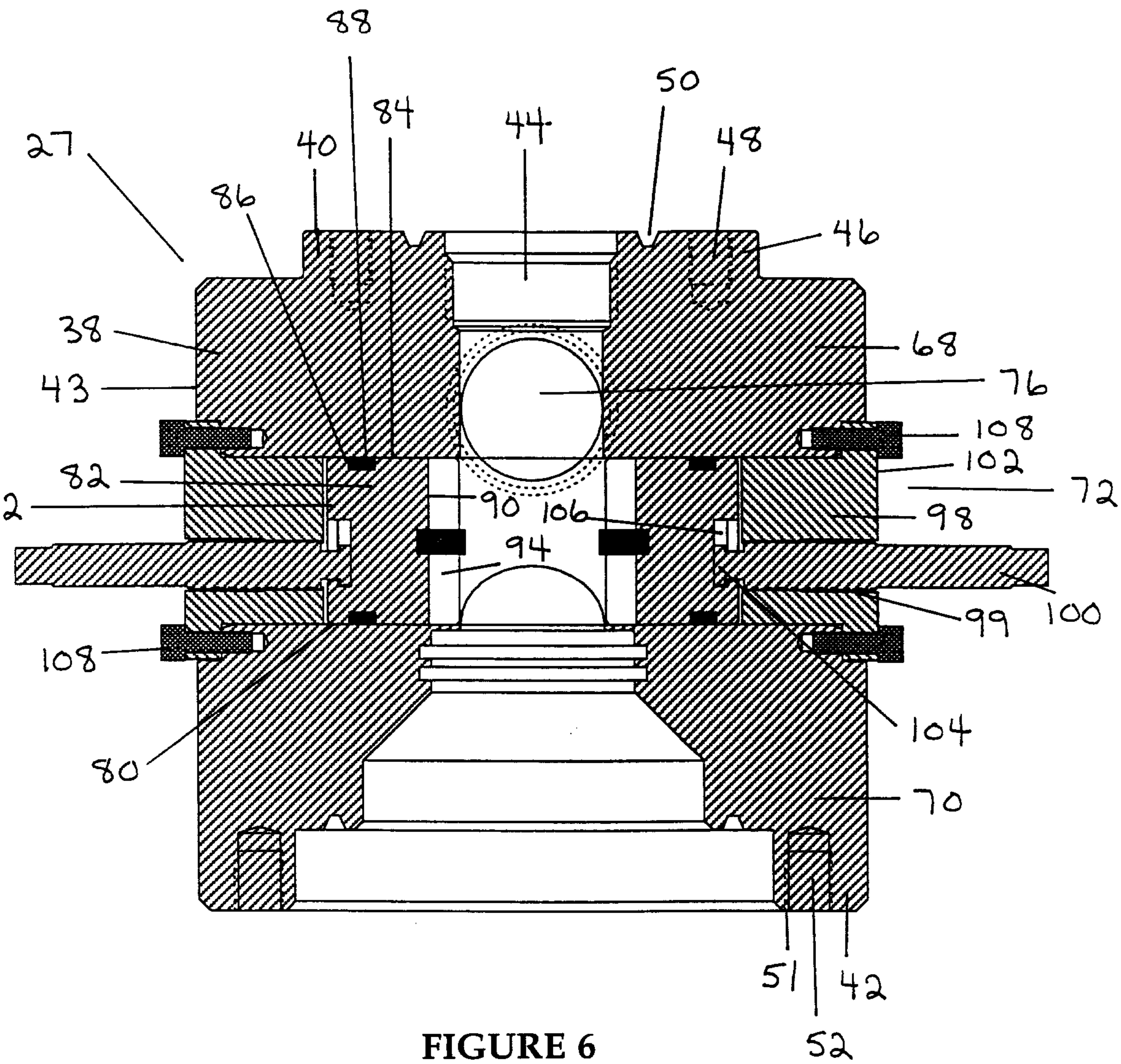
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FIGURE 6

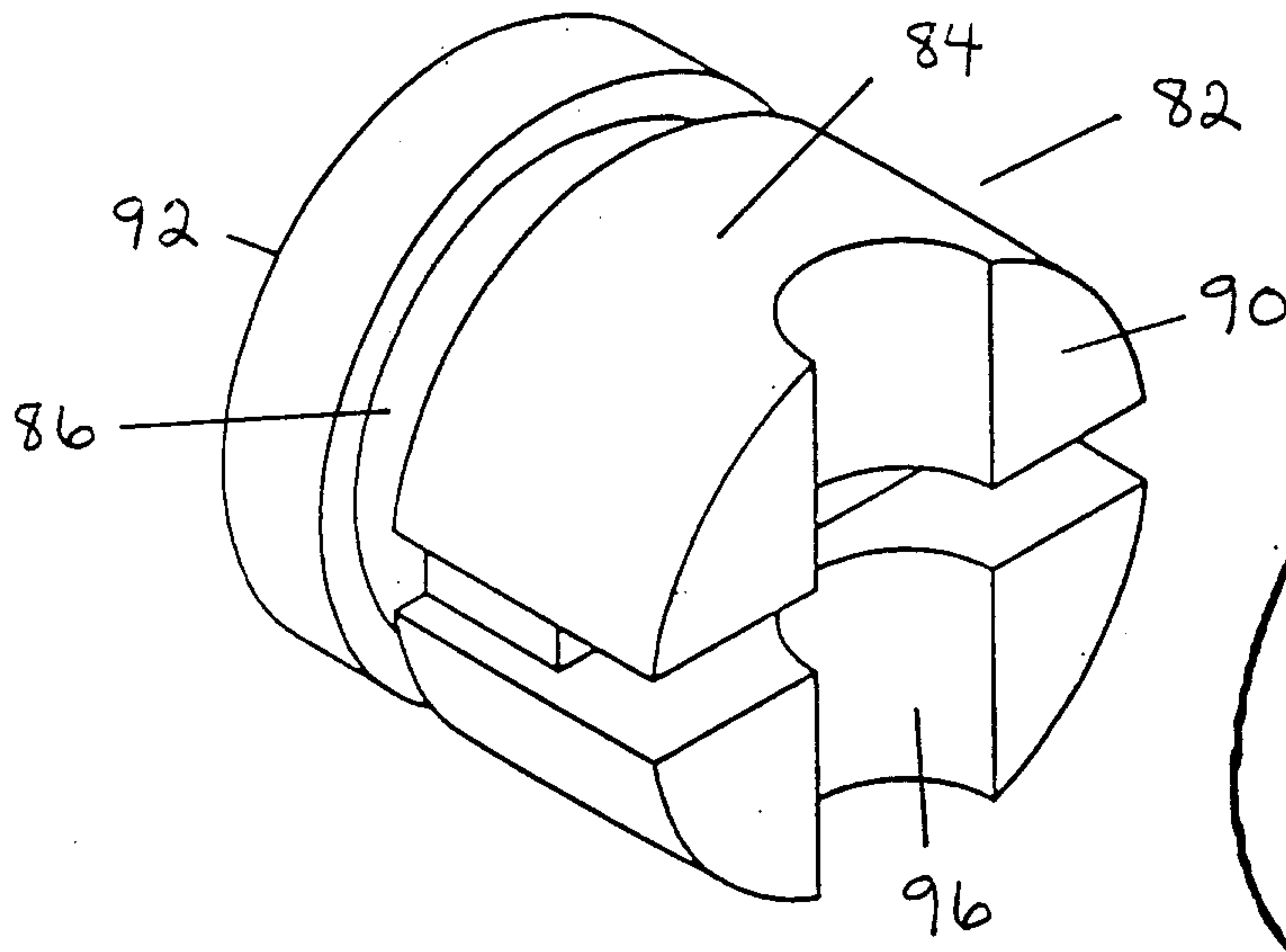

FIGURE 7

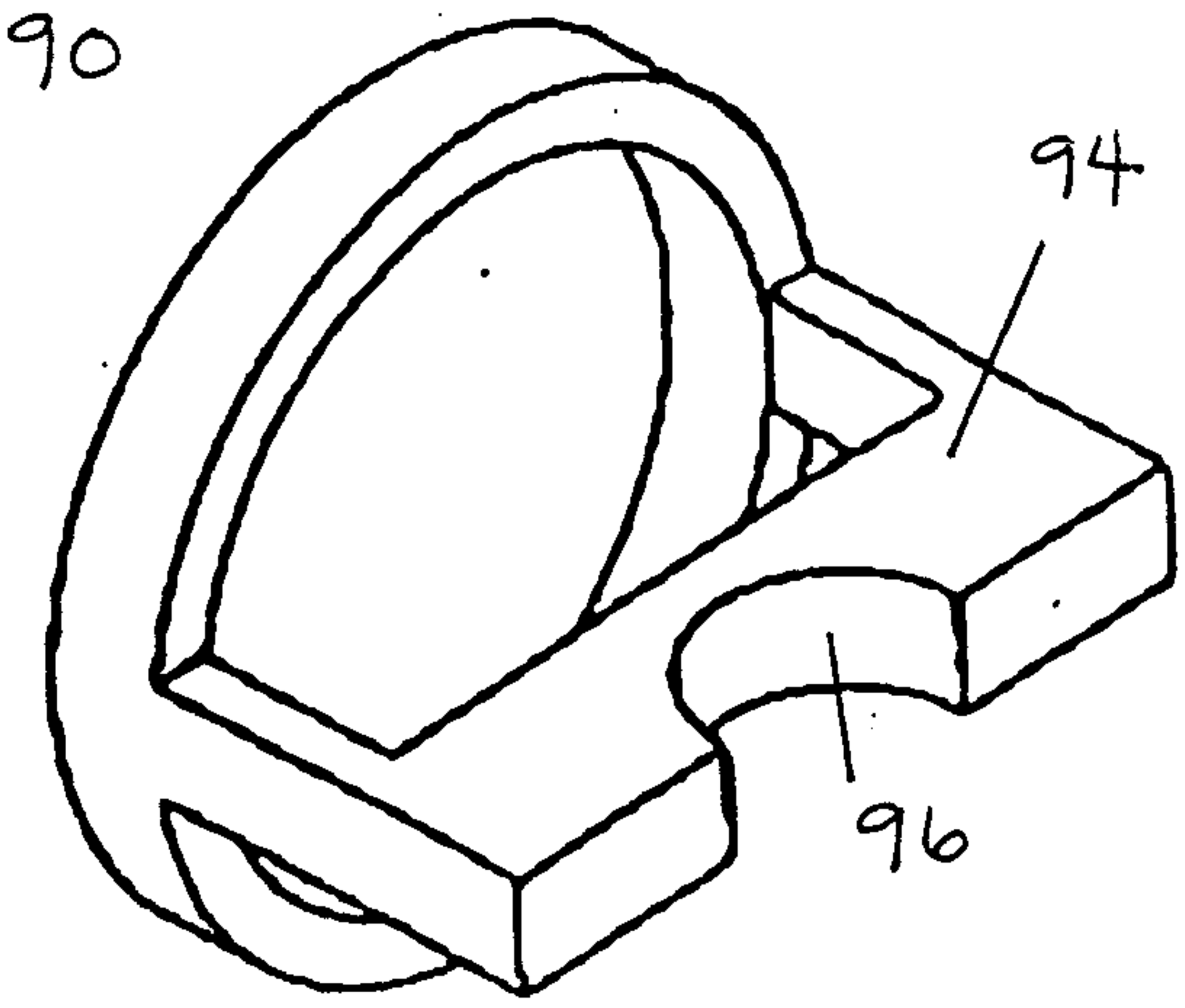

FIGURE 8

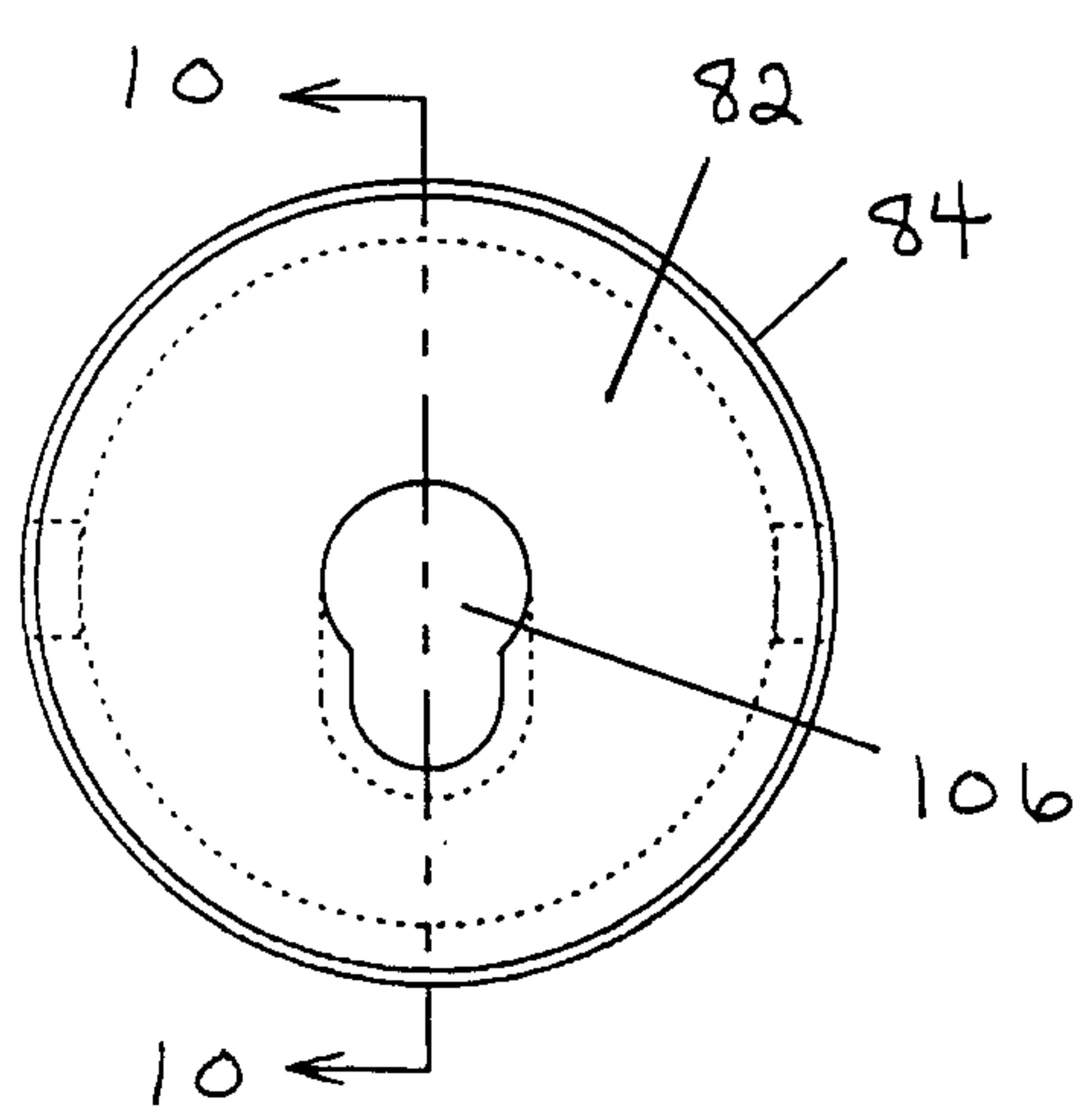

FIGURE 9

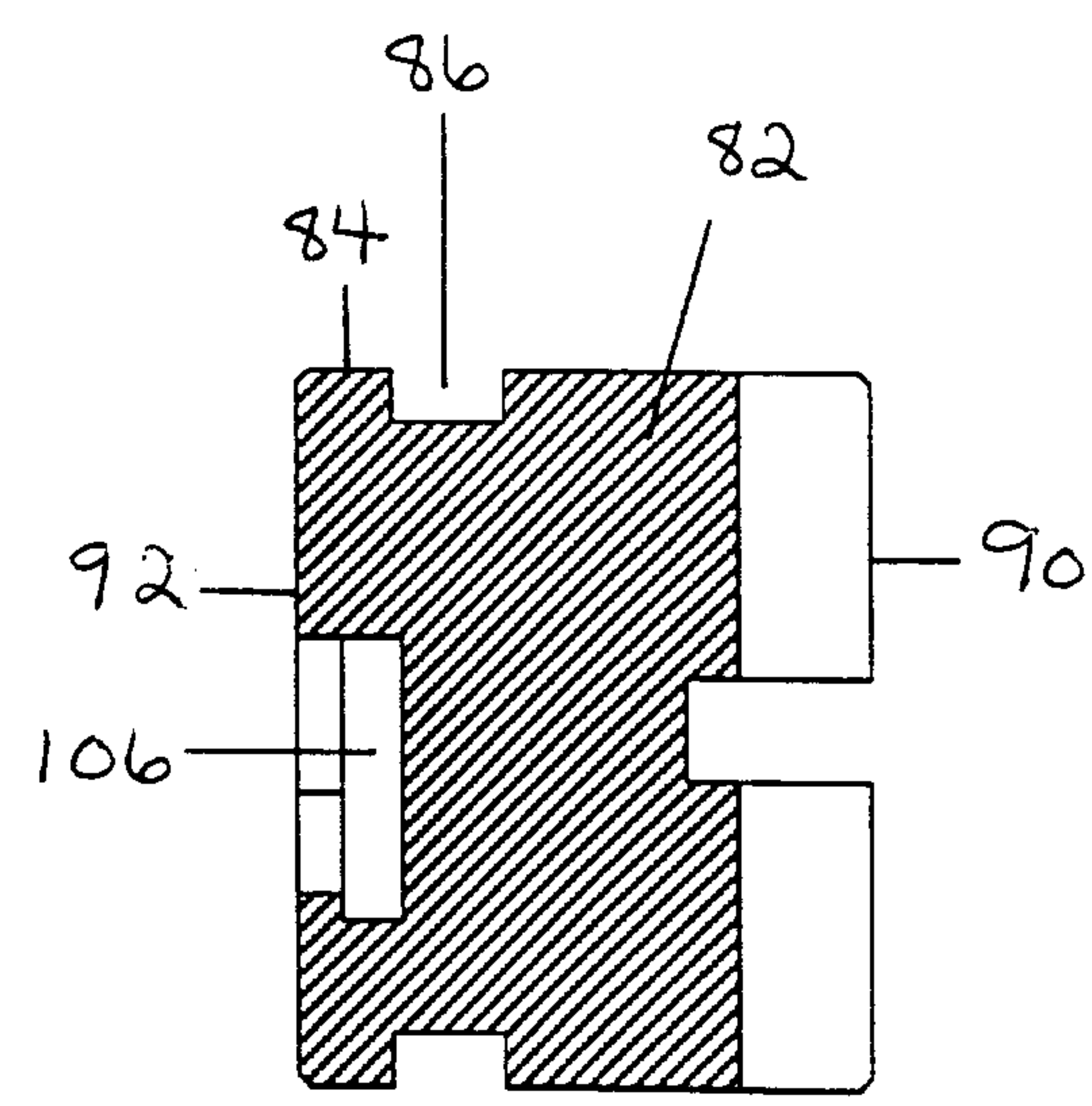

FIGURE 10

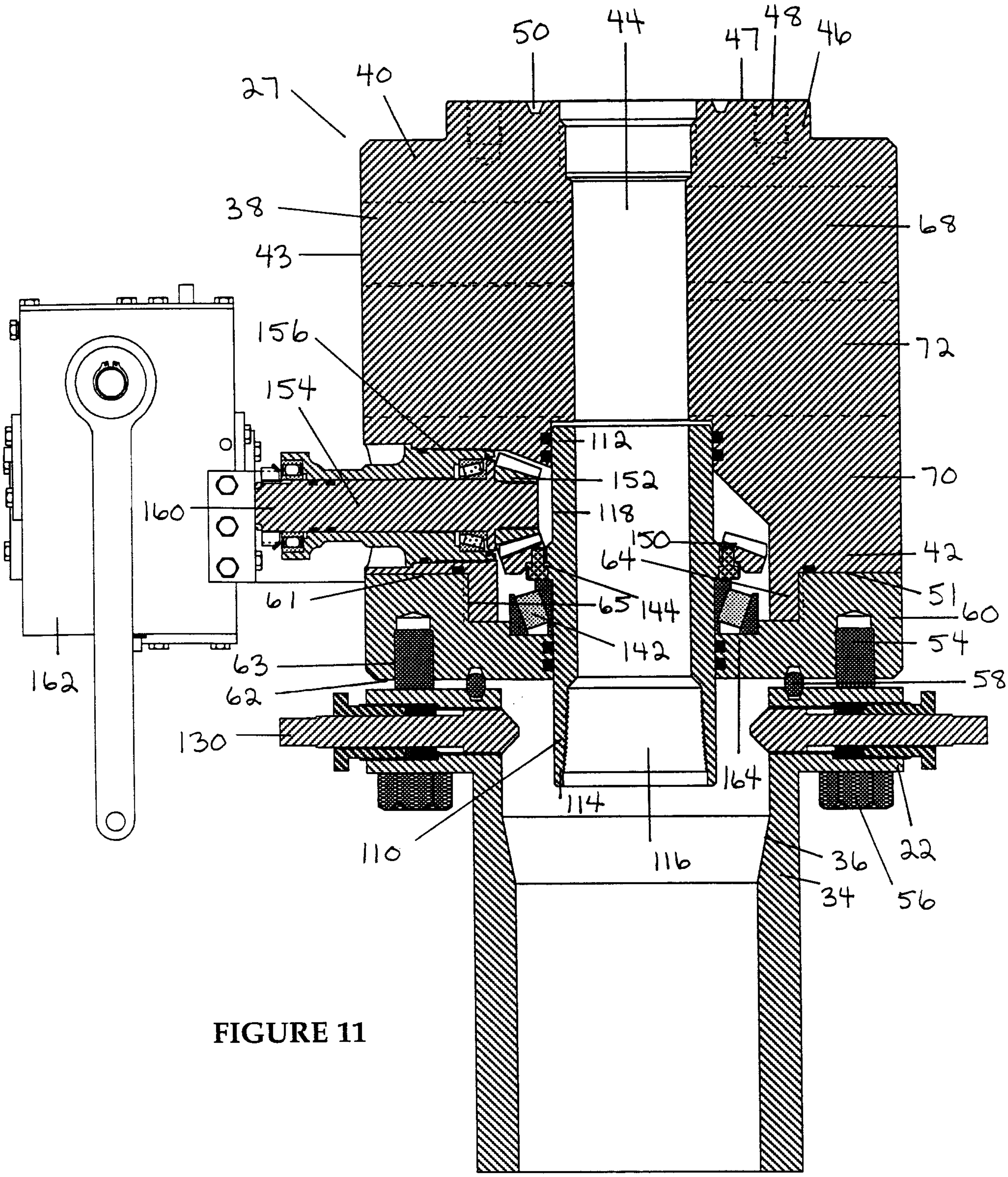
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FIGURE 11

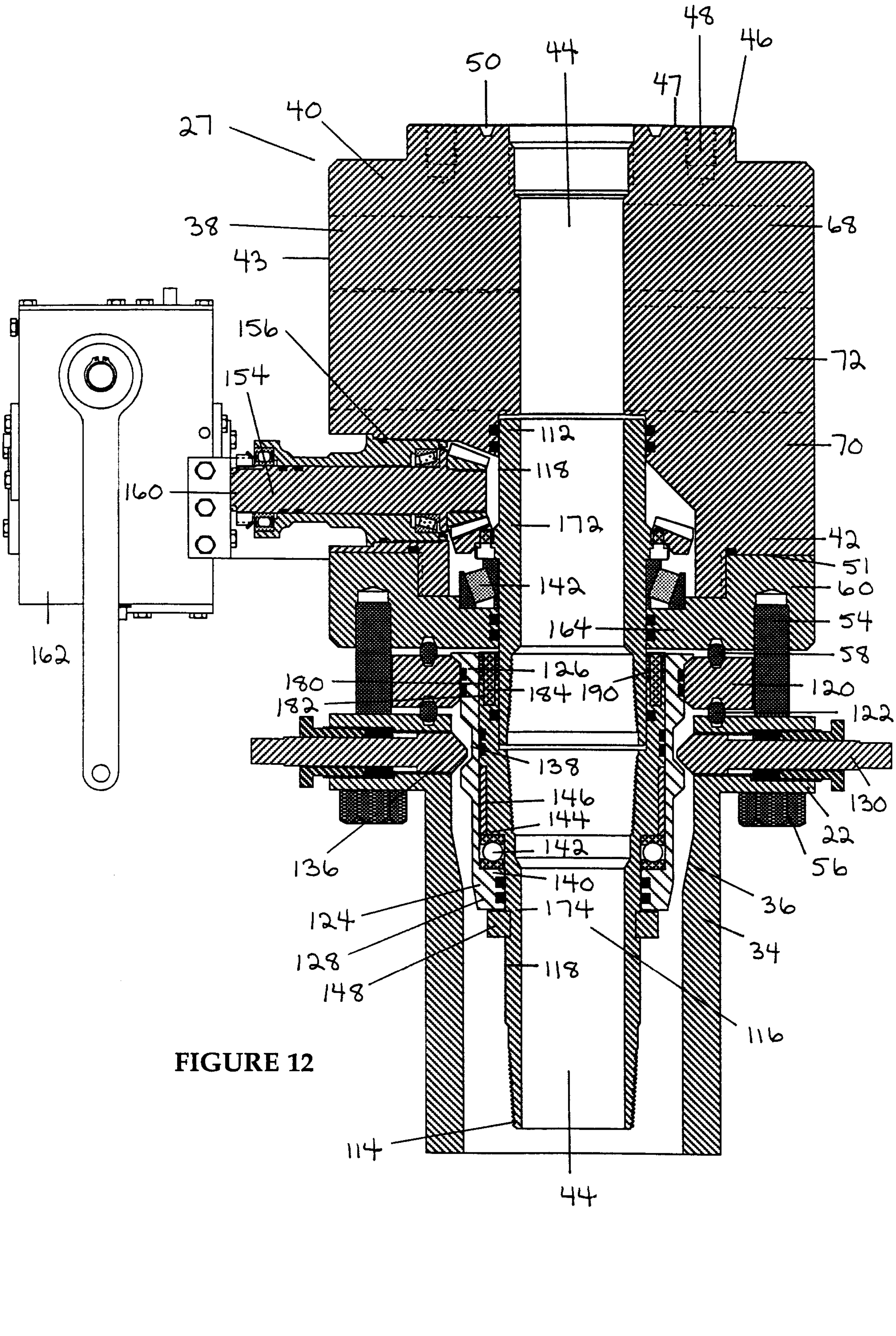
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FIGURE 12

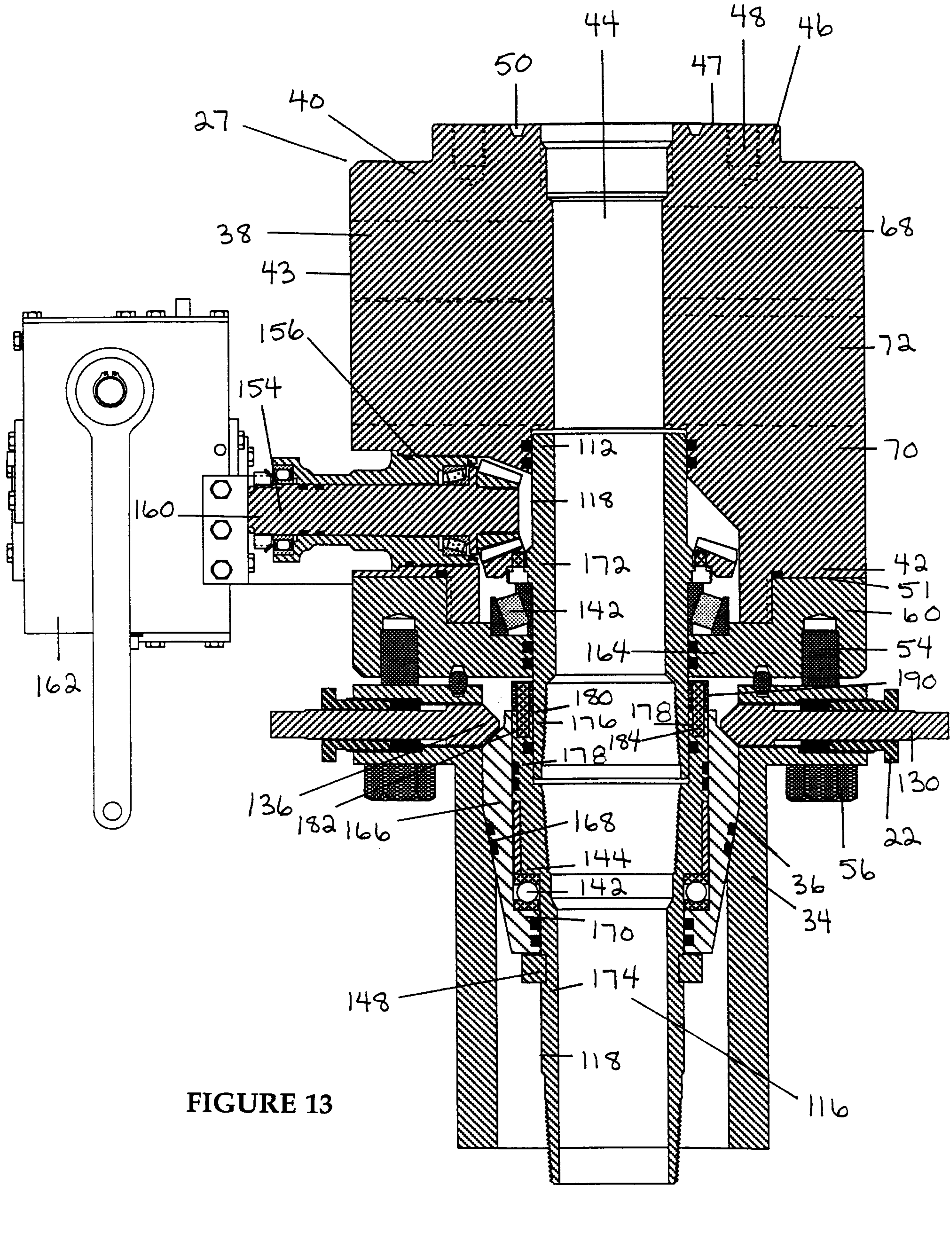
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FIGURE 13

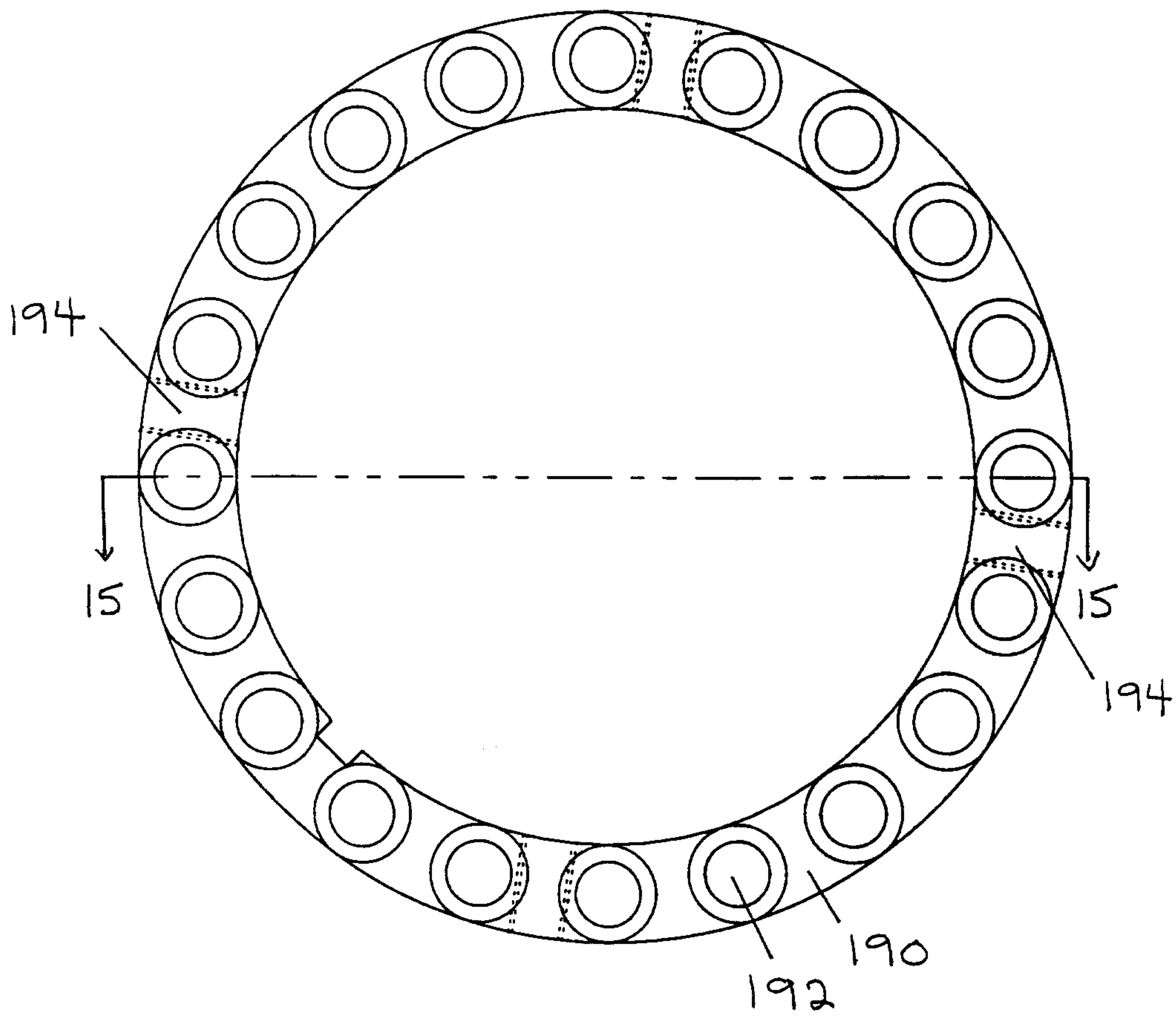


FIGURE 14

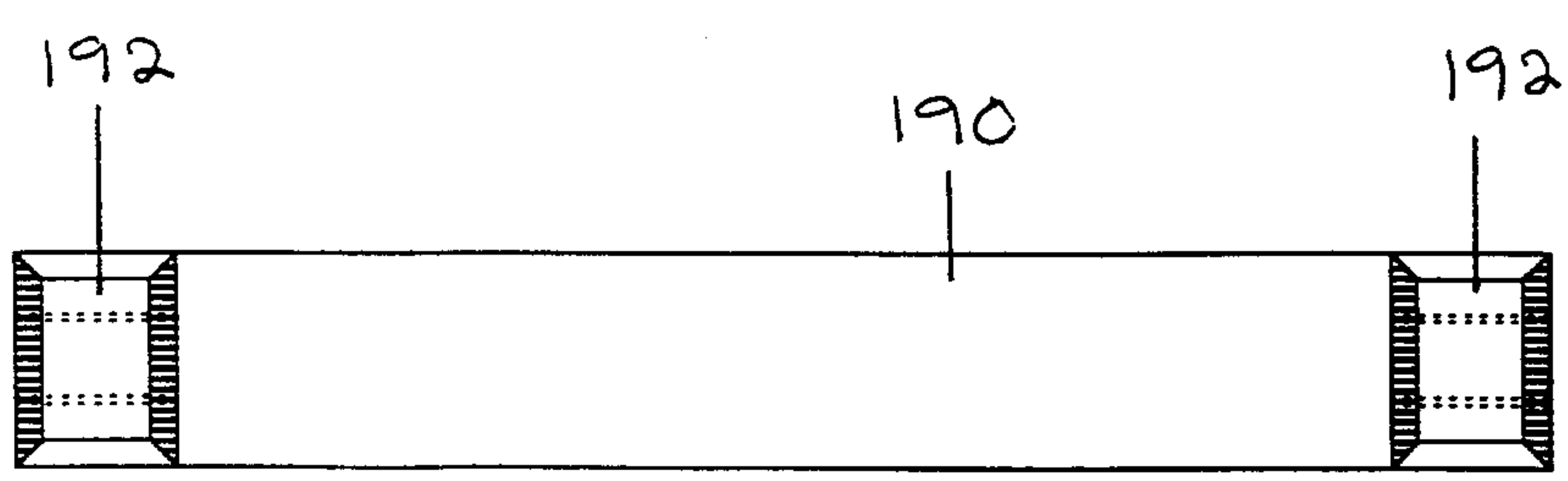


FIGURE 15

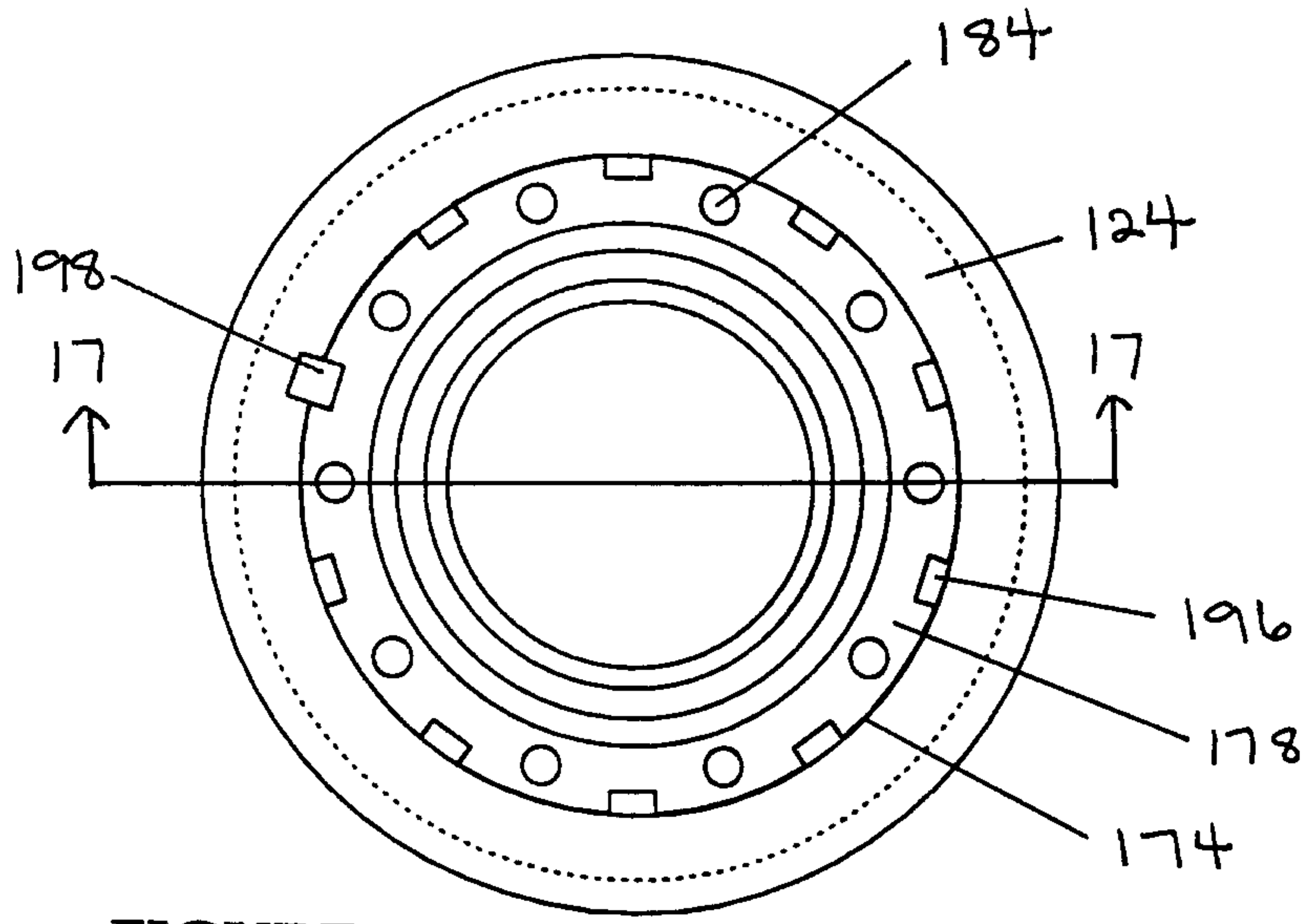


FIGURE 16

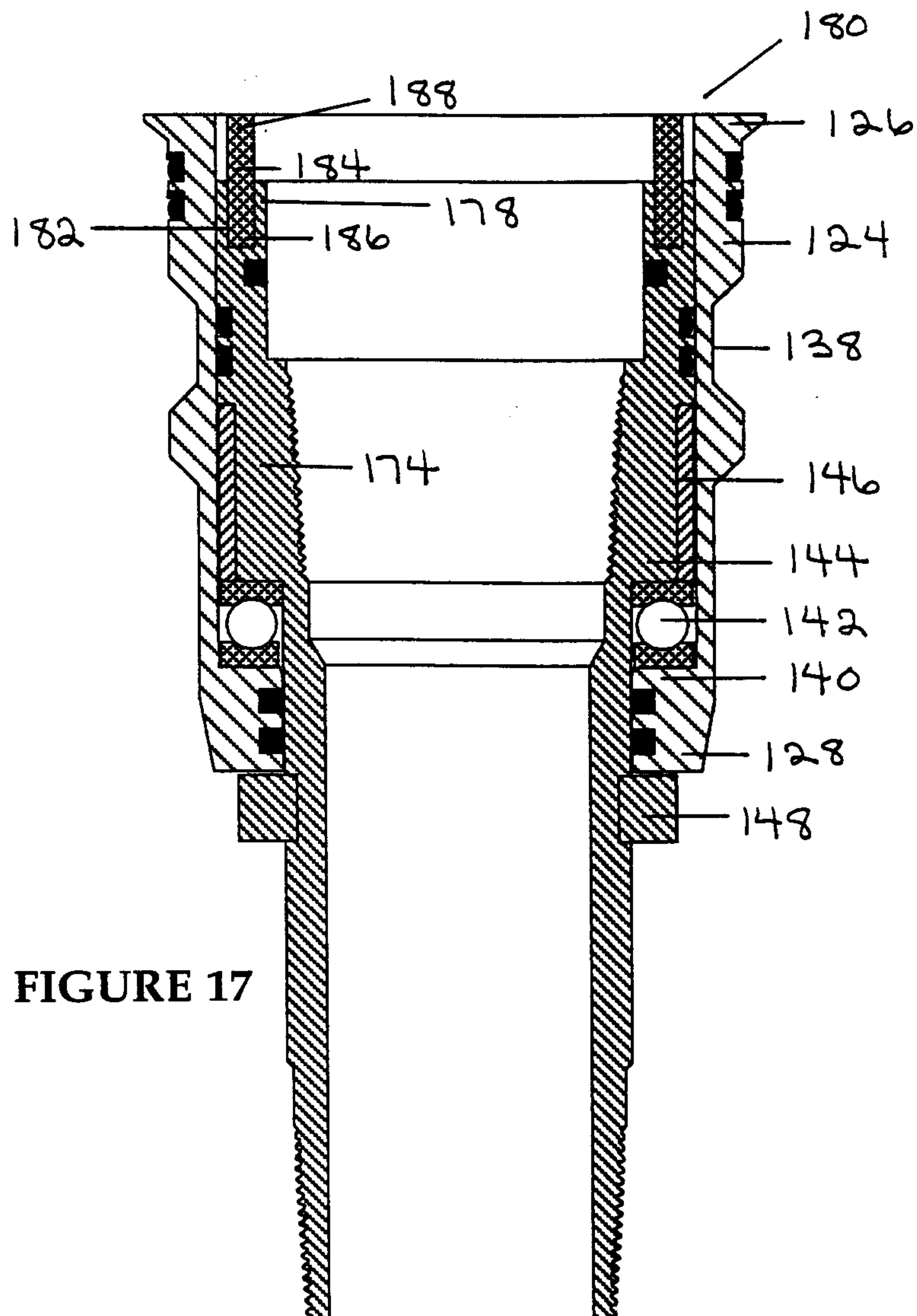
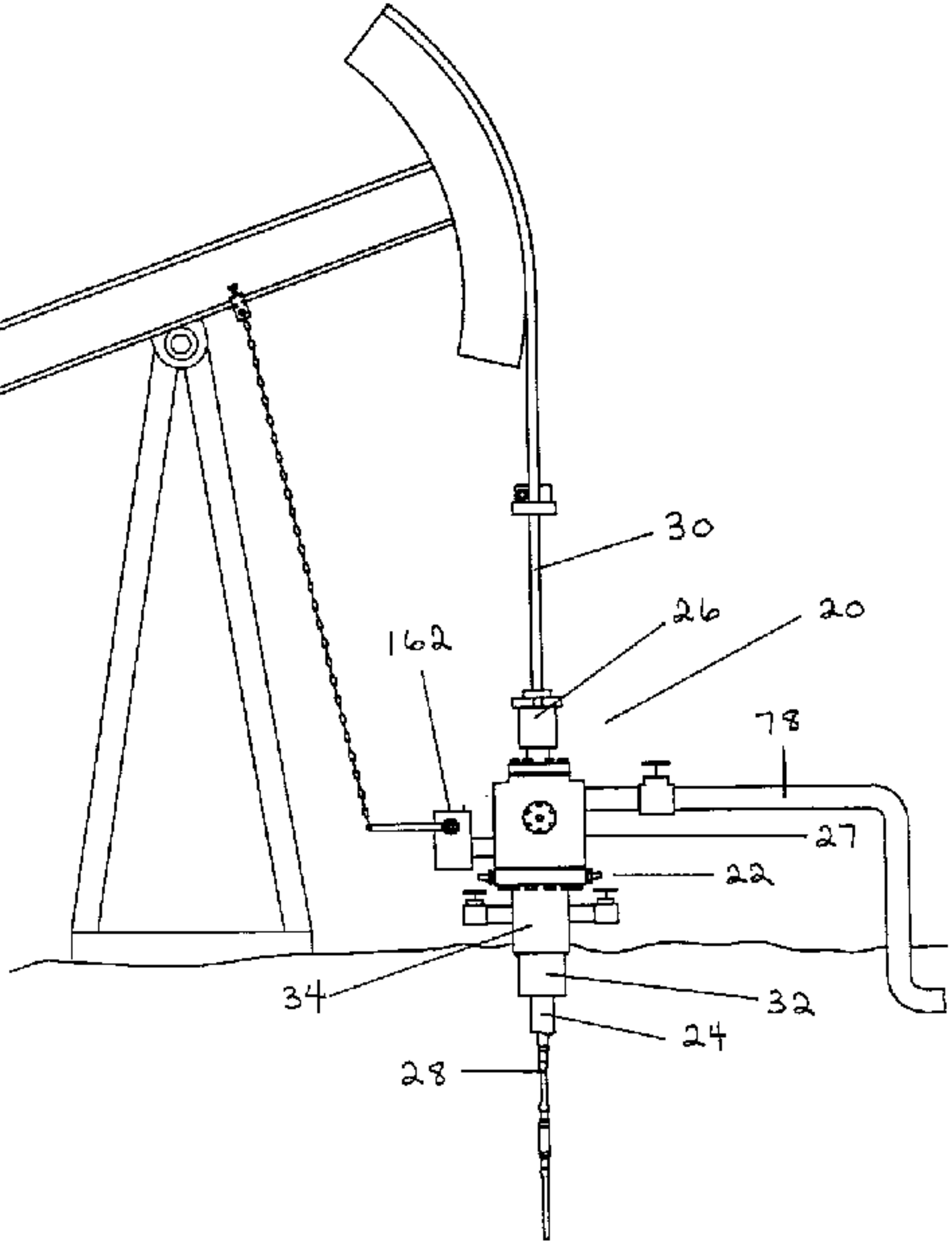


FIGURE 17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