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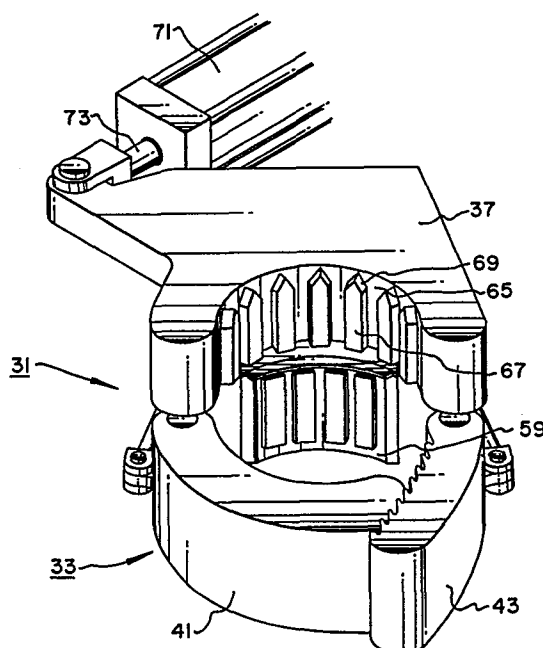
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## 54 **Wrench and wrench assembly.**

57 A wrench assembly for making and breaking connections between tubular members, such as a drill string and a top drive sub. The wrench assembly consists of a lower wrench (33) and an upper wrench (31). The lower wrench (33) has a curved gate arm (41) and a curved latch arm (43) pivotable between an open position and a closed position. The gate arm (41) has a plurality of teeth on its outer surface, and the latch arm (43) has a plurality of teeth on its inner surface, for locking engagement with the teeth on the gate arm (41). The lower wrench (33) also has a clamping cylinder (61) and a die block (59) for forcing the tubular member against the gate arm (41). The upper wrench (31), mounted above the lower wrench (33), has a semicircular plate (65). At least one spline (67) is mounted on the interior surface of the semicircular plate (59) for engagement with at least one spline on the top drive sub. A fluid cylinder (71) is provided for applying torque to the wrenches to rotate one of the wrenches with respect to the other wrenches.



WRENCH AND WRENCH ASSEMBLY

This invention relates in general to wrenches and wrench assemblies and in particular to a wrench assembly for use with a top drive well drilling apparatus.

5           In the drilling of oil and gas wells, hydraulically powered wrenches are used to make and break connections between tubular members. The wrench assemblies generally used in these applications have a pair of wrenches, one mounted directly above the other. Each wrench grips a  
10           joint on either side of the connection, and torque is applied to rotate the wrenches with respect to one another, to make up or break the connection. One such wrench assembly is shown in US patent No. 4,348,920 (BOYADJIEFF), issued September 14, 1982. One disadvantage inherent in  
15           the prior art has been that the wrenches must be adjusted to accomodate tubular members of different diameters.

          A top drive drilling system rotates a drill string from the top, rather than using a rotary table, a kelly, and a kelly bushing. An electric drilling motor is suspended from the drilling rig's conventional swivel and is  
20           attached to the top of the drill string. The drilling motor may also be attached to a carriage, which is guided by a pair of vertical tracks. The drilling motor is connected to the drill string by a cylindrical stem, which extends  
25           downward from the motor. A top drive sub is the bottom unit of the cylindrical stem, and is the unit to which the drill string is threaded. A wrench assembly is also suspended from the drilling motor, in order to make or break connections between the top drive sub and the drill  
30           string. In some prior art top drive drilling systems, the wrench assembly rotates with the drill string and is not removable therefrom. However, there are some top drive well drilling apparatus in which the wrench assembly may be retracted away from the drill string.

35           The object of the invention is a wrench and wrench assembly which may be used, without adjustment, on tubular members having a wide range of diameters.

          According to the invention the wrench has a curved gate arm and a curved latch arm, which are pivotally connected to the frame of the wrench. The gate arm has a  
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plurality of teeth on its outer surface, and the latch arm has a plurality of teeth on its inner surface. When the gate arm and the latch arm have been closed against the tubular member, the teeth on the gate arm will engage certain teeth on the latch arm, depending upon the diameter of the tubular member being gripped.

According to the invention the wrench assembly comprises a lower wrench and an upper wrench. The upper wrench of the wrench assembly has a semicircular plate having at least one vertical splines. The spline, which may be beveled on the upper end, are adapted to engage at least one spline on the top drive sub in a top drive drilling system. When constructed with a wrench according to the invention, the wrench assembly of the invention is capable of connecting and disconnecting connections between a top drive sub and a tool joint on a drill string regardless of the diameter of the tool joint.

The above, as well as additional objects, features, and advantages of the invention, will become apparent in the following detailed description of a preferred embodiment shown in the accompanying drawing, wherein:

Fig. 1 is a perspective view of a top drive drilling apparatus;

Fig. 2 is a perspective view of the (lower) wrench of the invention;

Fig. 3 is a top view, partially in section, showing how the gate arm and the latch arm engage tubular members of different diameters; and

Fig. 4 is a perspective view of the wrench assembly of the invention.

Figure 1 illustrates a top drive well drilling apparatus. A conventional traveling block 11 and a conventional hook 13 are suspended by cables 15 above the floor 17 of an oil well drilling rig. A top drive unit 19, which is a drilling motor of a conventional type, is suspended from the hook 13. A carriage 21 guides the top drive unit 19 up and down along a pair of vertical guide tracks 23. A tubular member, or stem 25, extends downward from the top drive unit 19. The upper end of a drill string 27 is

threaded to a top drive sub 29, which is the lowest unit of the stem 25. The drill string 27 consists of a series of tubular members, called pipe sections, and has a rotary rock bit attached at the lower end for drilling a well bore.

A wrench assembly 31 is used to make and break connections in the stem 25 and the connection between the top drive sub 29 and the drill string 27. The wrench assembly 31 is mounted on the carriage 21, and is movable horizontally between a working position along the stem 25, or the drill string 27, and a retracted position away from the axis of the drill string 27. The wrench assembly 31 is also movable vertically along the stem 25 and the drill string 27. When the wrench assembly 31 is used to make or break the connection between the drill string 27 and the top drive sub 29, the lower wrench 33 grips the tool joint 35 on the upper end of the drill string 27, and the upper wrench 37 engages the top drive sub 29. The top drive sub 29 has a plurality of splines 39 to facilitate the engagement between the wrench 37 and the sub 29.

Figure 2 shows the lower wrench 33 in the closed position. The lower wrench 33 has a curved gate arm 41 and a curved latch arm 43, pivotally connected to a frame 45 at pivot points 47 and 49, respectively. The gate arm 41 and the latch arm 43 are pivotable between the closed position, as shown in Fig. 2, and an open position wherein the wrench can be applied to or removed from the tool joint 35. A fluid cylinder 51, 53 is connected to each arm 41, 43 to provide means for pivoting the arms between the open and closed positions. The gate arm 41 has a plurality of latching teeth 55 on its outer surface, and the latch arm 43 has a plurality of latching teeth 57 on its inner surface for locking engagement with the teeth 55 on the gate arm 41. A die block 59, having tong dies 58, is mounted on the frame 45 opposite the gate arm 41 and latch arm 43. A clamping cylinder 61 moves the die block 59 reciprocally between a retracted position away from the drill string 27 and an extended position against the drill string 27. The clamping cylinder 61 and die block 59 are a

means for forcing the tool joint 35 against the gate arm 41.

Figure 3 illustrates how the wrench is capable of  
5 engaging tubular members of different diameters, without  
having to be adjusted. The solid lines show tong dies 60  
on the gate arm 41 engaging a tubular member 62 of a  
larger diameter. The teeth 55 on the gate arm 41 engage  
the teeth 57 on the latch arm 43, and the specific teeth  
10 57 which are engaged are near the outer end 63 of the  
latch arm 43. When the gate arm 41 engages a tubular mem-  
ber 64 of a smaller diameter, as shown in shadow in Fig.  
3, the teeth 55 on the gate arm 41 engage a different set  
of teeth 57 on the latch arm 43. In this case, the en-  
15 gaged teeth 57 on the latch arm 43 are closer to the pivot  
point 49. For tubular members of various diameters, the  
gate arm teeth 55 will engage different latch arm teeth 57.  
Thus, the gate arm 41 is capable of engaging tubular mem-  
bers having a wide range of diameters, without having to  
20 be adjusted.

Figure 4 shows the entire wrench assembly 31, which  
consists of the lower wrench 33 and an upper wrench 37.  
The upper wrench 37 does not completely encircle the top  
drive sub 29 but rather has a semicircular plate 65. A  
25 plurality of vertical splines 67 are mounted on the inte-  
rior surface of the semi-circular plate 65, for engaging  
the splines 39 on the top drive sub 29. The splines 67  
on the upper wrench 37 are spaced apart so as to fit  
between the splines 39 on the top drive sub 29. The upper  
30 end of each spline 67 is beveled to facilitate engagement  
with the splines 39 on the top drive sub 29. A fluid cy-  
linder 71 is attached to the lower wrench 33, and the  
piston rod 73 is connected to the upper wrench 37. When  
the piston rod 73 is extended, the upper wrench is rotated  
35 counterclockwise, relative to the lower wrench 33. The  
fluid cylinder 71 and piston rod 73 are thus means for ap-  
plying torque to the wrenches 33, 37 to rotate one of the  
wrenches with respect to the other wrench.

In operation, the wrench assembly 31 is first retrac-  
40 ted away from the stem, and then lowered to a position

below the connection between the tool joint 35 and the  
top drive sub 29. The wrench assembly 31 is then extended  
back to the center line of the drill string 27. The wrench  
5 assembly 31 is raised to engage the splines 67 on the upper  
wrench 37 and the splines 39 on the top drive sub 29.  
Interrotational capability is provided to align the  
splines 39, 67, aided by the bevels 69 at the top of the  
wrench splines 67. The splines 37 on the top drive sub 29  
10 are beveled at the lower end.

When the upper wrench 37 is aligned with the top  
drive sub 29, the lower wrench 33 will be aligned with  
the tool joint 35 at the top of the drill string 27. The  
fluid cylinder 51 is actuated to pivot the gate arm 41  
15 to its closed position, in which the inner surface of the  
gate arm 41 contacts the tool joint 35. Fluid cylinder 53  
is then actuated to pivot the latch arm 43 to close onto  
the gate arm 41. The latching teeth 57 on the latch arm  
43 may or may not mesh with the teeth 55 on the gate arm  
20 41 at this point. The clamping cylinder 61 is then actua-  
ted to extend the die block 59. The die block 59 pushes  
the tool joint 35 against the gate arm 41. The clamping  
cylinder 61 exerts substantial pressure and overcomes  
the gate arm cylinder 51, causing the gate arm 41 to be  
25 pushed back. The gate arm 41 will continue to be pushed  
back until the teeth 55, 57 on the arms 41, 43 become  
interlocked. The pressure in the clamping cylinder 61 is  
increased until the desired clamping pressure is achieved.  
The torquing cylinder 71 is then actuated to rotate the  
30 upper wrench 37 in relation to the lower wrench 33, thus  
making or breaking the connection between the top drive  
sub 29 and the tool joint 35 on the drill string 27.

To remove the wrench assembly 31 from the connection,  
the lower wrench 33 is first released. To release the lower  
35 wrench 33, the clamping cylinder 61 retracts the die block  
59 from the tool joint 35. Fluid cylinder 53 then pivots  
the latch arm 43 to the open position, and fluid cylinder  
51 pivots the gate arm to the open position. The wrench  
assembly 31 is then lowered to disengage the splines 39,  
40 67 on the top drive sub 29 and the top wrench 37. The

wrench assembly 31 is retracted away from the connection, raised, and returned to its storage position beneath the top drive unit 19.

5           The wrench assembly of the invention has several advantages over the prior art. Because of the various teeth 57 on the latch arm 43 which may be engaged by the gate arm teeth 55, the wrench assembly 31 may be used on a large variety of tubular members without having to be  
10       adjusted. The spline connection between the upper wrench 37 and the top drive sub 29 eliminates the need to repeatedly grip the top drive sub with tong dies. Repeated gripping with tong dies would damage the sub 29, which must then be replaced. The wrench assembly 31 of the inven-  
15       tion can be retracted away from the stem 25 and the drill string 27. This capability allows the wrench assembly 31 to remain stationary rather than to rotate with the drill string 27. The ability of the wrench assembly 31 to be raised to the storage position, shown in Fig. 1, allows  
20       the top drive drilling apparatus to drill the drill string to a deeper depth before additional pipe sections must be added to the drill string 27.

          While the invention has been shown in only one of its forms, it should be apparent to those skilled in the  
25       art that it is not so limited, but is susceptible to various changes and modifications without departing from the spirit thereof. For example, the wrench assembly may have an upper wrench of the same design as the lower wrench 33 described above.

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CLAIMS

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1. A wrench for making and breaking connections between tubular members, characterized by

(a) a frame (45);

5 (b) a gate arm (41), having latching teeth (55), the gate arm being pivotally secured to the frame and pivotable between an open position and a closed position;

(c) a latch arm (43), having latching teeth (57) along the interior surface for engagement with the latching  
10 teeth (55) on the gate arm (41), the latch arm (43) being pivotally secured to the frame (45) and pivotable between an open position and a closed position;

(d) means (59,61) for forcing one of the tubular members against the gate arm (41);

15 (e) means (51) for pivoting the gate arm (41) between the open position and the closed position; and

(f) means (53) for pivoting the latch arm (43) between the open position and the closed position.

2. The wrench according to claim 1, characterized in  
20 that the gate arm is a curved gate arm, the inner surface of the gate arm contacts one of the tubular members, and a plurality of said latching teeth (55) is provided on the outer surface of the gate arm, and that the latch arm (43) is a curved latch arm, the inner surface of the latch arm  
25 contacts the outer surface of the gate arm, and a plurality of said latching teeth (57) is provided for locking engagement with the latching teeth on the gate arm.

3. A wrench assembly for making and breaking connections between a tubular member and a top drive sub having  
30 at least one spline, characterized by

(a) a lower wrench (33), for engaging the tubular member;

(b) an upper wrench (37), mounted above the lower wrench, and having a semicircular plate (65);

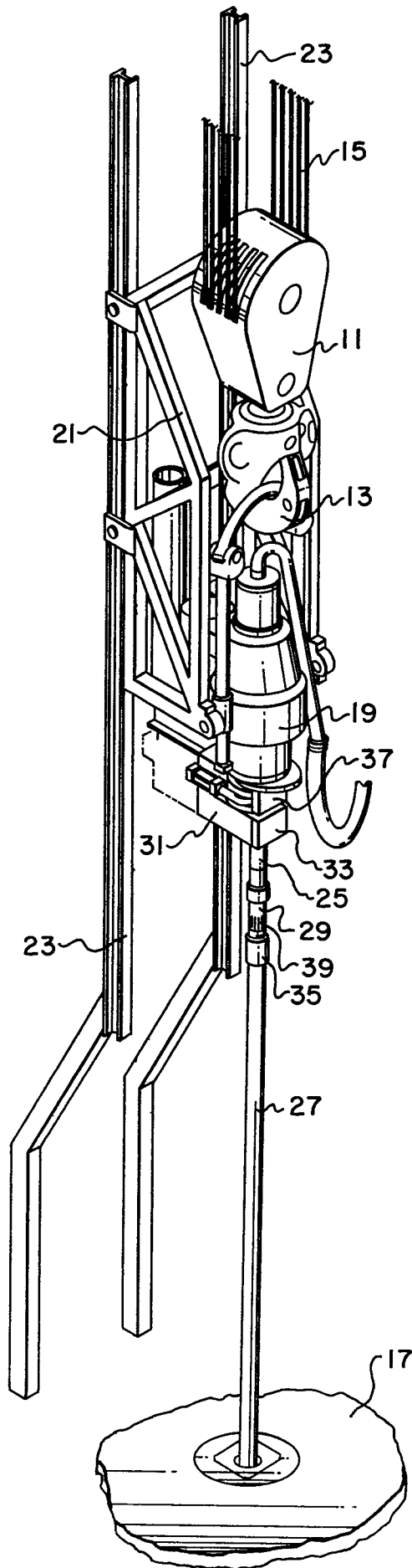
35 (c) means (71) for applying torque to the wrenches to rotate one of the wrenches with respect to the other wrench; and

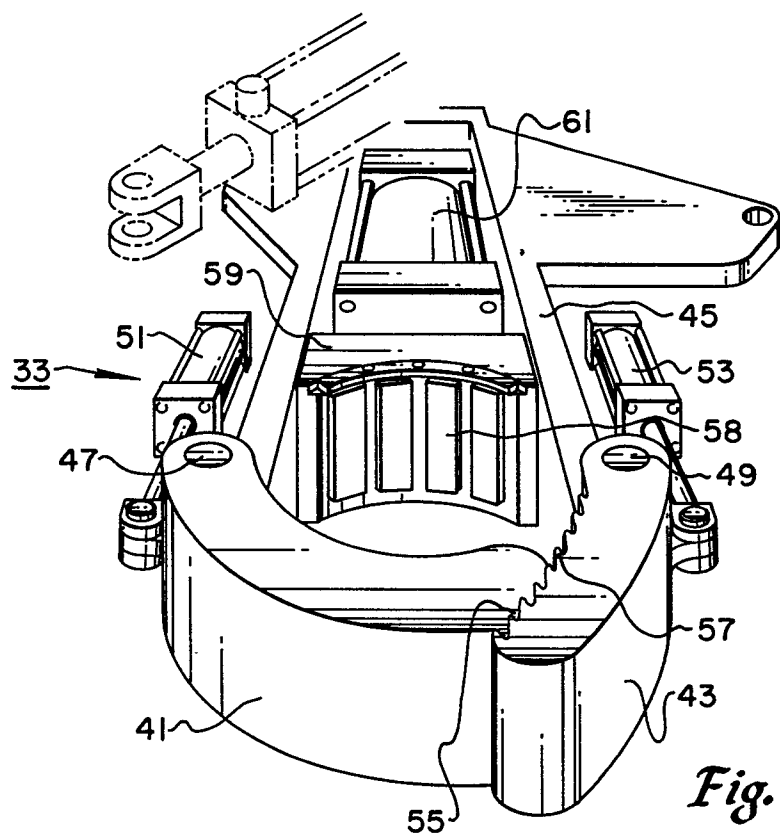
(d) at least one spline (67), on the interior surface of the semicircular plate (65), for engaging at least  
40 one spline on the top drive sub.



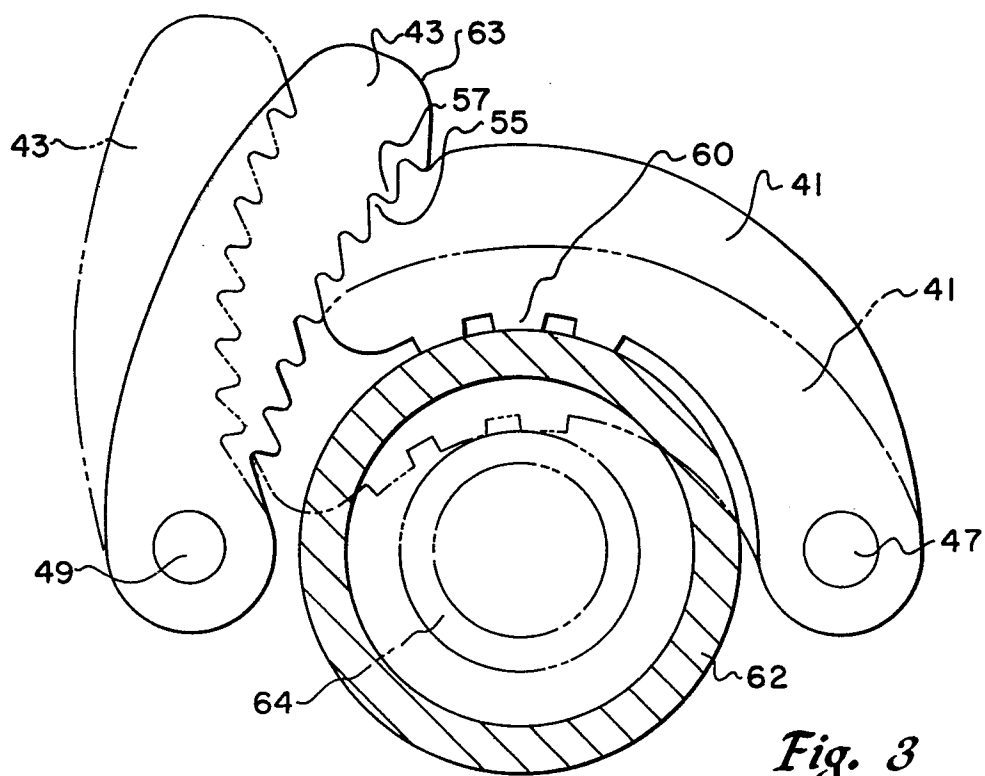
4. The wrench assembly according to claim 3, characterized in that the upper end (69) of at least one spline (67) is beveled to facilitate engagement with the spline  
5 on the top drive sub.

5. The wrench assembly according to claim 3 or 4, characterized in that the lower wrench (33) is a wrench according to claim 1 or 2.

*Fig. 1*

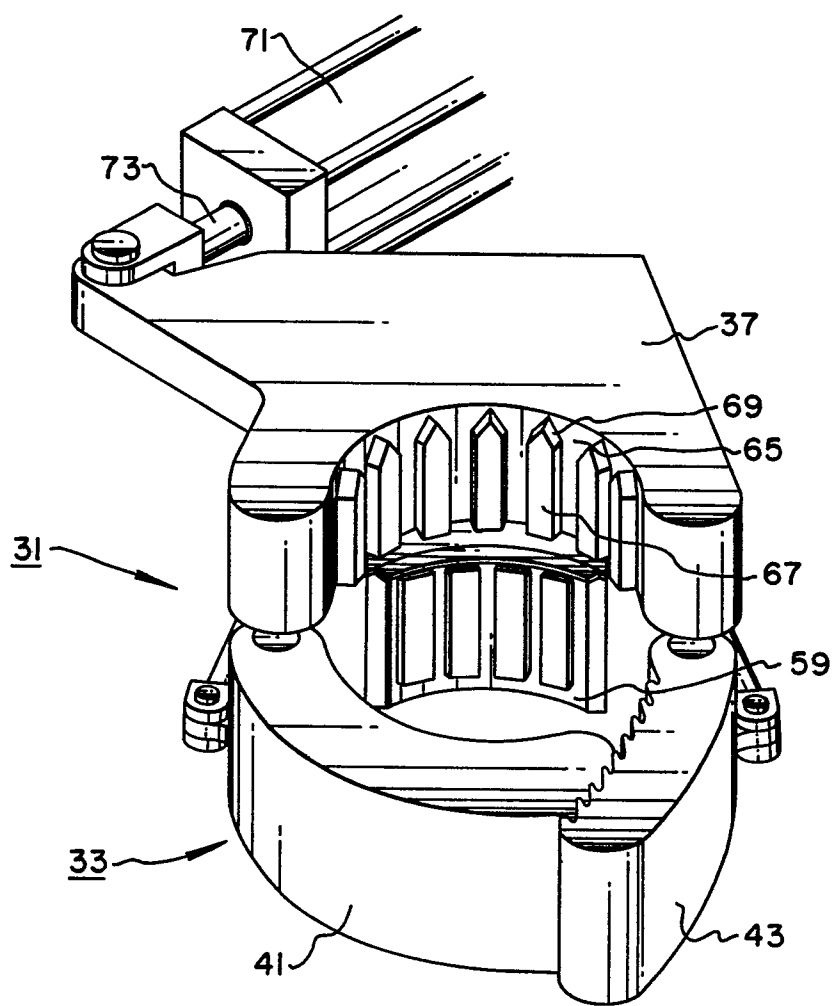


*Fig. 2*



*Fig. 3*

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*Fig. 4*