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(54) Title: TORQUE WRENCH WITH MODULAR INTEGRATED SPINNER ROLLERS AND CLAMPING DIES

(57) Abstract: This invention introduces a torque wrench 1 that has a plurality of modules 25 of integrating spinner rollers and clamping dies into an upper wrench 3 able to directly clamp on tool joint area of a tubular drill string or other threaded equipment. The spinner roller has a driving shaft in between there is a clamping die which can move in or out relatively to the spinner roller such that the spinner roller and die can engage the same tool joint but independently in sequence. This invention eliminates the extra spinner unit typically suspending above the upper wrench 3, simplifies the tripping operation, and provides the ample clamping power on all sizes of tool joints impossible in the prior arts. In addition to a plurality of modules 25 of integrated spinners and clamping dies, the clamping die holder is designed strong enough to clamp on any sizes of tool joints required in the field operation. Furthermore, a plurality of modules 25 of integrated spinners and clamping dies provide the self-centralizing capability to keep the tool joint in the well center position. This invention also has a lower wrench 7 with multiple clamping dies which are used to hold the tool joint of the drill typically called the "box" during the tripping operation. The lower wrench is stationary without rotational movement. The upper wrench 3 is supported by the lower wrench 7 and is rotational relative to the lower wrench about 4 the axis of the drilling string. The lower wrench 7 is supported by other means 5 & 6, which allows the lower and upper wrench together rising up and down along the drilling sting to locate the tool joint.



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A device of a tong or roughneck is usually used in running a string of drill pipe or other pipe into or out of a well typically called "tripping". The roughneck is usually consist of a torque wrench having a lower wrench and top wrench rotating relatively each other, and a spinner wrench used for connecting and disconnecting the various drilling components, such as drill pipes and drill collars. Typically the upper wrench holds the upper tool joint called "pin", and the lower wrench holds lower tool joint called "box". The spinner rollers are typically only engaging with stem of the drill string not with the tool joints.

U.S. Pat. No. 4,023,449, U.S. Pat. No. 4,348,920, and U.S. Pat. No. 4,765,401, issued to Boyadjieff at al., and U.S. Pat. No. 7,313,986, issued on Jan. 1, 2008 to West at al., all show the torque wrench and separate spinner wrench suspending above the torque wrench. The above prior arts are basically all having a torque wrench and a spinning wrench, which is separate from the torque wrench and mounted higher up on the carriage, not engaging with the tool joint rather with the stem of the upper joint of drill pipe and spins the upper joint of drill pipe until it is disconnected from the lower joint. Because the spinning wrench cannot get close enough to the torque wrench, the iron roughnecks of the prior art cannot be used for connecting and disconnecting some types of drill stem components. For example, spiral collars have external stabilizers along the stem which can be damaged by the rollers of a spinning wrench. Other components have other variations in surface and shape which make them unsuitable for contact with spinning rollers along their stems.

U.S. Pat. No. 6,776,070, issued on Aug. 17, 2004 to Mason at al., shows the torque wrench of a pair of integrated the spinner rollers with jaws formed in the confined recess area between the two sets of side rollers. Although it did disclose a pair of an integrated spinner with the torque wrench, the clamping jaws are formed in a very confined recess area which limits its clamping capacity and unable to provide the required torque capacity for different sizes of tool joints. Secondly, it is unable to centralize the tool joint while closing the spinners because the torque wrench cannot maintain the same position while engaging the tool joint without repositioning the entire torque wrench itself. Another problem with U.S. Pat. No. 6,776,070 is that the spinner rollers are limited in size it cannot provide the spinning torque big enough to tight the tool joint, therefore the top wrench needs to make repeated back and forward rotation cycles to tight the tool joint connection of drill string, which causes prolong tipping time in field.

The object of the present invention is to provide a plurality of modules of integrating spinner rollers with clamping dies into the torque wrench to connect or disconnect all types of drill strings by spinning and clamping directly on the tool joints rather than on stem of the drill strings, and all sizes of drill strings with enough industry required torque capacity. The preferred embodiment is with triple modules though double modules are also a simplified embodiment.

Another object of the present invention is to eliminate the separate spinner wrench overhanging above the torque wrench and to make the tripping operation simpler, faster and more efficient.

The further object of the present invention is to centralize the drill string by moving the modules in substantially straight line simultaneously towards to the center of the drill string without repositioning the entire torque wrench itself.

Another further object of this invention is to provide adequate spinning torque so the spinner rollers can quickly spin the tool joint connection tight enough such that subsequently the torque wrench can just make a single rotation cycle to make the connection with required torque, thus to drastically saving the tripping time.

Furthermore, the object of this invention is to provide a means of actuating the movement of spinner rollers and the clamping dies in an orderly manner such that the rollers and dies can engage the same tool joint but at the sequential order as required.

In addition, the object of this invention is to provide a stand-alone spinning and torque device in junction to other existing backup device to hold the box on the rig to connect or disconnect drill string or other threaded equipment

SUMMARY OF THE INVENTION

This invention introduces a torque wrench that has a plurality of modules of integrating spinners and clamping dies into an upper wrench able to directly clamp on the upper tool joint area of a drill string or other threaded equipment. Preferably two spinner roller are used with common driving shaft, located both on the top and the bottom in between there is a clamping die or dies and die holder which can move in or out relatively to the spinner rollers such that the spinner rollers and dies can engage with the same upper tool joint but independently in sequence. This invention eliminates the extra spinner unit typically suspending above the upper wrench, simplifies the tripping operation, and provides the ample clamping power on all sizes of tool joints impossible in the prior arts. In addition to the multiple modules of integrated spinners and clamping dies, the vertical arrangement of sandwiching the clamping die and the die holder in between the top and bottom rollers along the vertical direction of the drilling string makes it possible to have the clamping die holder designed strong enough to clamp on any sizes and types of tool joints widely used in the field operation. Furthermore, the integrated spinners and clamping dies provides the self-centralizing capability to keep the tool joint in the well center position.

This invention also has a lower wrench with multiple clamping jaws which are used to hold the lower tool joint of the drill typically called the "box" during the tripping operation. The lower wrench is stationary without rotational movement. The upper wrench is supported by the lower wrench and is able to rotate relative to the lower wrench about the axis of the drilling string. The lower wrench is supported by other means which allows the lower and upper wrenches together rising up and down along the drilling sting to locate the tool joint. Although the lower wrench is preferred it is not necessary to have it to connect or disconnect the drill string or other threaded equipment since other means such as the drill floor slip and other backup tong or clamping devices can also hold the lower tool joint of the drill string or other threaded equipment.

Other features and advantages of the present invention will be apparent from the following detailed description when read in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

In the drawings, which constitute part of this specification, embodiments demonstrating various features of the invention are set forth as follows:

FIG. 1 is the perspective view of the torque wrench of one preferred embodiment of the invention, attached to the carrier and the positioning device;

FIG. 2 is the perspective view of one preferred embodiment of the torque wrench;

FIG. 3 is the perspective view of another preferred embodiment of the torque wrench;

FIG. 4 is the perspective view of one preferred embodiment of the module for the torque wrench;

FIG. 5 is the perspective view of another preferred embodiment of the module for the torque wrench;

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

FIG.1 shows the perspective view of the torque wrench 1 of one preferred embodiment of the invention, attached to the carrier 60 and the positioning device 61. The lower wrench of the torque wrench is attached to carrier which can move the entire torque wrench up and down vertically. The positioning device can extend or retract the torque wrench in and out between the parking position and well center location.

FIG.2 shows the perspective view of one preferred embodiment torque wrench 1 which has the upper wrench 3 on the top and the lower wrench 7 at the bottom. The hydraulic cylinder 4 is attached to the both wrenches and apply torque to the upper wrench 3 to rotate the upper wrench about the center of the wrenches. At least one cylinder 4 is required. Preferably three equally spaced with 120 degrees apart modules 25 of the integrated spinner rollers and the clamping dies are used in the upper wrench. These modules can move in and out the wrench housing body by a hydraulic cylinder or a rotary actuator and engage or disengage with the upper tool joint so the spinner rollers can grip on the tool joint. The drill string can also be centralized by moving all modules in substantially straight line simultaneously towards to the center of the drill string without repositioning the entire torque wrench itself. In this invention, the spinner rollers with the grooves or knurled surface grip on the tool joint, therefore it can apply a great amount of normal clamping force directly on the tool joint otherwise not possible on the stem since the excessive force can crash the drill string, by which in turn this invention would be able to generate a great amount of spinning torque as long as the driving motor can provide. In this invention since the spinner rollers and the driving motors can generate enough amount torque it can be dually used to replace the traditional casing tong for connecting or disconnecting the casing for the casing running operation. The lower wrench 7 is used as backup device to hold the lower tool joint, typically having two or three clamping actuators. Dies and die holders, and brackets to connect the torque wrench carrier 60 so that the torque wrench can rise up and down along a vertical rail or guide, and also can extend or retract with the positioning device 61. The upper wrench rotation is preferably accomplished by using the hydraulic cylinder 4 or cylinders or actuators but it can also be done by using the gearbox instead for more rotational degrees.

FIG.3 shows the perspective view of another preferred embodiment torque wrench 8 which has the upper wrench 9 on the top and the lower wrench 10 at the bottom. The hydraulic cylinder 11 is attached to the both wrenches and apply torque to the upper wrench 9 to rotate the upper wrench about the center of the wrenches. At least one cylinder 11 is required. Preferably two modules 17 of the integrated spinner rollers and the clamping dies are used in the upper wrench. These two modules can move in and out in the opposite direction within the housing body by a hydraulic cylinder or a rotary actuator and engage or disengage with the upper tool joint so the spinner rollers can grip on the tool joint. The drill string can also be centralized by moving all modules in substantially straight line simultaneously towards to the center of the drill string without repositioning the entire torque wrench itself. The lower wrench 10 is used as backup device to hold the lower tool joint, typically having two or three clamping actuators, dies and die holders, and brackets to connect the torque wrench carrier 60 so that the torque wrench can rise up and down along a vertical rail or guide, and also can extend or retract with the positioning device 61. The upper wrench rotation is preferably accomplished by using the hydraulic cylinder 11 or cylinders or actuators but it can also be done by using the gearbox instead for more rotational degrees.

FIG.4 is the preferred embodiment of the said module 25 of integrating the spinner rollers 33 and the clamping dies 34 held by the die holder with dovetail shaped slot. There are three modules used and are equally spaced preferably with 120 degrees apart in between. At least one roller 33 is used but preferably a plurality of rollers are used as shown in the drawing. The die holder 28 driven by a hydraulic cylinder or piston built in the module can move in and out relative to the said rollers 33 so the die or dies can engage or disengage the tool joint. The spinner roller is driven by a shaft which can be driven directly by a hydraulic or electrical motor 35 or a rotary actuator or by a gearbox of sets of gears properly configured. The entire module 25 is driven by at least one hydraulic cylinder or rotatory actuator 26 in or out of the upper wrench housing body in a preferred embodiment. The end of cylinder or actuator 26 is connected to the wrench housing body through a pin or pins or bolts or similar means. A structure frame 30 attached to the module body 31 holds the spinner roller assembly consist of the driving motor, the driving shaft and the roller.

Another embodiment of moving the module can be accomplished by using a set of linkages pivoting around certain points with either hydraulic cylinder or rotatory actuator.

FIG.5 is another embodiment of the said module 17 of integrating the spinner rollers 33 and the clamping dies 34 held by the die holder with dovetail shaped slot. There are two modules used and move in the opposite direction. The die holder 35 driven by a hydraulic cylinder or piston built in the module can move in and out relative to the said rollers 33 so the die or dies can engage or disengage the tool joint. There are two sets of

driving shaft each of which can be driven directly by a hydraulic or electrical motor 2 or a rotary actuator or by a gearbox of sets of gears properly configured. The entire module is driven by at least one hydraulic cylinder or rotatory actuator 26 in or out of the wrench housing body in a preferred embodiment. The end of the cylinder or actuator 26 is connected to the wrench housing body through a pin or pins or bolts or similar means. A structure frame 30 attached to the module body 31 holds the spinner roller assembly consist of driving motor, the driving shaft and the roller.

Another embodiment of moving the modules can be accomplished by using a set of linkages pivoting around certain points with either hydraulic cylinder or rotatory actuator.

Although specific embodiments of the invention have been described herein in some detail, this has been done solely for the purposes of explaining the various aspects of the invention, and is not intended to limit the scope of the invention as defined in the claims which follow. Those skilled in the art will understand that the embodiment shown and described is exemplary, and various other substitutions, alterations and modifications, including but not limited to those design alternatives specifically discussed herein, may be made in the practice of the invention without departing from its scope

What is claimed is:

1. A module of integrating the spinner rollers and clamping dies into upper wrench of the said torque wrench connecting or disconnecting tool joint of a drill strings or other threaded drilling equipment, comprising:

at least one spinner roller assembly;

a die holder and at least one clamping die held by the die holder;

a means to move at least one said module towards or back from the tool joint so the roller can engage or disengage with the tool joint;

a means to move the said die holder and dies relative to the spinner roller so the die or dies can engage or disengage with the tool joint;

a means to rotate the said spinner roller assembly.

2. The apparatus of claim 1, wherein: the said each spinner roller assembly has at least one roller and a driving shaft.
3. The apparatus of claim 1, wherein: the said means to move the module back and forward is at least one hydraulic cylinder or pneumatic cylinder or rotary actuator or electrical actuator.
4. The apparatus of claim 1, wherein: the said means to move the said die holder and dies is a hydraulic cylinder or pneumatic cylinder or rotary actuator or electrical actuator.
5. The apparatus of claim 1, wherein: the said means to rotate the spinner rollers is a hydraulic motor or rotary actuator or electrical actuator or a gearbox with sets of gears combination.
6. A torque wrench connecting or disconnecting tool joint of a drill strings or other threaded drilling equipment, comprising:

a upper wrench having a plurality of said modules;

a housing holding a plurality of said modules;

a lower wrench having a plurality of clamping dies;

a means to move the said modules towards or back from the tool joint so the rollers can engage or disengage with the tool joint;

a means to move the die holder and dies relative to the spinner rollers so the dies can engage or disengage with the tool joint;

a means to rotate the upper wrench relative to the lower wrench to connect or disconnect the tool joints;

a means to rotate the spinner rollers to tighten or loosen the connection of tool joints.

7. The apparatus of claim 6, wherein: the said each spinner roller has at least one roller rotating with a driving shaft.
8. The apparatus of claim 6, wherein: the said means to move the module back and forward is at least one hydraulic cylinder or pneumatic cylinder or rotary actuator or electrical actuator.
9. The apparatus of claim 6, wherein: the said means to move the die holder and dies is a hydraulic cylinder or pneumatic cylinder or rotary actuator or electrical actuator.
10. The apparatus of claim 6, wherein: the said means to rotate the spinner rollers is a hydraulic motor or rotary actuator or electrical actuator or a gearbox with sets of gears combination.

11. The apparatus of claim 6, wherein: the said a means to rotate the upper wrench relative to the lower wrench is at least one hydraulic cylinder or pneumatic cylinder or rotary actuator or electrical actuator or a gearbox with sets of gears combination.

12. A method of disconnecting the tool joints of a drill string or other threaded equipment, comprising of the following steps:

Moving a plurality of modules of integrated spinner rollers and clamping die holder and dies in the upper wrench towards to the upper tool joint; extending the clamping die holder and dies and gripping on the upper tool joint;

Moving a plurality of clamping die holder and dies in the lower wrench or other backup device towards to the lower tool joint and gripping on the lower tool joint;

Rotating the upper torque wrench counterclockwise to loosen the connection;

Retracting back the extended clamping die holder and dies in the upper wrench and spinning the rollers counterclockwise to completely loosen the tool joint.

13. A method of connecting the tool joints of a drill string or other threaded equipment, comprising of the following steps:

Moving a plurality of clamping die holder and dies in the lower wrench or other backup device towards to the lower tool joint and gripping on the lower tool joint;

Moving a plurality of modules of integrated spinner rollers and clamping dies in the upper wrench towards to the upper tool joint; gripping the rollers on the upper tool joint; spinning the rollers clockwise to tighten the tool joint;

Extending the clamping die holder and dies in the upper wrench and spinning the rollers counterclockwise to tighten the tool joint.

Rotating the upper torque wrench clockwise to tighten the connection till a required torque is reached.

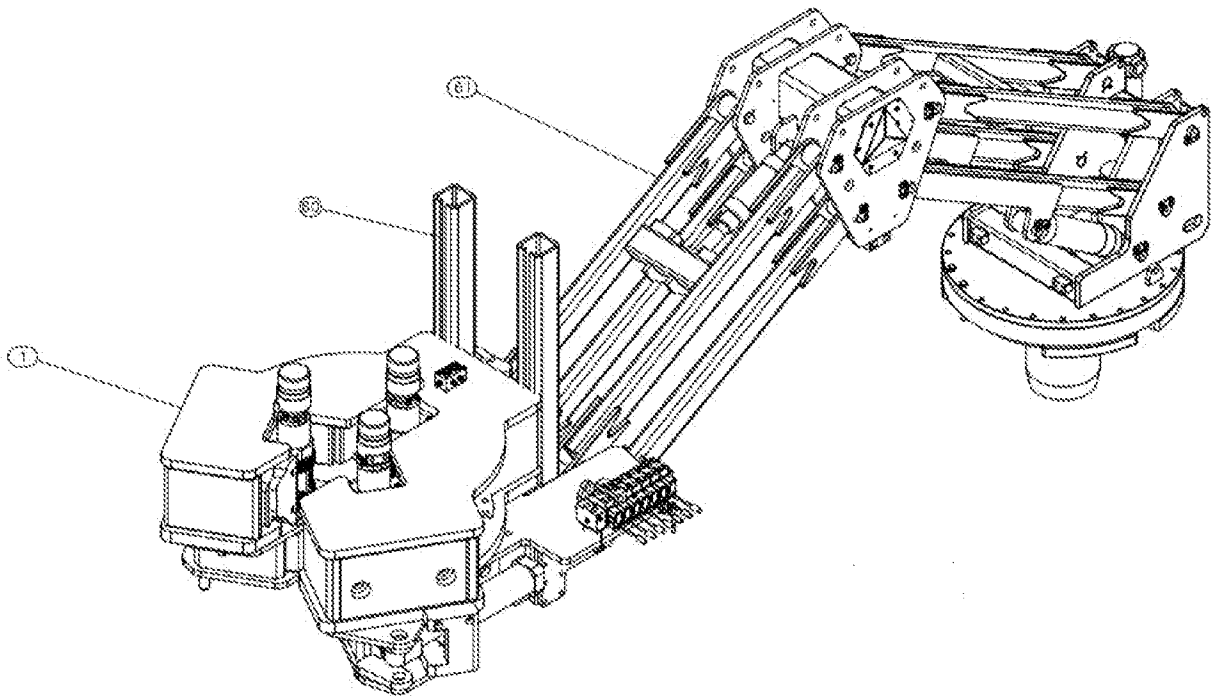


FIG. 1

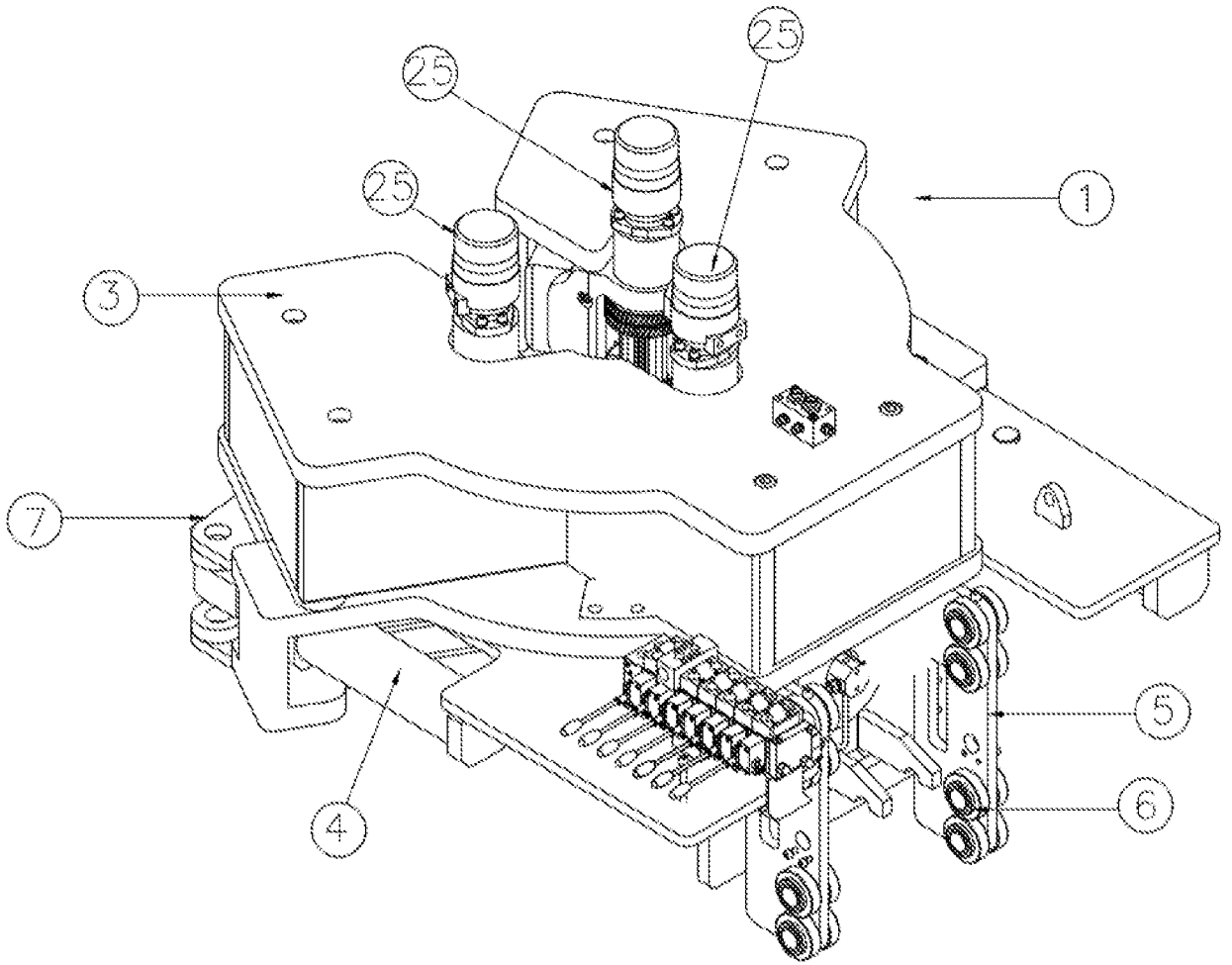


FIG. 2

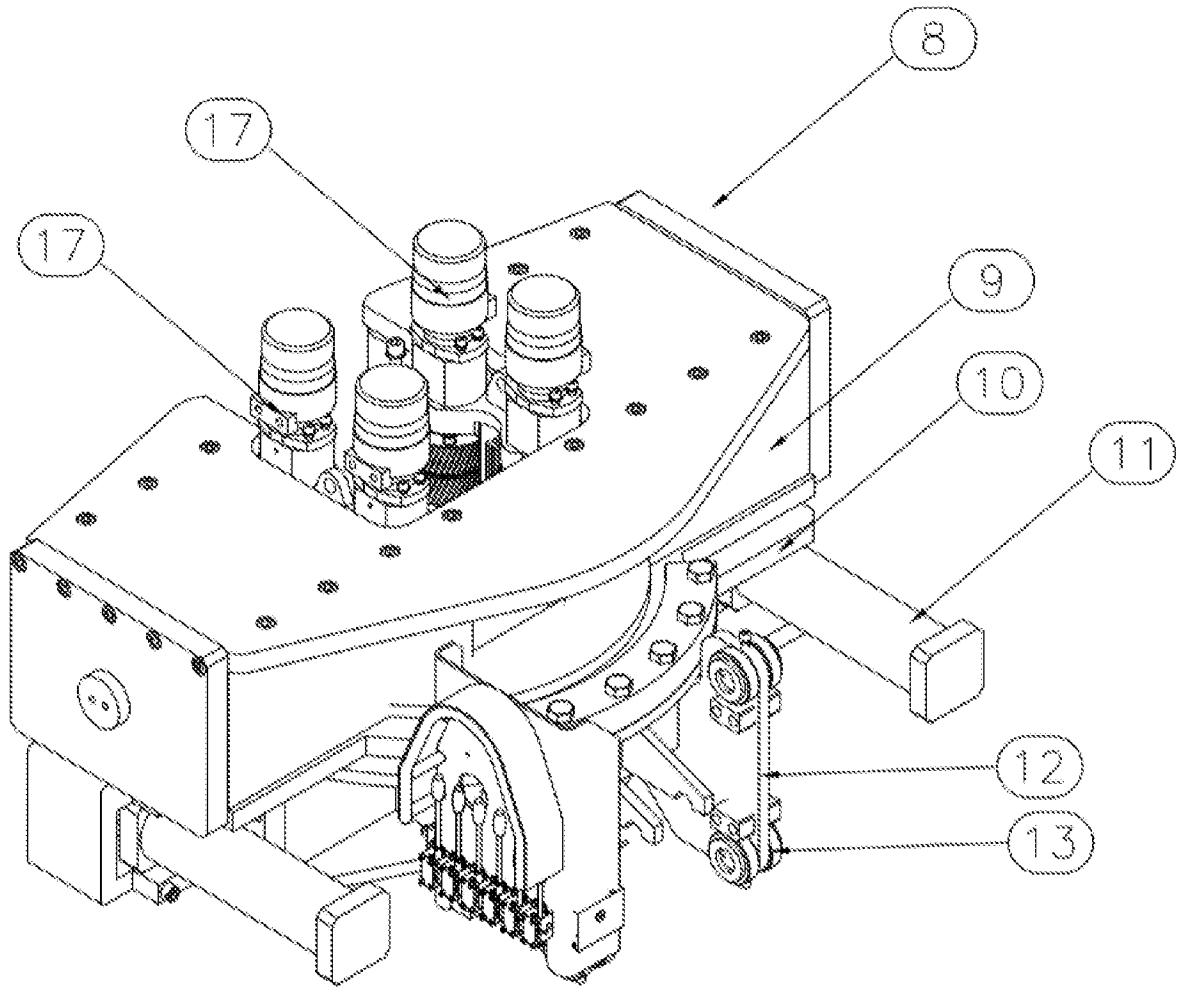


FIG. 3

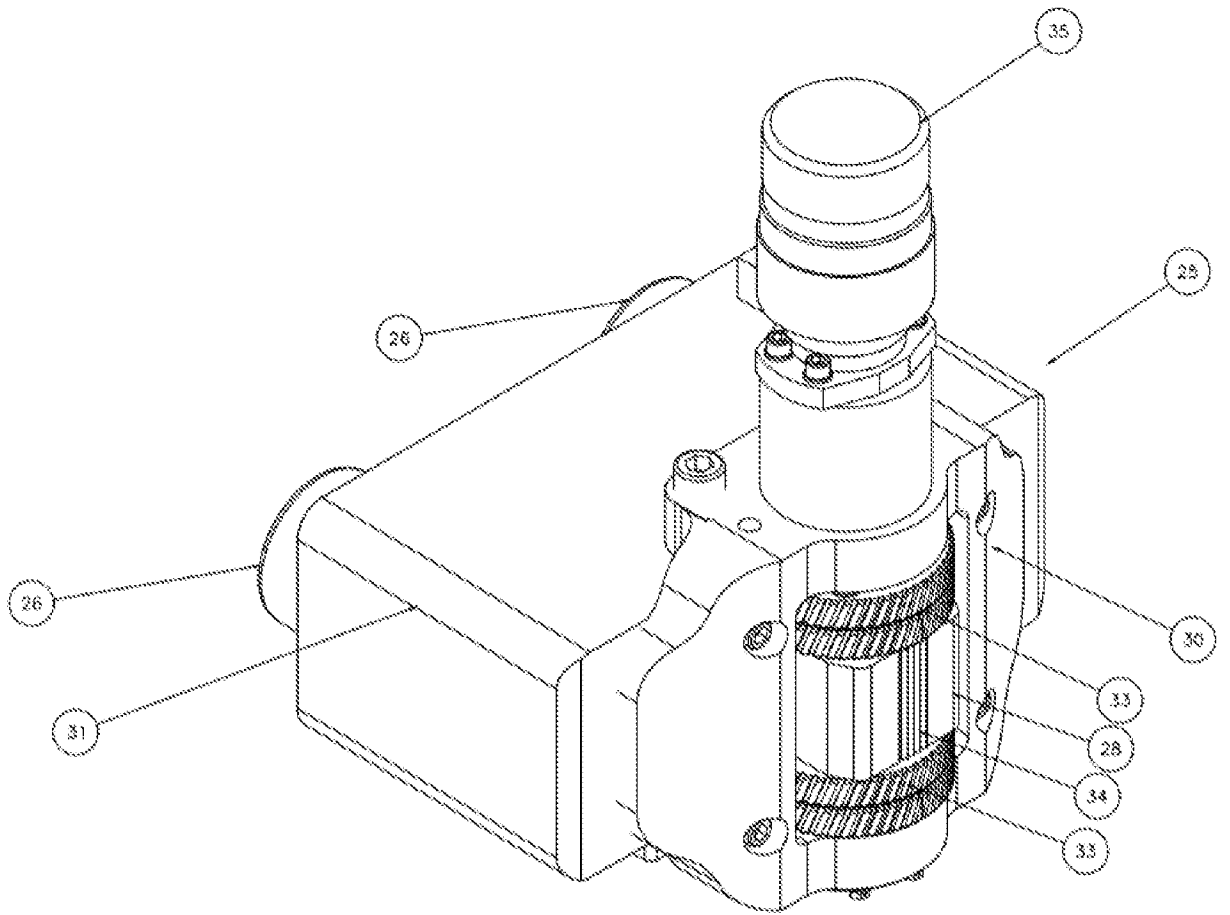


FIG. 4

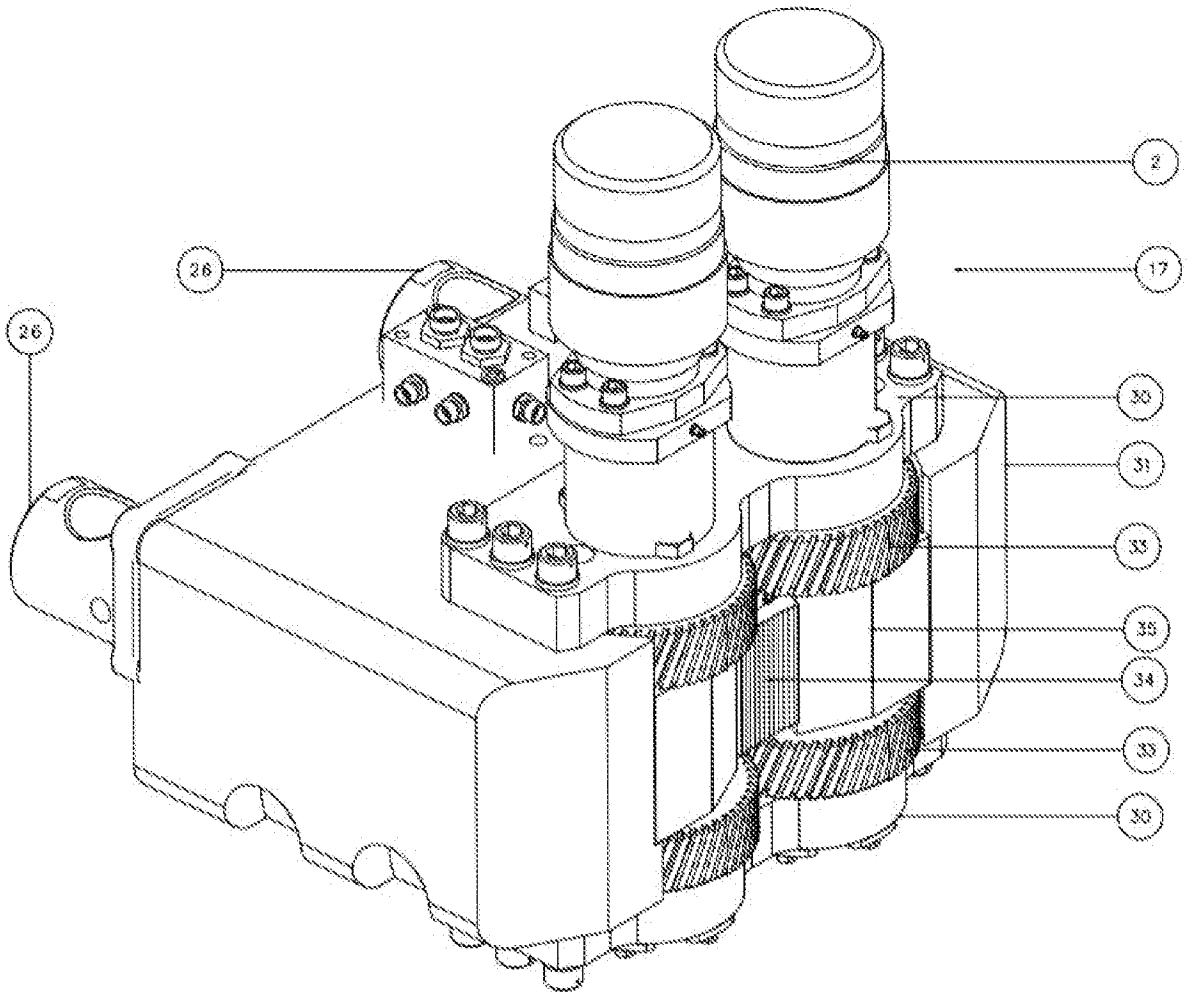


FIG. 5