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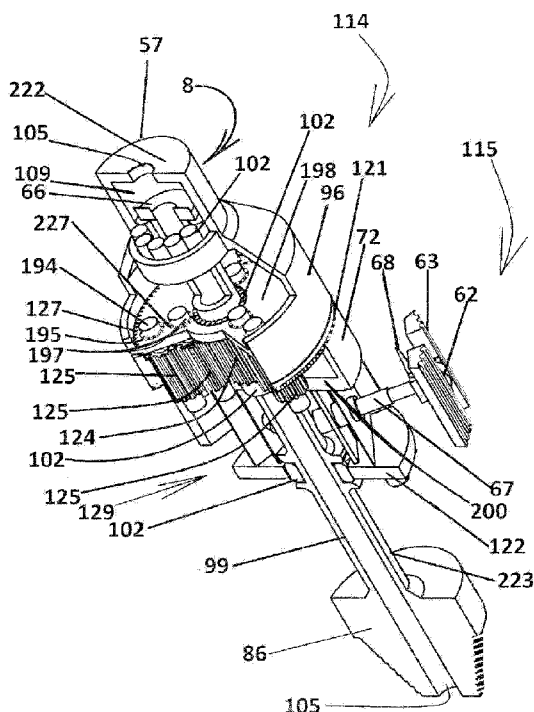


FIG.1

(57) Abstract: A gear system (10) comprises a modular gear assembly (124,125,127) which is housed in a gear assembly housing (114). The gear assembly housing (114) is adapted to be connected to another gear assembly (124,125,127) which drives an output drive shaft (99). The gear assembly (124,125,127) is sealed in the first gear assembly housing (114). The input drive (222) is operative to be driven by an output drive (223) of a second gear assembly (124,125,127) so that in use the angular speed ($\omega_{1\text{input}}$) of the input drive (222) is different from the angular speed ($\omega_{2\text{output}}$) of the output drive (223) and one or more stabilisers (63, 67) engage with the containment structure (113) so as to maintain the gear system in position. Gear assembly housings can be connected together so that a high speed or very high speed output is obtained. Ideally the gear assembly comprises a sun and planetary gear assembly.



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A GEAR SYSTEM

Field

The present invention relates to a gear system. More particularly, but not exclusively, the present invention relates to a gear system for use in the exploration and extraction of oil and gas.

Background

In many industrial applications, in particular in oil and gas exploration, there is a need to drill at high speeds. This is the case when initially forming a wellbore and within wellbores, for example as part of wellbore completions or extensions. When completing or extending a wellbore cutting and high speed friction welding may be required to be carried out on a well casing. Such specific applications require high speed devices (capable of operating in excess of 500 RPM) or very high speed devices (capable of operating in excess of 5000 RPM) for transmitting torque to tools remote from the surface in a controllable and reliable manner. Gear systems are employed in the process of transmitting power to remote locations.

Prior Art

US Patent US 2 701 123 (Standard Oil Development Company) discloses a gear system used for drilling well bore holes which has an outer casing containing a planet gear frame and a chamber that is in communication with an interior of a pipe string. The gear system engages with walls of a well bore by way of a plurality of pivotal dogs mounted in the gear frame.

US 4 314 615 (Sodder) discloses a self-propelled drilling head which has a base section, including gripper shoes, mounted for extension and retraction to selectively grip the wall of a hole being drilled. An actuator is provided for extending and retracting the gripper shoes. A drilling section is mounted on the base. A second actuator is provided for urging the drilling section downwardly relative to the base section when the gripper shoes are extended. A power transmitting mechanism is operably connected to a drive transmitting torque to rotate a cutter bit.

US Patent US 3 477 314 (Rutkowski) discloses a three speed transmission planetary gear unit for transmitting torque from an input drive to an output drive at one of three different user selectable speeds.

US 2015/00758871 (Halliburton Energy Services Inc) discloses a drill string assembly and a powertrain for a bottom hole assembly (BHA). The BHA includes a housing, a drill bit that is coupled to the housing and a fluid driven motor assembly. The motor assembly includes a differential gear set with a first gear member coupled to a drive shaft. A second gear member intermeshes with the first gear member. A third gear member is coupled to a drill bit. A differential gear set transmits rotational drive from the drive shaft to the drill bit and rotates the drill bit at a speed greater than the drive speed.

The present invention is an improved gear system which provides a wide range of input speed to output speed ratios to an operator.

An aim of the present invention is to provide a gear system which is easily and quickly repaired in the event of a failure or for maintenance.

A further objective of the present invention is to provide a gear system for use in remote and hazardous environments, including down hole locations, where a high speed (in excess of 500 RPM) or very high speed (in excess of 5000 RPM) drive is required in order to perform specific repair or construction operations.

Summary of the Invention

According to a first aspect of the invention there is provided a modular gear system which operates in a containment structure comprises: a gear assembly which is housed in a first gear assembly housing, an input drive drives the gear assembly which drives an output drive shaft; the gear assembly is sealed in the first gear assembly housing; the input drive is operative to be driven by an output drive of a second gear assembly, whereby in use the angular speed ($\omega_{1\text{input}}$) of the input drive is different from the angular speed ($\omega_{2\text{output}}$) of the output drive; and at least one stabiliser is adapted to engage with the containment structure so as to maintain the gear system in position.

Preferably gear assembly housings are connected so that the output axis of the first housing is coaxial with the input of the second gear assembly.

It is appreciated that the invention enables an input rotation to be applied to a plurality of gear assembly housings in a connected manner so that a faster output is obtained at each output stage which increases to a high speed or very high speed using a plurality of connected gear assembly housings.

The invention can be utilised in many situations where input high torque low speed rotation can be converted to high speed rotation.

Ideally the gear assembly comprises a sun and planetary gear set. Preferably the sun and planetary gear set are retained and operate in conjunction with a gear ring in order to stabilise planetary gear members.

Preferably an engagement means is provided on a first gear assembly housing for engaging with a second gear assembly housing or more preferably a wall of a container or a well bore liner. The engagement means prevents relative rotation of the two gear assembly housings so that when the first and second gear assembly housings are connected, for example when one is stacked atop another, the output drive from the first gear set, in the first gear assembly housing, is coupled to the input drive of the second gear set, in the second gear assembly housing. In the second gear assembly housing the relative angular speeds of the second input drive ($\omega_{3\text{input}}$) and second output drive ($\omega_{4\text{output}}$) are different.

The overall variation (reduction or increase) in speed, from the first input drive to the second output drive, when the first gear assembly housing is engaged, in a relatively fixed, non-rotational manner, with the second gear assembly housing, is therefore $\omega_{1\text{input}}/\omega_{4\text{output}}$.

The engagement means that prevents relative rotation of adjacent gear assembly housings is preferably a stabiliser. The stabiliser ensures torque is transmitted from the first output drive to the second input drive. The combined gear assemblies thereby provide a variable output torque which may be altered by including one or more additional gear assembly housings.

Ideally stabilisers are provided on an outer surface of a gear assembly housing. The stabilisers are arranged to engage with a well bore or liner so as to provide stability to the, or each, gear assembly housing. Stabilisers are ideally remotely controllable so that they can be extended to engage with a well bore or liner prior to the gear being deployed; and retracted after use by a remote operator.

Ideally, in addition to the planetary gears is a ring gear, single, double or multiple planet gear set linked to a central sun gear. The gear sets are preferably housed between a lower and upper carrier plate and a non-rotational stabiliser is provided so that the gear system is able to operate in any angle of inclination.

Preferably an isolation bearing seal separates rotation of planetary gear sets within the gear assembly housing from non-rotational items outside the gear assembly housing.

In one preferred embodiment of the invention a circulation chamber is provided and an output shaft is hollow and in fluid communication with the circulation chamber. An advantage of this feature is that coolant or mud may be delivered to a tool, such as a drill bit, for purposes of cooling and/or lubrication as well as removal of debris and drill cuttings.

Optionally tools are connected to an output drive or shaft by way of a male/female tool joint with a right or left hand thread connections.

Preferably the upper circulation chamber connected to the planetary housing can rotate freely on the planetary gear set isolation sealed bearing.

According to another aspect of the invention a system has a casing with an internally threaded surface and a moveable extender has a threaded surface which engages with the internally threaded surface of the casing, an actuator causes relative rotation of the casing with respect to the moveable extender thereby extending/retracting the moveable extender.

Ideally the casing has first and second groups of inter-digitated engaging portions arranged to move axially, one group with respect to another.

Preferably movement of the casing causes a fishing tool to close as the casing slides over sprung fingers thereby grabbing an item to be fished.

The internal section of the casing contains a central hollow or solid shaft which has the same outside diameter along the stage. The shaft is independent for each stage and is directly connected to the sun gear of a planetary gearing section.

The input drive may be a rotatable body and/or may be a rotatable portion of the gear assembly housing.

The output drive may be a rotatable body. The output drive may be or may comprise a shaft. The output drive may be operative to drive the output drive of another gear assembly.

In some embodiments, all of, or a portion of the gear assembly housing may be fixed with respect to, and rotate with, the input drive. The gear assembly housing may comprise the input drive.

The gear assembly may be a planetary gear set which may comprise a ring gear, a sun gear and a plurality of planet gears. The ring gear may be connected to and/or may rotate with the input drive. The sun gear may be connected to and/or may rotate with the output drive.

The planetary gear set ideally comprises one or more outer planet gears and one or more inner planet gears, each outer planet gear meshes with the ring gear and an inner planet gear.

In some embodiments, all of, or a portion of the gear assembly housing may be able to rotate with respect to the input drive and with respect to the output drive. This portion of the gear assembly may be isolated from the input drive and/or from the output drive by space or by one or more sealed bearings.

This portion of the gear assembly housing may support and/or may be connected to one of, a plurality of, or all of the one or more stabilisers. When the stabilisers engage with containment structure this portion of the gear assembly housing may be maintained in position, and/or may be prevented from rotating with respect to the containment structure.

The gear assembly housing may comprise a first portion which is fixed to, rotates with, and/or comprises the input drive, and a second portion which is rotatable with respect to the first portion, with respect to the input drive and with respect to the output drive. Bearings may separate the second portion from the output drive, the input drive and/or the first portion of the gear assembly housing. The second portion of the gear assembly housing may support and/or may be connected to one of, a plurality of, or all of the one or more stabilisers. The first portion may be an upper portion and the second portion may be a lower portion.

The containment structure may be a wellbore casing, may be a tube, may be the openhole portion of a wellbore, or may be the boundaries of any other cavity into which the modular gear system may be inserted.

The stabilisers preferably comprise arms which may extend from the modular gear system, from the gear assembly housing and/or may extend from a second or lower portion of the gear assembly as described above. The stabilisers may be extendable and/or retractable into and/or out of the gear assembly housing or contact with the containment structure. The stabilisers ideally comprise stabiliser pads which provide additional grip between the stabilisers and the containment structure. The gear system, the gear assembly housing, and/or a second portion of the gear assembly housing as described above, may comprise a jacking system for extending or retracting the stabilisers.

The input drive optionally comprises an engagement means. The engagement means may be operative to connect the other objects, such as rotating objects for driving the modular gearing system. The engagement means may be operative to connect the input drive to the output drive of a second gear system, and or to the output drive of a second gear system according to the invention.

The output drive may comprise an engagement means which may be operative to connect the output drive to other objects, such as a drill bit, or a milling tool. The engagement means may be operative to connected the output drive to the input drive of a second gear assembly and/or to the input another gearing system, and/or to the input drive of another gear system according to the invention.

In a preferred embodiment the modular gear system may comprise an outer housing which may be rotatable with respect to the input drive and the output drive. The outer housing may be may be connected to a second portion of the gear assembly housing as described above. The outer housing may be tubular and may entirely or partially enclose all of, or a portion of the modular gear system. Bearings, gaps and/or seals may be located between the outer housing and the input drive, the output drive and/or a first portion of the gear assembly housing as described above. In some embodiments, a single outer housing may enclose and/or be connected to a plurality of interconnected modular gear systems according to the invention.

Preferred embodiments of the invention will now be described with reference to the Figures in which:

Brief Description of the Drawings

Figure 1 is an isometric view of one embodiment of a gear system showing internal detail;

Figure 2 is an isometric view of two stacked gear systems within a vertical containment structure, such as a well bore casing;

Figure 3 is a vertical elevation showing three stacked gear systems with stabilisers extended in a vertical containment structure;

Figure 4 is a part sectional view of Figure 3;

Figure 5 is an outer sectional view showing four gear systems;

Figure 6 is an isometric view of a single gear system and shows a hollow shaft with a circulation bore;

Figure 7 is an isometric view of a single gear system and shows three transmission shafts at right angles to a main axis of the gear system;

Figure 8 is an overall schematic of a fishing well construction casing for an upstream fishing operation;

Figure 9 is a diagrammatic view of an example of a drill string or pipe assembly with two single gear systems;

Figure 10 is an isometric view of a single gear system with electrical generators and a pump;

Figure 11 is an isometric view of the gear system in Figure 10 and shows adjustable non-rotatable stabilisers;

Figure 12 is a vertical schematic of an example of a combination fishing and milling tool without its outer tool protection housing;

Figure 13 is an isometric view of the tool in Figure 12 and shows internal components;

Figure 14 is an isometric view of the tool in Figure 12 and shows the internal components from an alternative angle;

Figure 15 is an isometric view of a bottom part of a fishing locking mechanism;

Figure 16 is an isometric view of the fishing locking mechanism in Figure 15 and shows in detail a milling structure;

Figure 17 is an isometric view of a combination fishing and milling tool and shows the fishing locking mechanism.

Figure 18 is an isometric view from above of the fishing locking mechanism shown in Figures 16 and 17;

Figure 19 is an isometric view of the mechanical fishing locking mechanism including the items indicated in Figures 17 and 18;

Figure 20 is an overall schematic view of a drill collar including a drill pipe and a fishing neck engagement profile;

Figure 21 is an isometric view of Figure 20 from above;

Figure 22 is an isometric view of an example of a drill pipe tool joint;

Figure 23 is an isometric view displaying a locked finger mechanism over the drill pipe tool joint shown in Figure 22;

Figure 24 is an isometric view of a drill collar;

Figure 25 is a sectional isometric view of the drill collar, depicting its use in fishing, and shows a male pin end connection;

Figure 26 is a sectional schematic and depicts a casing cutting and window milling operation in a typical upstream oil and gas well construction;

Figure 27 is an isometric, view, showing internal detail, of a casing cutting and window milling assembly without its tool outer protection housing in a well bore casing;

Figure 28 is an isometric view of Figure 27 but from a different angle.

Figure 29 is an isometric view of the casing cutting and window milling assembly and shows internal detail;

Figure 30 is a schematic showing a casing section milling operation in a typical upstream oil and gas well construction;

Figure 31 is an isometric view of an example of a casing section milling assembly;

Figure 32 is a longitudinal cross sectional, isometric view of the casing section milling assembly shown in Figure 31;

Figure 33 is a schematic depicting friction welding in a typical example of an upstream oil and gas well construction casing;

Figure 34 is a longitudinal sectional view of a multi stage friction welding tool assembly inside a containment structure;

Figure 35 is an isometric view of an example of a single stage friction welding assembly;

Figure 36 is an isometric overall view of a vertical or horizontal dual water turbine unit;

Figure 37 is a plan view of three dual water turbine units, of the type shown in Figure 36, connected together for larger current flowing systems;

Figure 38 is an overall diagrammatical plan view of a water current power generation system;

Figure 39 is a schematic side elevation of Figure 38;

Figure 40 is an isometric view of the water current power generation system shown in Figures 38 and 39 where the water current power generation system is deployed as a water pumping system;

Figure 41 is a schematic side elevation of a wind generation system which includes the gear system shown in Figure 1;

Figure 42 is a schematic side elevation of a vertical wind powered water and a pump well accessing water from a subsurface aquifer or reservoir;

Figure 43A is schematic side elevation view of a ship, boat or yacht with a marine engine which includes the system shown in Figure 1;

Figure 43B is a schematic side elevation view of a ship, boat or yacht with a wind powered drive connected via the system shown in Figure 1, to a propeller;

Figure 44 is a vertical isometric view of a screw driver or drill includes the system shown in Figure 1;

Figure 45 is a vertical isometric view of a hand powered drill includes the system shown in Figure 1;

Figure 46 is a horizontal isometric view of an industrial power mixing system includes the system shown in Figure 1;

Figure 47 is a horizontal isometric view of a rotary handled power drill includes the system shown in Figure 1;

Figure 48 is a schematic of a well bore oil production pumping well for pumping heavy oil and comprising perforated sections and pumping units which include the system shown in Figure 1;

Figure 49 is an isometric view of a lower stage of the oil production pumping system shown in Figure 48;

Figures 50A and 50B show isometric views of an electrical double or single flush mounted socket profile drill, for cutting square or rectangular shaped profiles;

Figure 51 is an isometric view of a domestic or industrial air or liquid vacuum appliance which includes the gear system shown in Figure 1; and

Figure 52 is an overall block diagram for a stabilised gearing energy system with a programmable control system.

Detailed Description of Preferred Embodiments of the Invention

Figure 1 is an isometric partially cut away view of an embodiment of a single stage gear system comprising an upper assembly **114**, a lower assembly **115**, and a shaft **99**. A tool connector **86** is located at the lower end of the single stage gear system (in some embodiments a tool connector **86** may additionally, or alternatively be located at the upper end of the single stage gear system, as shown in Figure 6).

The single stage gear system also comprises a planetary gear set which is housed within the upper assembly **114** and which connects the upper assembly **114** to the shaft **99**, such that when the upper assembly **114** is rotated, the shaft **99** is rotated at a greater angular velocity. The lower assembly **115** comprises a plurality of extending or extendable stabilisers, and may comprise a power system and/or may comprise a control means.

The lower tool connector **86** is a male screw thread connector, and may have either a left or right handed thread. In use the lower tool connector may be used to connect the single stage gear system to a tool or device to be rotated by the single stage gear system, or to another single stage gear system so as to form a multiple stage gear system **111**. An upper tool connector **86** may connect the single stage gear system to another device (such as another single stage gear system, or an input rotational power source **8**) which rotates the upper tool connector thereby driving the single stage gear system.

An input rotational power source **8** may be connected to the upper end of the single stage gear system and/or to the upper assembly **114**, by an upper tool connector **86**, or otherwise. The input rotational power source **8** may create clockwise or anti-clockwise rotation, and may be, or may comprise a mechanical, electrical alternating current or direct current motor, hydraulic motor or pneumatic motor or any other source of power rotation.

In use, the single stage gear system (or multiple stage gear system **111**) may be arranged inside a containment structure **113** (as shown in Figures 2 to 7), such that the containment structure **113** surrounds the gear system. The containment structure provides a surface against which the stabiliser pads **63** of the stabilisers may be extended so as to fix the gear system in place and prevent rotation of the lower assembly **115**.

The lower assembly **115** comprises three or more stabiliser arms, which in use may extend or be extended from the lower assembly **115** such that their stabiliser pads **63** abut, and exert a force upon the inner surface of the containment structure **113**, thereby stabilising the lower assembly and preventing it from rotating with respect to the containment structure **113**.

The upper assembly **114** and the lower assembly **115** are separated by an assembly isolating bearing **121** which allows the upper assembly **114** to rotate freely with respect to the lower assembly **115**.

The containment structure **113** may be a casing, pipe or tubing; and may be made of any material with sufficient strength to resist the extension force of the stabiliser arms, thereby providing purchase for the stabiliser pads **63**, for example steel, stainless steel, concrete, plastic, or wood.

The single stage gear system has a low-speed end **222** and a high-speed end **223**. The low-speed **222** end is comprised by the upper assembly **114** (and optionally by an upper tool connector **86**). In use this low speed end may be connected to a device which drives the rotation of the single stage gear system (for example, an input rotational power source **8**, or the high-speed end **223**, or lower tool connector **86** of another single stage gear system). In use the single stage gear system is typically arranged such that the low speed end **222** is at the top of the single stage gear system, above the high-speed end **223**. In other embodiments the high speed end **223** may be driven and/or rotated, so as to rotate the low-speed end **222**, for example the input rotational power source **8** may be connected to and may drive the high speed end **223**.

The high-speed end **223** is comprised by the shaft **99** (and optionally by a tool connector **86** connected thereto). In use the high-speed end **223** is connected to a device to be rotated by the single stage gear system (for example a tool, or the low-speed **222** and/or upper tool connector **86** of another single stage gear system). In use the single stage gear system is typically arranged such that the high-speed end **223** is at the bottom of the single stage gear system, below the low-speed end **222**.

The upper assembly **114** comprises a circulation chamber housing **57**, a circulation chamber **109** defined by the circulation chamber housing **57**, and a planetary gear mechanism housing **96**. The circulation chamber **109** and the circulation chamber housing **57** are arranged above the planetary gear mechanism, at the low speed end **222** of the single stage gear system, and may be connected to an upper tool connector **86** (as shown in figure 6). The circulation chamber **109** and the circulation chamber housing **57** are both substantially cylindrical. The planetary gear mechanism housing **96** comprises a substantially cylindrical portion with a greater radius than that of the circulation chamber housing **57**. In the illustrated embodiment, the circulation chamber housing **57** and the cylindrical portion of the planetary gear mechanism housing **109** are connected by a conical frustum shaped portion of the planetary gear mechanism housing **109**, although they may be connected by other means. The planetary gear mechanism housing **96** has an open lower end and surrounds a planetary gear set which is comprised by the single stage gear system and which transmits rotation from the upper assembly **114** to the shaft **99**.

The lower assembly **115** comprises the stabilisers, a stabiliser base plate **122**, a planetary gear set lower carrier plate **200** and a stabiliser housing **72**. The stabiliser base plate **122** and the planetary gear lower carrier plate **200** are both circular and are connected to the stabiliser housing **72**. The stabiliser housing **72** is a cylindrical casing which extends between the stabiliser base plate and the upper assembly **114** (the lower portion of the stabiliser housing **72** is shown entirely cut away in Figures 1, 2, 3, 6, 7, 9, 13, 14, 27, 28, 29, 31, 32, 34, and 35 so as to allow the internal components of the stabiliser housing may be seen, a full exterior view of the stabiliser housing **72** may be seen in Figure 12, and partially cut away views of the full length of the stabiliser housing **72** wall may be seen in Figures 10 and 11).

The assembly isolating bearing **121** is arranged between the upper assembly **114** and the lower assembly **115**, between the planetary gear mechanism housing **96** and the stabiliser housing **72**. The assembly isolating bearing **121** therefore allows the upper assembly **114** to rotate with respect to the lower assembly **115**.

When the stabilisers are extended from the lower assembly **115** – such that the stabiliser pads **63** are forced against the inner surface of the containment structure **113** – and the upper assembly **115** is rotated – for example by rotating the low speed end **222** and/or an upper tool connector **86** – the assembly isolating bearing **121** prevents lower assembly **115** from being forced to rotate with the upper assembly **114** and the lower assembly do not rotate.

A planetary gear set which comprises a ring gear **127**, a sun gear **124**, and a plurality of inner and outer planet gears **125** is located inside the planetary gear set housing **96**. The ring gear **127** fixed to the inner surface of the planetary gear set housing **96**, and rotate when the upper assembly **114** is rotated. The rotation of the ring gear **127** causes the planet gears **125** and the sun gear **124** to rotate. The sun gear **124** rotates with a greater angular velocity than the ring gear **127** and the upper assembly **114**.

When the three or more stabilisers are not extended, they are housed within the stabiliser bladed sealed inner housing **72**. When the upper assembly **127** is rotated while the stabilisers are not extended (or while the stabilisers are extended but the stabiliser pads **63** are not forced against the interior of a containment structure **113**) the lower assembly **115** also rotates, in the same direction as the upper assembly **114**.

The planetary gear mechanism housing **96** of the upper assembly **114** contains a planetary gear set upper carrier plate **198**. The planetary gear set upper carrier plate **198** is isolated from the rotation of the shaft **99** by a shaft bearing **102** and from rotation of the planetary gear mechanism housing by a gap, or optionally by a bearing.

The lower assembly **115** comprises the planetary gear set lower carrier plate **200**, the stabiliser base plate **122** and the stabiliser housing **72** into which the stabilisers are retractable. These components are all isolated from rotation of the upper assembly **114** by the assembly isolating bearing **121**.

The planetary gear set lower carrier plate **200** and the stabiliser base plate **122**, are each isolated from the shaft **99** by shaft bearings **102**.

The shaft **99** extends between the circulation chamber **57** and the lower tool connector **86** at the high-speed end, passing through the upper and lower assemblies **114**, **115**. The shaft **99** is isolated from rotation of the circulation chamber **57**, the planetary gear set upper carrier plate **198**, and the planetary gear set lower carrier plate **200**, and the stabiliser base plate **122** by shaft bearings **102**. The shaft **99** is rigidly connected to the sun gear **124** of the planetary gear set, and to the lower tool connector **86**. Therefore, when the ring gear **127** is rotated, the shaft **99**, lower tool connector **86** and high speed end **223** are rotated.

A circulation bore **105** extends through the length of the single stage gear system. The circulation bore **105** forms a tubular passageway along the central axis of rotation of the single stage gear system. The circulation bore **105** is formed through the centre of any upper tool connector **86**, through the centre of the wall of the circulation chamber housing **57** at the low speed end **222**, and through the length of the shaft **99**, thereby forming a tubular passage from the circulation chamber **109** to the high-speed end **223** and the lower tool connector **86**.

The circulation chamber housing **57** – which is connected to the planetary gear mechanism housing **96** – is isolated from the top **66** of the shaft **99** by a shaft bearing **102**. This shaft bearing **102** is sealed to prevent fluid escaping from the circulation chamber to the interior of the planetary gear mechanism housing **96** when liquid passes through the circulation bore **105**.

One or more single stage gear systems as shown in Figure 1 may be connected in series, high-speed end **223** to low-speed end **222**, thereby forming a multiple stage gear system **111** as shown in Figures 2 to 5. Each individual single stage gear system having its own shaft **99**, and each single stage multiplying the output rotational speed of the lower end of the combined system.

In some embodiments, a single stage gear system may have no circulation bore **105**, and/or the shaft **99** may be hollow, solid, round or any other shape.

When the shaft **99** is hollow, or has a circulation bore **105** formed therethrough, fluids may be circulated through the shaft in use. This may be used for circulating fluids for flushing debris, such as for the removal of cuttings in upstream oil and gas subsurface fishing, casing cutting, window milling and section milling operations (as shown in Figures 8 to 32). Alternatively, or additionally, the system may be used in the subsurface oil and gas production industry for circulating steam (as shown in Figure 48).

Fluids may also be circulated through the circulation bore **105** and/or hollow shaft **99** for cooling purposes. Examples of areas where cooling would be beneficial are welding, grinding and milling, mixing or any application with high speed rotation. The use of cooling will be further explained with reference to Figures 43A and 43B.

When the shaft **99** is solid, it may be used as a rotational support shaft for external tool accessories as explained in Figure 44, Figure 45, Figure 46, Figure 47 and Figure 50.

Obtaining variable output rotation speeds requires the lower assembly **115** to not rotate. This is achieved by extending the three or more stabilisers, such that the stabiliser pads **63** about the inner surface of the containment structure **113** and exert sufficient force to prevent the lower assembly **115** from rotating.

A stabiliser jacking mechanism **67** may be used to extend the stabilisers from their retracted position. The stabiliser jacking mechanism may optionally comprise a spring retainer. The optional spring retainer of the stabiliser jacking mechanism **67** is not indicated and can be used as a back-up mechanism to return the blades to the closed position in the event of a failure of the jacking power system. The use of a jacking mechanism **67** allows the stabiliser arms to have a variable length dependent on the size of the containment structure **113** and the application of the gear system.

In other embodiments, suitable for other applications, the stabiliser arms may have a fixed arm length without a jacking mechanism **67** if suitable (as shown in Figures 35 to 49).

The shape, and/or design of the stabiliser pads **63** of the three or more stabilisers may be dependent upon the application for which the gear system is to be used, and/or upon the containment structure **113**. For example, the stabiliser pads **63** may be designed to match the curvature of the internal diameter of the containment structure **113**.

In Figures 1 to 13, and 27 to 35, the three or more stabiliser pad blades **63** have a grooved profile, however any suitable shaped profile may be used.

The stabiliser **63** arms may have length. In some embodiments, designed for applications where downward movement of the gear system is not required, the stabiliser arms may be orientated downwards, with ends of the arms connected to the stabiliser pads **63** lower than the ends connected to the remainder of the lower assembly **115**. In such a configuration the weight of the gear system may result in extra force being exerted against the inner surface of the containment structure **113**.

The three or more stabilisers each comprise a pair of stabiliser pads **63** and a stabiliser wheel **62**.

The stabiliser wheel **62** is located at the end of the stabiliser arm between the pair of stabiliser pads **63**. The stabiliser wheel **62** may have be solid, may be soft, may have any texture and/or may be made of any material. In some embodiments the stabiliser may not comprise a stabiliser wheel **62**, for example, the power ratchet screw driver or drill **255** shown in Figure 44, or hand powered drill **261** shown in Figure 45.

The lower assembly **115** may comprise a power system which may provide power to operate the stabiliser jacking mechanism **67**. The power system **129** may be hydraulic, electrical, and/or pneumatic; may be supported by, and/or affixed to the stabiliser base plate **122**; and/or may be contained within the stabiliser housing **72**.

One or more of the stabiliser may comprise a stabiliser antennae **68** for wireless data communications.

The gear system may be used in vertical inclinations, horizontal inclinations, or in any other inclination. It should be understood that references to top, bottom, upper and lower throughout the detailed description are with reference to a gear system in a vertical inclination with the low-speed end **222** at the top of the gear system, and the high-speed end **223** at the bottom of the gear system, but are not intended to preclude the possibility of the gear system being reoriented or utilised in any other orientation.

The planetary gear set lower carrier plate **200** and the stabiliser housing **72** are isolated from the upper assembly **114** by the assembly isolating bearing **121**, and from the shaft **99** by a shaft bearing **102**. The assembly isolating bearing **121** and the shaft bearing **102** may be in a vertical plane, a horizontal plane, or in any other plane.

When the three or more stabilisers are extended, such that their pads **63** are forced against the inner surface of the containment structure **113**, clockwise rotation of the upper assembly **114** rotates the ring gear **127** in a clockwise direction. This causes the outer planetary gears **125** to rotate in a clockwise direction, the inner planetary gears **125** to rotate in an anti-clockwise direction and the sun gear **124** and the shaft **99** to rotate in a clockwise direction with a greater angular velocity than that of the ring gear **127**.

The outer planet gears **125** are supported on outer planet gear shafts **194** and the inner planet gears are supported on inner planet gear shafts **197**. The inner and outer planet gear shafts **197**, **194** are isolated from the planetary gear set upper carrier plate **198** and the planetary gear set lower carrier plate **200** by planet gear shaft bearings **227**.

The planetary gear set is arranged such that one rotation of the ring gear **127** rotates the sun gear **124** and the shaft **99** significantly more than one rotation. The sun gear **124** is weld connected, or otherwise fixed to the shaft **99**. Therefore, rotation at various angular velocities of the upper assembly **114** at the low-speed end **222** produces rotations at various greater angular velocities of the shaft **99** at the high-speed end **223**. The shaft **99** is therefore rotated by the sun gear **124**, as it is isolated from other components of the upper and lower assemblies **114**, **115** by shaft bearings **102**.

A cross section of the planetary gear set is shown in detail in Figure 11. An even number of planet gears **125** in a gear train between the ring gear **127** and the sun gear **124** converts clockwise rotation of the ring gear **127** to clockwise rotation of the sun gear **124** and the shaft **99**, and converts anti-clockwise rotation of the ring gear **127** to anti-clockwise rotation of the sun gear **124** and the shaft **99**.

A single planet gear **125**, or a gear train with an odd number of planet gears **125** between the ring gear **127** and the sun gear **125** converts clockwise rotation of the ring gear **127** to anti-clockwise rotation of the sun gear **124** and the shaft **99** and converts anti-clockwise rotation of the ring gear **127** to clockwise rotation of the sun gear **124** and the shaft **99**.

Multiple single stage gear systems may be combined in series, thereby forming a multiple stage gear system **111** and may be used for certain applications. In some embodiments, a single stage gear system or a multiple stage gear system may be configured to reverse the direction of rotation between the upper most low-speed end **222** and the lower most high-speed end **223**, or to have the same direction of rotation, depending on whether the desired output rotation at the base of the gear system is clockwise or anti-clockwise.

In some embodiments, a single stage gear system as described above, or a tool comprising a single stage gear system as described above may comprise an outer housing **84** (as shown in Figures 13 and 14). The outer housing **84** may be substantially cylindrical and may surround or enclose all or part of the upper assembly **114**, the lower assembly **115**, and/or a tool connected to the high-speed end **223** of the gear system. The outer housing **84** may be welded, or otherwise rigidly connected to the stabiliser housing **72**. An outer housing bearing **138** may separate the outer housing **84** from the circulation chamber housing **57** of the upper assembly **114**. If the outer housing **84** surrounds the lower assembly **115**, it may have apertures through which the stabilisers may be extended. The outer housing **84** may be an outer tool housing.

Figures 13 and 14 show views of a tool comprising a single stage gear system with an upper tool connection **86** at its low-speed end **222** and a fishing and milling assembly **116** attached to its high-speed end **223**. A cylindrical outer housing **84** surrounds the tool between the circulation chamber housing **57** and the lower end of the fishing and milling assembly **116**. The outer housing **84** is open at its lower end – so as to allow access to the fishing and milling assembly **116** – and surrounds the circulation chamber housing **57** at its upper end. A sealed outer housing bearing **138** is located between the outer housing **84** and the circulation chamber housing **57**, and the outer housing **84** is fixed to the stabiliser housing **72**, such that the outer housing **84** rotates with the lower assembly **115** and not the upper assembly **114**.

The internal diameter of the outer housing **84** is required to be greater than the diameter of exterior of the planetary gear mechanism housing **96**. The outer housing bearing **138** separates the rotation of the planetary gear mechanism housing **96** from that of the outer housing **84**.

The components comprising the gear system, and its constituent parts such as the upper and lower assemblies **114**, **115** may be manufactured using materials suitable for the application and environmental conditions for which the gear system is intended; and to strengths that are selected as suitable for the application and the environmental conditions for which the gear system is intended.

Figure 2 is an isometric view of a multiple stage gear system **111** comprising two single stage gear systems connected in series. The multiple stage gear system **111** is contained within a tubular vertical containment structure **113** which is shown partially cut away.

The lower assembly **115** comprises a hydraulic, electrical and pneumatic power system **129** which is attached to the stabiliser base plate **122** and components of which are located above and below the stabiliser base plate **122**. The power system **129** powers the stabiliser jacking mechanism **67**.

In alternative embodiments of single and multiple stage gear systems, the stabilisers may be permanently extended and unretractable, the stabiliser arms may have a fixed length and the arms and/or the stabiliser pads **63** fixed to the interior of the containment structure **113** (for example they may be screwed into or welded to the containment structure **113**); or may pass through or interlock with the containment structure **113**.

The angular velocity of a rotating high-speed end **223** of a single stage gear system driven by a source of rotation at the low-speed end **222** of the single stage gear system may be increased by inserting one or more additional single stage gear systems between the source of rotation and the low speed end **222** so as to form a multiple stage gear system **111**. This significantly

increases the angular velocity of the high-speed end **223** of the lower most single stage gear system relative to the angular velocity of the source of rotation and the low-speed end of the uppermost single stage gear system. Note that the shafts **99** of each single stage of the multiple stage gear system **111** are not directly connected to each other, instead rotation is transmitted via the upper assemblies **114** and the planetary gear sets which separate the shafts **99**.

The connections between the single stage gear systems is made between the high-speed end **223** of an upper single stage gear system and the low-speed end **222** of a lower single stage gear system. The single stage gear systems are connected by an upper tool connector or engagement means **86** and a lower tool connector or engagement means **86**. The tool joint connections **86** may have either a right handed or left-handed thread.

As indicated if a single stage gear system comprises a single, or any odd number of planet gears **125** in the individual gear trains connecting the ring gear **127** to the sun gear **124** and multiple such single stage gear systems are connected in series, clockwise rotation of the low-speed end **222** of the first single stage gear system results in anti-clockwise rotation of the shaft **99** of the first gear system and of the low-speed end **222** of the second single stage gear system, thereby resulting in clockwise rotation of the shaft **99** at the high speed end **223** of the second single stage gear system. In this case the tool connection **68** at the connection **123** between the first and second stage may require being a left handed thread, right handed thread or any other type of connection. The tool connection **68** may be a male connector, or a female connector.

Figure 3 shows a multiple stage gear system **111** for the creation of variable high speed rotation comprising a plurality of single stage gear systems connected in series and housed within an outer housing **84**. The multiple stage gear system **111** is located within a vertical containment structure **113** which is partially cut away in the Figure.

The illustrated vertical containment structure **113** has a constant internal diameter, but in some embodiments, the internal diameter of the containment structure may vary, for example the containment structure may be tapered from its upper end to its lower end. The dimensions of the single stage gear systems may also be varied according to the required application of the embodiment.

Although the multiple stage gear system **111** is shown in a vertical orientation, it may be arranged horizontally or at any other inclination required for the application of the embodiment.

The outer housing **84** may be separated from each single stage gear system's circulation chamber housing **57** by a sealed outer housing bearing **138** and may be connected by welding or otherwise to the stabiliser housing **72** of each single stage gear system.

The assembly isolating bearing **121** of a single stage gear system prevents the stabiliser housing **72** being forced to rotate when the upper assembly **114** rotated if the three or more stabilisers are extended such that their stabiliser pads **63** press against the inner surface of the containment structure **113**.

The input rotation of each single stage gear system (the rotation of the low-speed end **222** of the gear system) is greater for each subsequent stage from the source of rotation. One rotation of the low-speed end **222** of the uppermost single stage gear system causes many rotations of the shaft **99** at the high speed end **223** of the lowermost single stage gear system.

Figure 4 is a sectional view of the multiple stage gear system **111** shown in Figure 3.

The top **66** of the shaft **99** is isolated from the upper assembly **114** by a sealed shaft bearing **102** located inside the circulation chamber **109**. The shaft **99** is directly connected to the internal diameter of the sun gear **124** such that when the sun gear is rotated by rotation of the upper

assembly **114**, the shaft **99** rotates and this allows the speed of rotation of each subsequent single stage gear system to be increased.

The top **66** of the illustrated shaft **99** comprises a lip which extends radially from the top of the shaft **99** over the top of the shaft bearing **102**.

In the embodiment shown in Figure 4, the stabilisers may be extended utilising the stabiliser jacking mechanism **67** such that the stabiliser pads **63** and the stabiliser wheel **62** are located against the inside surface of the containment structure **113**.

The planetary gear set ring gear **127** is attached to or formed on the inside surface of the planetary gear mechanism housing and extends between the upper planetary gear set carrier plate **198** and lower planetary gear set carrier plate **200**.

The connection **123** may be made using either right handed or left handed threaded tool connectors **86** depending on the embodiment and the intended application of the system. For example, if a single stage gear system comprises a single or any odd number of planet gears **125** in the gear trains connecting the ring gear **127** and the sun gear **124** and multiple such single stage gear systems are connected in series, clockwise rotation of the low-speed end **222** of the first (uppermost) single stage gear system results in anti-clockwise rotation of the shaft **99** as the high-speed end **223**. This anti-clockwise rotation is applied to the low-speed end **222** of the second single stage gear system resulting in clockwise rotation of the shaft **99** of the second single stage gear system. In such an embodiment the connection **123** between the first and second stage would be required to be made by left handed threaded tool connectors **86**.

Figure 5 is a side view of a multiple stage stabilised gear system **111** comprising four single stage gear systems connected in series and located within a vertical containment structure **113** which has been cut away in the Figure except in the portions where the stabilisers are extended. The optional outer housing **84** is not included in this embodiment.

Any number of single stage gear systems may be connected in series so as to define a multiple stage gear system **111**. The stages may be located within a containment structure **113** and each single stage gear system may be connected by male or female tool joint connections **86**. Such an arrangement allows an input variable rotation speed at the low-speed end **222** of the uppermost single stage gear system to be increased to a higher variable rotation speed at the high-speed end **223** of the lowermost single stage gear system.

The containment structure **113** may be vertical, horizontal or at any other angle or inclination.

The position of the hydraulic, electrical and pneumatic power system **129** is displayed and will be further described with reference to Figure 6.

Figure 6 is an isometric view of a single stage gear system located in a containment structure **113** with its stabilisers extended by the stabiliser jacking mechanism **67**. The containment structure **113** is shown partially cut away, except in the portion where the stabilisers are extended. The optional outer housing **84** is not included in this embodiment.

The upper assembly **114** comprises an upper male or female tool connector **86** connected to the circulation chamber housing **57**. When the upper tool connector **86** is rotated so is the entire upper assembly including the circulation chamber housing **57**, the planetary gear mechanism housing **96**, and the ring gear **127**. The lower assembly **115** is isolated from this rotation by the assembly isolating bearing **121**.

Components of the hydraulic, electrical and pneumatic power system **129** are positioned above and below the stabiliser base plate **122** comprised by the lower assembly **115**. The power system **129** provides power to operate the stabiliser jacking mechanism **67**. In some embodiments there is no power system **129** and the stabilisers have fixed arm lengths which

are not extendable, the stabilisers may for example, be welded onto, screwed into, or otherwise connected to the containment structure **113**.

The shaft **99** is isolated from the stabiliser base plate **122** by a sealed shaft bearing **102**. In some embodiments, the circulation bore **105** may pass through the upper and lower tool connectors **86** thereby forming a complete passage connecting the two ends of the single stage gear system. The circulation bore may also run along the centre of the shaft **99**.

Figure 7 is an isometric view of a single stage gear system without the optional outer housing **84** and comprising three rotation transmitting shafts **126** which extend at right angles to the axis of shaft **99** and exit the a containment structure **113**. The Figure shows the containment structure as partially cut away.

The outer planet gear shafts **194** are connected to gearing mechanisms **196** which are located below the stabiliser base plate **122**. The gearing mechanisms **196** convert rotation about the axes of the outer planet gear shafts **194** to rotation about the axes of the transmission shafts **126**, and rotates the rotation transmitting shafts **126**, thereby transmitting rotation from the upper assembly **114** to the exterior of the containment structure **113**. The rotation transmitting shafts **126** may be at right angles to the outer planet gear shafts **194**

In the embodiment shown in Figure 7, the single stage gearing mechanism and the containment structure **113** are arranged vertically with the shaft **99**, the circulation bore **105**, and the outer planetary gear shafts **194** being vertical. The rotation transmitting shafts **126** are all within the horizontal plane at approximately 40 degrees to each other.

This embodiment may be used when a multiple stage gear system **111** is installed in a containment structure **113** and where different rotational output speeds are required at different lengths along the length of the containment structure **113**.

Figure 43 shows an engine powered propeller **189** and a wind powered propeller **189**, both of which comprise a multiple stage gear system **111** which may comprise single stages as described in Figure 7. Rotation transmitting shafts may be used to transmit rotation to other devices, such as a bilge pumping system which may require a different rotational speed to the propeller. In this embodiment, the multiple stage gear system may comprise a circulation bore **105** which be utilised for cooling the gear system.

In some embodiments, the single stage gear systems comprise hydraulic, electrical and pneumatic power systems **129** positioned below the stabiliser base plates **122** which provide power to operate the stabiliser jacking mechanisms **67**. Some embodiments may not comprise a power system **129** as it may not be required. For example, in embodiments where a fixed stabiliser arm length is used, and/or where the stabiliser arms or stabiliser pads **63** are attached to the internal surface of the containment structure **113**, for example, by welding or screwing.

Single stage gear systems, and/or multiple stage gear systems **111** may be used in a plurality of industrial applications.

Figures 8 to 32 show embodiments of gear systems, tools which comprise gear systems for use in the upstream oil and gas industry, and component parts of or for said tools.

Figures 12 to 14 show views of a multi-purpose fishing and milling tool **17**. The fishing and milling tool **17** comprises a single stage gear system as described above, this allows components of the tool mechanism to be rotated faster than a source of rotational power which drives the tool (such as a top drive unit or a rotating drill string component). In alternative embodiments the fishing and milling tool **17** may comprise multiple single stage gear systems which may be connected end to end so as to further increase the rotation speed.

The single stage gear system comprised by the fishing and milling tool **17** comprises stabilisers which allow the fishing and milling tool **17** to be stabilised within a containment structure **113**. The fishing and milling tool **17** may be used for multiple functions and tasks, including, but not limited to fishing and milling, thereby providing a combination fishing milling stabilised drilling tool. In some embodiments, the fishing and milling tool **17** may be automated.

A single stage gear system comprising fishing and milling tool **17** may be combined with additional single stage gear systems so as to allow further increases in the rotational speed of a tool component without increasing the speed of the source of rotational power. Alternative embodiments of fishing and milling tools, and other drilling tools, may comprise multiple stage gear systems so as to produce high speed rotation of tool components.

The use of a single or multiple stage gear system as described above to produce variable high speed rotation of tool components may improve the efficiency of operations such as fishing with milling and washover, casing cutting, window milling and casing section milling operations in the upstream oil and gas industry.

The high-speed rotation produced by the multiple stage gear system **111** in a fishing and milling tool **17** is dependent upon the number of single stage gear systems installed into the tool.

The use of a fishing and milling tool **17** comprising a gear system as described above is expected to improve the time taken by, and thereby the success rate of fishing operations in the upstream oil and gas industry.

The use of a single or multiple stage gear system as described above allows jarring to be performed in both a downwards and an upwards direction when a fishing neck **10** comprised by the fish **117** is engaged by the fishing and milling tool **17**. Conventional fishing assemblies are only able to jar in an upwards direction as the method to release the fishing overshot involves bumping downwards on the tool.

The fishing and milling tool **17** allows right hand torque to be applied and the fishing and milling tool **17** to be jarred downwards which is a recognised industry method for freeing stuck pipe if the sticking occurs while pulling out.

The fishing and milling tool **17** may be used in situations where the top hole subsurface formations are too soft to drill and washout easily. These situations may present operational problems, especially in deep water well construction when running the initial conductor pipe, and in other situations where casing jetting and drilling is considered. The fishing and milling tool **17** may be modified for use in these situations. The fishing and milling tool **17** can be modified to be run with a conductor pipe or a casing in order to perform jetting, and/or jetting and drilling to place the conductor pipe or the casing shoe of the casing in a consolidated formation. A combined jetting and drilling operation can be performed using the fishing and milling tool **17**.

Figures 27 to 29 show views of a casing cutting and window milling assembly **119** and figures 31 and 32 show views of a casing section milling assembly **118**. These assemblies each comprise a single stage gear system as described above. These assemblies may be utilised when an oil or gas well has been abandoned over the reservoir section and a decision has been taken to side-track the well utilising the same well surface casing strings. This can be achieved in one of two ways, dependent on the side-track section length and depth. A window can be milled in the casing, or the casing can be cut above the top of cement, the casing may then be retrieved and the casing section milled in order to provide a sufficient clearance below the preceding casing shoe.

Figures 26 to 32 illustrate the use of the casing cutting and window milling assembly **119** and the casing section milling assembly **118** to perform these operations.

The process of milling a window and a section of casing may be time consuming process involving multiple separate runs to achieve the objectives. The casing cutting and window milling assembly **119** may reduce the time taken and the costs involved in casing milling and casing cutting in the upstream oil and gas industry. The use of the single stage gearing mechanism gives the casing cutting and window milling assembly a high speed rotation capability which may increase the milling rate. The increased rotation speed may also allow for lighter assemblies to be run as lower weights may be used for milling. With high speed milling, smaller steel cuttings are expected to be produced allowing for quicker and easier wellbore clean-ups.

Figures 33 to 35 illustrate a use of the single stage gear system to perform single stage friction welding **174** or multiple stage friction welding **175**.

Further applications of the single stage gear system are displayed in figures 36 to 51. These applications relate to the renewable power generation industry, the construction industry and the oil and gas production industry. They include a well bore and pipeline oil production pumping system.

Figure 8 is a sectional view of a well construction for a fishing operation **1** in the upstream oil and gas industry. Fishing is the removal of fish from a wellbore, a fish is anything left in a wellbore, and it may be debris, junk metal, a tool or a component for construction of a wellbore. Fish may be retrieved from a wellbore in order to recover valuable equipment, or to remove an obstruction from the wellbore. In the illustrated embodiment the fish **117** comprises drilling components that have been left in the open hole section **21** (the uncased portion) of the wellbore, for example due to a mechanical failure.

The illustrated fish **117** comprises a drill bit **6**, a near bit stabiliser **3**, drill collars **9** (spiral or flat profile), and a string stabiliser **7**. The upper end **11** of the fish **117** has a fishing neck **10**. A fishing neck is the point or surface with which a fishing tool engages in order to retrieve a fish, tools and equipment may comprise fishing necks so as to facilitate their retrieval from a wellbore in the event that a fishing operation is required to retrieve them.

The design of the fishing neck **10** may be conventional or may be a new design of fishing neck engagement profile **69** which is further detailed in Figures 20 and 21.

The well construction for the fishing operation **1** comprises a multi-purpose fishing and milling tool **17** as shown in detail in figures 12 to 14, which may be used for both fishing and milling. The fishing and milling tool **17** is capable of fishing for both conventional fishing neck profiles (as shown in Figures 22 to 25), and for the new fishing neck engagement profile **69** shown in Figures 20 and 21.

The fishing and milling tool **17** is the first oil and gas industry tool which can perform either wash-over, milling, fishing or a combination of these operations during a single trip inside a well bore. The fishing and milling tool **17** comprises a single stage gear system.

The multi-purpose fishing and milling tool **17** may be run down the well bore on drill pipe **43**, a heavy weight drill pipe **5** and a fishing bottom hole assembly **19** to above the upper end **11** of the fish **117** in preparation to recover the fish **117**.

The multi-purpose fishing and milling tool **17** indicated comprises a single stage gear system. Additional stages may also be used in order to increase the speed of the rotation of the drilling tool **17** with respect to the speed of rotation of the drill pipe **43**, heavy-weight drill pipe **5** and the fishing bottom hole assembly **19**.

The lower assembly **115** of the single stage gear system comprises three or more stabilisers which may be extended such that their stabiliser pads **63** are pressed against the walls of the open hole section **21**.

The tool mechanism of the fishing and milling tool **17** driven by the single stage gear system comprises a lower fishing and milling tool shaft **77** and three or more fishing fingers **53**.

The single stage gear system comprised by the multi-purpose drilling tool **17** provides variable high speed subsurface rotation with a greater angular velocity than, and dependent upon the angular velocity of the surface input rotational power source **8** which is located at the upper end **45** of the drill pipe **43** on the rig floor **39**.

The well construction for the fishing operation **1** comprises a circulation bore **105** which passes through the upper end **45** of drill pipe **45**, through the length of the drill pipe **43**, through the length of the heavy weight drill pipe **5**, through the fishing bottom hole assembly **19**, through the single stage gear system comprised by the fishing and milling tool **17**, through an internal cavity of a ball housing cylinder **97**, through a shaft end ball **101**, through the upper fishing and milling and tool shaft **88**, through the fishing and milling tool shaft mechanism **65**, through the lower fishing and milling tool shaft **77** and through the jetting nozzle **75** (as shown in Figures 17 and 19).

The well construction for a fishing operation **1** comprises a pump pressure gauge **49** which indicates the pumping pressure through the circulation bore **105**. The pump pressure gauge **49** may be either digital or analogue. The pump pressure may be utilised to aid with tool functions which will be explained in more detail when describing the functions of the fishing and milling tool **17**. The well construction **1** further comprises a drill string weight indicator **47** which may be used to monitor the up and down weight of the drill string in order to aid the functions of the fishing and milling tool **17**.

The well shown in Figure 8 may comprise blowout preventer equipment and a wellhead **37**, which may be located on the seabed, on a mobile drilling rig substructure or on the cellar base **41** of a land based drilling rig as shown in Figure 8. The casing of the well may comprise multiple casing intervals including: surface conductor casing **35**, surface casing **31**, intermediate casing **27** and production casing **23**. The casing intervals may all be cemented in place **33**.

Figure 9 shows an example of a drill string – or pipe assembly – which comprises two single stage gear systems as described above. The outer housings **84** comprised by the two single stage gear systems are not shown. The drill string is located within a production casing **23**.

In use, the high-speed end **223** of the drill string illustrated in Figure 9 rotates with a greater angular velocity than the low speed end of the drill string. Rotation is transferred from the upper assembly **114** of a first uppermost single stage gear system, to the shaft **99** of the first single stage gear system, to a heavy weight drill pipe **5**, to the upper assembly of a second lower single stage gear system, to the shaft **99** of the second single stage gear system, to a drill bit **6**. The lower assemblies **115** of the first and second single stage gear systems have stabilisers which are extended against the interior of a production casing **23** within which the drill string is located, thereby stabilising the drill string and fixing its location within the production casing **23**.

The heavy weight drill pipe **5** comprises tool connectors **42** at each end which connect to a lower tool connector **86** of the first single stage gear system and an upper tool connector **86** of the second single stage gear system.

Additional single stage gear systems may be used if the application of the drill string and/or the speed or desired speed or rotation of the drill bit **6** requires it. The one or more additional single stage gear system(s) may be connected directly to one of the two single stage gear systems – for example between two tool connectors comprised by the two single stage gear systems – or may be connected by one or more additional intermediate heavy weight drill strings **5**, or other drill strings.

By increasing the number of gear system stages, the angular velocity of the rotation of the drill bit **6** may be increased to many times the rotation of the low-speed end **222** of the drill string created by the input rotational power source **8** which may be connected to the top of the upper assembly **114** of the first single stage gear system.

The drill string shown in Figure 9 comprises a fluid path through its length connecting the upper end of the uppermost single stage gear system to the drill bit **6**. The fluid path comprising circulation bores **105** through each of the single stage gear systems, through the heavy weight drill pipe **5** and through the drill bit **6**. The drilling fluid circulation path is through the circulation bores **105**, out through the drill bit **6**, and upwards through the annulus between the outside of the drill collars **9** and the inside of the production casing **23** as indicated by the arrows in Figure 9.

The stabilisers comprise stabiliser pads **63** which may be extended against the inner surface of a cavity within which the illustrated drill string and the single stage gear systems are located, such as a containment structure **113** or the open hole section of a wellbore. For example, the inner surface of the production casing **23**, the inner surface of a containment structure **113**, the inner surface of any other casing, or the inner surface of an open hole section **21**.

The single stage gear systems may comprise hydraulic, electrical and pneumatic power systems **129** which are located above and below the stabiliser base plates **122** and which provide power to operate the stabiliser jacking mechanisms **67** comprised by the single stage gear systems. Power systems **129** may or may not be required or comprised by the single stage gear systems, depending on whether or not, or how the stabilisers are extended.

Before the illustrated drill string assembly is returned to the surface, the direction of rotation of the system may be reversed, for example, by reversing the direction of rotation of the input rotational power source. Control systems comprised by the single stage gear system may detect the change in direction of rotation and may retract the stabilisers into the stabiliser housings **72**.

The connections of a conventional oil field heavy weight drill pipe **5** and drill collars **9** are right handed threaded connections. Therefore, the planetary gear sets comprised by the single stage gear systems require an even number of planetary gears **125** in each gear train between the ring gear **127** and the sun gear **124**, in order to ensure the all the external components of the drill string rotate in the same clockwise direction.

The illustrated drill string comprises two crossover subs **44** (which allow components of different dimensions to be attached to each other). The crossover subs may correspond to the size of the connections of the tool connector **86** of the second single stage gear system, the drill bit **6**, and the drill collar **9**.

The illustrated system may be used as an alternative to the conventional oil and gas industry drilling mud motors, in order to create high speed rotation of the drill bit **6**.

Figure 10 is an isometric partially cut away view of the single stage gear system comprised by the fishing and milling tool **17** shown in Figures 12 to 14 and described above, which shows the lower assembly **115** in detail.

A sealed shaft bearing **102** isolates the rotation of the shaft **99** from the rotation of the outer housing **57** of the circulation chamber **109** of the upper assembly **114**.

The upper assembly **114** surrounds the planetary gear set upper carrier plate **198**, the rotation of which is isolated from the rotation of the shaft **99** by a sealed shaft bearing **102**.

The sealed assembly isolating bearing **121** isolates rotation of the upper assembly **114** from rotation of the lower assembly **115** and the stabiliser housing **72**.

The outer housing **84** of the single stage gear system may be seen more clearly in Figure 13.

The lower assembly **115** comprises a power system **129** which comprises a hydraulic tank, an air tank and a cooling system **128**. The power system **129** further comprises three power generating means **131**. The power generating means may comprise a hydraulic pump, an electrical alternating current, a direct current generator, and/or an air compressor. These components are used to operate the stabiliser jacking mechanism **67** to extend and retract the stabilisers and the stabiliser pad blades **63**.

The outer planet gear shafts **194** are connected to the three power generating systems **131** (as shown in Figure 11).

The control system **132** of the power system **129** may be connected to the three power generating means **131** by cable conduits **136**. The control system **132** may transmit or receive data either wirelessly, or via a wired connection.

The fishing and milling drilling tool **17** comprises one or more electrical, hydraulic or pneumatic motors **154** with a motor gear shaft **133** which connected to the underside of the stabiliser base plate **122** with a motor support arm **130**. The motor **154** rotates a motor gear shaft **133** which rotates a gear **166**, which meshes with and rotates a fishing and milling casing element ring gear **153**. This motor arrangement will be described in more detail with reference to Figures 18 and 19.

A rotary electrical connector or slip ring may transmit data and/or power from the control system **132** to components which are rotated along with the shaft **99** of the single stage gear system.

In the illustrated embodiment, three or more electrical brush contacts **156** are attached to and supported on the underside of stabiliser base plate **122**. The electrical brush contacts **156** interface with a rotating electrical contact **152** on the shaft **99** which may for example be a metal ring. The rotating electrical contact **152** is connected to three or more electrical transfer conduits **155**. Data and power is transmitted from the electrical brush contacts **156** to the rotating electrical contact **152** and then to the electrical transfer conduits **155**.

The three or more electrical transfer conduits **155** are connected to a battery **144**. The electrical trunking conduits and the battery rotate with the shaft **99** when the upper assembly **114** is rotated.

The electrical transfer conduits **155** may comprise trunking.

Figure 11 is an isometric view of the lower assembly **115** and the planetary gear set of the single stage gear system.

The planetary gear set comprises a sun gear **124** which is formed around the shaft **99** through which the circulation bore **105** is formed; a ring gear **127** which is formed around the inside of the planetary gear mechanism housing **96**; and outer and inner planet gears **125** which are connected to the outer planet gear shafts **194** and the inner planet gear shafts **197** respectively. The inner and outer planet gears **125** being arranged such that two planet gear long gear trains are arranged between the ring gear **127** and the sun gear **124**, such that the ring and sun gear rotate in the same direction.

The planetary gear set is located between the planetary gear set upper carrier plate **198** and the planetary gear set lower carrier plate **200** and is surrounded by the cylindrical wall of the planetary gear mechanism housing **96**. The planet gear shafts **194**, **197** are supported by the carrier plates **198**, **200**, but are able to rotate with respect to the carrier plates **198**, **200** due to the sealed planet gear shaft bearings **227**.

Rotation of the ring gear **127** in a clockwise direction imparts clockwise and anticlockwise rotation to the outer and inner high speed gears **125** respectively and clockwise rotation to the sun gear **124** which is directly connected to the outer diameter of the shaft **99**. The shaft **99** is isolated from the planetary gear set upper and lower carrier plates **198**, **200** by sealed shaft bearings **102**.

The lower assembly **115** comprises a sealed stabiliser housing **72** for the stabilisers when they are retracted. The lower assembly **115** is isolated from the rotation of the components of the upper assembly **115** by the assembly isolating bearing which is located between the planetary gear mechanism housing and the stabiliser housing **72**.

The outer housing **84** is not shown in Figure 11 but is indicated in Figures 12 and 13.

Figure 11 shows the three or more stabilisers in the extended position activated by the stabiliser jacking mechanism **67**. The ends of the stabilisers each comprise two stabiliser pads **63** which may be grooved to prevent debris build-up while moving down and to allow fluid to circulate around and along the grooves. The stabilisers may have ends of any shape, for example one or more rollers may be supported on the ends of the arms in some embodiments.

In the illustrated embodiment, the stabilisers comprise a sealed stabiliser wheel bearing mechanism located between the two blades which support a stabiliser wheel **62**. The stabiliser wheel **62** may facilitate movement of the device comprising the single stage gear system upwards or downwards inside a containment structure **113**.

In some embodiments, the stabilisers may not comprise a stabiliser wheel bearing mechanism or a stabiliser wheel **62**, and in other embodiments the stabiliser wheel bearing mechanism and/or the stabiliser wheel **62** may be removable or detachable from the stabiliser.

The stabiliser antennae **68** may be located on and/or supported by the stabiliser arms or stabiliser jacking mechanism **67** extensions. The stabiliser antennae **68** may be used for wireless communication where appropriate.

Three power generating means **131** are located between the stabiliser jacking mechanisms **67** within the stabiliser housing **72**. The power generating means are connected to and/or driven by the outer planet gear shafts **194** which may drive the generating means so as to generate power when the upper assembly **114** is rotated, thereby rotating the planetary gear set.

Cable conduits **136** connect the power generating means **131** to the control systems **132** of the electrical hydraulic or pneumatic power system **129** which are located on the stabiliser base plate **122**. The control systems **132** may transmit or receive data via either wired or wireless connections, and may be connected to the stabiliser antennae **68**, for example, for wireless data communication to the surface.

The software which controls the control systems **132** may be adaptable and/or updatable for present and future developments to operate a variety of mechanical and electrical tool functions.

The control systems **132** may comprise three or more junction distributors **134** for the hydraulic, electrical and pneumatic power system **129**. The central electrical, hydraulic or pneumatic control systems **132** may be cooled by air, may be thermally insulated or may be otherwise arranged.

Figure 12 is an exterior isometric view of a fishing and milling tool **17** which comprises a single stage gear system as described above. The outer protection housing **84** of the fishing and milling tool **17** is not shown (a cut away view of the housing **84** is shown in Figure 13).

The circulation bore **105** enters the top of the tool at the male or female tool connector **86** into the outer housing **57** of the circulation chamber **109**, through the top **66** and along the length of

the shaft **99** of the single stage gear system. The circulation bore passes through the fishing and milling tool upper and lower tool shafts **88**, **77** and exits to the fishing and milling tool **17** via the jetting nozzle **75**.

The jetting guide nozzle has an outer diameter smaller than the internal diameter of the upper end **11** of the fish **117** indicated in Figure **8**. The jetting nozzle **75** serving as a cutting and high pressure jetting guide.

The upper end of the milling and fishing tool **17** may have a male or a female tool connector **86** with either a right or left hand thread. The tool connector **86** may comprise a drilling rig elevator lifting recess profile **61** which can be of any design to suit the drilling rig lifting equipment.

The fishing and milling tool **17** comprises two main sections. A single stage gear system and a fishing and milling assembly **116**.

The hydraulic, electrical and pneumatic power system **129** indicated in Figure **11** is housed inside the lower assembly **115**.

The fishing and milling assembly **116** comprises a first fishing and milling casing element **48** and a second fishing and milling casing element **50**. The two fishing and milling casing elements **48**, **50** are displaceable with respect to each other. The two fishing and milling casing elements **48**, **50** are interlocking, the first fishing and milling casing element **48** comprising a plurality of elongate and substantially flat finger portions which interlock with elongate grooves or depressions formed in the exterior of the second fishing and milling casing element.

The fishing and milling assembly **116** of the fishing and milling tool **17** comprises a plurality of fishing fingers **53** (preferably three or more). The fishing fingers **53** comprise a fishing finger milling and cutting profile **90** on the distal ends of their inner surface from the single stage gearing mechanism comprised by the fishing and milling tool **17**. The fishing fingers **53** being located inside the second fishing and milling casing element **50**.

The second fishing and milling casing element **50** is displaceable in an axial direction with respect to the first fishing and milling casing element **48**, the single stage gear system comprised by the fishing and milling tool **17** and the outer housing **84**. The axial direction being parallel to the shafts **99**, **88**, **77** and the circulation bore **105**. The second fishing and milling casing element **50** being displaceable upwards and downwards when the fishing and milling tool **17** is in a vertical arrangement, for example within a vertical well or vertical containment structure **113**.

The second fishing and milling casing element **50** may be displaced in the axial direction with respect to the other components, **48**, **84**, by rotation of second fishing and milling casing element **48**.

The first fishing and milling casing element **48**, may be rotated by rotating the fishing and milling casing ring gear **153** which is fixed to or formed integrally with the second fishing and milling casing element **48** as shown in figures **17** to **19**. The fingers of the first fishing and milling casing element **48** which interlock with the grooves of the second fishing and milling casing element **50** cause the second fishing and milling casing element **50** to rotate when the first fishing and milling casing element **50** is rotated.

The second fishing and milling casing element **50** has a cylindrical inner surface which is threaded **70** and which engages with an externally threaded tube **71**. The externally threaded tube **71** is located at a fixed distance along the axial length of the fishing and milling tool **17** and does not rotate with the first fishing and milling casing element **48**. Therefore, when the first fishing and milling casing element **48** is rotated, the second fishing and milling casing element **50** is rotated with respect to the externally threaded tube **71** and as such the interlocking threads

causes the second fishing and milling casing element **50** to be displaced axially with respect to the externally threaded tube **71** and the first fishing and milling casing element **48**.

The internal threading **70** of the second fishing and milling casing element **50** is male and the external threading of the externally threaded tube **71** is female.

The first and second fishing and milling casing elements **48**, **50** having interlocking fingers and slots so as to allow axial movement of the two fishing and milling casing elements **48**, **50** with respect to each other as they are rotated by the rotation of the ring gear **153**.

The distal end of the second fishing and milling casing element **50** with respect to the single stage gear system and the first fishing and milling casing element **48** (typically the lower end in use) comprises an end connector **56** which enables the attachment of different ends and accessories to the end of the second fishing and milling casing element **50**. The illustrated end connector **56** being annular.

Accessories which are attachable to the second fishing and milling casing element **50** by use of the end connector **56** include a sealing element to provide a seal against the outer housing **84**, a washover sub **55** (as shown in Figures 12 to 17), and/or a interchangeable size locking sub **91** (as shown in Figures 23 and 25).

The illustrated washover sub **55** is a substantially circular hollow mill which is connected to the end of the second fishing and milling casing element **50** by the end connector **56**. The washover sub **55** comprises a plurality of external cutting blades, male locator profile and internal fishing neck male profile engagement thread **70** can be interchangeable to extend the length and the diameter of the external cutting blades and locator profile; or to install an extension sub with internal thread to match a design of fishing neck engagement profile **69**. Any extensions can be made up at the connection **56** to the second fishing and milling casing element **50**. This situation may arise for example if the drill pipe **43**, drill collar **9** has parted in the body and an extension section is required to reach the fishing neck sleeve **15** or fishing neck **10**.

The fishing and milling tool **17** may be used to retrieve in a single run, conventional drill string components which have been lost downhole, (these are examples of what are termed fish **117** in the industry). The fishing and milling tool **17** may also be used retrieve any fish **117** which comprises a new design of fishing neck engagement profile **69**. If the upper end **11** of a fish **117** has been damaged, for example where it has been bevelled out, this may prevent conventional overshot assemblies from swallowing the upper end **11** of the fish **117** as a result of tight tool internal dimensional tolerances. The fishing and milling tool **17** may mill and washover the upper end **11** of the fish **117** with high rotational speed using the milling structure **80** prior to engagement.

Figures 13 and 14 are isometric cut away views of the fishing and milling tool **17** shown in Figure 12 with the outer housing **84** included. Figure 13 being a view from below the fishing and milling tool **17** in its typical arrangement, and Figure 14 being a view from above.

The fishing and milling tool has a female treaded tool connector **86** at its upper end which is fixed to or comprised by the upper assembly **114** of the single stage gear system comprised by the single stage gear system comprised by the fishing and milling tool **17**. The fishing and milling tool **17** comprises an outer housing **84** which is cylindrical and surrounds and encloses portions of the fishing and milling tool **17** between the circulation chamber housing **57** and the lower far end of the second fishing and milling casing element **50** proximate to the end connector **56**. Sealed outer housing bearings **138** are located between a first (upper) end of the outer housing **84** and the circulation chamber housing **57**, and between a circumference of the inner surface of the outer housing **84** approximately mid-way along its length and the upper end of the first fishing and milling casing element **48**, coplanar with the fishing and milling casing element ring gear **153**.

The outer housing **84** comprises apertures through which the stabilisers may be extended from the lower assembly **115** of the single stage gear system. In use the outer housing **84** rotates with the lower assembly **115**, as such it does not rotate when the stabilisers are extended and braced against some surface, but is free to rotate when the stabilisers are retracted.

An annular outer housing end seal **120** is fixed to the inner wall of the outer housing **84** adjacent its lower end. The outer housing end seal **120** is located between the outer housing **84** and the second fishing and milling casing element **50**. The second fishing and milling casing element **50** is displaceable with respect to the first fishing and milling casing element **48**, the outer housing **84** and the outer housing end seal **120**, but the outer housing end seal **120** is arranged to maintain a seal against the second fishing and milling casing element **50** as it is displaced. The outer housing end seal **120** may be a packing seal. The outer housing end seal **120** may seal with upwards, downwards rotational movement of the second fishing and milling casing element **50**.

The female tool connector or engagement means **86** at the top of the milling and fishing tool **17** has a drilling rig elevator lifting recess profile **61**.

The fishing and milling tool **17** comprises a single stage gear system as described earlier in the detailed description, a hydraulic, electrical and/or pneumatic power system **129** and the fishing and milling assembly **116**.

Fluid passing through the circulation bore **105** enters the circulation chamber housing **57** of the upper assembly **114** which is isolated from the top **66** of the shaft **99** by a sealed shaft bearing **102**. The fluid enters the circulation bore **105** formed through top **66** of the shaft **99** and continues through the shaft **99** into the ball housing cylinder **97** comprised by the fishing and milling assembly **116**.

The ball housing cylinder encloses the shaft end ball **101** which is formed on the end of the upper fishing and milling tool shaft **88**. The lower fishing and milling tool shaft **77**, the upper fishing and milling tool shaft **88**, and the shaft end ball **101** form a combined unit which is displaceable with respect to the ball housing cylinder **97** and the other components of the tool.

In use a mechanical means, gravity, and/or the pressure of liquid passing through the circulation bore, is located combined upper and lower fishing and milling tool shafts **77**, **88**, and shaft end ball **101** is usually be located such that the shaft end ball **101** is at the lower end of the ball housing cylinder **97**. In this arrangement, the shaft end ball **101** blocks the circular aperture formed in the lower end of the ball housing cylinder **97** such that fluid may only exit the ball housing cylinder **97** through the circulation bore **105** formed through the shaft end ball **101** and the remainder of the shaft.

When the lower end of the fishing and milling tool shaft **77**, **88**, **101** where the jetting nozzle **75** is located is pressed against some external object, for example the upper end **11** of a fish **117**, the fishing and milling tool shaft **77**, **88**, **101** is axially displaced upwards. The shaft end ball **101** is therefore displaced upwards within the ball housing cylinder **97**. The motion sensors **94** comprised by the ball housing cylinder detect that the ball has been displaced, thereby detecting that the end of the fishing and milling tool **17** has been pressed against some debris or an item to be recovered.

When the shaft end ball **101** has been raised, this allows fluid to exit the ball housing cylinder **97** via the circular aperture in the lower end **95** of the ball housing cylinder **97** in addition to via the circulation bore **105** through the shaft **77**, **88**, **101**. Fluid which passes through the circular aperture in the lower end **95** of the ball housing cylinder **97** enters a space between the lower end **95** of the ball housing cylinder **97** and a plate **93** which forms the upper end of the lower hollow cylinder housing. The fluid may continue through the nozzle ports **108** in plate **93** and into the lower hollow cylinder housing **58** before exiting through the milling circulation and cooling nozzles **78**.

If the end of the shaft **77, 88, 101** is pressed sufficiently against some external object the shaft end ball **101** is displaced to the upper end of the ball housing cylinder **97**, where it blocks the entrance of the circulation bore **105** through the shaft **99** into the ball housing cylinder **97**. As such, fluid is only be able to pass through the tool **17** through the circulation bores **105** through the shafts **99, 77, 88, 101**, before exiting via the jetting nozzle **75**. This results in an increase in the fluid pressure within the circulation bore **105**, this pressure increase may be detected thereby allowing the fact the drilling tool **17** has been pressed against something such that the fishing and milling tool shaft **77, 88, 101** has been fully axially displaced to its uppermost position.

The pressure increase and the motion sensors **94** allow users to determine when the fishing and milling tool has contacted a fish **117** within a wellbore. The pressure increase allows users to determine when the fishing and milling tool shaft **77, 88, 101** has been fully displaced such that the fishing and milling tool is in a suitable arrangement for milling to occur.

The upper fishing and milling tool shaft **88** has a hexagonal cross section and is received by a slot with a hexagonal cross section through the plate **93**. The plate **93** is rotated with the cylindrical ball housing **97** and the shaft **99** of the single stage gear system, such that the fishing and milling tool shaft **77, 88, 101** rotate with the shaft **99** of the single stage gear system. Plate **93** also comprises a plurality of nozzle ports **108** and supports the spring **89** which presses the lower end **95** of the ball housing cylinder against the annular sealing seat **150**.

The lower end **95** of the ball housing cylinder **97** is displaceable with respect to the curved wall of the ball housing cylinder **97** and the upper end **106** of the ball housing cylinder **97**, but is held in position by a spring **89**. As such if the pressure of the fluid inside the ball housing cylinder is increased sufficiently, the lower end **95** is displaced downwards away from an annular sealing seat **150** formed around the lower end of the curved wall of the ball housing cylinder, thereby creating a gap through which fluid may exit the ball housing cylinder **97** into the milling circulation path **107**, through the nozzle ports **108** in plate **93** and into the lower hollow cylinder housing **58** before exiting through the milling circulation and cooling nozzles **78**.

The ball housing cylinder **97** comprises three or more motion sensors **94** and the intermediate fishing and milling tool shaft mechanism **65** comprises motion sensors **103**.

The shaft of fishing and milling mechanism **116** comprises a fishing and milling tool shaft connector **199** which is fixed to the end of the fishing and milling tool shaft mechanism **65** (which in turn is located at the end of the upper fishing and milling tool shaft **88**). The fishing and milling tool shaft connector allows a variety of different attachments to be attached to the fishing and milling tool shaft mechanism so as to form the end of the rotating central axial shaft of the fishing and milling tool **17**. Attachments which may be attached include the lower fishing and milling tool shaft **77**.

The lower fishing and milling tool shaft **77** has an annular shaft seal **104** which is formed around the lower fishing and milling tool shaft **77**, a sealed shaft seal bearing **82** is located between the annular shaft seal **104** and the lower fishing and milling tool shaft **77**, thereby allowing the lower fishing and milling shaft **77** to continue to rotate when the annular shaft seal **104** has created as seal between the lower fishing and milling tool shaft **77** and some other object, such as part of the upper end **11** of a fish **117**.

The lower fishing and milling tool shaft **77** of the fishing and milling tool **17** may comprise a jetting nozzle **75** through which the circulation bore exits the fishing and milling tool **17**. Jetting is the process wherein soft materials are drilled by hydraulic impact loading only, through the use of high pressure fluid exiting the circulation bore. The jetting nozzle may be interchangeable, for example to allow differently sized and/or shaped jetting nozzles to be used, such as an asymmetric nozzle which may allow the well to be deviated. An interchangeable jetting nozzle **75** may be removable from the lower fishing and milling tool shaft **77**, or a plurality of lower

fishing and milling tool shafts **77** may be available and attachable to the fishing and milling tool **17** by use of the fishing and milling tool shaft connector **199**.

The fishing and milling tool **17** comprises a heavy duty high speed milling structure **80**.

The jetting guide **75** and interchangeable heavy duty high speed milling structure **80** may be modified to be used for jetting, drilling, or a combination of jetting and drilling dependent on the formations and environment in which the fishing and milling tool **17** is to be used

The hydraulic tank, air tank and cooling system **128** are attached to the base of the planetary gear set lower carrier plate **200**.

The lower assembly **115** of the single stage gear system comprised by the fishing and milling tool **17** comprises three power generating means **131** which are located between the stabilisers and the stabiliser jacking mechanisms **67**. The cable conduits **136** transfer electrical power generated by the power generating means **131** to the central electrical, hydraulic or pneumatic control systems **132** which are positioned above the stabiliser base plate **122**.

The one or more electrical, hydraulic or pneumatic motors **154** with motor gear shafts **133** are each connected with a motor support arm **130** (as shown in Figure 18) to the underside of the stabiliser base plate **122** and may be connected to the central electrical, hydraulic or pneumatic control systems **132** in order to be powered and controlled.

The shaft **99** which passes through a central aperture in the stabiliser base plate **122** is separated from the stabiliser base plate **122** by a sealed shaft bearing **102**.

The three or more electrical brush contacts **156** attached to the underside of the stabiliser base plate **122** are connected to the central electrical, hydraulic or pneumatic control systems **132** and may transmit data and/or power via the rotating electrical contact **152** to the three or more data and power transfer electrical conduits **155**.

The three or more data and power transfer electrical conduits **155** may be connected to the battery **144** which may store electricity, to the three or more motion sensors **94**, the motion sensors **103** on the fishing and milling tool shaft mechanism **65**, the one or more leadscrew motors **60**, the fishing finger sensor mechanism **79**, the fishing finger outer magnetised plate surfaces and inward facing with sensors **85**, sensors on the one or more of the stop mechanism slots **64**, or any other installed sensors. These sensors may for example be resistance, torque, pressure, temperature, photo resistance, and/or camera monitoring sensors, or may be any other type of sensors.

The lower section of the fishing and milling tool **17** indicated in Figure 12 as the fishing and milling assembly **116**, comprises the electrical storage battery **144** for storing and transmitting power generated by the three power generating systems **131**, a hollow ball housing cylinder **97** with three or more motion sensors **94** which are used to detect the position of the shaft end ball **101**. The ball housing cylinder **97** is connected to the circulation bore **105** through the shaft **99** and upper fishing and milling tool shaft **88** as indicated in Figure 17.

The three or more motion sensors **94** comprised by the ball housing cylinder **97** are spaced along the inner surface of the ball housing cylinder **97** and may be aligned in a vertical orientation, a helical orientation, or any other orientation.

The one or more leadscrew motors **60** have a gear shaft **133** with a gear **166** which meshes with and rotates the inner cog profile of a fishing and milling tool internal ring gear **36** which is separated from the shaft **99** by a sealed shaft bearing **102**.

The one or more leadscrew motors **60** are attached directly to the shaft **99** below the battery **144**. The leadscrew motors **60** may create high torque with micro processed control, and may

be used to extend or retract the three or more fishing fingers **53** by rotating the outer cog profile of the fishing and milling tool internal ring gear **36**.

The fishing and milling tool internal ring gear **36** comprises both internal and external cog teeth. The internal cog teeth mesh with the gear or gears **166** driven by the one or more leadscrew motors **60**. The external cog teeth mesh with and drive two or more leadscrew gears **59** (as shown in Figure 19).

The two or more leadscrew gears **59** are each attached to a leadscrew shaft **76**. The leadscrew shafts **76** are partially or entirely threaded, and are received by threaded apertures in the fishing finger support outer section **54** (as shown in Figure 15).

Therefore, when the one or more leadscrew motors **60** rotate their associated gear shafts **133**, their associated gears **36** are rotated, the fishing and milling tool internal ring gear **36** is rotated, the leadscrew gears **59** are rotated and the leadscrew shafts **76** are rotated. The rotation of the leadscrew shafts **76** causes the fishing finger support outer section **54** to be displaced along the length of the leadscrew shafts **76**.

The fishing fingers **53** are connected to the fishing finger support outer section **54** and is axially displaced along with the fishing finger support outer section **54**. Therefore, the fishing fingers **53** which are supported by the fishing finger supporting body **96** is axially displaced with respect to the single stage gear system, and the first fishing and milling casing element **48** when the one or more lead-screw motors **60** rotate their gear shafts **133**.

The mechanism for extending and retracting the three or more variable fishing fingers **53** will be explained further with reference to Figure 15.

The washover sub **55** is connected to the connection **56** at the end of the second fishing and milling casing element **50**. The washover sub **55** may comprise cutting blades radially extending from its external surface (as shown in Figure 16). These blades may enable washover of the fishing neck protection locked sleeve **15** and engagement of the fishing neck with the thread **70** formed on inside of the second fishing and milling casing element **50**. This can be achieved by extending the second fishing and milling casing element **50** using the rotation of the second fishing and milling casing element against the externally threaded tube **71**.

The externally threaded tube **71** surrounds the fishing finger support outer section **54** and connects with a tube support means **16** which comprises three arms which are connected to the exterior of the cylindrical ball housing **97**. The fishing finger support outer section **54** is slotted to allow the movement downwards and upwards of the three or more fishing fingers **53**.

The three or more fishing fingers **53** are connected to the fishing finger support outer section **54** by three or more removable hinges or other fixing mechanisms **52**.

When the three or more fishing fingers **53** are axially displaced downwards or upwards by clockwise or anti-clockwise rotation of the two or more lead-screw shafts **76**, the three or more fishing fingers **53** moves down or up along three or more corresponding guide slots of the guide slotted body **98**.

The fishing finger support outer section **54** comprises stop mechanism fingers **110**. The stop mechanisms fingers comprise rigid downwards protruding strips which are located between the fishing fingers **53** and which are displaced with the fishing finger support outer section **54**. As the fishing finger support outer section **54** is displaced downwards, the stop mechanism fingers **110** strips are displaced into stop mechanism slots **64**. When the fishing finger support outer body **54** is in its lowest position, such that the fishing fingers **53** are fully extended, the presence of the stop mechanism fingers **110** will activate sensors in the stop mechanism slots **64**, thereby producing a signal that indicates that the fishing fingers are in their fully extended arrangement.

The inner surfaces of the lower parts of the fishing fingers **53** have protrusions **92** formed thereon. The protrusions **92** are in the form of a smooth arcuate hump which protrude from the inner surface of the lower parts of the fishing fingers **53**. As the fishing fingers **53** are displaced axially downwards, the ends of the fishing fingers **53** are displaced outwards when the protrusion come into contact with the outer surface of the milling structure **80**.

The fishing fingers **53** have tips with fishing finger milling and cutting profiles, at the bottom of which are outer magnetised plate surfaces and inward facing sensors **85**.

Below the guide slotted body **98** is the lower shaped sub **83** which has a lower diameter within which the protrusions **92** are located when the fishing fingers are in their uppermost location, such that the outer ends of the fishing fingers **53** are not expanded and they remain in the slots of the guide slotted body **98**.

The lower shaped sub **83** comprises a female milling structure connector **81** (shown in Figure 15) which may be used to connect the pin end of the interchangeable heavy duty high speed milling structure **80** or any other tool accessory, such as a lead impression block, a flat bottom mill or a hollow drill bit which is able to accommodate the fishing and milling tool shaft mechanism **65**.

Figure 15 is an isometric view of the fishing and milling tool **17** from below.

The circulation bore **105** enters the upper section of the tool through the shaft end ball **101**. The shaft end ball **101** comprises shaped slots or with nozzles **40** and is attached to the upper end of the upper fishing and milling tool shaft **88**. The shaft end ball **101** mates with an indent formed in the lower end **95** of the ball housing cylinder **97**.

The fishing fingers **53** attached to the fishing finger support outer section **54** by removable hinges or other fixing mechanisms **52** and are displaceable in an axial direction upwards and downwards by rotating clockwise or anti-clockwise the two or more lead-screw shafts **76**.

The guide slotted body **98** may have a hexagonal outside shape or other outside shape and is connected directly to the lower hollow cylinder housing **58**. The outside shape is slotted to accommodate the two or more lead-screw shafts **76** which can provide up and down axial movement of the three or more fishing fingers **53** when rotated by the one or more leadscrew motors **60**.

The outside shape of the guide slotted body **98** enables the fishing finger support outer section **54** to rotate together at high speed when rotating the shaft **99** connected to the moveable ball housing cylinder **97** which in turn is connected to the lower hollow cylinder housing **58**.

At the bottom and on the outside of the fishing fingers **53** are outer magnetised plate surfaces inward facing with sensors **85** which aid with confirmation of the location of the upper end **11** of the fish **117**.

The lower part of the fishing fingers **53** have shaped protrusions **92** to extend them outwards when they come in contact with the exterior of the milling structure **80** as the fishing finger support outer section **54** is moved in a downward direction along the two or more lead-screw shafts **76**.

The fishing finger milling and cutting profile **90** is used to dress any external damage to the female connector **12** and any surface damage to the upper end **11** of the fish **117** may be milled with the milling structure **80**.

Different sizes of milling structure **80** and other connectable tool accessories, such as a lead impression block may be connected to the lower section utilising the female milling structure connector **81** of the lower shaped sub **83**.

The milling structure **80** may comprise one or more stop mechanism slots **64** with sensors for detecting the one or more stop mechanism fingers **110** attached to the fishing finger support outer section **54** when they are in their lowermost position.

On the internal surface of the second fishing and milling casing element **50** is a thread **70** for engaging the fishing neck profile. The second fishing and milling casing element **50** comprises an end connector **56** which may be used to change the washover sub **55** to be suitable for the dimensions of the upper end **11** of a fish **117**, and/or to be suitable for use with the new generation of fishing neck engagement profile **69** further described with reference to Figure 20.

Extending from the inside of the lower section is the lower fishing and milling tool shaft **77** with the shaft seal **104** positioned over a shaft seal bearing **82**. When the shaft seal **104** enters the upper end **11** of the fish **117** and seals, the lower fishing and milling tool shaft **77** is free to rotate on the shaft seal bearing **82**. Once sealed, attempts may be made to circulate through the fish **117**.

The jetting nozzle **75** is located at the end of the lower fishing and milling tool shaft **77**. High pressure liquid **75** may be emitted from the jetting nozzle **75** and may be used to clear any debris from the top and/or inside of a fish **117** as the fishing and milling tool **17** is lowered.

A seal may be created between the outer housing **84** and the washover sub **55** and/or the Second fishing and milling casing element **50** by an outer housing seal **120** or equivalent installed on the inner surface of the bottom section of the outer housing **84**. The outer housing seal **120** may seal with upwards, downwards rotational movement of the surface of the second fishing and milling casing element **50**.

The first fishing and milling casing element **48** comprises an interdigitated connection with the second fishing and milling casing element **50**. When the first fishing and milling casing element **48** is rotated, it rotates the second fishing and milling casing element **50** against the externally threaded tube **71**. This causes the second fishing and milling casing element **50** to be axially displaced upwards or downwards with respect to second fishing and milling casing element **50**. The externally threaded bearing **71** surrounds the fishing finger support outer section **54** and is connected with three armed tube support means **16** to the exterior of the ball housing cylinder **97**.

Figure 16 is an isometric view of the fishing and milling assembly **116** from below, displaying the interchangeable heavy duty high speed milling structure **80** which comprises a plurality of shaped cutters and adjustable milling circulation and cooling nozzles **78**.

The lower fishing and milling tool shaft **77**, and the high pressure jetting nozzle **75** have outer diameters smaller than the internal diameter of the upper end **11** of the fish **117**. The activation shaft seal **104** is made rotatable with respect to the lower fishing and milling tool shaft **77** by a shaft seal bearing **82**.

The connection **56** allows the connection of accessories such as the washover sub **55** which has an external cutting profile to enable washover milling and a male locator profile for engagement of a female locator alignment profile **51** comprised by a fishing neck sleeve **15** (as shown in Figure 21).

The fishing and milling tool **17** may comprise a camera and light system **140** in order to allow the monitoring of a fishing operation.

The fishing finger milling and cutting profile **90** which is located on the inner surface of the tips of the fishing fingers **52** may be used to cut or mill away any damaged material from the upper end **11** of a fish **117**, the outside diameter of which may be regulated by a fishing finger sensor mechanism **79** comprising sensors supported on the inner surface of the fishing fingers **53** above the milling and cutting profiles **90** and below the protrusions **92**. This may aid with mechanical engagement of the new generation of fishing neck engagement profile **69** which is

shown in Figure 20. Once the fishing neck engagement profile **69** has been located the fishing finger sensor mechanism **79** retracts. The sensors can be pre-programmed to suit the dimensions of the upper end **11** of a specific fish **117**.

Slot profiles **87** are formed in the milling structure **80** (as shown in figure **16**) and contain the fishing finger sensor mechanisms **79**. An outward movement of the fishing finger sensor mechanism **79** increases the outside diameter of the three or more fishing fingers **53** to enable them to surround, enclose and thereby grip the upper end **11** of the fish **117**.

Figure **17** is an isometric cross sectional view of the fishing and milling assembly **116** of the fishing and milling tool **17**.

The location of the upper end **11** of a fish **117** may be determined by means of a pump pressure increase registered on the surface pump pressure gauge **49** (indicated in Figure 8) and/or by a signal indicative of magnetic detection by the sensors located on the outer magnetised plate surfaces **85** of the fishing finger guides **53**.

The pump pressure increases may be as a result of the jetting nozzle **75**, the lower fishing and milling tool shaft **77**, and the fishing and milling tool shaft mechanism **65** which comprises motion sensors **103**, entering the upper end **11** of the fish **117**, such that the shaft seal bearing **82** is located in and seals with the restricted fish tool joint internal diameter.

As the drill string is lowered further after this seal has been made, the shaft end ball **101** which is attached to the upper end of the upper fishing and milling tool shaft **88** is displaced upwards in an axial direction off of the spring **89** retained lower end of the ball housing cylinder **97**. The three or more motion sensors **94** indicated in Figure 13 determines the position of the shaft end ball **101** within the ball housing cylinder **97**.

The shaft end ball **101** may be held in place either electrically or mechanically against the spring **89** retained lower end of the ball housing cylinder **97**, until a pre-set force has exerted on the jetting nozzle **75**.

The upper fishing and milling tool shaft **88** is shaped (for example with a hexagonal cross section) to maintain orientation to ensure the three or more motion sensors **94** detect the shaft end ball **101** and to enable the upper fishing and milling tool shaft **88** to be rotate when the ball housing cylinder **97** and the lower hollow cylinder housing **58** are rotated by the shaft **99**.

Sensors indicate when the shaft end ball **101** with ball circulation shaped slots or nozzles **40** formed on its upper half has mated with the upper end **106** of ball housing cylinder **97**.

The ball circulation shaped slots or nozzles **40** allows the circulation fluid to bypass the shaft end ball when the shaft end ball **101** mates with the upper end **106** of ball housing cylinder **97**.

Increasing the circulation through the circulation bore **105** increases the pump pressure and moves the lower end **95** of ball housing cylinder **97** downwards along with the annular sealing seat **150** located thereon. This compresses the spring **89** and allows the circulation fluid to escape the cylindrical ball housing **97**, through the milling circulation path **107** and through the plate **93** nozzle ports **108** into the lower hollow cylinder housing **58** and out through the milling circulation and cooling nozzles **78**. Circulation can be required to flush any milled cuttings up the well bore to the surface and to cool the interchangeable heavy duty high speed milling structure **80**.

The internal profile of the plate **93** and the lower end **95** of ball housing cylinder **97** matches the external profile of the shaft end ball **101** and the upper fishing and milling tool shaft **88** such that the upper fishing and milling tool shaft **88** will rotate when the ball housing cylinder **97** is rotated by the rotation of the shaft **99** (for example the upper fishing and milling tool shaft **88** may have

a hexagonal cross section, and the plate **93** may have a hexagonal aperture through which it is arranged).

The fishing finger sensor mechanism **79** may be used to increase or decrease the fishing fingers **53** outer diameter. When extended, this increases the outside diameter of the three or more fishing fingers **53**, thereby allowing differently dimensioned fish **117** to be retrieved.

On the internal surface of the second fishing and milling casing element **50** is a fishing neck male profile engaging thread **70**. With the shaft **99** stationary, rotation of the first fishing and milling casing element **48** by fishing and milling casing element ring gear by the one or more electrical, hydraulic or pneumatic motors **154** rotates the thread **70** against the externally threaded tube **71** with outer female thread profile. This causes the washover sub **55** to be axially displaced downwards and lowered over the upper end **11** of the fish **117** increasing the machined tolerance gap **74** between the interdigitating portions of the first fishing and milling casing element **48** and the second fishing and milling casing element **50**. The fishing neck sleeve **15** may be released with high torque and rotated downwards. The new generation of fishing neck engagement profile **69** shown in Figure 21 may be engaged with the fishing neck male profile engagement thread **70**.

The second fishing and milling casing element **50** with the fishing neck male profile engagement thread **70** formed on its internal surface extends upwards underneath the smooth interior surface of the interdigitating portions of the first fishing and milling casing element **48**.

The milling structure **80** and the lower shaped sub **83** at the base of the lower hollow cylinder housing **58** connected to the ball housing cylinder **97** is rotated by the upper fishing and milling tool shaft **88** when the shaft **99** is rotated.

The outer housing **84** is attached and isolated from the first fishing and milling casing element **48** by a sealed bearing **138** as part of the fishing and milling tool casing end plate **149**.

The three or more data and power electrical conduits **155** continue downwards along the shaft **99** to the electrical storage battery **144** and to any sensor equipment such as the motion sensors **103**.

A camera and light system **140** may be included if monitoring of fishing operations is required. Figure 18 is an isometric detailed view of the upper end of the fishing and milling assembly **116** with the outer housing **84** partially cut away.

The slotted section outside surface of the second fishing and milling casing element **50** has a smooth machined surface and as it moves downwards the machined tolerance gap **74** – between the bottom of the slots formed in the outer surfaces of second fishing and milling casing element **50** and the lower ends of the finger portions comprised by the first fishing and milling casing element **48** – increased.

The three or more electrical brush contacts **156** are connected to the underside of the stabiliser base plate **122** as indicated in Figure 17 and mate with the rotating electrical contact **152** which is formed around on the exterior of the shaft **99**.

The one or more electrical, hydraulic or pneumatic motors **154** each with a motor gear shaft **133** are each connected with a motor support arm **130** to the underside of the stabiliser base plate **122** and are connected to the central electrical, hydraulic or pneumatic control systems **132** indicated in Figure 14 for power, control signals, and/or programmable functions.

The motor gear shaft **133** connected to the motor gear **166** can rotate the fishing and milling casing element ring gear **153** situated on the fishing and milling casing end plate **149**. This can extend and retract the second fishing and milling casing element **50** to connect and lock onto

the fishing neck sleeve **15** indicated in Figure 21. This can only be performed when the shaft **99** is not rotating.

Clockwise motion of the motor gear **166** rotated the fishing and milling casing element ring gear **153** clockwise. The fishing and milling casing element ring gear **153** is attached to the interior surface of the first fishing and milling casing element **48** and to the fishing and milling casing end plate **149**. This rotates the first fishing and milling casing element **48** in a direction either to extend or retract the second fishing and milling casing element **50**. Clockwise motor rotation moves the second fishing and milling casing element **50** downwards to connect and lock onto the fishing neck engagement profile **69** and anticlockwise motor motion moves the second fishing and milling casing element **50** upwards to release from the fishing neck engagement profile **69** indicated in Figure 20.

The second fishing and milling casing element **50** with an internal thread **70** which is an internal fishing neck male profile engagement thread, rotates against the fixed female thread externally threaded tube **71** resulting in downward axial displacement of the second fishing and milling casing element **50**.

Anti-clockwise rotation of the motor gear **166** rotates the fishing and milling casing element ring gear **153** anti-clockwise and move upwards the second fishing and milling casing element **50** of the fishing and milling assembly **116**.

The power to operate the one or more electrical, hydraulic or pneumatic motors **154** is transmitted from the central electrical, hydraulic or pneumatic control systems **132** which convert either clockwise or anti-clockwise movement of the motor gear **166** to anti-clockwise or clockwise movement of the fishing and milling casing element ring gear **153**.

The motor gear **166** is able to rotate freely either in a clockwise or anti-clockwise direction when the motor is not active. This ensures the gear **166** does not prevent rotation of the fishing and milling casing element ring gear **153** when rotation of the shaft **99** rotates the second fishing and milling casing element **50** via the externally threaded tube **71** which thereby rotates the first fishing and milling casing element **48**.

The circulation bore **105** passes through the shaft **99** which is separated from the fishing and milling casing element ring gear **153** and fishing and milling casing end plate **149** by a shaft sealed bearing **102** seal.

The three or more electrical brush contacts **156** which are connected to the underside of the stabiliser base plate **122** connect while stationary and while rotating to one or more rotating electrical contacts **152** which in some embodiments may comprise three or more insulated armature data transfer mechanisms. The rotating electrical contact **152** is fixed to and rotates with the shaft **99**. Data may be sent and received and power may be transmitted via the three or more electrical transfer conduits **155** attached to the shaft **99**. The three or more electrical transfer conduits **155** extend downwards along the exterior of the shaft **99** to the electrical storage battery **144**, to the three or more motion sensors **94**, and/or to any other sensors.

Insulated armature data transfer mechanisms **152** are insulated from each other and can be placed anywhere suitable along the shaft **99** where data communication between stationary and rotatable parts is required.

Figure 19 is an isometric cross sectional view of the fishing and milling assembly **116**.

The outer housing **84** is attached to and rotationally isolated from the first fishing and milling casing element **48** by a sealed bearing mechanism **138** which contacts part of the fishing and milling casing end plate **149**.

The electrical storage battery **144** is attached to and rotates with the shaft **99**.

With the shaft **99** stationary, engagement of the fishing neck protection sleeve **15** may be attempted by rotating the first fishing and milling casing element **48** with the motor gear **166** against the fishing and milling casing element ring gear **153** which rotates the fixed externally threaded tube **71** with outer female thread profile. This in turn rotates the second fishing and milling casing element **50** internal fishing neck male profile engagement thread **70** lowering the washover sub **55** to release the fishing neck protection sleeve **15** and engage the new fishing neck engagement profile **69** indicated in Figure 20. During this operation, the shaft **99** is isolated from the fishing and milling casing element ring gear **153** by the shaft sealed bearing **102** seal.

The second fishing and milling casing element **50** which comprise the fishing neck male profile engagement thread **70** extends upwards behind the smooth interior surface of the extending finger or tab shaped portions of the first fishing and milling casing element **48**.

The circulation flow path is through the circulation bore **105**, the shaft **99** into the attached ball housing cylinder **97**, through the shaft end ball **101**; the upper fishing and milling tool shaft **88**; the intermediate fishing and milling tool shaft mechanism **65** with the shaft seal bearing **82**; the lower fishing and milling tool shaft **77** and out through the jetting nozzle **75**.

When the circulation pressure is sufficiently increased the spring **89** may be compressed and the lower end **95** of the ball housing cylinder **97** may be displaced downwards off its sealing seat **150**, thereby allowing the fluid to by-pass the lower end **95** of the ball housing cylinder **97** and flow through the nozzle ports **108** in the plate **93** into the lower hollow cylinder housing **58** and through the milling circulation and cooling nozzles **78**.

The fishing finger milling and cutting profile **90** may have outer magnetised plate surfaces and inward facing sensors **85**. This may be used to locate the upper end **11** of a fish **117**.

When the fishing fingers **53** are lowered by rotating clockwise the two or more lead-screw shafts **76** the shaped protrusions **92** extends the fingers radially outwards as they are pressed outwards when they contact the exterior of the milling structure **80** (which has a greater radius than the lower shaped sub **83** adjacent to which the protrusions are located when the fishing fingers **53** are retracted). This may facilitate in the surrounding the upper end **11** of a fish **117**.

The one or more leadscrew motors **60** have a gear shaft **166** with a gear **166** connected to the inner cog profile of the fishing and milling tool internal ring gear **36** which is isolated from the activation shaft by a sealed shaft bearing **102**.

The variable speed geared leadscrew motors **60** which are attached to the shaft **99** by supports create high torque with micro processed control which can be used to extend or retract the fishing fingers **53** by rotating the outer cog profile of the fishing and milling tool internal ring gear **36** which rotates two or more leadscrew gears **59** which are fixed to the end of the two or more leadscrew shafts **76**. The two or more lead-screw shafts **76** attached to the leadscrew gears **59** extend through threaded apertures in the fishing finger support outer section **54** into the slots of the three or more guide slotted body **98** and terminate above the top of the lower shaped sub **83**.

When the shaft **99** rotates, the fishing and milling assembly **116** assembly rotates as a unit inside the outer housing **84**. The two or more leadscrew shafts **76** may or may not be simultaneously rotated by the leadscrew motors **60** so as to lower or raise the three or more fishing fingers **53** by the rotation of the fishing and milling tool internal ring gear **36**. The fishing and milling tool internal ring gear is isolated from the activation shaft by a sealed shaft bearing **102** which is situated on the top of the upper end **106** of the ball housing cylinder **97**.

A seal may be created between the outer housing **84** of the tool and the fishing and milling assembly **116** by an outer housing seal **120** which may be a packing seal or equivalent. The outer housing seal **120** may be installed on the inner surface of the outer housing **84** and may

contact the exterior of the washover sub **55**, the connection **56** or the second fishing and milling tool casing element **50**. Alternatively, the outer housing seal **120** may be installed on the exterior of the fishing and milling assembly **116**.

Figure 20 is side view of a drill string component **158** such as a drill collar **9**, drill pipe **43** or heavy weight drill pipe **5** comprising a unique design of fishing neck engagement profile **69**. The fishing neck engagement profile **69** may be used to replace the conventional fishing neck **10** of other drill string components, such as a string stabiliser **7** and/or near bit stabiliser **3**.

The new design of fishing neck engagement profile **69** may have a recessed female threaded profile positioned below or as a part of the upper tool connector **42** or upper engagement means **42** of the component **158**. This engagement profile or thread corresponds to the fishing neck male profile engagement thread **70** comprised by the fishing and milling assembly **116**. The fishing neck male profile engagement thread **70** can be sized to suit the upper end **11** of the fish **117**. In some embodiments, the fishing neck engagement profile **69** and the fishing neck male profile engagement thread **70** may be left handed or right handed threads with a wide thread pitch and square type crest. This may ease make-up and break-out of the fish **117**.

The upper tool connector **42** or engagement means **42** comprises a female threaded indent **12**. The drill string component **158** also comprises a lower tool connector **42** or engagement means **42** which in the illustrated embodiment comprises a male threaded connector **18**. A circulation bore **105** enters the female connector **12**, extends through the length of the drill string component **158** and exits through the male threaded connector **18**.

The fishing neck sacrificial wear ring **73** and the lower tool connector **42** or engagement means **42** each comprise circulation cut-outs **157** or grooves **157** so as to provide circulation flow by pathways. The fishing neck sacrificial wear ring **73** may have a hardness greater than that of the body of the drill string component **158** so as to extend the usage life of the fishing neck engagement profile before replacement is necessary.

Figure 21 is an isometric view of a drill string component **158** as shown in Figure 20 with the new fishing neck engagement profile **69** covered by a fishing neck protection locked sleeve **15** viewed from a different angle. The fishing neck protection sleeve **15** which may be locked in place at its lower end by one or more locking recessed nuts **38** or by any other suitable locking mechanism which may break after a pre-determined torque has been reached.

The fishing neck sleeve female locator alignment profile **51** matches the washover sub **55** profile indicated in Figure 16.

When the second fishing and milling casing element **50** is lowered the washover sub **55** engages the fishing neck sleeve female locator alignment profile **51** and – with either left handed or right handed torque, dependent upon the thread profile – shears on the lower end underside the one or more protection sleeve locking recessed nuts **38** or other suitable locking mechanism.

Further rotation lowers the fishing neck protection sleeve **15** exposing the fishing neck engagement profile **69** which connects to the fishing neck male profile engagement thread **70** and create a seal.

If the drill string component **158** is to be recovered from a wellbore it may be an example of a fish **117**.

The length of interior of the fish **117** such as the drill string component **158** may have liquid circulated through via the circulation bore **105**. The fish **117** or the drill string component **158** may be worked on with the drilling jars in an upward or downward direction to free if stuck and recovered to surface.

In the event the fish **117** cannot be freed, the fishing and milling tool **17** tool may be released from the fish **117** or drill string component **158** with anticlockwise or clockwise rotation of the washover sub **55** utilising the one or more electrical, hydraulic or pneumatic motors **154**.

Figures 22 to 25 illustrate conventional drill pipe components comprising conventional fishing necks **10** instead of the new fishing neck engagement profile **69**.

Figure 22 is an isometric view of a conventional length of drill pipe **43** with upper and lower tool connectors **42** or engagement means **42**. The drill pipe comprises a lower male pin end connection **18**, and an upper female connector **12** which is also the fishing neck **10**. The circulation bore **105** enters through the upper female connector **12** and exits through the lower male pin end connection **18**.

Figure 23 is an isometric view of the conventional length of drill pipe **43** shown in figure 22 with the end of the fishing and milling tool **17** enclosed over its upper end so as to retrieve it from a wellbore. The figure displays the fishing finger mechanism positioned over the end of conventional drill pipe **43** upper tool joint **42**. The fishing fingers **53** can be locked by the locking sub **91** which compresses the finger mechanisms around the tool joint **42** when fishing for conventional drill pipe **43**.

The locking sub **91** may have a cutting profile on the external surface which may aid with clearing debris around the upper end **11** of the fish **117** while washing over.

Differently sized locking subs **91** with external cutting profiles may be installed at the end connection **56** on the interchangeable sized second fishing and milling casing element **50** in order to correspond to differently dimensioned upper ends **11** of fish **117**.

The external cutting profile of a sub **55**, **91** may be any shaped design and used to wash over and clear debris from around the upper end **11** of a fish **117**.

The outside profile of the fishing fingers **53** when fishing for conventional equipment can be conical shaped **167** with their tips extending radially outwards from their upper ends in order to aid with compressing and locking the fingers over the end fishing neck tool joint **42**.

Figure 24 is an isometric view of a conventional drill collar **9** with either a spiral or a flat surface profile and where the fishing neck **10** has a smooth surface. The circulation bore **105** is through the upper female connector **12** and exits through the lower male pin end connection **18**.

Figure 25 is a cross sectional isometric view of the conventional drill collar **9** shown in Figure 24 with the end of the fishing and milling tool **17** enclosing its upper end. The figure indicates the mechanism for locking with the locking sub **91** which may have cutting profiles on the external surface.

Each of the fishing fingers **53** has three or more male cutting profiles **173** on the inside diameter and may have magnetic plate surfaces with sensors on the outside diameter. Two or more grooves **46** can be cut into the fishing neck **10** surface of the drill collar **9** by rotation of the extended fishing finger support outer section **54**.

The outside profile of the fishing fingers **53** may be conically or frustum shaped **167** outwards to aid with compressing and locking the fishing fingers **53** over the fishing neck **10** when the locking sub **91**, connected to the interchangeable sized second fishing and milling casing element **50** is moved downwards by rotation of the fishing and milling casing element ring gear **153**.

Figure 26 is a cross sectional view of a well construction **4** for a casing cutting and window milling operation.

The casing cutting and window milling assembly **119** is the first tool in the upstream oil and gas industry, which may perform high speed casing cutting or window milling or a combination of both operations.

The casing cutting and window milling assembly **119** may be run on drill pipe **43**, a heavy weight drill pipe **5** and a casing cutting and window milling bottom hole assembly **29** inside the production casing **23** to the planned top casing cut or the window length to be milled **32**.

The casing cutting and window milling assembly **119** comprises a single stage gear system as described earlier in the detailed description, with three or more stabiliser pads **63** extended against the inside of the production casing **23**.

High speed rotation of the shaft **99** of the gear system may be induced by surface rotation of the top of the drill pipe **45** at the rig floor **39** and the input rotational power source **8**.

The lever powered jacking system **160** can adjust the angle of the casing cutting and window milling head **168** and is explained further with reference to Figures 28 and 29.

The circulation bore **105** enters through the top of the drill pipe **45** and the drill pipe **43** with the pumping pressure indicated on the pump pressure gauge **49** (which may be either digital or analogue). The drill string weight indicator **47** may be used to monitor the up and down weight of the drill string to aid with the operational functions of the casing cutting and window milling assembly **119**.

The well indicated can be made up of the blowout preventer equipment and wellhead **37**, either positioned on the seabed, mobile drilling rig substructure or land rig cellar base **41**.

The casing scheme may consist of a surface conductor casing **35**, surface casing **31**, intermediate casing **27** and a production casing **23** all cemented in place **33**. The watered-out perforations **26** in the production casing **23** may have been isolated with a cement plug **28** with the bottom casing shoe cement sealed **20**.

Figure 27 is an isometric view of the casing cutting and window milling assembly **119** without its outer housing **84** in a well bore casing **23** with parts of the casing being shown cut away. The upper male or female tool connector or engagement means **86** may be either a right or left hand thread connection.

Figure 28 is another isometric view of the assembly **119** shown in Figure 27.

The device may be arranged in a well bore casing, for example the production casing **23** as indicated in Figure 26, positioned at the top of the casing cut, or the window length to be milled **32**.

To achieve high speed casing cutting or window milling at the high-speed end **223**, the casing cutting and window milling assembly **119** comprises a single stage gear system as described earlier in the detailed description. Three or more stabiliser pads **63** are extended against the inner surface of the production casing **23** and when retracted is flush with the outside diameter of the stabiliser housing **72**. The input rotational power source **8** rotates the drill pipe **45**, the heavy weight drill pipe **5** and the casing cutting and window milling bottom hole assembly **29** connected to the male or female tool connector or engagement means **86** at the low-speed end **222**.

The lower assembly **115** is isolated from the shaft **99** by a sealed shaft bearing **102**. The hydraulic, electrical and pneumatic power system **129** provides power to operate the stabiliser jacking mechanism **67** and the lever powered jacking system **160**.

Although only as single stage gear system is indicated, any number of stages in series may be included in the device dependent on the application and the speed of rotation required at the high-speed end **223**.

The central tool shaft comprises an upper shaft **99** with two or more adjustable nozzle profiles **143** on the outer circumference, connected to an upper and lower solid or hollow window milling and casing cutting rotating shaft **164** separated by one or more orientable cardon mechanisms **161** to orientate the casing cutting and window milling head **168** from a horizontal to an inclined elevation in a vertical well.

The sealed bearing housing **165** around the lower solid window milling and casing cutting rotating shaft **164** may be connected by a hinged mechanism or similar to a lever **163** and lever powered jacking system **160**.

The circulation bore **105** enters the top of the tool with fluid circulation to cool the casing cutting and window mill outward shaped cutting profile **169** with or without shaped regenerative cutters. This is achieved by jetting through the two or more adjustable nozzle profiles **143** in a downwards direction against the tool outer housing **84** (not shown in this figure) and the top of the casing cutting and window milling head **168**.

The adjustable circulation nozzle profiles **143** can be replaced and connected to extension flexible hoses when the window milling and casing cutting rotating shaft **164** is hollow. The flexible hoses can be attached to the window milling and casing cutting rotating shaft **164** to allow circulation through the shaft and the adjustable sized guide with cutting profile **172**. This aids with keeping the window mill outward shaped cutting profile **169** clear of milled debris with a return path for the circulation fluid via the inside diameter of the production casing **23** and the outside diameter of the outer housing **84**.

The bottom of the casing cutting and window milling assembly **119** consists of a casing cutting and window milling head **168** with an attachment for a solid or hollow adjustable sized guide with cutting profile **172**. The dimensions of the solid or hollow adjustable sized guide with cutting profile **172** can be sized to suit the production casing **23** inside diameter and planned angle of orientation of the casing cutting and window milling head **168**.

When the casing cutting and window milling assembly **119** is used to cut casing and is positioned at the top of the casing cut **32** in the production casing **23**, the casing cutting and window milling head **168** can be orientated by the hinged lever **163** and the lever powered jacking system **160** and a section of the production casing **23** cut with high speed and low downward weight utilising the single stage gear system. The device may then be rotated a third of a turn for example using surface rotation of the top of the drill pipe **45** and the remaining section of the production casing **23** cut.

When the casing cutting and window milling assembly **119** is used to mill a window at the planned top of the window length to be milled **32**, the casing cutting and window milling head **168** can be orientated by the hinged lever **163** and lever powered jacking system **160**. The rotation of the drill pipe **45** results in high rotational speed of the shaft **99** connected to the single stage gear system. The planned top of the window length to be milled **32** may then be cut while lowering the casing cutting and window milling assembly **119** monitoring the up and down weights indicated on the drill string weight indicator **47**.

Figure 29 is an isometric view of the casing cutting and window milling assembly **119** with its outer housing **84** in an inclined well bore production casing **23** with parts of the casing being rendered transparent and the window milling head **168** in its initial position. The three or more stabiliser pads **63** are extended against the inside of the production casing **23**. The sealed assembly isolating bearing **121** allows the upper assembly **114** to rotate without rotating the stabiliser housing **72** when the three or more stabiliser pads **63** are extended.

Movement in an upwards or downwards direction of the hinged lever system **163** attached at the bottom to the sealed bearing housing **165** and at the top to the lever powered jacking system **160** can orientate the casing cutting and window milling head **168** and the window mill outward shaped cutting profile **169** to perform the cutting or window milling operations.

The hinged lever system **163** can be activated in an upwards or downwards direction by the lever powered jacking system **160** with hydraulic power received from the hydraulic, electrical and pneumatic power system **129** positioned above and below the stabiliser base plate **122**. The planet gear shafts **194** are connected and provide rotation to the hydraulic, electrical and pneumatic power system **129** when input rotation is applied to the top tool connector or engagement means **86** maintaining a fully charged electrical storage battery **144**.

The lever powered jacking system **160** is connected directly to the stabiliser base plate **122**. When the hinged lever system **163** is activated in a downwards direction, the one or more orientated cardon mechanisms **161** orientates the casing cutting and window milling head **168** for example, against the upper surface of the inclined production casing **23** enabling the window mill outward shaped cutting profile **169** to cut the casing or mill a window in the production casing **23**. Upwards movement of the hinged lever system **163** can return the casing cutting and window milling head **168** to its initial position. Further movement upwards may move the window mill outward shaped cutting profile **169** for example, against the lower surface of the inclined production casing **23** enabling the window mill outward shaped cutting profile **169** to cut the casing or mill a window in the production casing **23**.

The sealed bearing housing **165** prevents rotation of the hinged lever system **163** and the lever powered jacking system **160** when the shaft **99** rotates.

Figure 30 shows a cross sectional view of a well assembly **2** for an upstream oil and gas well construction casing section milling operation.

The casing section milling assembly **118** can perform variable high speed casing section milling with regenerative, feeding cutting shaped profiles **112** indicated in Figure 31 and Figure 32.

The device can be run on drill pipe **43**, heavy weight drill pipe **5** and a casing section milling bottom hole assembly **34** inside the intermediate casing **27** to the production casing **23** top cut **24** of the section length to be milled **22**. The production casing **23** has previously been cut at the top cut **24** and the casing recovered to surface.

High speed rotation can be generated from the surface rotation of the top of the drill pipe **45** at the rig floor **39** and the input rotational power source **8**.

The casing section milling assembly **118** indicated comprises the single stage gear system with three or more stabiliser pads **63** extended against the inside of the intermediate casing **27**, the casing section milling head **147** and the casing section mill lower ported adjustable sized guide with cutting profile **170**.

The circulation bore **105**, enters through the top of the drill pipe **45** and the drill pipe **43** with the pumping pressure indicated on the pump pressure gauge **49** which may be either digital or analogue. The drill string weight indicator **47** can be used to monitor the up and down weight of the drill string to aid with the casing section milling assembly **118** tool operational functions.

The well indicated can be made up of the blowout preventer equipment and wellhead **37**, either positioned on the seabed, mobile rig sub structure or the land rig cellar base **41**. The casing scheme may consist of a surface conductor casing **35**, surface casing **31**, intermediate casing **27** and production casing **23** all cemented in place **33**. The watered-out perforations **26** in the production casing **23** may have been isolated with a cement plug **28** with the bottom casing shoe cement sealed **20**.

Figure 31 is an isometric view of the casing section milling assembly **118** with an upper tool connector or engagement means **86** with either a right or left hand thread connected to the top of the circulation chamber **109** and with the outer housing **86** and the casing portions **23**, **27** being partially cut away.

Figure 32 is a cross sectional isometric view of the assembly **118** shown in Figure 31. The casing section milling assembly **118**.

The outer housing **84** has been removed to display the internal components and can be connected to the top of the upper assembly **114** with a sealed bearing mechanism **138** as indicated in Figure 13. Permanent fixing can be made at the stabiliser base plate **122** and the upper plate **148** with the outer housing **84** extending down to above the section milling head circulation channels **141**.

The casing section milling head **147** is positioned at the top of the planned casing section length to be milled **22** at the previously production casing **23** top cut **24**.

The single stage gear system is indicated with three or more stabiliser pads **63** extended against the inside of the intermediate casing **27** positioned on the stabiliser base plate **122**. The assembly converts the rotational speed of the casing section milling bottom hole assembly **34** connected to the male or female tool connector or engagement means **86** at the low speed end **222** to a variable higher speed at the casing section milling head **147** high speed end **223**. Although one stage is indicated the casing section milling assembly **118** may comprise any number connected in series in order to increase the rotational speed at the high speed end **223**.

Section milling fluid enters the circulation bore **105** through the shaft **99** partly exiting through the casing section mill lower nozzle ported adjustable sized guide **170** and with circulation cooling bores **171** through the casing section milling head **147** connected to the surface regenerative cutting shaped profile **112** channels. The return circulation path may partly bypass around the casing section milling head **147** with the remaining flow upwards through the section milling head circulation channels **141**, between the inside diameter of the intermediate casing **27** and the outside diameter of the outer housing **84**.

The nozzle profile size can be adjusted dependent on how much flow is required through the nozzle ported adjustable sized guide **170** or around through the surface regenerative cutting shaped profiles **112**.

The casing section mill lower nozzle ported adjustable sized guide **170** can be any size of outside diameter with a maximum being the drift size of the production casing **23** to be section milled. Circulation may cool the surface regenerative cutting shaped profiles **112**, maintain the casing section milling head **147** clear of milled debris and circulate the milled cuttings to surface via the annulus between the outer housing **84** and the intermediate casing **27**.

The casing section milling head **147** has on its exterior surface regenerative cutting shaped profiles **112** activated by three or more telescopic hydraulic-electrical controlled jacking devices **142** attached to the underside of the stabiliser base plate **122**, powered by the hydraulic, electrical and pneumatic power system **129** positioned above and below the stabiliser base plate **122**. The planet gear shafts **194** are connected and provide rotation to the hydraulic, electrical and pneumatic power system **129** when input rotation is applied to the upper tool connector or engagement means **86** thereby maintaining a fully charged electrical storage battery **144**.

The mechanism for feeding the regenerative cutting shaped profiles **112** is by means of forcing downwards utilising the three or more telescopic hydraulic-electrical controlled jacking devices **142** the upper plate **148** against the regenerative cutting shaped profiles **112** encased in fixed cylinder housings **151** attached to the base of the lower rotational plate **146**. This compresses the spring mechanism **145**. The upper plate **148** is isolated from the shaft **99** by a sealed shaft

bearing **102** and from the lower rotational plate **146** and the outer housing **84** by a full diameter sealed thrust bearing **137**.

The compressed spring mechanism **145** returns the regenerative cutting shaped profiles **112** back inside the casing section milling head **147** when the jacking force is released thereby maintaining them free from locking with any corrosion or fluid debris.

An alternative means of locking the regenerative cutting shaped profiles **112** once extended can be to install a ratcheting mechanism to the upper non-rotational plate **148** to hold the plate in position thus allowing the jacking devices **142** not to be constantly activated by hydraulic pressure and only used when extending the regenerative cutting shaped profiles **112**. Once the section length to be milled **22** indicated in Figure 30 has been completed the ratchetting mechanism can be disengaged and the regenerative cutting shaped profiles **112** retracted from the casing section milling head **147** by the compressed spring mechanism **145**.

Figure 33 shows a cross sectional view of a well assembly for an upstream oil and gas well construction casing operation. The multiple stage friction welding **175** tool assembly comprises the high speed multiple stage gear system **111** as indicated in Figure 34.

The illustrated embodiment includes four single stage gear systems. Any number of stages can be used dependent on the rotational speed required at the high-speed end **223**.

The multiple stage friction welding **175** tool assembly can perform high speed friction welding with one trip of the assembly.

A fish **117** may have been left in the open hole section **21** as a consequence mechanical failure. Attempts may be made to recover the fish with conventional fishing equipment or with the combination fishing milling stabilised automated drilling tool **17** as described above.

The multiple stage friction welding **175** tool assembly provides the option to friction weld and blank off the inner bore of the solid or hollow metallised item **180** if required. Attempts may then be made to recover the fish **117** or release from the fish **117** at the friction welding tool safety joint **176**.

The fish **117** length components can be made up of a drill bit **6**, a near bit stabiliser **3**, drill collars **9** with a spiral or flat profile, string stabiliser **7** and the solid or hollow metallised item **180** to be high speed friction welded and blanked off utilising the inner insulation shaped friction welding conical profile **178** inside the outer adjustable sized friction welding housing **184**.

Above the outer adjustable sized friction welding housing **184** is the friction welding tool safety joint **176** with easy release with anticlockwise rotation.

The multiple stage friction welding **175** tool assembly can be run on drill pipe **43**, heavy weight drill pipe **5** and a friction welding bottom hole assembly **25** to above the upper end **11** of the fish **117** in preparation to weld and blank off the fish **117** length components.

The multiple stage friction welding **175** tool assembly comprises in this example of four single stage gear systems, each with the three or more stabiliser pads **63** which may be extended against the open hole section **21** above the friction welding tool safety joint **176**.

The multiple stage gear system **111** can provide a variable high speed rotation dependent upon the surface rotation of the top of the drill pipe **45** at the rig floor **39** and the input rotational power source **8**.

The circulation bore **105**, is through the top of the drill pipe **45** and the drill pipe **43** with the pumping pressure indicated on the pump pressure gauge **49** which can be either digital or

analogue. The drill string weight indicator **47** can be used to monitor the up and down weight of the drill string to aid with the multiple stage friction welding **175** tool functions.

The well indicated can be made up of the blowout preventer equipment and wellhead **37**, either positioned on the seabed, mobile drilling rig substructure or land rig cellar base **41**. The casing scheme may consist of a surface conductor casing **35**, surface casing **31**, intermediate casing **27** and production casing **23** all cemented in place **33**.

Figure 34 is a cross sectional view of the multiple stage friction welding **175** tool assembly inside a containment structure **113** with the outer housing **84** not shown.

The upper section consists of a multiple stage gear system **111** comprising four single stage gear systems connected in series.

The hydraulic, electrical and pneumatic power system **129** positioned above and below the stabiliser base plate **122** provides power to operate the stabiliser jacking mechanism **67**. This may not be required in the situation when a solid stabiliser arm length is being used with the stabiliser ends attached to the internal surface of the containment structure **113**, for example by welding or screwing.

The lower section of the multiple stage friction welding **175** tool assembly comprises a friction welding tool safety joint **176** with outer body circulation channels connected to the lower part of the multiple stage gear system **111**.

The components below the friction welding tool safety joint **176** comprise the lower fishing neck profile **183** and the outer adjustable sized friction welding housing with circulation channels **184** with a shaped external washover cutting profile **179** at the lower end. The outer adjustable sized friction welding housing with circulation channels **184** has an inner shaped conical profile **178** which rotates at high speed against the top of the solid or hollow metallised item **180** generated from the high-speed end **223** of the multiple stage gear system **111**.

The inner shaped conical profile **178** may be any suitable shape for the welding application.

Variable rotation at the low speed end **222** creates high-speed rotation at the high-speed end **223** dependent on the number of stages installed and the input rotational power source **8**.

Figure 35 is an isometric view of a single stage friction welding **174** assembly without a containment structure **113** illustrating in further detail the lower stage of the multiple stage friction welding **175**.

The female box of the friction welding tool safety joint **176** is easy to release with anticlockwise rotation and is made up to a friction welding male pin end safety joint sub **182** as part of the friction welding connection cross over sub **181** which attaches to the shaft **99** extending below the lower assembly **115**.

The hydraulic, electrical and pneumatic power system **129** positioned above and below the stabiliser base plate **122** may provide power to operate the stabiliser jacking mechanism **67** if required.

The components below the friction welding tool safety joint **176** comprise the lower fishing neck profile **183**, the adjustable sized shaped friction welding head **177** with inner shaped conical profile **178**, the outer adjustable sized friction welding housing with circulation channels **184** with a shaped external washover cutting profile **179** at the lower end. The high-speed rotation of the inner shaped conical profile **178** mating with the top of the solid or hollow metallised item **180** can create the high temperature required to friction weld.

Extension body lengths can be attached to the outer adjustable sized friction welding housing with circulation channels **184** dependent on the length of the solid or hollow metallised item **180** to be washed over, if required.

Friction welding heat is generated by the inner conical profile rotating at a high speed with weight against the internal diameter of the circulation bore **105** of the solid or hollow metallised pipe item **180**.

Figure 36 is an isometric view of a vertical or horizontal dual water turbine unit **201** which comprises as part of the equipment a multiple stage gear system **111** for clockwise rotation and a gear system **206** for anti-clockwise rotation. Each system comprising a number of single stage gear systems as described earlier in the detailed description connected in series and installed inside vertical containment structures **113**.

Figure 37 is a plan view of the dual water turbine unit **201** shown in figure 36 with one or more grouped arrow shaped vertical or horizontal dual water turbine units **271** connected together for a larger flowing system. Any number can be grouped where each unit has unobstructed current flow **250** either river, tidal or any other water flow.

In this instance the rotational power source **8** applied to the shaft **99** at the low speed end **222** is created by the current flow **250** entering the arrow shaped debris protection mesh **202** through the venturi shaped vertical housing **203** and between the vertical bladed turbine **204** and **205** rotating against each other. The turbine shafts **212** coupled to the drive mechanisms **208** on the submerged or not lower drive mechanism base support **210** rotate the activation shafts **99** connected to the low speed end **222** of the high speed multiple stage gear system **111** for clockwise rotation and the high speed stabilised multi-functional gearing energy system **206** for anti-clockwise rotation.

As an alternative to the vertical bladed turbine **204** an anti-clockwise rotational upper horizontal bladed turbine **253** can be used and a clockwise rotational lower horizontal bladed turbine **251** used to replace vertical bladed turbine **205**. In this case a venturi shaped double horizontal housing **252** would replace the venturi shaped vertical housing **203** guiding the current flow between the upper horizontal bladed turbine **253** and the lower horizontal bladed turbine **251** rotating against each other.

The rotation of the bladed turbines rotate the horizontal turbine drive shafts **254** connected to internal shafts, inside the front two fixing or piling guide conduits **211** using a bevel gear mechanism or any other means. The internal shafts are connected to the activation shafts **99** at the low speed end **222** of the high speed multiple stage gear system **111** for clockwise rotation and the high speed stabilised multi-functional gearing energy system **206** for anti-clockwise rotation.

Electrical power can be generated at the high speed end **223** by the electrical generators **207** situated on the generator base support **209** elevated above the maximum current flow level in a dry environment.

The horizontal turbine system can be used for shallow fast current flow **250** or tidal flow currents.

The three or more stabiliser pads **63** of each of the lower assemblies **115** assemblies reference Figure 1 housed in the vertical containment structures **113** can be any shape and fixed to the internal surface of the containment structures **113** by means of a matching internal profile to maintain stability and non-rotation, or welded in place or attached by any means through the outside body.

The vertical or horizontal dual water turbine unit **201** can be used where there is unobstructed current flow **250** either river, tidal estuary or any other water flow.

The arrow or chevron shaped debris protection mesh **202** can be design shaped in any way to satisfy the environmental conditions and to reduce debris build up.

Each vertical or horizontal dual water turbine units **201** can be transported in separate manageable parts dependent on the means of transport, reassembled and floated to their planned location to aid access and use for remote areas.

Once at the required installation position each unit can be secured utilising four fixing and piling guide conduits **211** with the base of each vertical or horizontal dual water turbine unit **201** positioned above the fluid bed to allow access underneath or to the sides for species movement and to increase the current flow **250** through the venturi shaped vertical housing **203** or the venturi shaped double horizontal housing **252**.

The four fixing and piling guide conduits **211** may contain the fluid bed fixing pin devices, for example an auger with a right hand and left hand auger flight, which can be connected to the high speed multiple stage gear system **111** for clockwise rotation or the high speed stabilised multi-functional gearing energy system **206** for anti-clockwise rotation.

The fixing pin devices can be rotated clockwise or anti-clockwise to a consolidated formation utilising the power from the anti-clockwise rotational vertical bladed water turbine **204** and the clockwise rotational vertical bladed water turbine **205** coupled using the drive mechanisms **208** to the low speed end **222** and the shaft **99**.

The drive mechanisms **208** can be belt, chain driven or any mechanical rotational transmission system.

The arrow or chevron shaped debris protection mesh **202** can be selected to stop debris entering the venturi shaped vertical housing **203** or the venturi shaped double horizontal housing **252** and to deflect debris away from the arrow point but can be design shaped in any way to satisfy the environmental conditions and to reduce debris build-up.

The multiple stage gear system **111** in the containment structure **113** can create variable high speed clockwise rotation at the high speed end **223**, generating electrical power from the electrical generators **207** situated on the generator base support **209** elevated above the maximum current flow level in a dry environment.

The variable high speed multiple stage gear system **206** in the containment structure **113** can convert the anti-clockwise rotation at the low speed end **222** to variable high speed clockwise rotation at the high speed end **223**, creating electrical power from the electrical generators **207** situated on the generator base support **209** above the maximum current flow level in a dry environment.

Figure 38 is a plan view of a water current power generation system **213**.

The water current power generation system **213** comprises and utilises the multiple stage gear system **111**.

The high speed multiple stage gear system **111** consists of a number of single stage gearing systems connected in series, installed inside a horizontal containment structure **113** supported on the hydro-power base structure support frame **219** further indicated in Figure 40.

The method described for obtaining variable high speed rotation when supplying an input rotational power source **8** which may create either clockwise or anti-clockwise. In this instance the rotational power source **8** applied to the low speed end **222** shaft **99** is created by the water current flow through the venturi water collection opening **226**.

The three or more stabiliser pads **63** of the lower assembly **115** may be any shape and fixed to the internal surface of the horizontal containment structure **113**. For example, the containment structure **113** may have a matching internal profile to maintain stability and non-rotation, or the three or more stabiliser pad blades **63** can be welded in place or attached by any means through the outside body.

The water current flows through the arrow shaped debris protection mesh **202** over the hydro-power base structure **218** and structure support frame **219** through the venturi water collection opening **226**.

The electrical power generator **220** is positioned above the high-speed end **223** of the high speed multiple stage gear system **111**. The high-speed rotation pulley **224** drives the electrical power generator **220**.

Figure 39 is a schematic side elevation of the embodiment shown in Figure 38 of a water current power generation system **213**.

The water current flows through the arrow shaped debris protection mesh **202** over the hydro-power base structure **218** and structure support frame **219** through the venturi water collection opening **226** into the water current collection funnel **214**.

The venturi water collection opening **226** increases the flow speed which is used to rotate the hydro-power turbine generator **215** and generator rotation shaft **216** connected by a drive mechanism **217** to the shaft **99** at the low speed end **222**.

The drive mechanism **217** can be belt, chain driven or any mechanical rotational transmission system.

Fluid may flow through shaft **99** to cool down the internal components of the multiple stage gear system **111**.

At the high speed-end **223**, the high speed rotation of the shaft **99** is connected to the high speed rotation end chain drive or other mechanism **217** driving the high speed rotation pulley **224**. This in turn is connected to the power generator shaft **221** of the electrical power generator **220** converting variable high speed rotations into electrical power.

The electrical power generator is positioned on a support base **225**, suitably sized to place the electrical generator above the maximum expected water level.

Figure 40 is an isometric view of the device illustrated in Figures 38 and 39 where the water current power generation system **213** has been converted to a water pumping system **185**. The water pumping system **185** includes and utilises the multiple stage gear system **111**.

At the high speed end **223** the water pump **186** positioned on the support base **225** is powered by the high-speed rotation of the shaft **99** connected to the chain drive or other mechanism **217**, driving the high-speed rotation pulley **224**.

Water is sourced from the mesh protected water pump suction inlet **187** below the river water level and is pumped out via the water pump outlet **188** which can deliver water to a higher level.

The water pumping system **185** may be used to pump and store water at a higher level for example from a valley to a mountain side, to generate electrical power when required, to supply water for an irrigation system, to fill storage tanks or helicopter transportable mobile storage tanks for firefighting or to supply water for domestic or industrial purposes.

Figure 41 is a schematic side elevation of a vertical wind power electrical generation system **228** comprising a multiple stage gear system **111** consisting of a plurality of single stage gear

systems as describe earlier in the detailed description connected in series, installed inside a vertical containment structure **113** encompassed and housed in a wind power vertical tower structure **230** supported on a wind power base platform **229**.

In this embodiment the input power source **8** is the wind rotating the wind powered propeller blade **232**.

The three or more stabiliser pads **63** of each of the lower assemblies **115** can be any shape and may be fixed to the internal surface of the vertical containment structure **113**. For example, the containment structure **113** can have a matching internal profile to maintain stability and non-rotation, or the three or more stabiliser pad blades **63** can be welded in place or attached by any means through the outside body.

Any appropriate shape of stabilisers and/or stabiliser pads **63** may be used.

The wind powered propeller blade **232** can be connected to the horizontal low speed drive shaft **240** operating the gearing room structure **234** converting high torque of the generated low propeller speed to high speed rotation of the gearing room vertical drive shaft **239** supported on the gearing room base support **233** at the top end of the vertical tower structure **230**.

The drive mechanism **235** which rotates the rotation shaft end housing **236** connected to the shaft **99** at the low speed end **222** converts variable low speed to variable high speed rotation at the high-speed end **223**. The drive mechanism **235** can be chain driven or any mechanical rotational transmission system.

At the high-speed end **223** the shaft **99** is joined by the electrical generator drive connection **237** to the generator rotation shaft **238** generating power from the electrical generator **231**.

Fluid or gas may flow through shaft **99** to cool down the internal components of the multiple stage gear system **111**.

The wind power vertical tower structure **230** may either be stand alone or included as part of a high rise building with the wind generating system on the roof of the structure. The vertical multiple stage gear system **111** may contain along the vertical containment structure **113**, outlets for right angled rotational power transmission shafts **126** as explained with reference to Figure 7. The right angled rotational power transmission shafts **126** have higher rotational speeds moving from the low speed end **222** at the top of the structure to the high speed end **223** at the base of the vertical multiple stage gear system **111**. The variable rotational speeds at different levels can be used to generate power in the building for lighting or any other suitable application.

The gearing room structure **234** can be smaller with reduced weight compared with conventional wind powered equipment and may increase the stability and decrease the dimensions and strengths of the wind power vertical tower structure **230**.

The height of the wind power vertical tower structure **230** can be selected for steady horizontal wind power used to generate variable high speed rotation at the high speed end **223**.

Figure 42 is a schematic side elevation of a vertical wind powered surface or sub-surface water pump well **241** accessing water from a subsurface aquifer reservoir **273** with a subsurface or surface pumping system **242**.

The equipment items on the ground surface generating the rotational speed of the shaft **99** are the same as those described in Figure 41 with the omission of the electrical generator **231** and inclusion of a pumping system control room with chargeable battery storage **245** with power generated from the high speed multiple stage gear system **111**.

The input power source **8** utilised is the wind rotating the wind powered propeller blade **232**. For shallower water pumping wells the input power source **8** can be by any means available such as manual in order to create high torque with low speed to the rotation shaft end housing **236** of the low speed end **222** of the shaft **99**.

The drive mechanism **235** which rotates the rotation shaft end housing **236** connected to the shaft **99** at the low speed end **222** converts variable low speed high torque to variable low torque, high speed rotation at the high-speed end **223** operating the subsurface or surface pumping system **242**. The drive mechanism **235** can be chain driven or any mechanical rotational transmission system.

The shaft **99** which can be hollow or solid extends downwards through the water production tubing **274** run inside the water well casing **243** protecting the drilled hole section.

The shaft **99** operates the subsurface pumping system **242** positioned in the subsurface aquifer reservoir **273** or at the surface with a surface pumping system **242** installed in a suitable water well completion.

Fluid or gas may flow through shaft **99** to cool down the internal components of the multiple stage gear system **111**.

The water well delivery output **244** with valve system can be connected via piping through the wind power base platform **229** or otherwise to the well bore water production tubing **274**.

Dependent on the depth of the aquifer the vertical multiple stage gear system **111** may be considered to drill the water well when the wind power vertical tower structure **230**, the wind power base platform **229** and associated equipment have been installed.

Figures 43 are schematic side elevations of ships, boats or yachts with a marine engine or wind powered propeller **189** comprising a multiple stage gear system **111** consisting of a number of single stage gear assemblies connected in series housed in a horizontal containment structure **113**.

The input rotational power source **8** in Figure 43 A is generated from the marine engine **190** output rotational power attached to the shaft **99** and in Figure 43 B generated from a wind powered propeller blade **232** connected to the gearing room structure **234** supported on the wind power vertical tower structure **230**.

Both methods of power source **8** can be available on a single vessel.

In Figure 43 B the rotation of the vertical drive shaft (not indicated) inside the vertical tower structure **230** is attached to a bevel gear change mechanism **247** in the hull of the ship, boat or yacht converting the vertical rotation to horizontal rotation of the shaft **99** at the low speed end **222**.

Orientation of the gearing room structure **234** and the wind powered propeller blade **232** can be able to maintain accessibility to any wind direction.

The three or more stabilisers or stabiliser pads **63** of the lower assemblies **115** may be any design shape and may be fixed or attachable to the internal surface of the horizontal containment structure **113**. For example, the containment structure **113** may have a matching internal profile to maintain stability and non-rotation, or the three or more stabilisers or stabiliser pads **63** can be welded in place or attached by any means to or through the containment structure **113**.

In Figure 43 A, the low speed end **222** is connected to the marine engine **190** rotational power output and in Figure 43 B the low speed end **222** is connected to the bevel gear change mechanism **247** by the shaft **99**.

In both Figures 43 A and 43 B the high speed end **223** is connected to the shaft union joint **193**, the propeller shaft **191** and the high speed propeller **192**.

The shaft **99** connects the high speed multiple stage gear system **111** to the low speed end **222** and to the high-speed end **223**.

Circulation of fluid or gas may cool the internal components of the multiple stage gear system **111** in Figures 43 A and 43 B, the gear end of the marine engine **190** in Figure 43 A and the bevel gear change mechanism **247** in Figure 43 B.

The wind powered input power source **8** can be used as a back-up for the marine engine **190**.

The multiple stage gear system **111** can contain along the horizontal containment structure **113**, outlets for rotational power transmission shafts **126** as explained with reference to Figure 7. The rotational power transmission shafts **126** have higher rotational speeds as the speed increases from the low speed end **222** to high speed end **223** and can be used to generate power for example, running bilge pumps or any other suitable marine equipment requirement.

Figure 44 is a vertical isometric view of a power ratchet screw driver or drill **255** with manual, electric, hydraulic or pneumatic drive utilising the multiple stage gear system **111**.

The containment structure **113** with a side support handle **269** houses any number of single stage high speed gear systems connected in series, dependent on the rotational speed required at the high speed end **223**.

The side support handle **269** can be included for stability and to facilitate the use of the tool. The screw driver handle **257** can be powered by hand, electric, hydraulic or pneumatic motor. A ratchet spiral **258** is attached to the screw driver handle **257** with a locking mechanism **259** to enable right only, left only or both rotations and increases the rotation at the low speed end **222**.

Rotation of the low speed end **222** creates high speed at the high-speed end **223** via the housed high speed multiple stage gear system **111**.

The three or more stabilisers or stabiliser pads **63** of each lower assembly **115** inside the containment structure **113** may be of any shape or design and may be fixed to the internal surface of the horizontal containment structure **113**. For example, the containment structure **113** can have a matching internal profile to maintain stability and non-rotation of the three or more stabiliser arm ends or stabiliser pads **63** or the three or more stabilisers may be welded in place or attached by any means to or through the containment structure **113**.

Drill bit accessories **256**, for example, screw heads, milling heads, sanding heads, routers or any application requiring high speed can be installed with the fixing attachment chuck and draw **260**.

Figure 45 is a vertical isometric view of a hand power drill **261** utilising the multiple stage gear system **111**.

The containment structure **113** may contain any number of single stage gear systems connected in series, dependent on the rotational speed required at the high speed end **223**.

The power drill main handle **267** can be shaped round for hand use or curved to suit a human shoulder or any suitable shaped profile and can be attached to the handle support body **272** with a secondary side support **268**. The hand and power drill side support handle **270** can be

opposite the turning handle **265** which creates the input power source **8** which can be either clockwise or anti-clockwise rotation applied to the drive wheel **264** of the upper pinion **262** and the lower pinion **263** imparting clockwise or anti-clockwise rotation of the shaft **99** at the low speed end **222**.

As an alternative, the turning handle **265** connected to the multiple stage gear system **111** can be replaced with a bicycle pedal gear individually or grouped. This can convert rotational energy to electrical power from a generator connected to the fixing attachment chuck and draw **260** to create for example electricity to heat water for a health club swimming pool.

The three or more stabiliser pad blades **63** of each stage of the adjustable stabiliser power generating and control room **115** assemblies inside the containment structure **113** can be any shaped design and fixed to the internal surface of the containment structure **113**. For example, the containment structure **113** can have a matching internal profile to maintain stability and non-rotation of the three or more stabiliser pad blades **63** or the three or more stabiliser pad blades **63** may be welded in place or attached by any means through the outside body.

Attached to the high-speed end **223** can be the fixing attachment chuck and draw **260** for the drill bit accessories **256**, for example screw heads, drills, milling heads, sanding heads, routers or any application requiring high speed.

Figure 46 is a horizontal isometric view of a mixing system **277** utilising a multiple stage gear system **111** housed in a containment structure **113**.

The containment structure **113** contains any number of single stage gear systems connected in series, dependent on the rotational speed required at the high speed end **223**.

The input rotational power source **8** can be from an alternating current or direct current electrical, hydraulic, or pneumatic motor to provide rotation of the shaft **99** at the low speed end **222**. In the illustrated mixing system **277**, the motor power input **8** has been selected as electrical with an electrical plug **279**, connected by electrical wiring **278**. High torque and low speed rotation at the low speed end **222** is converted by the multiple stage gear system **111** to high speed with low torque at the high-speed end **223**.

Attached to the high-speed end **223** of the shaft **99** are the female **281** and the male **282** quick union connections and shaft **284** with the mixing head **283** or any other shaped accessory.

The double handle **280** can be required to prevent any rotation of the containment structure **113** caused by re-active torque generated while mixing and can be lowered or elevated utilising the adjustable double handle slot holding **285**.

The three or more stabiliser pad blades **63** of each stage of the adjustable stabiliser power generating and control room **115** assemblies inside the containment structure **113** can be any shaped design and fixed to the internal surface of the containment structure **113**. For example, the containment structure **113** can have a matching internal profile to maintain stability and non-rotation of the three or more stabiliser pad blades **63** or the three or more stabiliser pad blades **63** may be welded in place or attached by any means through the outside body.

The power mixing system **277** can be converted for alternative applications by attaching different shaped accessories such as a liquid pumping system utilising an auger scroll for example positioned in a casement where the outside diameter of the auger scroll is slightly smaller than the inside diameter of the casement.

Other examples can be a conversion to a portable hammer drill or a portable boat propeller with a battery supply.

Figure 47 is a horizontal isometric view of a rotary handled power drill **286** with a manual front power handle **289** drive utilising the high speed multiple stage gear system **111** inside the containment structure **113**.

A manual power source can be required with variable high speed achieved in order to reduce noise emissions.

The containment structure **113** with adjustable positioned side support handle **287** houses any number of single gear systems connected in series, dependent on the rotational speed required at the high speed end **223**.

The manual front power handle **289** powered by hand is attached to the outer casing **57** of the first planetary gear system enabling right or left hand rotation at the low speed end **222**.

Rotation of the low speed end **222** creates high speed at the high-speed end **223** via the housed multiple stage gear system **111**.

The three or more stabiliser pad blades **63** of each stage of the adjustable stabiliser power generating and control room **115** assemblies inside the containment structure **113** can be any shaped design and fixed to the internal surface of the containment structure **113**. For example, the containment structure **113** can have a matching internal profile to maintain stability and non-rotation of the three or more stabiliser pad blades **63** or the three or more stabiliser pad blades **63** may be welded in place or attached by any means through the outside body.

The adjustable positioned side support handle **287** is required to prevent any rotation of the containment structure **113** caused by re-active torque generated and can be lowered or elevated utilising the adjustable side handle slot holding **288**.

Drill bit accessories **256** such as screw heads, drills, milling heads, sanding heads, routers or any application requiring high speed can be installed utilising the male **282** and female **281** quick union connections.

Figure 48 is a cross sectional view of a well assembly **14** for a well bore oil production pumping system **296** for heavy oil or any other produced fluid. The pumping unit **306** comprises a single stage or multiple stage gear system connected to an Archimedes type screw pump **297** to pump and produce heavy waxy oil or other well bore fluids from the perforations **26** in a subsurface oil well.

The Archimedes type screw pump **297** can be made of any material to suit the pumping and fluid composition requirements.

In heavy waxy oil situations, the viscosity can be reduced by injecting steam from the surface into the circulation bore **105**, through the shaft **99** and out through the perforated section **298** and into the perforations **26**. After soaking for a period of time the heavy waxy oil can be lifted and pumped out through the annulus between the outer surface of the Archimedes type screw pump **297**, the shaft **99** and the inner surface of the production tubing **305** exiting through the production flow line **302**.

To improve production while pumping and lifting the heavy oil or other well bore fluids, steam, oil associated gas, Nitrogen, wax inhibitor, scale inhibitor or any other fluid chemical can be injected down the shaft **99** and out through the perforated section **298** or via a one way valve or other situated where required along the shaft **99** into the production stream. Produced oil associated gas can be pumped through the circulation bore **105** and commingled with the pumped oil improving production utilising gas lift. In other situations oil can be produced naturally under its own pressure upwards through the circulation bore **105** of the shaft **99** as well as being pumped and lifted with the Archimedes type screw pump **297**.

Each pumping unit **306** in the well schematic comprises a single stage or multiple stage gear system connected to the Archimedes type screw pump **297**. Each unit can be spaced out in series along the production tubing **305** and joined together by the shaft **99** to the outer housing **57** of the circulation chamber **109** as detailed in Figure 1.

One or more pumping units **306** can be installed dependent on the well depth and the particular application to achieve a regulated pumping flow along the wellbore. The lower assemblies **115** may have three or more stabilisers and/or stabiliser pads **63** which may be extended against the inside of the production tubing **305**.

Each stage has its own independent shaft **99** which runs through the centre and is directly connected to the Archimedes type screw pump **297**. The top **66** of each independent shaft **99** terminates in the outer housing **57** of the circulation chamber **109** as detailed in Figure 1. When the shaft **99** rotates the Archimedes type screw pump **297** can rotate with increased rotation along the well bore.

At the top of each pumping unit **306** the top **66** of the shaft **99** is isolated from the outer housing **57** of the circulation chamber **109** by a shaft sealed bearing **102** seal as detailed in Figure 1.

The rotation speed increases along the wellbore from the low speed end **222** to the high speed end **223** dependent on the surface rotation of the top of the shaft **99** exiting through the production tree **301** attached to the top of the wellhead **303** on the production deck **304**.

The pumping units **306** may be made up as an individual assembly with the stabiliser pads extended **63** and weld attached for example to the inside of the production tubing **305** and made up and run into the well bore when installing the well completion or can be run separately as a spaced out pumping unit assembly after the production packer **299** has been set and the production tubing **305** run.

The casing scheme may consist of a surface conductor casing **35**, surface casing **31**, intermediate casing **27** and production casing **23** all cemented in place **33**. The production casing **23** shoe can be cement sealed **20**.

Figure 49 is an isometric view of the lower stage of the well bore oil production pumping system **296** inside the production tubing **305**.

The perforated section **298** if required may be connected at the connection **308** to the lower part of the shaft **99** directly connected as the central part of the Archimedes type screw pump **297**.

At the base of the lower assembly **115**, the shaft **99** is isolated from the outer housing **84** by a sealed bearing assembly **300**. The three or more stabiliser pad blades **63** are extended against the inside of the production tubing **305**.

The independent shaft **99** of the preceding stage connects to the male or female tool connector or engagement means **86** at the low speed end **222** increasing applied rotation to the single stage gear system, to a higher rotational speed at the high speed end **223**.

The circulation bore **105** can be used to inject steam, oil associated gas, Nitrogen, wax inhibitor, scale inhibitor or any other fluid chemical or as an additional production conduit.

The well bore oil production pumping system **296** indicated can be used to increase production in a conventional oil well. It can be converted to pump heavy oil through a horizontal pipeline to a port or refinery and converted to pump pigging devices through the surface production lines.

Figures 50 A and 50 B are isometric views of an electrical double or single flush mounted socket profile power drill **310** to drill square, rectangular, circle or any shaped profiles, each comprising a multiple stage gear systems **111** housed in a containment structure **113**.

The containment structure **113** may contain any number of single stage gear systems connected in series, dependent on the rotational speed required at the high speed end **223**.

The three or more stabiliser pad blades **63** of each stage of the adjustable stabiliser power generating and control room **115** assemblies inside the containment structure **113** can be any shaped design and fixed to the internal surface of the containment structure **113**. For example, the containment structure **113** can have a matching internal profile to maintain stability and non-rotation of the three or more stabiliser pad blades **63** or the three or more stabiliser pad blades **63** may be welded in place or attached by any means through the outside body.

The input rotational power source **8** can be from an alternating current or direct current electrical, hydraulic, or pneumatic motor **329** or any other source of power rotation to provide rotation of the shaft **99** at the low speed end **222**.

The containment structure **113** side support handle **287** can be elevated up or down along the adjustable side handle slot holding **288**. The lower drill base handle **311** provides extra handling for the device.

Attached to the quick union female **281** and male **282** connections is the variable high speed drive shaft **328** connected to the central double gear cog **315** of the upper gear support plate **312**.

The variable high speed drive shaft **328** with clockwise rotation, rotates clockwise the top and bottom of the central double gear cog **315** directly below on the lower gear support plate **313** and anti-clockwise the top and bottom of the double gear cogs **315** on either side of the central double gear cog **315**. The eight single gear cogs **314** on their cog shafts **331** on the upper gear support plate **312** attached to the drilling bits **330** are driven by the central and double gear cogs **315** which can rotate without conflict, the inner one rotating clockwise and the outer one rotating anti-clockwise.

The bottom gear cog of the three double gear cogs **315** on the lower gear support plate **313** can rotate without conflict and drive clockwise the middle single gear cog **314** on each of the outer rows with the adjacent single gear cog **314** rotating anti-clockwise and the outer peripheral single gear cog **314** clockwise, as seen from the top of the upper gear support plate **312**.

The bottom gear cog of the central double gear cog **315** on the lower gear support plate **313** can drive the inner row and rotate the inner single gear cogs **314** anti-clockwise and the outer single gear cogs **314** clockwise, as seen from the top of the upper gear support plate **312**.

Drilling bits **330** or other devices can be attached to the cog shafts **331** of the total of fourteen single gear cogs **314** on the lower gear support plate **313**. The central extended drilling bit **330** attached to the central double gear cog **315** shaft is longer than the others in order to drill a pilot hole and act as a fixment to the surface drilled before the other drilling bits **330** commence drilling holes.

With this arrangement, a total of twenty-five drilling bits **330** may rotate to perform the task required. Any number of drilling bits **330** can be used. The shape of the gear support plates **313** are indicated to be square but can be designed for any shape required for the application.

The components such as gear cogs may be smooth, toothed or any shape and manufactured with materials and strengths selected suitable for the application and the environmental conditions.

Figure 51 is an isometric view of a domestic or industrial air or liquid vacuum appliance **316** comprising the multiple stage gear system **111** housed in a containment structure **113**.

The containment structure **113** may contain any number of single stage gear systems connected in series, dependent on the rotational speed required at the high speed end **223**.

The input rotational power source **8** can be from an alternating current or direct current electrical motor **321** with electrical power from the electrical storage rechargeable sealed battery **320** creating rotation of the shaft **99** at the low speed end **222**. High torque and low speed rotation at the low speed end **222** can be converted by the multiple stage gear system **111** to high speed with low torque at the high-speed end **223**.

Attached to the high-speed end **223** of the shaft **99** is the reduction coupling with internal vacuum mechanism **319** connected to an upper **322** and lower **323** ball joint to support the electrical storage rechargeable sealed battery **320** and provide appliance stability. The vacuum head **324** including the roller mechanism **325** connects to the lower **323** ball joint.

The device can be utilised to air or fluid vacuum with the dust, debris or fluid being vacuumed up via the hollow shaft **99** to the removable collection bag or tank **317** situated below the alternating current or direct current electrical motor **321** and the device handle **317**.

The three or more stabiliser pad blades **63** of each stage of the adjustable stabiliser power generating and control room **115** assemblies inside the containment structure **113** can be any shaped design and fixed to the internal surface of the containment structure **113**. For example, the containment structure **113** can have a matching internal profile to maintain stability and non-rotation of the three or more stabiliser pad blades **63** or the three or more stabiliser pad blades **63** may be welded in place or attached by any means through the outside body.

The domestic or industrial air or liquid vacuum **316** appliances can vacuum with high speed rotation for improved efficiency and can operate with reduced noise emissions resulting from the high torque lower input motor speed.

The domestic or industrial air or liquid vacuum **316** can be converted and utilised as a low noise emission drier or a low noise emission air blower.

Figure 52 is an operating block diagram for a gear system programmable control system **326** which can be digital, analogue or a combination of digital and analogue. This can be used for wellbore (**W**) fishing, window milling, casing cutting, casing section milling, friction welding, pumping operations and any other subsurface or surface operation comprising as part of the equipment a single or any number of single stage gear systems.

The gear system wireless sender and receiver (**H**) for automatic operating functions can be used for a downhole application of a gear system in a well bore (**W**) or a surface application.

Data (**X**) can be transmitted downhole generated from the monitoring and computer system (**M**) from the programmable logic controller (**A**), powered from the power source (**P**). Data (**K**) from the sensors (**E**) can be received from the gear system in the wellbore (**W**) which may be used to control the gear system (**H**) hydraulic pumps and mechanical, electrical, hydraulic and pneumatic motors and control tools (**D**).

The connection between the programmable logic controller (**A**) and the wellbore (**W**) gear system wireless sender and receiver (**H**) is by means of the wireless communication paths (**U**) and (**N**) from the wellbore (**W**).

Information from the down hole sensors (**E**) measuring torque, temperature, pressure, equipment positions, magnetic interference, camera or any other sensor (**E**) signals can be transmitted from the well bore (**W**) via the wireless communication path (**U**) and (**N**), combined with the information recorded on the one or more multi-functional analogue or digital surface gauge such as G1 for pump pressure and G2 for surface rotation may be sent to the programmable logic controller (**A**).

The general wireless network (T) and the wired network (C) can be connected to the programmable logic controller (A) and can provide the information received by the programmable logic controller (A) instantaneously to any location where required. Each network can be used separately or both together.

The downhole camera monitoring system (R) may record and transmit information into the programmable logic controller (A).

The programmable logic controller (A) can be operated by current and future software interfaces (B) suitable for monitoring the sensors (E) utilised in the gear system or future robotic devices.

Although the invention has been described with reference from a low to high however it is appreciated that the invention may be used to convert a high speed drive to a low speed drive, that is the invention may be used as a speed reducer.

The invention has been described by way of exemplary embodiments and example applications only, and it will be appreciated that variation may be made to the embodiments described without departing from the scope of the invention as defined by the claims.

Parts List

- 1 Well construction for a fishing operation
- 2 Well assembly
- 3 Near bit stabiliser
- 4 Well assembly
- 5 Heavy weight drill pipe
- 6 Drill bit
- 7 String stabiliser
- 8 Input rotational power source
- 9 Drill collars (spiral or flat profile)
- 10 Fishing neck
- 11 Upper end (of a fish)
- 12 Female end connector
- 15 Fishing neck sleeve
- 16 Tube support means
- 17 Fishing and milling tool
- 19 Fishing bottom-hole assembly
- 21 Open-hole section
- 23 Production casing
- 27 Intermediate casing
- 31 Surface casing
- 33 Cementing location
- 35 Surface conductor casing
- 36 Fishing and milling tool internal ring gear
- 37 Wellhead
- 39 Rig floor
- 40 Nozzles
- 41 Cellar base (of a land based drilling rig)
- 43 Drill pipe
- 44 Crossover sub
- 45 Upper end of the drill pipe
- 47 Drill string weight indicator
- 48 First fishing and milling casing element
- 49 Pump pressure gauge
- 50 Second fishing and milling casing element
- 51 Female locator profile
- 52 Removable hinges or other fixing mechanisms
- 53 Fishing fingers
- 54 Fishing finger support outer section
- 55 Wash-over sub
- 56 End connector
- 57 Circulation chamber housing
- 58 Lower hollow cylinder housing
- 59 Leadscrew gears
- 60 Leadscrew motors
- 61 Drilling rig elevator lifting recess profile
- 62 Stabiliser wheel
- 63 Stabiliser pads
- 64 Stop mechanism slots
- 65 Fishing and milling tool shaft mechanism
- 66 Top of shaft (99)
- 67 Stabiliser jacking mechanism

68	Stabiliser antennae
69	New design of fishing neck engagement profile
70	Thread formed on inside of wash-over sub (55)
71	Externally threaded tube
72	Stabiliser housing
74	Gap between interdigitating portions of
75	Jetting nozzle
76	Leadscrew shaft
77	Lower fishing and milling tool shaft
79	Fishing finger sensor mechanism
80	(heavy duty high speed) milling structure
81	Female milling structure connector
82	Shaft seal bearing
83	Lower shaped sub
84	Outer housing
85	Outer magnetised plate surfaces and inward facing sensors
86	Tool connector (or engagement means)
87	Slot profile
88	Upper fishing and milling tool shaft
90	Fishing finger milling and cutting profile
91	Interchangeable sized locking sub
92	Protrusions (formed on inner surfaces of the lower parts of the fishing fingers 53)
93	Plate
94	Motion sensors
95	Lower end of ball housing cylinder 97
96	Planetary gear mechanism housing
97	Ball housing cylinder
98	Fishing Finger supporting body
99	Shaft
101	Shaft end ball
102	Shaft bearing
103	Motion sensors
104	(Annular) shaft seal
105	Circulation bore
106	Upper end of ball housing cylinder 97
108	Nozzle ports in plate 93
109	Circulation chamber
110	Stop mechanism fingers
111	Multiple stage gearing system
113	Containment structure
114	Upper assembly
115	Lower assembly
116	Fishing and milling assembly
117	(illustrated) fish
118	Casing section milling assembly
119	Casing cutting and window milling assembly
120	Outer housing seal
121	Assembly isolating bearing
122	Stabiliser base plate
123	Connection (between single stage gearing systems)
124	Sun gear
125	Planet gears
126	Rotation transmitting shafts
127	Ring gear
128	Hydraulic tank, air tank and cooling system
129	Power system (optionally hydraulic, electrical and pneumatic)
130	Motor support arm

131	Power generating means
132	Central electrical, hydraulic or pneumatic control system
133	Motor gear shaft
134	Junction distributors
136	Cable conduits
138	Outer housing bearing
140	Camera and light system
144	Battery
149	Fishing and milling tool casing end plate
150	(Annular) sealing seat
152	Rotating electrical contact
153	Fishing and milling casing element ring gear mechanism
154	(Electrical hydraulic or pneumatic) motor(s)
155	Electrical transfer conduits
156	Electrical brush contacts
166	Gear meshes with ring gear (153 or 36)
174	Single stage friction welding
175	Multiple stage friction welding
189	Wind / engine powered propeller
194	Outer planet gear shafts
196	Gearing mechanisms
197	Inner planet gear shafts
198	Planetary gear set upper carrier plate
199	Fishing and milling tool shaft connector
200	Planetary gear set lower carrier plate
222	Low-speed end
223	High-speed end
227	Planet Gear shaft bearings
255	Power ratchet screw driver or drill
261	Hand powered drill

Claims

1. A modular gear system (10) which operates in a containment structure comprises: a gear assembly (124,125,127) which is housed in a first gear assembly housing (114), an input drive (222) drives the gear assembly (124,125,127) which drives an output drive shaft (99); the gear assembly (124,125,127) is sealed in the first gear assembly housing (114); the input drive (222) is operative to be driven by an output drive (223) of a second gear assembly (124,125,127), whereby in use the angular speed ($\omega_{1\text{input}}$) of the input drive (222) is different from the angular speed ($\omega_{2\text{output}}$) of the output drive (223); and at least one stabiliser (63, 67) is adapted to engage with the containment structure (113) so as to maintain the gear system in position.
2. A gear system according to claim 1 wherein a circulation chamber defines a fluid pathway through a hollow input and/or output shaft.
3. A gear system according to claim 1 wherein gear assembly housings are connected so that the axis of the output drive of a first gear assembly is coaxial with the axis of the input drive of a second gear assembly.
4. A gear system according to any preceding claim wherein the first gear assembly housing is larger than the second gear assembly housing and an output drive of the first gear assembly housing has a larger diameter than the output drive of the second gear assembly so that when the gear assembly housings are connected together they form a composite tapered assembly.
5. A gear system according to any preceding claim wherein the gear assembly comprises a sun and planetary gear set.
6. A gear system according to claim 5 wherein a gear ring retains and stabilises the planetary gear set.
7. A gear system according to claim 5 or 6 wherein the planetary gears are configured to convert a clockwise input to a counter-clockwise output, and vice versa.
8. A gear system according to any preceding claim wherein an engagement means is provided on a gear assembly, to engage with another gear assembly housing, so as to prevent the gear assembly housings from rotating one with respect to another.
9. A gear system according to any preceding claim wherein three stabilisers are provided, the stabilisers are disposed at approximately 120° one to another in order to engage with the containment structure, a wellbore or a liner.
10. A gear system according to claim 9 wherein the stabilisers are hydraulically actuated to extend and retract.
11. A gear system according to claim 9 or 10 wherein the stabilisers comprise stabiliser arms and pads and include a jacking mechanism.
12. A gear system according to any preceding claim includes a right or left hand thread connection for connecting to a tool with a male or female connection which derives torque from an output drive.
13. A gear system according to any of claims 2 to 12 wherein a circulation chamber housing is adapted to deliver a coolant, lubricant, steam, acid, brine or nitrogen.

14. A gear system according to any preceding claim wherein the second gear assembly housing has a reduced diameter conical input connected to the output drive of the first second gear assembly housing.
15. A system according to claim 4, or any claim dependent on claim 4, includes a bevel gear system which is rotated by the planetary gears and a transmission shaft provides a drive which is at right angles to an input shaft.
16. A system according to any preceding claim includes a cutting and/or milling tool.
17. A system according to any preceding claim has a casing with an internally threaded surface and a moveable extender has a threaded surface which engages with the internally threaded surface of the casing, an actuator causes relative rotation of the casing with respect to the moveable extender thereby extending/retracting the moveable extender.
18. A system according to claim 17 wherein the casing has first and second groups of interdigitated engaging portions arranged to move axially, one group with respect to another.
19. A system according to claim 17 or 18 wherein movement of the casing causes a fishing tool to close as outer casing slides over sprung fingers for grabbing an item to be fished.
20. A system as claimed in any of claims 1 to 15 is connected to a union joint or an elbow joint for transmitting torque at an angle with respect to its axis of rotational symmetry.
21. A system according to any of claims 1 to 15 includes a friction welding tool.
22. A system as claimed in any of claims 1 to 15 is connected to a pump and is arranged to pump fluids through lines or to pump a pigging device for cleaning lines.
23. A system as claimed in any of claims 1 to 15 is connected to a funnel and debris protection mesh.
24. A power tool includes the gear system according to any of claims 1 to 15.
25. A drive for a household or industrial device includes the gear system according to any of claims 1 to 15.
26. A mud motor includes the gear system according to any of claims 1 to 15.
27. An electrical generator includes the gear system according to any of claims 1 to 15 and a rechargeable battery.
28. An electrical generator according to claim 27 includes a rechargeable battery.
29. An engine includes the system as claimed in any of claims 1 to 15
30. A downhole fishing system includes the gear system according to any of claims 1 to 15.
31. A downhole fishing system according to claim 30 further comprising a mechanical fishing locking mechanism with a ring gear mechanism.
32. A downhole fishing system as claimed in claim 30 or 31 includes an interchangeable sized fishing neck sacrificial wear ring with flow by areas.
33. A downhole fishing system as claimed in any of claims 30 to 32 further comprises a fishing device whose fingers are interchangeable.

34. A downhole fishing system as claimed in any of claims 30 to 33 further comprises a magnetic plate surface and sensor so that a mechanical fishing lock mechanism is capable of controlled compression of a finger mechanism around an item being fished from a well.
35. A downhole fishing system as claimed in any of claims 30 to 34 whose external cutting profile is shaped to enable wash over and removal of debris from around a fishing tool.
36. A downhole fishing system as claimed in any of claims 30 to 35 further comprising a debris protection mesh.
37. An interchangeable connection for installing accessories downhole includes the gear system according to any of claims 1 to 15.
38. An interchangeable connection for installing accessories downhole according to claim 37 further comprises a movable ball hollow housing cylinder.
39. A system as claimed in any of claims 1 to 15 includes a wireless and/or wired communications.
40. A system as claimed in any of claims 1 to 15 includes a robotic device.
41. A system as claimed in any of claims 1 to 15 is connected to an Archimedes screw.
42. A system as claimed in any of claims 1 to 15 is included in a dual water turbine unit.
43. A method of operating a system as claimed in any preceding claim.
44. A system has a casing with an internally threaded surface and a moveable extender has a threaded surface which engages with the internally threaded surface of the casing, an actuator causes relative rotation of the casing with respect to the moveable extender thereby extending/retracting the moveable extender.
45. A fishing tool includes the system of claim 44.

AMENDED CLAIMS

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1. A modular gear system which operates in a containment structure comprising: a gear assembly which is housed in a first gear assembly housing, and wherein an input drive drives the gear assembly which drives an output drive shaft; the gear assembly is sealed in the first gear assembly housing; the input drive is operative to be driven by an output drive of a second gear assembly, whereby in use the angular speed ($\omega_{1\text{input}}$) of the input drive is different from the angular speed ($\omega_{2\text{output}}$) of the output drive shaft; and at least one stabiliser is adapted to engage with the containment structure so as to maintain the gear system in position.
2. A gear system according to claim 1 wherein a circulation chamber defines a fluid pathway through a hollow input and/or output shaft.
3. A gear system according to claim 1 wherein the gear assembly housings are connected so that the axis of the input drive of the gear assembly is coaxial with the axis of the output drive of the second gear assembly.
4. A gear system according to any preceding claim wherein the second gear assembly housing is larger than the first gear assembly housing and an output drive of the second gear assembly housing has a larger diameter than the output drive of the first gear assembly so that when the gear assembly housings are connected together they form a composite tapered assembly.
5. A gear system according to any preceding claim wherein the gear assembly comprises a sun and planetary gear set.
6. A gear system according to claim 5 wherein a ring gear retains and stabilises the planetary gear set.
7. A gear system according to claim 5 or 6 wherein the planetary gears are configured to convert a clockwise input to a counter-clockwise output, and vice versa.
8. A gear system according to any preceding claim wherein an engagement means is provided on a gear assembly, to engage with another gear assembly housing, so as to prevent the gear assembly housings from rotating one with respect to another.
9. A gear system according to any preceding claim wherein three stabilisers are provided, the stabilisers are disposed at approximately 120° one to another in order to engage with the containment structure, a wellbore or a liner.
10. A gear system according to claim 9 wherein the stabilisers are hydraulically actuated to extend and retract.
11. A gear system according to claim 9 or 10 wherein the stabilisers comprise stabiliser arms and pads and include a jacking mechanism.
12. A gear system according to any preceding claim including a right or left hand thread connection for connecting to a tool with a male or female connection which derives torque from an output drive.
13. A gear system according to any of claims 2 to 12 wherein a circulation chamber housing is adapted to deliver a coolant, lubricant, steam, or nitrogen.
14. A gear system according to any preceding claim wherein the first gear assembly housing has a reduced diameter conical input connected to the output drive of the second gear assembly housing.

15. A gear system according to claim 1, including a bevel gear system which is rotated by the planetary gears and a transmission shaft provides a drive which is at right angles to an input shaft.
16. A gear system according to any preceding claim including a cutting and/or milling tool.
17. A gear system according to any preceding claim having a casing with an internally threaded surface and a moveable extender having a threaded surface which engages with the internally threaded surface of the casing, and an actuator arranged to cause relative rotation of the casing with respect to the moveable extender thereby extending/retracting the moveable extender.
18. A gear system according to claim 17 wherein the casing has first and second groups of inter-digitated engaging portions arranged to move axially, one group with respect to another.
19. A gear system according to claim 17 or 18 wherein movement of the casing causes a fishing tool to close as outer casing slides over sprung fingers for grabbing an item to be fished.
20. A gear system as claimed in any of claims 1 to 15 connected to a union joint or an elbow joint for transmitting torque at an angle with respect to its axis of rotational symmetry.
21. A gear system according to any of claims 1 to 15 including a friction welding tool.
22. A gear system as claimed in any of claims 1 to 15 connected to a pump and arranged to pump fluids through lines or to pump a pigging device for cleaning lines.
23. A gear system as claimed in any of claims 1 to 15 connected to a funnel and debris protection mesh.
24. A power tool including the gear system according to any of claims 1 to 15.
25. A drive for a household or industrial device including the gear system according to any of claims 1 to 15.
26. A drill string including the gear system according to any of claims 1 to 15.
27. An electrical generator including the gear system according to any of claims 1 to 15 and a rechargeable battery.
28. An engine including the system as claimed in any of claims 1 to 15
29. A downhole fishing system including the gear system according to any of claims 1 to 15.
30. A downhole fishing system according to claim 29 further comprising a mechanical fishing locking mechanism with a ring gear mechanism.
31. A downhole fishing system as claimed in claim 29 or 30 including an interchangeable sized fishing neck sacrificial wear ring with flow by areas.
32. A downhole fishing system as claimed in any of claims 29 to 31 further comprising a fishing device whose fingers are interchangeable.
33. A downhole fishing system as claimed in any of claims 29 to 32 further comprising a magnetic plate surface and sensor so that a mechanical fishing lock mechanism is capable of controlled compression of a finger mechanism around an item being fished from a well.

34. A downhole fishing system as claimed in any of claims 29 to 33 with an external cutting profile shaped to enable wash over and removal of debris from around a fishing tool.
35. A downhole fishing system as claimed in any of claims 29 to 34 further comprising a debris protection mesh.
36. An interchangeable connection for installing accessories downhole including the gear system according to any of claims 1 to 15.
37. An interchangeable connection for installing accessories downhole according to claim 36 further comprising a movable ball hollow housing cylinder.
38. A gear system as claimed in any of claims 1 to 15 including a wireless and/or wired communications.
39. A gear system as claimed in any of claims 1 to 15 including a robotic device.
40. A gear system as claimed in any of claims 1 to 15 connected to an Archimedes screw.
41. A gear system as claimed in any of claims 1 to 15 included in a dual water turbine unit.
42. A method of operating a system as claimed in any preceding claim.

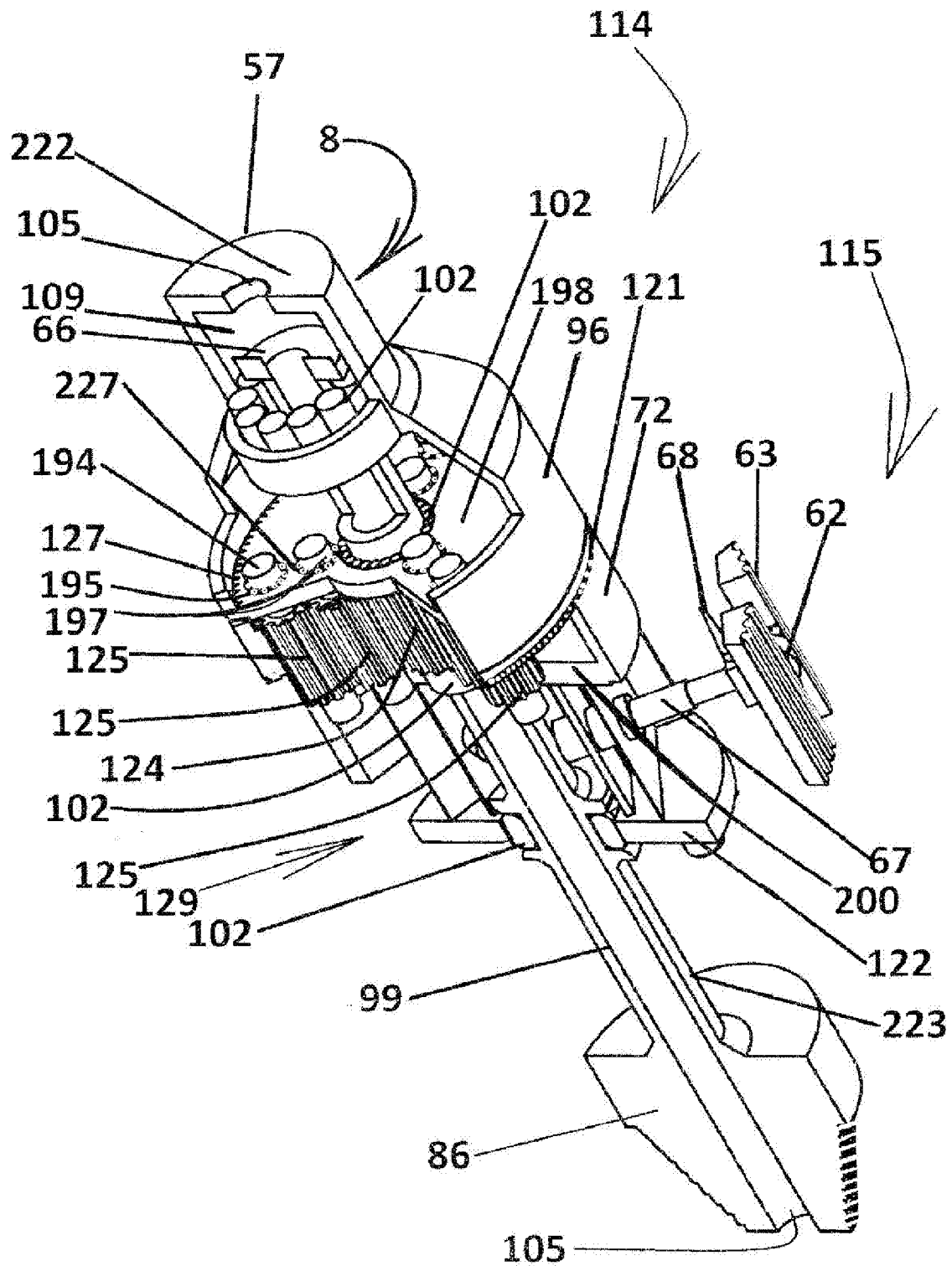


FIG.1/52

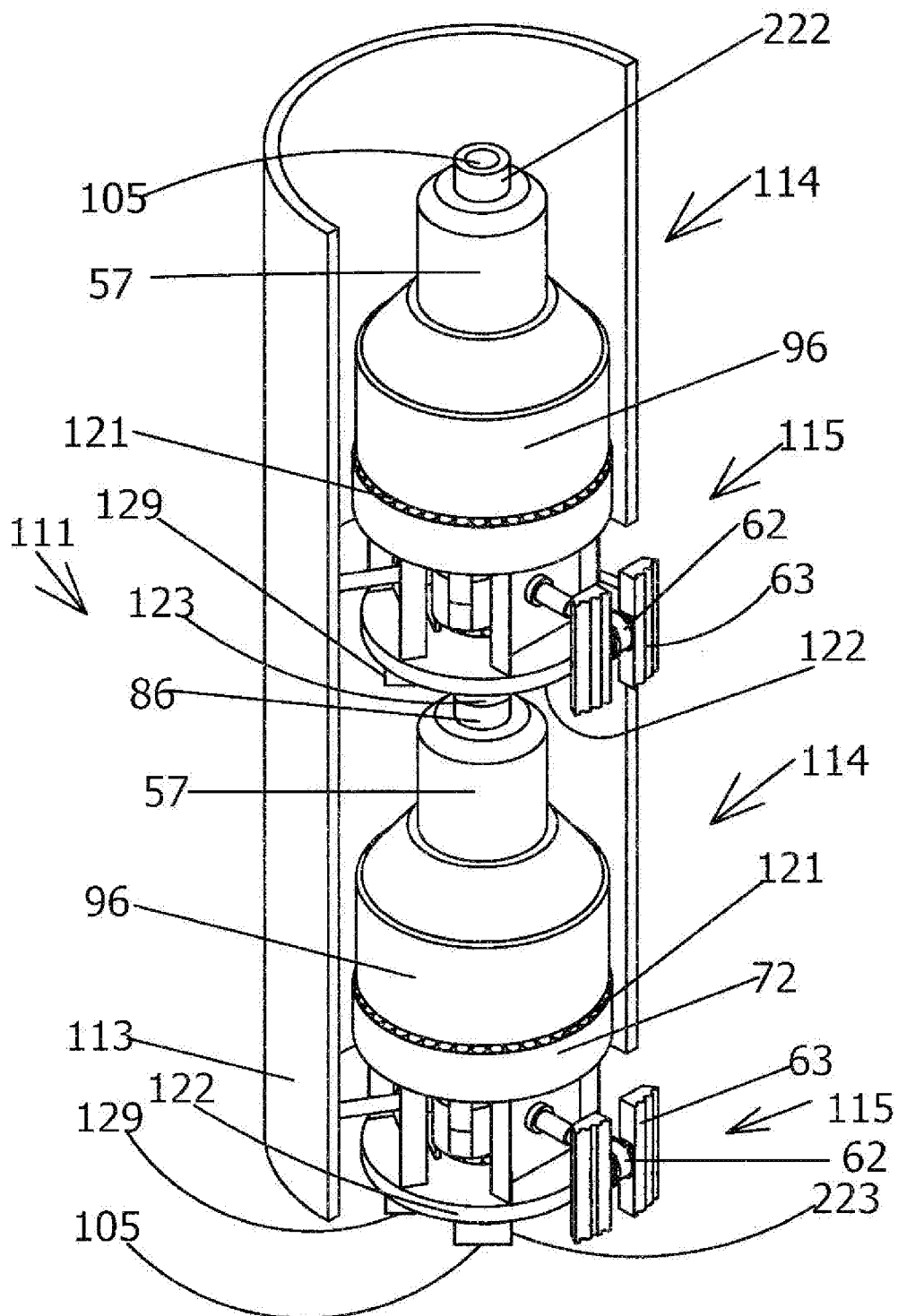


FIG.2/52

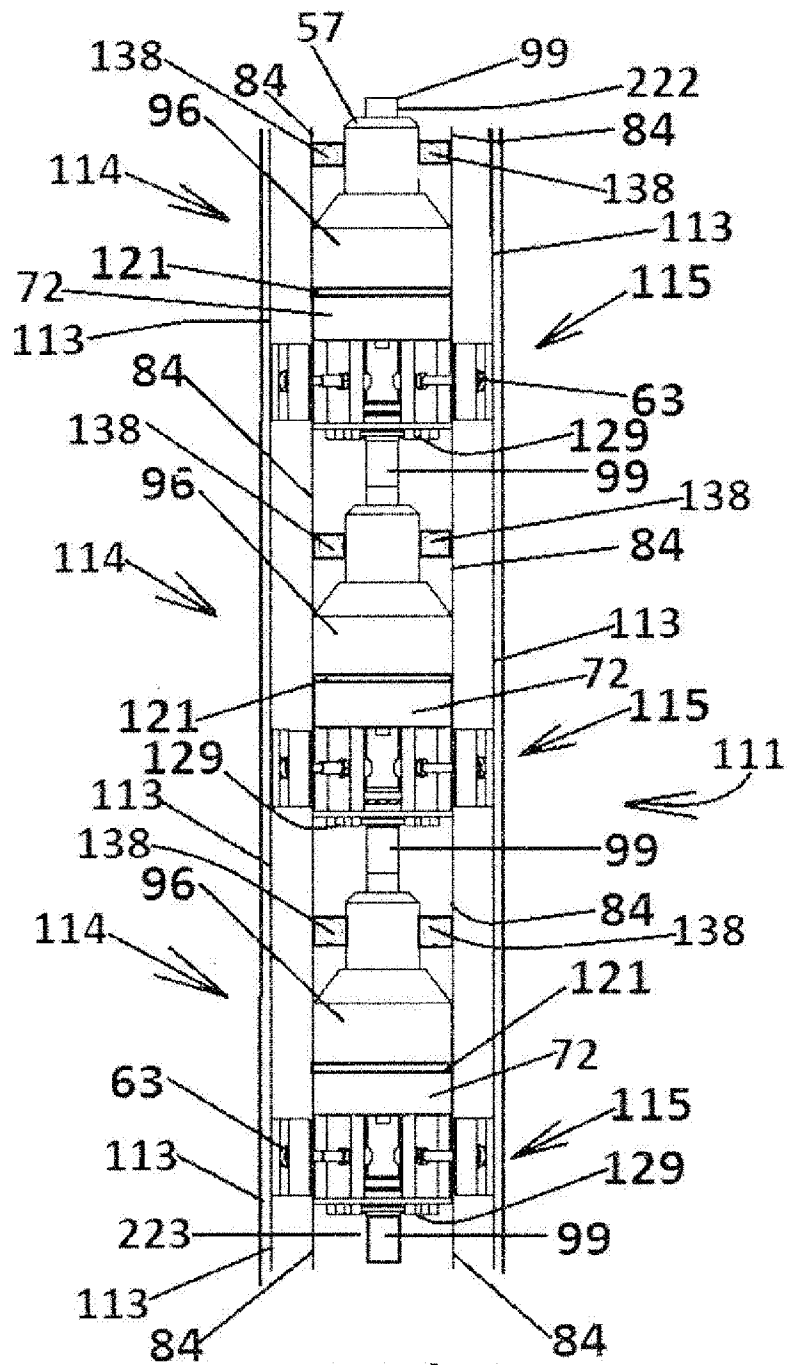


FIG. 3/52

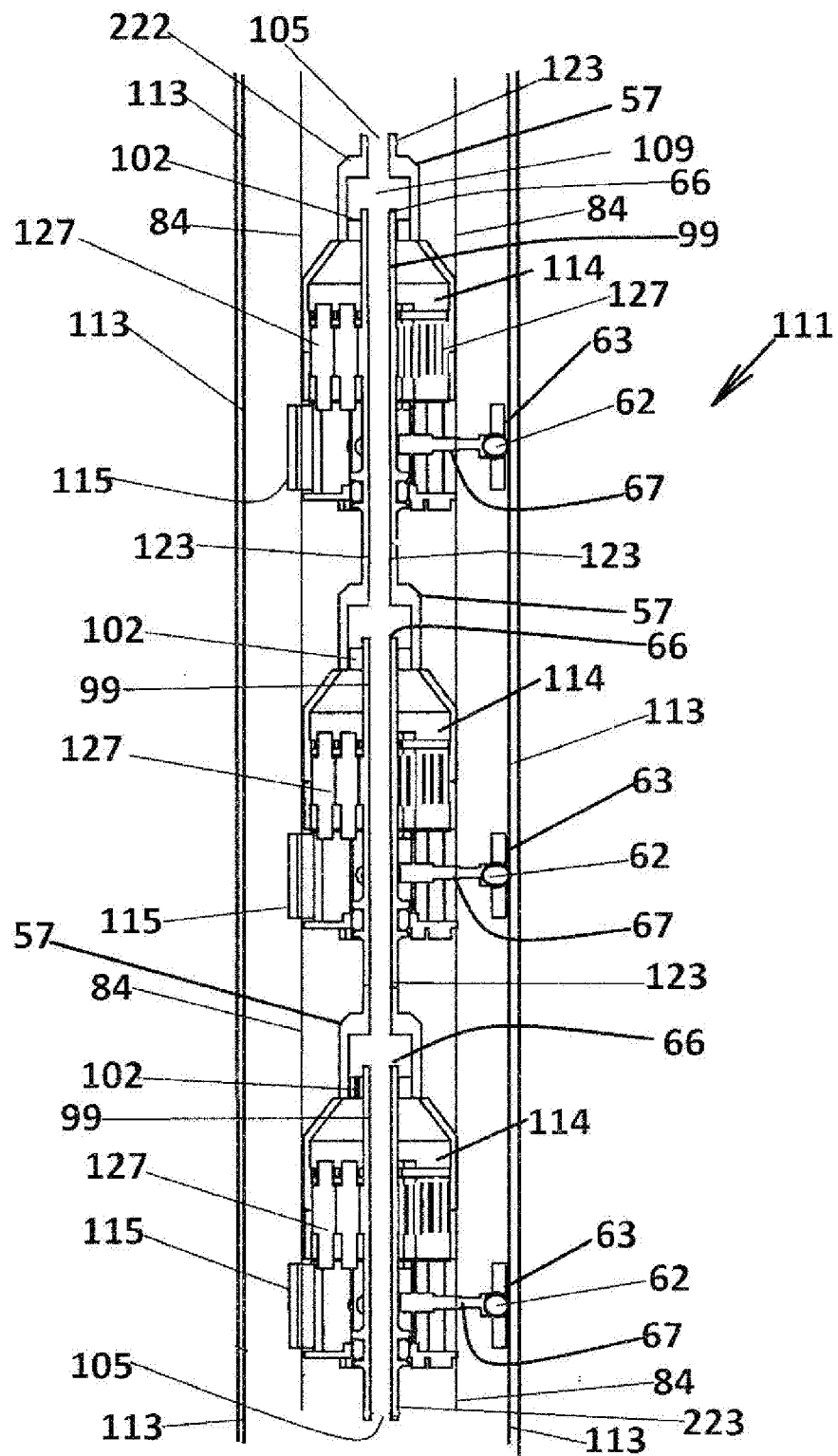


FIG. 4/52

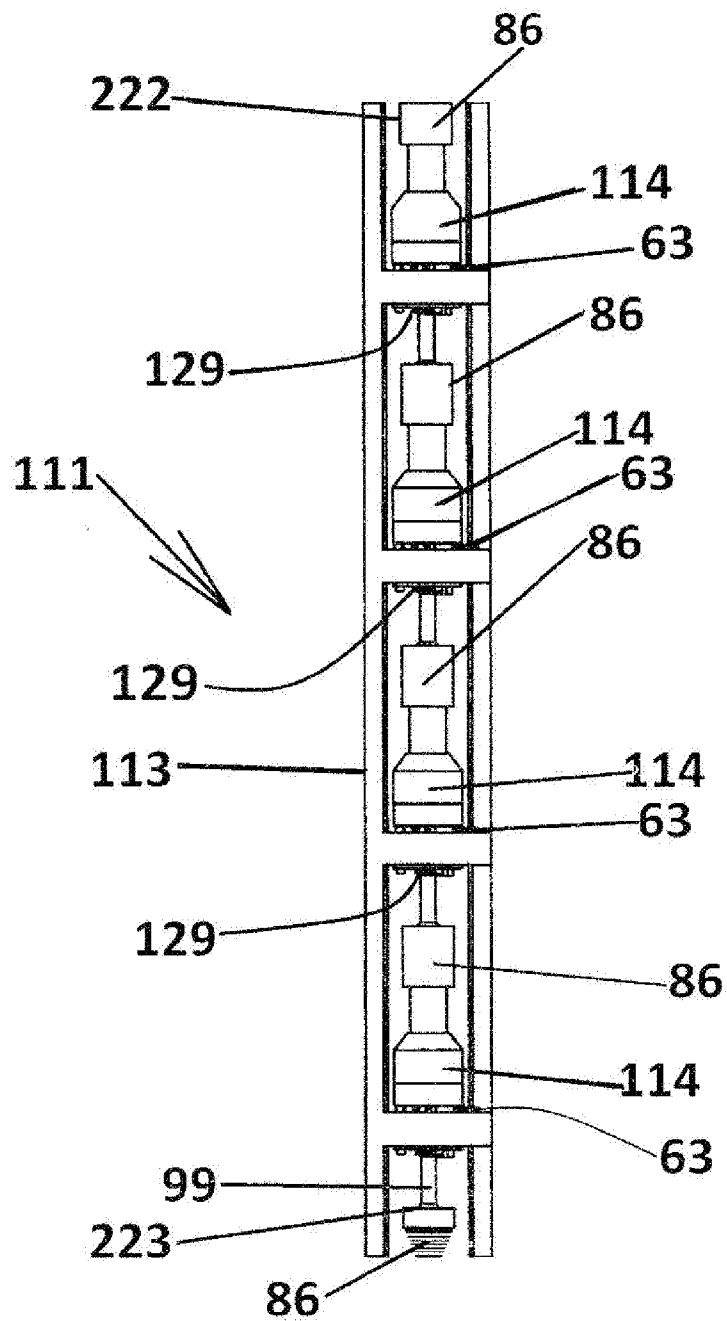


FIG. 5/52

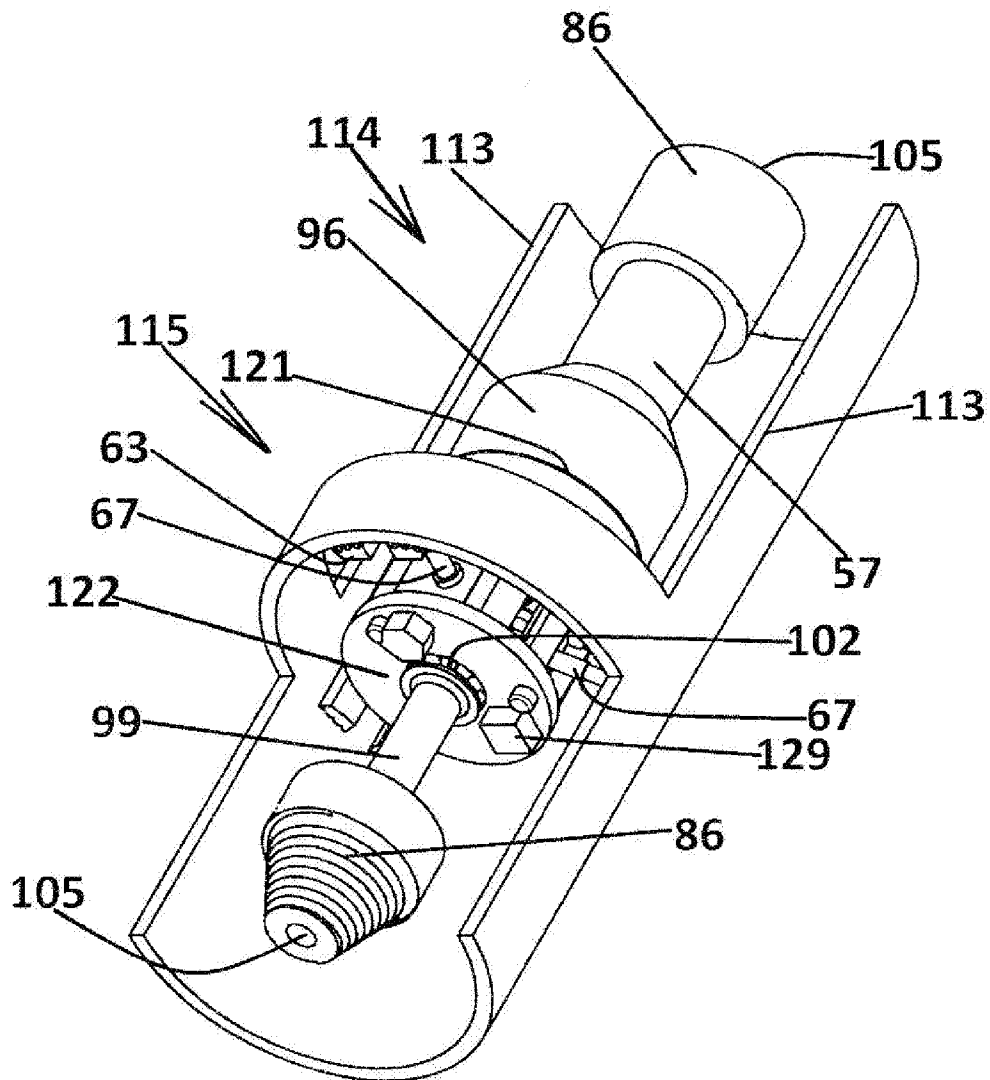


FIG.6/52

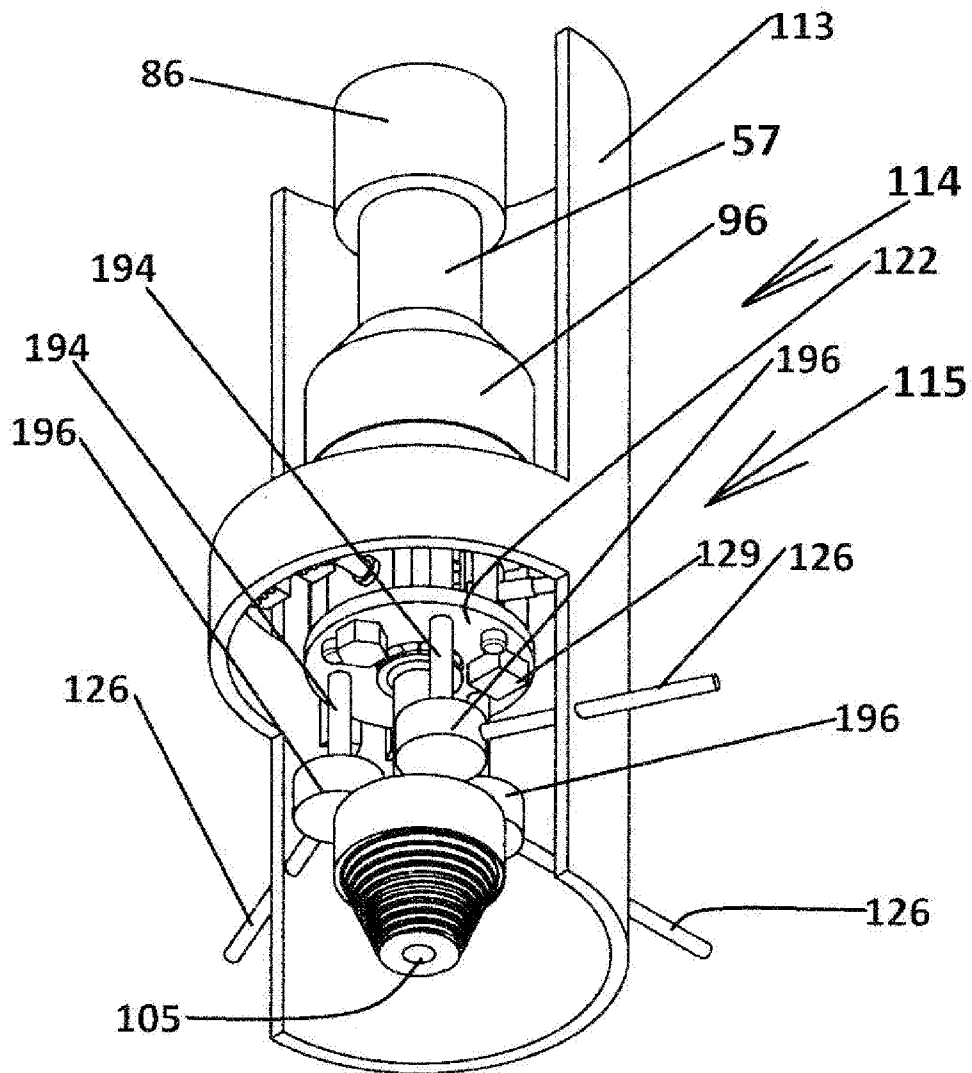
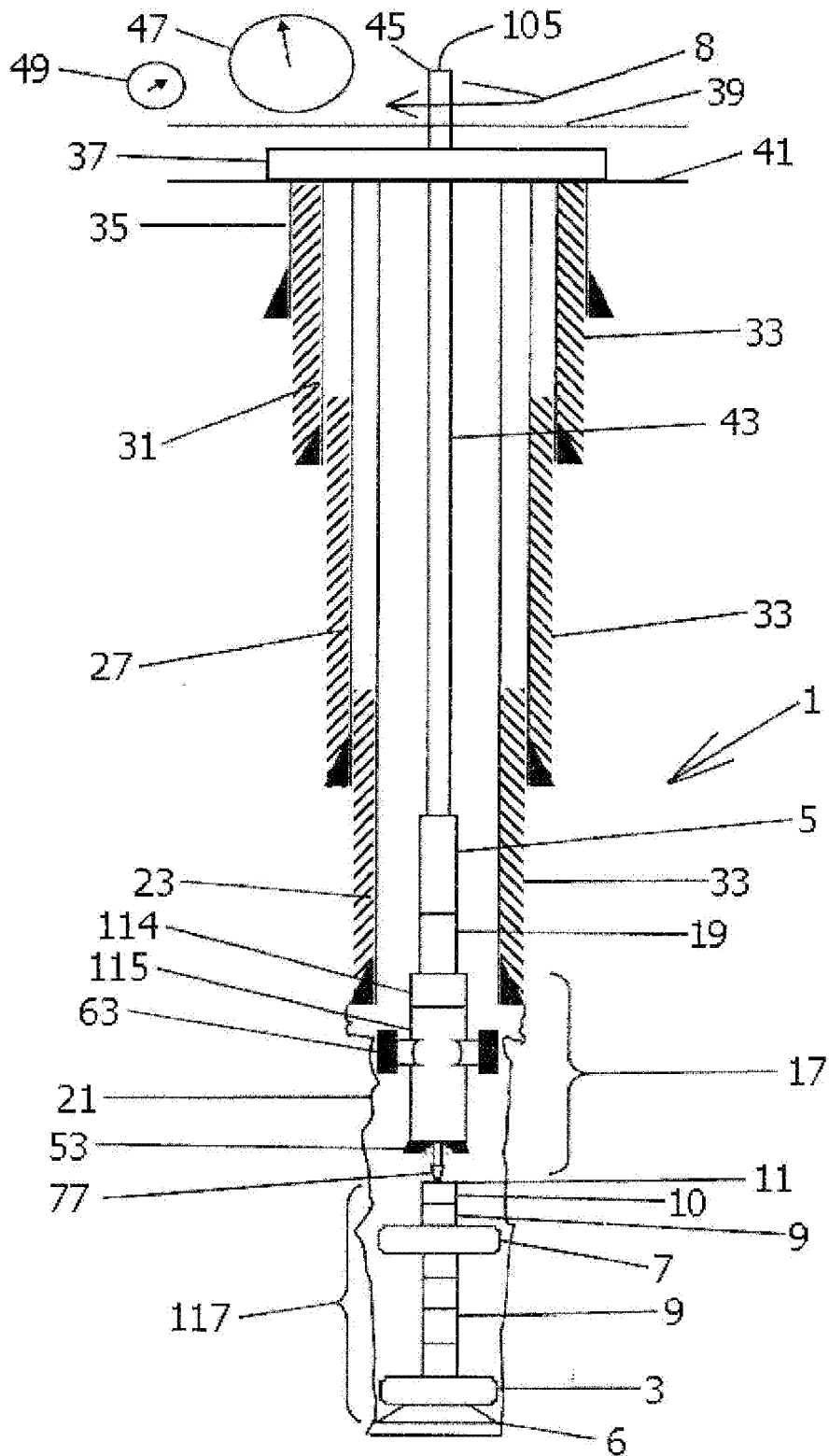


FIG. 7/52

**FIG. 8/52**

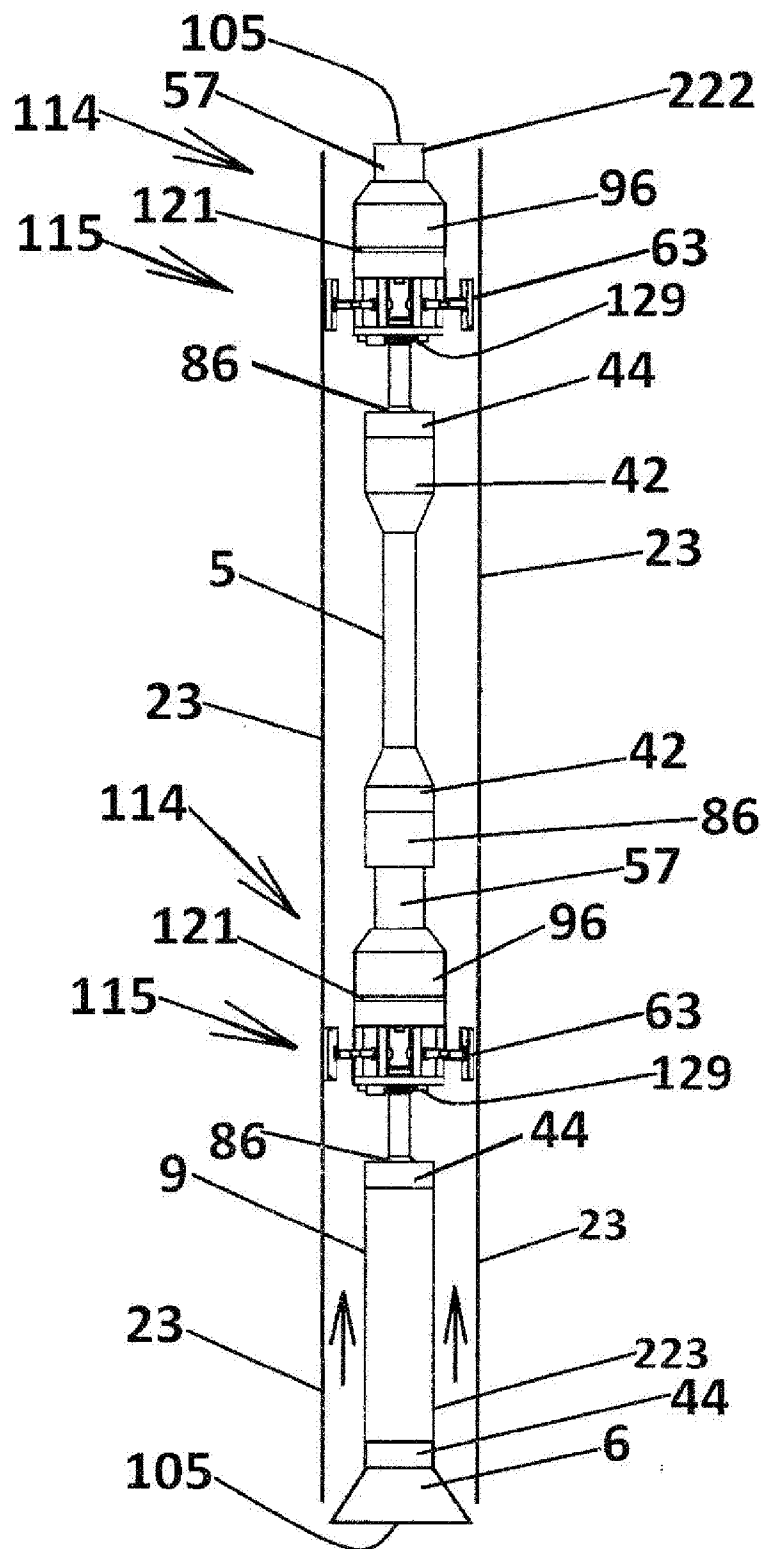


FIG.9/52

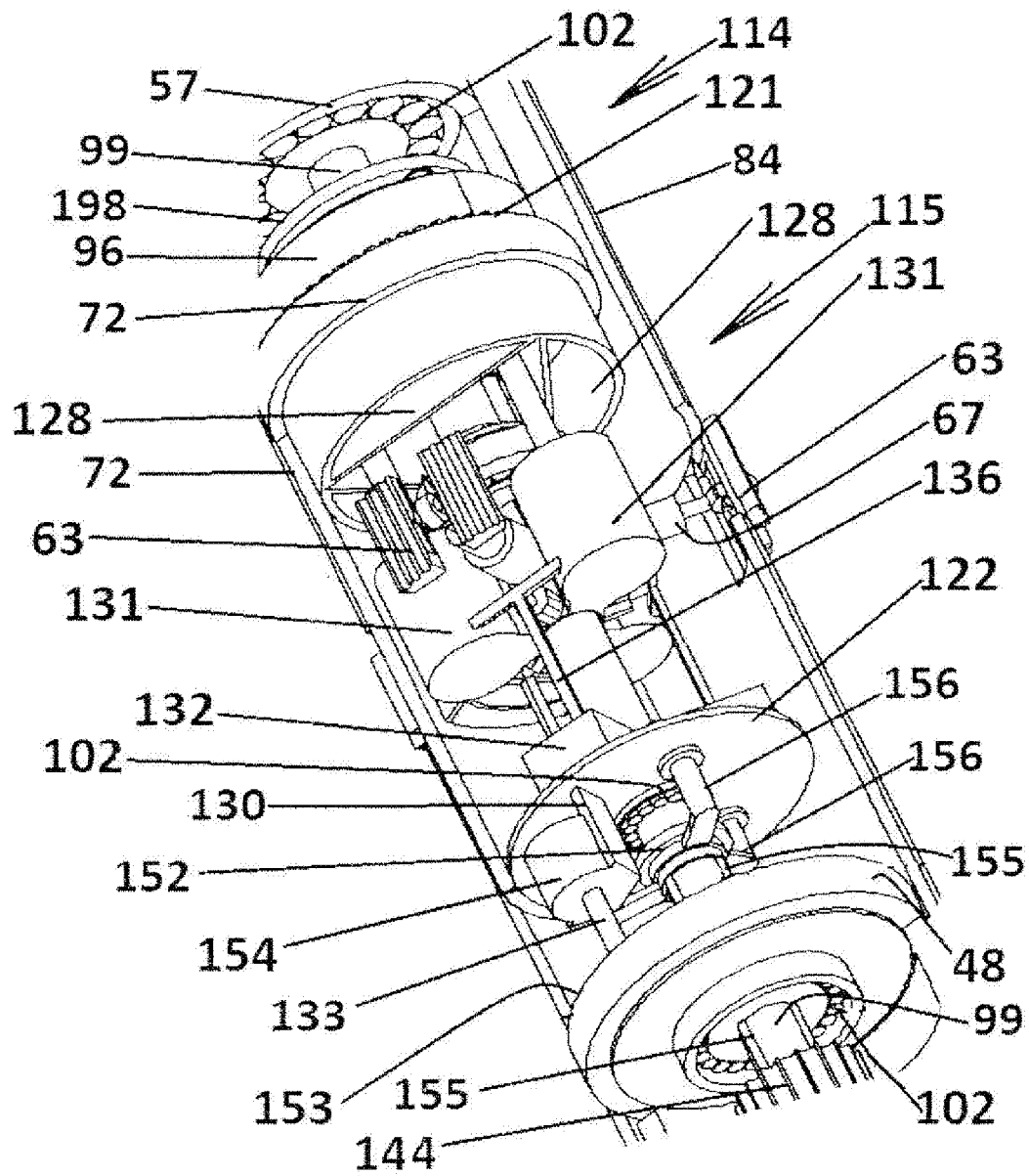


FIG.10/52

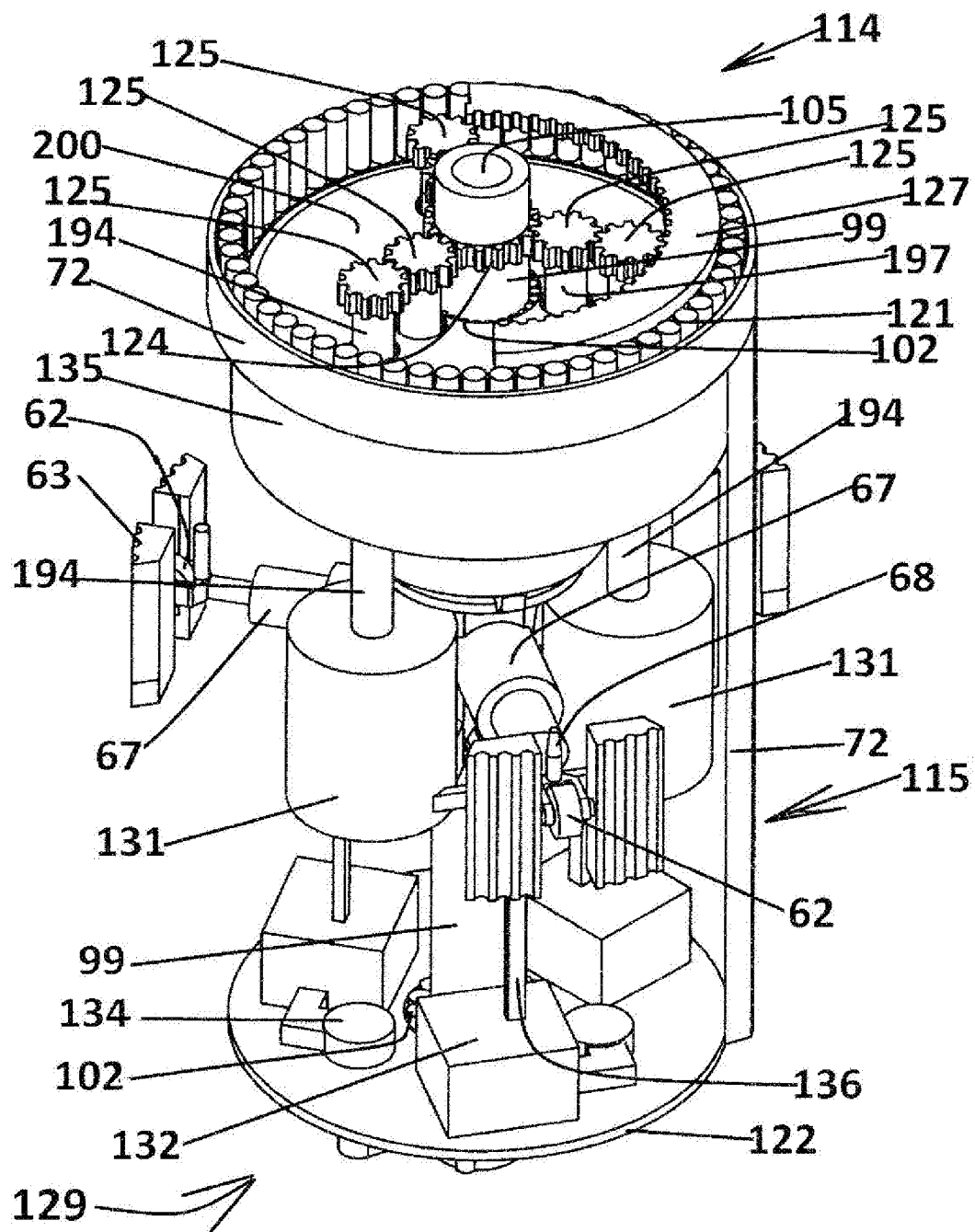


FIG.11/52

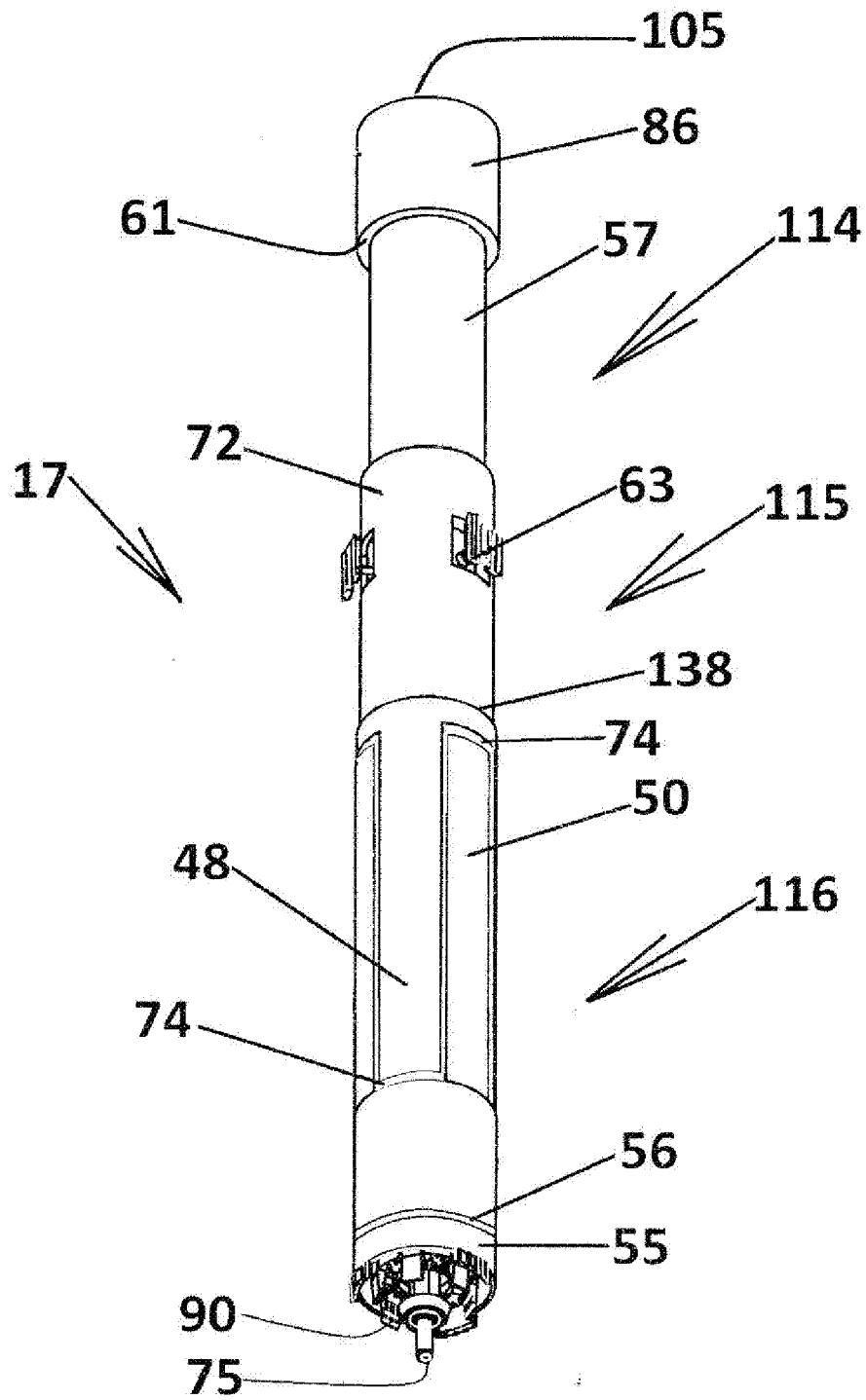


FIG.12/52

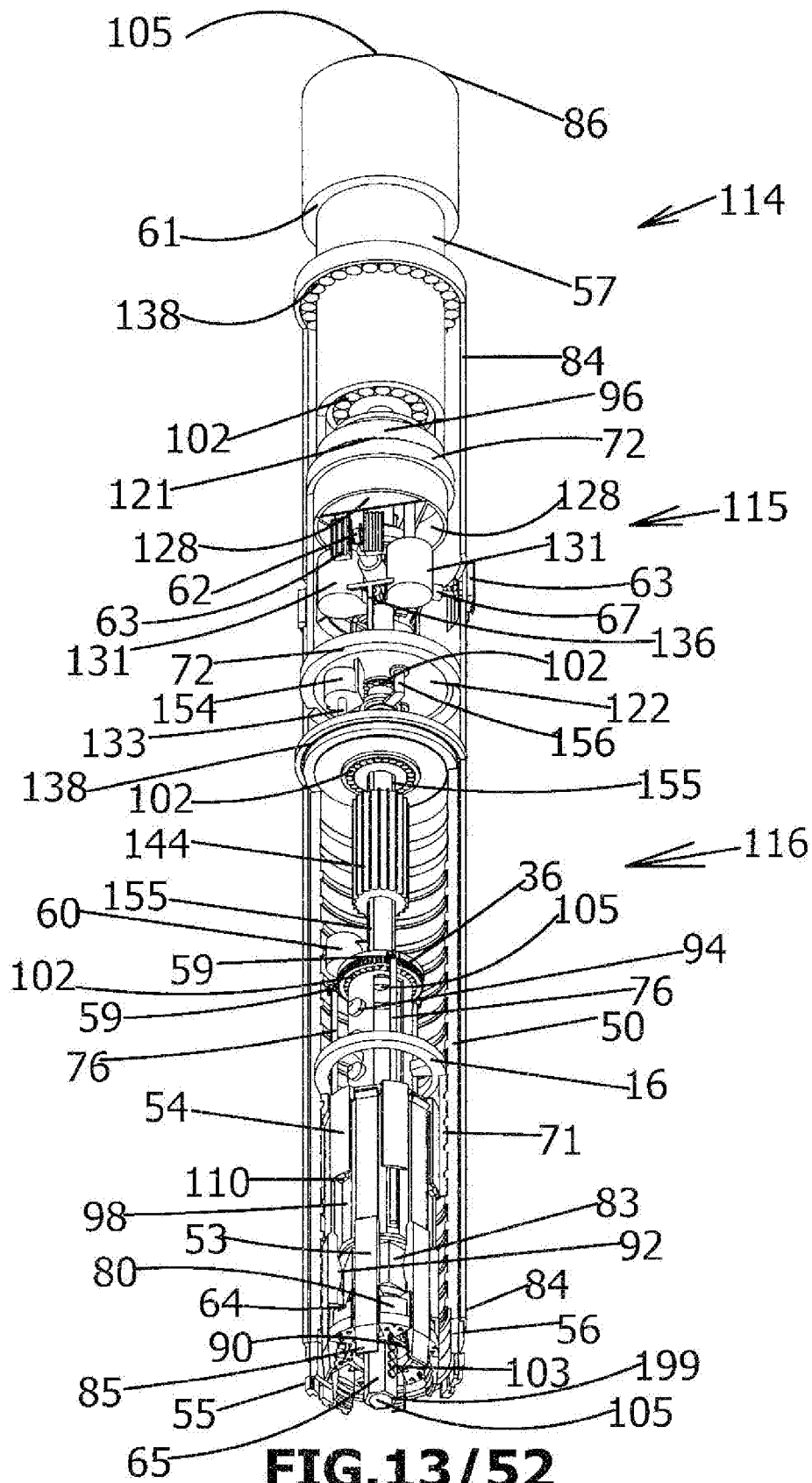
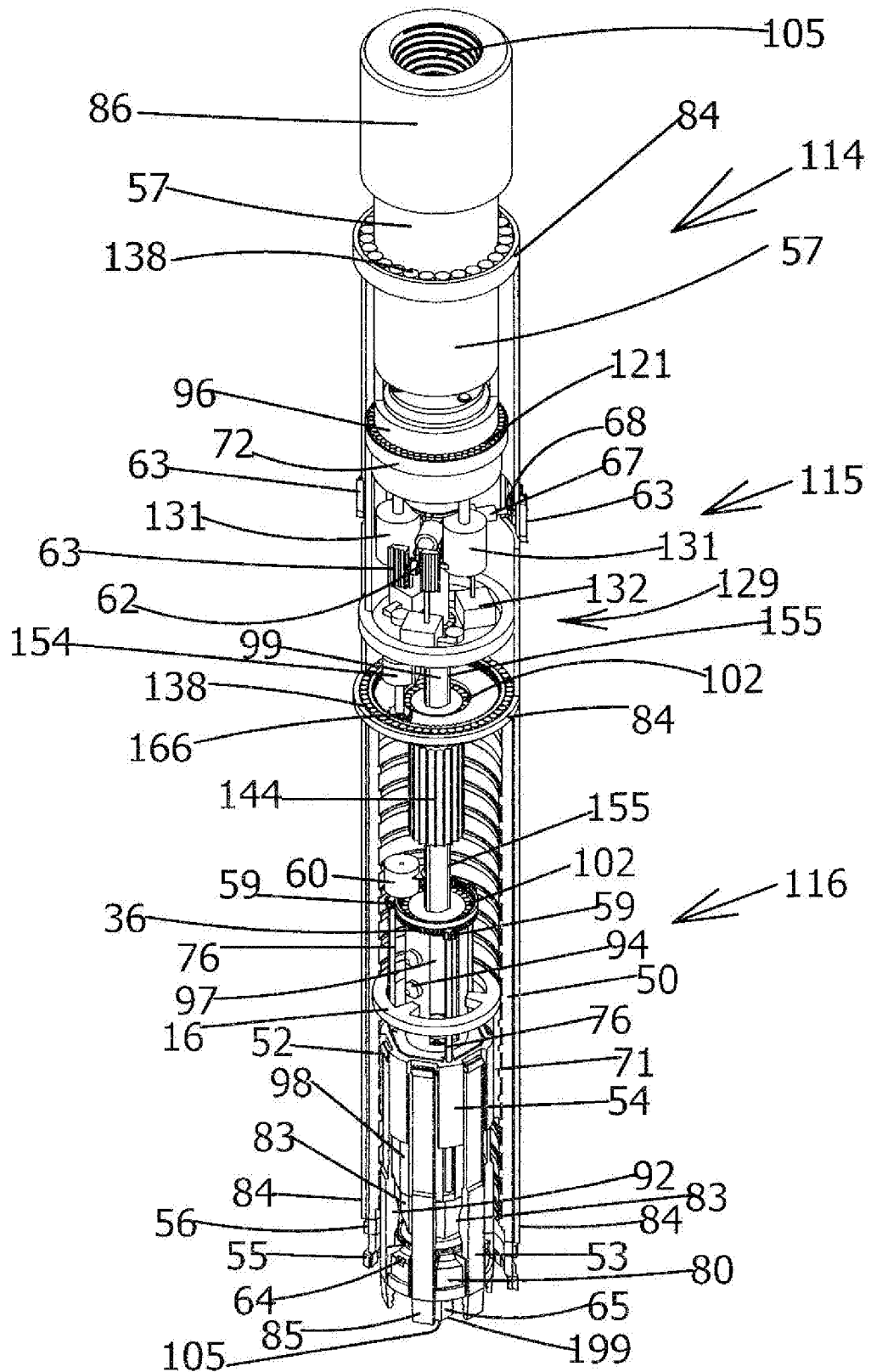
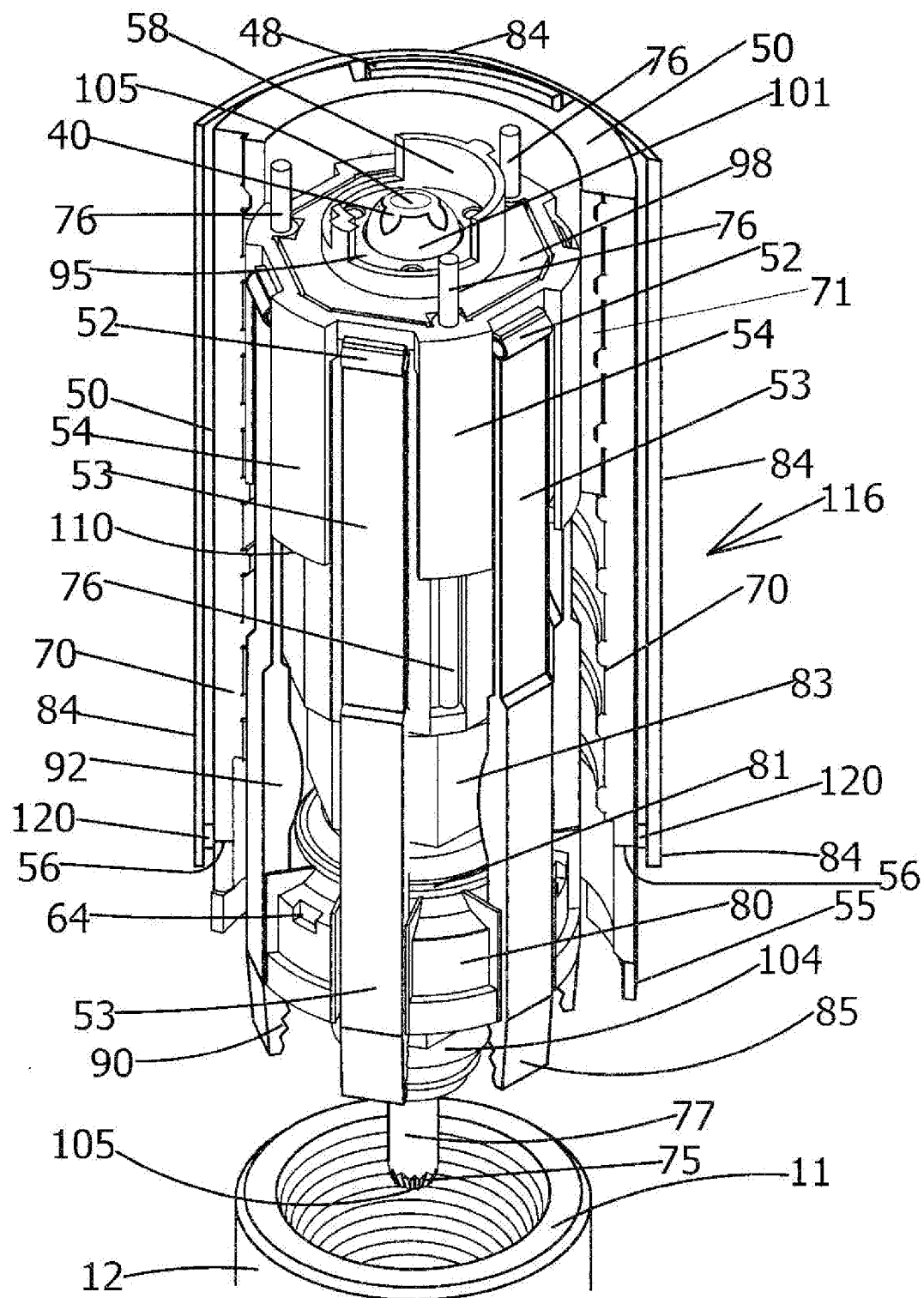


FIG.14/52

**FIG.15/52**

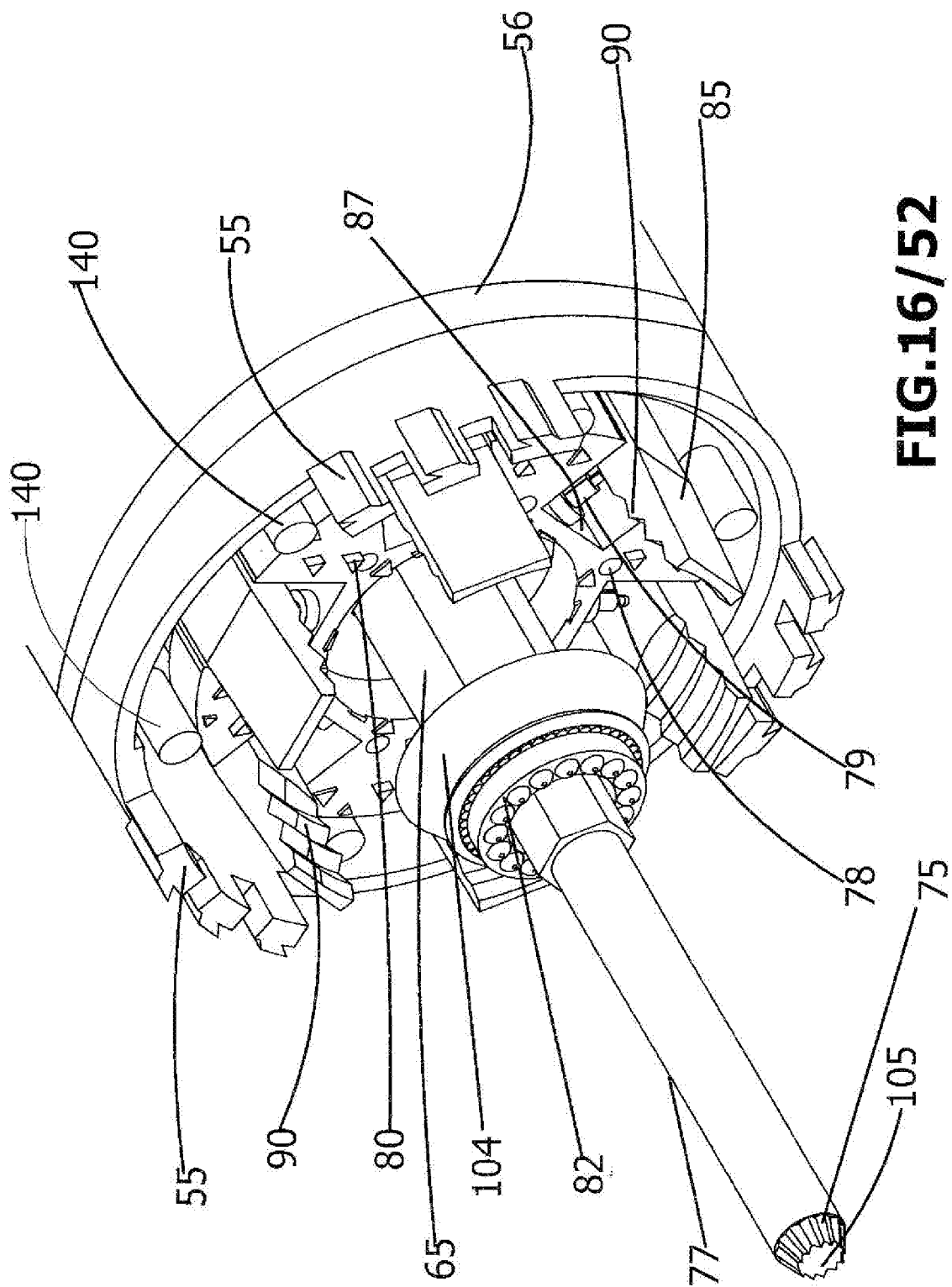
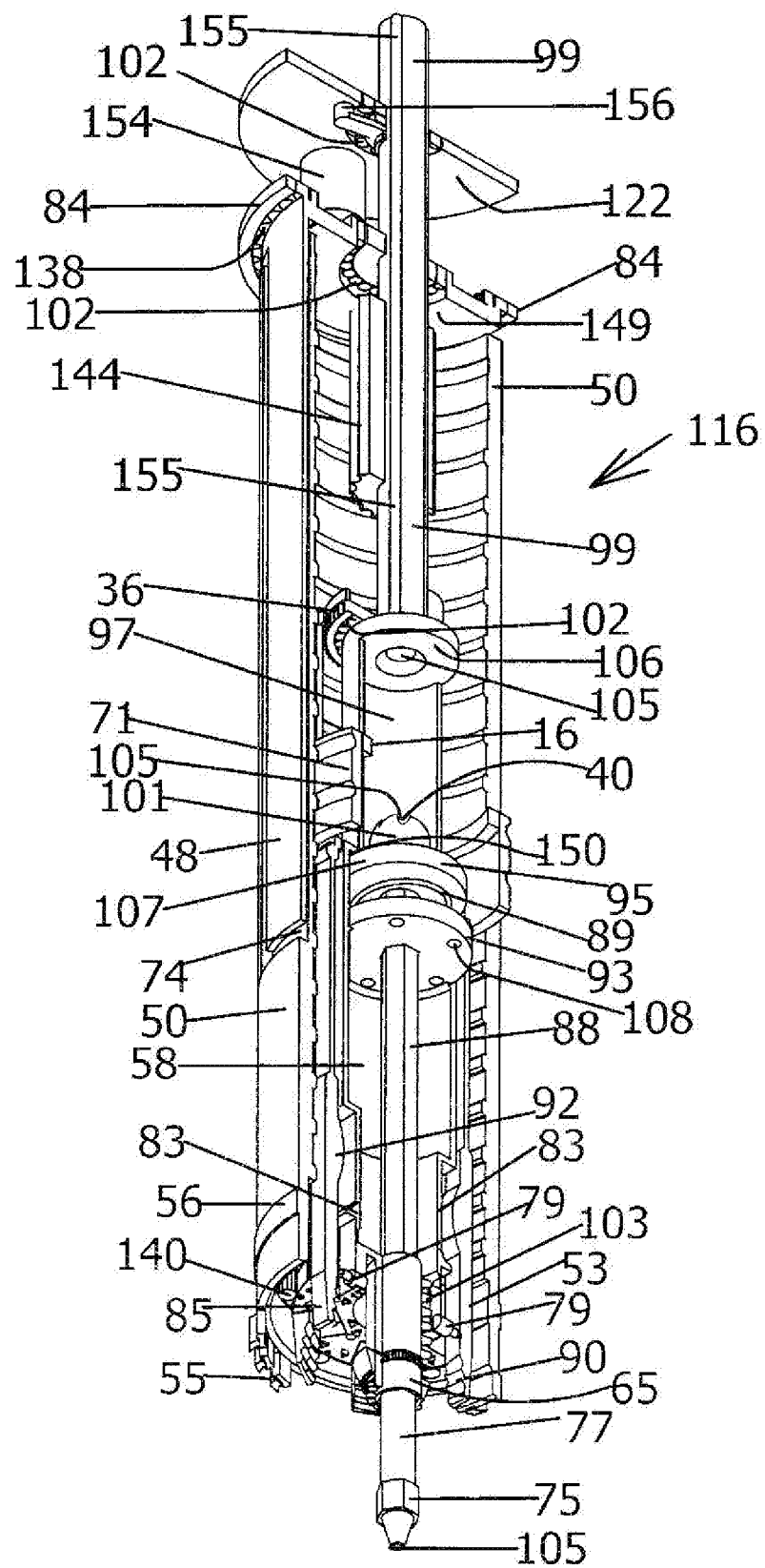


FIG.16/52

**FIG.17/52**

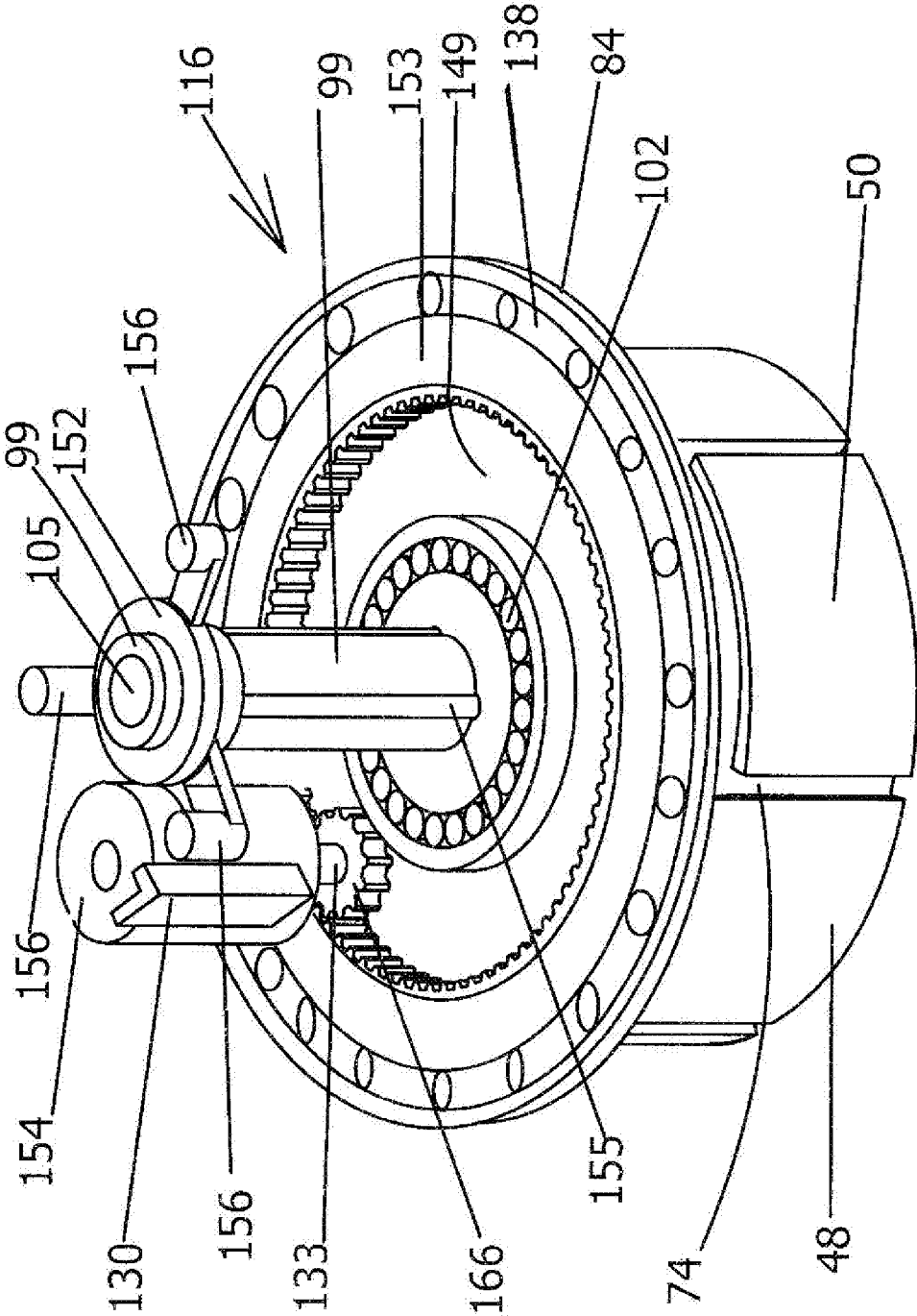
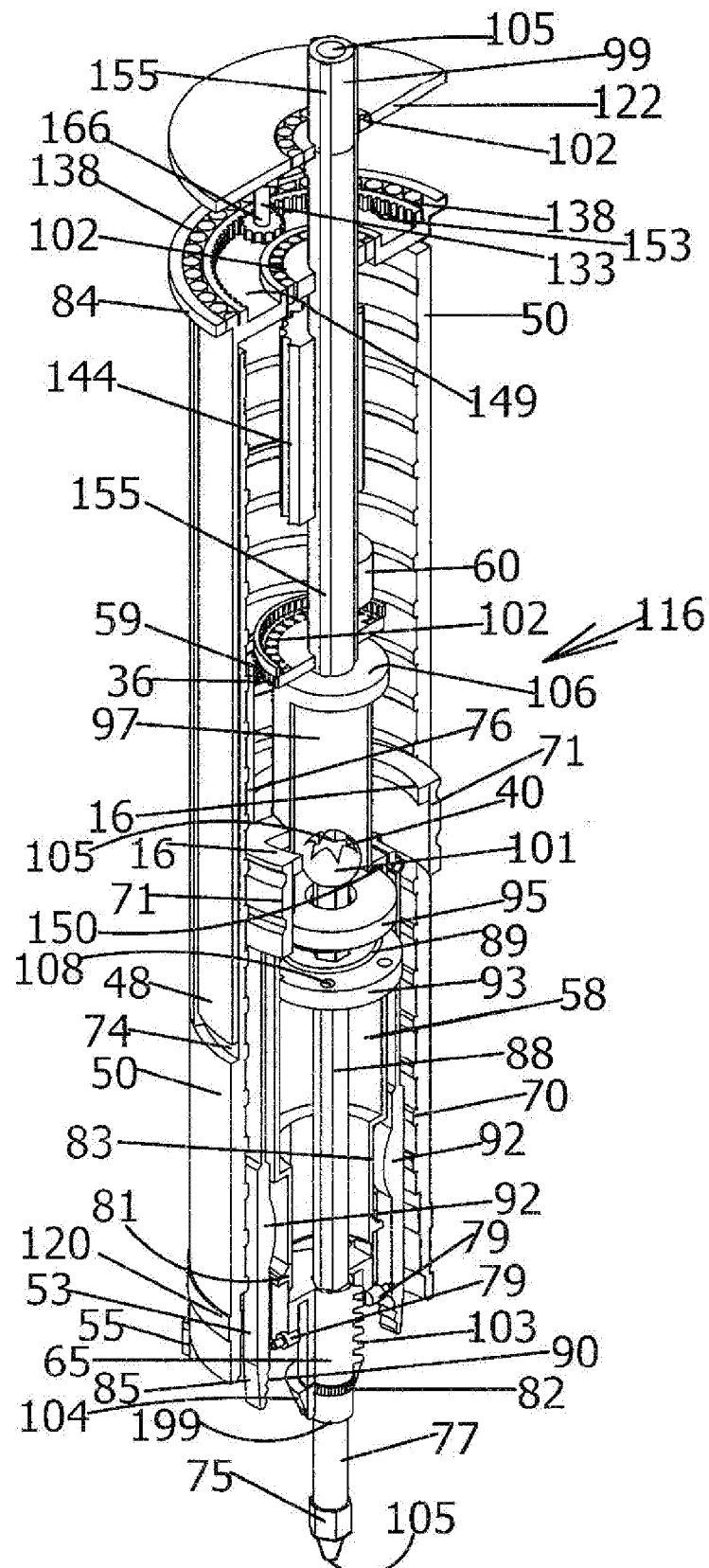
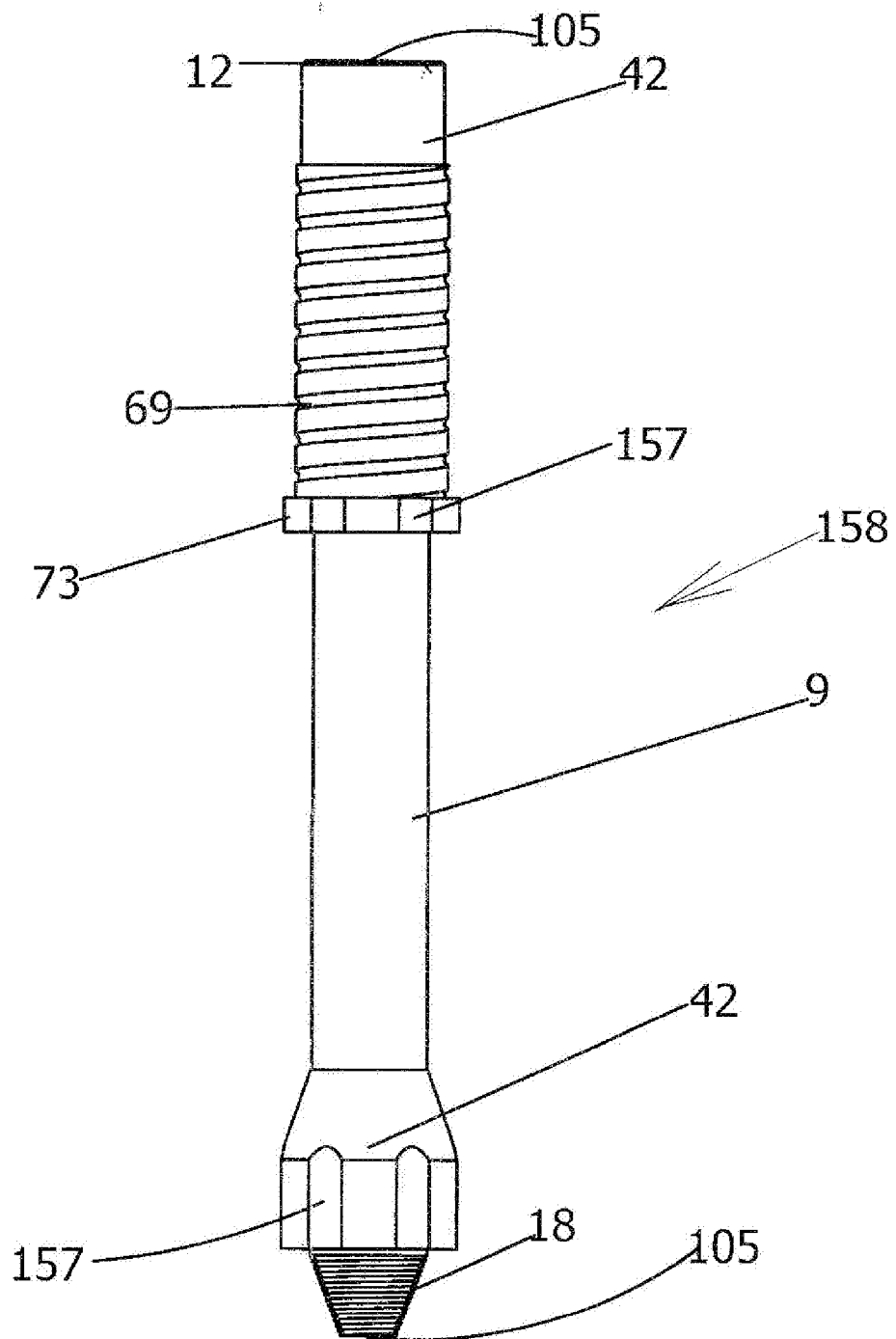


FIG.18/52



**FIG.20/52**

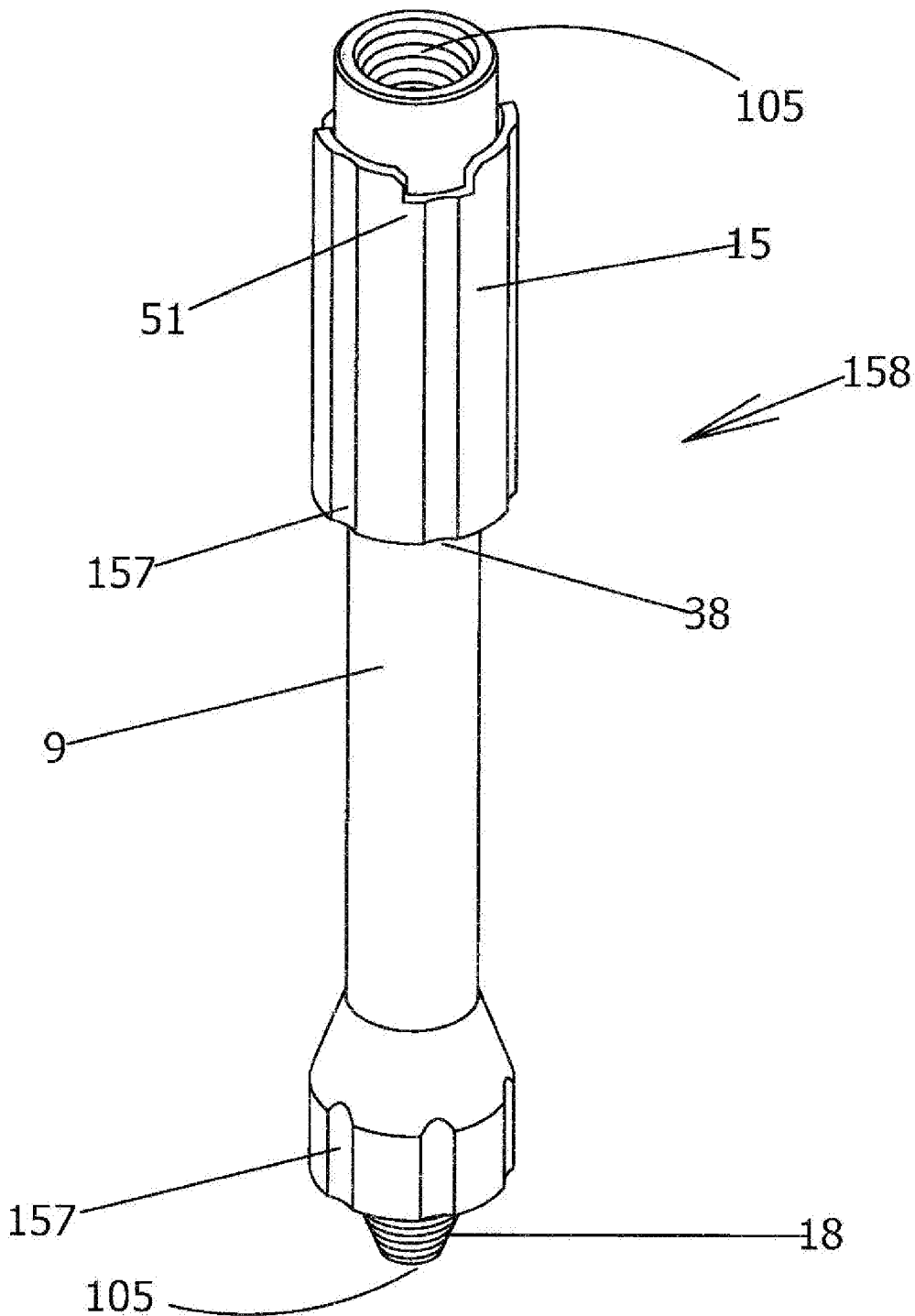


FIG.21/52

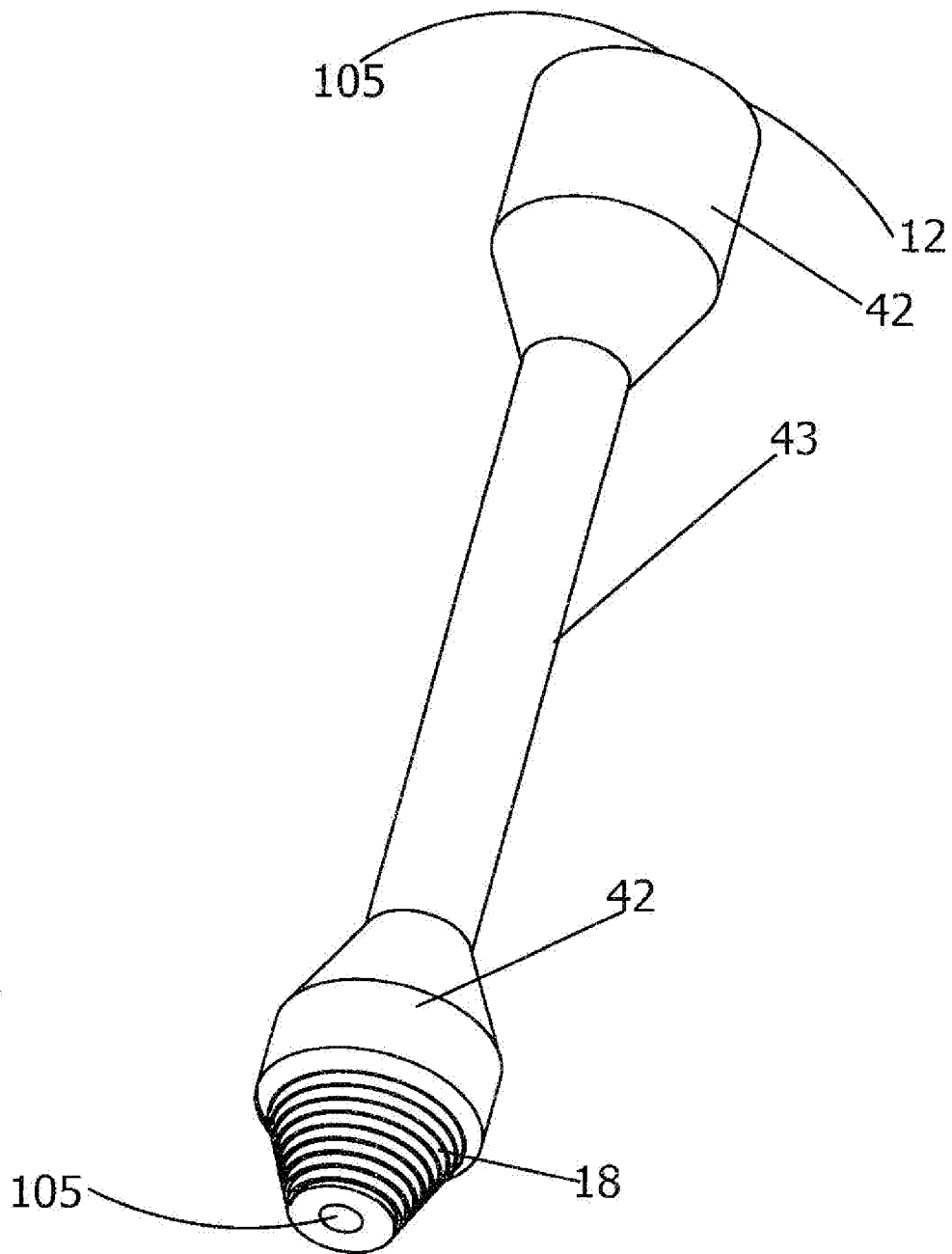
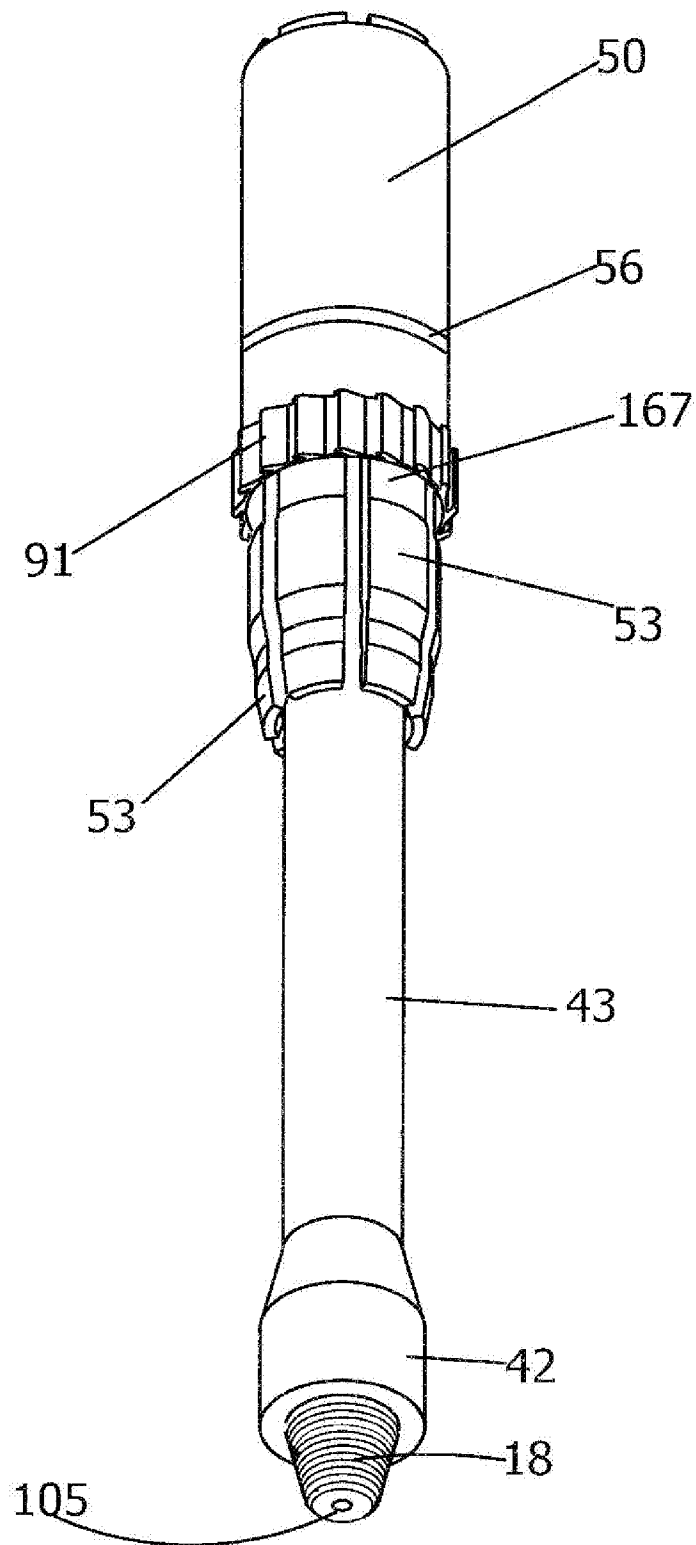


FIG.22/52

**FIG23/52**

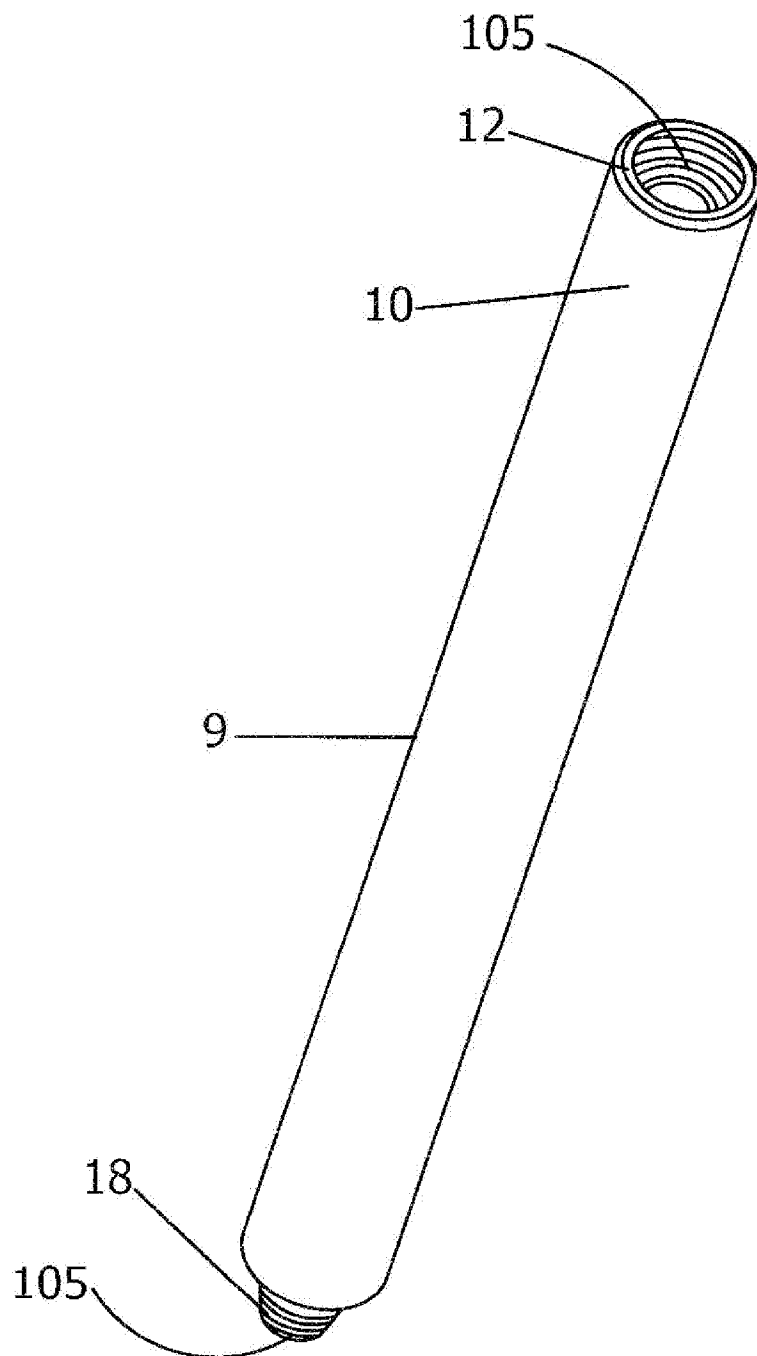
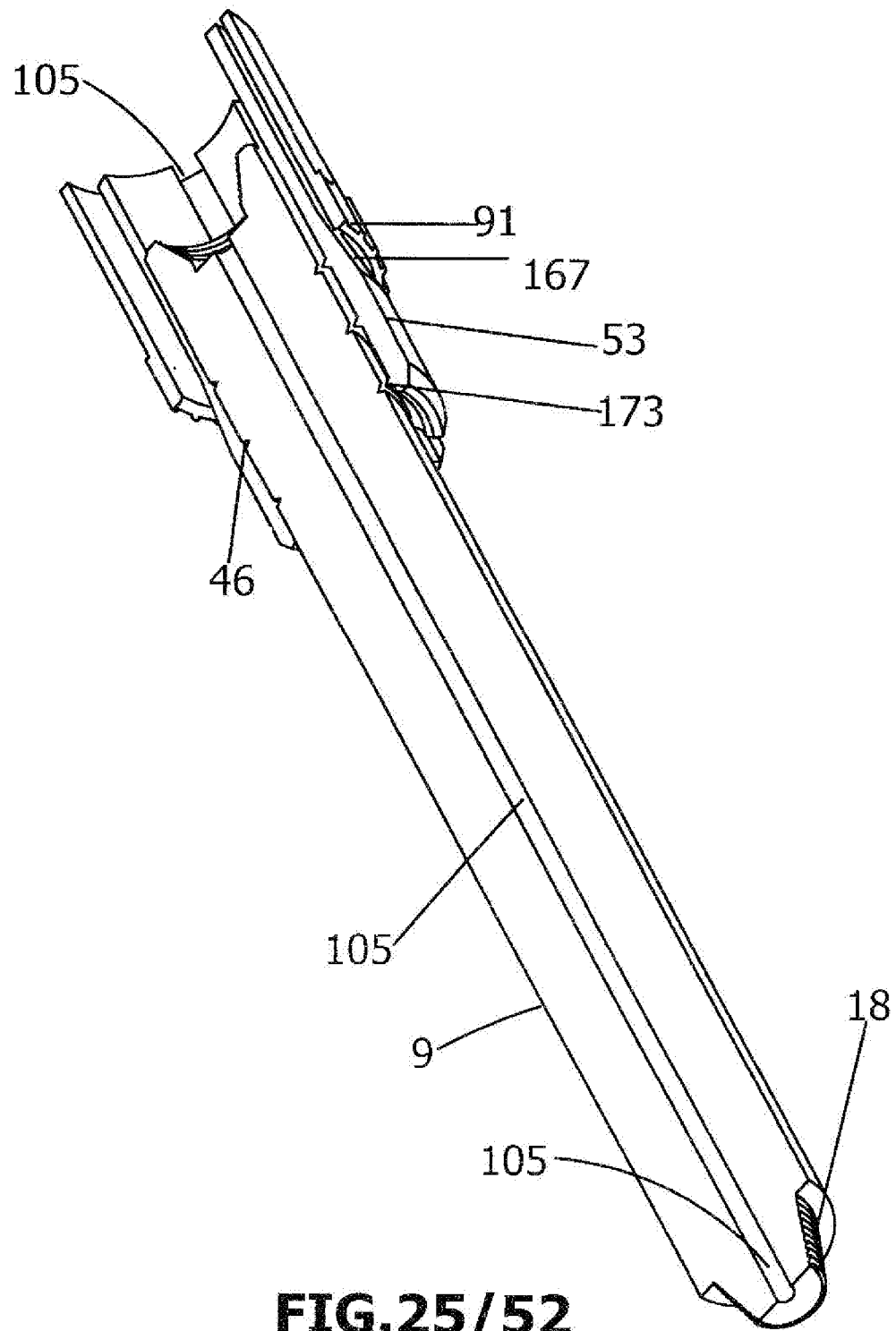
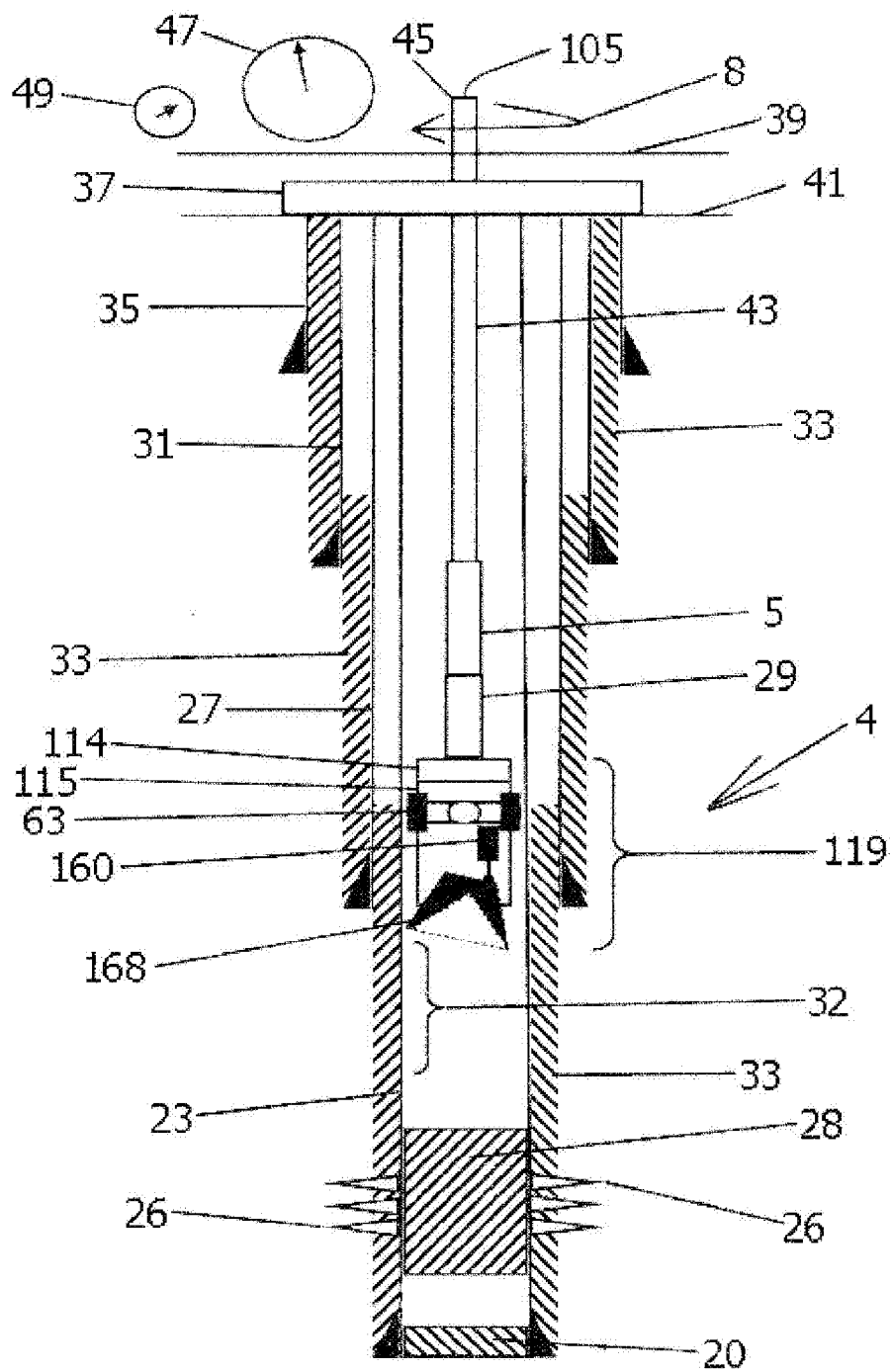


FIG.24/52





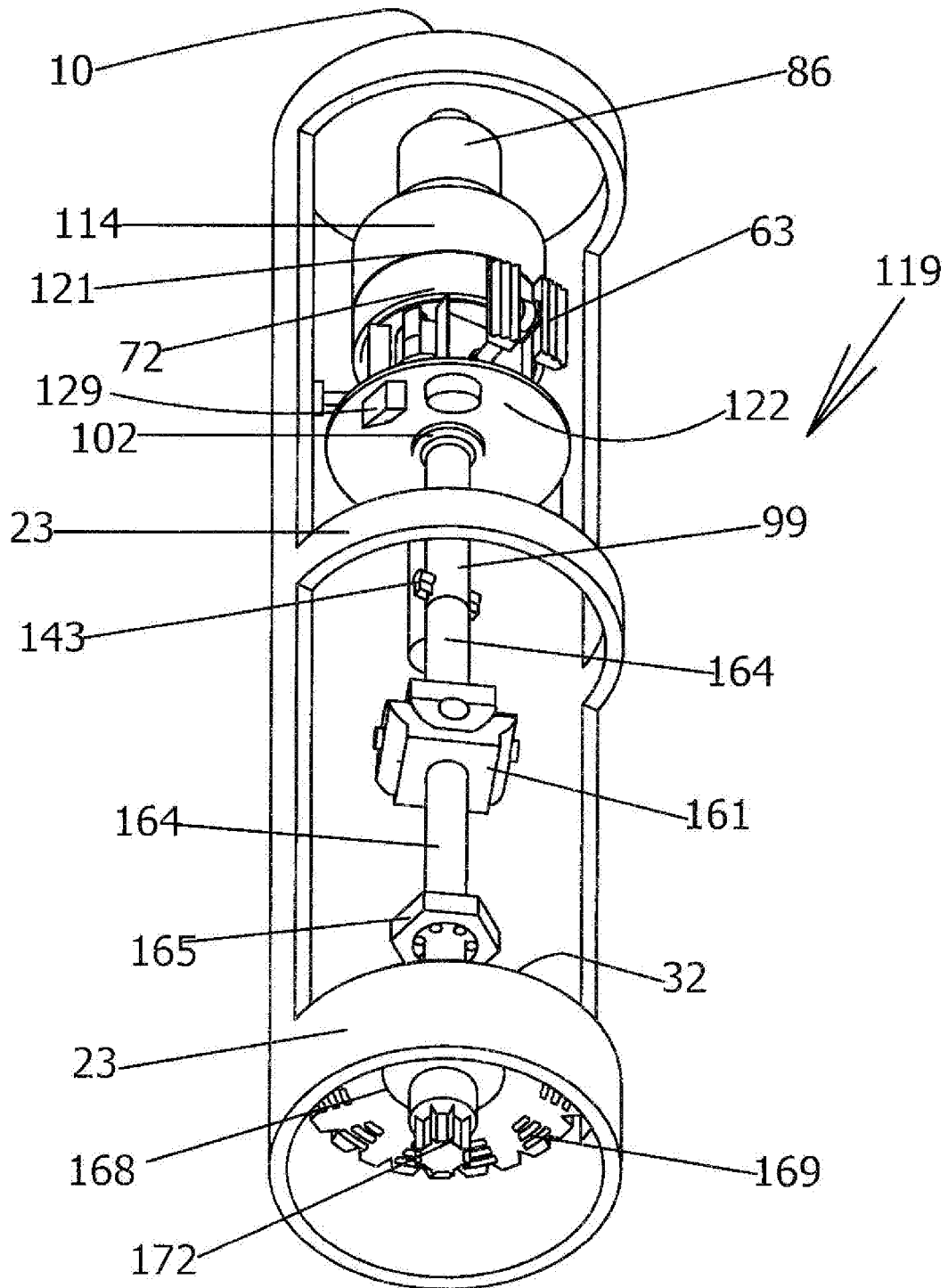
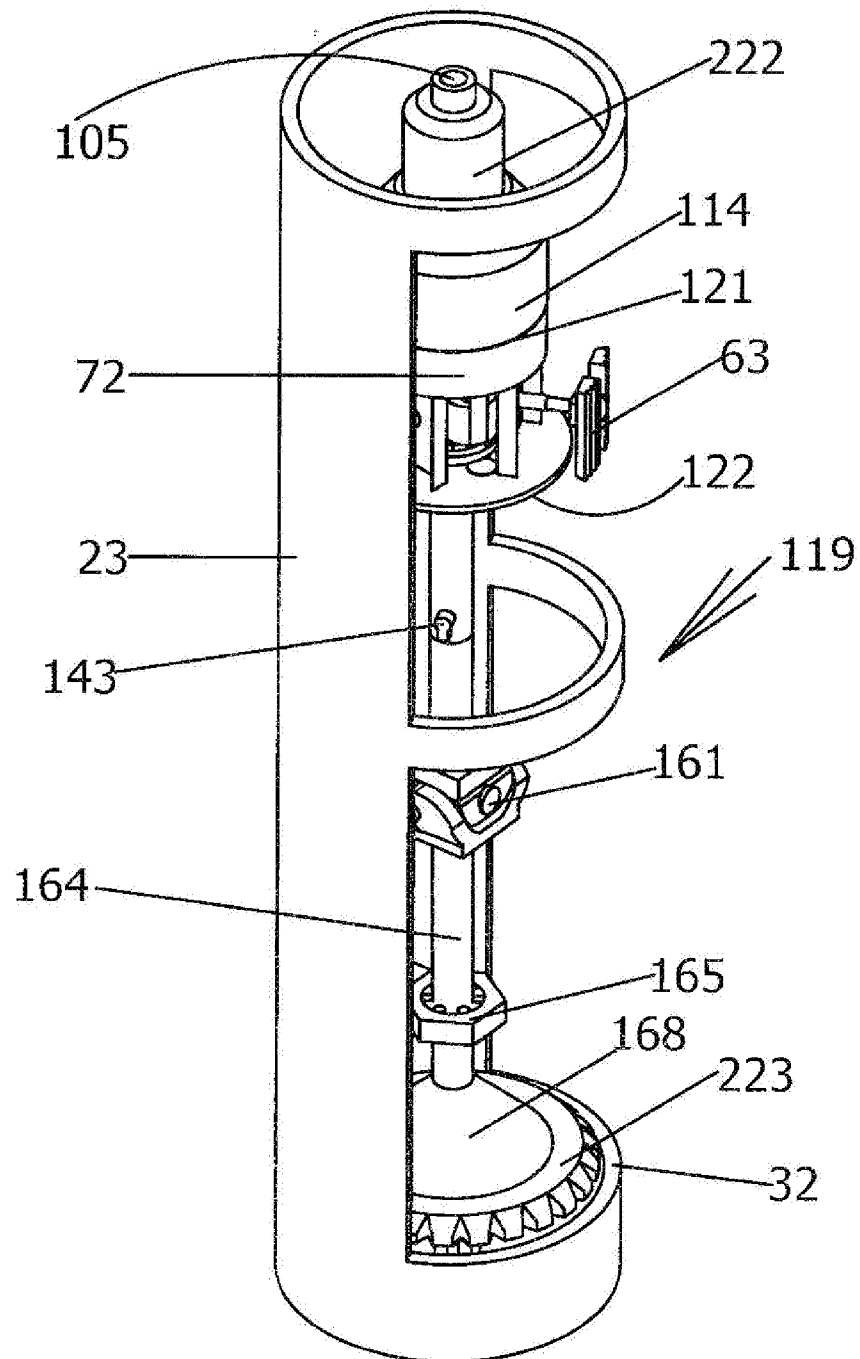


FIG.27/52

**FIG. 28/52**

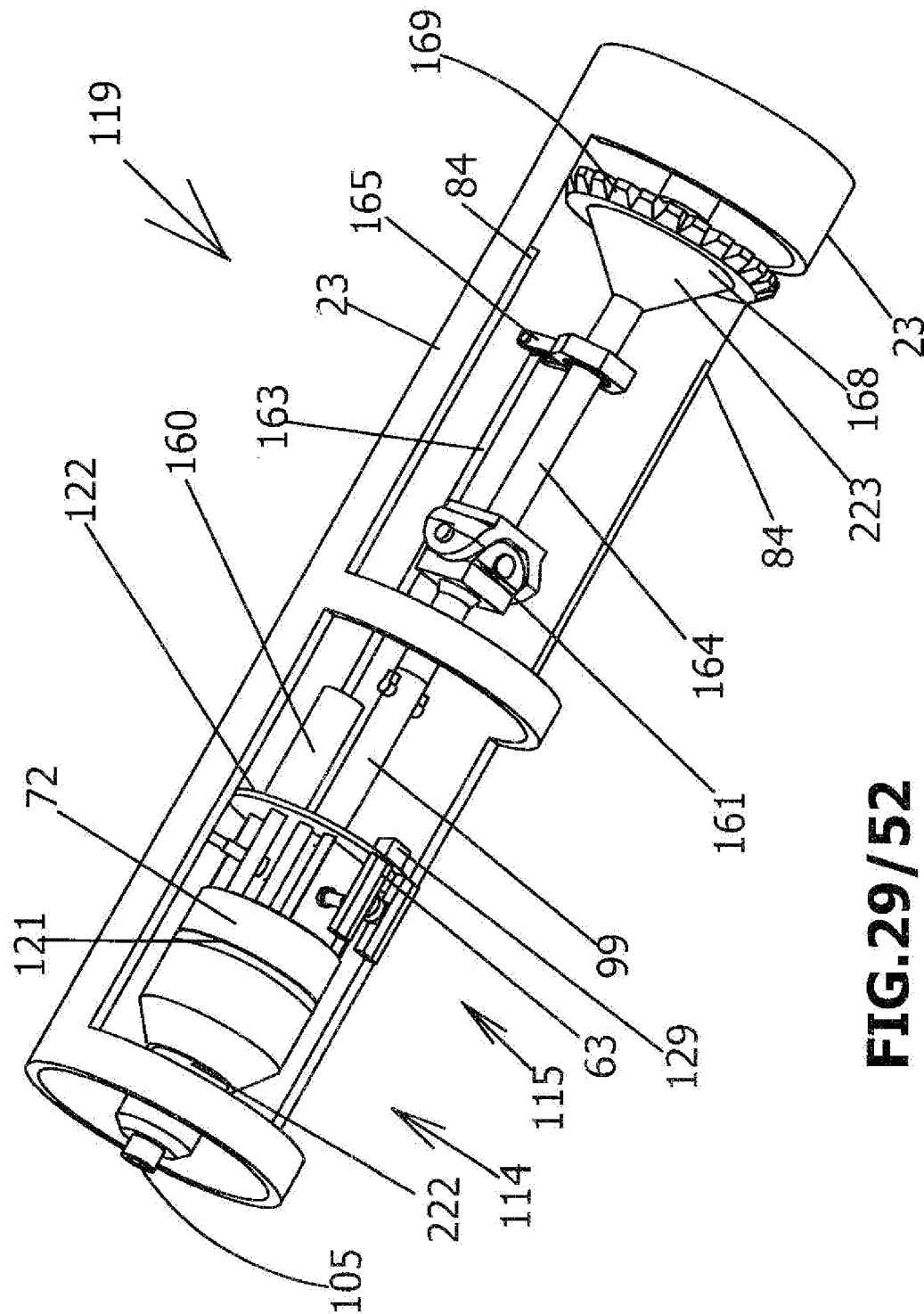


FIG. 29/52

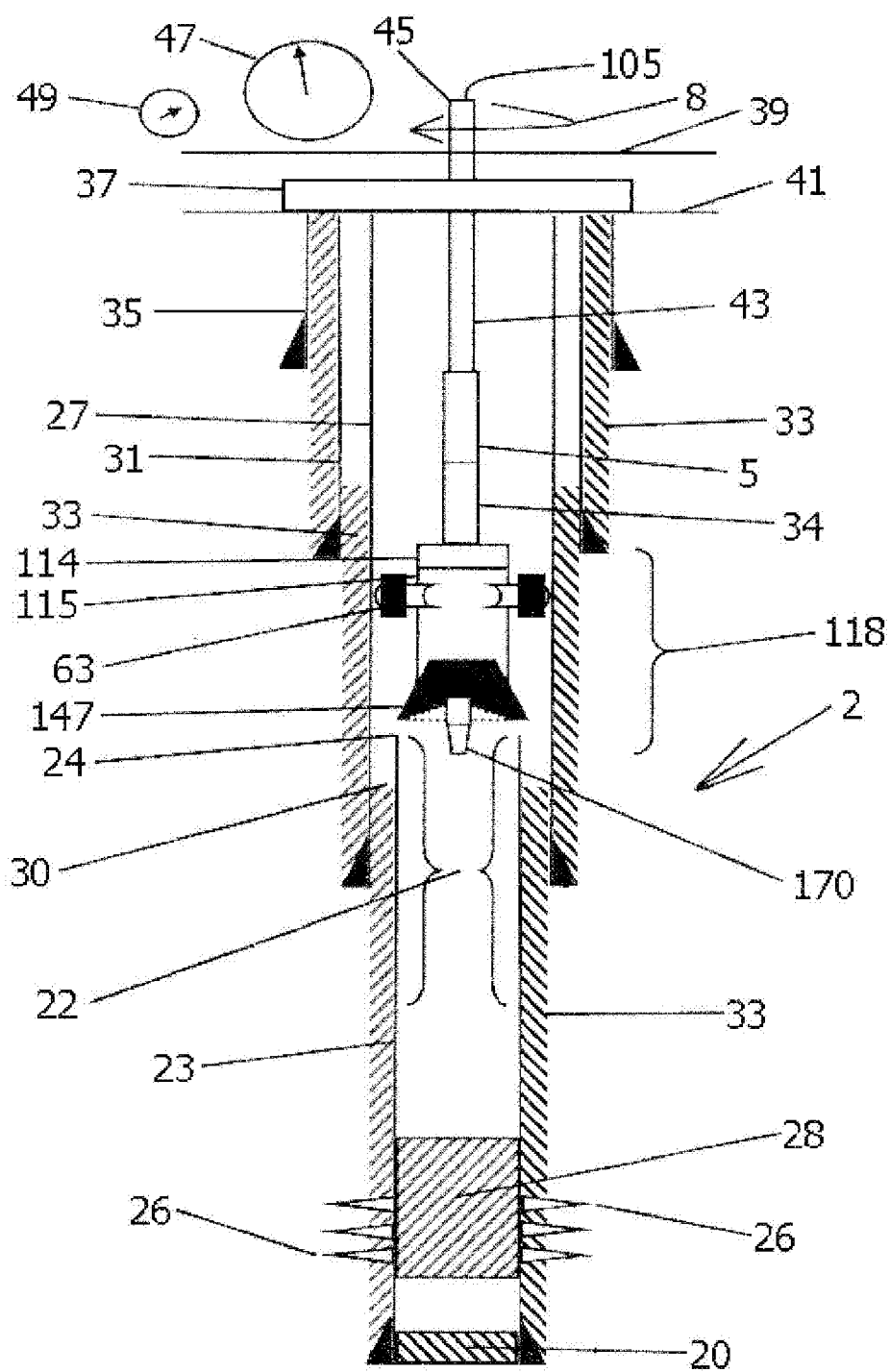


FIG. 30/52

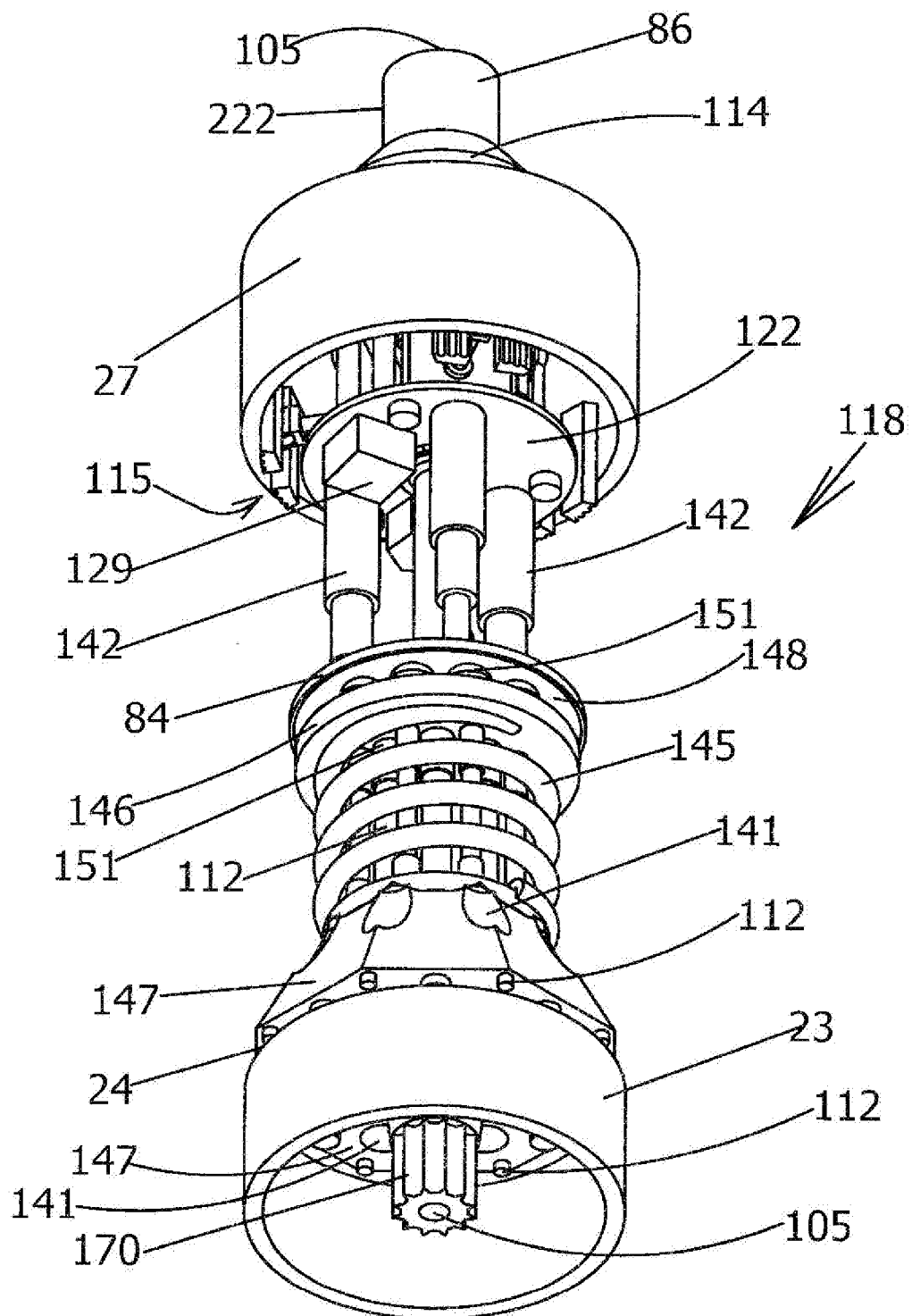


FIG.31/52

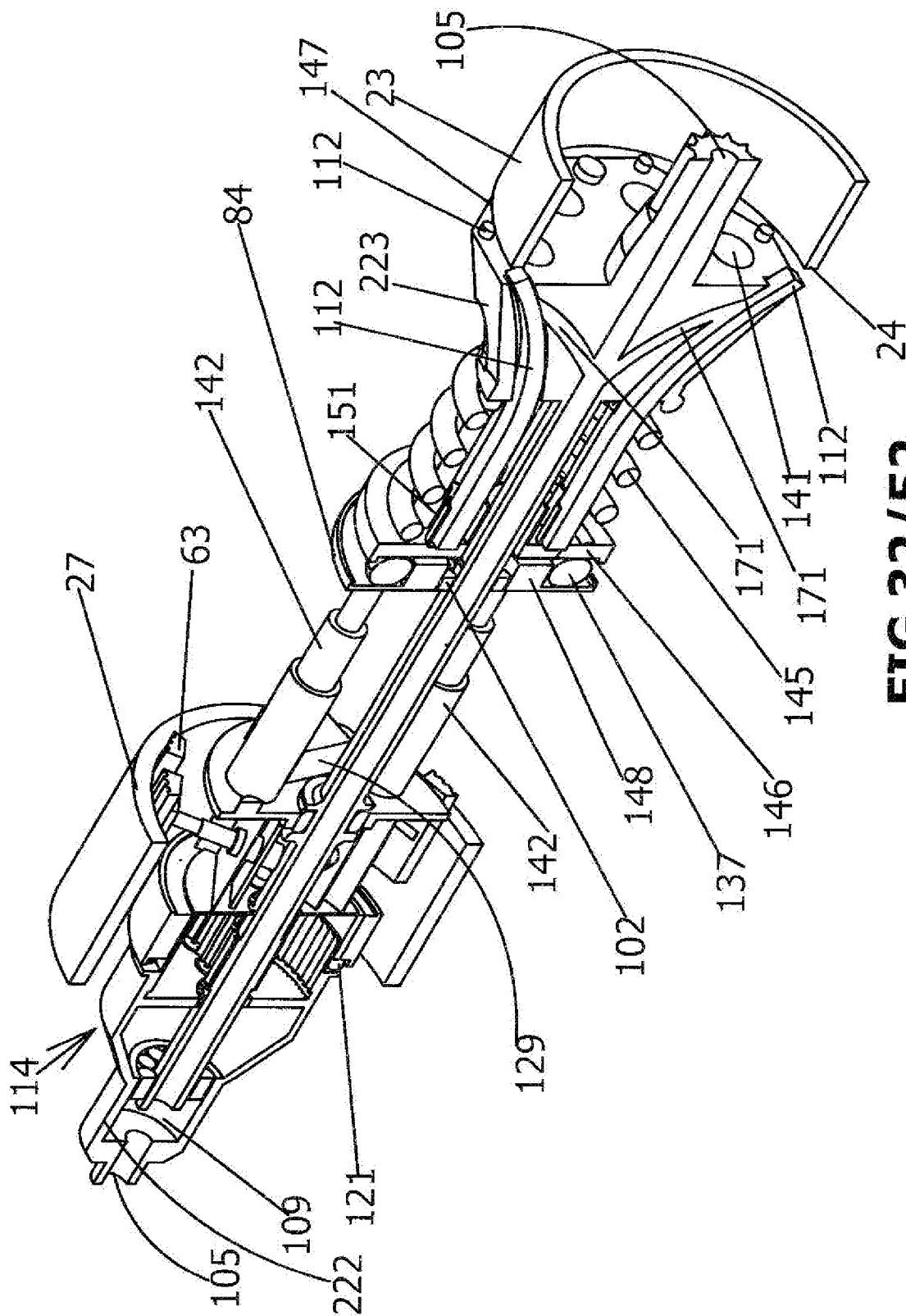
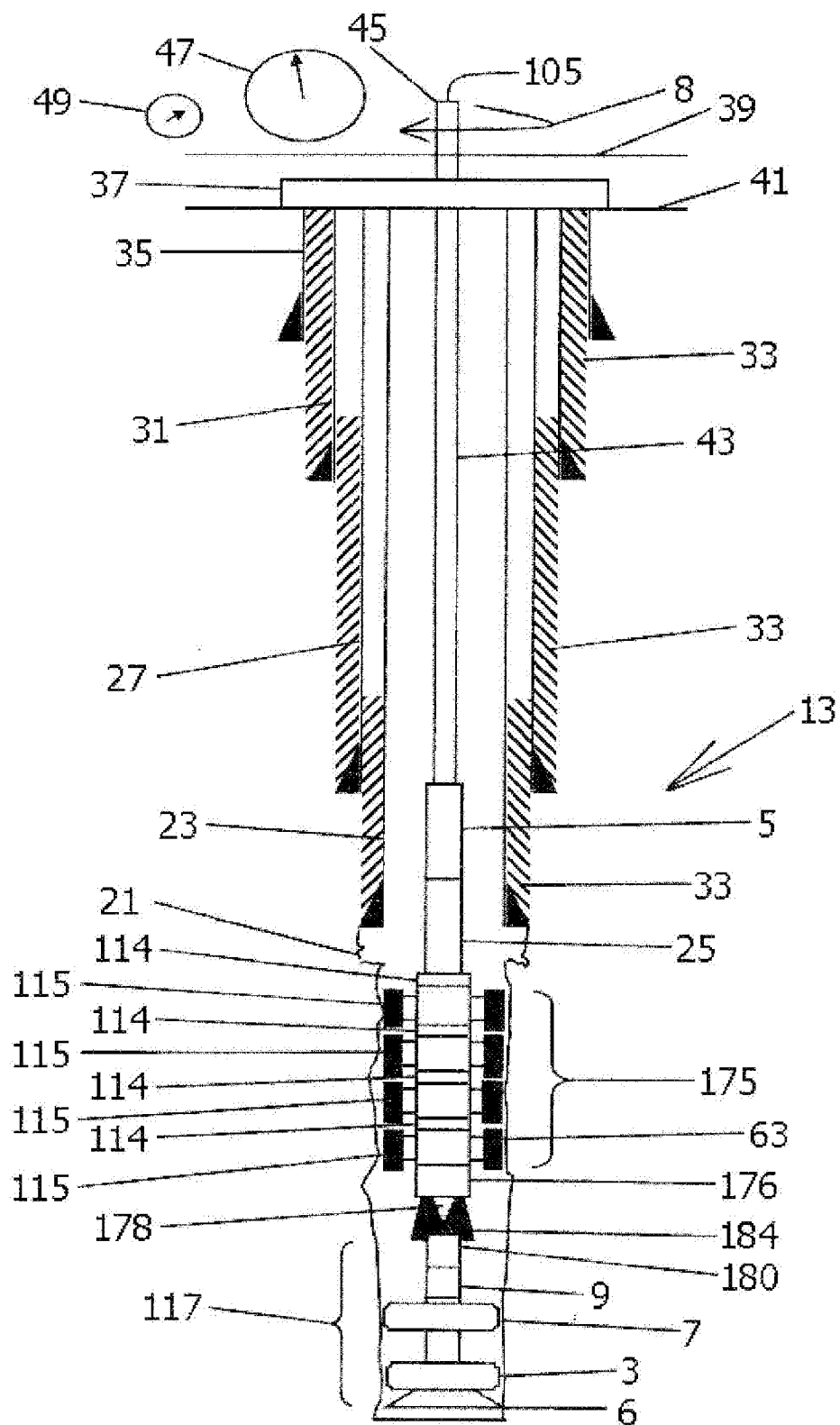


FIG.32/52

**FIG. 33/52**

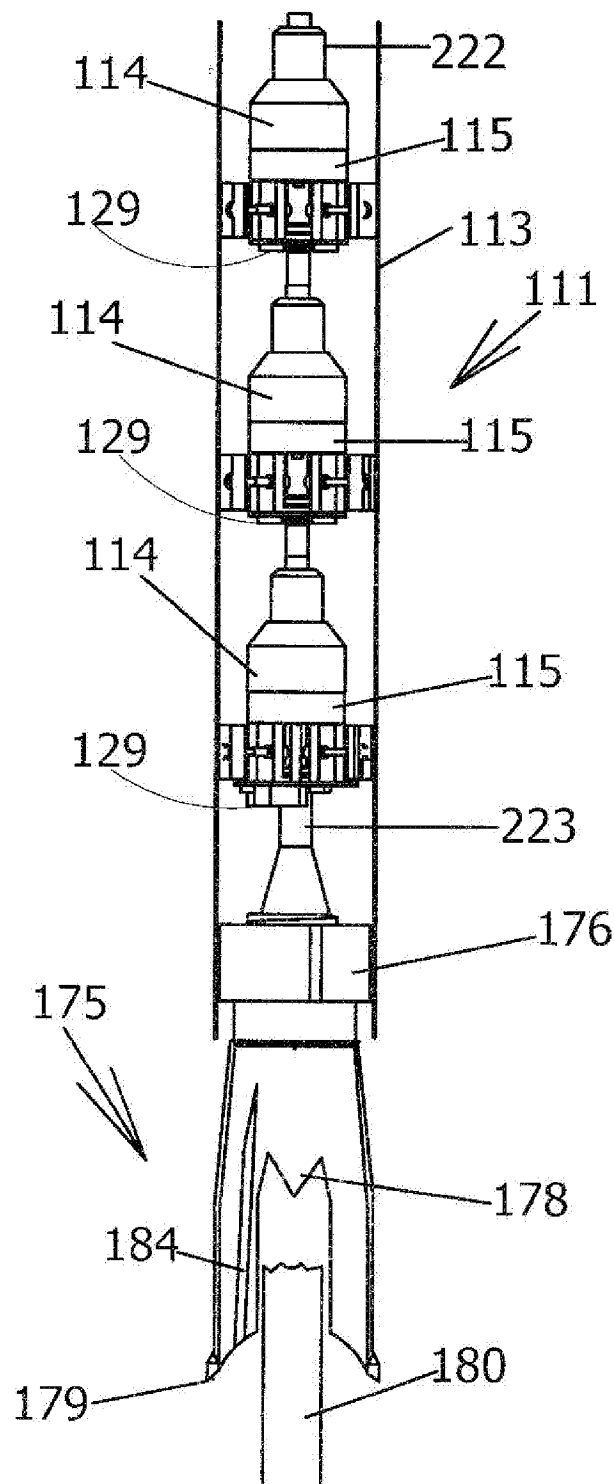


FIG.34/52

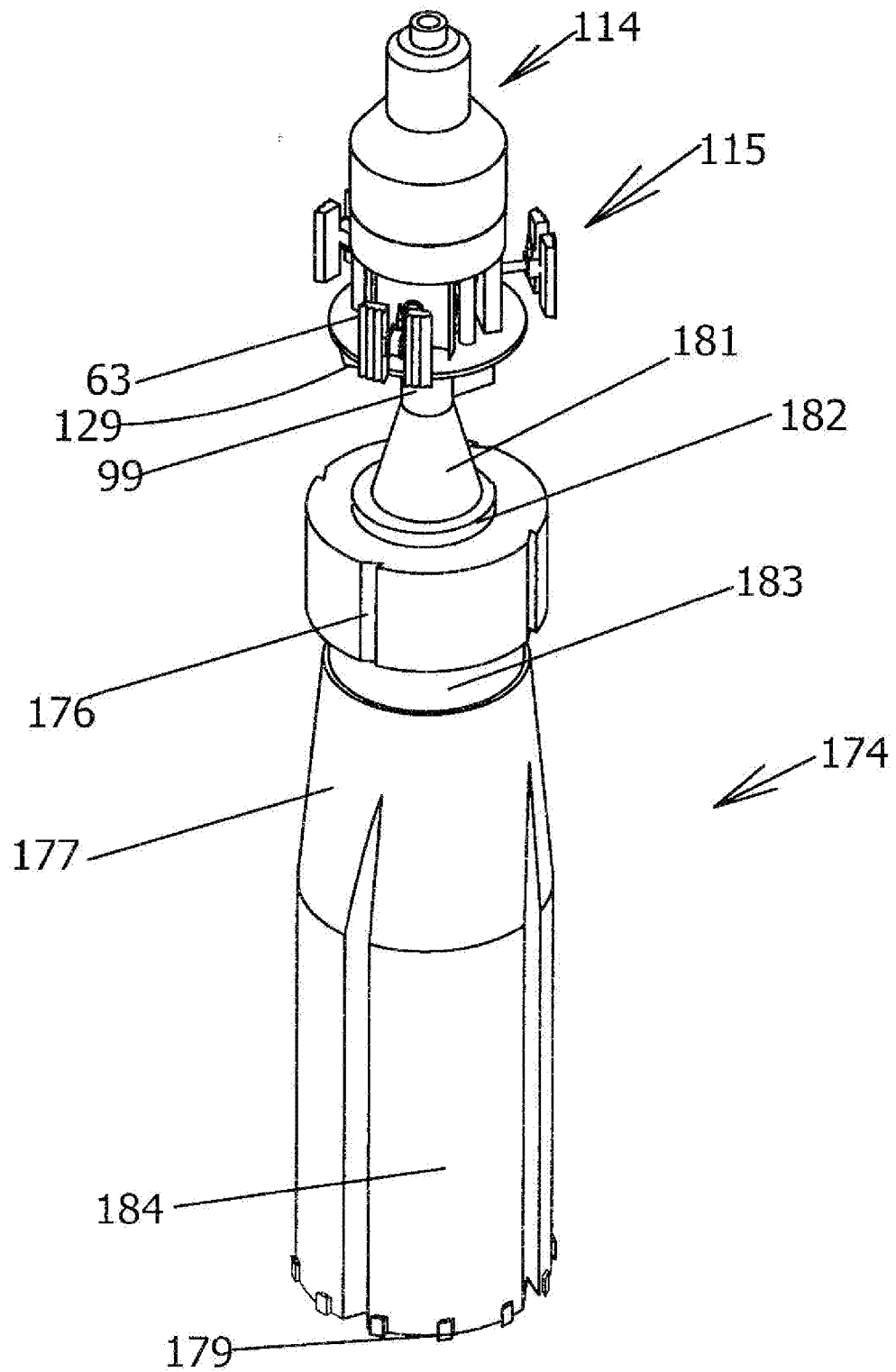
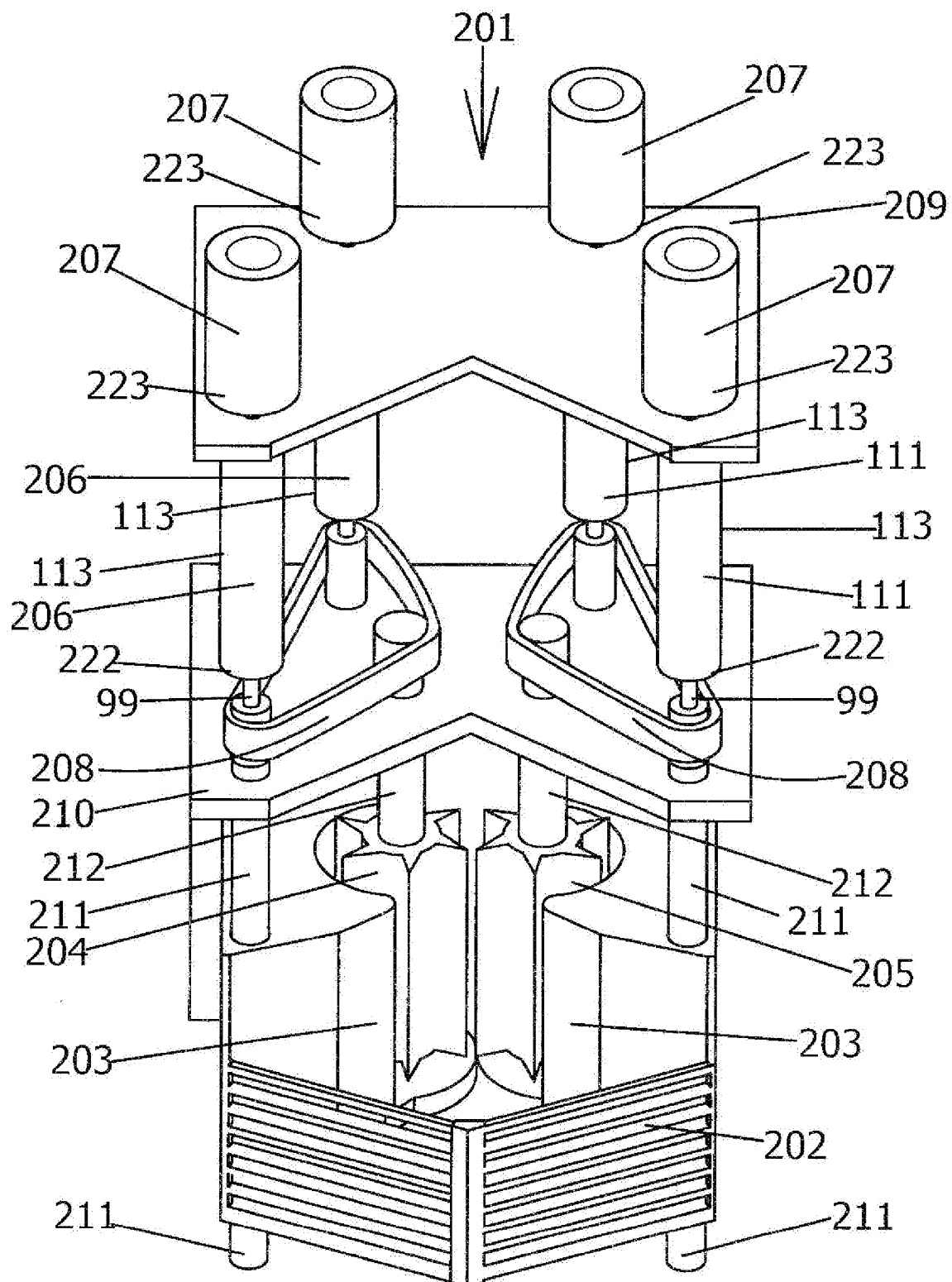


FIG.35/52

**FIG. 36/52**

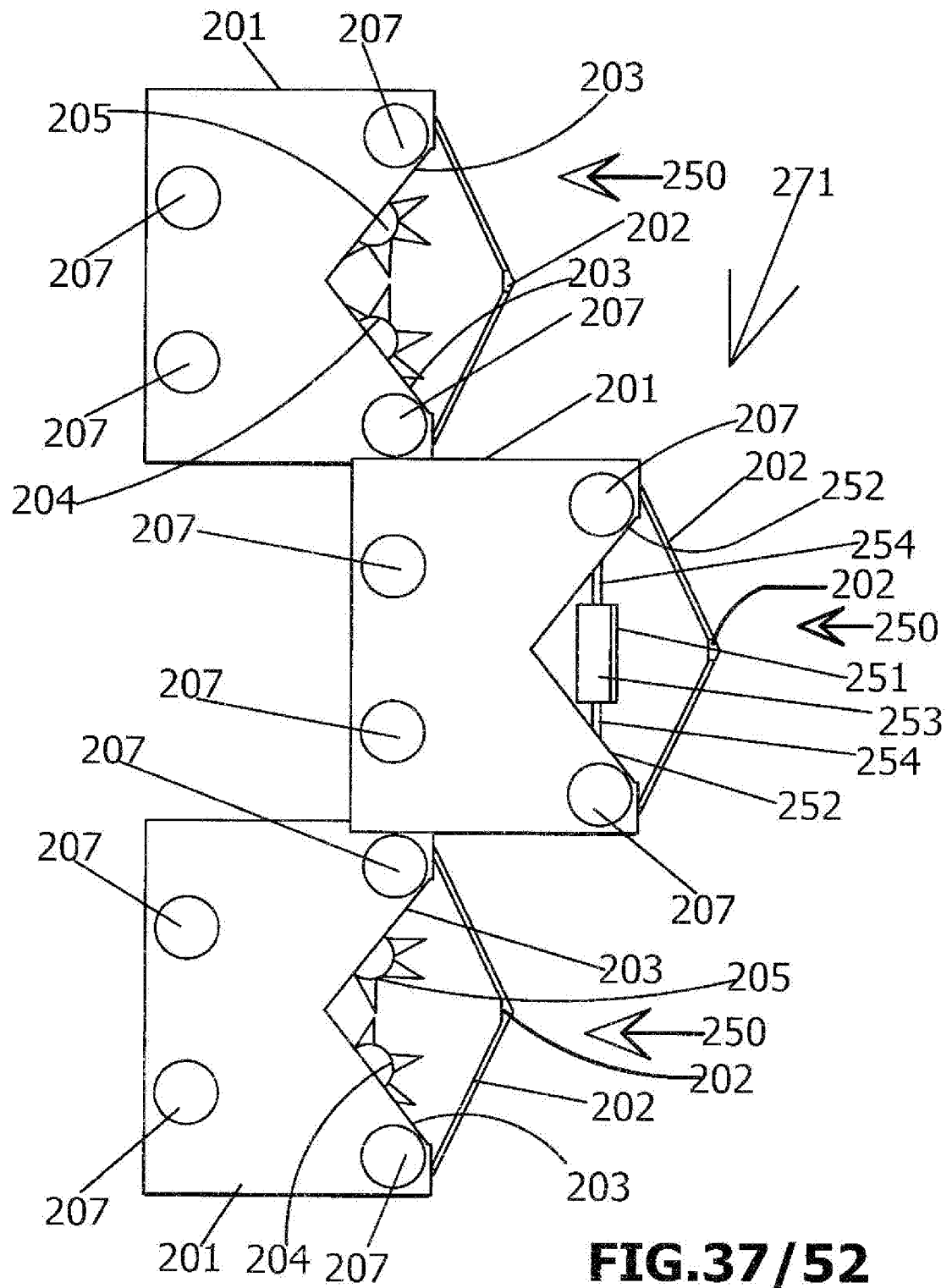


FIG.37/52

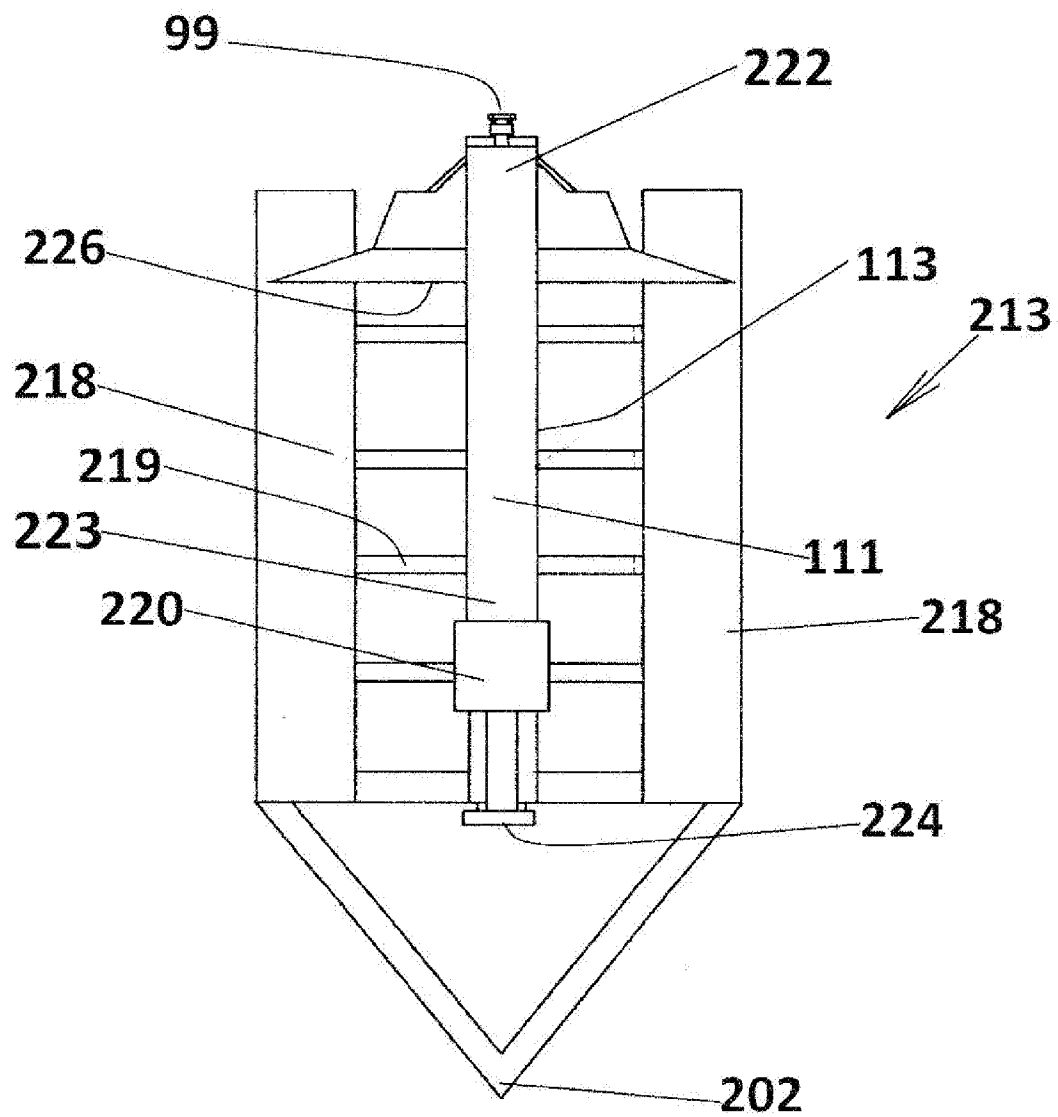


FIG.38/52

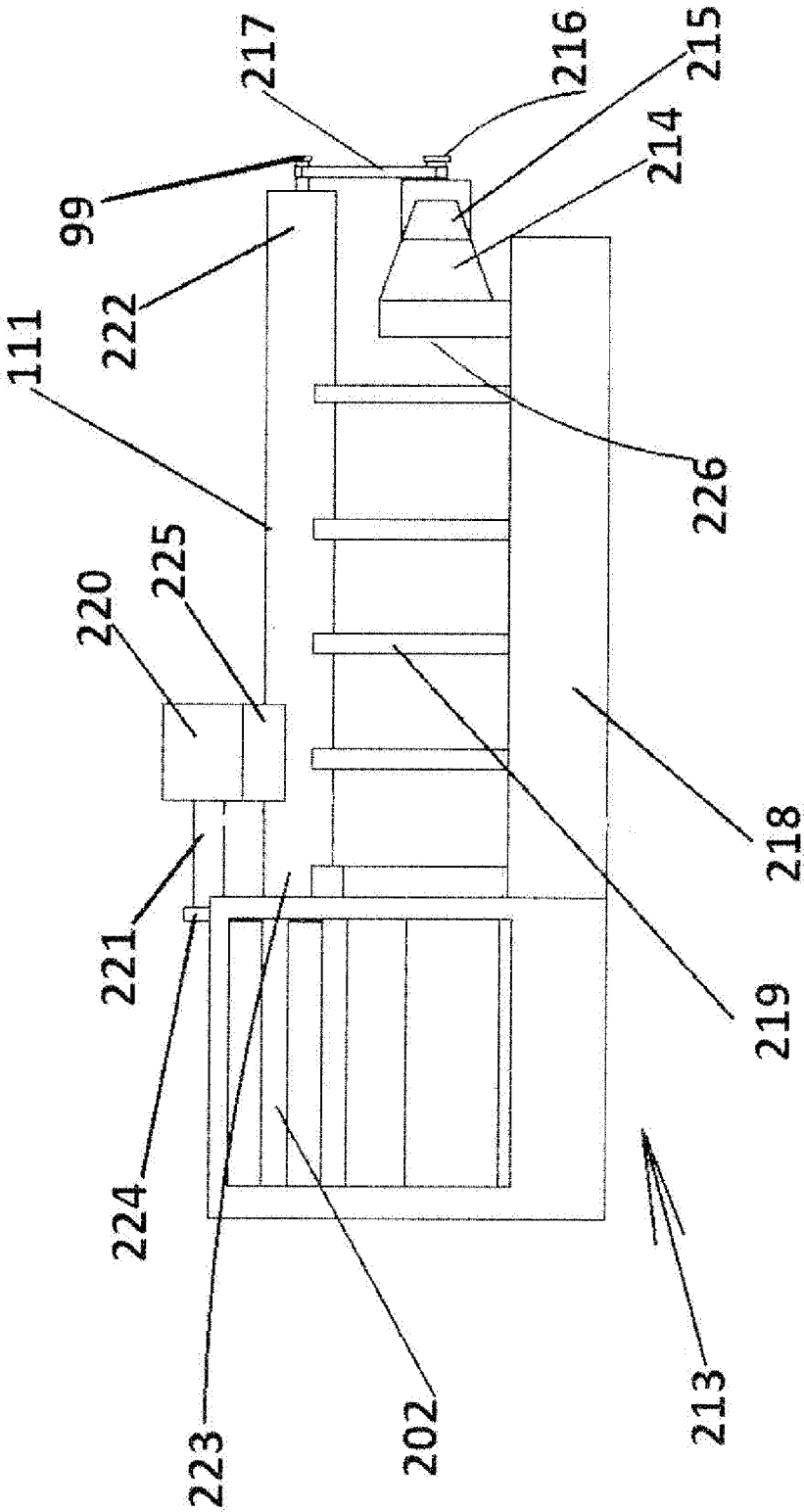
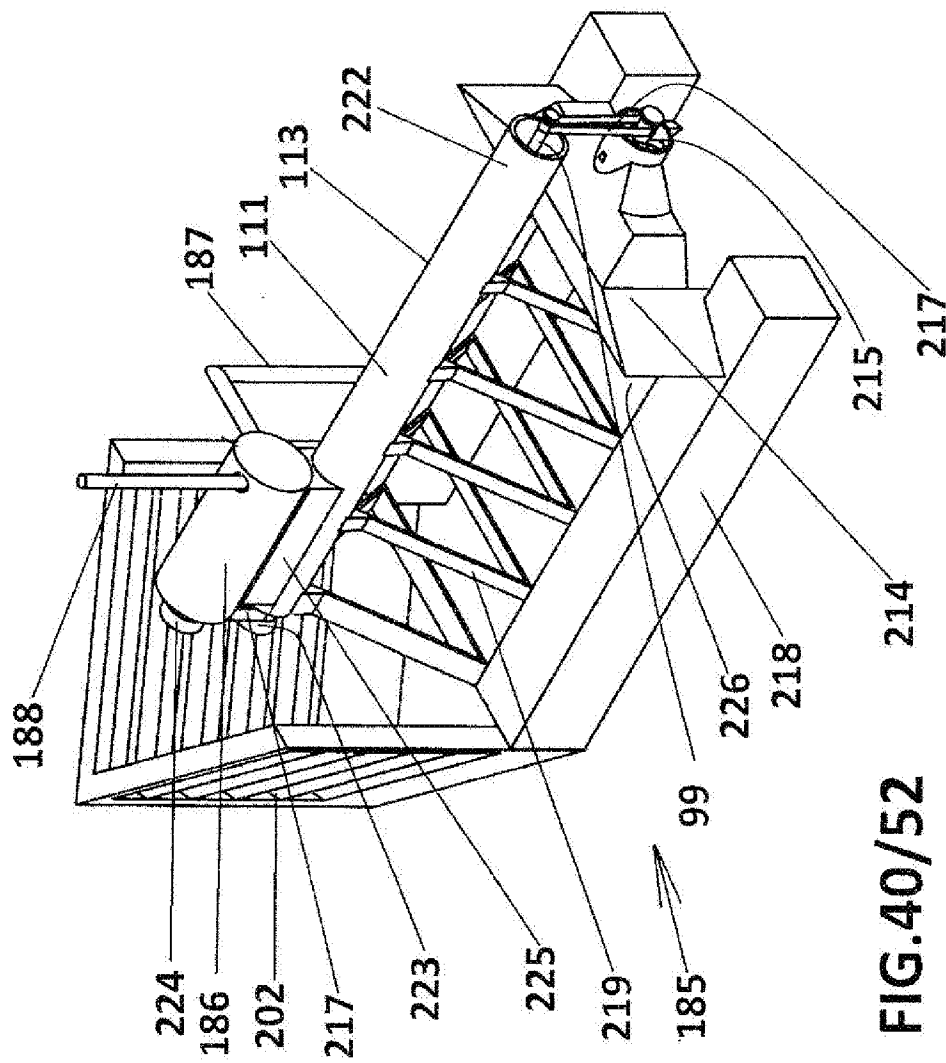


FIG. 39/52



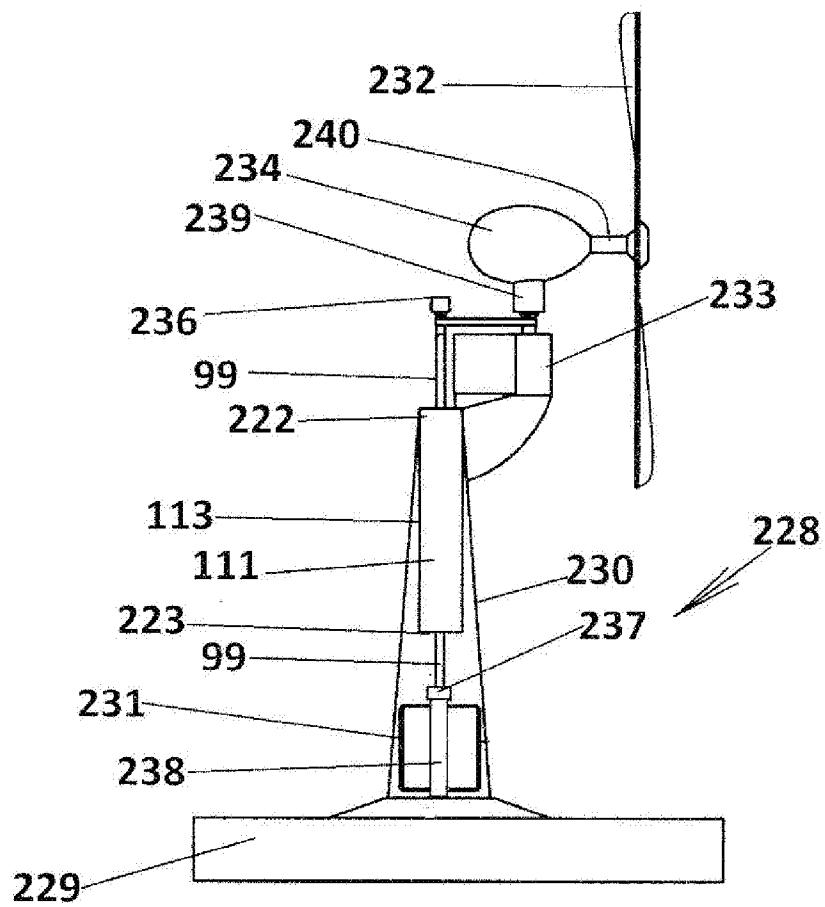


FIG.41/52

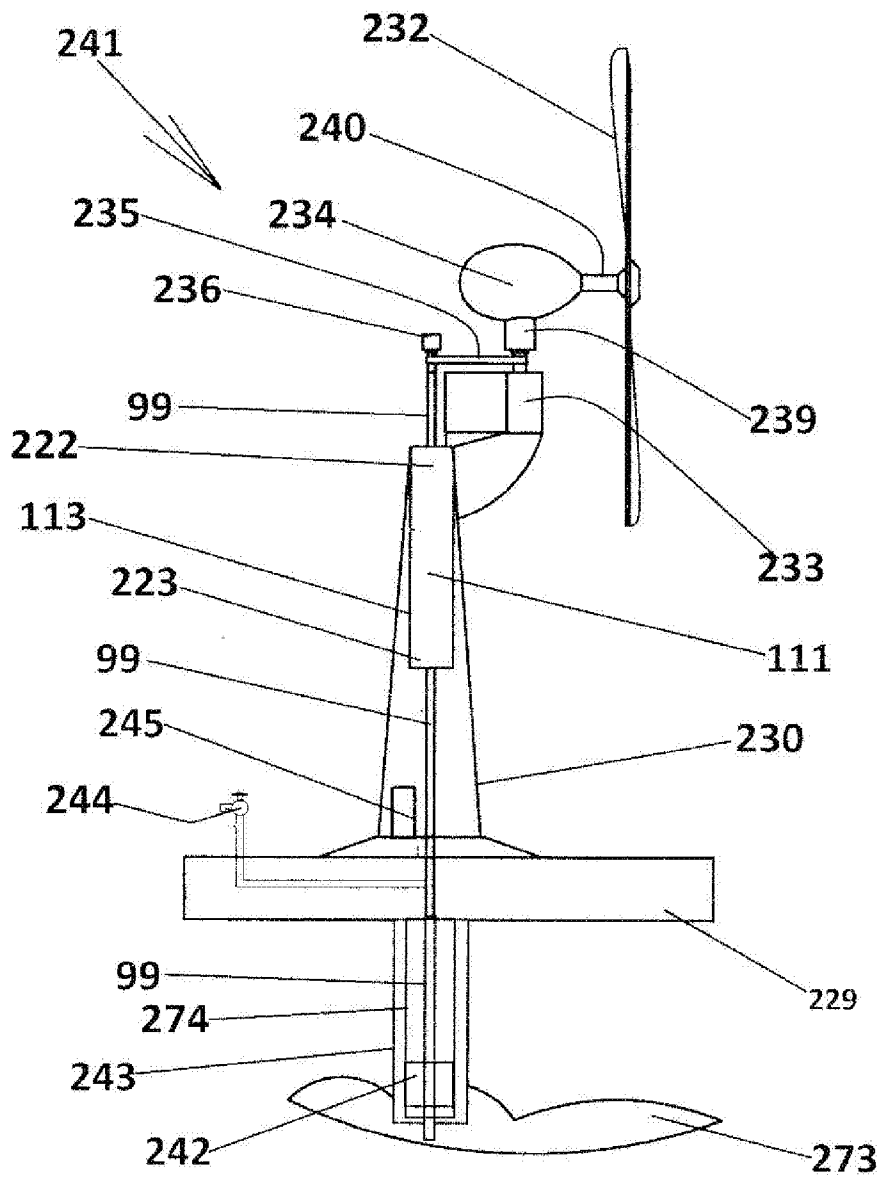


FIG.42/52

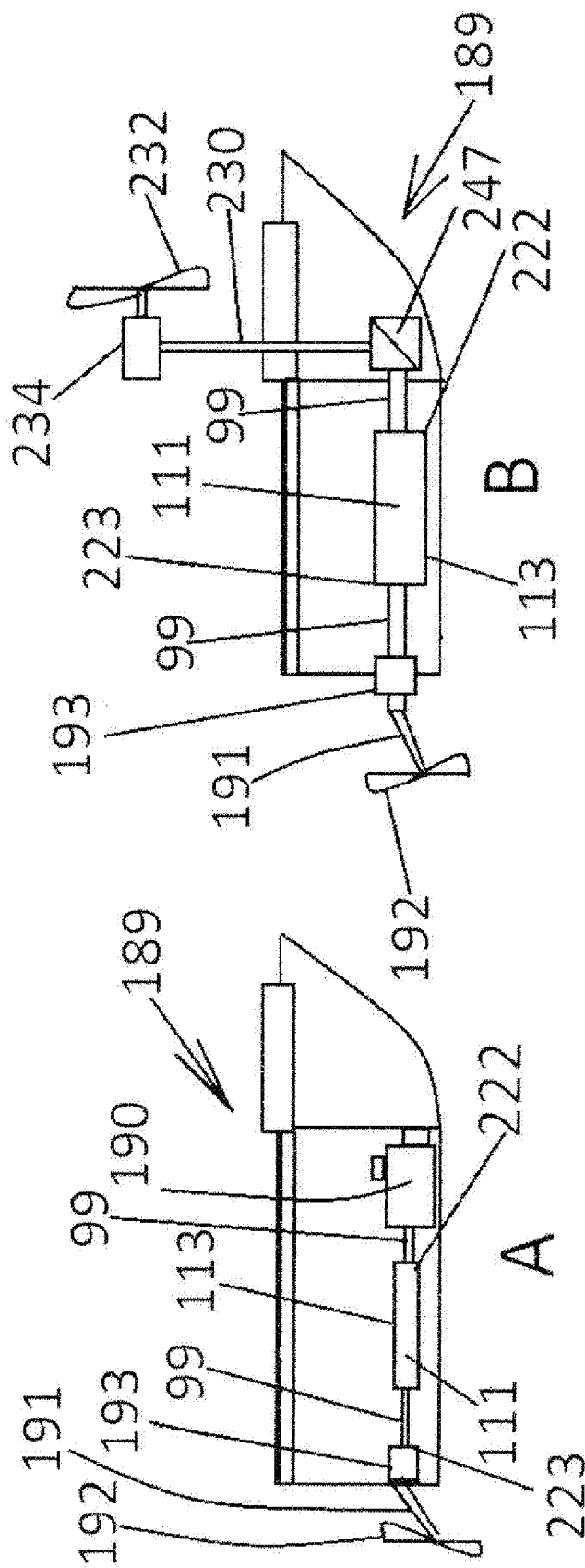


FIG.43/52

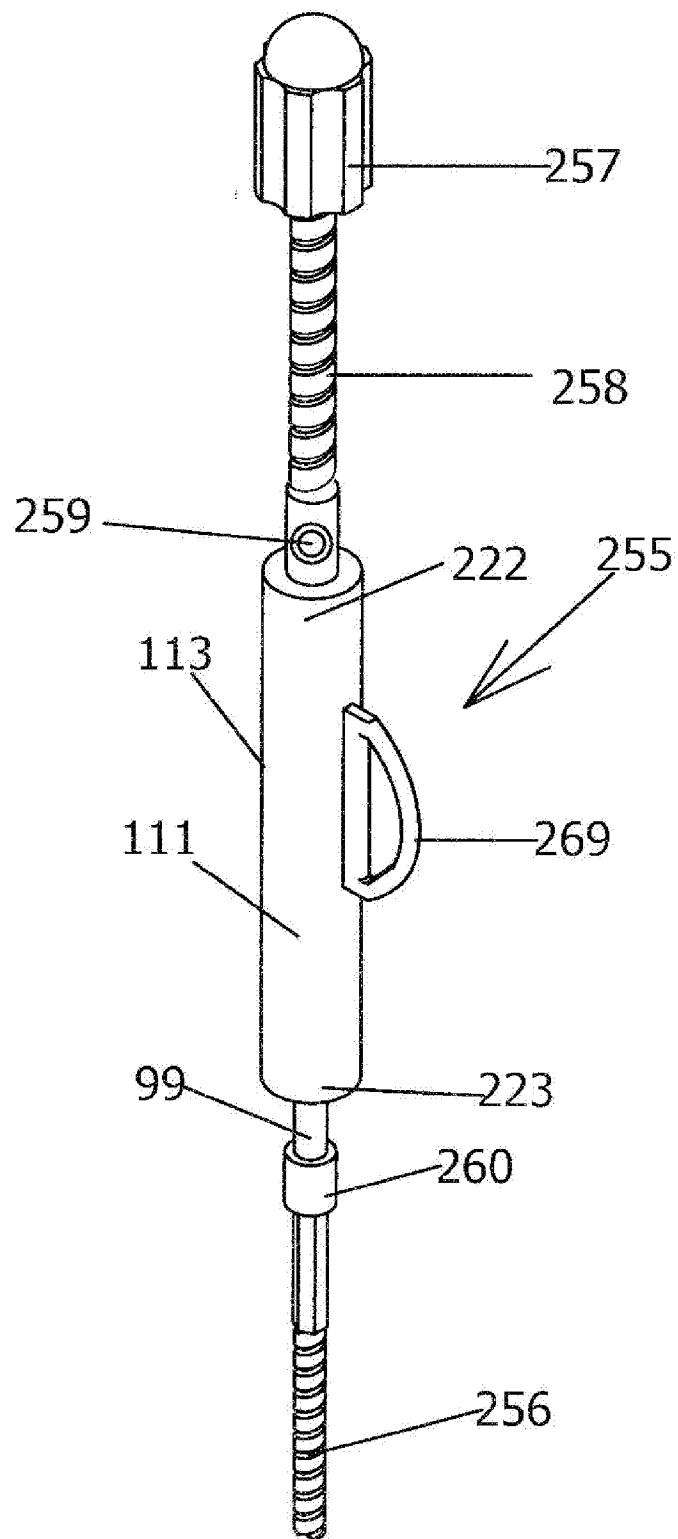
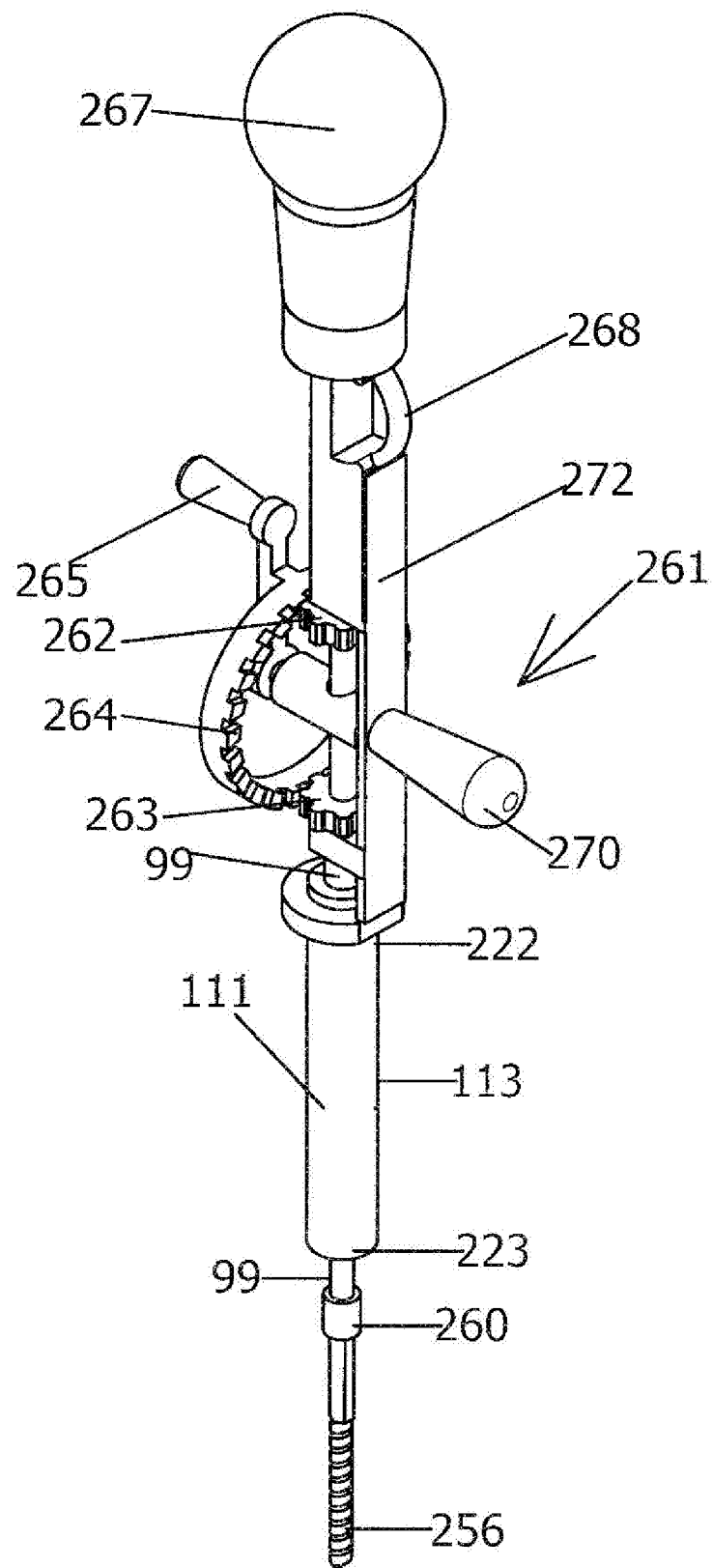
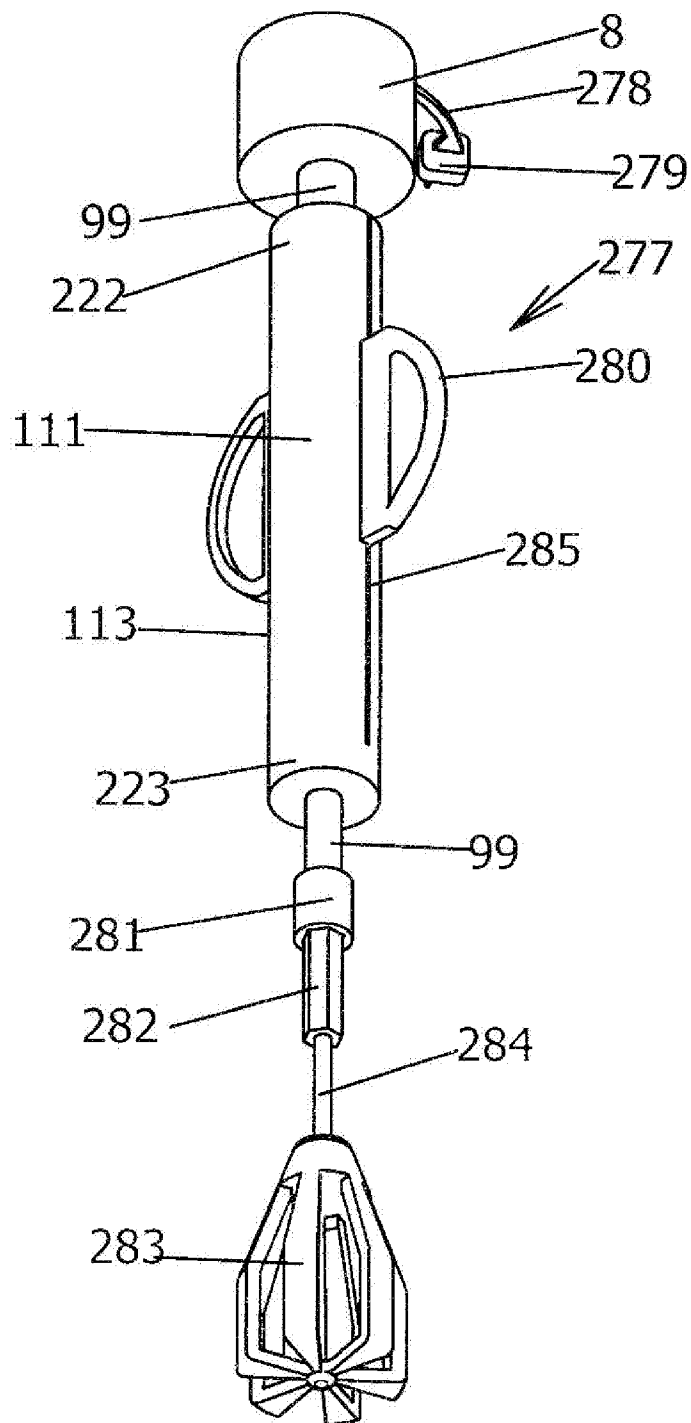


FIG.44/52

**FIG.45/52**

**FIG.46/52**

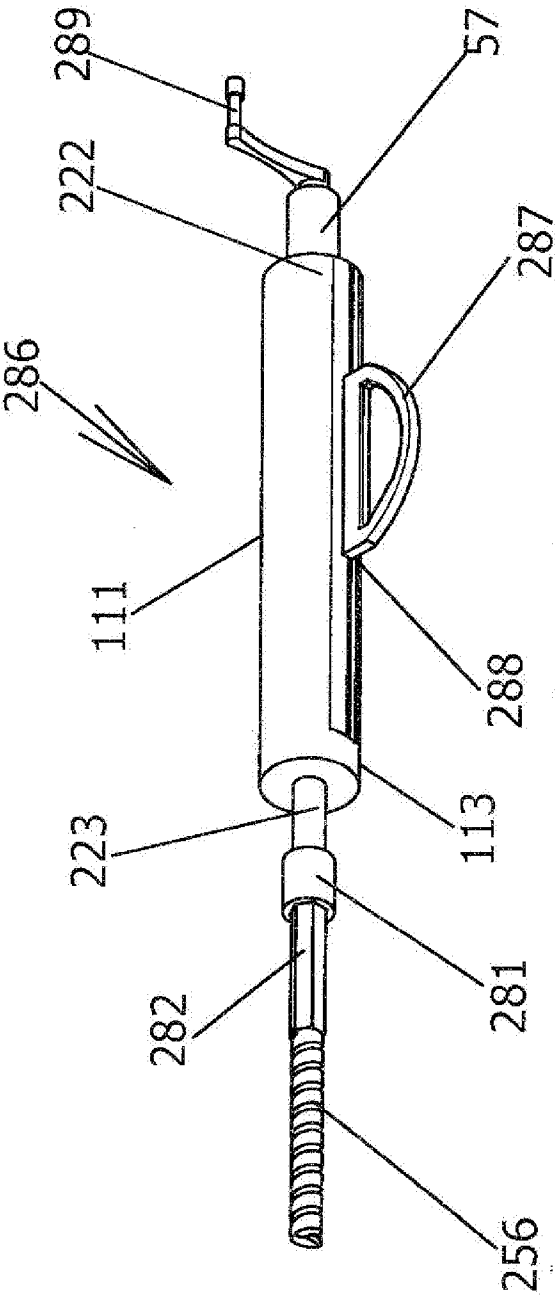


FIG.47/52

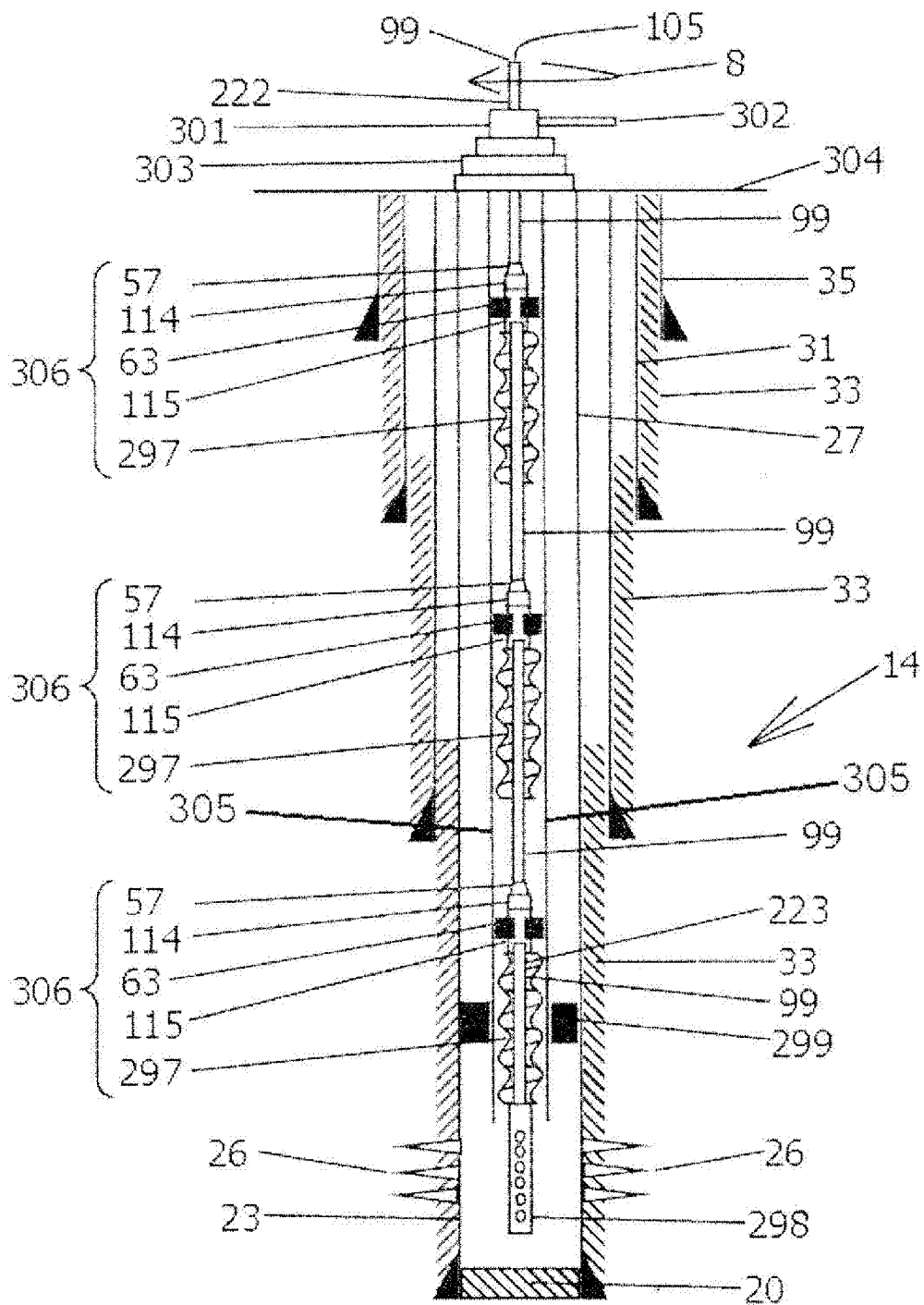


FIG. 48/52

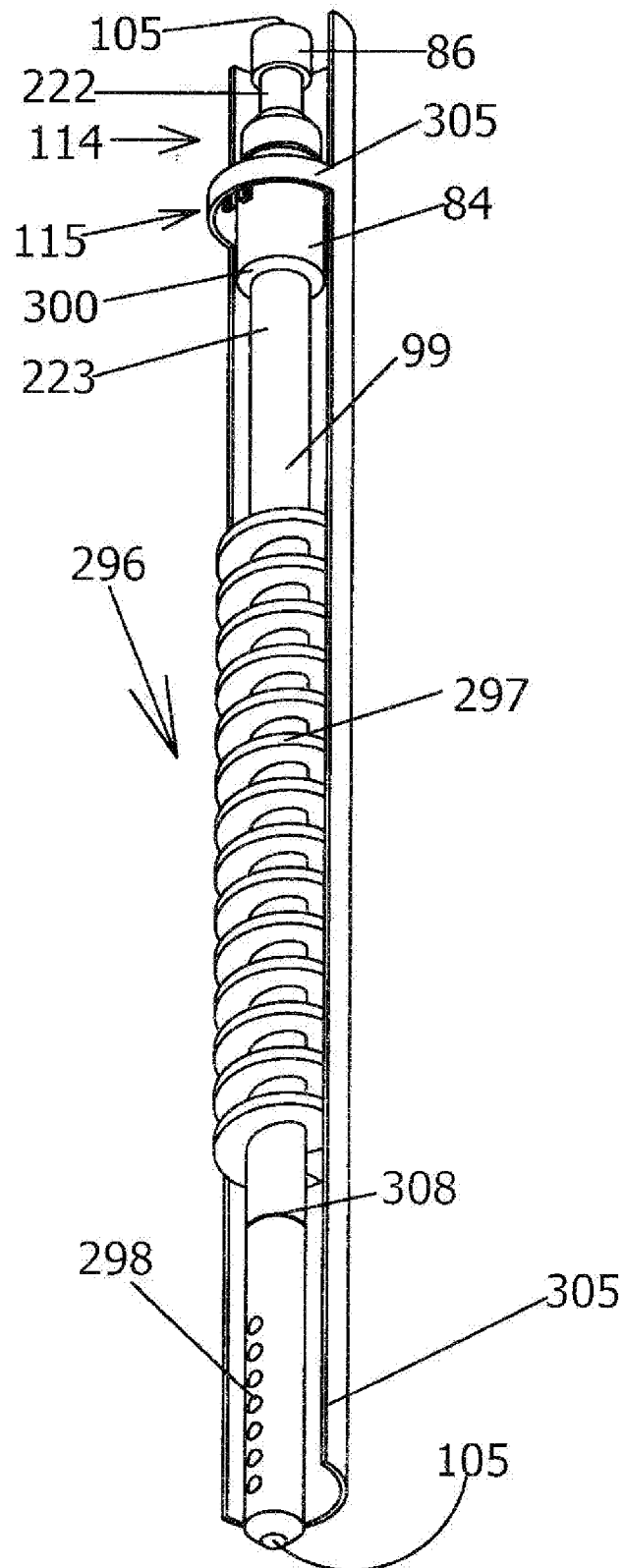
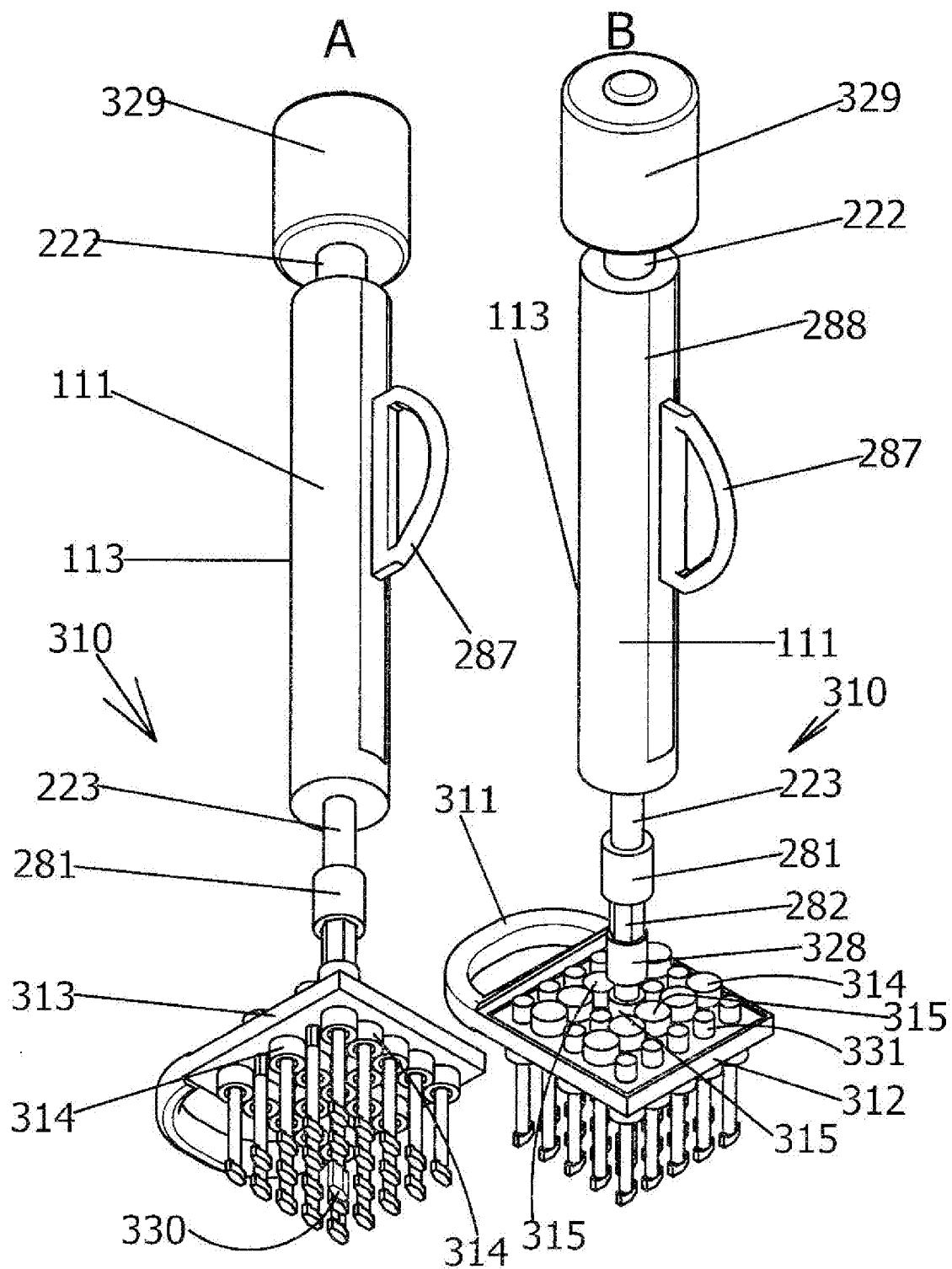


FIG.49/52

**FIG. 50/52**

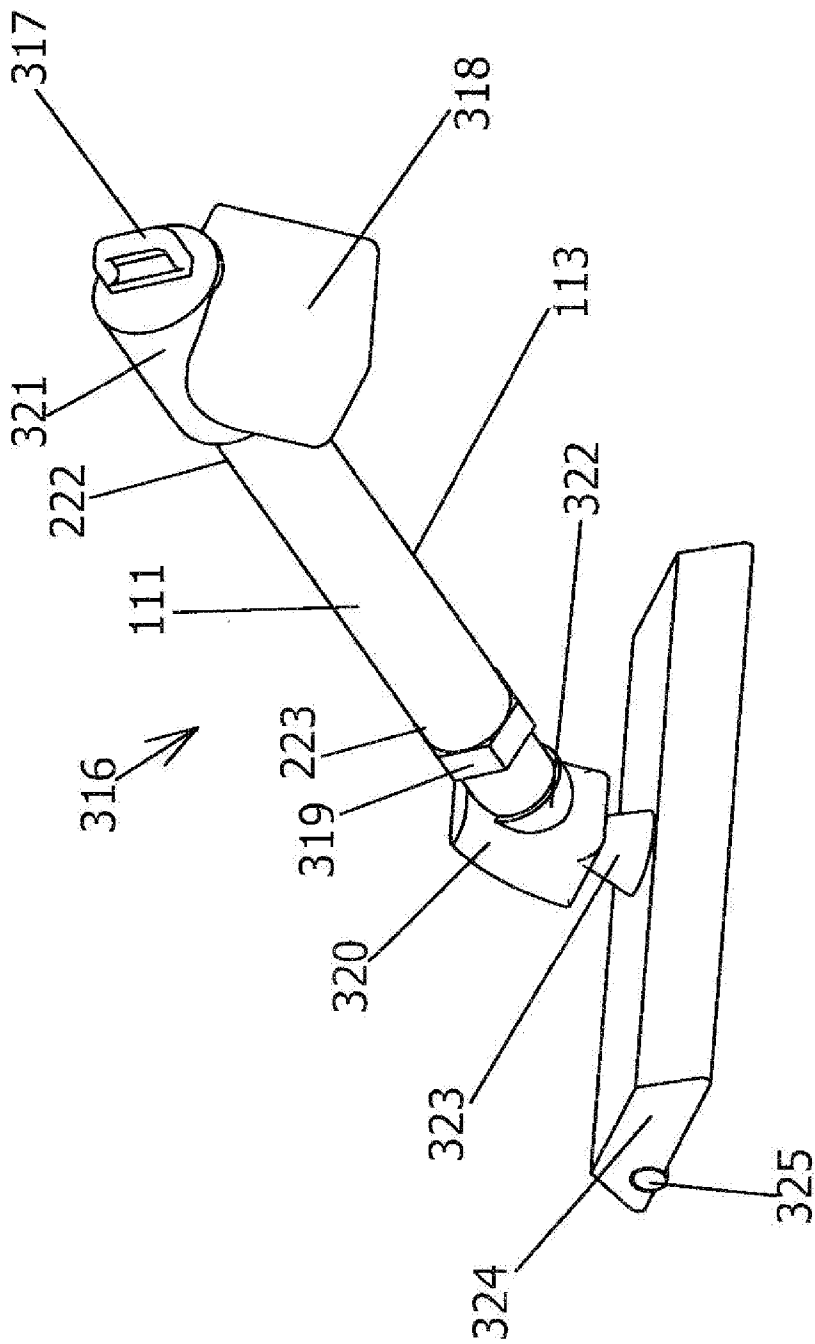


FIG.51/52

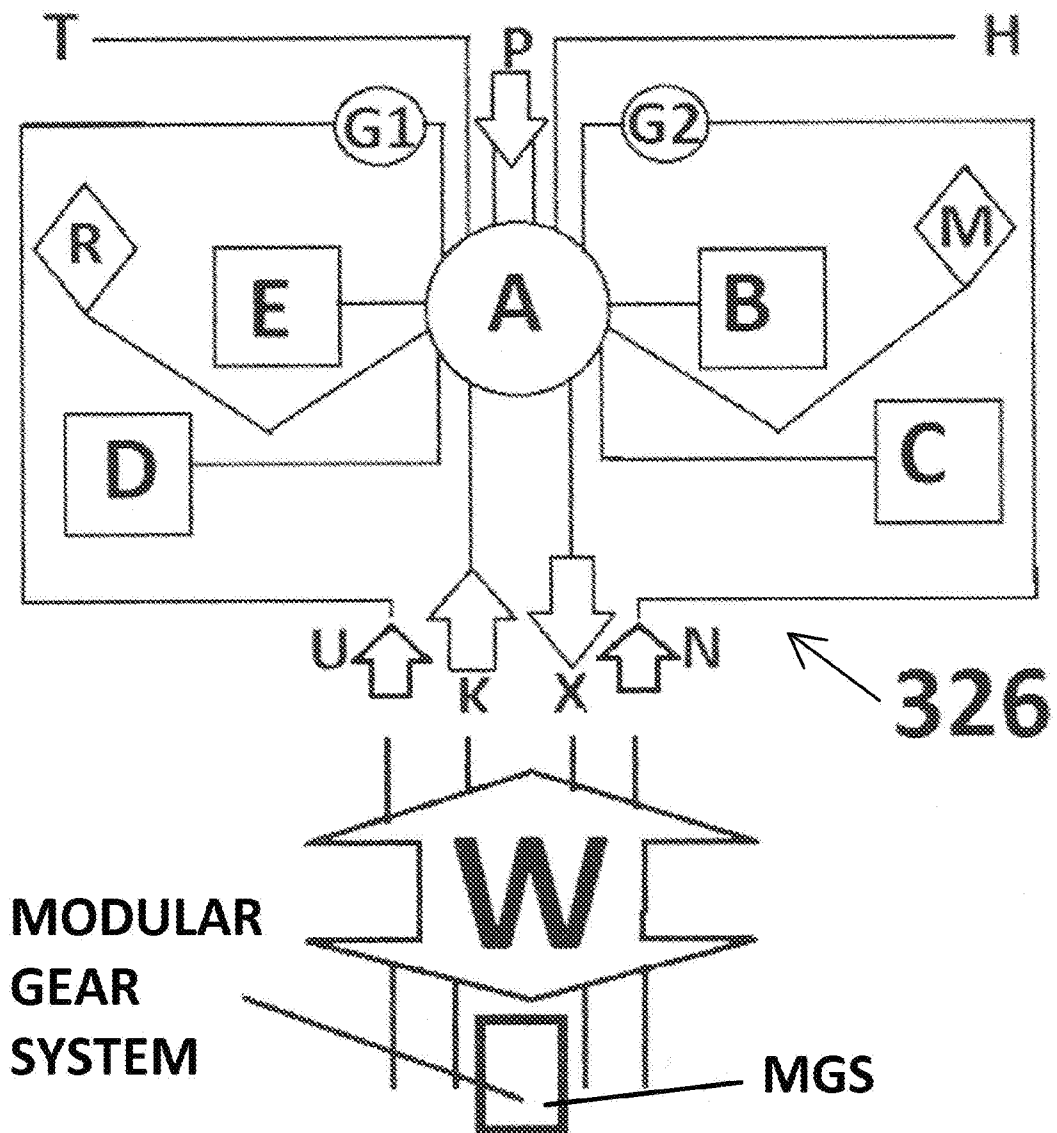


FIG.52/52

INTERNATIONAL SEARCH REPORT

International application No
PCT/IB2017/051576

A. CLASSIFICATION OF SUBJECT MATTER

INV. E21B4/18 E21B17/10 E21B29/00 E21B31/00
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

E21B F16H

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2 701 123 A (MOORE THOMAS V) 1 February 1955 (1955-02-01) cited in the application	1-7,9, 12-43
Y	column 1, line 57 - column 2, line 27;	10,11
A	figures 1,2,4	8
X	US 4 314 615 A (SODDER JR GEORGE ET AL) 9 February 1982 (1982-02-09) cited in the application	1-3,5-7, 43
Y	column 3, line 14 - column 4, line 56;	10,11
A	figures 1,2,3,4b,5	8
X	US 2015/075871 A1 (STRITTMATTER ANDREW JEROME [US]) 19 March 2015 (2015-03-19) cited in the application paragraphs [0027] - [0035]; figures 2,3,4	1,43
	----- -/-	



Further documents are listed in the continuation of Box C.



See patent family annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search

19 May 2017

Date of mailing of the international search report

24/07/2017

Name and mailing address of the ISA/

European Patent Office, P.B. 5818 Patentlaan 2
NL - 2280 HV Rijswijk
Tel. (+31-70) 340-2040,
Fax: (+31-70) 340-3016

Authorized officer

Beran, Jiri

INTERNATIONAL SEARCH REPORT

International application No

PCT/IB2017/051576

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	CA 1 098 110 A (PERM VNII B) 24 March 1981 (1981-03-24) page 16, line 5 - page 23, line 13; claims 1,2,5; figure 1 -----	1-7,12, 13,43

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/IB2017/051576

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2701123	A	01-02-1955	NONE
US 4314615	A	09-02-1982	NONE
US 2015075871	A1	19-03-2015	CA 2870276 A1 24-10-2013
		CN 104334817 A	04-02-2015
		EP 2839102 A1	25-02-2015
		US 2015075871 A1	19-03-2015
		WO 2013158096 A1	24-10-2013
CA 1098110	A	24-03-1981	CA 1098110 A 24-03-1981
		DE 2900189 A1	19-07-1979
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		NL 7900168 A	11-07-1979
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		NL 8700400 A	01-06-1987
		SE 444053 B	17-03-1986
		SE 459875 B	14-08-1989
		SU 943385 A1	15-07-1982

INTERNATIONAL SEARCH REPORT

International application No.
PCT/IB2017/051576

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:
2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:
3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

see additional sheet

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.
2. ☐ As all searchable claims could be searched without effort justifying an additional fees, this Authority did not invite payment of additional fees.
3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:
4. ☒ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

1-43

Remark on Protest

- ☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.
- ☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.
- ☐ No protest accompanied the payment of additional search fees.

FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

This International Searching Authority found multiple (groups of) inventions in this international application, as follows:

1. claims: 1-43

A modular gear system which operates in a containment structure comprises: a gear assembly which is housed in a first gear assembly housing, an input drive drives the gear assembly which drives an output drive shaft; the gear assembly is sealed in the first gear assembly housing; the input drive is operative to be driven by an output drive of a second gear assembly, whereby in use the angular speed of the input drive is different from the angular speed of the output drive; and at least one stabiliser is adapted to engage with the containment structure so as to maintain the gear system in position.

2. claims: 44, 45

A system has a casing with an internally threaded surface and a moveable extender has a threaded surface which engages with the internally threaded surface of the casing, an actuator causes relative rotation of the casing with respect to the moveable extender thereby extending/retracting the moveable extender.
