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Perry

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(54) **FRICTION REDUCING DOWNHOLE ASSEMBLIES**

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(51) **Int. Cl.**
E21B 17/10 (2006.01)

(52) **U.S. Cl.**
CPC ***E21B 17/1014*** (2013.01); ***E21B 17/1057*** (2013.01)

(58) **Field of Classification Search**
CPC E21B 17/1057; E21B 17/1064; E21B 17/1014; E21B 17/1021; E21B 17/1078; E21B 17/1007; E21B 17/10; E21B 7/62; E21B 17/1028
See application file for complete search history.

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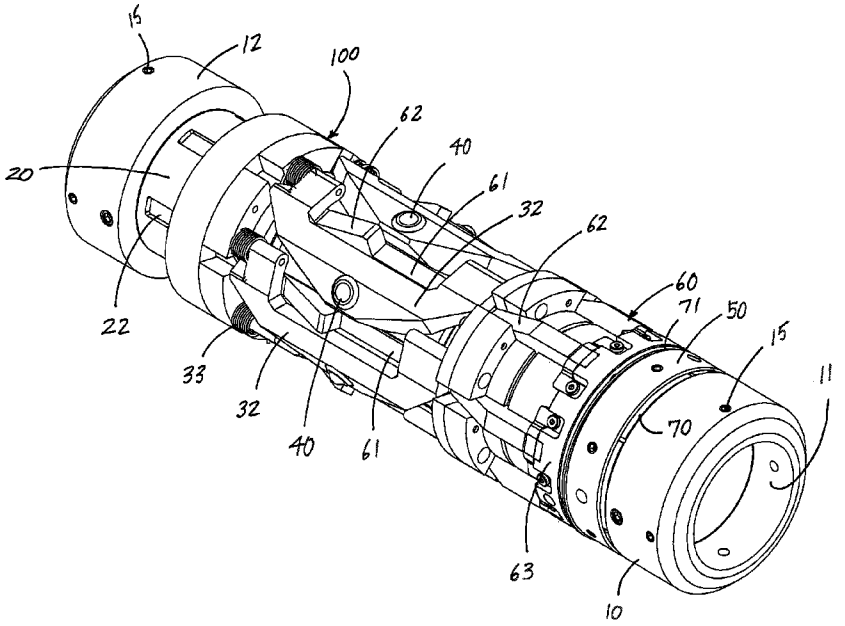
(57) **ABSTRACT**

A friction reducing assembly has a substantially cylindrical body member having an outer surface and friction reducing elements, such as ball transfer units or other omni-directional rolling-element bearing assemblies, disposed along such outer surface. The friction reducing assembly can take many different configurations including a rolling sub assembly, a mule shoe assembly or a centralizer assembly having an adjustable outer diameter.

11 Claims, 9 Drawing Sheets



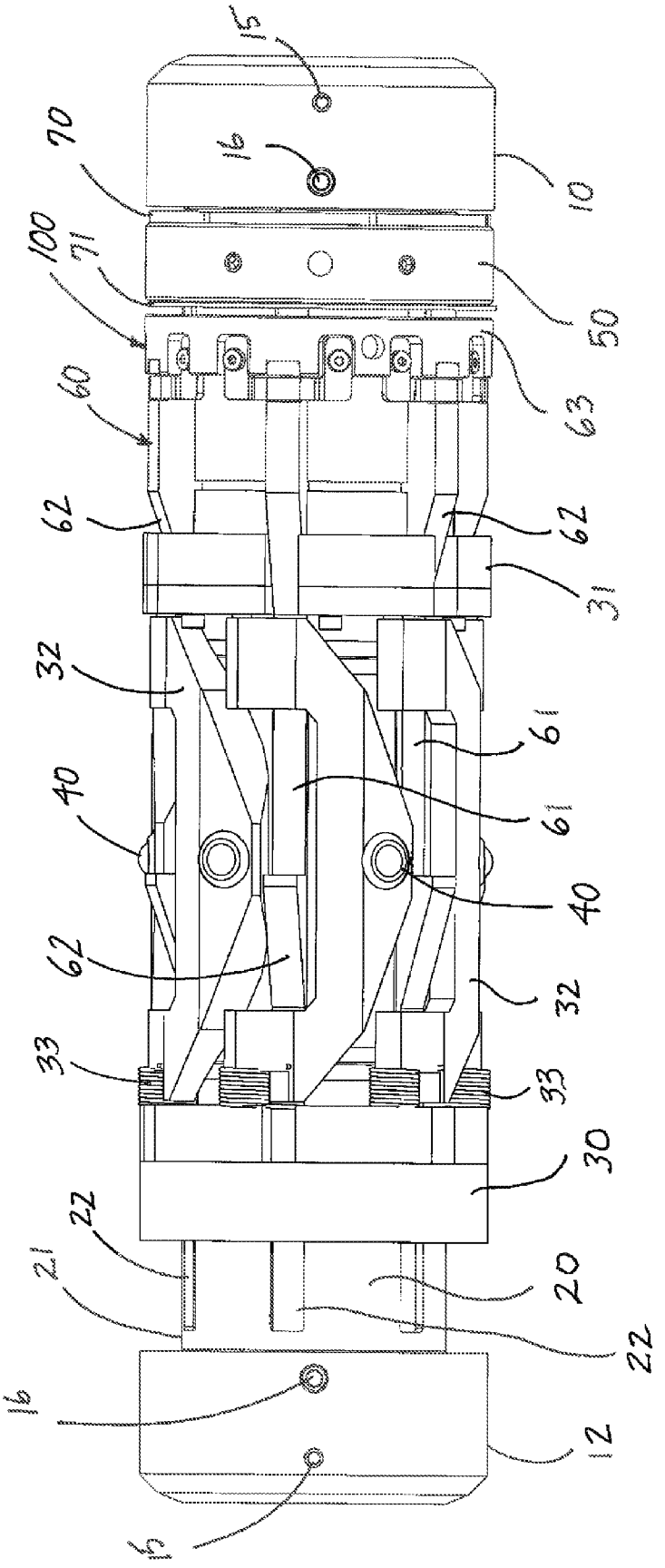

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FIG. 1

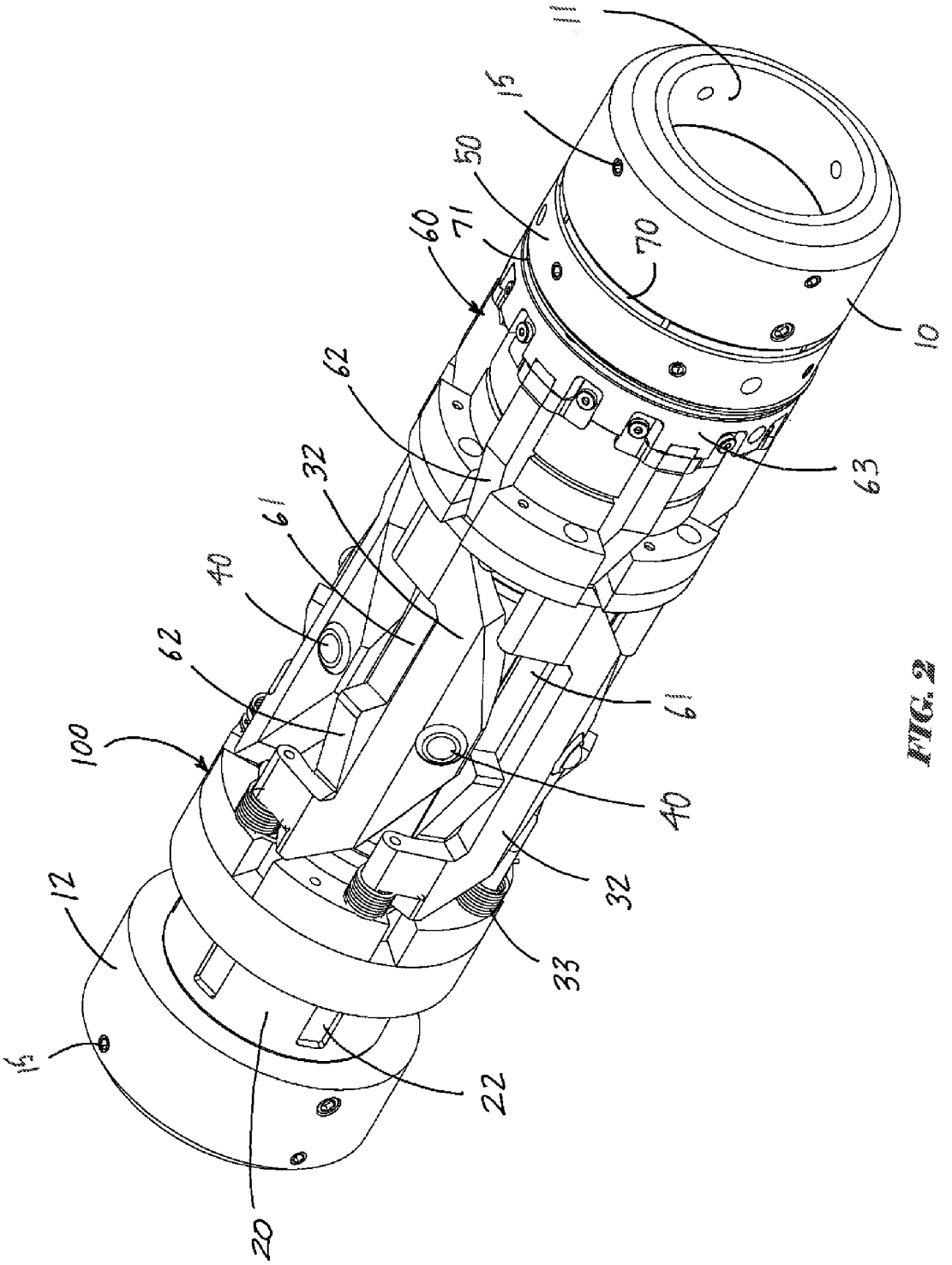

FIG. 2

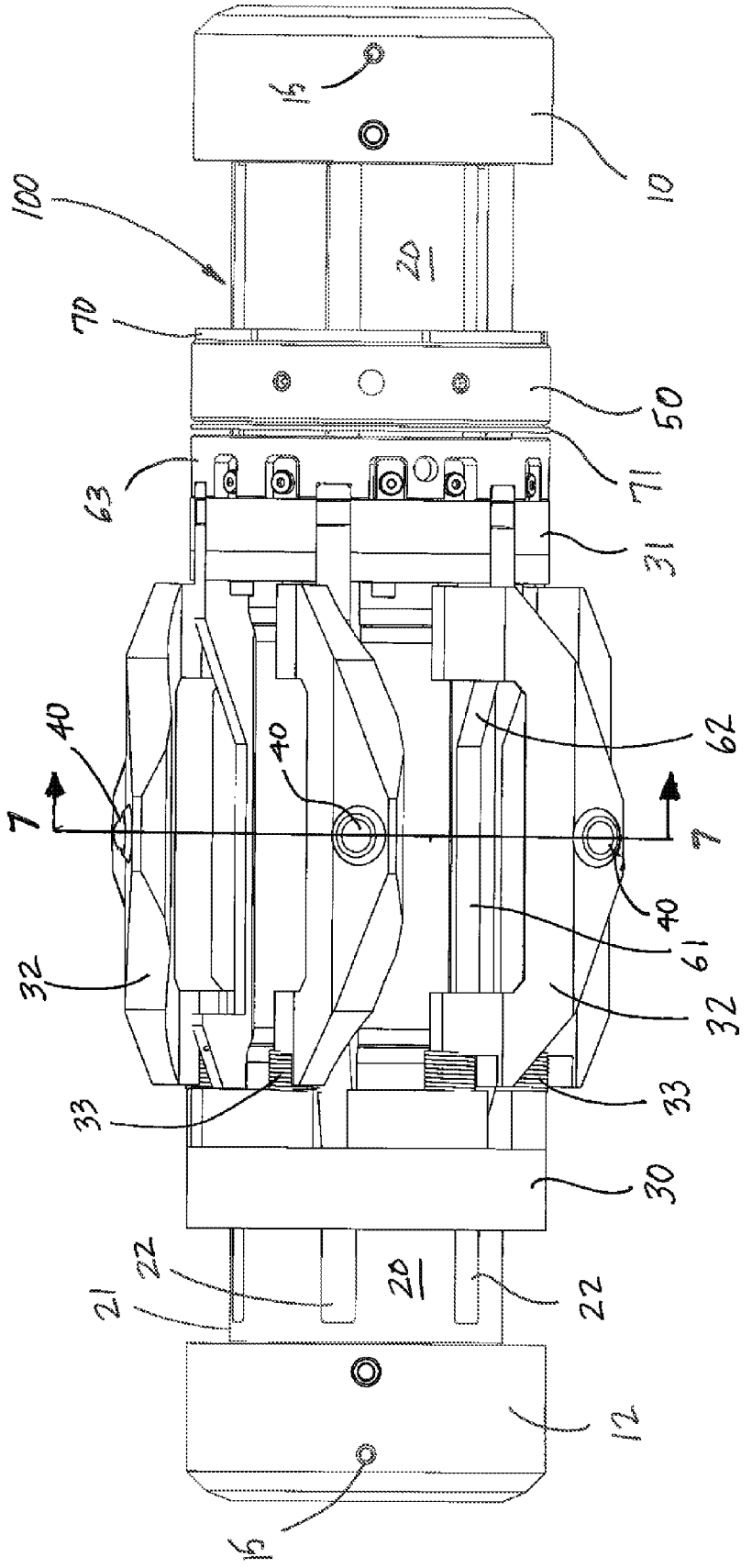
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FIG. 3

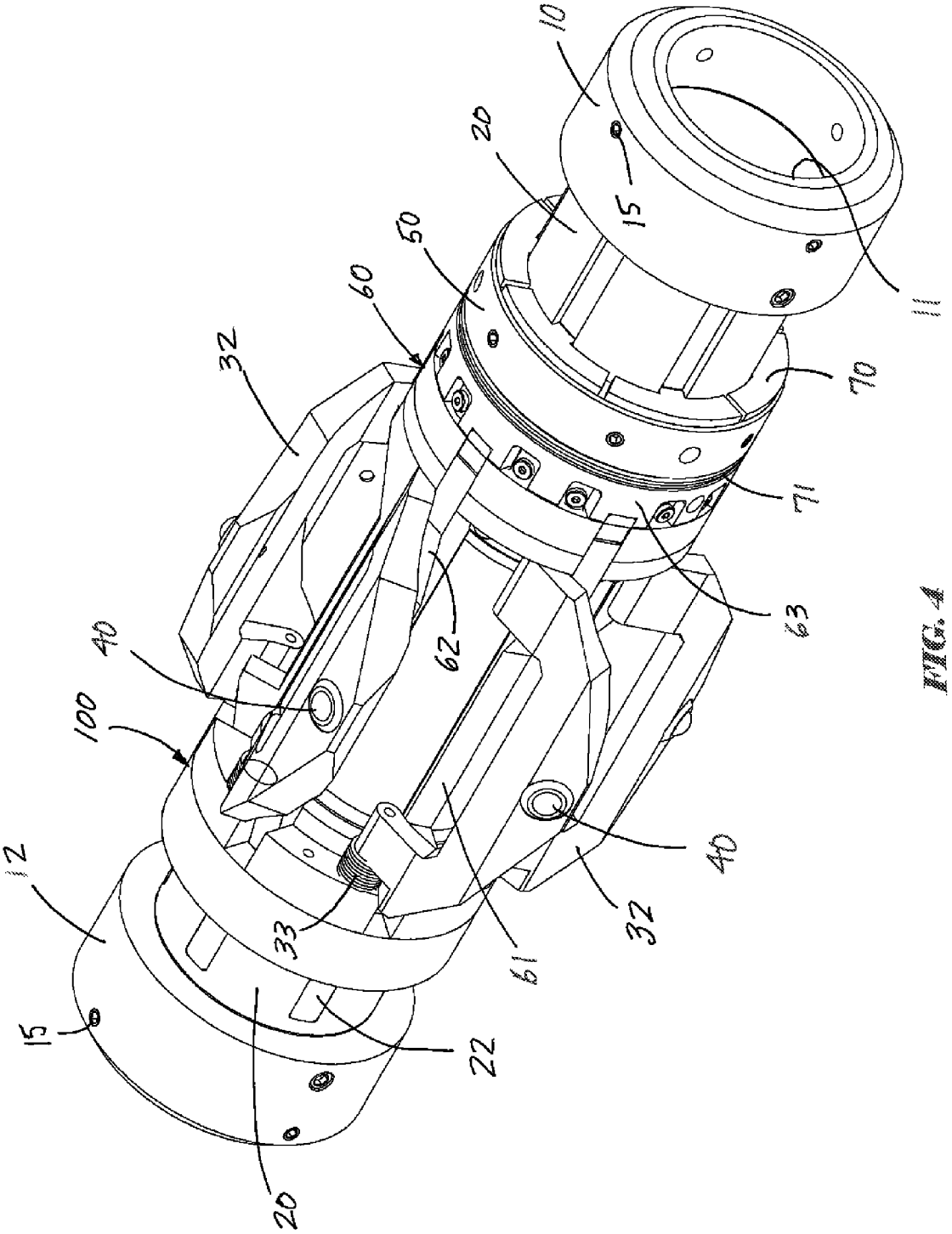

FIG. 4

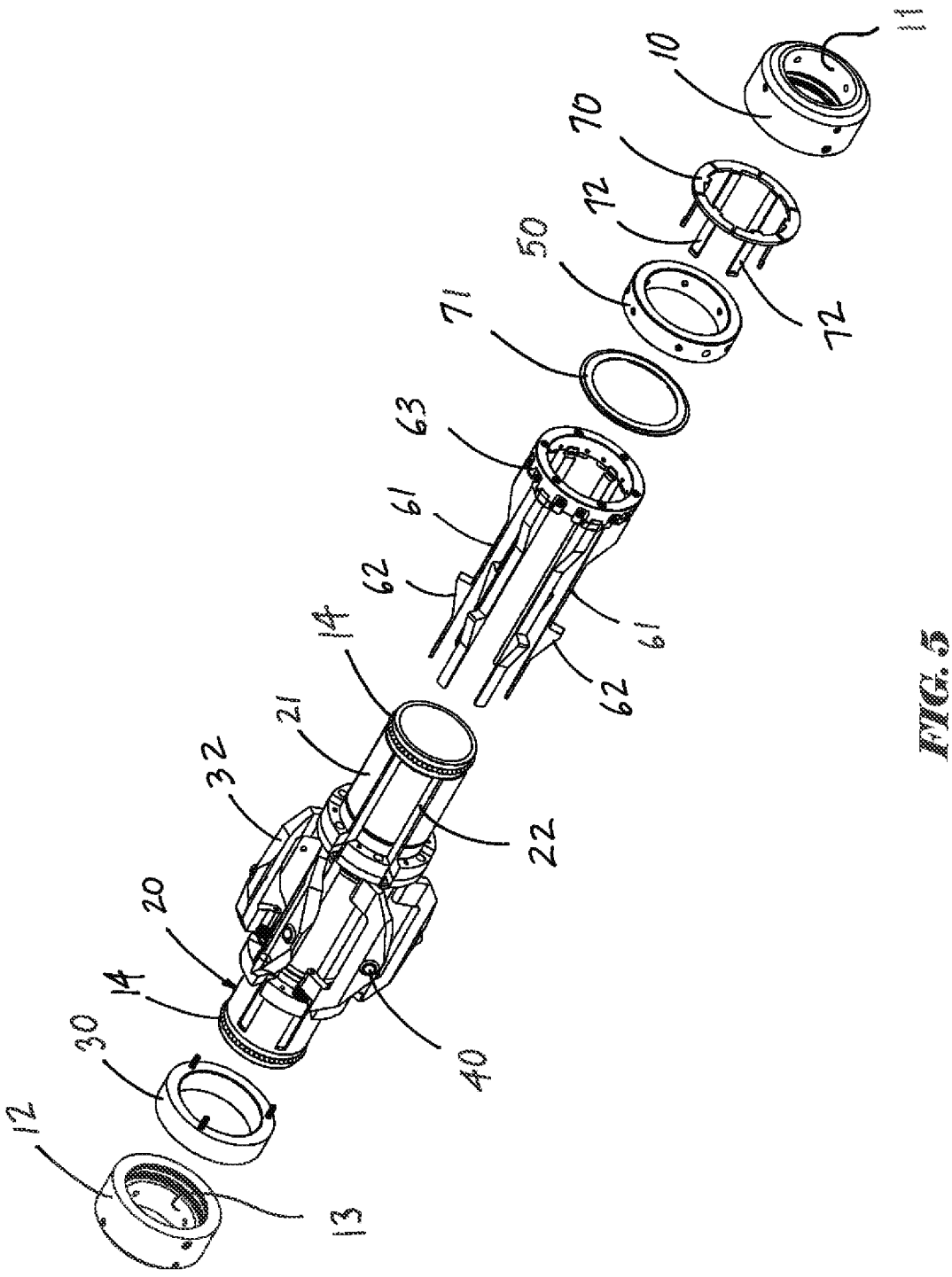

FIG. 5

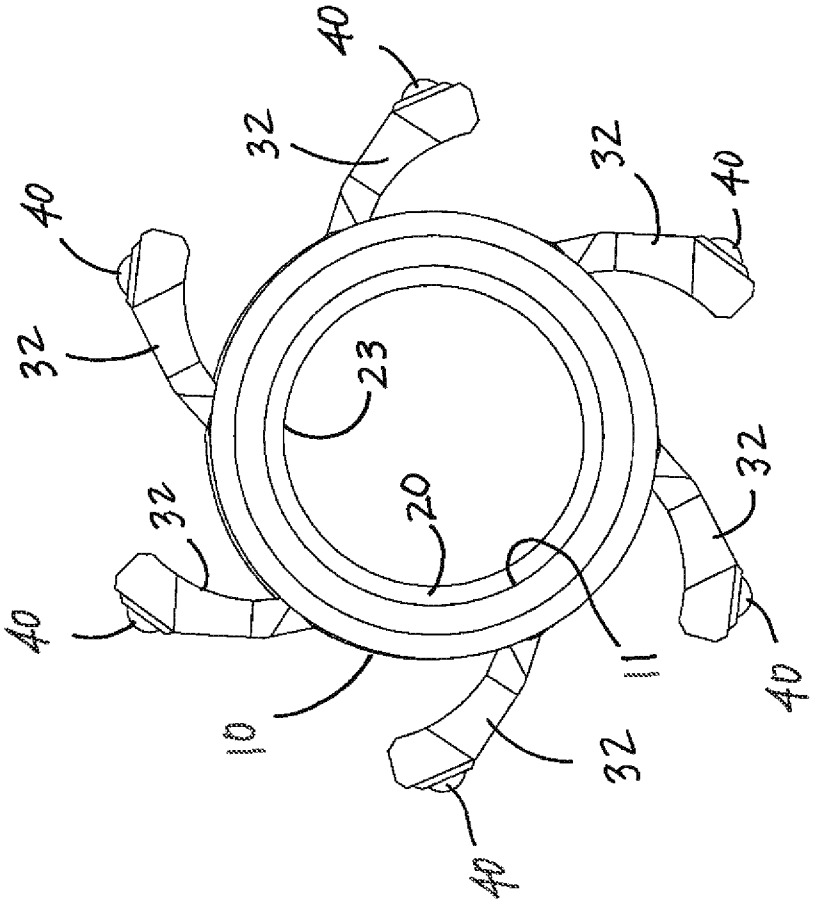

FIG. 6

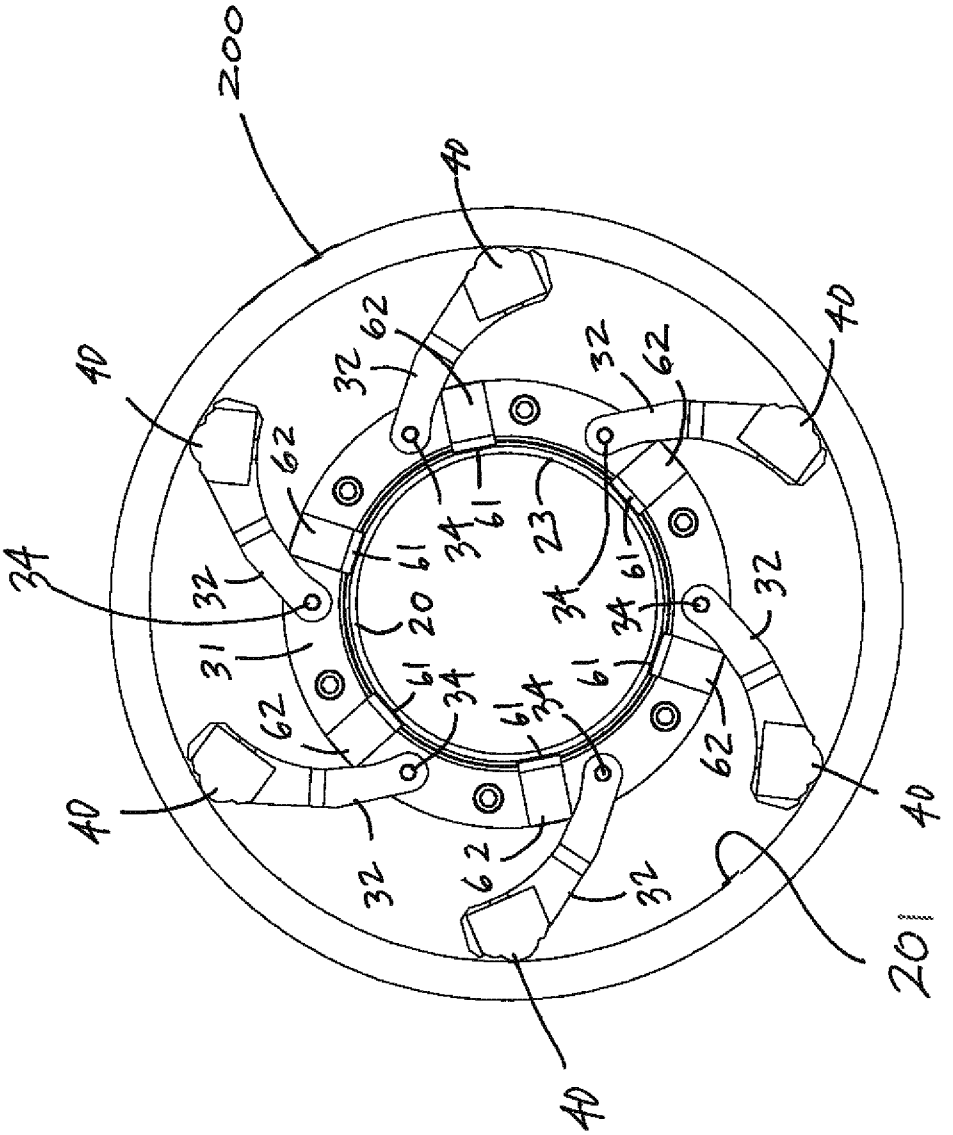

FIG. 7

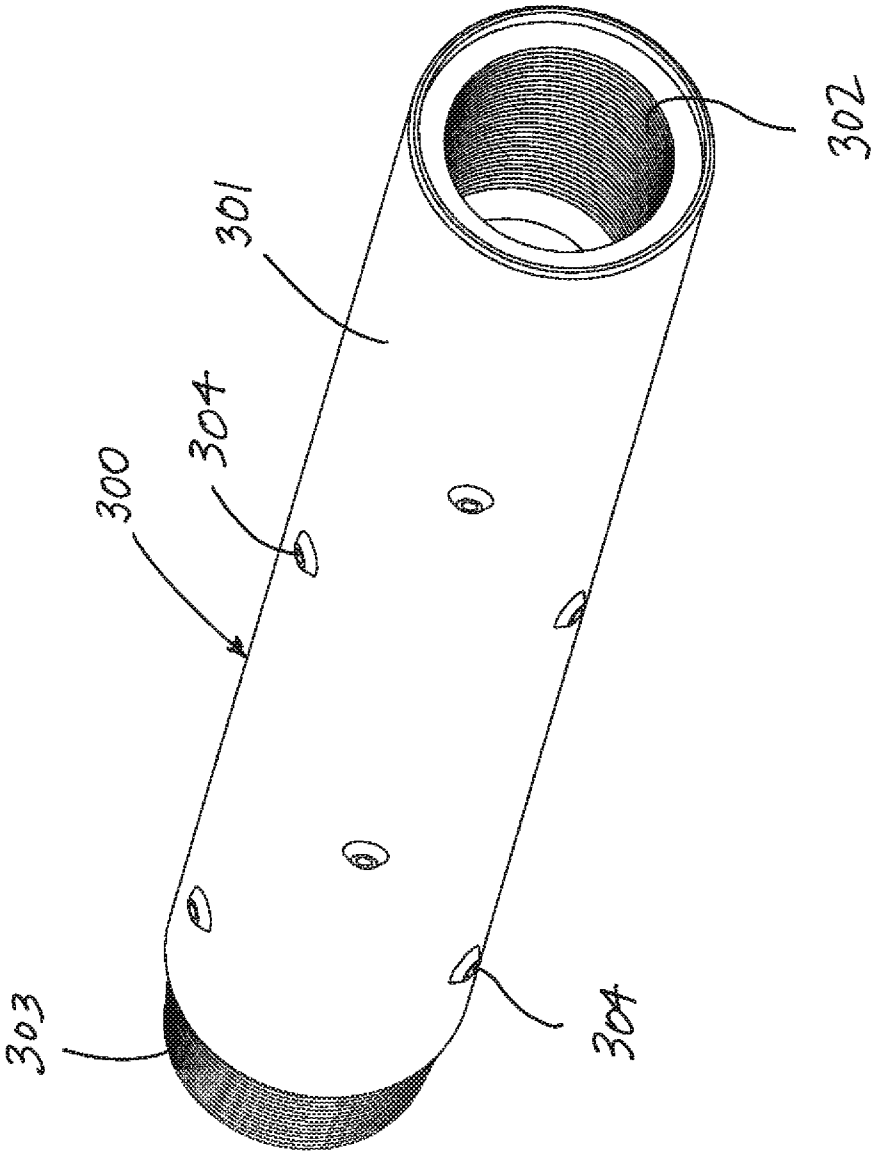

FIG. 8

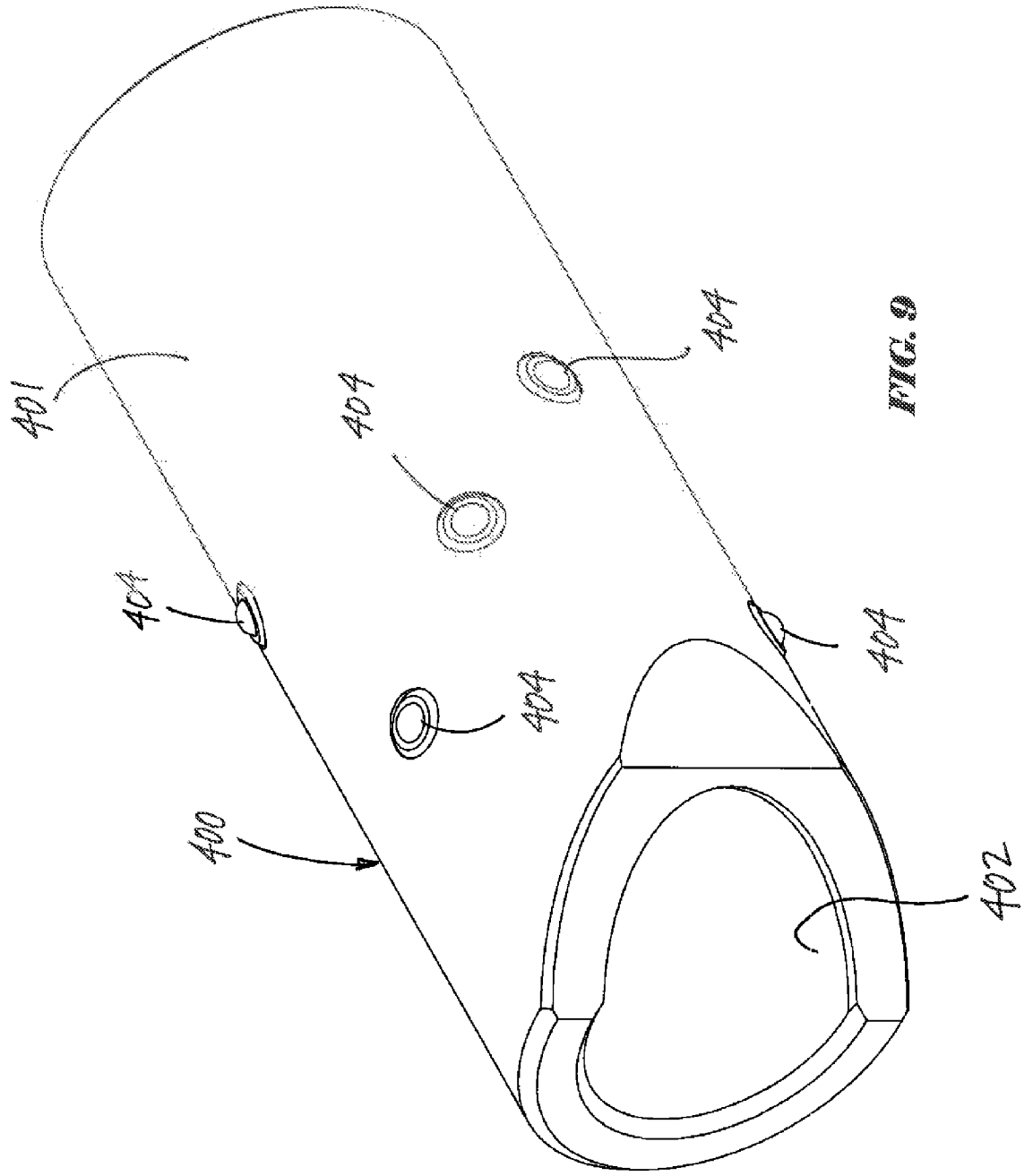

FIG. 9

FRICTION REDUCING DOWNHOLE ASSEMBLIES

CROSS REFERENCES TO RELATED APPLICATION

Priority of U.S. Provisional Patent application Ser. No. 61/781,167, filed Mar. 14, 2013, incorporated herein by reference, is hereby claimed.

STATEMENTS AS TO THE RIGHTS TO THE INVENTION MADE UNDER FEDERALLY SPONSORED RESEARCH AND DEVELOPMENT

None

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention pertains to downhole assemblies having friction reducing elements. More particularly, the present invention pertains to dowhole assemblies having at least one friction reducing element on at least one exterior surface to reduce frictional forces acting on said assemblies. More particularly still, the present invention pertains to downhole assemblies having at least one ball transfer unit on at least one exterior surface.

2. Brief Description of the Prior Art

During operations in the oil and gas industry, a pipe or substantially tubular tool having a certain outer diameter is frequently inserted or otherwise received within a wellbore or pipe having a larger inner diameter. Such operations are often performed during both drilling and production phases of a well's life cycle. By way of illustration, but not limitation, drill pipe, casing and other tubular goods are routinely run into cased and uncased wellbores. Similarly, tools and other downhole assemblies are often conveyed in and out of wells via jointed pipe, continuous (spooled) tubing and/or wireline.

In such cases, frictional forces—typically so-called "sliding friction—from surrounding surfaces acting on such inner pipe or tool(s) can impede such inner pipe or tool(s) from advancing further into a well. In order to reduce or lessen such frictional forces, friction reducing assemblies can be utilized. In most cases, such friction reducing assemblies are installed on at least one outer surface of a tubular or assembly that is being conveyed into a well.

Various types of friction-reducing devices including, without limitation, so-called "roller subs," are currently used throughout the oil and gas industry in an effort to reduce or limit such sliding friction. Conventional roller subs typically comprise substantially cylindrical body members having radial slots at predetermined intervals. Rollers and/or wheels are rotatably disposed within said slots. In many cases, such roller subs are modular in construction; as such, the roller subs can be assembled in a manner to secure the rollers and/or roller wheels in place, avoiding the need for grub screws and facilitating relatively compact dimensions.

Although such devices can be used in many different applications, use of roller subs is especially prevalent during downhole wireline operations. Such wireline operations generally rely on gravity alone in order to advance a toolstring in a well. As such, roller subs can be especially useful in directional wellbores that deviate substantially from vertical. Roller subs help to reduce sliding friction, thereby allowing wireline tools to advance deeper within a well.

During drilling of a well, stabilizers may be coupled into a drill string to bear against a wall of a drilled hole and thus

centralize a drill string in a wellbore. After a well has been drilled, devices known as centralizers may also be employed to centrally locate a liner or casing within a well and provide "stand off" from a surrounding wellbore or casing. Conventional roller subs are also used to reduce sliding friction associated with devices such as stabilizers and centralizers. However, such conventional roller subs are typically not adjustable to various conditions within a well such as, for example, wells having multiple internal diameters.

One type of conventional stabilizer rolling sub assembly comprises rollers mounted on multiple axes, which are each parallel to a longitudinal axis of a stabilizer body (and, hence, also parallel to the longitudinal axis of a drillstring and of a well drilled thereby). The functional effect associated with this form of stabilizer is to reduce rotational friction, while having a neutral or even adverse effect on longitudinal sliding frictional forces.

Conventional roller subs are also sometimes run in connection with bow spring centralizers to reduce sliding friction. However, such bow spring centralizers are typically not sturdy enough to support the full weight of tubing, casing or other pipe strings. Additionally, such conventional centralizer roller subs typically include axles, grub screws and/or other mechanical components that are especially vulnerable to failure during use.

Thus, there is a need for a friction reducing apparatus that significantly reduces frictional forces acting upon tubulars, tool strings, centralizers and/or other downhole assemblies. Such friction reducing apparatus must reduce or diminish frictional forces including, without limitation, sliding friction, generated between outer surface(s) of a pipe or tool, and inner surfaces of a surrounding wellbore or tubular. Among other benefits, the friction reducing apparatus should beneficially assist pipe or downhole tools to traverse obstructions or so-called "tight spots" within a wellbore, minimize or eliminate damage caused when said pipes or downhole tools scrape against surrounding wellbore walls, and reduce rotational friction forces and pipe torsional strain.

SUMMARY OF THE INVENTION

In a preferred embodiment, the present invention comprises a substantially cylindrical body member having an outer surface and a plurality of friction reducing elements disposed at least partially along said outer surface. Although many different friction reducing elements can be utilized, said elements can beneficially comprise ball transfer units or other omni-directional rolling-element bearing assemblies.

Although the present invention can take many different configurations, in a preferred embodiment the present invention can comprise a rolling sub assembly, a mule shoe assembly or a centralizer assembly. The friction reducing assembly of the present invention comprises a body section having an outer surface with at least one pocket or recess. At least one ball transfer unit or other omni-directional rolling-element bearing is singly mounted in said at least one pocket or recess, and extends at least partially beyond said outer surface of body section.

The rolling sub, mule shoe and centralizer assemblies of the present invention can be used in many different applications and industries. By way of illustration, but not limitation, the assemblies of the present invention can be used in subterranean well drilling and related operations (water, oil and/or gas wells), mining, deviated holes for construction purposes, quarry drilling, and pipe cleaning. Further, the friction reducing assemblies of the present invention, having much smaller dimensions, can also be used in various medical applications.

When utilized in oil and/or gas wells, the friction reducing assemblies of the present invention provide a number of significant operational benefits. Specifically, the friction reducing assemblies of the present invention allow pipe deployment in highly-deviated and/or horizontal wellbores. Said friction reducing assemblies substantially reduce rotational friction and torque in horizontal and diagonal planes, while reducing sliding friction and drag in vertical and diagonal planes. Further, although conventional roller subs typically only permit rotation about a longitudinal axis, the friction reducing assemblies of the present invention permit full 360-degree rotational contact between friction reducing elements and surrounding well or other surfaces.

Additionally, the friction reducing assemblies of the present invention reduce pipe wear and fatigue during deployment (and retrieval, if necessary), while also reducing or eliminating damage to liner tops and liners. Said assemblies permit deployment of tools conveyed via wireline and/or continuous tubing in highly deviated and horizontal wells, while reducing the risk of damage to exposed packer slips and seals.

BRIEF DESCRIPTION OF DRAWINGS/FIGURES

The foregoing summary, as well as any detailed description of the preferred embodiments, is better understood when read in conjunction with the drawings and figures contained herein. For the purpose of illustrating the invention, the drawings and figures show certain preferred embodiments. It is understood, however, that the invention is not limited to the specific methods and devices disclosed in such drawings or figures.

FIG. **1** depicts a side view of a centralizer assembly (sometimes referred to herein as "Adjustable Tension Centralizer Assembly" or "ATCA") of the present invention with radially extending arms in a substantially collapsed position.

FIG. **2** depicts a side perspective view of an adjustable tension centralizer assembly of the present invention with radially extending arms in a substantially collapsed position.

FIG. **3** depicts a side view of an adjustable tension centralizer assembly of the present invention with radially extending arms in a partially extended position.

FIG. **4** depicts a side perspective view of an adjustable tension centralizer assembly of the present invention with radially extending arms in a partially extended position.

FIG. **5** depicts an exploded perspective view of an adjustable tension centralizer assembly of the present invention.

FIG. **6** depicts an end view of an adjustable tension centralizer assembly of the present invention with radially extending arms in an extended position.

FIG. **7** depicts a sectional view of an adjustable tension centralizer assembly of the present invention along line **7-7** disposed within the inner bore of a pipe section with radial centralizer arms in an extended position.

FIG. **8** depicts side perspective view of an alternative embodiment roller sub assembly of the present invention.

FIG. **9** depicts a side perspective view of an alternative embodiment muleshoe assembly of the present invention.

DETAILED DESCRIPTION OF A PREFERRED EMBODIMENT

The present invention comprises an adjustable tension centralizer assembly **100** having a plurality of omni-directional rolling-element bearings that assist the delivery of a centralized tool, pipe section, tubular good, tool, or other device. More particularly, adjustable tension centralizer assembly **100** comprises an adjustable device having friction reducing rolling elements disposed in radially extendable arms. Said friction reducing elements contact and reduce frictional forces against the inner surface of a surrounding casing, hole, pipe or other surrounding enclosure. The adjustable centralizer assembly **100** of the present invention can be included within a larger pipe assembly using threaded connections, set screws, or other connection means well known to those having skill in the art.

Referring to the drawings, FIG. **1** depicts a side view of an adjustable tension centralizer assembly **100** of the present invention. In a preferred embodiment, said adjustable tension centralizer assembly **100** comprises first end connection member **10** having central through bore **11**, as well as second end connection member **12** having central through bore **13**. Said first and second connection members, and their respective central through bores, are substantially axially aligned with each other.

Substantially cylindrical body member **20** is disposed between said first end connection member **10** and second end connection member **12**. Said substantially cylindrical body member **20** has outer surface **21** and central through bore **23**. A plurality of elongate grooves **22** are disposed at desired spacing around the circumference of said outer surface **21**; said elongate grooves **22** are oriented substantially parallel to the longitudinal axis of said body member **20**. In a preferred embodiment, substantially cylindrical body member **20** is freely rotatable within said aligned bores **11** and **13** of end connection members **10** and **12**, respectively.

First centralizer end collar **30** and second centralizer end collar **31** are disposed around said cylindrical body member **20** and spaced a desired distance apart from each other. A plurality of generally u-shaped centralizer arm members **32** are disposed between said first and second centralizer end collars and pivotally mounted to said first and second end collars. Said centralizer arm members **32** are pivotal about a pivot axis that is oriented substantially parallel to the longitudinal axis of said body member **20**. As such, said centralizer arm members **32** are capable of pivoting radially outward from outer surface **21** of body member **20**.

Still referring to FIG. **1**, at least one friction reducing omni-directional rolling element **40** is disposed on an outer surface of each such centralizer arm member **32**. In a preferred embodiment, said friction reducing omni-directional rolling elements **40** comprise ball transfer units. Further, bias springs **33** can be beneficially provided to bias said centralizer arm members **32** in an inward or closed position (that is, generally toward or against central body member **20**).

Adjustable collar member **50** is slidably disposed on outer surface **21** of central body member **20** and, thus, is capable of moving axially along said central body member **20**. Although not depicted in FIG. **1**, in a preferred embodiment, mating threads are disposed on the inner surface of said adjustable collar member **50** and outer surface **21** of body member **20**, such that rotation of adjustable collar member **50** causes said collar member **50** to move axially along the length of said central body member **20**.

Wedge assembly **60** comprises base ring **63** as well as a plurality of track arms **61**. Base ring **63** is slidably disposed over outer surface **21** of central body member **20**, while track arms **61** are slidably received within longitudinal grooves **22** along said outer surface **21** of body member **20**. Spring **71** can be disposed between base ring **63** and collar member **50**. Wedge latch member **70** having collet fingers **73** can extend under collar member **50** and connect to wedge assembly **60**.

Tapered wedge members **62** are disposed on the outer surfaces of track arms **61**; in a preferred embodiment, said

wedge members **62** have a smaller thickness in the direction of first end connector **10**, and a larger thickness in the direction of second end connector **12**. Further, said tapered wedge members **62** are at least partially disposed under pivotally mounted centralizer arm members **32** (that is, between outer surface **21** of central body member **20** and said centralizer arm members **32**).

FIG. **2** depicts a side perspective view of an adjustable tension centralizer assembly **100** of the present invention with radially disposed centralizer arm members **32** in a substantially collapsed position. As depicted in FIG. **2**, said adjustable tension centralizer assembly **100** comprises first end connection member **10** having central through bore **11**, as well as second end connection member **12** (also having a central through bore **13**, not visible in FIG. **2**).

Substantially cylindrical body member **20** having outer surface **21** and central through bore **23** is rotatably disposed between said first end connection member **10** and second end connection member **12**. A plurality of elongate grooves **22**, oriented substantially parallel to the longitudinal axis of said body member **20**, are disposed at desired radial spacing around the circumference of said outer surface **21**. Opposing first centralizer end collar **30** and second centralizer end collar **31** are disposed around said cylindrical body member **20** and spaced a desired distance apart from each other.

A plurality of generally u-shaped centralizer arm members **32** are disposed between said first and second centralizer end collars **30** and **31**, and are pivotally mounted at both ends to said first and second end collars. At least one friction reducing omni-directional rolling element **40** is disposed on an outer surface of each such centralizer arm member **32**. Bias springs **33** bias said centralizer arm members **32** in a closed or radially inward direction.

Adjustable collar member **50** is slidably disposed on outer surface **21** of central body member **20**. Wedge assembly **60** comprises base ring **63** as well as a plurality of track arms **61**. Base ring **63** is slidably disposed over outer surface **21** of central body member **20**, while track arms **61** are slidably received within longitudinal grooves **22** along said outer surface **21** of body member **20**. Tapered wedge members **62** are disposed on the outer surfaces of track arms **61** and are at least partially disposed between outer surface **21** of central body member **20** and said centralizer arm members **32**.

FIG. **3** depicts a side view of adjustable tension centralizer assembly **100** of the present invention with radially extending centralizer arm members **32** in a partially extended position. Adjustable collar member **50** and wedge base ring **63** can be moved axially along said central body member **20** and locked in place. Axial movement of said adjustable collar member **50** and wedge base ring **63** in turn causes axial movement of wedge assembly **60** along the length of said central body member **60**.

FIG. **4** depicts a side perspective view of adjustable tension centralizer assembly **100** of the present invention with radially extending centralizer arm members **32** in a partially extended position. As said adjustable collar **50** and wedge assembly **60** move axially along the length of said central body member **20**, track arms **61** of wedge assembly **60** also move within longitudinal grooves **22** along said outer surface **21** of body member **20**. Tapered wedge members **62** likewise move under pivotally mounted centralizer arm members **32** (that is, between outer surface **21** of central body member **20** and said centralizer arm members **32**), thereby forcing said centralizer arm members **32** to pivot and extend radially outward.

FIG. **5** depicts an exploded perspective view of adjustable tension centralizer assembly **100** of the present invention. In a preferred embodiment, said adjustable tension centralizer assembly **100** comprises first end connection member **10** having central through bore **11**, as well as second end connection member **12** having central through bore **13**. Substantially cylindrical body member **20** is disposed between said first end connection member **10** and second end connection member **12**. Said substantially cylindrical body member **20** has outer surface **21** and central through bore **23**, as well as bearings **14** disposed around the circumference of body member **20**.

A plurality of elongate grooves **22** are disposed at desired spacing around the circumference of said outer surface **21**; said elongate grooves **22** are oriented substantially parallel to the longitudinal axis of said body member **20**. In a preferred embodiment, substantially cylindrical body member **20** is freely rotatable within said aligned bores **11** and **13** of end connection members **10** and **12**, respectively. First centralizer end collar **30** and second centralizer end collar **31** are disposed around said cylindrical body member **20**. A plurality of generally u-shaped centralizer arm members **32** are disposed between said first and second centralizer end collars and pivotally mounted to said first and second end collars.

At least one friction reducing omni-directional rolling element **40** is disposed on an outer surface of each such centralizer arm member **32**. In a preferred embodiment, said friction reducing omni-directional rolling elements **40** comprise ball transfer units. Adjustable collar member **50** is slidably disposed on outer surface **21** of central body member **20** and, thus, is capable of moving axially along said central body member **20**.

Wedge assembly **60** comprises base ring **63** as well as a plurality of track arms **61**. Base ring **63** is slidably disposed over outer surface **21** of central body member **20**, while track arms **61** are slidably received within longitudinal grooves **22** along said outer surface **21** of body member **20**. Spring **71** is disposed between base ring **63** and collar member **50**. Wedge latch member **70** having collet fingers **73** can connect to wedge assembly **60**.

Tapered wedge members **62** are disposed on the outer surfaces of track arms **61**; in a preferred embodiment, said wedge members **62** have a smaller thickness in the direction of first end connector **10**, and a larger thickness in the direction of second end connector **12**. Further, said tapered wedge members **62** are at least partially disposed under pivotally mounted centralizer arm members **32** (that is, between outer surface **21** of central body member **20** and said centralizer arm members **32**).

FIG. **6** depicts an end view of adjustable tension centralizer assembly **100** of the present invention with centralizer arm members **32** in an extended position. First end connection member **10** has central bore **11**. Body member **20** having central bore **23** is freely rotatable within said bore **11** of end connection member **10**. Generally u-shaped centralizer arm members **32** are disposed around the outer surface of said body member **20**; as depicted in FIG. **5**, said centralizer arm members **32** are capable of pivoting radially outward from body member **20**. At least one friction reducing omni-directional rolling element **40** is disposed on an outer surface of each such centralizer arm member **32**.

FIG. **7** depicts a sectional view of adjustable tension centralizer assembly **100** of the present invention along line **7-7** of FIG. **3**, disposed within a section of casing **200** having a central bore defining inner wall **201**. Body member **20** has central bore **23**; second centralizer end collar **31** is disposed around cylindrical body member **20**. A plurality of centralizer arm members **32** are pivotally mounted to second centralizer end collar **31** (and first centralizer end collar **30**, not depicted

in FIG. **6**) via pivot pins **34**. Pivot pins **34** and, thus, the pivot axis of centralizer arm members **32**, are oriented substantially parallel to the longitudinal axis of said body member **20**.

Track arms **61** are slidably received within longitudinal grooves disposed along the outer surface **21** body member **20**. Tapered wedge members **62** are disposed on the outer surfaces of track arms **61** and are at least partially disposed under pivotally mounted centralizer arm members **32** (that is, between outer surface **21** of central body member **20** and said centralizer arm members **32**). At least one friction reducing omni-directional rolling element **40** is disposed on an outer surface of each such centralizer arm member **32**. When centralizer arm members **32** are extended radially outward, said rolling elements **40** contact inner wall **201** of pipe section **200**.

In operation, adjustable tension centralizer assembly **100** of the present invention can be installed at various locations along toolstrings, workstrings or other downhole assemblies. By significantly reducing sliding and rotational frictional forces, said adjustable tension centralizer assembly **100** allows such toolstrings, workstrings and/or other downhole assemblies to maneuver in and out of wells. By way of illustration, but not limitation, adjustable tension centralizer assembly **100** can be used to deploy packers, bridge plugs and other tools in horizontal or highly deviated wells, eliminating the need for pumping such equipment down such wells. Said adjustable tension centralizer assembly **100** greatly reduces the need to convey equipment in and out of wells using more expensive work strings and continuous tubing, thereby reducing rig down-time and operating costs.

Although adjustable tension centralizer assembly **100** can be included as part of a threaded string of tools or pipe, it is to be observed that said adjustable tension centralizer assembly will typically be received over the outer surface of a tool, tubular, pipe or similar device. When so configured, first end connection member **10** and second end connection member **12** are both secured to the outer surface of said tool, tubular or pipe section using set screws **15** or other fastening means; in this configuration, said tool, tubular or pipe section extends through central through bore **23** of body member **20**, which is freely rotatable within said aligned bores **11** and **13** of end connection members **10** and **12**.

As noted above, a plurality of generally u-shaped centralizer arm members **32** are disposed between said first and second centralizer end collars and pivotally mounted to said first and second end collars. Said centralizer arm members **32** are each pivotal about a pivot axis that is oriented substantially parallel to the longitudinal axis of said body member **20**. As such, said centralizer arm members **32** are capable of pivoting radially outward from outer surface **21** of body member **20**.

At least one friction reducing omni-directional rolling element **40** is disposed on an outer surface of each such centralizer arm member **32**. In a preferred embodiment, said friction reducing omni-directional rolling elements **40** comprise ball transfer units. Adjustable collar member **50** is capable of moving axially along said central body member **20**. As said adjustable collar member **50** move axially toward the midpoint of central body member **20**, track arms **61** of wedge assembly **60** move within longitudinal grooves **22** along said outer surface **21** of body member **20**.

As said track arms **61** move axially relative to central body member **20**, tapered wedge members **62** also move axially under pivotally mounted centralizer arm members **32** (that is, between outer surface **21** of central body member **20** and said centralizer arm members **32**). Said wedge members **62** force centralizer arm members **32** radially outward. In this manner, the outer diameter of said radially extending centralizer arm members **32** can be adjusted to a predetermined outer diameter by moving adjustable collar member **50**. Once said centralizer arm members **32** are set to a desired location, adjustable collar member **50** can be secured in place.

The outer diameter formed by said cooperating radially extending centralizer arm members **32** can be quickly and easily adjusted, such as when a tool string employing said adjustable tension centralizer assembly **100** is used in multiple wells or pipe sizes having different inner diameters. Further, bias springs **33** permit limited inward movement of said centralizer arm members **32**, such as when centralizer assembly **100** must pass through a downhole restriction or so-called "tight spot."

FIG. **8** depicts a side perspective view of an alternative embodiment rolling sub **300** of the present invention. Rolling sub **300** comprises cylindrical body member **301** having a central bore, as well as threaded end connection members **302** and **303**. A plurality of omni-directional rolling elements **304** assist the delivery of tools, tubing, and pipe strings within a well, pipeline, or other similar environment. Rolling elements **304** are disposed along the outer surface of body section **301** of sub assembly **300** in order to reduce sliding friction and to allow sub assembly **300** to maneuver obstructions, such as commonly found in cylindrical pipe, casing, or uncased wells.

Sub assembly **300** of the present invention can be placed anywhere (typically by threaded connection) in a longer string of tubing/pipe/coiled tubing, and can be placed as frequently as needed along such length; rolling sub assembly **300** of the present invention can be included within a larger pipe assembly using threaded connections, set screws, or other connection means well known to those having skill in the art.

Roller sub assembly **300** ensures integrity of tubing and casing during their deployment. Mostly used in high deviated wells, the roller sub assembly reduces friction and torque. It incorporates a ball transfer system allowing full rotation and movement in all vertical, horizontal, and diagonal directions. Said roller sub assembly design allows full integrity without compromising pressure loss or the need to have external centralizers which can break or create fishing problems.

Uses for rolling sub assembly **300** of the present invention include, but are not limited to, reducing friction caused by a string scraping on the hole walls, assisting a string to traverse obstructions, minimizing internal scraping of walls, minimizing damage caused by a tool scraping on walls, and to allow a tool string freedom to rotate easier on the trip reducing pipe torsional strain. Rolling elements **304** can have varied configurations or placement on sub **300** including more concentration, varied concentrations, and configurations.

FIG. **9** depicts an alternative embodiment rolling muleshoe assembly **400** of the present invention. Muleshoe assembly **400** generally comprises cylindrical body member **401** having a central bore **402**; although not visible in FIG. **9**, muleshoe assembly **400** can include a threaded connection for attachment to a tool or pipe string. A plurality of omni-directional rolling elements **404** assist the delivery of tools, tubing, and pipe strings within a well, pipeline, or other similar environment. Rolling elements **404** are disposed along the outer surface of body section **401** of muleshoe assembly **400** in order to reduce sliding friction and to allow muleshoe assembly **400** to maneuver obstructions, such as commonly found in cylindrical pipe, casing, or uncased wells.

Muleshoe assembly **400** is typically placed on the distal end of a string of pipe, tubing, or other continuous convey-

ance means. The rolling mule shoe assembly of the present invention has a plurality of rolling **402** elements disposed along the outer surface of body member **401** of said mule shoe assembly **400** in order to reduce sliding friction and to allow the mule shoe assembly to maneuver obstructions, such as commonly found in cylindrical pipe, casing, or uncased wells.

Uses for the rolling mule shoe assembly **400** of the present invention include, but are not limited to, reducing friction caused by string scraping on the hole walls, assisting the string to traverse obstructions, minimizing internal scraping of walls, minimizing damaged caused by a tool scraping on walls, and to allow the tool string freedom to rotate easier on the trip reducing pipe torsional strain. Rolling elements **404** can have varied configurations on muleshoe body **401** including more concentrations, varied orientations, and configurations. Rolling mule shoe assembly **400** of the present invention can be included within a larger pipe assembly using threaded connections, set screws, or other connection means well known to those having skill in the art.

In a preferred embodiment depicted in FIG. **8**, rolling mule shoe assembly **400** of the present invention helps ensure integrity of packers and bridge plugs during their deployment. Mostly used in high deviated wells, rolling mule shoe assembly **400** reduces friction and torque. In a preferred embodiment, rolling mule shoe assembly **400** beneficially incorporates a ball transfer system allowing full rotation in all vertical, horizontal, and diagonal directions. It also allows ease with deploying packers and bridge plugs on horizontal wells where equipment typically must be pumped down said wells, reducing rig down-time and rig costs. It also greatly reduces the need to run equipment using more expensive work strings and continuous tubing.

The above-described invention has a number of particular features that should preferably be employed in combination, although each is useful separately without departure from the scope of the invention. While the preferred embodiment of the present invention is shown and described herein, it will be understood that the invention may be embodied otherwise than herein specifically illustrated or described, and that certain changes in form and arrangement of parts and the specific manner of practicing the invention may be made within the underlying idea or principles of the invention.

What is claimed is:

1. An adjustable centralizer assembly comprising:

a) a first connection member defining an inner bore;

b) a second connection member defining an inner bore;

c) an elongate body member having an outer surface and a longitudinal axis, wherein said elongate body member is rotatably disposed within said inner bores of said first and second connection members;

d) a plurality of centralizer members pivotally disposed along said outer surface of said elongate body member, wherein said centralizer members are adjustably extendable radially from said body member;

e) at least one wedge shaped member at least partially disposed between at least one centralizer member and the outer surface of said body member, wherein movement of said at least one wedge shaped member in a direction parallel to said longitudinal axis of said body member causes said at least one centralizer member to extend radially outward from said body member; and

f) at least one omni-directional friction reducing element disposed on at least one of said centralizers, wherein said omni-directional friction reducing element comprises a ball transfer assembly.

2. The adjustable centralizer assembly of claim **1**, further comprising at least one elongate groove extending along the outer surface of said body member, wherein said at least one elongate groove is oriented substantially parallel to said longitudinal axis.

3. The adjustable centralizer assembly of claim **2**, wherein said at least one wedge shaped member is slidably disposed with said at least one elongate groove.

4. A rotatable centralizer assembly comprising:

a) a first collar member having a central bore;

b) a second collar member having a central bore;

c) a body member rotatably disposed within said bores of said first and second collar members;

d) a plurality of centralizer arms pivotally attached to said body member, wherein said centralizer arms are adapted to extend radially outward from said body member;

e) at least one omni-directional rolling element disposed on said centralizer arms; and

f) at least one wedge shaped member at least partially disposed between said at least one centralizer arm and the outer surface of said body member, wherein said body member has a longitudinal axis and movement of said at least one wedge shaped member in a direction parallel to said longitudinal axis causes said at least one centralizer arm to extend radially outward from said body member.

5. The rotatable centralizer assembly of claim **4**, further comprising at least one elongate groove extending along the outer surface of said body member, wherein said at least one elongate groove is oriented substantially parallel to said longitudinal axis.

6. The rotatable centralizer of claim **5**, wherein said at least one wedge shaped member is slidably disposed with said at least one elongate groove.

7. The rotatable centralizer assembly of claim **4**, wherein said at least one omni-directional rolling element comprises a ball transfer assembly.

8. The rotatable centralizer assembly of claim **4**, wherein each of said centralizer arms comprise a substantially u-shaped member defining a first end and a second end, and wherein said first and second ends are pivotally mounted to said body member and pivot about a pivot axis that is substantially parallel to the longitudinal axis of said body member.

9. The rotatable centralizer assembly of claim **8**, wherein said at least one omni-directional rolling element is adapted to contact a surrounding surface when said centralizer arms are extended radially outward from said body member.

10. The rotatable centralizer assembly of claim **4**, further comprising bearings disposed between the central bore of said first collar member and said body member.

11. The rotatable centralizer assembly of claim **4**, further comprising bearings disposed between the central bore of said second collar member and said body member.

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