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(54) **REAMING SYSTEM**

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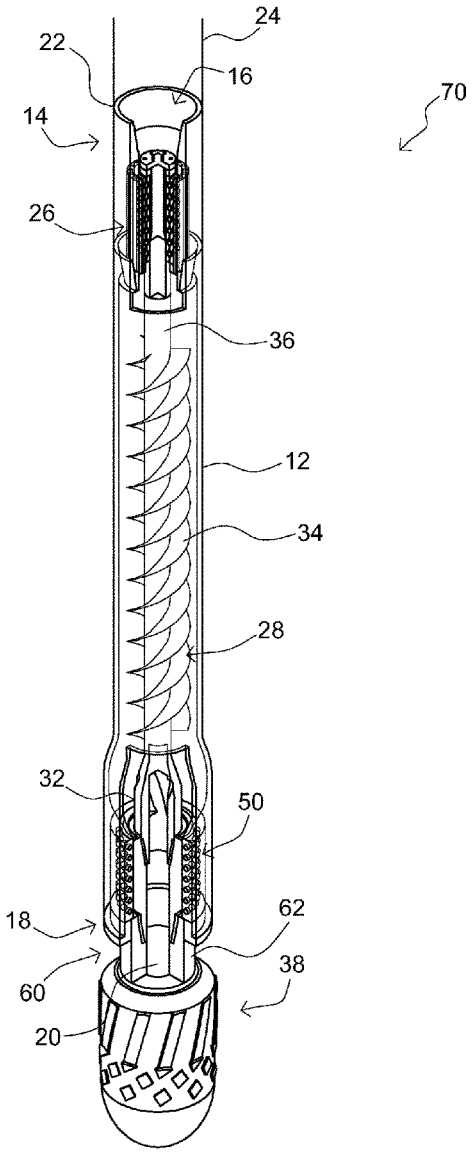
(57) **ABSTRACT**

A reaming system including an elongated tubular housing having a first end and a fluid inlet aperture. The elongated tubular housing includes a second end having a fluid outlet aperture. The reaming system includes a first bearing pack disposed circumferentially about the first end of the housing. The first bearing pack is only of sacrificial materials which may be drilled through. The reaming system includes an auger. The reaming system includes a reaming tool functionally coupled to the auger. The reaming tool may be a tool selected from the group consisting of: a float shoe, a reamer shoe, and a guide shoe. The reaming system includes a second bearing pack functionally coupled to a bottom end of the auger. The reaming system includes a connection sub functionally coupled to a bottom end of the auger that transfers rotational motion from the auger to an attached tool.



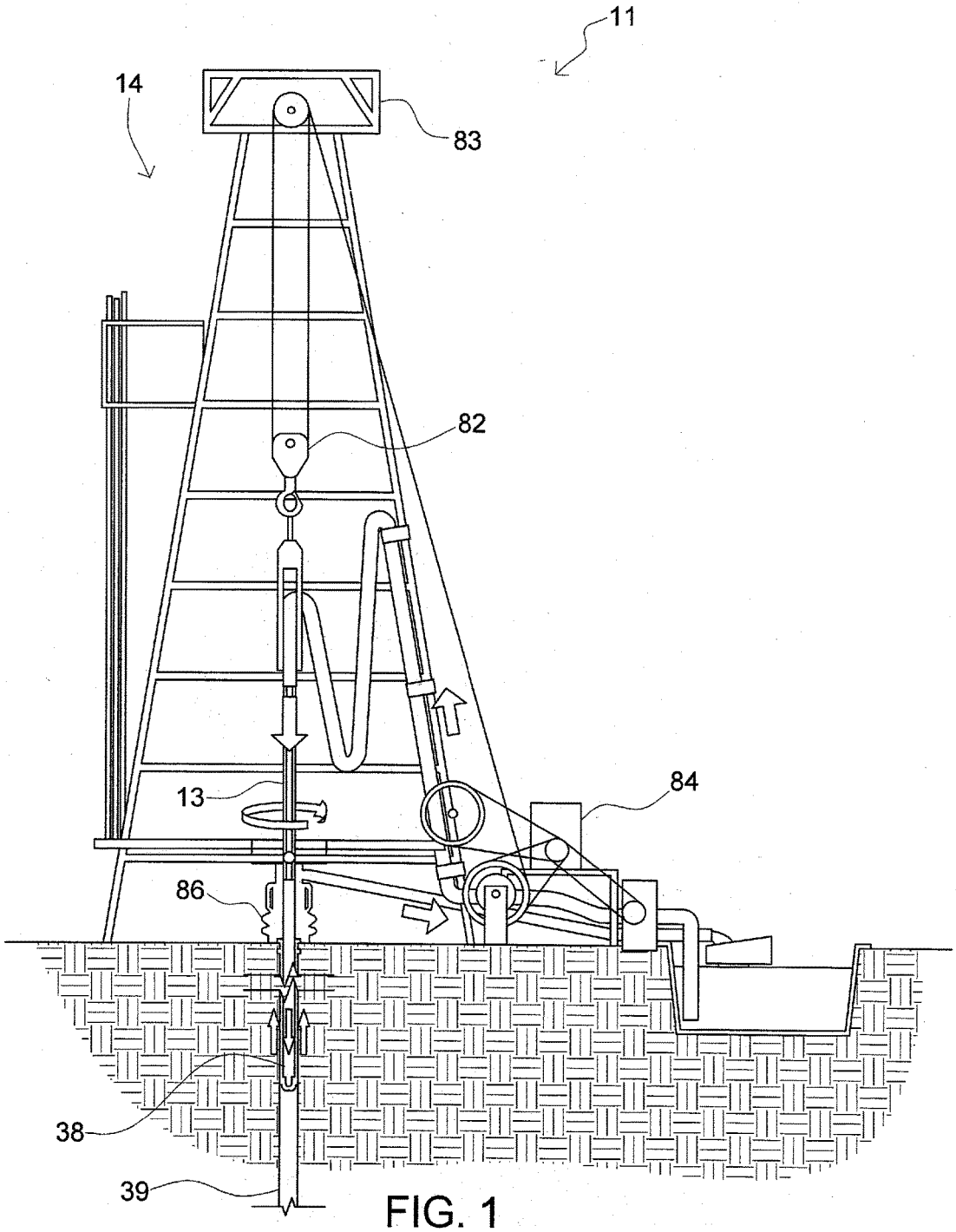


FIG. 1

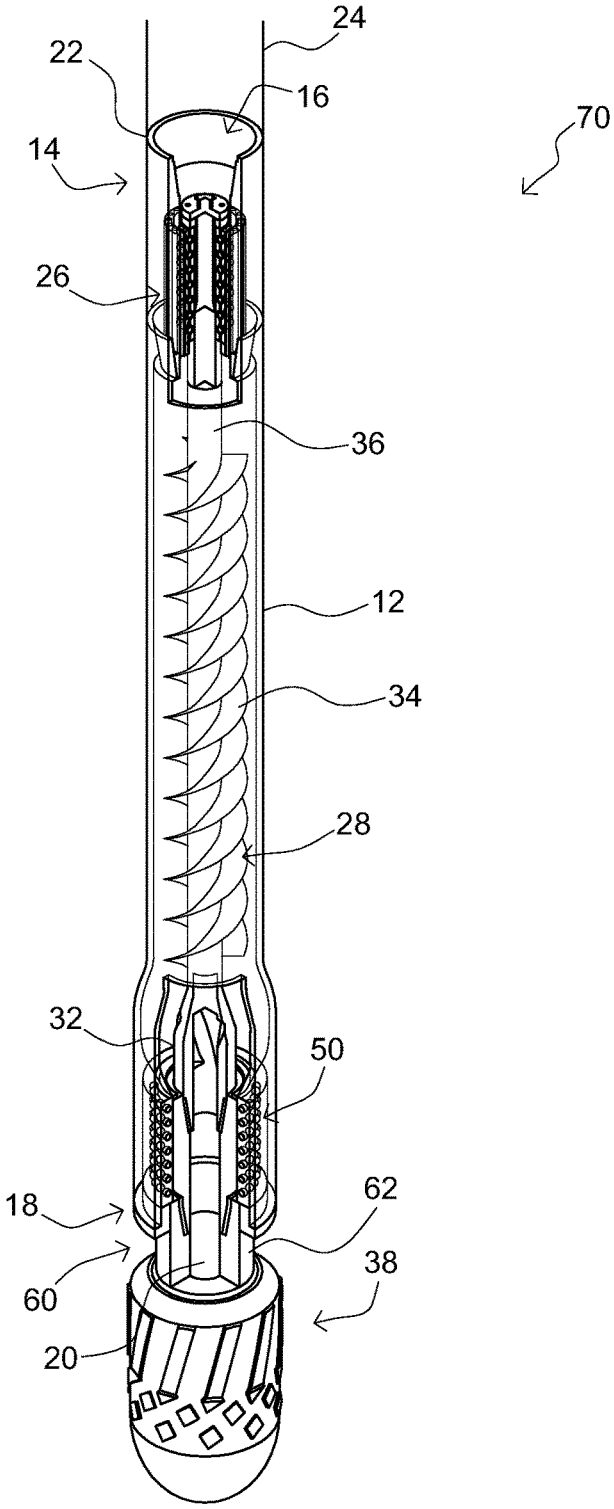


FIG. 2

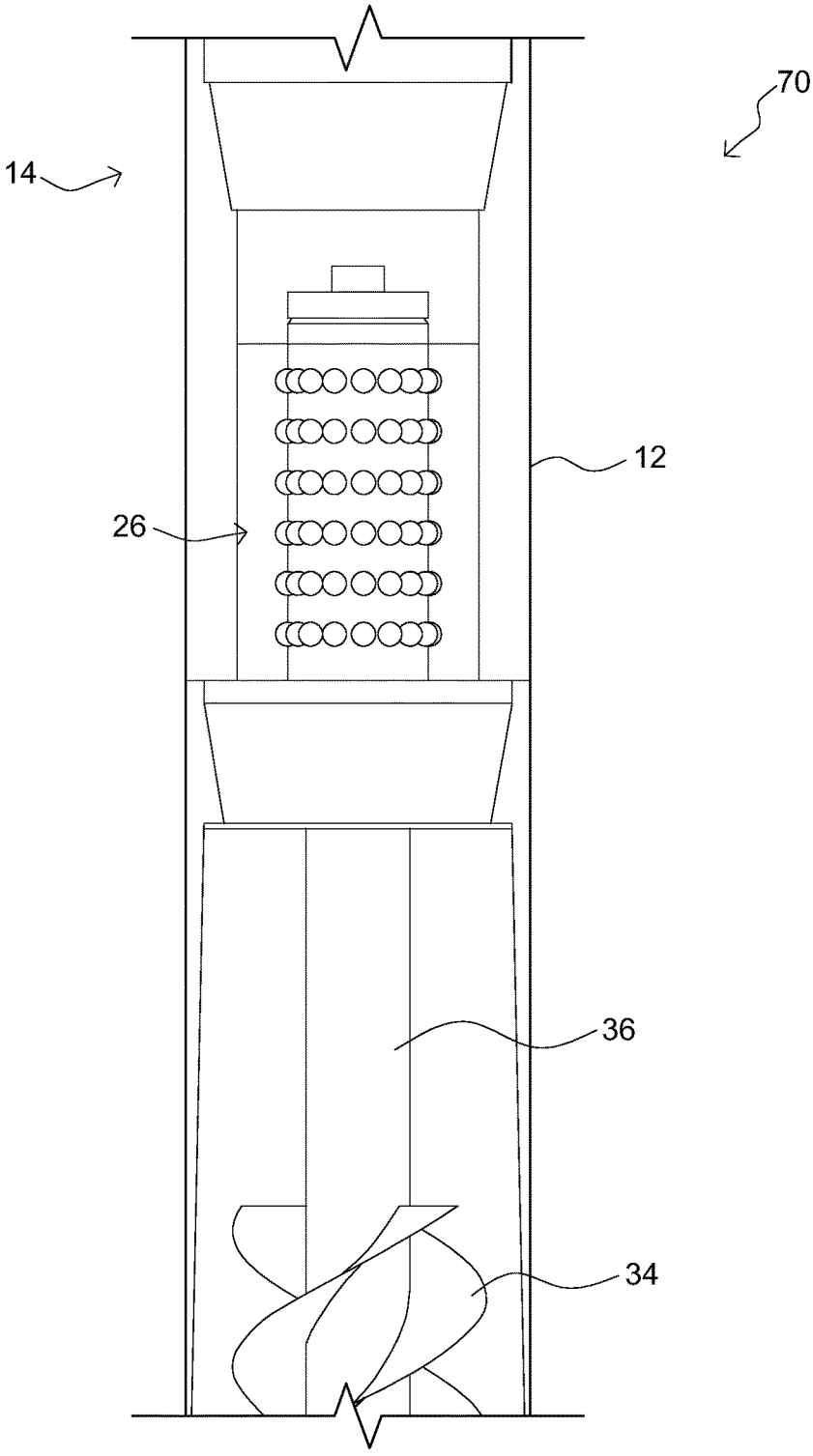


FIG. 3

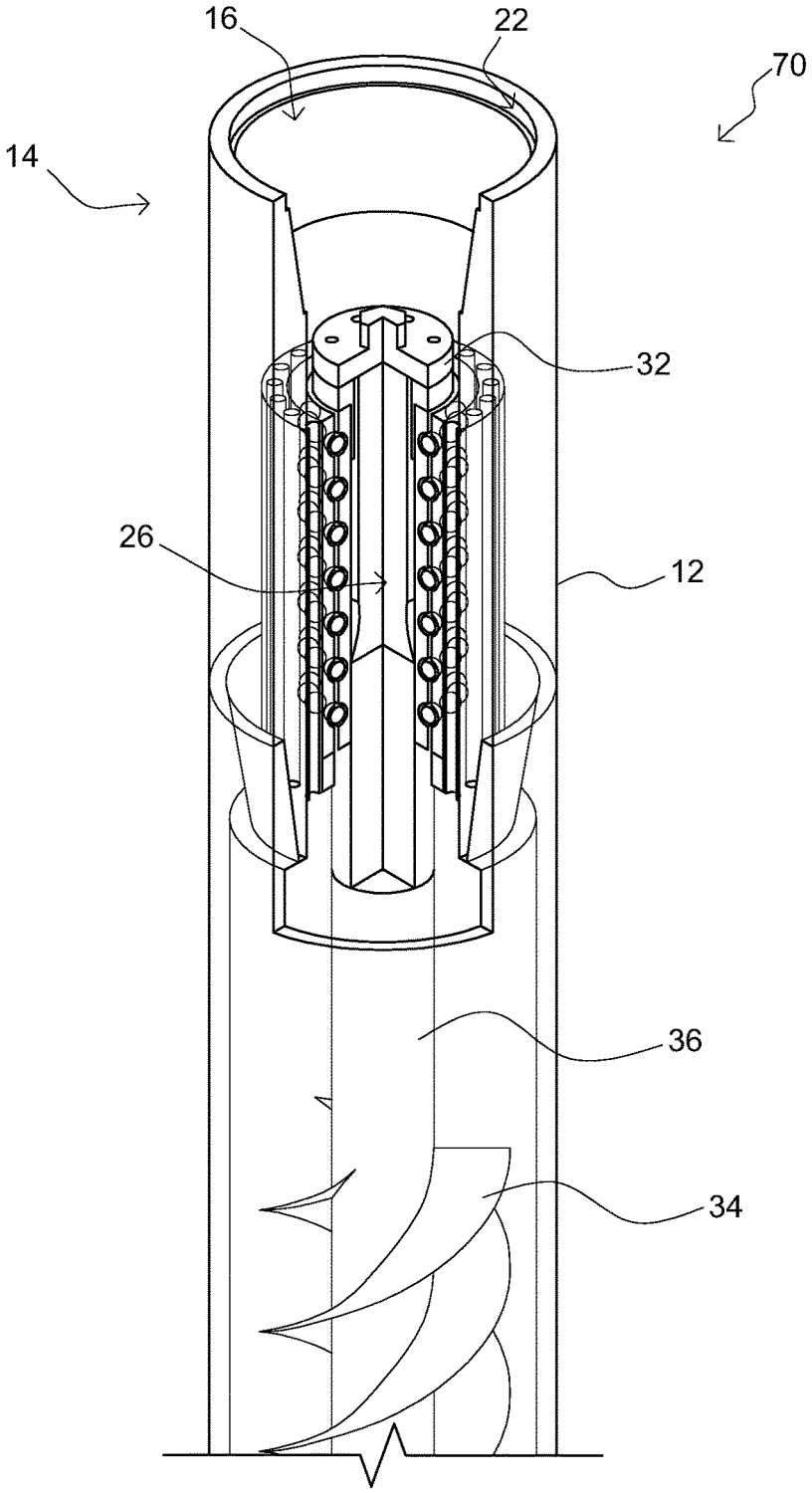


FIG. 4

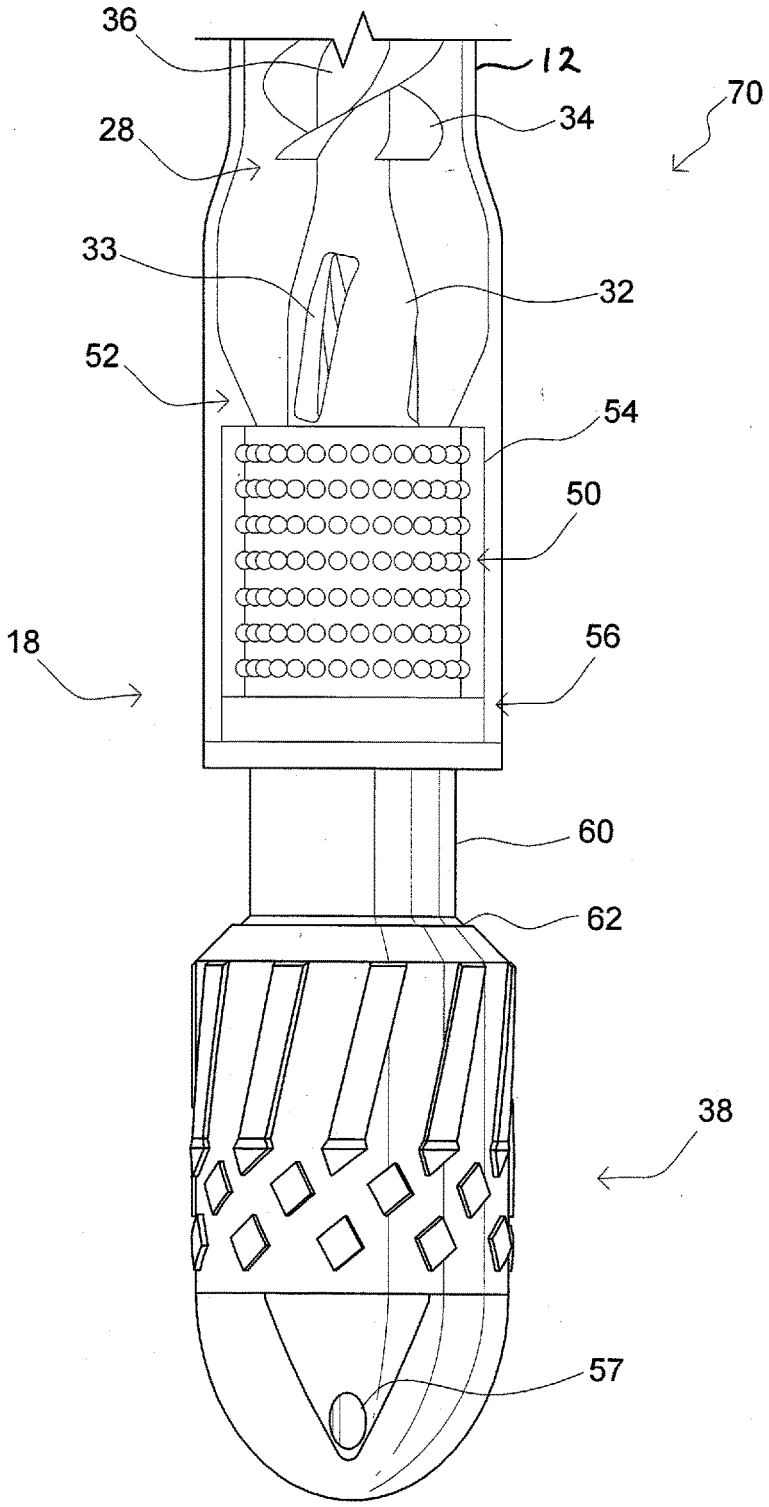


FIG. 5

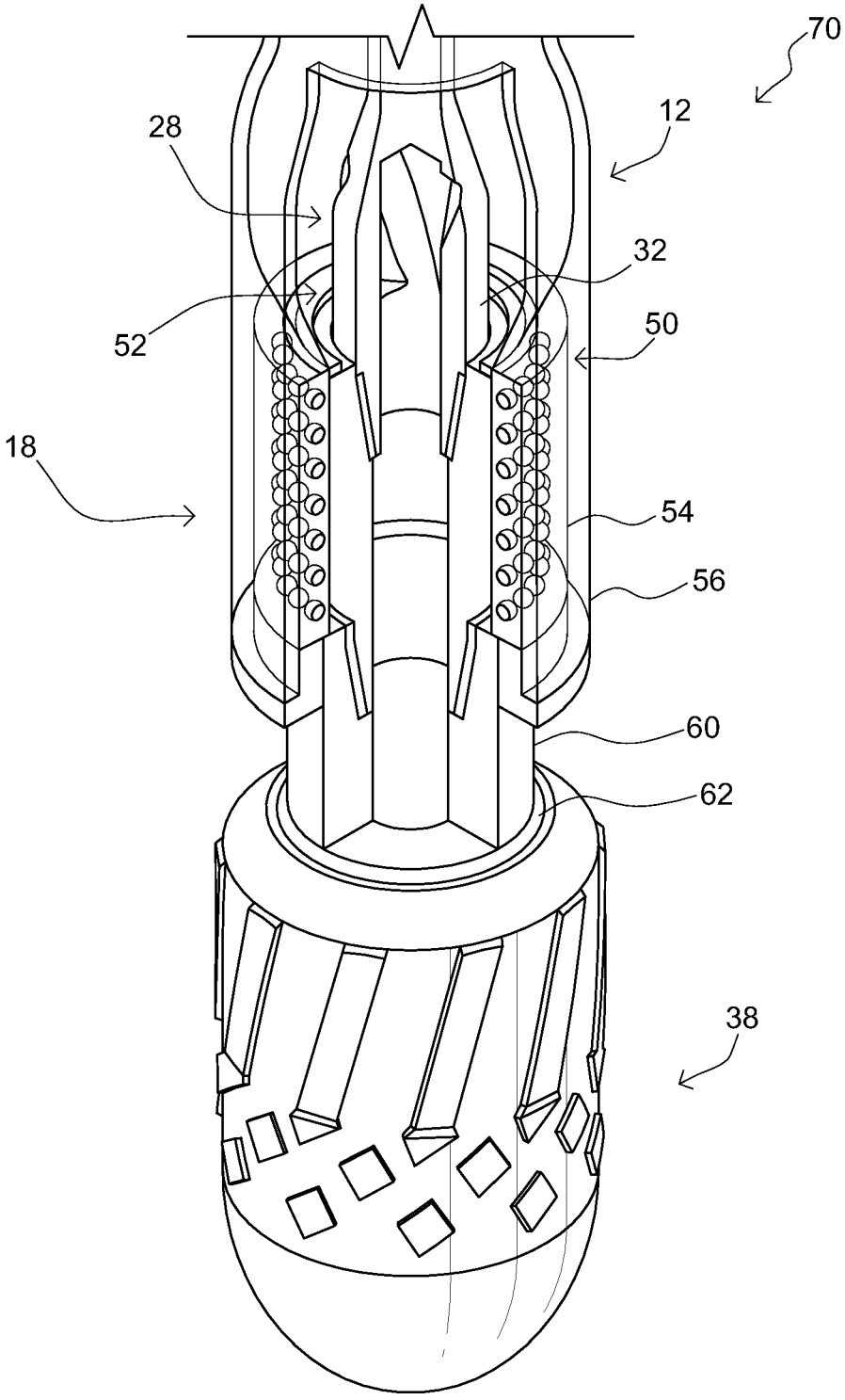


FIG. 6

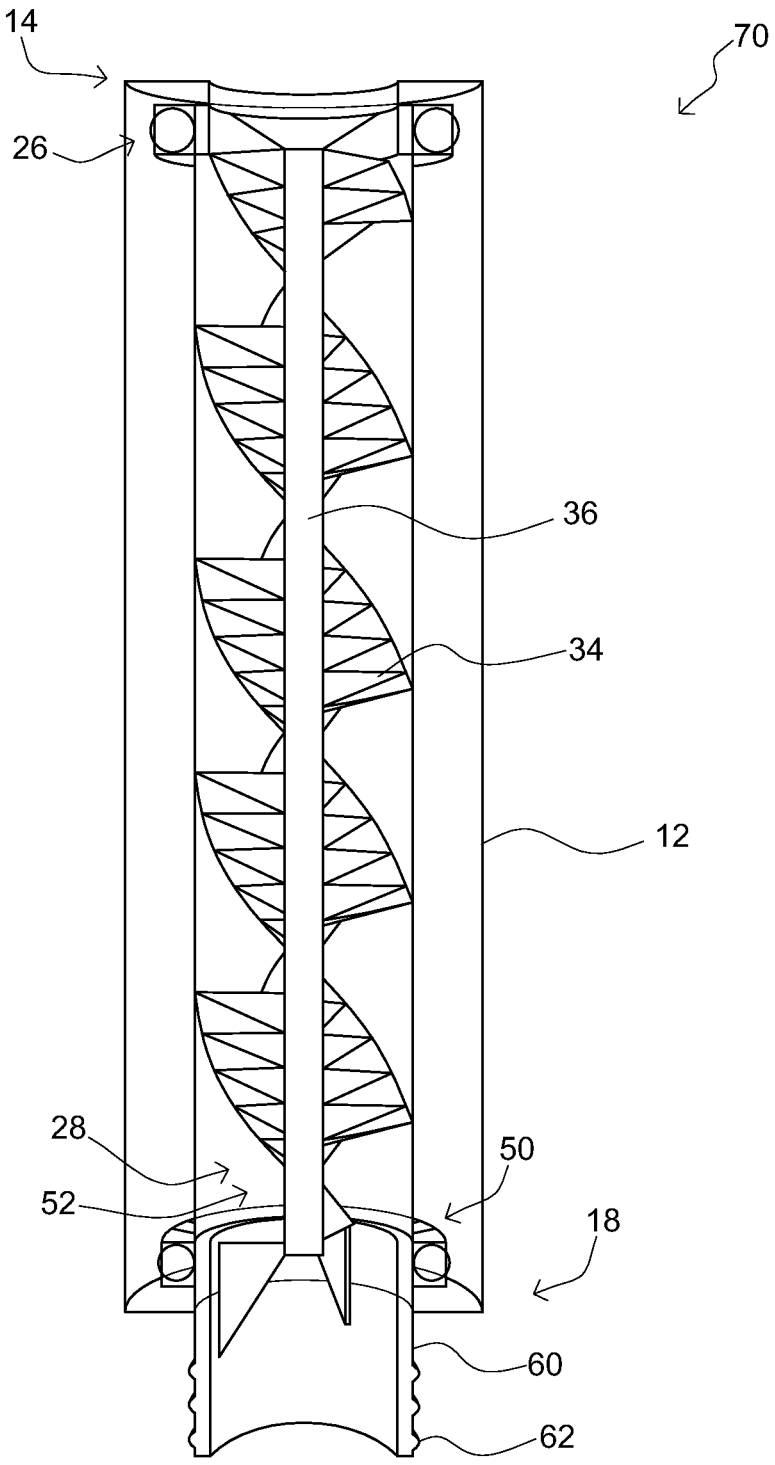


FIG. 7

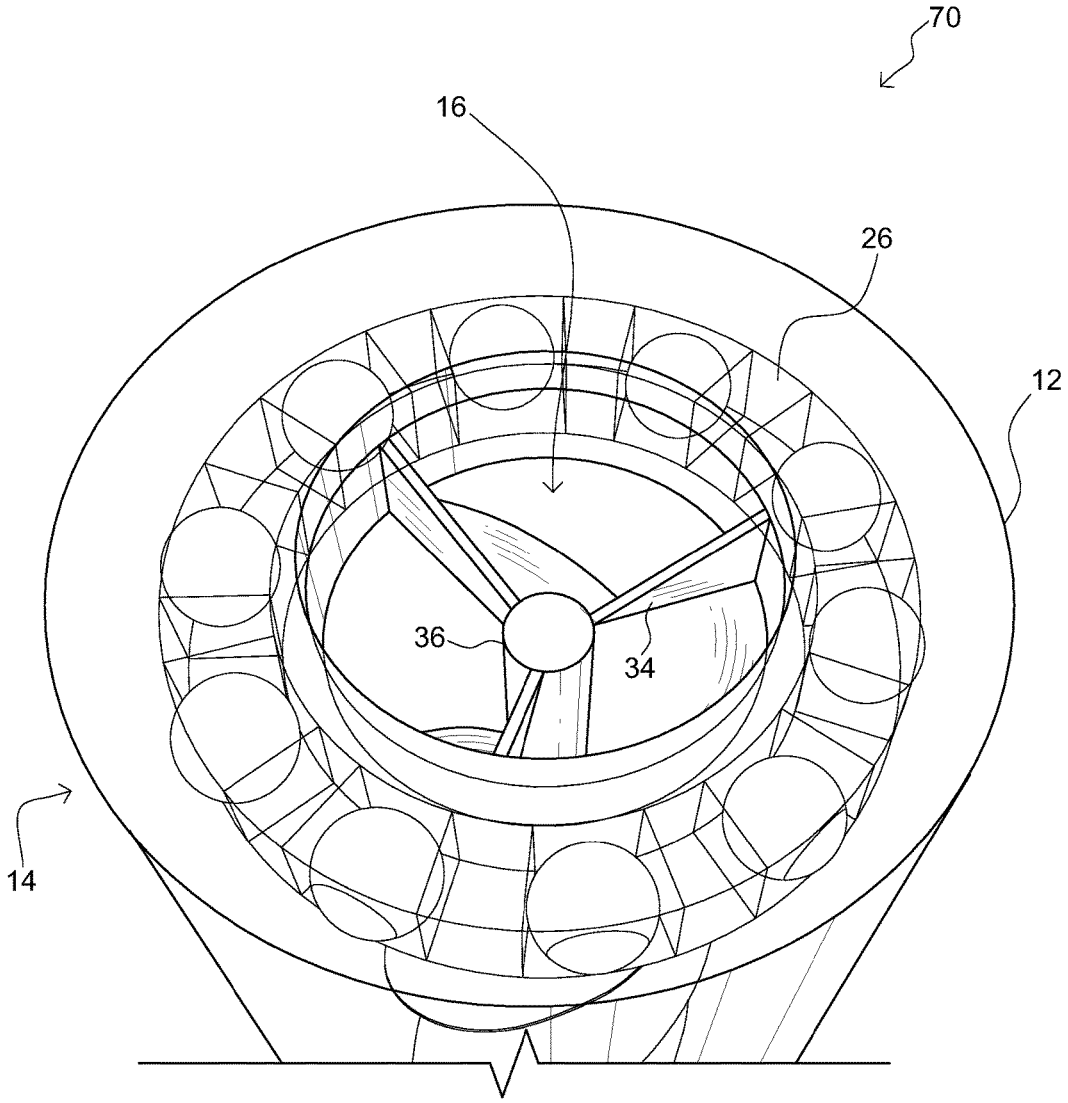


FIG. 8

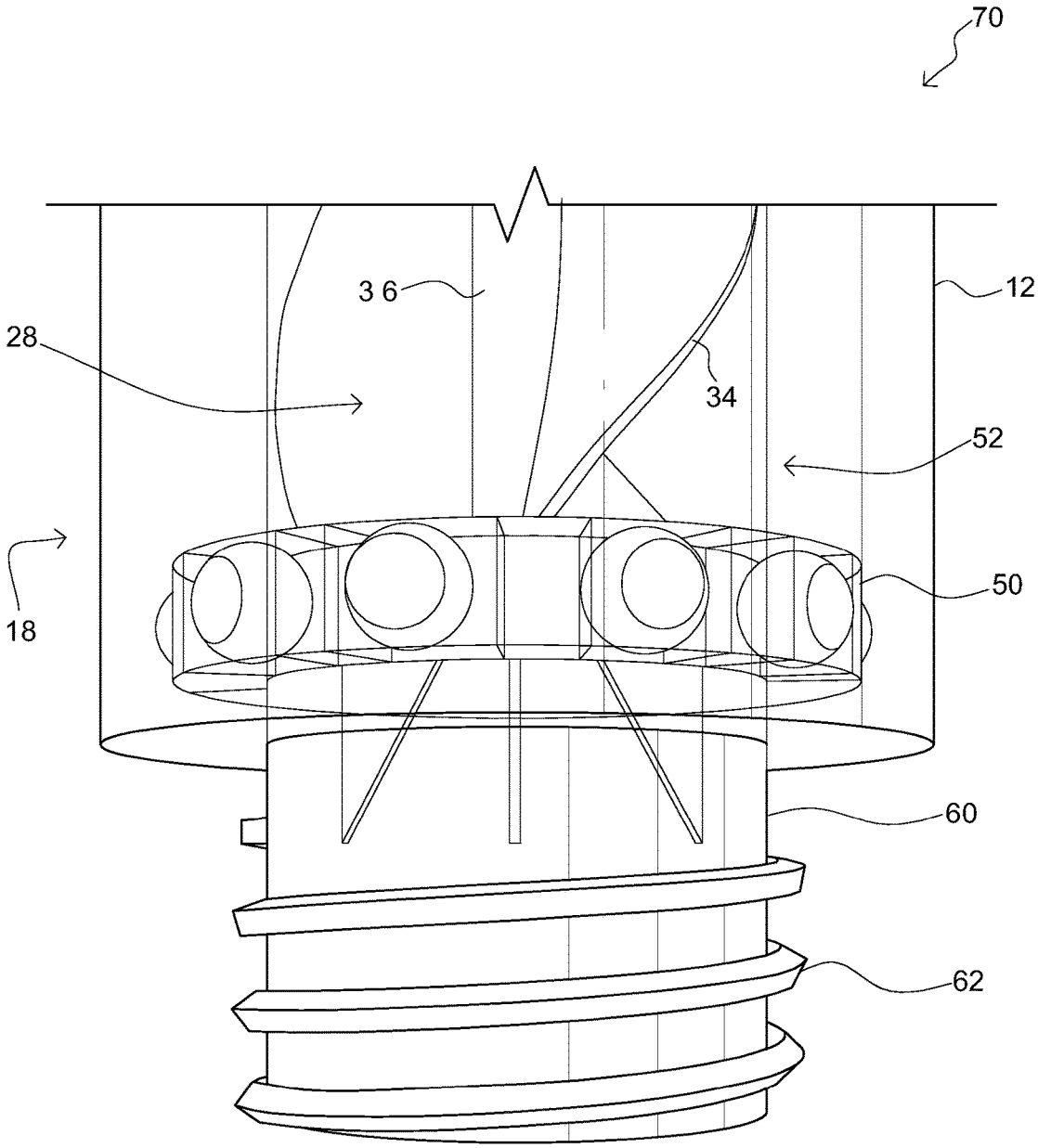


FIG. 9

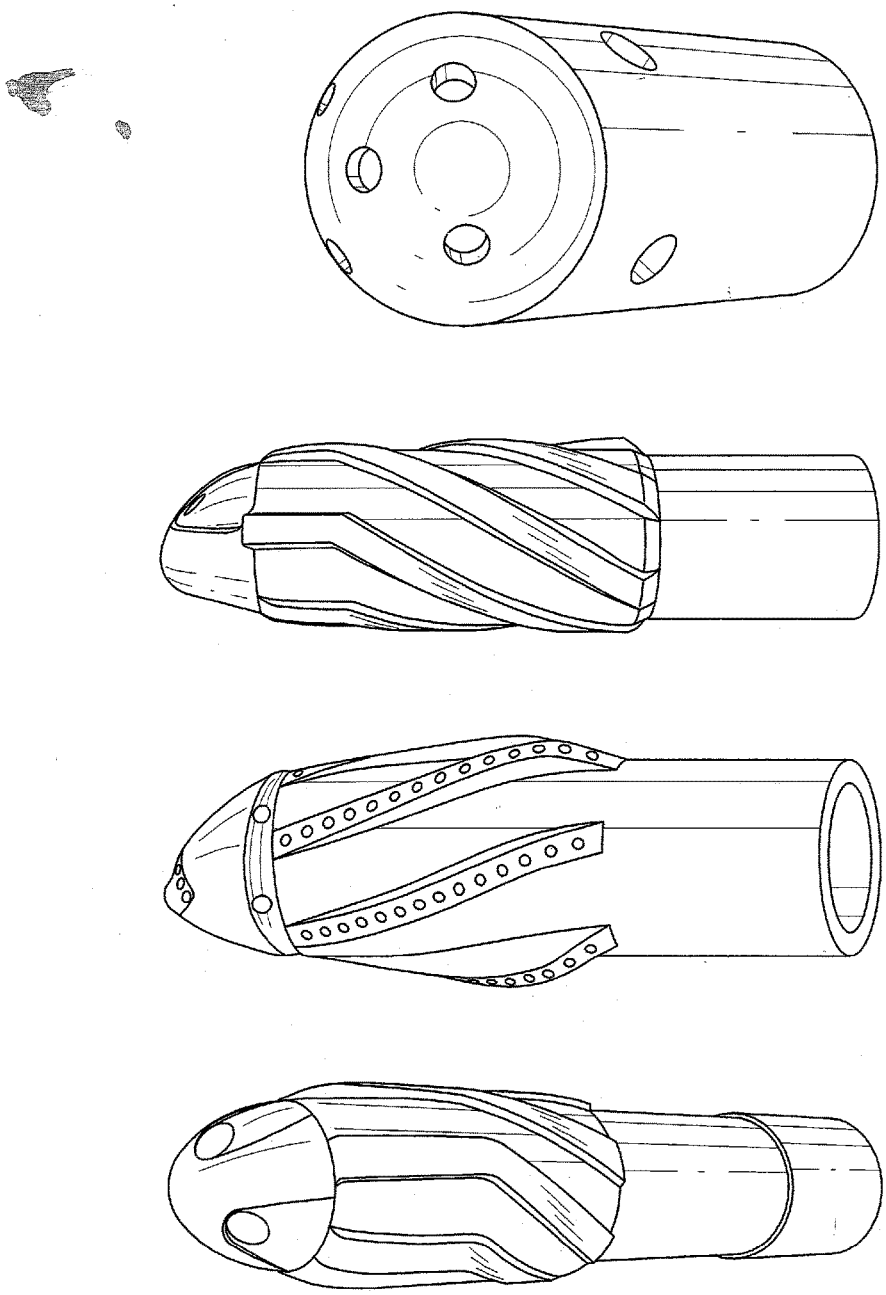


FIG. 10

REAMING SYSTEM

BACKGROUND OF THE INVENTION

[0001] Field of the Invention

[0002] The present invention relates to drilling, specifically to reaming systems and devices, including mandrel assemblies associated therewith.

[0003] Description of the Related Art

[0004] A reamer is a type of rotary cutting tool used to clean and/or enlarge the size of a previously formed hole, generally to leave the sides of the hole sufficiently smooth for later purposes. The process of so cleaning and/or enlarging the hole is called reaming. There are many different types of reamer and they may be designed for use as a hand tool or in a machine tool, such as a milling machine or drill press, in drilling system for drilling for oil, and/or in other earth drilling contexts, etc.

[0005] In the context of drilling for oil, once a hole is drilled, the hole so drilled will generally not maintain a clean, smooth profile. Drilling changes the fundamental characteristics of the surrounding and produces a void with respect to pressure, water content, and even chemical interactions may occur by exposing the materials surrounding the hole to the air. Further, natural layering, fissures, facture lines and etc. may react different to the hole than the surrounding material. Accordingly, such holes will often end up with discontinuities that make it difficult to operate the hole as desired. Thus, reaming systems/devices may be used to make the sides of the hole sufficiently smooth for continued operation. Also, it is often useful to follow the reaming with a pipe that then prevents further distortion of the surrounding material from intruding on the working portion of the hole.

[0006] Where a pipe follows the reaming device, it would be difficult and expensive to retrieve the reaming device since the pipe is literally right behind the device and the device must have a large enough profile to make room for the pipe. Accordingly, the reaming device is generally left in the hole at the bottom of the pipe. Wherein further drilling needs to occur, the drill will generally just drill through the reaming device on its way past.

[0007] Some improvements have been made in the field. Examples of references related to the present invention are described below in their own words, and the supporting teachings of each reference are incorporated by reference herein:

[0008] U.S. Pat. No. 2,084,096, issued to Everett, discloses a self-supporting, self-guiding rotary oil well drilling, apparatus and "particularly to that type embodying two rotary drill bits, two rotary drill stems therefor and an operating block for operating the said rotary drill bits and stems, a-gatherer, container and retainer for drill bit cuttings, a propelling shaft therefor and differential gears for operating the said shaft, and electrically driven motors for operating the aforesaid mechanism, however, while the present invention is embodied in an apparatus of this type, there are certain features which may of course be utilized in rotary oil well drilling apparatus different from the specific form shown, and other means of power such as steam, hydraulic or compressed air pressure may be utilized in actuating and rotating the drill bits and other mechanism in connection with the operation of the aforesaid rotary oil well drilling apparatus.

[0009] U.S. Pat. No. 7,823,657, issued to Zeni, discloses drilling assemblies, drilling reamer arm assemblies, and methods of drilling. In one implementation, a drilling assembly includes a cutting head apparatus configured to cut into earthen material as the cutting head apparatus is rotated. A drive shaft extends aft of and is configured to rotate the cutting head apparatus. A plurality of reamer arm assemblies projects radially outward of the drive shaft and are mounted for rotation therewith aft of the cutting head apparatus. Individual of the reamer arm assemblies include a radial inner portion extending radially outward of the drive shaft. A radial outer portion connects with and extends radially outward of the radial inner portion. The radial outer portion includes a cutter. At least one breakaway retainer fastens the radial inner and outer portions together and restrains the radial outer portion from moving relative to the radial inner portion towards the cutting head apparatus and the drive shaft. Other aspects are contemplated.

[0010] U.S. Pat. No. 7,938,204, issued to Buske, discloses a reamer bit for use in earth boring operations comprising a body, mounting elements on the bit body having rolling cutters, and nozzles configured to emit a cleaning spray that is angled with respect to the well bottom. The cleaning spray may be angled up to about 20.degree. with respect to the well bottom. The reamer may further include a pilot bit on a drill pipe extending downward from the reamer body.

[0011] U.S. Pat. No. 8,201,643, issued to Soby et al., discloses a system and method for enabling longitudinal and radial drilling in a wellbore is described. The system and method enable an operator to perforate the casing of a wellbore with an under-reamer at the end of a drill string and, without removing the drill string from the wellbore, initiate and complete lateral jetting of the wellbore into the surrounding formation. The system utilizes a perforation tool having a ball seat, which upon seating a drop ball in the ball seat enables the perforation tool to move from a closed position to an open position thereby allowing access to the formation using a jetting tool. Prior to seating the drop ball, an under-reaming operation may be performed using a hydraulic pressure activated under-reaming tool.

[0012] U.S. Pat. No. 8,205,689, issued to Radford, discloses drilling systems and methods for enlarging a borehole that include at least one expandable reamer and at least one expandable stabilizer axially spaced therefrom in a tubular string, such as a drill string, the at least one expandable reamer and the at least one expandable stabilizer being independently actuatable by different-sized actuation devices. A relatively lower tool is actuatable by a smaller actuation device, such as a drop ball, which passes through a relatively higher tool in the drill string without triggering the higher tool.

[0013] The inventions heretofore known suffer from a number of disadvantages which include being limited in use, being expensive, being unduly complex, being difficult to use, being limited in application, being limited in adaptability, being limited in conversion, being limited in torque, having too slow a rotation, not being usable with a variety of shoes, and/or failing to prevent a shoe from falling off when drilling through the system.

[0014] What is needed is a reaming system, device and/or mandrel assembly that solves one or more of the problems described herein and/or one or more problems that may come to the attention of one skilled in the art upon becoming familiar with this specification.

SUMMARY OF THE INVENTION

[0015] The present invention has been developed in response to the present state of the art, and in particular, in response to the problems and needs in the art that have not yet been fully solved by currently available reaming systems. Accordingly, the present invention has been developed to provide an effective and efficient reaming system for drill holes.

[0016] According to one embodiment of the invention, there is a reaming system. The reaming system may include an elongated tubular housing. The elongated tubular housing may include a first end that may have a fluid inlet aperture. The elongated tubular housing may include a second end, opposite the first end, that may have a fluid outlet aperture. The elongated tubular housing may include a coupling structure at the first end of the housing that may selectably mate with a bottom end of a casing tube.

[0017] The reaming system may include a first bearing pack that may be disposed circumferentially about the first end of the housing. The first bearing pack may be only of sacrificial materials which may be drilled through.

[0018] The reaming system may include an auger that may be disposed within the housing and may be functionally coupled to the first bearing pack such that the auger may rotate with respect to an attached casing tube. The auger may include a rotation transmission structure that may transfer rotation motion. The auger may rotate within the housing. The auger may include a spiral blade that may be wrapped about a central axle.

[0019] The reaming system may include a reaming tool that may be functionally coupled to the auger. The reaming tool may be a tool selected from the group consisting of: a float shoe, a reamer shoe, and a guide shoe.

[0020] The reaming system may include a casing tube that may be coupled to the housing. The reaming system may include a hydraulic fluid that may be disposed within the housing and may flow therethrough. The reaming system may include a pump that may be in fluid communication with the casing tube.

[0021] The reaming system may include a second bearing pack that may be functionally coupled to a bottom end of the auger. The second bearing pack is not only of sacrificial materials and includes an internal profile sized substantially similar to an inner profile of a casing tube such that a drill may pass through without having to drill therethrough.

[0022] The reaming system may include a connection sub that may be functionally coupled to a bottom end of the auger that may transfer rotational motion from the auger to an attached tool. The connection sub may include a lock assembly that may lock an attached tool to the connection sub.

[0023] According to one embodiment of the invention, there is a mandrel assembly. The mandrel assembly may include an elongated tubular housing. The elongated tubular housing may include a first end that may have a fluid inlet aperture. The elongated tubular housing may include a second end, opposite the first end, that may have a fluid outlet aperture. The elongated tubular housing may include a coupling structure at the first end of the housing that may selectably mate with a bottom end of a casing tube.

[0024] The mandrel assembly may include a first bearing pack that may be disposed circumferentially about the first end of the housing. The first bearing pack may be only of sacrificial materials which may be drilled through.

[0025] The mandrel assembly may include an auger that may be disposed within the housing and may be functionally coupled to the first bearing pack such that the auger may rotate with respect to an attached casing tube. The auger may include a rotation transmission structure that may transfer rotation motion. The auger may rotate within the housing. The auger may include a spiral blade that may be wrapped about a central axle.

[0026] The mandrel assembly may include a second bearing pack that may be functionally coupled to a bottom end of the auger. The second bearing pack may not only be of sacrificial materials. The second baring pack may include an internal profile that may be sized substantially similar to an inner profile of a casing tube such that a drill may pass through without having to drill therethrough.

[0027] The mandrel assembly may include a connection sub that may be functionally coupled to a bottom end of the auger that may transfer rotational motion from the auger to an attached tool. The connection sub may include a lock assembly that may lock an attached tool to the connection sub.

[0028] Reference throughout this specification to features, advantages, or similar language does not imply that all of the features and advantages that may be realized with the present invention should be or are in any single embodiment of the invention. Rather, language referring to the features and advantages is understood to mean that a specific feature, advantage, or characteristic described in connection with an embodiment is included in at least one embodiment of the present invention. Thus, discussion of the features and advantages, and similar language, throughout this specification may, but do not necessarily, refer to the same embodiment.

[0029] Furthermore, the described features, advantages, and characteristics of the invention may be combined in any suitable manner in one or more embodiments. One skilled in the relevant art will recognize that the invention can be practiced without one or more of the specific features or advantages of a particular embodiment. In other instances, additional features and advantages may be recognized in certain embodiments that may not be present in all embodiments of the invention.

[0030] These features and advantages of the present invention will become more fully apparent from the following description and appended claims, or may be learned by the practice of the invention as set forth hereinafter.

BRIEF DESCRIPTION OF THE DRAWINGS

[0031] In order for the advantages of the invention to be readily understood, a more particular description of the invention briefly described above will be rendered by reference to specific embodiments that are illustrated in the appended drawing(s). It is noted that the drawings of the invention are not to scale. The drawings are mere schematics representations, not intended to portray specific parameters of the invention. Understanding that these drawing(s) depict only typical embodiments of the invention and are not, therefore, to be considered to be limiting its scope, the invention will be described and explained with additional specificity and detail through the use of the accompanying drawing(s), in which:

[0032] FIG. **1** is a side elevational view of a reaming system, according to one embodiment of the invention;

[0033] FIG. **2** is a partial cross-sectional perspective view of a mandrel assembly with an elongated tubular housing illustrated transparently, according to one embodiment of the invention;

[0034] FIG. **3** is a partial side elevational view of a top portion of a mandrel assembly with an elongated tubular housing illustrated transparently, according to one embodiment of the invention;

[0035] FIG. **4** is a partial cross-sectional perspective view of a top portion of a mandrel assembly with an elongated tubular housing illustrated transparently, according to one embodiment of the invention;

[0036] FIG. **5** is a partial side elevational view of a bottom portion of a mandrel assembly with an elongated tubular housing illustrated transparently, according to one embodiment of the invention;

[0037] FIG. **6** is a partial cross-sectional perspective view of a bottom portion of a mandrel assembly with an elongated tubular housing illustrated transparently, according to one embodiment of the invention;

[0038] FIG. **7** is a side cross-sectional view of a middle portion of a mandrel assembly, according to one embodiment of the invention;

[0039] FIG. **8** is a top perspective view of an elongated tubular housing and a first bearing pack, according to one embodiment of the invention;

[0040] FIG. **9** is a side elevational view of a second bearing pack with an elongated tubular housing illustrated transparently, according to one embodiment of the invention; and

[0041] FIG. **10** is a plurality of perspective views of shoes, according to one embodiment of the invention.

DETAILED DESCRIPTION OF THE INVENTION

[0042] For the purposes of promoting an understanding of the principles of the invention, reference will now be made to the exemplary embodiments illustrated in the drawing(s), and specific language will be used to describe the same. It will nevertheless be understood that no limitation of the scope of the invention is thereby intended. Any alterations and further modifications of the inventive features illustrated herein, and any additional applications of the principles of the invention as illustrated herein, which would occur to one skilled in the relevant art and having possession of this disclosure, are to be considered within the scope of the invention.

[0043] Reference throughout this specification to an "embodiment," an "example" or similar language means that a particular feature, structure, characteristic, or combinations thereof described in connection with the embodiment is included in at least one embodiment of the present invention. Thus, appearances of the phrases an "embodiment," an "example," and similar language throughout this specification may, but do not necessarily, all refer to the same embodiment, to different embodiments, or to one or more of the figures. Additionally, reference to the wording "embodiment," "example" or the like, for two or more features, elements, etc. does not mean that the features are necessarily related, dissimilar, the same, etc.

[0044] Each statement of an embodiment, or example, is to be considered independent of any other statement of an embodiment despite any use of similar or identical language characterizing each embodiment. Therefore, where one embodiment is identified as "another embodiment," the identified embodiment is independent of any other embodiments characterized by the language "another embodiment." The features, functions, and the like described herein are considered to be able to be combined in whole or in part one with another as the claims and/or art may direct, either directly or indirectly, implicitly or explicitly.

[0045] As used herein, "comprising," "including," "containing," "is," "are," "characterized by," and grammatical equivalents thereof are inclusive or open-ended terms that do not exclude additional unrecited elements or method steps. "Comprising" is to be interpreted as including the more restrictive terms "consisting of" and "consisting essentially of."

[0046] FIG. **1** is a side elevational view of a reaming system, according to one embodiment of the invention. There is shown a reaming system **11** designed to cut the final size and finish of a drill hole. Generally, a reaming system, device, etc. will not make the original hole, but instead, enlarge and/or clean or otherwise make more smooth the interior of a previously drilled or bored hole. The illustrated reaming system **11** includes a rig structure (derrick) **14** supporting a casing **13** lead by a mandrel assembly **38** that is disposed within a hole **39**. The derrick **14** includes structure and devices to operate the mandrel assembly and to permit the addition of more casing sections as the mandrel assembly works its way down the hole. Accordingly, the reaming system **11** advantageously allows for a hole to be reamed and lined with a casing for future operations, such as but not limited to oil production. Similar reaming systems may be constructed for reaming in other contexts, wherein the derrick is replaced with appropriate support structure and/or wherein the casing may or may not be present.

[0047] The illustrated reaming system **11** includes a derrick **14** for supporting the components and parts of the reaming system **11** during use. A derrick is a lifting device generally including a guyed mast, as in a gin pole, which may be articulated over a load by adjusting its guys. The term derrick is also applied to the framework supporting a drilling apparatus in an oil rig.

[0048] The illustrated derrick includes a crown block **83**. The illustrated crown block **83** is functionally coupled to a traveling block **82** that travels vertically within the derrick **14**. A crown block is the stationary section of a block and tackle that contains a set of pulleys or sheaves through which the drill line (wire rope) is threaded and is opposite and above the traveling block. A traveling block is the freely moving section of a block and tackle that contains a set of pulleys or sheaves through which the drill line (wire rope) is threaded is opposite (and under) the crown block (the stationary section). The combination of the traveling block, crown block and wire rope drill line gives the ability to lift weights in the hundreds of thousands of pounds. On larger drilling rigs, when raising and lowering the derrick, line tensions over a million pounds are not unusual.

[0049] The illustrated derrick **14** includes a motor **84** or other power source that may be used to operate one or more pumps, winches, drills, and/or the like and combinations thereof. The motor **84** may be used to pump fluid through the casing and thereby through the mandrel assembly to cause a shoe at a bottom portion of the mandrel assembly to rotate at high speeds and with strong torque to effectively ream the hole.

[0050] The illustrated derrick **14** also includes a blowout preventer **86** functionally coupled around a top of the hole **39**. The blowout preventer **86** is generally a large, specialized valve or similar mechanical device, usually installed redundantly in stacks, used to seal, control and monitor oil and gas wells. Blowout preventers were developed to cope with extreme erratic pressures and uncontrolled flow (formation kick) emanating from a well reservoir during drilling. Kicks may lead to a potentially catastrophic event known as a blowout. In addition to controlling the down hole (occurring in the drilled hole) pressure and the flow of oil and gas, blowout preventers are intended to prevent tubing (e.g. drill pipe and well casing), tools and drilling fluid from being blown out of the wellbore (also known as bore hole, the hole leading to the reservoir) when a blowout threatens. Blowout preventers improve the safety of crew, rig (the equipment system used to drill a wellbore) and environment, and to the monitoring and maintenance of well integrity; thus blowout preventers are intended to provide fail-safety to the systems that include them.

[0051] The reaming system **11** includes a mandrel assembly **38** coupled to a bottom end of the casing **13** and configured to ream a drill hole when a shoe is coupled to a bottom end thereof. The mandrel assembly **38** may be coupled to the bottom end of the casing in a variety of manners, including but not limited to mating threads, snap-fits, friction fitting, adhesives, bolts, and the like and combinations thereof. The mandrel assembly **38** grips a shoe, which is the operating component that interfaces with the interior of the hole to be reamed and abrades away material, thereby reaming the hole. The shoe generally includes protrusions that, when the shoe spins, impact with non-smooth regions of the interior of the hole and thereby abrade the same making such regions more smooth and increasing the effective interior diameter of the same so that the casing can follow behind without getting stuck.

[0052] Generally, after the drilling is completed for a particular section of a hole, one puts a casing down the hole to create a smooth interior bore through which additional work may be completed. However, the hole is generally not perfect and often includes defects that can stop the casing from going all the way down. Accordingly, it is desirable to put a reaming tool, the operating tip of which is usually called a shoe, towards the bottom to ream out the hole as the casing slides down.

[0053] In one non-limiting embodiment, there is a reaming system, device, and/or mandrel assembly that is, advantageously, a low costs system that attaches to any of a great variety of shoes (e.g. float shoe, reamer shoe, guide shoe) from a variety of manufacturers. It includes an internal/central axle that rotates inside a housing and/or includes a pin-down connection (e.g. pin to pin, box-pin) to couple to a shoe so it can connect to any tool/shoe. The internal axle spins when you pump fluid through the mandrel assembly and spins a sub that is connected to the shoe which therefore also spins. The internal axle and/or other centrally positioned parts are generally of an aluminum and/or zinc alloy (or other material that may be drilled through rather easily, since the mandrel assembly is generally left at a bottom of the hole when the casing is finished being installed). There is an internal corkscrew/auger shaped set of blades that cause the internal axle to rotate and thus cause the tool to rotate when fluid is pumped through the housing that contains the corkscrew/auger.

[0054] It may be that there is an auger in fluid communication with the inside of the casing with in use. It may be that there is a mandrel (i.e. axle) fixedly coupled to the auger. Such may be a single molded piece with the auger. It may be that there is a connection sub (e.g. pin to pin, pin to box, box to box, box to pin) inside the housing that may be coupled by a threaded connection that may be assembled with the bottom bearing pack and/or that selectably couples to the shoe. It may be that there are bearing packs functionally coupled between the mandrel and the housing. It may be that a housing is selectably coupled to a casing when in use with a fluid tight seal. It may be that there is a set of apertures near the bottom of a mandrel assembly in fluid communication with the shoe which may have nozzles and thereby hydraulic fluid exits therefrom. It may be that there is an auger with a pair of bearing packs (one top and one bottom). It may be that a bottom bearing pack is coupled to a connection sub such that an attached shoe does not fall off when the mandrel assembly is drilled through, thus reducing the likelihood of fouling the hole with debris that is more difficult to drill through.

[0055] FIG. **2** is a partial cross-sectional perspective view of a mandrel assembly with an elongated tubular housing **12** illustrated transparently, according to one embodiment of the invention. There is shown a mandrel assembly **70** including an elongated tubular housing **12**, a first bearing pack **26**, a second bearing pack **50**, an auger **28** and a reaming tool (shoe) **38** functionally coupled thereto.

[0056] The illustrated mandrel assembly **70** is for drilling or reaming down a drill hole. The mandrel assembly **70** includes an elongated tubular housing **12** configured to support and protect the components and parts disposed therein and also to channel fluid therethrough such that flowing fluid causes the auger to spin. The elongated tubular housing **12** includes a first end **14** having a fluid inlet aperture **16**; wherein fluid enters the elongated tubular housing **12** therein, passes through a hollow interior of the first bearing pack **26** into the auger **28**, through apertures in the rotation transmission structure **32**, through a hollow interior of the second bearing pack **50**, and then out the mandrel assembly (generally through nozzles in a front region of the attached shoe), then up the sides of the hole between the casing that follows the mandrel assembly and the hole and thereby back out the hole. The elongated tubular housing **12** includes a second end **18**, opposite the first end **14**, and having a fluid outlet aperture **20**; wherein fluid entering from the fluid inlet aperture **16** exits out the fluid outlet aperture **20**, out near and/or from the shoe. The elongated tubular housing **12** includes a coupling structure **22** at the first end **14** of the housing that selectably mates with a bottom end of a casing tube **24**, thereby coupling a casing tube **24** to the elongated tubular housing **12**.

[0057] The illustrated mandrel assembly **70** includes a first bearing pack **26** disposed circumferentially about the first end **14** of the housing **12**. Notably, the illustrated first bearing pack **26** is of a smaller diameter than the illustrated second bearing pack **50**. The illustrated first bearing pack **26** is generally made only of sacrificial materials which may be drilled through (e.g. aluminum and/or zinc alloys), while the second bearing pack may have an interior diameter sufficiently large enough to allow for a drill to pass through without needing to drill the bearing pack itself. Accordingly

the second bearing pack may be of materials that are harder and/or more difficult to drill through than the materials used in the first bearing pack.

[0058] The illustrated mandrel assembly **70** includes an auger **28** disposed within the housing **12** and functionally coupled to the first bearing pack **26** such that the auger **28** rotates with respect to an attached casing tube **24**. The auger **28** includes a rotation transmission structure **32** that transfers rotation motion. The illustrated auger **28** rotates within the housing **12**. The auger **28** includes a spiral blade **34** wrapped about a central axle **36**, wherein fluid may be pumped therethrough to cause the spiral axle to rotate and thereby cause the shoe to also rotate. Applicant notes, for clarity, that the auger does not drill, dig, or otherwise move material to be reamed (e.g. earth), but is instead part of a power transfer mechanism to cause the shoe to operate against the material being reamed.

[0059] The illustrated mandrel assembly **70** includes a second bearing pack **50** functionally coupled to a bottom end of the auger **28**. The second bearing pack **50** is not generally only of sacrificial materials and therefore may include materials that are more difficult to drill through. The second bearing pack **50** cooperates with the first bearing pack to allow for the auger and axle to rotate with respect to the housing when fluid is pumped therethrough.

[0060] The illustrated mandrel assembly **70** includes a connection sub **60** functionally coupled to a bottom end of the auger **28** that transfers rotational motion from the auger **28** to an attached tool **38**. The connection sub **60** includes a lock assembly **62** that locks the attached tool **38** to the connection sub **60**. The lock assembly **62** is disposed circumferentially about the end of the tubular housing at a radius that is large enough to not be destroyed when drilled through (similar to how the second bearing pack is not destroyed during drill-through). Accordingly, the lock assembly continues to grip the shoe and keep the same coupled to the tubular housing even while the shoe is being drilled through. Thus the shoe does not dislodge and fall into the hole during drilling.

[0061] FIG. **3** is a partial side elevational view of a top portion of a mandrel assembly with an elongated tubular housing illustrated transparently, according to one embodiment of the invention. There is shown a mandrel assembly **70** including an elongated tubular housing **12**, and a first bearing pack **26**.

[0062] The illustrated mandrel assembly **70** includes an elongated tubular housing **12** configured to support and protect the components and parts of the mandrel assembly **70**. The elongated tubular housing **12** includes a first end **14**, wherein fluid may enter therein. The elongated tubular housing **12** includes a coupling structure at the first end **14** of the housing that selectably mates with a bottom end of a casing tube **24**.

[0063] The illustrated mandrel assembly **70** includes a first bearing pack **26** disposed circumferentially about the first end **14** of the housing **12**. The first bearing pack **26** is only made of sacrificial materials which may be drilled through. The mandrel assembly **70** includes an auger (not shown) disposed within the housing **12** and functionally coupled to the first bearing pack **26** such that the auger rotates with respect to an attached casing tube **24**. The auger includes a spiral blade **34** wrapped about a central axle **36**.

[0064] FIG. **4** is a partial cross-sectional perspective view of a top portion of a mandrel assembly with an elongated tubular housing illustrated transparently, according to one embodiment of the invention. There is shown a mandrel assembly **70** including an elongated tubular housing **12**, and a first bearing pack **26**.

[0065] The illustrated mandrel assembly **70** includes an elongated tubular housing **12** configured to support and protect the components and parts disposed therein. The elongated tubular housing **12** includes a first end **14** having a fluid inlet aperture **16**. The elongated tubular housing **12** includes a coupling structure **22** at the first end **14** of the housing that selectably mates with a bottom end of a casing tube.

[0066] The illustrated mandrel assembly **70** includes a first bearing pack **26** disposed circumferentially about the first end **14** of the housing **12**. The first bearing pack **26** is only made of sacrificial materials which may be drilled through. The mandrel assembly **70** includes an auger (not shown) disposed within the housing **12** and functionally coupled to the first bearing pack **26** such that the auger rotates with respect to an attached casing tube. The auger includes a rotation transmission structure **32** that transfers rotation motion. The auger rotates within the housing **12**. The auger includes a spiral blade **34** wrapped about a central axle **36**.

[0067] FIG. **5** is a partial side elevational view of a bottom portion of a mandrel assembly with an elongated tubular housing illustrated transparently, according to one embodiment of the invention. There is shown a mandrel assembly **70** including an elongated tubular housing **12**, a second bearing pack, an auger **28**, a connection sub, and a reaming tool (shoe) **38**.

[0068] The illustrated mandrel assembly **70** is for drilling or reaming down a drill hole. The mandrel assembly **70** includes an elongated tubular housing **12** configured to support and protect the components and parts disposed therein. The elongated tubular housing **12** includes a second end **18**, opposite a first end (not shown). The mandrel assembly **70** includes an auger **28** disposed within the housing and functionally coupled to a first bearing pack (not shown) such that the auger **28** rotates with respect to an attached casing tube. The auger **28** includes a rotation transmission structure that transfers rotation motion. The illustrated auger **28** rotates within the housing. The auger **28** includes a spiral blade **34** wrapped about a central axle **36**.

[0069] The mandrel assembly **70** includes a second bearing pack **50** functionally coupled to a bottom end **52** of the auger **28**. The second bearing pack **50** is not only of sacrificial materials. The second baring pack **50** includes an internal profile **54** sized substantially similar to an inner profile **56** of a casing tube such that a drill may pass through without having to drill therethrough.

[0070] The mandrel assembly **70** includes a connection sub **60** functionally coupled to a bottom end of the auger **28** that transfers rotational motion from the auger **28** to an attached tool **38**. The connection sub **60** includes a lock assembly **62** that locks the attached tool **38** to the connection sub **60**.

[0071] There are apertures **33** through the illustrated rotation transmission structure **32** such that fluid may pass from the auger-region of the tubular housing interior to through a hollow interior of the second bearing pack and into the shoe. The illustrated shoe **38** includes a nozzle **57** out through which fluid may exit the system into the hole.

[0072] FIG. **6** is a partial cross-sectional perspective view of a bottom portion of a mandrel assembly with an elongated

tubular housing illustrated transparently, according to one embodiment of the invention. There is shown a mandrel assembly **70** including an elongated tubular housing **12**, a second bearing pack, an auger **28**, a connection sub, and a reaming tool **38**.

[0073] The illustrated mandrel assembly **70** is for drilling or reaming down a drill hole. The mandrel assembly **70** includes an elongated tubular housing **12** configured to support and protect the components and parts disposed therein. The elongated tubular housing **12** includes a second end **18**, opposite a first end (not shown). The mandrel assembly **70** includes an auger **28** disposed within the housing **12** and functionally coupled to a first bearing pack (not shown) such that the auger **28** rotates with respect to an attached casing tube. The auger **28** includes a rotation transmission structure **32** that transfers rotation motion. The illustrated auger **28** rotates within the housing **12**. The auger **28** includes a spiral blade (not illustrated) wrapped about a central axle.

[0074] The mandrel assembly **70** includes a second bearing pack **50** functionally coupled to a bottom end **52** of the auger **28**. The second bearing pack **50** is not only of sacrificial materials. The second baring pack **50** includes an internal profile **54** sized substantially similar to an inner profile **56** of a casing tube such that a drill may pass through without having to drill therethrough.

[0075] The mandrel assembly **70** includes a connection sub **60** functionally coupled to a bottom end of the auger **28** that transfers rotational motion from the auger **28** to an attached tool **38**. The connection sub **60** includes a lock assembly **62** that locks the attached tool **38** to the connection sub **60** at a radius substantially similar to that of the second bearing pack **50** so that the shoe **38** stays connected thereto when being drilled through.

[0076] FIG. **7** is a side cross-sectional view of a middle portion of a mandrel assembly, according to one embodiment of the invention. There is shown a mandrel assembly **70** including an elongated tubular housing having a first end and a second end.

[0077] The illustrated mandrel assembly **70** includes an elongated tubular housing **12** configured to support and protect the components and parts of the mandrel assembly **70**. The elongated tubular housing **12** includes a first end **14** having a fluid inlet aperture. The elongated tubular housing **12** includes a second end **18**, opposite the first end **14**, and having a fluid outlet aperture; wherein fluid entering from the fluid inlet aperture exits out the fluid outlet aperture.

[0078] The illustrated mandrel assembly **70** includes a first bearing pack **26** disposed circumferentially about the first end **14** of the housing **12**. The first bearing pack **26** is only made of sacrificial materials which may be drilled through. The mandrel assembly **70** includes an auger **28** disposed within the housing **12** and functionally coupled to the first bearing pack **26** such that the auger **28** rotates with respect to an attached casing tube. The illustrated auger **28** rotates within the housing **12**. The auger **28** includes a spiral blade **34** wrapped about a central axle **36**.

[0079] The mandrel assembly **70** includes a second bearing pack **50** functionally coupled to a bottom end **52** of the auger **28**. The second bearing pack **50** is not only of sacrificial materials. The mandrel assembly **70** includes a connection sub **60** functionally coupled to a bottom end of the auger **28** that transfers rotational motion from the auger **28** to an attached tool. The connection sub **60** includes a lock assembly **62** that locks the attached tool to the connection sub **60**.

[0080] FIG. **8** is a top perspective view of an elongated tubular housing and a first bearing pack, according to one embodiment of the invention. There is shown a mandrel assembly **70** including an elongated tubular housing **12** and a first bearing pack **26**.

[0081] The illustrated mandrel assembly **70** is for drilling or reaming down a drill hole. The mandrel assembly **70** includes an elongated tubular housing **12** configured to support and protect the components and parts disposed therein. The elongated tubular housing **12** includes a first end **14** having a fluid inlet aperture **16**.

[0082] The illustrated mandrel assembly **70** includes a first bearing pack **26** disposed circumferentially about the first end **14** of the housing **12**. The first bearing pack **26** is only made of sacrificial materials which may be drilled through. The mandrel assembly **70** includes an auger **28** disposed within the housing **12** and functionally coupled to the first bearing pack **26** such that the auger **28** rotates with respect to an attached casing tube **24**. The auger **28** includes a spiral blade **34** wrapped about a central axle **36**.

[0083] FIG. **9** is a side elevational view of a second bearing pack with an elongated tubular housing illustrated transparently, according to one embodiment of the invention. There is shown a mandrel assembly **70** including an elongated tubular housing **12**, an auger **28**, a second bearing pack **50**, and a connection sub **60**.

[0084] The illustrated mandrel assembly **70** is for drilling or reaming down a drill hole. The elongated tubular housing **12** includes a second end **18**, opposite a first end (not shown). The mandrel assembly **70** includes an auger **28** disposed within the housing **12** and functionally coupled to a first bearing pack (not shown) such that the auger **28** rotates with respect to an attached casing tube. The auger **28** includes a rotation transmission structure that transfers rotation motion. The illustrated auger **28** rotates within the housing **12**. The auger **28** includes a spiral blade **34** wrapped about a central axle **36**.

[0085] The mandrel assembly **70** includes a second bearing pack **50** functionally coupled to a bottom end **52** of the auger **28**. The second bearing pack **50** is not only of sacrificial materials. The mandrel assembly **70** includes a connection sub **60** functionally coupled to a bottom end of the auger **28** that transfers rotational motion from the auger **28** to an attached tool. The connection sub **60** includes a lock assembly **62** that locks the attached tool to the connection sub **60**.

[0086] FIG. **10** is a plurality of perspective views of shoes, according to one embodiment of the invention. Shoes may be of a variety of shapes and/or may have various connectors that may be coupled to a mandrel assembly as described herein. Such shoes are generally hollow capped cylindrical bodies with textures exterior surfaces for abrading hole walls when spun and may include nozzles near a front thereof out through which fluid may be expelled by pressure.

[0087] It is understood that the above-described embodiments are only illustrative of the application of the principles of the present invention. The present invention may be embodied in other specific forms without departing from its spirit or essential characteristics. The described embodiment is to be considered in all respects only as illustrative and not restrictive. The scope of the invention is, therefore, indicated

by the appended claims rather than by the foregoing description. All changes which come within the meaning and range of equivalency of the claims are to be embraced within their scope.

[0088] For example, although the illustrated auger includes a central axle at an interior region of the spiral blades of the auger, an auger may have a central axle that is a cylinder disposed on an exterior of the blades, such that the blades are contained therein. There may be an internal mandrel/auger with an external spiral profile.

[0089] Further, while fixed (i.e. non-rotating) connections between parts will generally be threaded connections threaded in a direction such that any typical rotation of the same will tend to tighten the connection, such connections may be of any type of connection that creates a non-rotating fluid tight connection between such parts, including but not limited to tight snap-fit connectors, bolts, industrial adhesives, and the like and combinations thereof suitable for the environment and stresses under which such parts will be operated.

[0090] Additionally, although the figures illustrate two bearing packs, a top pack and a bottom pack, there may be additional bearing packs. Also, the auger spiral may be clockwise or counter clockwise as needed for the desired spin of the shoe.

[0091] It is also envisioned that in one embodiment of the invention, there is no bottom bearing pack and the entire device below the first bearing pack spins, thereby spinning the attached shoe. A shoe may be fixedly coupled to a bottom of a mandrel assembly instead of being rotatable with respect to the mandrel assembly housing.

[0092] It is expected that there could be numerous variations of the design of this invention. An example is that the mandrel assembly may be adorned, branded, or otherwise decorated with decorative layers, engravings, bass relief structures and the like and combinations thereof.

[0093] Finally, it is envisioned that the components of the device may be constructed of a variety of materials, unless otherwise indicated herein, including but not limited to metals, plastics, ceramics, stone, wood, resins, woven fibers, alloys, composites and/or combinations thereof.

[0094] Thus, while the present invention has been fully described above with particularity and detail in connection with what is presently deemed to be the most practical and preferred embodiment of the invention, it will be apparent to those of ordinary skill in the art that numerous modifications, including, but not limited to, variations in size, materials, shape, form, function and manner of operation, assembly and use may be made, without departing from the principles and concepts of the invention as set forth in the claims. Further, it is contemplated that an embodiment may be limited to consist of or to consist essentially of one or more of the features, functions, structures, methods described herein.

What is claimed is:

1. A reaming system, comprising:

a) an elongated tubular housing, including:

a1) a first end having a fluid inlet aperture;

a2) a second end, opposite the first end, having a fluid outlet aperture and

a3) a coupling structure at the first end of the housing that selectably mates with a bottom end of a casing tube; and

b) a first bearing pack disposed circumferentially about the first end of the housing; and

c) an auger disposed within the housing and functionally coupled to the first bearing pack such that the auger may rotate with respect to an attached casing tube and including a rotation transmission structure that transfers rotation motion.

2. The system of claim **1**, further comprising a reaming tool functionally coupled to the auger.

3. The system of claim **1**, further comprising a casing tube coupled to the housing.

4. The system of claim **1**, further comprising a hydraulic fluid disposed within the housing and flowing therethrough.

5. The system of claim **1**, further comprising a pump in fluid communication with the casing tube.

6. The system of claim **2**, wherein the reaming tool is a tool selected from the group consisting of: a float shoe, a reamer shoe, and a guide shoe.

7. The system of claim **1**, further comprising a second bearing pack functionally coupled to a bottom end of the auger.

8. The system of claim **1**, further comprising a connection sub functionally coupled to a bottom end of the auger that transfers rotational motion from the auger to an attached tool and including a lock assembly that locks an attached tool to the connection sub.

9. The system of claim **1**, wherein the auger rotates within the housing.

10. The system of claim **1**, wherein the first bearing pack is only of sacrificial materials which may be drilled through.

11. The system of claim **1**, wherein the auger includes a spiral blade wrapped about a central axle.

12. The system of claim **7**, wherein the second bearing pack is not only of sacrificial materials and includes an internal profile sized substantially similar to an inner profile of a casing tube such that a drill may pass through without having to drill therethrough.

13. A mandrel assembly, comprising:

a) an elongated tubular housing, including:

a1) a first end having a fluid inlet aperture;

a2) a second end, opposite the first end, having a fluid outlet aperture and

a3) a coupling structure at the first end of the housing that selectably mates with a bottom end of a casing tube; and

b) a first bearing pack disposed circumferentially about the first end of the housing; and

c) an auger disposed within the housing and functionally coupled to the first bearing pack such that the auger may rotate with respect to an attached casing tube and including a rotation transmission structure that transfers rotation motion.

14. The assembly of claim **13**, further comprising a second bearing pack functionally coupled to a bottom end of the auger.

15. The assembly of claim **14**, further comprising a connection sub functionally coupled to a bottom end of the auger that transfers rotational motion from the auger to an attached tool and including a lock assembly that locks an attached tool to the connection sub.

16. The assembly of claim **15**, wherein the auger rotates within the housing.

17. The assembly of claim **16**, wherein the first bearing pack is only of sacrificial materials which may be drilled through.

18. The assembly of claim **17**, wherein the auger includes a spiral blade wrapped about a central axle.

19. The assembly of claim **18**, wherein the second bearing pack is not only of sacrificial materials and includes an internal profile sized substantially similar to an inner profile of a casing tube such that a drill may pass through without having to drill therethrough.

20. A reaming system, comprising:

a) an elongated tubular housing, including:

a1) a first end having a fluid inlet aperture;

a2) a second end, opposite the first end, having a fluid outlet aperture and

a3) a coupling structure at the first end of the housing that selectably mates with a bottom end of a casing tube; and

b) a first bearing pack disposed circumferentially about the first end of the housing; wherein the first bearing pack is only of sacrificial materials which may be drilled through;

c) an auger disposed within the housing and functionally coupled to the first bearing pack such that the auger may rotate with respect to an attached casing tube and including a rotation transmission structure that transfers rotation motion; wherein the auger rotates within the housing; wherein the auger includes a spiral blade wrapped about a central axle;

d) a reaming tool functionally coupled to the auger; wherein the reaming tool is a tool selected from the group consisting of: a float shoe, a reamer shoe, and a guide shoe;

e) a casing tube coupled to the housing;

f) a hydraulic fluid disposed within the housing and slowing therethrough;

g) a pump in fluid communication with the casing tube;

h) a second bearing pack functionally coupled to a bottom end of the auger; wherein the second bearing pack is not only of sacrificial materials and includes an internal profile sized substantially similar to an inner profile of a casing tube such that a drill may pass through without having to drill therethrough; and

i) a connection sub functionally coupled to a bottom end of the auger that transfers rotational motion from the auger to an attached tool and including a lock assembly that locks an attached tool to the connection sub.

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