June 3, 1969 J. D. TIPTON 3,447,652

TELESCOPING DRILLING DEVICE

Filed March 13, 1968 Sheet 1 of 3

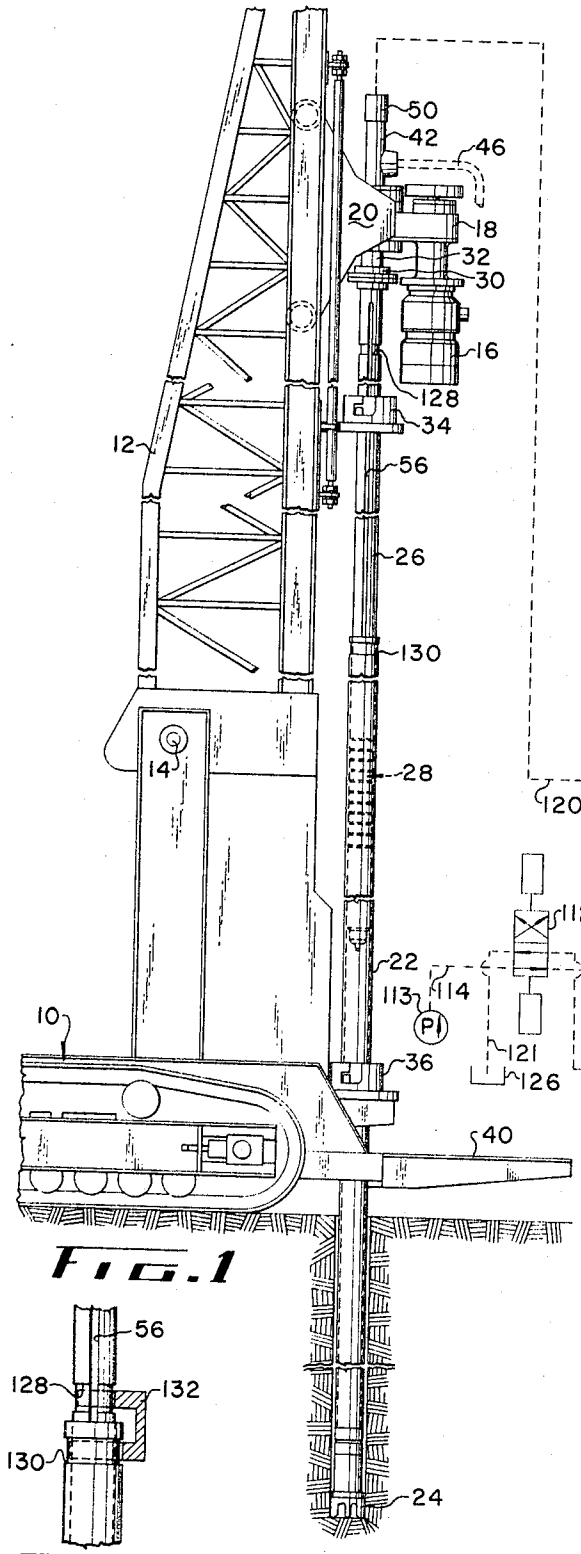


FIG. 1

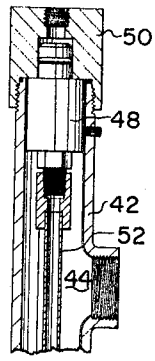


FIG. 2

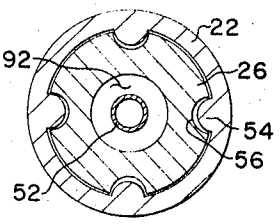


FIG. 6

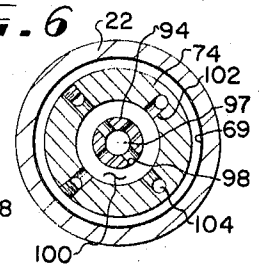


FIG. 7

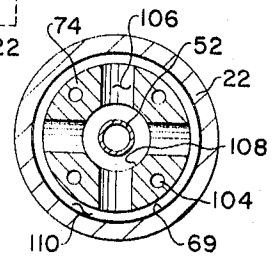


FIG. 8

FIG. 9

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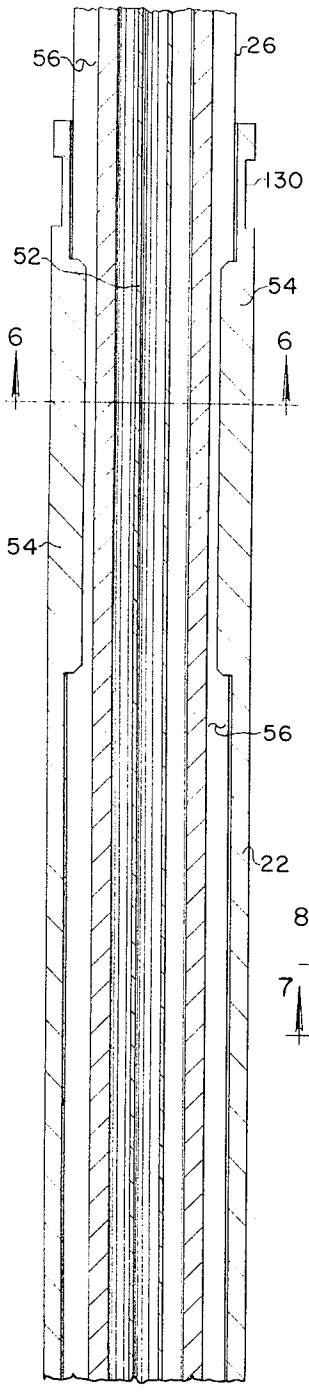


FIG. 3

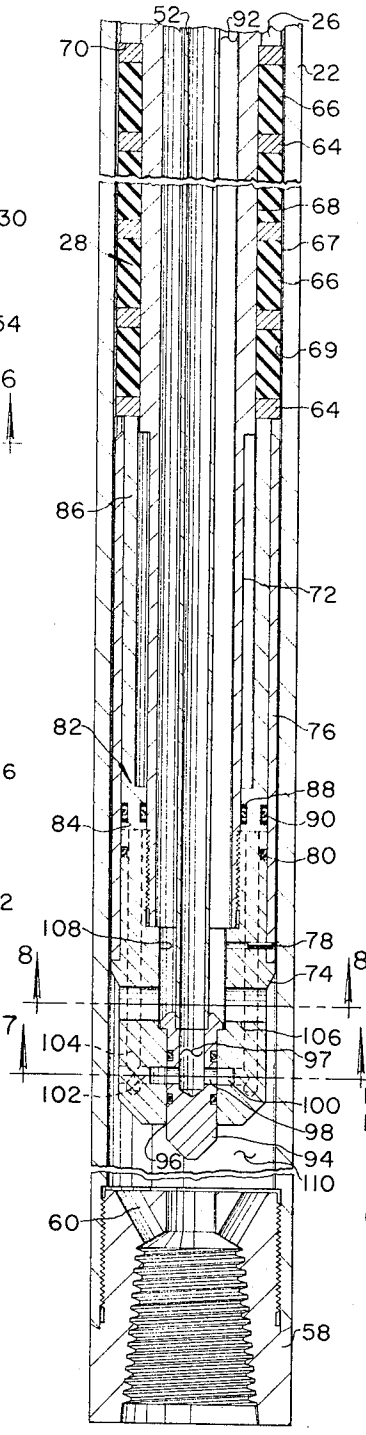


FIG. 4

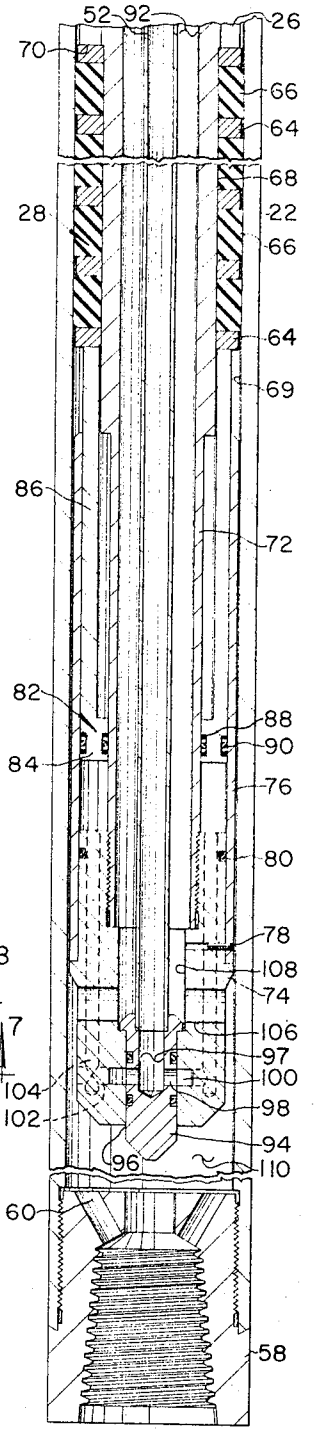


FIG. 5

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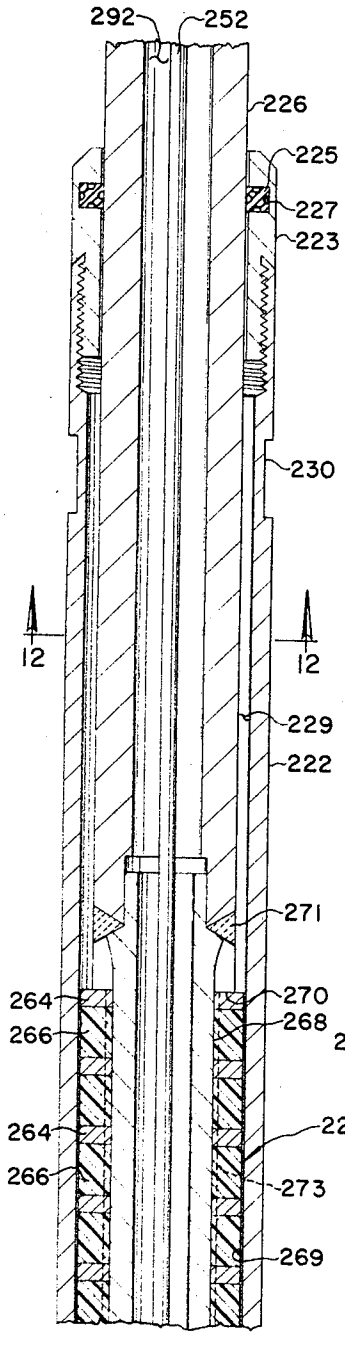


FIG. 10

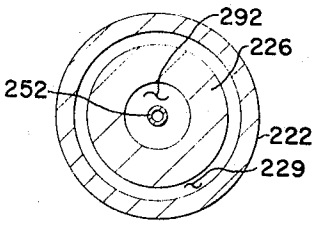


FIG. 12

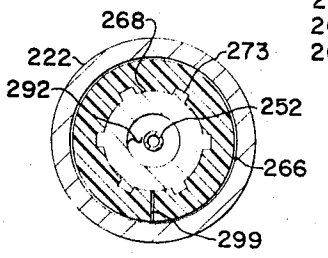


FIG. 13

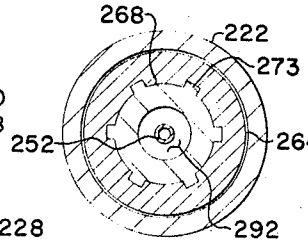


FIG. 14

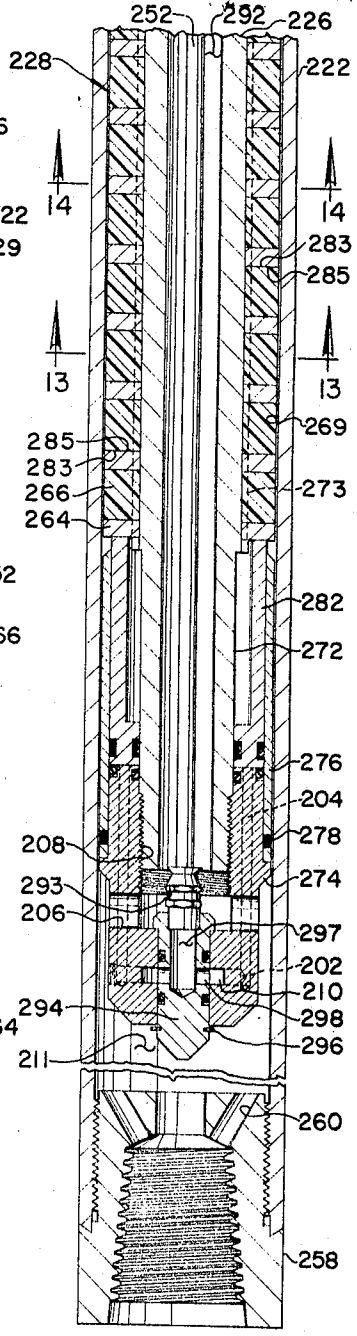


FIG. 11

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TELESCOPING DRILLING DEVICE

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Continuation-in-part of application Ser. No. 673,066, Oct. 5, 1967. This application Mar. 13, 1968, Ser. No. 716,272

Int. Cl. F16d 25/00, 19/00, 11/06

U.S. Cl. 192—85

4 Claims

ABSTRACT OF THE DISCLOSURE

A telescoping drill pipe assembly comprising an inner pipe, an outer pipe, and a frictional hydraulically actuated coupling device for holding the two pipe members in any desired position between and including the maximum extended and collapsed positions. The inner pipe member has sleeved about its lower end a stack of alternate resilient rings and rigid rings adapted to be compressed by a hydraulic piston and cylinder assembly. A hydraulic fluid supply tube extends the length of the inner pipe and is connected to the cylinder. Pressurizing the cylinder will cause the piston to compress the ring assembly axially thereby deforming the resilient rings radially outwardly into frictional gripping contact with the inner wall of the outer pipe for holding the inner and outer pipes fixed relative to each other.

Background of the invention

This application is a continuation-in-part of applicant's prior copending application Ser. No. 673,066, filed Oct. 5, 1967, now abandoned.

Drilling devices of the type used for drilling blast holes for quarrying, mining, and geophysical exploration are usually mounted on wheeled or tracked vehicles for portability. Also, in the interest of portability, the drill mast is limited in length and usually hinged for erection at the drill site to a substantially vertical position prior to commencing the drilling operations. Consequently, the depth to which a hole may be drilled without adding extension lengths of drill pipe is limited by the mast height. Moreover, the use of extension pipe sections requires pipe storing and handling apparatus on the mast with the penalty of additional weight and bulk which is undesirable from the standpoint of ease in raising nad lowering the mast.

To overcome the aforementioned problems associated with the operation of portable drilling rigs, telescoping drilling members have been developed which permit the drilling of holes having a depth greater than the height of the drill rig mast without the use of extension sections and the associated handling equipment.

For example, U.S. Patent 3,255,612 issued to J. R. Mayer and J. D. Tipton discloses a telescoping drill pipe or kelly for use with a drilling rig equipped with a rotary table drive, and which can be operated either in the fully extended or fully collapsed condition. However, it is desirable to have telescoping drilling devices for use with drilling rigs employing drive units attached to the top end of the drill pipe, and it is also desirable to be able to extend the telescoping members to any desired position intermediate the fully collapsed or extended positions.

Summary of the invention

The principal object of the invention is the provision of a telescoping drill pipe assembly capable of being operated and held in any position intermediate the extreme extended or collapsed positions.

It is also an object of the invention to provide a telescoping drill pipe assembly that is simple and provides ease of operation from a remote location such as the driller's operating station, and may be stored on the mast in a collapsed condition when not in use.

A further object of the invention is the provision of an extensible drill pipe assembly for a drilling rig having a top drive unit slidably mounted on the drill mast which drives the drill pipe from one end only.

The invention lies in the provision of a telescoping drill pipe assembly having a novel means for coupling one pipe section relative to the other in any selected position between the totally collapsed or telescoped condition and the maximum extended position.

The preferred embodiments of the invention contemplate not only retention of the inner and outer telescoping members to prevent relative axial movement, but also the provision of coupling means capable of transmitting substantial torque from one member to the other without rotational slippage of one member relative to the other.

The hydraulically actuated resilient gripper rings form a simple and positive locking means between the inner and outer pipe sections. The coupling rings are also responsive to increased axial loading of the drill pipe to grip the pipe member with a progressively greater frictional force thereby being, to a degree, self-energized. Since the hydraulic actuating mechanism is essentially automatically operable, it can be remotely controlled and requires virtually no physical effort on the part of the drill operating personnel in order to achieve rapid and precise positioning of the telescoping pipe members.

The novel features of the invention as well as additional objects and advantages thereof will be understood more fully from the following description when read in connection with the accompanying drawings.

Brief description of the drawings

FIG. 1 is a view of a typical rotary drill rig mounted on a tracked vehicle and employing the subject telescoping drilling device which is shown in a partially extended condition. Included in FIG. 1 is a schematic representation of a control system for the hydraulically actuated coupling.

FIG. 2 is a fragmentary sectional view of a hole cleansing fluid inlet pipe illustrating the components whereby the coupling pressure fluid and the drill hole cleansing fluid are introduced to the upper portion of the telescoping drill pipe assembly.

FIG. 3 is a longitudinal sectional view of a portion of the telescoping drill pipe assembly showing the torque transmitting splines.

FIG. 4 is a partial longitudinal section of the hydraulically actuated coupling assembly in the non-gripping condition.

FIG. 5 is a partial longitudinal sectional view of the coupling assembly in the gripping condition.

FIG. 6 is a transverse sectional view taken along the line 6—6 in FIG. 3.

FIG. 7 is a transverse sectional view taken along the line 7—7 of FIG. 4.

FIG. 8 is a transverse sectional view taken along the line 8—8 of FIG. 4.

FIG. 9 is a fragmentary view of the telescoping drill pipes connected by a mechanical coupling.

FIG. 10 is a longitudinal sectional view of a portion of an alternate embodiment of the telescoping drill pipe assembly.

FIG. 11 is a partial longitudinal section of the hydraulically actuated coupling assembly of the embodiment of FIG. 10.

FIG. 12 is a transverse sectional view taken along the line 12—12 of FIG. 10.

FIG. 13 is a transverse sectional view taken along the line 13—13 of FIG. 11.

FIG. 14 is a transverse sectional view taken along the line **14—14** of FIG. 11.

Description of the preferred embodiments

In the drawings a preferred form of the telescoping drilling device is shown as a telescoping drill pipe assembly for driving a rotary bit. In FIG. 1 the drill pipe assembly is shown in drilling position mounted on a portable drilling rig having a track laying undercarriage **10** carrying a mast **12** which is hinged at **14** for allowing the mast **12** to be lowered to a substantially horizontal position when the drilling rig is to be moved from one drilling site to another. The particular type of rotary drill rig illustrated has what is commonly known as a top drive assembly comprising a hydraulic motor **16** drivably connected to a gear box **18**. The top drive assembly is mounted on a carrier **20** suitably retained on a mechanism, not shown, but well known to those familiar with the art which powers the top drive assembly along the mast **12** for feeding and retracting the drill pipe assembly.

The telescoping drill pipe assembly includes an outer tubular drill pipe **22** having a rotary bit **24** attached to the lower end thereof, an inner tubular drill pipe **26** telescopically disposed within the outer pipe **22**, and a hydraulically actuated coupling assembly generally designated by **28** and explained herein later in detail.

The upper end of the inner drill pipe **26** is drivably connected to the top drive gear box **18** by a drive coupling **30** which is also connected to the top drive output shaft **32**.

Drill pipe stabilizers **34** and **36** are mounted on the mast **12** to journal the drill pipe assembly and stabilize respectively the inner drill pipe **26** and the outer drill pipe **22** about their axis of rotation.

Also shown in FIG. 1 is a schematic representation of a typical hydraulic control system for actuating the coupling assembly **28** and will be explained herein later in detail. The control system could logically be mounted on a drill control panel, not shown, and operated from the drill operator's platform **40**.

In FIG. 2 a fragmentary section of a drill hole cleansing fluid inlet pipe **42** is shown. The pipe **42** is rigidly fixed to the top drive gear box **18** (FIG. 1) but is also sealably in communication with the hollow drive shaft **32**. Hole cleansing fluid such as compressed air may be introduced to the interior **44** of the pipe **42** via a hose **48** (FIG. 1) from a suitable source The hole cleansing fluid may then flow down through the hollow drive shaft **32** (FIG. 1) and via the drive coupling **30** into the inner drill pipe **26**, down through the outer drill pipe **22**, and through the bit **24** for blowing drill chips from the drill hole. In applications using a down-the-hole drill (not shown) attached to the lower end of the outer drill pipe, the hole cleansing fluid also serves as the drill working fluid.

FIG. 2 also illustrates the means for introducing hydraulic actuating fluid to the coupling assembly **28**. A rotating union **48** of a well known type is disposed within the pipe **42** and the cap **50** and is also coupled to a hydraulic fluid supply tube **52** which extends through the hollow drive shaft **32** and down through the interior of the inner drill pipe **26** to the coupling assembly **28**. Hydraulic fluid is thereby suitably conducted to the coupling assembly **28** which rotates with the inner drill pipe member **26** as does the tube **52**.

Referring to FIGS. 3 and 6, in a preferred form of the telescoping drill pipe assembly, driving torque is transmitted from the inner drill pipe **26** to the outer drill pipe **22** through internal splines **54** on the outer drill pipe **22** disposed to slide in complementary grooves **56** formed on the circumference of the inner drill pipe **26**. The splines **54** extend only over a small portion of the length of the outer pipe **22**; however, to make the inner pipe **26** fully telescopic within the outer pipe **22**, the grooves **56** extend substantially the full length of the inner pipe **26**.

The outer pipe **26** terminates at its lower end with a threaded sub **58** (FIG. 4) having a plurality of holes **60** for conducting hole cleansing fluid to the bit **24**.

In FIG. 4, the lower end of the inner drill pipe **26** is shown with the coupling assembly **28** attached thereto. The coupling assembly consists of a plurality of alternately stacked rigid metal force transmitting and distributing rings **64** and resilient rings **66** closely fitted but slidable on the reduced diameter portion **68** of the inner drill pipe **26**. A preferred material for the resilient rings **66** is synthetic rubber. The ring assembly is retained at the upper end by a shoulder **70** on the inner drill pipe **26**.

Threadably attached to the extreme lower end of a second reduced diameter portion **72** of the inner pipe **26** is a hydraulic cylinder head **74**. A cylinder barrel **76** extends upwardly from the cylinder head **74** and is affixed to the head **74** by a pin **78**. An O-ring **80** forms a circumferential seal between the head **74** and the barrel **76**. In the annular space formed by the cylinder barrel **76** surrounding the reduced diameter **72** of the inner pipe **26** is axially slidably housed a piston **82** having a head **84** and an elongated skirt **86**. O-rings **88** and **90** prevent leakage of hydraulic fluid past the piston head **84**. The upper end of the piston skirt **86** engages one of the metal force transmitting rings **64** thereby retaining the lower end of the coupling assembly **28**.

Hydraulic fluid is admitted to the cylinder by means of the elongated tube **52** which, as previously described, extends down through the interior **92** of the inner pipe **26** from the upper end attached to the rotating union **48** (see FIG. 2).

The lower end of the tube **52** is pressed into the fitting **94** which in turn is suitably secured in the cylinder head **74** as by welding at **96**. Hydraulic fluid flows to the cylinder from the tube **52** through passage **97**, and radial extending passages **98** in the fitting **94** into a cavity **100** in the cylinder head **74** and then through passages **102** and longitudinally extending passages **104** as shown in FIG. 7. Referring to FIGS. 4 and 8, additional passages **106** are in communication with the bore **108** of the head **74** for receiving drill holes cleansing fluid from the interior **92** of the inner pipe **26** and transmitting the same to the interior **110** of the outer drill pipe **22**.

In the deenergized condition of the coupling assembly **28**, as shown in FIG. 4, the resilient coupling members **66** have an outside diameter **67** slightly less than the inside diameter of the wall **69** of the outer drill pipe **22** so that the inner and outer drilling members are free to slide.

FIG. 5 illustrates the energized condition of the coupling assembly **28**. Hydraulic fluid under pressure acting against the piston **82** will cause axial displacement and forceable engagement against the first force transmitting ring **64** and successive transmittal of force through each resilient ring **66** causing elastic deformation as shown so that each resilient ring **66** fills the annular space formed between each force transmitting ring **64**, the outer diameter **68** of the inner drill pipe **26**, and the inner wall **69** of the outer drill pipe **22**. Particularly significant in the embodiment shown is that the outer diameter **67** of each resilient ring **66** is now in positive engagement with the inner wall **69** of the outer drill pipe **22** thereby establishing af riction coupling between the inner pipe **26** and the outer pipe **22** preventing longitudinal displacement of one relative to the other even under a substantial axial load. In fact, a degree of self-energization is experienced due to the fact that an increase in axial force on the inner drill pipe **26** tends to cause additional elastic deformation of the rings **66** and resulting in greater forces exerted on the pipe wall **69** which establishes greater frictional resistance to axial displacement of the inner pipe **26** relative to the outer pipe **22**.

The frictional holding force of the coupling assembly is also proportional to the area of contact between the resilient rings **66** and the wall **69** so that increasing the

total number of rings will increase the holding capacity of the coupling assembly. By way of example, a coupling assembly having a total of twelve synthetic rubber rings one inch long used on a 3.75 inch diameter drill pipe assembly will support an axially applied force on the inner drill pipe sufficient to raise a typical drilling rig off the ground at the mast end of the undercarriage.

In operation, drilling would begin with the inner and outer pipe members in the fully telescoped condition. The coupling assembly **28** would be energized by operating a control valve **112** (FIG. 1) to valve hydraulic fluid from a supply pump **113** mounted on the drill rig through conduits **114** and **116**, a pilot operated check valve **118**, and conduit **120** to the rotating union **48** and supply tube **52**. An axially applied drill feeding force from the top drive carrier **20** could then be transmitted from the inner pipe **26** through the coupling **28** to the outer pipe **22**, to put sufficient pressure on the bit **24** for effective drilling.

After drilling the maximum depth in the telescoped condition, the control valve **112** would be operated to deenergize the coupling by supplying hydraulic fluid via the pump **113** to the conduit **122** and the check valve pilot operator **124** to open the check valve **118**. Hydraulic fluid would then be forced out of the coupling assembly **28**, via conduits **120**, **116**, and **121**, to the sump **126**, as the resilient rings **66** resumed their relaxed condition of FIG. 4. The top drive carrier **20** could then be operated to pull the inner drill pipe **26** up the mast **12** at least the distance equal to the additional depth of hole desired while the outer pipe **22** would remain in the hole due to its own weight. After again energizing the coupling assembly **28**, as described, drilling operations could be resumed with the inner and outer pipe members securely coupled in an extended position.

At the completion of drilling operations the extended assembly is withdrawn from the drill hole by raising the carrier **20** up the mast **12** until a grooved portion **130** near the top end of the outer drill pipe **22** is just above the lower stabilizer **36**. In this position a somewhat C-shaped retaining member (not shown) is inserted in the grooved portion **130** and also rests on the stabilizer **36** thereby supporting the pipe **22** when the coupling assembly **28** is deenergized. The drill pipe assembly can then be collapsed and after energizing the coupling assembly **28**, once again, the telescoped pipe assembly can be withdrawn completely from the hole.

In the event of hydraulic supply pressure failure, or a seal failure in the coupling assembly, the outer drill pipe **22** could be withdrawn from the hole by collapsing the drill pipe assembly until the groove **128** on the inner drill pipe **26** was adjacent the grooved portion **130** on the outer drill pipe **22** whereupon as shown in FIG. 9, a mechanical coupling **132** could be inserted in the grooves to couple the drill pipes for raising or lowering the telescoped assembly.

In the aforedescribed embodiment it can be appreciated that due to the fact that elastic deformation of the resilient rings **66** causes them to frictionally grip the reduced diameter portion **68** of the inner drill pipe **26** as well as the inner wall **69** of the outer pipe **22** the coupling assembly could be used to transmit a limited amount of driving torque such as required for rotary indexing of percussion drills and down-the-hole type drills.

An alternate embodiment of the telescoping drill pipe assembly is illustrated in FIGS. 10 through 14. Referring particularly to FIGS. 10 and 11, portions of an outer tubular drill pipe **222** are shown telescopically disposed over an inner tubular drill pipe **226**. The outer drill pipe **222** has a grooved portion **230** near the top end serving the same purpose as the grooved portion **130** of the drill pipe **222**. The top end of tubular pipe **222** has a cap **223** threadedly disposed thereon. The cap **223** houses a circumferential sealing member **225** in a groove **227**. The sealing member **225** functions to prevent drill chips and dust from falling down into the annular space **229** between the inner and outer drill pipes when the top end of the outer drill pipe is below ground level. The lower end of the outer tubular drill pipe **222** (FIG. 11) terminates with a threaded sub **258** having a plurality of holes **260** for conducting pressure fluid for hole cleaning when using a drilling tool (not shown) such as a rotary bit, or for energizing a down-the-hole drill attached to the sub **258**.

In FIGS. 10 and 11, the lower end of the inner drill pipe **226** is shown with a hydraulically actuated coupling assembly **228** attached thereto. The coupling assembly consists of a plurality of alternately stacked metal force transmitting ring members **264** and resilient ring members **266** disposed on a reduced diameter portion **268** of the inner drill pipe **226**. As shown in FIG. 10, the reduced diameter portion **268** may be formed as a separate member and suitably fastened to the inner drill pipe **226** such as by welding at **271**. As shown in FIGS. 10–14, the reduced diameter portion **268** has straight sided splines **273** for engaging complementary grooves in the force transmitting rings **264** and the resiilent rings **266**. The ring assembly is retained at the upper end of the reduced diameter portion **268** by a shoulder **270**.

Threadably attached to the extreme lower end of a second reduced diameter portion **272** of the inner pipe **226** is a hydraulic cylinder head **274**. A cylinder barrel **276** extends upwardly from the cylinder head **274** and is affixed to the head **274** by welding at **278**. In the annular space formed by the cylinder barrel **276** surrounding the reduced diameter **272** of the inner pipe **226** is axially slidably housed a piston **282** of the same configuration as the piston **82**. The upper end of the piston **282** engages one of the metal force transmitting rings **264** thereby retaining the lower end of the coupling assembly **228**.

Hydraulic fluid is admitted to the cylinder by means of a flexible elongated tube **252** which, as in the embodiment of FIGS. 1 through 9, extends down through the interior **292** of the inner pipe **226**.

The lower end of the tube **252** terminates in a threaded connector **293** which is pressed into a fitting **294**. The fitting **294** is suitably secured in the cylinder head **274** by a retaining ring **296**. Hydraulic fluid flows to the cylinder from the tube **252** through passage **297**, and radial extending passages **298** in the fitting **294** into a cavity **210** in the cylinder head **274** and then through passages **202** and longitudinally extending passages **204** as shown in FIG. 11. Additional passages **206** are in communication with the bore **208** of the head **274** for receiving pressure fluid from the interior **292** of the inner pipe **226** and transmitting the same to the interior **211** of the outer drill pipe **222**.

The operation of the coupling assembly **228** is similar to the coupling assembly **28** previously described. However, as will be noted from FIGS. 10 and 12, the complementary torque transmitting splines and grooves have been eliminated from the outer drill pipe **226** and the inner drill pipe **222**, respectively. In the energized condition (not shown) of the coupling assembly **228**, the axial compressive force exerted on the stacked rings by the piston **282** will cause the resilient and elastically deformable ring members **266** to deform radially to frictionally grip the inner wall **269** of the outer drill pipe **226**. Due to the fact that the resilient rings **266** are splined to the inner telescoping drill pipe and are in frictional engagement with the metal force transmitting rings **264** over respective transverse surfaces **283** and **285**, the coupling assembly **228** is able to sufficiently transmit all the torsional effort required in rotary drilling as well as maintaining the fixed axial relationship of the inner and outer telescoping members.

In the embodiment of FIGS. 10 through 14, the resilient ring members **266** can be suitably made of a polyurethane elastomer of approximately 90–100 durometer hardness. Replacement of worn rings is facilitated by providing a radial split **299** in the rings **266** (see FIG. 13) to enable the rings to be forcibly spread for inser-

tion over and removal from the reduced diameter portion **268** without complete disassembly of the coupling.

Although in the embodiments described herein the illustrative drilling rig is a top drive rotary rig, it will be appreciated that the invention could be used to equal advantage with various types of drilling equipment such as percussion, down-the-hole, and auger drills to extend the depth of hole drilled without resorting to adding and removing extension drill string members.

What is claimed is:

1. In a drilling device including drive means for rotating a drill pipe, a telescoping drill pipe assembly comprising:

(a) an elongated outer tubular member having attachment means adjacent its lower end for attaching a drill bit or the like;

(b) an elongated inner tubular member operable to be rotatively driven by said drive means and dimensioned for longitudinal telescopic movement with respect to said outer tubular member; and

(c) frictional coupling means mounted on said inner tubular member adjacent the lower end thereof for telescopic movement therewith and operable to releasably couple said tubular members in fixed longitudinal relationship, said coupling means comprising:

(1) at least one elastically deformable ringlike member surrounding said lower end of said inner tubular member, said ringlike member in its nondeformed condition being movable with respect to the inner wall of said outer tubular member and in its deformed condition being in frictional gripping engagement with said inner wall of said outer tubular member; and

(2) pressure fluid operable actuator means attached adjacent said lower end of said inner tubular member, including cylinder and piston component means, one of said component means being extendable in response to operation of said actuator means to deform said resilient member into frictional gripping engagement with said inner wall of said outer tubular member thereby to hold said outer and inner tubular members in fixed longitudinal relationship.

2. The invention set forth in claim **1** wherein:

said ringlike member in its nondeformed condition being movable with respect to the outer wall of said inner tubular member and in its deformed condition being in frictional gripping engagement with said outer wall of said inner tubular member, whereby, in response to operation of said actuator means, said inner tubular member and said outer tubular member are held against relative rotation.

3. The invention set forth in claim **1** wherein:

said coupling means includes at least one substantially rigid ringlike force transmitting member surrounding said lower end of said inner tubular member and engageable with said elastically deformable member over respective transverse surface means, said lower end of said inner tubular member includes longitudinal external splines formed on its outer wall, said ringlike members include complementary grooves for engaging said splines, and in response to operation of said actuator means said resilient member is forced into frictional gripping engagement with said transverse surface means on said rigid member thereby to hold said outer and inner tubular members against relative rotation.

4. The invention set forth in claim **1** wherein:

said outer tubular member includes inwardly projecting longitudinal spline members disposed on its inner wall and said inner tubular member includes complementary longitudinal grooves disposed in its outer wall whereby said outer tubular member is operable to be rotatively driven by said inner tubular member.

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BENJAMIN W. WYCHE, III, *Primary Examiner.*

U.S. Cl. X.R.

175—321; 285—338; 192—76