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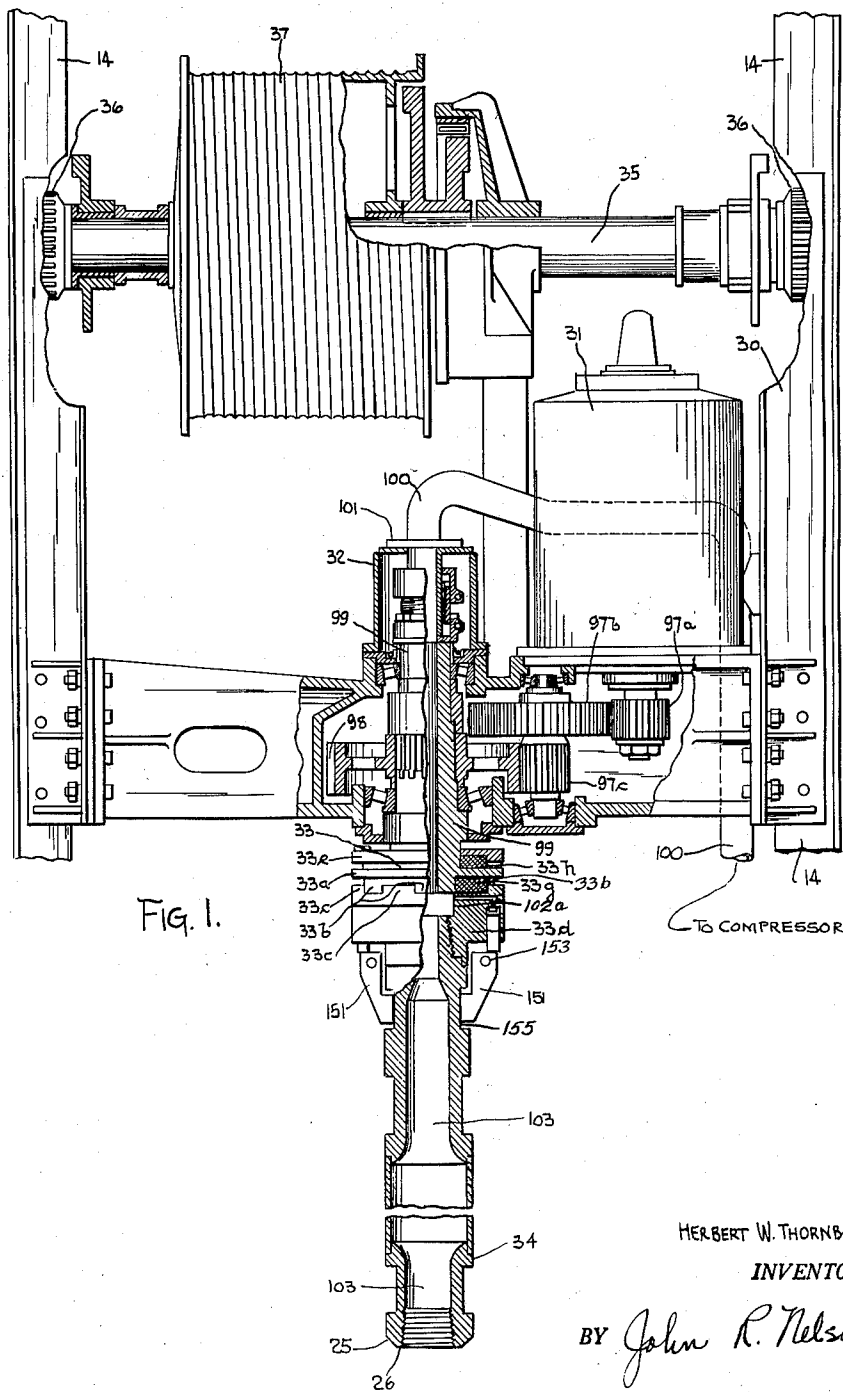
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2,863,638

ROTARY DRILL STRING APPARATUS

Original Filed Aug. 14, 1953

3 Sheets-Sheet 1



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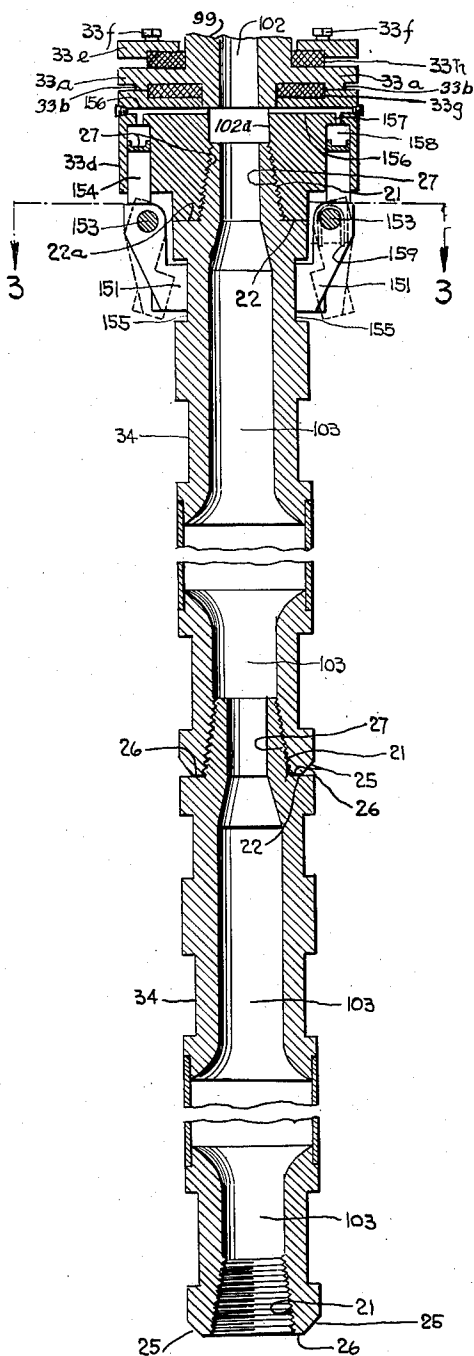


FIG. 2.

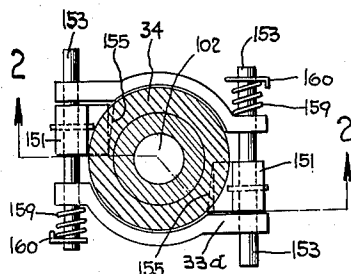


FIG. 3.

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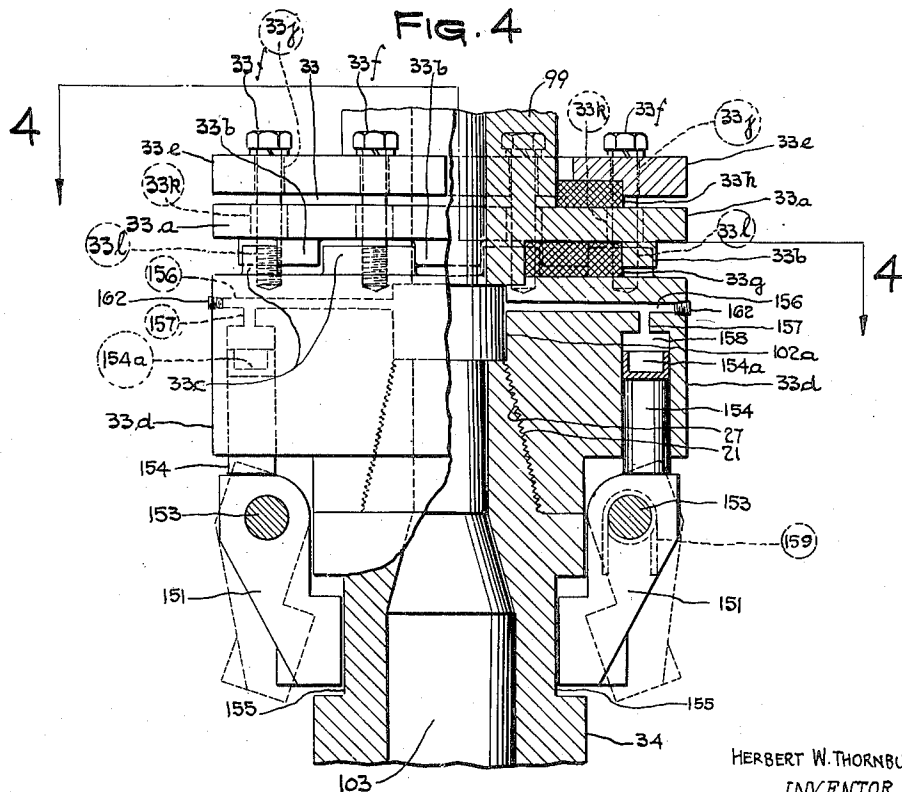
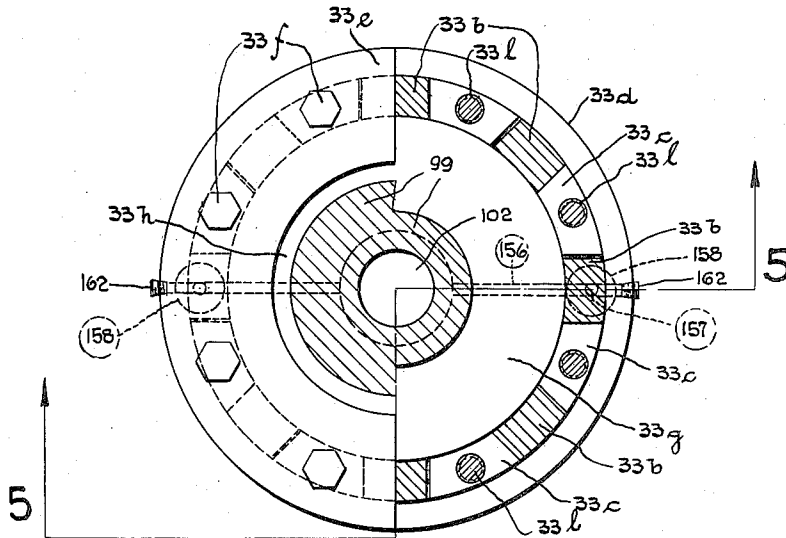


FIG. 5.

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ROTARY DRILL STRING APPARATUS

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Original application August 14, 1953, Serial No. 374,364.
Divided and this application April 19, 1955, Serial No. 502,397

6 Claims. (Cl. 255—19)

This invention relates to well-drill equipment and more particularly to new and useful improvements in drill-string apparatus for rotary-type blast-hole drills.

This invention is a divisional of copending application Serial No. 374,364, filed August 14, 1953, for Rotary Well Drill.

The principal objects of the invention are to provide an improved detachable rotary drill-string apparatus in which:

(1) A flexible coupling between the rotary driving unit and the drill pipe provides with limited transverse flexibility a direct positive torque drive and pull-down connection and at the same time a passage for compressed air supplied to the drill bit.

(2) The upper end of the drill pipe is automatically locked against rotation relative to the drive shaft responsive to the compressed air supplied to the string.

(3) The drill-pipe joints will break before the joint between the drill pipe and rotary-driving unit, eliminating the need for tool wrenches to hold the driving unit-drill pipe joint while unscrewing of the drill-pipe joints during take-down of the drill string.

(4) The uppermost drill-pipe joint is self-tightening, and automatically locked against unscrewing.

In addition to the principal objects above stated, a number of novel and useful details have been worked out which will be readily evident as the description progresses.

The invention consists in the novel parts and in the combination and arrangement thereof, which are defined in the appended claims, and of which one embodiment is exemplified in the accompanying drawings, which are hereinafter particularly described and explained.

Throughout the description the same reference-number is applied to the same member or to similar members.

Figure 1 is a side elevation, partly in section, showing the rotary-power unit, rotary-drive coupling and tool wrench on the rotary-drive coupling.

Figure 2 is a vertical section taken along line 2—2 of Figure 3, showing the flexible coupling connected to the drill pipe and showing the tool wrench engaged with the upper end of the drill pipe.

Figure 3 is a horizontal section, taken along line 3—3 of Figure 2, showing the tool wrench which is associated with the rotary-drive coupling.

Figure 4 is an enlarged plan view of Figure 2, taken along line 4—4 of Figure 5, showing the upper split collar of the flexible coupling bolted in place, and in cross section, the lower resilient washer and interlocking teeth of the flexible coupling in driving contact during clockwise rotation of the drive shaft.

Figure 5 is an enlarged vertical section view taken along line 5—5 of Figure 4, showing the assembled elements of the flexible coupling, and the interconnection between the fluid conduits, plunger mechanism and pawls which engage with the upper end of the drill pipe section adjacent the rotary drive coupling.

Turning now to the figures, Figure 1 shows the drill

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string of the rotary-type blast-hole drill shown and described in my copending applications, Serial No. 374,364, filed August 14, 1953, for Rotary Well Drill, and Serial No. 464,471, filed October 25, 1954, for Well Drill Pipe-Handling Apparatus, which are hereby incorporated by reference herein.

From Figure 1, it is seen that frame 30, which is vertically movable with reference to the supporting fixed mast 14 (fully described in said copending applications), carries the rotary-drive machinery for the drill-pipe 34 and the coupling 33 and that coupling 33 provides not only a rotary-drive connection, but also a supporting connection, to the drill pipe so that the drill pipe can be raised and lowered as well as rotated. Frame 30 is operatively connected to the rotary-drill mast by pinions 36 meshing with a vertical rack on the mast (not shown), and is raised and lowered under power of cables (not shown) reeved on shipper-shaft drum 37 keyed to shipper-shaft 35 rotatably mounted on frame 30, all of which is more particularly shown and described in my aforementioned copending applications.

Drill pipe 34 is made up of one or more tubular drill-pipe sections detachably connected one to another by threaded joints. A rotary drill bit (not shown) is threaded joint connected to the lower end of the lowermost drill-pipe section.

Reversible electric motor 31 is drivably connected, through reduction gears 97a, 97b, and 97c, to gear 98 which is splined to shaft 99 of rotary-drive unit 32. The lower end of shaft 99 is connected by coupling 33 to the upper end of the drill string.

Referring to Figures 1, 2, 4 and 5, the flexible coupling 33 will now be described.

Driving flange 33a is built integral with the lower end of shaft 99 and is provided with a plurality of depending downwardly projecting teeth 33b (Figure 5) spaced near the periphery of said flange 33a. A plurality of corresponding upwardly projecting teeth 33c near the periphery of the upper face of socket 33d register with teeth 33b on flange 33a to provide torsional driving connection to socket 33d. The teeth 33c are held in interlocking engagement with teeth 33b in the following manner.

Annular resilient washer 33g is fitted over the lower end of shaft 99 and is spaced between the upper face of socket 33d and the lower face of flange 33a. Annular resilient washer 33h is fitted over shaft 99 adjacent the upper face of flange 33a. A split annular collar 33e (Figure 4) is fitted adjacent the upper face of resilient washer 33h (Figure 5). Cap screws 33f extend vertically downward through holes 33j, bored in split collar 33e, through enlarged holes 33k bored in flange 33a to register with holes 33j, and are threaded vertically downward into teeth 33c at threads 33l tapped in socket 33d to secure split collar 33e to said socket. By tightening cap screws 33f, split collar 33e and socket 33d are rigidly connected, resilient washers 33g and 33h are placed under compression, and teeth 33b and 33c are interlocked, but are provided with some vertical spacing between the top surface of each tooth and the bottom surface of its corresponding notch due to the thickness of resilient washers 33g and 33h. Split collar 33e and bolts 33f, which rigidly connect said collar and socket 33d, take the tension in hoisting the drill line.

The lower portion of socket 33d (Figures 1 and 5) is threaded to make a threaded joint with the top drill pipe section 34 at threads 21 and 27, and carries a drill pipe gripping mechanism (hereinafter described) for locking said drill pipe section to socket 33d.

The resilient washers 33g and 33h provide a laterally and axially flexible coupling between the rotary drive unit 32 and the drill pipe 34, so that the head of the

drill string may wobble slightly, and vibrations in the drill string are absorbed instead of being transmitted directly into the rotary drive mechanism. Whenever there is a lateral deflection of drill string 34, the resilient washers 33g and 33h permit the joint to bend, but engagement between teeth 33b and 33c is retained for applying torque to the drill string. In this respect, the coupling is similar to a universal joint. If the drill string, for example, is laterally deflected to the left in Figure 5, socket 33d will pivot about the center of central core 102, and resilient washer 33h will be further compressed between flange 33a and split collar 33e on the right side of the coupling and said washer will expand on the opposite side of the coupling. Meanwhile resilient washer 33g on the right side of the coupling will expand, and on the opposite side of the coupling said washer will be further compressed between socket 33d and flange 33a. Resilient washer 33g will absorb any shock in the coupling created by vertical bouncing of the drill string, and also acts as an air-tight seal between central core 102 of the drive shaft 99 and central annular chamber 102a. Chamber 102a is bored axially from the bottom of socket 33d and narrows in diameter near the top of said socket to register with central core 102. Resilient washer 33h will similarly absorb any shock in the coupling in a downward direction caused by downward movement of the drill string relative to the coupling.

Although these resilient washers provide a limited flexibility under compression and lateral forces, a rotary drive coupling is always maintained between teeth 33b and 33c. The fact that there is clearance between the sides of the teeth opposite their sides that are in driving engagement, and the further fact that there is vertical clearance between the tips of teeth 33b and 33c and the respective bottom surface of their corresponding notches allow the teeth limited lateral and vertical shifting movement relative to each other.

Flexible pressure-fluid conduit 100 (Figure 1) extends from a compressor (not shown) to pressure fluid-tight sealing ring 101 on rotary-drive unit 32. The upper end of central core 102 (see Figures 2 and 5), extending axially of shaft 99, registers with conduit 100 (Figure 1) and makes a fluid-tight connection therewith at pressure fluid-tight sealing ring 101. Central core 102 extends from pressure fluid-tight sealing ring 101 through coupling 33 and makes a fluid connection with central core 103 of drill pipe 34.

Referring to Figures 2, 3 and 5, a drill-pipe gripping mechanism consisting of two pawls 151 mounted on either side of the lower end of rotary-drive coupling socket 33d to pivot about horizontal pins 153 is employed to engage the upper end of the uppermost drill-pipe section just below its connection to the rotary-drive coupling 33.

Each pawl 151 is actuated by the downward extension of its corresponding plunger 154 bearing against the upper horizontal surface of said pawl outwardly of the center of its horizontal pin 153 (Figure 5) to rotate said pawl inwardly at its lower end and engage notches 155 in the upper end of the top section of drill pipe 34, each of said notches being formed to receive its corresponding pawl 151 to permit only right-hand or clockwise rotation of the rotary drive coupling relative to said drill pipe (Figure 3).

Each plunger 154 fits into a corresponding chamber 158 formed on diametrically opposite sides of socket 33d. Port 157, which is bored vertically from the upper end of each chamber 158, makes a fluid connection between the upper end of chamber 158 and a transverse passage 156, said passage being bored radially near the upper end of socket 33d and is sealed by plugs 162 (see Figures 4 and 5). Passage 156 opens into central annular chamber 102a in socket 33d. Fitted above plunger 154 in chamber 158 is an air seal 154a to prevent leakage of air past plunger 154. Each plunger 154 is actuated by compressed

air which passes from supply conduit 100 into central core 102 of coupling 33, then through transverse passages 156 and port 157 into chamber 158 in which the plunger 154 is seated. Pawls 151 are normally held in their outward position (dotted outline in Figure 5) by coil springs 159 (Figures 3 and 5). Each respective plunger 154 rests against the upper outer horizontal edge of its matching pawl 151. The vertical line of contact between plunger 154 and pawl 151 is outward of the center of rotation of horizontal pin 153, which is the pivot point of pawl 151. Therefore, whenever plunger 158 is actuated downward by compressed air, each pawl 151 is rotated inwardly to engage the top drill pipe section 34 at a notch 155. During drilling compressed air or other fluid is forced through central core 102, central core 103 of drill pipe 34 and out through the bottom of the drill bit into the drill hole. This is a conventional means of scavenging dirt and rock chips from the drill hole. The fluid pressure used to clear material from the drill hole is also used to actuate and seat pawls 151 of the wrench. Pawls 151 are automatically actuated by plunger 154 to engage the drill pipe as soon as fluid pressure is built up in the core of the drill string. When so engaged the pawls will, due to the notches, permit right-hand or clockwise (Fig. 3) rotation of the rotary drive coupling to screw the coupling threads onto the threads of the upper drill pipe section, but will lock the rotary driving coupling against unscrewing from the drill pipe counterclockwise relative to the drill pipe when the rotary drive rotates the drill pipe in a left-hand or counterclockwise direction of rotation. This permits right-hand threads 27 on the upper end of drill pipe 34 to screw into corresponding threads 21 of coupling 33 and tighten the joint between coupling 33 and drill pipe 34 while pawls 151 are engaged, but prevents threads 21 and 27 from unscrewing, and the joint from loosening during takedown of the drill string.

During drilling and make-up of the drill string, the rotary drive rotates the drill string in the right-hand or clockwise direction (Fig. 3). During take-down of the drill string, the section of drill pipe adjacent the uppermost drill-pipe section is held stationary by a tool wrench (shown in Fig. 22 of my copending application, Serial No. 464,471, filed October 25, 1954), and the rotary drive rotates in the left-hand or counterclockwise direction, unscrewing the joint between the stationary drill-pipe section and the uppermost drill-pipe section.

When air pressure is shut off, springs 159 between coupling 33d and collar 160 of pins 153 bias each pawl 151, so that pawls 151 will normally return to disengaged position (shown in phantom lines in Fig. 2), and thereby bias plungers 154 to return to their retracted position in chamber 158 (see Fig. 5).

A further feature of the invention is that bevel face 25 at the lower end of each drill-pipe section 34 (Figure 2), makes horizontal shoulder 26, at said lower end of drill pipe 34, smaller in diameter than shoulder 22 at the upper end of each drill-pipe section 34. Shoulder 22a on coupling 33 is of the same diameter as shoulder 22 on the upper end of drill-pipe section 34. Accordingly, the contact between shoulders 22 and 26 will have less friction resistance to unscrewing than the contact between shoulders 22 and 22a, and hence the lower thread-joint will normally break before the upper thread-joint at coupling 33. Should the next lower joint become stuck or frozen and thus fail to break first, the drill pipe gripping mechanism is available for standby use to lock the upper joint against unscrewing. By turning on the air supply, which is fed through central core 102 (Fig. 2), pawls 151 can be engaged when needed and prevent the thread-joint at coupling 33 from unscrewing while unscrewing the next lower drill pipe thread-joint.

Now that one embodiment of the invention has been described, it is to be understood that the invention is not to be limited to the specific form or arrangement of parts

as herein described and shown, or specifically covered by the claims.

I claim:

1. In a detachable torque-drive coupling device for coupling a rotary drive power means and the uppermost tubular drill-pipe section of a rotary drill string for transmitting rotation thereto and absorbing lateral and axial vibrations, the combination of: a rotary drive member associated with said rotary drive power means; a driven member having a detachable rotary-drive connection with the upper end of said uppermost drill-pipe section; interlock means providing a loose laterally flexible rotary-drive connection between said driving member and said driven member; a first pair of axially-opposed lateral bearing surfaces located one on and adjacent the lower end and the other on and adjacent the upper end of the driving and driven members respectively; first resilient means interposed between said first pair of bearing surfaces, said first resilient means being subjected to axial compression by said first pair of bearing surfaces when said driving and driven members are in mutual compression; a coupling member detachably connected in axially-fixed relation to one of said driven and driving members; a second pair of axially-opposed lateral bearing surfaces located one on said coupling member and the other on the other of said driven and driving members; second resilient means interposed between said second pair of bearing surfaces, said second resilient means being subjected to compression by said second pair of bearing surfaces when said driving and driven members are in mutual axial tension; a longitudinal hollow core for the passage of pressure fluid extending longitudinally through said driving member, said driven member, and said coupling member, to said uppermost drill-pipe section; said first resilient means forming a seal between the driving and driven members to prevent the escape of pressure fluid from said longitudinal hollow core.

2. A torque-drive coupling device according to claim 1, further characterized by having a drill-pipe gripping mechanism mounted on said driven member, and pressure fluid responsive actuating means having a pressure fluid connection with said longitudinal hollow core and operatively connected to said drill-pipe gripping mechanism to automatically actuate said mechanism by pressure fluid in said hollow core to engage the uppermost drill-pipe section and lock it against rotational displacement in one direction relative to said driven member.

3. A torque-drive coupling device according to claim 2, further characterized by the fact that the drill-pipe mechanism includes a pair of pawls adapted to engage cooperating notches on said uppermost drill-pipe section.

4. A torque-drive coupling device according to claim 3, further characterized by having resilient means operatively connected to said pair of pawls biasing said pawls to normally disengage the uppermost drill-pipe section.

5. In a detachable torque-drive coupling device for coupling a rotary drive power means and the uppermost tubular drill-pipe section of a rotary drill string, for transmitting rotation and vertical movement thereto, the

combination of: a rotary drive member associated with said rotary drive power means; a driven member having a disengageable rotary-drive connection with the upper end of said uppermost drill-pipe section; a rotary-drive connection between said driving member and said driven member; a longitudinal hollow core for the passage of pressure fluid longitudinally through said driving member and said driven member to said uppermost drill-pipe section; a drill-pipe gripping mechanism mounted on one of said members, and pressure-fluid responsive actuating means having a pressure-fluid connection with said hollow core and operatively connected to said drill-pipe gripping mechanism to automatically actuate said mechanism by pressure fluid in said hollow core to engage the uppermost drill-pipe section and lock it against rotational displacement in one direction relative to said driven member.

6. In a detachable torque-drive coupling device for coupling a rotary drive power means and a rotary drill string for transmitting rotational and vertical movement thereto, the combination of: a rotary drive member associated with said rotary drive power means; a driven member; a rotary drive connection between said drive member and said driven member; a drill-pipe section adapted to form the uppermost drill-pipe section of said rotary drill string; said uppermost drill-pipe section having threads at its upper and lower ends, one an inner thread and the other an outer thread, for threaded joint connections to the rotary drive member and the next lower drill-pipe section of the rotary drill string, and having a cooperating friction contact surface adjacent each of said upper and lower threads adapted to have cooperating contact with opposing friction surfaces on said rotary drive member and said next lower drill-pipe section; said rotary driven member having a thread for said threaded joint connection with the uppermost drill-pipe section, and being engageable and disengageable therewith by rotation of said driven member about its axis relative to said uppermost drill-pipe section; and a cooperating friction contact surface at the lower end of the driven member adjacent the threaded joint connection between the driven member and the uppermost drill-pipe section having cooperating friction contact with the cooperating friction contact surface at the upper end of the uppermost drill-pipe section when the last-mentioned threaded joint connection is substantially engaged; the area of such cooperating friction contact being greater than the area of the cooperating friction contact surface at the lower end of the uppermost drill-pipe section.

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