

May 5, 1942.

K. RANSONE ET AL

2,281,952

WELL DRILLING DEVICE

Filed Jan. 25, 1937

5 Sheets-Sheet 1

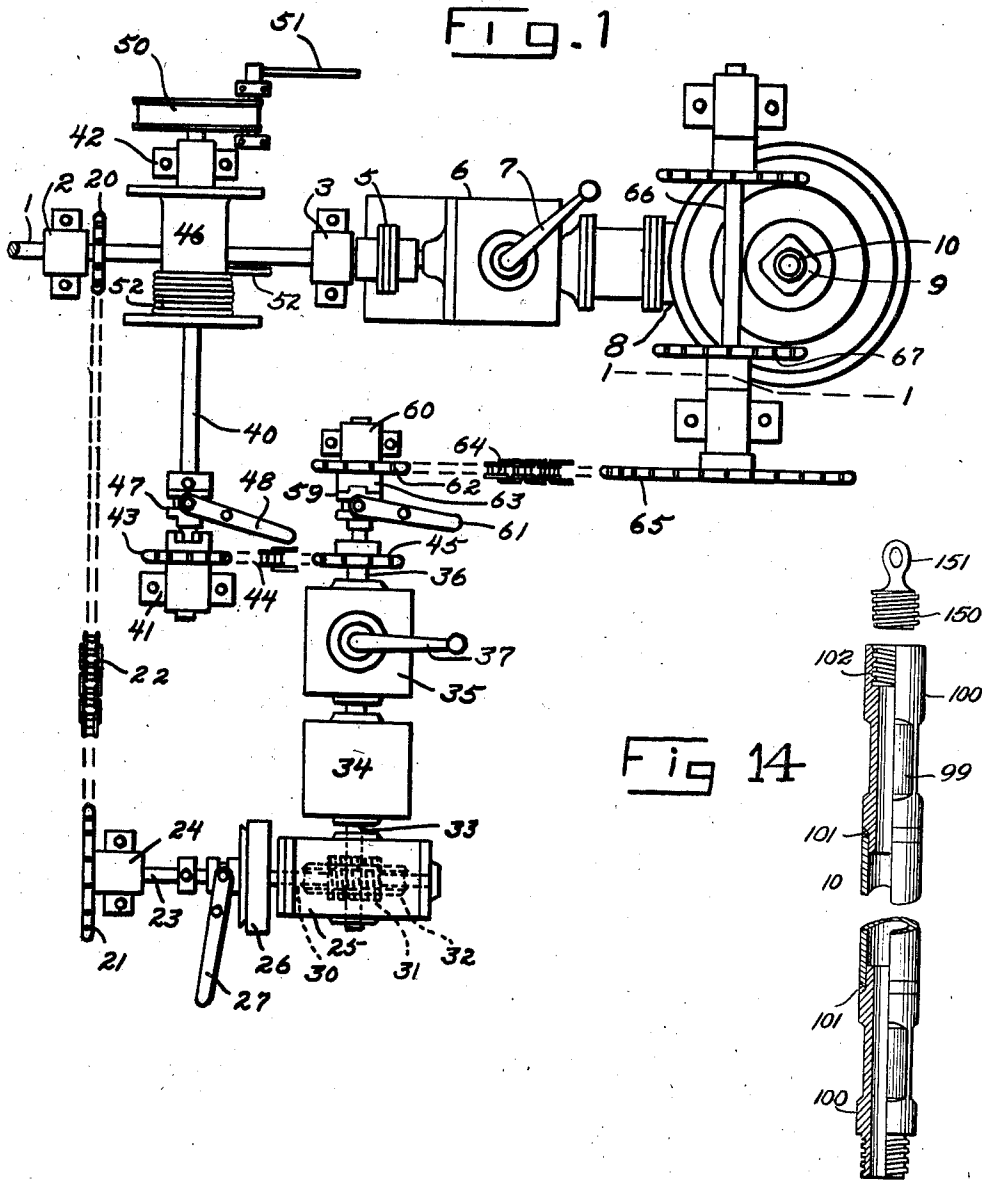


Fig 14

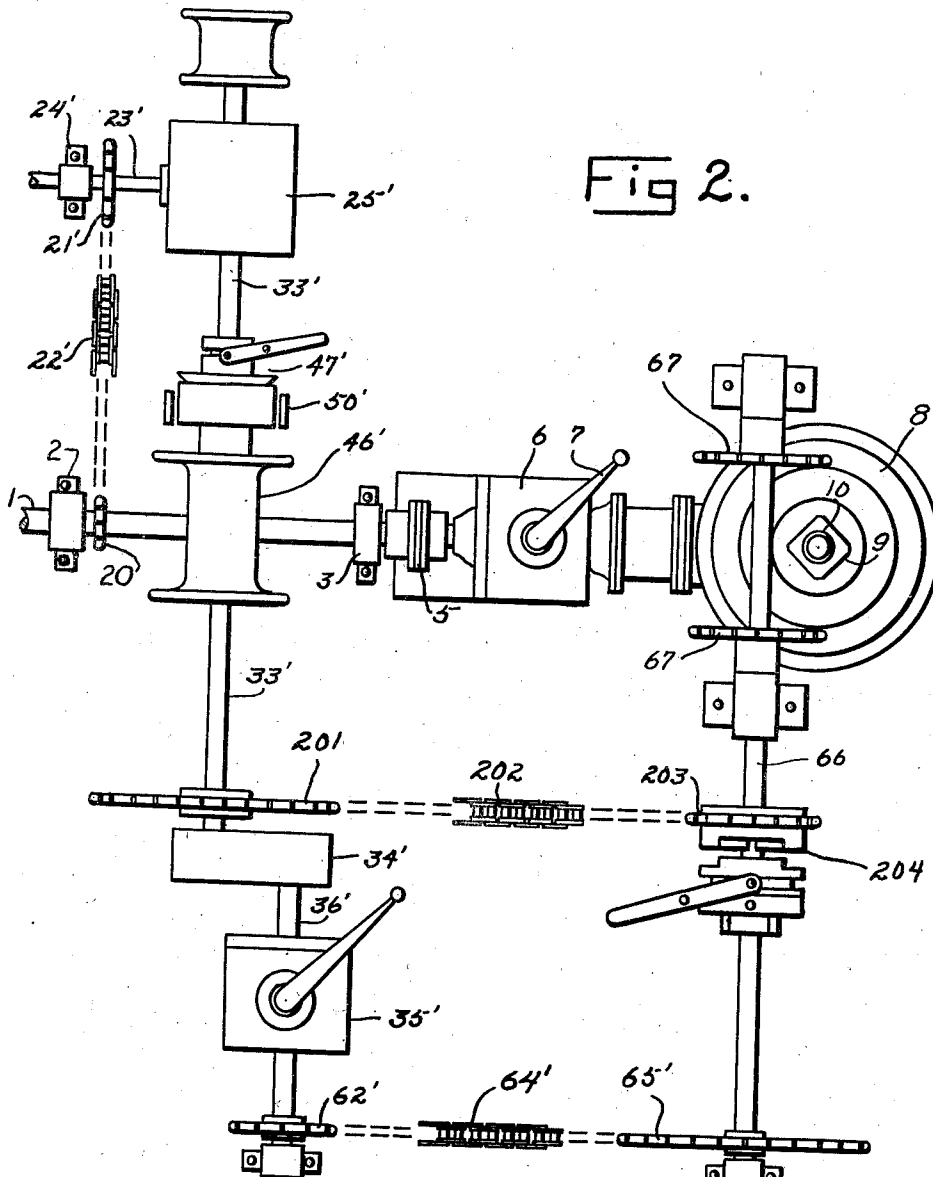
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5 Sheets-Sheet 2



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5 Sheets-Sheet 3

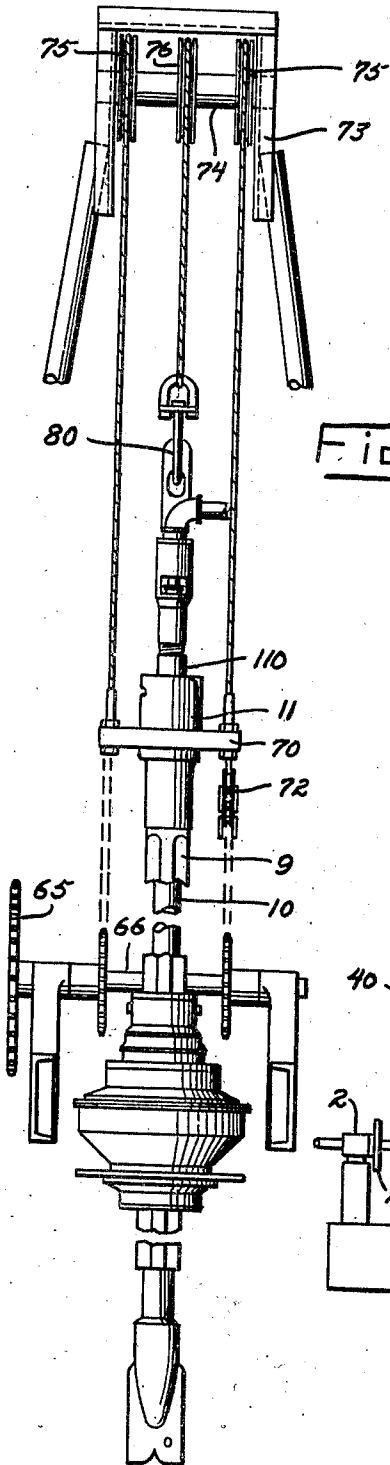


Fig. 4.

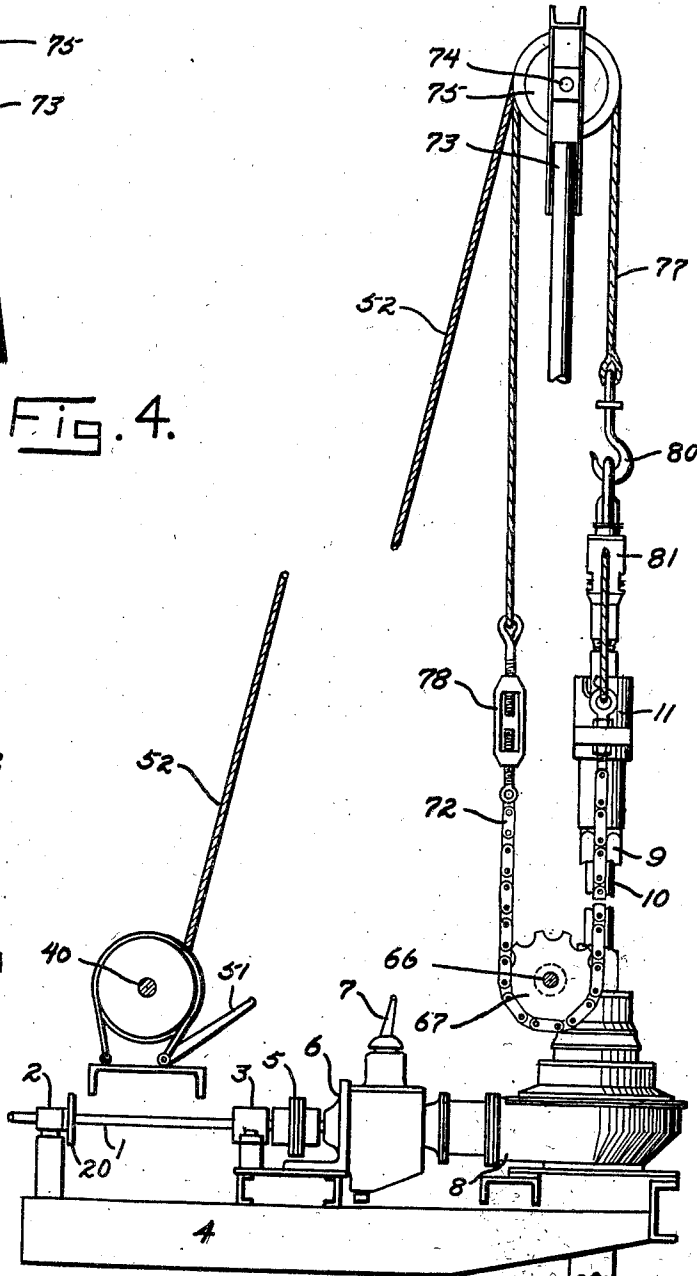


Fig. 3.

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5 Sheets-Sheet 4

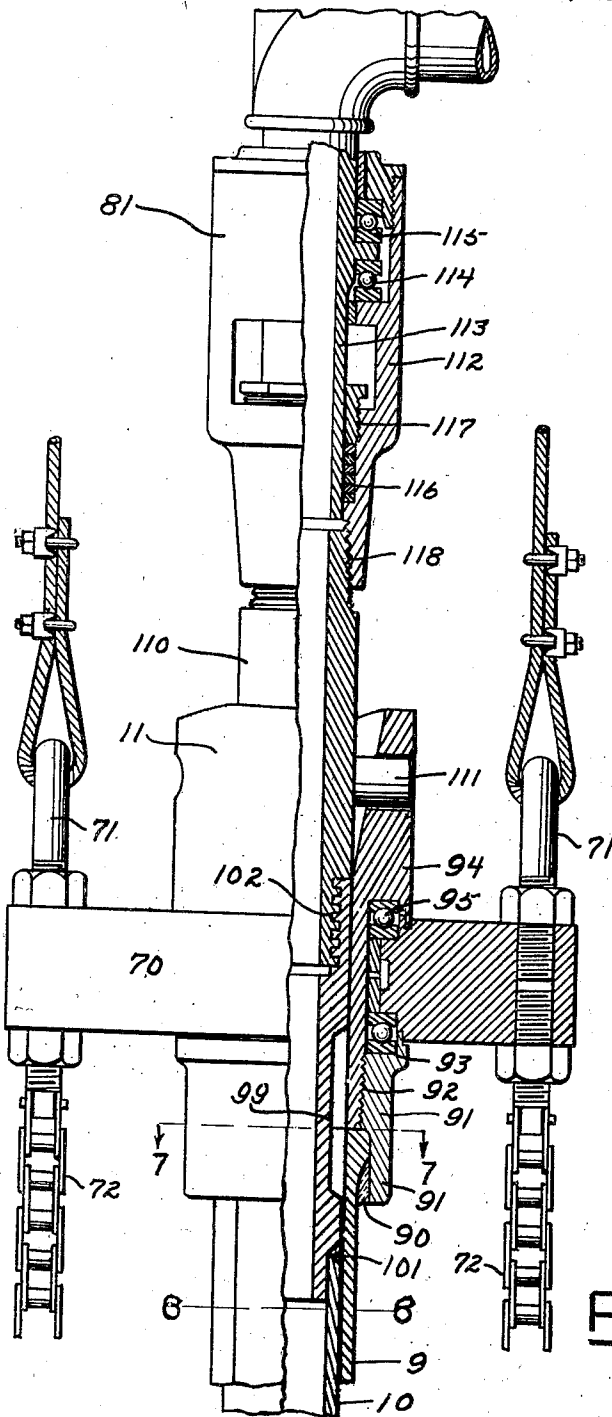


Fig. 5.

Fig. 8.

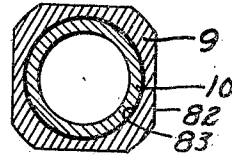


Fig. 7.

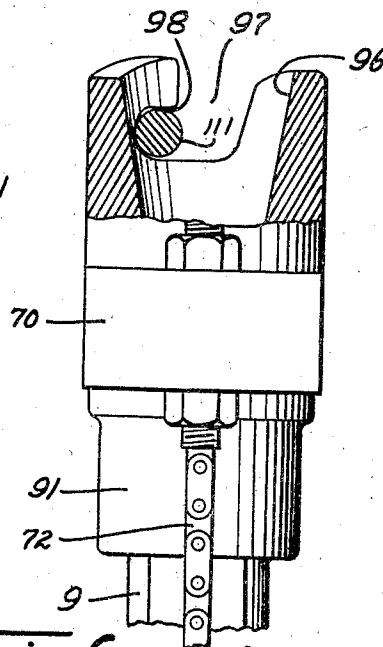
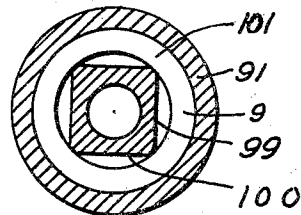


Fig. 6.

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5 Sheets-Sheet 5

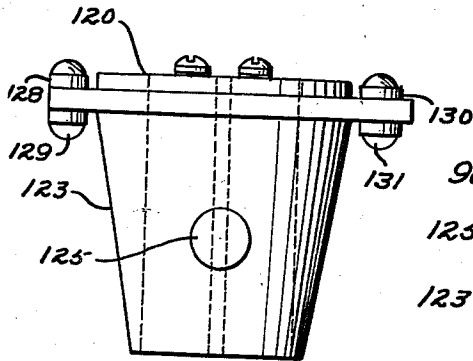


Fig. 9.

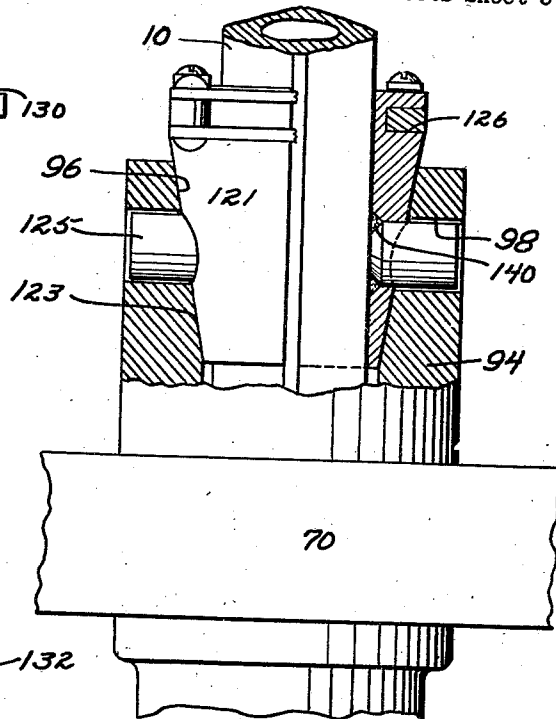


Fig. 11.

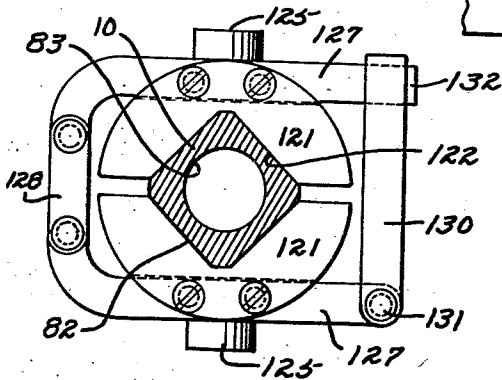


Fig. 10.

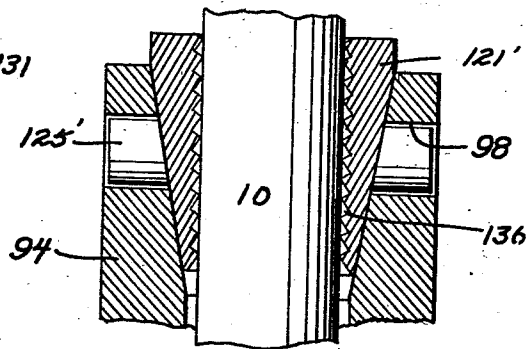


Fig. 12.

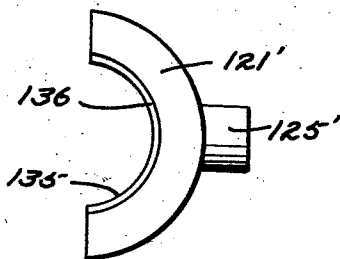


Fig. 13.

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WELL DRILLING DEVICE

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Application January 25, 1937, Serial No. 122,195

3 Claims. (Cl. 255—22)

The invention comprises improvements in the well drilling art and has for its principal objects the provision of a new and useful method of well drilling and the introduction of new and improved drilling equipment which is capable of carrying out the method of drilling.

A more specific object of the invention is the provision of well drilling equipment which facilitates drilling and at the same time makes it unnecessary for an operator to climb the rig tower, hence eliminating this time wasting and dangerous practice.

A further object is the provision of apparatus having downward drilling speeds synchronized with the rotational speed of the drill.

Another object is the construction of drilling apparatus that utilizes power from the driving engine for breaking out and inserting sections of the drill rod.

Still another object of the invention is the provision of means for effecting positive driving engagement between the grip stem and the drill rod.

Other objects, together with the foregoing, will be apparent from the following description taken in connection with the drawings in which:

Fig. 1 is a plan view showing the general arrangement of equipment comprising the invention.

Fig. 2 is a plan view showing an alternative arrangement.

Fig. 3 is a side elevation of a portion of the device of Fig. 1, taken on line I—I of that figure.

Fig. 4 is an end elevation of the portion of the device shown in Fig. 3 and including the drilling means extending below the rotary table.

Fig. 5 is an enlarged view, partly in section, showing the construction and arrangement of the pull down mechanism, hydraulic swivel and kelly and their connection with the drill rod.

Fig. 6 is a detail elevational view illustrating the driving connection between the kelly and the drill stem.

Fig. 7 is a sectional view on line 7—7 of Fig. 5 taken in the direction of the arrows.

Fig. 8 is a sectional view taken on line 8—8 of Fig. 3.

Fig. 9 is an elevation of a slip used, as a part of the invention, for holding the drill stem in the driving connector of Fig. 6.

Fig. 10 is a plan view of the slip of Fig. 9.

Fig. 11 is an elevation, partly in section, showing the construction of the slip of Fig. 9 and its cooperative relation with the driving connector when in use.

Fig. 12 shows a modification of the slip for use when a stem portion of circular cross section is to be held thereby.

Fig. 13 is a plan view of one of the slip jaws of Fig. 12.

Fig. 14 shows the drill rod and lifting plug.

The numeral 1 represents a drive shaft which is driven by a suitable source of power (not shown). This shaft is mounted in bearings 2, 3 which are mounted upon a suitable bed plate 4, Fig. 3, and transmits power through coupling 5 to a selective gear transmission 6. Gearshift lever 7 is provided for shifting the gears within transmission 6 to suitable selected ratios forward or reverse or to obtain a neutral setting thereof. The power transmitted through the transmission 6 drives the rotary which is enclosed in an oil containing housing 8 and thereby drives the kelly 9 which in turn rotates the drill stem 10 through a construction 11 which will later be described.

A sprocket 20 is mounted upon shaft 1 and is driven thereby. A second sprocket 21 in aligned spaced relation with sprocket 20 is driven from the latter through chain 22. Sprocket 21 is mounted upon shaft 23 which is parallel with shaft 1. This shaft is mounted upon bed plate 4 by means of bearing 24 and gear housing 25. A friction clutch 26, which is provided with actuating lever 27, is provided on shaft 23 to enable the operator to drive certain of the apparatus from the shaft at will.

Housing 25 encloses a worm gear through which power is transmitted from clutch 26, through shaft 30, to worm 31. It is preferred that such worm-to-gear ratio be used that when clutch 26 is disengaged the load applied back through gear 32 will not cause rotation of worm 31. Worm wheel 32, driven by worm 31, is mounted upon shaft 33 whereby power is transmitted through step-down gears in housing 34 to selective speed transmission 35 through which shaft 35 is driven at a suitable pre-selected speed by proper manipulation of clutch lever 27 and gear shift lever 37. It is to be understood that each of the transmission elements is suitably mounted upon bed plate 4. It should also be noted that suitable drive-to-driven ratios of the various power transmission devices will be selected and that chosen ratios may be such that reduction gears 34 may be entirely omitted without altering the invention.

A countershaft 40 is mounted in bearings 41, 42 above, and extending transversely of, shaft 1. Rotatably mounted upon shaft 40 is a driven sprocket 43 which is connected through chain 44 to sprocket 45 fixed upon shaft 36. A hoisting

drum 46 is fixedly mounted upon shaft 40. When it is desired to drive drum 46 a dental clutch 47, which is splined to shaft 40, is engaged thus providing a connection between the shaft and the driven sprocket 43. When hoisting is to be done clutch 47 is engaged and transmission 35 is shifted to a gear ratio that will give the desired hoisting speed. Power for hoisting is then applied by operation of clutch 26.

A brake 50 on shaft 40 enables, through brake control lever 51, control of the unreeling of cable 52 on the drum and also permits locking of the drum when weight is suspended on the cable and the unit is disconnected from the power source by disengagement of dental clutch 47.

A clutch element 59 is splined upon shaft 36 and is movable thereon by actuation of clutch lever 61 to engage clutch collar 63 which is integral with sprocket 62 and is rotatably mounted on shaft 36 adjacent support bearing 60. Mounted on sprocket 62 is drive chain 64 which drives sprocket 65 of the feed mechanism.

The upper end of the grief stem or kelly 9 is rotatably mounted in a cross arm 70 in a manner that will be later described. At the opposite ends of crossarm 70 are provided eye-bolts 71, Fig. 5, which extend below the crossarm 70 and have attached thereto the chains 72.

The invention comprehends either a portable rig or the usual fixed derrick as is well known. For purposes of illustration the derrick means shown in the drawings comprises a supporting frame generally designated as 73 in which sheaves 75 and 76 are mounted upon a supporting shaft 74. Cables 77 are attached to the eye-bolts 71 and pass thence upwardly over sheaves 75. The opposite ends of these cables are attached to turnbuckles 78 which are in turn attached to the ends of chains 72 which pass downwardly around sprocket 67 mounted upon and driven by sprocket 65. It is thus clear that cable 77 and chain 72 form a closed loop which is attached to crossarm 70 and which may be maintained free from lost motion by adjustment of turnbuckle 78. It is obvious that chain 72 must be of sufficient length to permit a maximum upward movement of crossarm 70. It is also obvious that this construction permits either upward or downward movement of crossarm 70 under power and at a preselected speed by suitable selection of gear ratios as heretofore described. While the mechanism just described is termed a feed means, such means may exert a negative or lifting pull while actually feeding downward if desired. This construction fulfills a long-felt want, for it is well known that in drilling the shallow stages of a bore hole the weight of the drill rod is insufficient to obtain effective drilling. At a considerable depth, however, the weight of the drill stem may produce excessive bit pressures causing clogging of the liquid stream and, for this and other reasons, retards drilling speed. The feed mechanism just described obviates these difficulties and provides synchronized downward and rotational speed, thereby providing a control that fulfills the purpose of a power feed for holes in the shallow stage, preventing excessive bit pressures in deep holes and providing proper control of downward speed at all stages.

Hoisting cable 52 from drum 46 passes over sheave 76 and is provided with a hook 80 on the depending end thereof. While this hoisting arrangement may be used for any hoisting purposes incident to drilling operations it is normally con-

nected to the hydraulic swivel 81 while actual drilling is in progress.

An important aspect of the present invention resides in the construction of the kelly and drill rod and the means for connecting these constructional elements for normal operation and for removal or insertion of drill stem sections. In constructions heretofore used the drill stem has been attached to the kelly in various manners, such as by the use of set screws, clutch jaws, slips, and by screwing the drill rod to the bottom of the kelly. These various methods have inherent disadvantages such, for example, as marring the drill rod, slippage and time consumption. The construction herein shown is designed to remedy these evils.

The grief stem or kelly 9 of the present construction is a tube having a polygonal peripheral section 92 to cooperate with the rotary table as is well known in the art. The central bore 93 is of sufficient diameter to receive the drill stem for a reason that will be made apparent. The kelly terminates at its upper end in a ring 91 to which it is attached in a suitable manner as by weld metal 90. A raceway in the upper face of ring 91 receives anti-friction bearing 93. The ring is also provided with left-handed threads 92 to receive complementary threads on a bowl member 94 provided with a downwardly facing raceway to receive anti-friction bearing 95. Complementary annular raceways in crossarm 70 receive bearings 93 and 95 and in this manner the kelly 9 is rotatably supported in the crossarm.

Bowl member 94 is of special construction as is best illustrated in Fig. 6. The inner walls thereof taper outwardly at 96 from the inner diameter of the kelly to facilitate the effecting of a driving connection between the kelly and the drill stem and to receive a specially constructed slip as will be later described. J-slots 97, having undercut portions 98, are provided in bowl member 94. These J-slots, in connection with cooperating lugs 111 on sub 110, provide the positive driving means between the kelly and drill stem. The sub and its functions will be described in greater detail in connection with the drill rod, and the procedure of drilling.

An important feature of the invention is the provision of a drill rod 10 with an end portion having a square or polygonal cross section with gripping faces 99 as is best shown in Figs. 5, 7 and 14. This portion of the drill rod may be integral with the remainder of the drill rod section or it may be composite as shown in Figs. 5 and 14, and comprise a tubular section 10 to which is attached an end fitting 100 as by weld metal 101. The purpose of the described construction is twofold, namely, the polygonal section of a drill rod conveniently receives a wrench when making up or breaking out sections of the drill stem and the section cooperatively functions with the equipment hereafter described in connection with Figs. 9 to 11.

The upper end of the drill stem is provided with conventional drill pipe threads 102 which receive complementary threads in sub 110. Bayonet projections 111, secured to sub 110, as by welding, are adapted to enter the J-slots of the Kelly bowl 94 whereby a driving connection between the kelly and the drill stem is effected. It is thus apparent that a positive driving connection between the kelly and the drill stem may be readily effected and that, at the same time, these members may readily be disconnected in

event it is desired to add or remove a drill stem section.

The upper end of sub 110 is provided with left-handed threads 118 by means of which the body 112 of swivel 81 is connected thereto. The stationary member 113 of the swivel is rotatably mounted within swivel body 112 through anti-friction bearings 114, 115 and the swivel is sealed against leakage through packing gland 117 and packing 116.

Figs. 9 to 11 illustrate a slip constituting an essential part of the invention. This slip which is generally referred to as 120 comprises a plurality of slip jaws 121 having inner faces 122 which are adapted to fit about the polygonal portion of the end section 100 of the drill rod. The outer surface of the slip jaws is tapered at 123 to provide a surface that is complementary with the inner surface of bowl member 94. Through this conical interfitting engagement the slips are caused to effectively engage and hold the drill stem within the kelly 9. Slip jaws 121 are recessed at 126 to receive bars 127 which are hingeably interconnected through links 128 and rivets 129. In order to hold the slip in operative position upon the drill stem a U-shaped retaining link 130 is swingably mounted adjacent the end of one of bars 127 upon a rivet 131 and the opposite end is adapted to engage the end 132 of the other of bars 127.

A plurality of outwardly extending pins 125 are secured in the slip jaws 121 in a suitable manner such as by weld metal 140. These pins are so positioned as to enter slots 97 in the Kelly bowl and hence function to effect a positive engagement of the slip with the kelly.

A modification of the slip of Figs. 9 to 11 is illustrated in Figs. 12 and 13 and the respective elements are similarly identified by primed reference characters. As this modification is designed for use in gripping a circular section of the drill stem obviously the inner surface of the slip jaws must be of suitable contour to engage the drill stem. This feature is best shown in Fig. 11 in which the jaw 121' is shown as having a curved inner face 135 which is provided with teeth 136 for gripping the drill stem as is well known in the art. The jaws are also provided with pins 125' to engage within J-slots 97.

The embodiment of the invention, shown in plan view in Fig. 2, is intended for use with a readily obtainable automobile transmission. In this embodiment parts which correspond to similar parts in Fig. 1 bear the same reference characters and parts which serve the same purpose as those in Fig. 1 bear similar primed characters.

An ordinary automobile transmission 35' is used instead of the specially built transmission 35 of Fig. 1. The high speed reverse motion is obtained by the use of sprockets 201, 203, chain 202, and dog clutch 204. Gear box 34' is a speed reducer and serves also to reverse the relative direction between shafts 33' and 36' so that through sprocket 203 the direction of rotation of feed shaft 66 is the reverse of that when driven through sprocket 65'. Winch 45' serves the same purpose as winch 46 in Fig. 1, but is constructed to rotate freely on shaft 33', except when clutch 47' is engaged to cause it to rotate with said shaft. With clutch 47' disengaged, the drum may be held against rotation by brake 50' which serves the same purpose as brake 50 in Fig. 1.

A preferred method of operation will be described, reference being had primarily to Fig. 1.

Suppose the drilling operation has proceeded to the point where it is necessary to add a section of drill rod. Rotation is stopped by disconnecting the main drive shaft 1, through a clutch (not shown). Gear 6 is shifted to neutral, dog clutch 59 and brake 50 are released, and clutch 47 is engaged. Gears 35 are shifted to reverse and the power source connected to rotate winch drum 46 enough to lift the drill rod a few inches out of the J-slots in the kelly; the kelly does not move. The slips 121 (Fig. 10) are inserted and the drill rod is lowered by winch 46 so that the slips hold the square-flanged tool joint in the kelly, the sub 110 being entirely exposed. The flange on the tool joint prevents dropping the drill rod. Next, clutch 47 is disengaged, gear 6 is engaged, a wrench is applied to the sub, power is applied to rotate the drill rod, through the medium of gear 7, the slips, and the square portion of the rod. The wrench for the sub should be long enough so that it will stop against some part of the derrick frame. When the drill rod is rotated, the tool joint is unscrewed. This constitutes the power break-out, obviating use of man power and increasing safety and speed. When the sub is free from the drill rod, the rotation is stopped, gear 7 is put in neutral, clutch 47 is engaged, brake 50 is released and power applied, winch 46 being rotated to raise the sub a foot or two, after which the power drive is again disconnected. A new section of drill rod is screwed to sub 110. If desired, the winch 46 may be released through clutch 47 so that the sub can be lowered and screwed onto a length of rod lying on the ground.

Power is then applied, winch 46 lifting the sub and new section of rod to the necessary height so that the lower end of the new section may be screwed a turn or two into the top of the rod projecting above the kelly. The whole string of drill rod is then raised through the medium of winch 46 until the slips can be removed, power is cut off, brake 50 applied, and clutch 47 disengaged. The brake 50 holds the drill stem suspended. Gear 35 is put in reverse, gear 7 and clutch 59 engaged and power applied which rotates and raises kelly. When kelly has raised sufficiently for the J-slots to engage with the sub, clutch 26 is disengaged, gear 37 is shifted to the appropriate forward speed for drilling, brake 50 is partially released so that the cable will reel off drum 46 under sufficient tension to keep the slack out of the cable. All the while the kelly is rotating, and after engagement with the sub through the J-slots 97 and lugs 111, the drill rod is also rotating. Clutch 59 and clutch 26 are then engaged to start the downward feed with the new section of drill rod in place.

As soon as the bit meets resistance to rotation, the partially made up joints are tightened under power after which the drill again starts cutting. Drilling proceeds automatically until the limit of travel of the kelly is reached, at which time the downward feed is stopped by disengaging clutch 26, either manually or automatically.

The safety device, to prevent damage to feed and lifting mechanisms, is provided in the form of motion limiting links. When the kelly has nearly reached the bottom or top of its travel, or the hook on end of cable 52 is near the top of its travel limit, links operating through rods or cables automatically strip to disengage clutch 26.

The operation involving withdrawal of the drill

rod after completing the hole will now be described. This operation would normally start with the kelly at its lowest position.

After washing the hole the requisite amount, rotation is stopped and the procedure for adding a new joint of rod followed up to the point where the sub 110 is freed from the drill rod. The sub is then unhocked from the lifting cable and a lifting plug 150 (Fig. 12) is screwed a few turns into the top of the drill rod and the cable hook 50 is engaged with the eye 151 in the plug 150.

Gear 7 is then put in neutral, clutch 47 is engaged, brake 50 is released, and power applied to left drill rod the amount necessary to take out the top section or sections. Lifting is stopped when the top of the second joint is clear of the kelly, the power drive is disengaged, brake 50 is applied, clutch 47 is disengaged, and the brake 50 is released to lower the rod as the slips are inserted to hold the second joint. At this point, the value of the square-flanged joint becomes important, the flange preventing the rod from falling back into the hole. Brake 50 is applied to support the top section of rod. A wrench is applied to the bottom of the top section of drill rod, on the square-flanged joint to prevent rotation of the top section. Gear 7 is engaged, clutches 47 and 59 are disengaged, power is applied, and the kelly and lower section of drill rod are rotated to break out the joint. When this joint is free, power is cut off, gear 7 is put in neutral, brake 50 is released slowly and the top joint lowered to the ground. The hook 80 is disengaged from plug 150, which is then unscrewed from the drill rod, and is screwed into the top of the second joint extending above the kelly. From this point on is simply a repetition of removing the remaining drill rod sections. The last section, with the bit attached at its lower end, may be left inside the kelly.

From a reading of the method of operation, it is evident that it is unnecessary for a member of the drill crew to climb the tower. This makes for greater safety and speed of operation.

What is claimed is:

1. In a rotary drill rig in combination, a rotary table, means for driving said table, drilling means operatively connected to said table, feed means for said drilling means, said feed means being operatively connected to said driving means, whereby the rotary table and the feed means are synchronously driven, said drilling means comprising a tubular kelly rotatably connected to said feed means, a drill stem passing through said kelly, and means for effecting a driving connection between said kelly and the drill stem.

2. A well drilling device comprising a rotary table, a tubular kelly rotatably supported to extend downwardly within said table, said kelly having an inner bore adapted to receive a drill stem and having a slip receiving cavity at the upper end thereof, a drill stem section within said kelly and having a square tool joint adjacent the end thereof, and a slip in gripping engagement with said tool joint and the walls of said cavity.

3. A well drilling device comprising a rotary table, a tubular kelly rotatably suspended to extend downwardly within said table, the bore of said kelly being adapted to receive a drill stem and terminating at the upper end in a slip receiving cavity, J-slots in the walls of said cavity, a slip within the cavity for engaging a drill stem within the kelly bore, and means on said slip for engaging said J-slots whereby a positive driving connection is effected between the slip and kelly.

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