Aug. 14, 1951 K. E. BURG ET AL 2,564,188

PORTABLE DRILLING EQUIPMENT

Filed Nov. 20, 1946

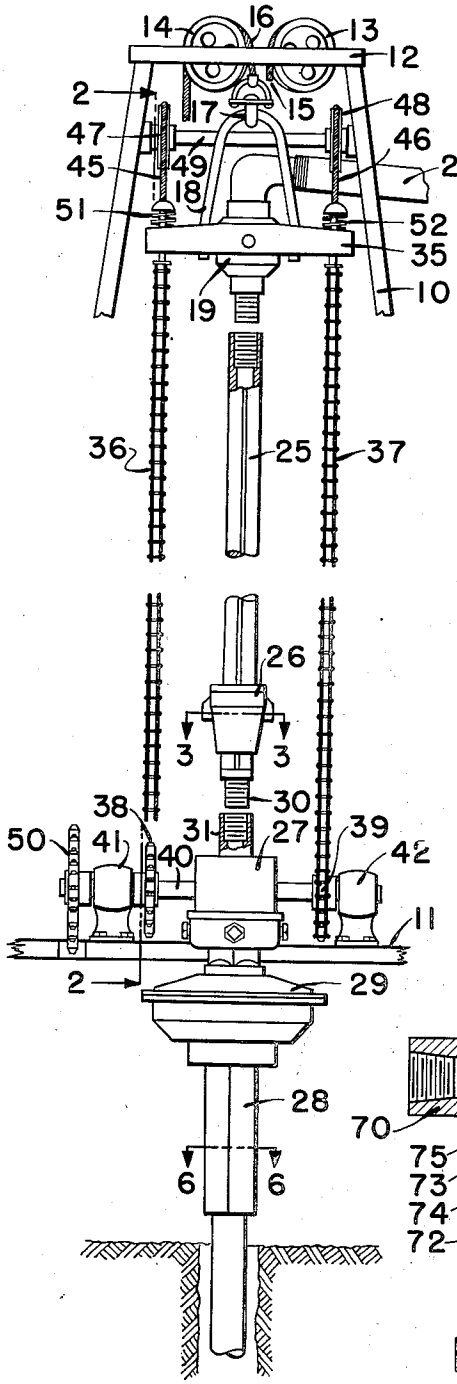


Fig. 1

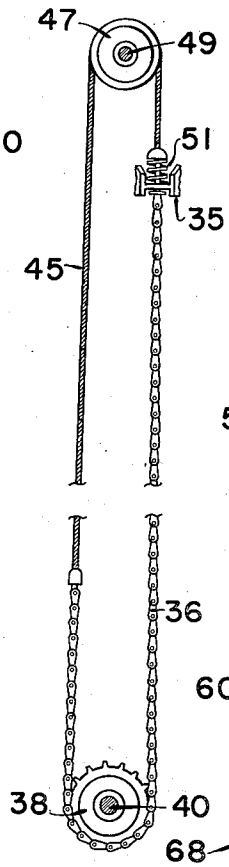


Fig. 2

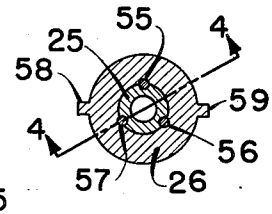


Fig. 3

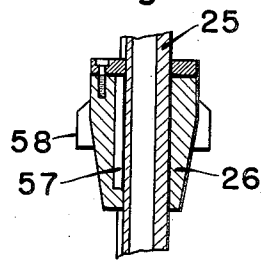


Fig. 4

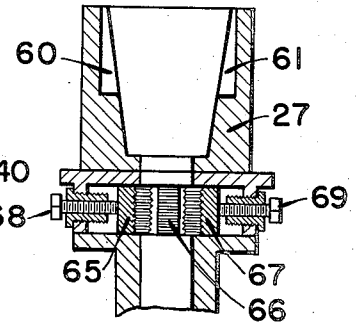


Fig. 5

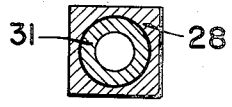


Fig. 6

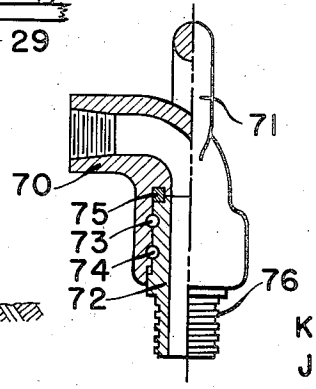


Fig. 7

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PORTABLE DRILLING EQUIPMENT

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This invention relates to rotary well-drilling equipment and is directed particularly to portable drills of the type commonly mounted on motor trucks and used for drilling relatively shallow core holes for geological information or shot holes for geophysical surveying by the seismic method. Specifically, the invention comprises a novel arrangement of the drill pipe feeding and rotating mechanism capable of greater speed, flexibility, and ease of operation than existing feed and rotary devices.

As a rule the formations encountered in shallow drilling are softer and much more rapidly penetrated than are the deeper formations where oil and gas are found. For this reason, during the operation of portable drilling units a relatively smaller proportion of the total working time is devoted to the actual drilling and more of it is consumed in such auxiliary operations as handling the drill pipe, taking down, moving, and setting up the rig than is the case in deeper drilling with heavy equipment. Accordingly, the saving of even relatively small amounts of time by increasing the speed of auxiliary operations, which time is then available for actual drilling, brings about substantial increases in footage drilled and correspondingly lowers the cost per foot for the drilling operation.

On this basis can be justified the expenditure of considerable time and effort on improving the design of the equipment. Changes do not have to be radical in order to increase the over-all efficiency of a drilling unit to such an extent as to render it undesirable to continue unimproved models in operation. Where it can be done without too extensively rebuilding a unit, it is often worth while to modify it in order to take advantage of the improvements.

For a proper understanding of the nature of our invention it should first be noted that the portable drills heretofore in widest use employ one or the other of two general types of rotating and feed mechanisms. One of these types employs a kelly of polygonal cross section, generally square or hexagonal, which is turned by the rotary table. Downward force to bring about proper bit pressure in shallow formations is applied by pull-down chains or cables to a yoke or cross member fixed at the upper end of the kelly. The other type of feed and rotary mechanism employs a splined kelly of generally circular cross section having extending along most of its length longitudinal grooves which are engaged by a special drive bushing turned by the rotary table. Downward thrust is ordinarily supplied by pistons in hydraulic cylinders cooperating with chucks which grip the splined kelly for application of force to it.

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The drill pipe in general use on these portable drills is of two kinds, differentiated chiefly by their couplings. Tool joint pipe has box-and-pin coupling sections of larger diameter than the pipe itself so that there are external shoulders by which the drill stem can be held using rotary-table slips. Flush-joint pipe, on the other hand, is of uniform external diameter throughout and requires chucks or similar positive gripping means to hold it during manipulations for adding or removing pipe lengths.

Either kind of pipe can be used with either kind of driving kelly, but because chucks for holding it are already available as part of the hydraulic pull-down mechanism, flush-joint pipe is most often used with a splined kelly. For other reasons tool-joint pipe is generally used with the square kelly. Each combination has in its favor certain advantages over the other, but it is also true that the advantages offered by each system are offset by certain disadvantages.

Thus, the square kelly with a chain or cable pull-down is considerably faster in operation than the splined kelly using a hydraulic pull-down. A full length of drill pipe can be forced down by the chain pull-down without interruption, whereas the short stroke of the hydraulic system requires an interruption every two or three feet to release the chucks and take a new grip on the splined kelly.

On the other hand, the splined-Kelly arrangement permits the drilling of a smaller and cleaner hole. With the square kelly it is necessary to drill a shallow surface hole of fairly large diameter in order to provide adequate clearance for the drilling fluid and cuttings to pass around the kelly and to avoid undue wear of the kelly by abrasion against the wall of the hole. This enlargement of the hole permits the accumulation of cuttings due to the reduction of drilling-fluid velocity, which accumulation can occasionally cause trouble in any of several ways. The cuttings may fall back down the hole while a length of pipe is being added or at the end of drilling; or by partially plugging the hole they may stick the pipe or force the drilling fluid out into shallow porous formations, promoting loss of circulation and collapse of the hole. As the hole drilled using the splined kelly is of uniform diameter from top to bottom, cuttings are carried completely out of the hole by circulation of the drilling fluid at moderate rates, and correspondingly

less trouble is encountered due to their lodging in the hole.

Although tool-joint pipe can be manipulated more speedily and with less effort than flush joint and is also less likely to be dropped into the hole accidentally, it is necessary to drill a somewhat larger diameter hole to provide clearance for the enlarged joints. The external shoulders inevitably interfere more or less with the free circulation of cuttings and drilling fluid, and in the event of caving of the hole or sticking of the pipe by other causes the tool joints are a real hindrance to recovery of the pipe string.

As a matter of fact, neither the square kelly and tool-joint pipe combination nor the splined kelly and flush-joint pipe system is fully satisfactory in the matter of freeing the pipe when it becomes stuck. With neither type of kelly is there any way of rotating the pipe after the kelly has been pulled upward out of the rotary table. In most other respects, however, flush-joint pipe is much easier to work free after it has become stuck than is tool-joint pipe. Tension alone without rotation will sometimes recover flush-joint pipe, whereas sometimes the joints of tool-joint pipe become stuck so that rotation and tension together are ineffective.

It is accordingly a primary object of our invention to provide, for feeding and rotating the drill stem of portable rotary drills, a novel and improved apparatus which avoids most of the foregoing disadvantages. A further object is to provide for portable drills a feeding and rotating mechanism which is an advantageous combination of the chain or cable pull-down means with the small-diameter splined kelly and flush-joint drill pipe. Another object is to provide, in a portable drilling apparatus, means by which the drill pipe can be held or rotated at any time regardless of whether the kelly can be engaged by the rotary table or not. A still further object is to provide, for a portable rotary drill, means by which flush-joint pipe can be held and the pipe joints broken or made up in a convenient, safe, and rapid manner. Still another object is to provide, in apparatus of the type referred to, means for holding and rotating the pipe which are immediately adaptable to the operations required for freeing the pipe when it becomes caught or stuck in the hole. Other objects, uses, and advantages of our invention will become apparent as the description proceeds.

For a better understanding of the nature of our invention an embodiment thereof is illustrated in the accompanying drawing, in which drawing the same reference numeral is used in the different figures to refer to the same or a corresponding part. In this drawing:

Figure 1 is a view in elevation of parts of the rotating and feed mechanism of a rotary drill embodying the invention;

Figure 2 is a cross section of Figure 1 on the lines 2—2 showing the pull-down mechanism;

Figure 3 is a cross section of Figure 1 on the lines 3—3 showing the kelly drive bushing;

Figure 4 is a cross section of the splined kelly drive bushing of Figure 3 on the lines 4—4 of that figure;

Figure 5 is a cross section of the kelly bushing driver and pipe-holding chucks;

Figure 6 is a cross section of Figure 1 on the lines 6—6; and

Figure 7 is a view partly in elevation and partly in section of an extra swivel assembly for use with our invention.

Referring now to Figure 1, the conventional elements of a portable drilling unit to which this invention is applicable ordinarily include a mast or derrick 10 which is mounted on a bed or platform 11 carried by a suitable vehicle (not shown) such as a motor truck. On top of mast 10 is a crown block 12 which may be equipped with two sheaves 13 and 14 over which pass respectively wire lines 15 and 16, one for supporting and raising or lowering the drilling string, and the other for handling extra lengths of drill pipe and other operations. Lines 15 and 16 may be wound on power-driven reels or drums (not shown) in a conventional manner. Line 16 supports the drilling string through the hook 17 and bail 18 of the drilling-fluid swivel 19 through which drilling fluid under pressure is supplied from the flexible hose 20 to the drill string during rotation.

The rotating and feed mechanism, in accordance with our invention, includes the splined kelly 25, which is coupled to the swivel 19 and driven by a bushing 26 adapted to fit a bushing driver 27, which is carried by a short polygonal kelly 28 engaged by the rotary table 29 in the usual way. Bushing driver 27 is fixed to and rotates with the short kelly 28 as a unit, being attached to or forming an integral part of the chuck housing which itself forms a part of or is fixed to the upper end of short kelly 28. Kelly 28 in this case is much shorter than the usual polygonal kelly, preferably being only long enough to reach from the rotary table about to the surface of the ground beneath the bed 11. As kelly 28 does not extend into the hole being drilled, it is unnecessary to enlarge the top portion of the hole. Splined kelly 25 is adapted for connection by conventional threads 30 to flush-joint drill pipe 31 having a uniform external diameter. As can be seen in Figure 6, the opening in square kelly 28 is just large enough to pass drill pipe 31 or splined kelly 25 freely.

In place of hydraulic cylinders and chucks for gripping splined kelly 25 and applying downward force thereto, the pull-down mechanism comprises the yoke 35 pivoted at its center to swivel 19 at the top end of splined kelly 25. Force is applied to the two ends of yoke 35 by the belt chains 36 and 37 which are engaged by the sprockets 38 and 39 mounted on a shaft 40 fixed between the bearings 41 and 42 bolted to bed 11. Connected between the ends of the respective pull-down chains 36 and 37 are cables 45 and 46, which pass over sheaves 47 and 48 on shaft 49 mounted near the top of mast 10. As is shown more clearly in Figure 2, this arrangement forms a closed loop, the chain 36 and cable 45, for example, forming a loop around the sheave 47 and the sprocket 38. Upon then applying power to sprockets 38 and 39 from a suitable source (not shown), as by connection through a driving sprocket 50, downward force is thus transmitted to the ends of the yoke 35. If desired, compression springs 51 and 52 may be interposed between the ends of yoke 35 and the driving chains to absorb vibrations and shocks during drilling.

As is best shown in Figures 3 and 4, splined kelly 25 is round in cross section except for the longitudinal semi-circular grooves engaged by the short cylindrical rods 55, 56, 57 which fit into complementary grooves in the drive bushing 26. The latter is preferably tapered downwardly so as to seat snugly in the bushing driver 27 (Figure 5) and is provided with projections 58

and 59 which fit in recesses 60 and 61 of driver 27 so as to be driven by it.

As shown by Figure 5, the top of short kelly 28, besides carrying bushing driver 27, is also provided with a plurality of chuck jaws 65, 66, 67 by which the drill pipe 31 can be held, upon tightening the screws 68 and 69 and forcing the respective chuck jaws against the pipe.

In Figure 7 is shown an extra swivel assembly for use with this invention under certain circumstances. This consists of an L 70 to which is welded a lifting bail or loop 71, and which is connected to a nipple 72 by a double row of ball bearings 73, 74. The fluid pressure is retained by a ring seal or packing 75, and threads 76 on nipple 72 are adapted for connection to the drill-pipe sections.

In operation, during the progress of normal downward drilling, torque is transmitted from rotary table 29 through the square kelly 28 and driver 27 to the bushing 26 and thence to the splined kelly 25, which is connected to the drill rods. Chucks 65, 66, and 67 are unclamped, and such downward force as is required is applied to the yoke 35 through the chain-drive mechanism. This force is available at any time without any interruption of the drilling process. The addition of new drill-rod sections is performed by the following sequence of steps: lifting up the string to the position of Figure 1; clamping the pipe 31 by the chucks 65, 66, 67; breaking the connection to the kelly threads 30 and removing splined kelly 25; screwing on a new length of drill rod to the upper end of pipe 31; unclamping chucks 65, 66, 67; lowering and reclamping to the top end of the new drill pipe; reconnecting kelly threads 30 to the new pipe section; unclamping the chucks; and continuing to drill.

In this sequence of manipulations, the chucks are used primarily as a means of holding the drill stem 31 from falling into the well when the splined kelly 25 is disengaged. In addition, the kelly 28 and chucks 65, 66, and 67 apply torque to the drill string 31 for unscrewing it from kelly threads 30, the kelly 25 being held stationary by a conventional back-up wrench (not shown). However, in this particular series of steps, it is not usually necessary that the drill stem be rotated while being raised or lowered, nor that it be raised or lowered while being rotated to unscrew it from the kelly threads. This is the normal situation, and square kelly 28 remains in its lowermost position at all times.

After the addition of a new pipe section, the abnormal but not infrequent situation sometimes occurs that, due to bridging or caving of the hole, the bit cannot be lowered back close enough to the well bottom so that splined kelly 25 can be reconnected to the top end of the newly added pipe section. In such an instance, one of the chief advantages of this invention appears, as short kelly 28 is now available both for applying torque and for permitting vertical movement of the drill pipe. This is accomplished by first lifting up the short kelly 28, either manually or by use of the extra hoisting line 15, and then clamping the chucks 65, 66, and 67 to the added drill-pipe section. Rotation of the rotary table 29 then rotates the pipe 31 to drill it down through the distance the short kelly 28 was lifted. This operation of lifting, clamping, and drilling down is repeated as many times as are necessary to lower the top end of pipe 31 to where it can be attached to kelly threads 30.

If fluid circulation is desired during this drilling-down operation, it is available by attaching the extra swivel of Figure 7 to the top end of the added pipe section 31 and by making a suitable hose connection from the swivel to the mud pump.

Sometimes in adding new pipe sections to the drilling string, it is possible to reconnect the splined kelly 25 to the top end of the added drill-pipe section, but it is impossible to lower the lengthened drill string and kelly far enough into the bore hole to engage the bushing 26 within the bushing driver 27. In such an event, short kelly 28 may then be lifted the short distance necessary to bring the driver 27 and the bushing 26 into engagement. Upon then tightening the chucks 65, 66, and 67 against either the splined kelly 25 or the drill pipe 31, the bushing 26 and driver 27 are held in engaged position. Then when the short kelly 28 has been drilled down to its lowermost position in rotary table 29, the chucks are unclamped, and drilling proceeds in the normal way with the bushing 26 and driver 27 remaining in engagement and the splined kelly 25 feeding downwardly through the bushing 26.

Whenever during the withdrawal of the drill pipe from the hole a tight place is encountered through which the bit will not pass readily, torque for rotating the pipe and drilling upwardly is immediately applied by clamping chucks 65, 66, 67 to the drill pipe, even though the regular splined kelly 25 is not in place, or the bushing 26 cannot be engaged by the bushing driver 27. The drill pipe is then rotated by table 29 while being lifted through a distance approximately the length of the short kelly 28. If this is insufficient to drill upwardly through the tight place in the bore hole, the chucks are unclamped to let the kelly 28 drop down and are then reclamped against the pipe to drill upwardly another length of the short kelly, this operation being repeated as many times as necessary. Or, if it happens that the pipe is stuck by caving of the hole, both circulation and rotation to clear out the interfering material may be had by connecting the extra swivel to the pipe and rotating it with the short kelly through the chucks. It is in such operations as these, which may not be required frequently but which are very important upon occasions, that the rotating and feed mechanism of our invention is particularly useful.

While the invention has been described in terms of the foregoing specific embodiment, it will be understood that this is only for purposes of illustration. As numerous modifications will occur to those skilled in the art, the scope of our invention should not be considered as limited to this specific embodiment, but is to be defined by the following claims.

We claim:

1. Drilling apparatus comprising, in combination, a rotary table, an outer kelly driven by said table, an inner splined kelly driven by said outer kelly and slidable therethrough, means coupled to the upper end of said splined kelly for applying downward force thereto, and chuck means carried by said outer kelly capable of gripping a drill pipe when it extends through said outer kelly.

2. Drilling apparatus comprising, in combination, a rotary table, an outer kelly driven by said table, an inner splined kelly slidable through said outer kelly, coupling means for driving said inner kelly from said outer kelly, means coupled to the upper end of said inner splined kelly for

applying downward force thereto, and chuck means carried by said outer kelly having jaws adapted to grip a tubular member extending through said outer kelly.

3. Drilling apparatus comprising, in combination, a rotary table mounted on a portable platform, a polygonal kelly driven by said table and of a length less than the distance between said table and the surface of the ground, a splined kelly slidable through and driven by said polygonal kelly, a chain-driven pull-down means coupled to the upper end of said splined kelly whereby downward force may be applied thereto, and chuck means carried at the upper end of said polygonal kelly capable of gripping a drill pipe when it extends through said polygonal kelly.

4. A drilling apparatus comprising, in combination, a rotary table mounted on a portable platform, a polygonal kelly driven by said table and of a length less than the distance between said table and the surface of the ground, means carried at the upper end of said polygonal kelly capable of gripping a drill pipe when it extends therethrough, a splined kelly substantially of the same diameter as a drill pipe coupled thereto, slidable within and driven by said polygonal kelly, and a pull-down means coupled to the upper end of said splined kelly for urging it downwardly through said polygonal kelly.

5. An apparatus for rotary drilling of wells which comprises a splined inner kelly having means at its lower end for connection to a drill pipe and at its upper end for connection to a swivel head, an outer second kelly having a longitudinal passage adapted to permit said splined kelly or a drill pipe to pass therethrough, means

engaging the splines of said splined kelly and driven by said outer kelly, chuck means at the upper end of said outer kelly for temporarily engaging a drill pipe when it extends through said passage, a rotary table adapted to drive said outer kelly, and tension means for applying force at the upper end of said splined kelly for urging it downwardly through said outer kelly while being driven thereby.

6. In a drilling apparatus comprising a rotary table, a drill pipe, and means for rotating said pipe by said table while forcing said pipe downwardly, the improvement which comprises, in combination, a hollow kelly adapted to be driven by said table, a splined kelly adapted to extend through said hollow kelly and be driven thereby, coupling means for connecting said splined kelly to said drill pipe thereby forming a drill string of substantially uniform diameter, pipe-clamping means carried by said hollow kelly for engaging said drill pipe when it extends through said hollow kelly, and means for applying downward force to the upper end of said splined kelly.

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