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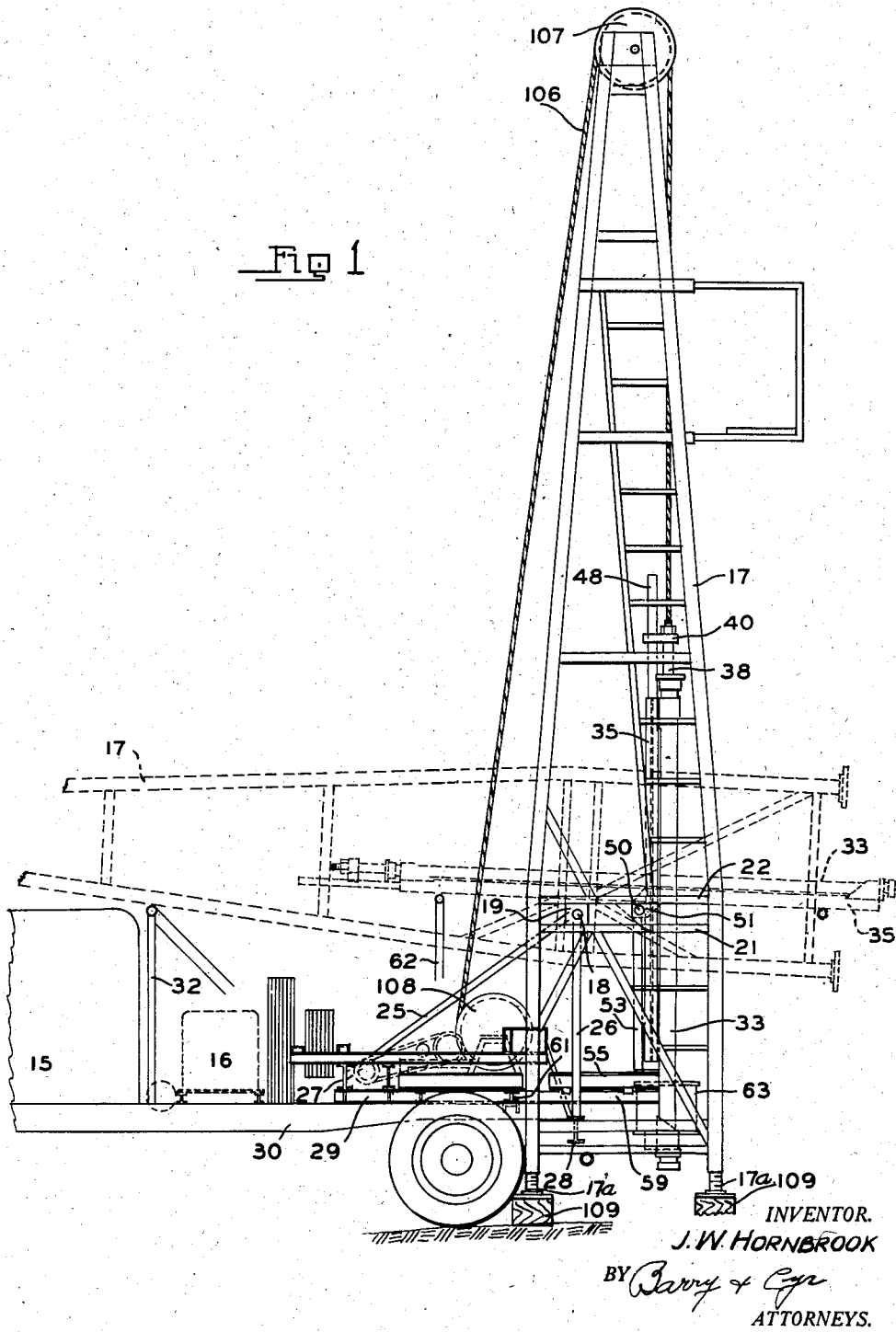
J. W. HORN BROOK

2,215,928

DRILLING APPARATUS

Filed Dec. 19, 1936

6 Sheets-Sheet 1



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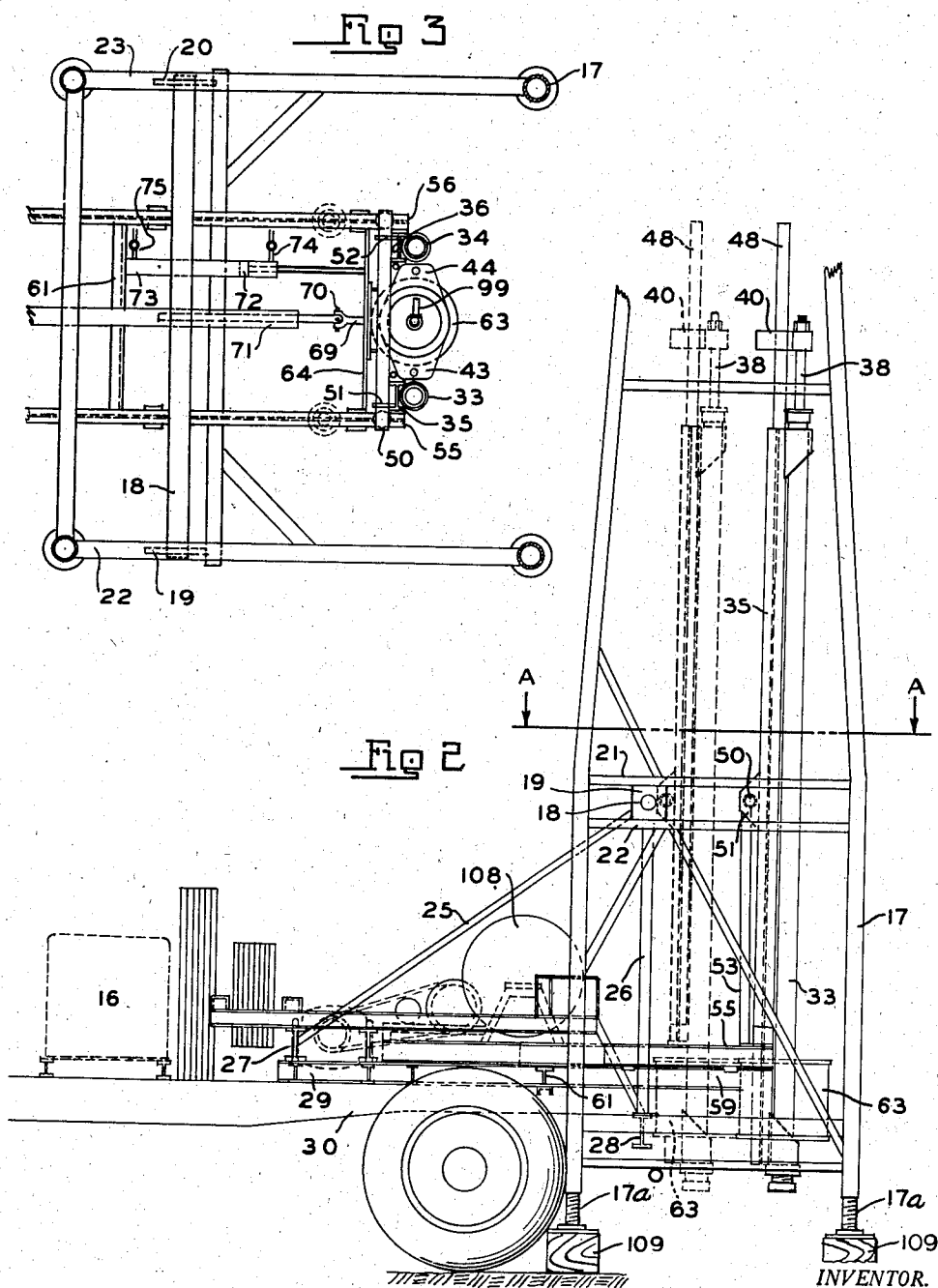
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DRILLING APPARATUS

Filed Dec. 19, 1936

6 Sheets-Sheet 2



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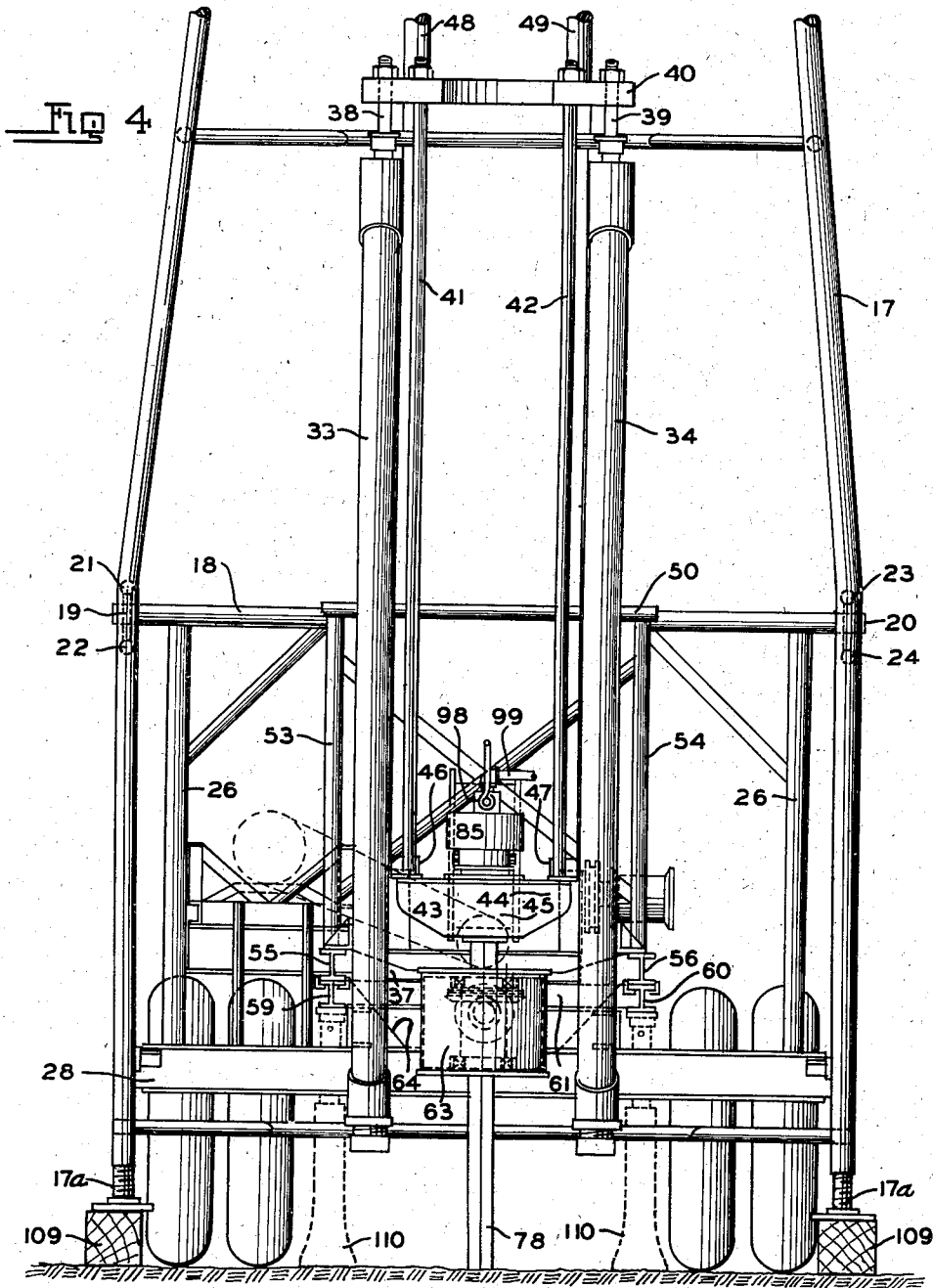
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DRILLING APPARATUS

Filed Dec. 19, 1936

6 Sheets-Sheet 3



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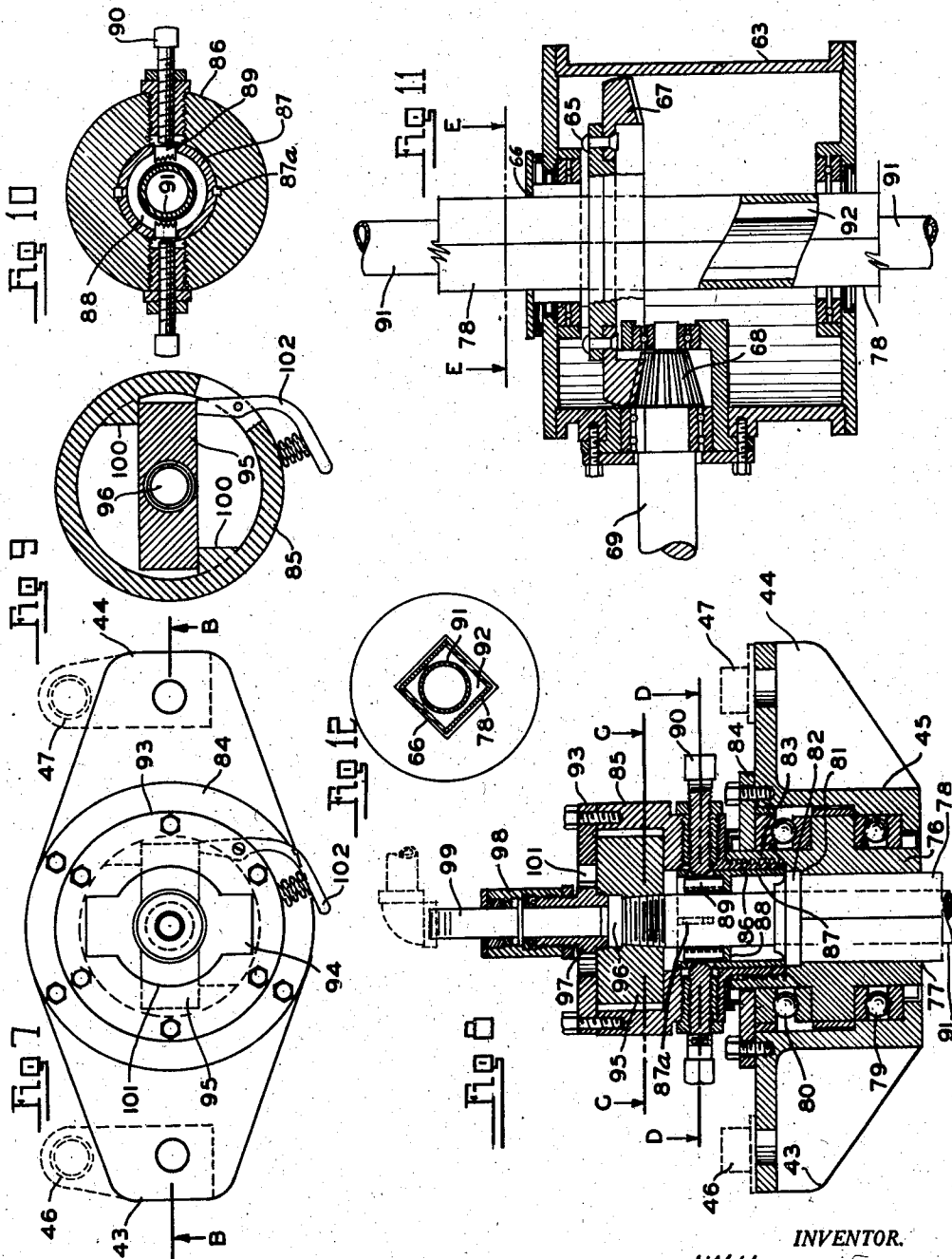
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2,215,928

DRILLING APPARATUS

Filed Dec. 19, 1936

6 Sheets-Sheet 5



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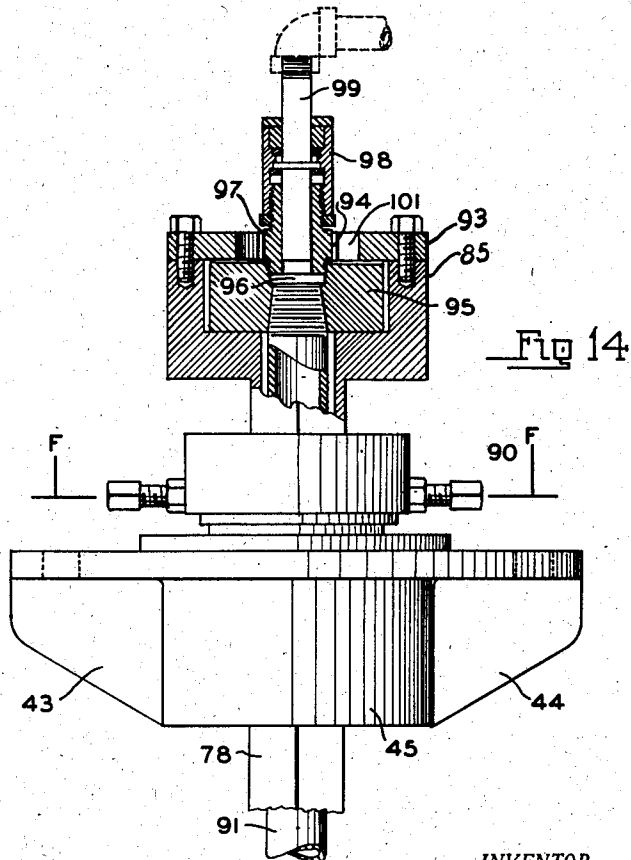
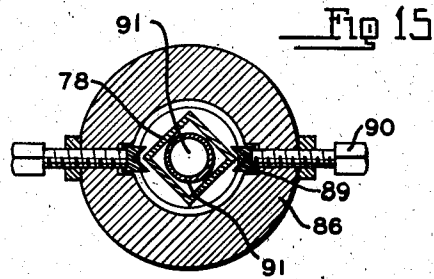
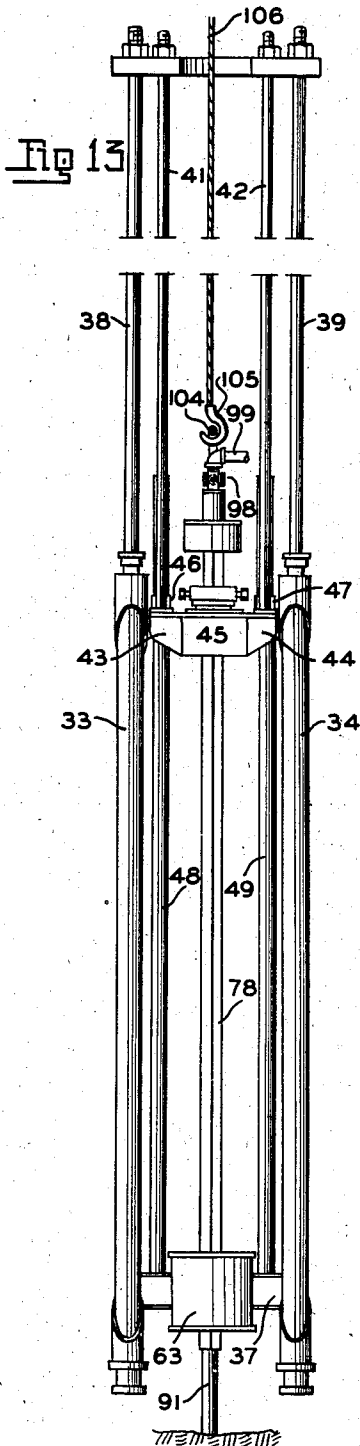
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2,215,928

DRILLING APPARATUS

Filed Dec. 19, 1936

6 Sheets-Sheet 6



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UNITED STATES PATENT OFFICE

2,215,928

DRILLING APPARATUS

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Application December 19, 1936, Serial No. 116,794

18 Claims. (Cl. 255—19) *

This invention relates to rotary drilling apparatus for core drilling, water or oil well drilling and the like, and relates particularly to machines in which such apparatus is assembled as a complete unit for mounting on motor trucks or other vehicles and which may be transported from place to place without disassembling the principal elements of the machines.

Included in the elements of a machine in accordance with this invention, are a derrick, by means of which drill pipe, casing or drilling tools may be suspended, run into or withdrawn from the well, and a hydraulic lift for feeding the drill pipe into the well. Such elements are well known and commonly used in portable machines of the class to which this invention belongs, but in the types of machines heretofore used there are certain disadvantages in the arrangement of these elements which reduce the over-all efficiency of the machine. For example, in most machines in use heretofore, while the derrick, which is generally about thirty feet in height, may be pivotally mounted on a frame so that it can be laid back in a horizontal position on the transporting vehicle when the machine is to be moved, the hydraulic lift is generally fixed in a vertical position and as a result, its length or height must be limited to such as will permit the entire machine to pass beneath under-passes, bridge structures and the like when the machine is to be moved from one location to another. By so limiting the height, i. e. the length of the hydraulic device, the stroke of the hydraulic pistons which feed the drill pipe must be correspondingly limited in length and in machines of this type, the stroke of the hydraulic pistons is seldom more than three or four feet. This becomes a distinct disadvantage when it is noted that the drill pipe used in such machines is generally provided by pipe factories in ten or twenty foot lengths. With a ten foot length of drill pipe, for example, such machines require from two to three strokes of the hydraulic pistons to feed a full joint of drill pipe into the well. This means that at the end of each stroke of the hydraulic pistons, drilling must be stopped while the hydraulic is released and moved back to its top position where it is again attached to the drill pipe before the drilling can be continued for another stroke of the hydraulic pistons. This operation must be repeated as many times as is necessary to feed a single joint of drill pipe into the well and thereby greatly increases the drilling time for any well drilled.

In a hydraulic lift having a stroke equal to the

length of a joint of drill pipe is used, then, in machines heretofore constructed, the lift must be of such length that in order to transport the device on a truck or other vehicle, it must be disassembled from the other portions of the machine thereby causing considerable loss of time in dis-assembling and re-assembling the machine when the machine is to be moved from one location to another.

Therefore, a principal object of this invention is to provide a fully portable rotary drilling machine having a hydraulic lift which is capable of feeding a full length of drill pipe in a continuous operation and which may be transported with the balance of the machine without dis-assembly therefrom.

This object is fulfilled in this invention by mounting the derrick and the hydraulic lift on pivots supported independently of each other on the assembly frame, thereby permitting both the derrick and the hydraulic lift to be laid back in a substantially horizontal position over the transporting vehicle without requiring dis-assembly of either of these elements from the other portions of the drilling machine.

In rotary drilling machines heretofore used, rotation of the drill pipe is effected by using a plane surfaced member, generally square in cross section, and known as the "kelly," at the top of the drilling string. The kelly co-acts with a suitably shaped opening in the rotary table to rotate the entire drilling string. To permit free rotation of the drilling string, the top of the kelly is connected by a swivel to the pipe supplying drilling fluid to the interior of the drilling string. With this arrangement, in order to add new joints of pipe to the drilling string, the pipe must be withdrawn above the rotary table so that it may be gripped by suitable jaws while the kelly is disconnected and a new joint of pipe added. This is a cumbersome and time-consuming arrangement and it is a further object of this invention to provide an improved form of chuck for connecting the pipe directly to the swivel of the drilling fluid supply pipe, whereby the drill pipe may be disconnected from the swivel and new joints added thereto without having to lift the entire string off the bottom of the well, thereby reducing considerably the amount of time necessary for adding joints of pipe to the drilling string and reducing the hazard of dropping the pipe back into the well while attempting to add new joints of pipe to the string.

Another object of this invention is an improved form of drill head used in conjunction with the

98 aforementioned chuck which permits the use of a hollow kelly, that is, a kelly which is not connected to the drilling string but which forms a sleeve through which the drilling string passes freely, thereby providing advantages which will appear from the detailed description to follow.

Other objects and advantages of this new invention will be apparent from the following detailed description when read in conjunction with the accompanying drawings which diagrammatically illustrate one form of the invention.

In the drawings:

93 Fig. 1 is a side elevation of an assembly of the machine showing the derrick, hydraulic lift and other equipment in normal drilling position in full lines and, in dotted lines, the position of the derrick and hydraulic lift when in position to be transported from place to place.

03 Fig. 2 is a similar view showing the hydraulic lift and rotary table in extended or drilling position within the derrick in full lines and in the retracted position in dotted lines.

Fig. 3 is a section along the line A—A of Fig. 2 showing means for retracting the rotary table and hydraulic lift.

91 Fig. 4 is an end elevation of the machine in drilling position, showing the hydraulic lift and its attached parts in the position assumed at the end of the stroke of the lift.

01 Fig. 5 is a detail showing the hydraulic lift at the beginning of its stroke.

Fig. 6 is a detail showing the hydraulic lift at the end of its stroke with the parts of the chuck separated.

9 Fig. 7 is a plan view of the drill head and chuck. Fig. 8 is a sectional elevation taken along line B—B of Fig. 7.

Fig. 9 is a section through the chuck taken along line C—C of Fig. 8.

40 Fig. 10 is a section through the chuck taken along line D—D of Fig. 8.

Fig. 11 is a sectional elevation of the rotary table.

Fig. 12 is a section along line E—E of Fig. 10.

45 Figs. 13, 14, and 15 are details of another modification of the chuck and drill head in accordance with this invention.

Referring to the drawings, particularly to Figs. 1, 2, 3 and 4, the numeral 15 designates a truck or other vehicle on which the drilling machine is mounted. A power plant and its attendant mechanisms for operating the different parts of the drilling machine, shown in dotted outlines, are mounted on the truck. The power plant 16 and its attendant mechanisms are constructed and operated in a manner well known in the art and do not of themselves form a part of this invention. A derrick 17 having adjustable feet 17a is pivotally mounted on a cross member 18 which is journaled at each end in bearings 19 and 20 which are supported between girt members 21, 22 and 23, 24 at opposite sides of derrick 17. Braces 25 and 26 on each side of derrick 17 support member 18 from cross members 27 and 28 of a frame 29 which is mounted on the main truck frame 30. The derrick 17 is thus pivotally supported on the main truck frame 30 and when laid back in transporting position, shown in dotted outlines in Fig. 1, rests on a support 32 which extends upwardly from frame 30.

75 A hydraulic lift mechanism consists of a pair of hydraulic cylinders 33 and 34 attached longitudinally to a pair of beams 35 and 36 respectively. Beams 35 and 36 are connected together at their lower ends by a cross beam 37. A pair

of piston rods 38 and 39 emerge vertically from the upper ends of cylinders 33 and 34 respectively and are fastened at their upper ends to a yoke 40. A pair of lift rods 41 and 42 are firmly connected to yoke 40 between cylinders 33 and 34 and depend vertically downward from yoke 40. The lower ends of lift rods 41 and 42 are firmly attached to the wings 43 and 44 of a drill head 45. Reciprocation of piston rods 38 and 39 reciprocates drill head 45 correspondingly. A pair of sleeves 46 and 47 are mounted at the back of wings 43 and 44 respectively and a pair of guide bars 48 and 49 are mounted vertically on cross beam 37 and pass through sleeves 46 and 47 respectively holding the movement of drill head 45 to a true vertical reciprocation and together with hangers 41 and 42 prevent drill head 45 from twisting.

This entire hydraulic lift mechanism is pivotally mounted on a cross bar 50 which is journaled in bearing plates 51 and 52 attached to beams 35 and 36 respectively. A pair of vertical braces 53 and 54 support the assembly from a corresponding pair of horizontal frame members 55 and 56 which are connected together by a cross member 57. Members 55, 56 and 57 constitute an auxiliary frame for supporting the hydraulic lift assembly. This frame is slidably mounted on another frame formed by a pair of members 59 and 60 underlying members 55 and 56 and acting as rails or runners therefor and a cross member 61 tying members 59 and 60 together. Members 59, 60 and 61 are connected to and form a part of frame 29. It will thus be seen that the hydraulic lift mechanism is pivotally supported on a frame which is slidable on a portion of frame 29. Also since the hydraulic lift mechanism and the derrick 17 are pivotally supported on the frame 29 independently of each other, both may be laid back on their independent pivots in a horizontal position without interfering with each other and without being dis-assembled from the balance of the machine. A support 62 extending upward from frame 29 acts as a rest for the hydraulic lift mechanism when it is in the horizontal position. Slidability of the auxiliary frame supporting the lift mechanism on frame 29 permits this mechanism to be retracted toward the back of the derrick 17 to the position shown in dotted outline in Fig. 2, which facilitates laying back of both the derrick and the lift mechanism as well as providing other advantages to be later described.

A rotary table 63 is mounted on the auxiliary sliding frame and is centered between cylinders 33 and 34 by means of a plate 64 attached to the ends of members 55 and 56. Centering table 63 thus brings it in line with and beneath drill head 45. Since rotary table 63 is attached to the auxiliary sliding frame on which the hydraulic lift mechanism is mounted, it is advanced or retracted with the corresponding movement of the lift mechanism. Its relative retracted position is shown in dotted outline in Fig. 2. Rotary table 63 consists of well known elements comprising a rotary bushing 65 having a square opening 66 to receive a kelly 78 and driven by means of a gear 67 and pinion 68 which is connected to a drive shaft 69 having the usual universal joints 70 and splined connection 71 driven from the power plant 16.

The hydraulic lift mechanism and rotary table 63 may be retracted or advanced within the confines of derrick 17 by any well known means. 76

Fig. 3 illustrates very generally a hydraulic means for effecting this movement. A hydraulic piston 12 is attached at one end to plate 64 of the auxiliary sliding frame on which these mechanisms are mounted. Piston 12 is slidably engaged in a cylinder 73 anchored to cross member 61 of the frame 29. Hydraulic fluid connections 74 and 75 into cylinder 73 permit introduction of hydraulic fluid under pressure to either side of piston 12 depending upon the direction of movement desired. Other mechanical means such as a screw, gear and pinion, ratchet and pawl or similar devices may be used for this purpose instead of the hydraulic mechanism described. The latter is utilized in the particular machine herein described because a supply of hydraulic fluid and a pump therefor is already available in connection with the hydraulic lift mechanism previously described.

Within drill head 45 is mounted a bushing 76 having a bore 77 therethrough which is generally square in cross section to slidably receive kelly 78 which is usually square in cross section. Kelly 78 has a hollow circular bore of sufficient diameter to permit free passage therethrough of drill pipe used by the machine. Bushing 76 is mounted between roller bearings 79 and 80 suitably housed in drill head 45, which permits free rotation of bushing 76 in drill head 45. A shoulder 81 formed in bore 77 provides a seat for a circular flange 82 which is attached to the upper end of kelly 78. Flange 82 has a circular opening in the center thereof to permit passage of drill pipe therethrough. Kelly 78 may thus be slidably inserted in bore 77 of bushing 76, but is prevented from passing entirely therethrough by coaction of flange 82 and shoulder 81. The upper end of bushing 76 forms an internally threaded collar 83, the inner bore of which is circular and of somewhat larger diameter than flange 82. An annular plate 84 surrounds collar 83 and is bolted to the upper surface of drill head 45 enclosing bearing 80 and locking bushing 76 within drill head 45. A chuck consisting of a hollow circular box 85 has a male member 86 depending from its lower side 85a and externally threaded to engage the threads of collar 83. The inner bore of male member 86 is of sufficient diameter to permit kelly 78 and flange 82 to pass therethrough so that flange 82 may be received on shoulder 81. An annular jaw frame 87 is inserted within the bore of member 86 and is keyed against rotary movement therein by means of keys 87a (Figs. 8 and 10). Frame 87 rests on flange 82 and extends upward in member 86 to a point just below the lower surface of box 85. An annular ring 88 within frame 87 supports a pair of toothed jaws 89 which are adjustable horizontally by means of set screws 90 which are inserted through the walls of male member 86 and jaw frame 87. The central opening in annular ring 88 is of sufficient diameter to permit drill pipe 91 to pass freely therethrough. Jaws 89, since they are adjustable, may be advanced by means of set screws 90 until they grip the outside of pipe 91 or may be retracted out of engagement with the drill pipe. Box 85 is closed at the top with a plate 93 having a central slot 94 of elongated key-hole shape best shown in Fig. 7 and adapted to permit insertion therethrough into box 85 of a rectangular chuck block 95 having a bore 96 extending therethrough and threaded internally at its lower end to engage the male threads of the upper end of drill pipe 91 and threaded at its upper end to engage the threaded male member 97 of a swivel

88 to which is connected a pipe 99 through which drilling fluid may be introduced into drill pipe 91. The connections described between drill pipe 91, chuck block 95, swivel 98 and pipe 99 form a continuous hollow passageway for the introduction of drilling fluid into drill pipe 91 to facilitate the drilling operation. Chuck block 95 is insertable through slot 94 into box 85 in one position only, and when rotated counterclockwise within box 85 through an angle of 90°, engages stops 100 and becomes locked between the overhanging edges 101 of plate 93 and floor plate 85a of box 85. Movement of chuck block 95 in the reverse or clock-wise direction is prevented by a spring latch 102 mounted in the side of box 85. A ball 104 is attached to swivel 98 for engagement with a hook 105 at one end of a hoist line 106 which passes over a sheave 107 at the top of derrick 17 to a hoisting drum 108 operated by the power plant 16.

Chuck box 85 and chuck block 95 form the novel chuck which is one of the features of this invention. Use of this new chuck permits rapid engagement of the rotating elements of the machine with the drill pipe and avoids the necessity for continuous handling of the cumbersome kelly when adding new joints of drill pipe to the drilling string.

Power plant 16 includes among its elements and mechanisms, shafts, pulleys, belts, etc., for driving the rotary table, pumps for drilling fluid and hydraulic fluid and for operating the hoisting drum 108. As noted above, all of these mechanisms and their arrangement are well known in the art and do not of themselves form a part of this invention.

Kelly 78, as noted above, is not directly connected to the drill pipe and acts simply as a sleeve connection from the rotary table to the drill head whereby the rotary motion of bushing 65 in rotary table 63 is imparted to rotary bushing 76 in drill head 45. Kelly 78 is readily insertable through the aforementioned bushings and can easily be withdrawn therefrom when the machine is not in use.

The drilling machine, the parts of which are described above, is operated in the following manner: The machine, with derrick 17 and the hydraulic lift mechanism in the horizontal position shown in dotted outlines in Fig. 1, is transported by truck 15 to the location of the well to be drilled and the derrick and hydraulic mechanism elevated over the well location. Blocks 109 are placed on the ground under derrick feet 17a which are adjusted until the derrick is set firmly and levelled. This setting up operation, due to the improvements provided by this invention, can usually be accomplished in from five to ten minutes. Hydraulic cylinders 33 and 34 and drill head 45, all now in vertical position, together with rotary table 63 are advanced to the proper drilling position near the front of derrick 17 by suitable operation of hydraulic piston 12. Pump connections for supplying hydraulic fluid to cylinders 33, 34 and 73 and for supplying drilling fluid to pipe 99 are permanent connections and are, therefore, continually ready for instant use. Swivel 98 with its connected pipe 99 is suspended over the drill head 45 by means of line 106. Chuck block 95, also permanently connected to swivel 98, is connected to a joint of drill pipe 91. Jaw frame 87 is then slipped over pipe 91 followed by kelly 78. Kelly 78 and pipe 91 are then inserted through slot 94 in plate 93, thence through bore 77 in ro-

tary bushing 76 of drill head 45 and thence through bushing 65 of rotary table 63. At this time drill head 45 is in the down position best shown in Fig. 6. Hydraulic fluid is then introduced into cylinders 34 and 33 raising pistons 38 and 39 and hangers 41 and 42 by means of which drill head 45 is raised to the position best shown in Fig. 5. As drill head 45 is raised, it slides over kelly 78 and pipe 91 until kelly 78 is seated in rotary bushing 76 when flange 82 comes to rest upon shoulder 81. At this time frame 87 enters member 86 and is seated therein by means of keys 87a, jaws 89 being at this time in their retracted position so as not to contact pipe 91. The stroke of pistons 38 and 39 is about fifteen inches longer than the ten foot length of the joint of drill pipe 91. This allows drill head 45 to travel upward the full length of the joint of pipe 91 and come in contact with chuck block 95 which is then inserted in slot 94 into box 85 where it is turned counter-clockwise through an angle of 90° and held against stops 100 by means of latch 102. The overhanging edges 101 of plate 93 hold chuck block 95, which is now turned crosswise of slot 94, from coming out of box 85. At this point the lower end of pipe 91 will protrude below rotary table 63 whereupon a drilling bit is attached thereto and the machine is in readiness to begin drilling. Bushing 65 in rotary table 63 is rotated by means of the means of the mechanical connections to the power plant 16, as described above, and will, in turn rotate kelly 78 which will impart this motion to bushing 76 in drill head 45. Since rotary bushing 76 is rigidly connected to box 85 in which is locked chuck block 95 and pipe 91, the rotary motion is thus imparted to pipe 91 which turns the drill bit producing the drilling operation.

As the bit drills down, pipe 91 is fed into the resulting hole by controlled withdrawal of fluid from cylinders 33 and 34 until about ten feet, length of one joint of drill pipe, is drilled. At this point drill head 45 will be about fifteen inches above rotary table 63. Drilling is stopped, latch 102 released and chuck block 95 turned clockwise until it registers with slot 94. Drill head 45 is then lowered an additional distance by a corresponding movement of pistons 38 and 39 which permits chuck block 95 and pipe 91 to protrude above box 85. Pipe 91 can now be grasped by pipe tongs or gripped firmly by advancing jaws 89 by turning set screws 90 and held while chuck block 95 is unscrewed from the end of pipe 91. Chuck block 95 is then attached to another joint of drill pipe which is then raised into the derrick by means of line 106 and connected to the protruding end of the first joint of drill pipe. The tongs are removed or jaws 89 released from the drill pipe and drill head 45 is again raised by means of pistons 38 and 39 and slides up over the new joint of pipe until box 85 again receives chuck block 95 which is quickly locked into place and drilling resumed. The operation described for adding the second joint of drill pipe is repeated until a well of required depth has been drilled. It will be noted that after the first joint of drill pipe has been utilized, thereafter, the kelly 78 and frame 87 no longer appear in the operation and the operation of adding new joints of drill pipe to the drilling string is accomplished with a few operations which can be very quickly performed.

The advantages of the above described machine should now be apparent. Independently pivoting the derrick and hydraulic lift mechanism allows both to be transported without disassembly from

the machine and allows these members to be placed in position for drilling in a minimum amount of time, five to ten minutes as noted above. This arrangement also permits use of a hydraulic lift having a stroke sufficiently long to feed a full joint of drill pipe without interruption, which is a very important time saving feature. By the use of the described drill head and chuck, very fast time can be made in adding joints of drill pipe to the drilling string. Chuck block 95 can be disconnected from box 85, a new joint of pipe connected and box 85 re-connected to chuck block 95 in less than one minute, which permits of very fast drilling and provides important economies over other methods in the cost of drilling wells.

The apparatus described also facilitates withdrawal of the drill pipe from the well with important savings in time and other advantages. In withdrawing pipe, the combined power of the hydraulic lift and of the power plant applied through drum 108 to line 106 may be used. For example, with drill head 45 in the down position and with chuck block 95 locked in box 85, raising of pistons 38 and 39, assisted if necessary by pull on line 106, will lift the entire string of pipe from the well for a distance equal to the stroke of pistons 38 and 39. The pipe can be held in this position with line 106 while chuck block 95 is unlocked and drill head 45 run back down to the next lower joint of drill pipe which is then gripped firmly by advancing jaws 89. The first joint of pipe is then unscrewed from the next lower one and swung out of the derrick by means of line 106 and then disconnected from chuck block 95 which is then reconnected to the top of the next lower joint of pipe, now held by jaws 89. Drill head 45 is then raised sufficiently to receive chuck block 95 again and the lifting operation repeated. Power plant 16, operating through drum 108 and line 106 may be used alone for withdrawing pipe. In this case jaws 89 may be used to hold the pipe between pulls applied by line 106 or the entire hydraulic lift mechanism and rotary table 63 may be retracted to the position shown in dotted outline in Fig. 2 and thus not interfere with the operation of line 106.

To reduce the load on the springs of the transporting vehicle when the drilling machine is in operation, jacks 110, shown in dotted outline in Fig. 4, may be placed under members 59 and 60 and raised so that the weight of the drilling apparatus is transferred from the vehicle springs to the jacks which rest on the ground.

The drilling machine as described above is particularly adapted to the use of standard ten foot joints of drill pipe, as the stroke of pistons 38 and 39 is approximately 11 feet 3 inches and the over-all height of the derrick 31 feet 6 inches.

However, longer joints of drill pipe may be used with equal facility by making the stroke of the pistons correspondingly longer. The pistons may be single stroke pistons of any length necessary to feed longer joints of pipe or may be made collapsible, in order to reduce the length of the hydraulic cylinders. This form of hydraulic lift mechanism is well known in the art pertaining to hydraulic lifting mechanisms.

Longer joints of drill pipe than that described may be used in the above machine without change in the elements of the machine but by a slight change in the method of operation described. If for example, twenty foot joints of drill pipe are to be used in the above machine, the operation is as follows: The drilling operation is usually got-

ten underway in the above described manner using a ten foot joint of pipe for the initial operation. Then, at the end of a stroke of pistons 38 and 39, chuck block 95 is disconnected from the drill pipe in the manner previously described and connected to one end of a twenty foot joint of pipe, the other end of which is then connected to the end of the first joint of drill pipe protruding above box 85. Drill head 45 is now raised to its top position by the normal stroke of pistons 38 and 39, which will leave protruding above drill head 45 about ten feet of the twenty foot joint of pipe, to the top of which chuck block 95 is attached. Jaws 89 are then advanced by set screws 90 until the pipe is tightly gripped thereby and drilling begun. Jaws 89 supplant the normal function of chuck box 85 and chuck block 95 in imparting the rotary motion of bushing 76 to the pipe. Drilling is continued throughout one stroke of the pistons 38 and 39 or about ten feet. Jaws 89 are then retracted releasing the drill pipe and drill head 45 can then be raised again a distance equal to the stroke of the pistons 38 and 39 which will now bring box 85 into position to receive chuck block 95 which is then locked therein in the usual manner and drilling can now be continued through another stroke of pistons 38 and 39 which will complete the feeding of the full twenty foot joint of drill pipe into the well.

When the stroke of the hydraulic pistons 38 and 39 is of a length designed to run a full joint of drill pipe in one stroke, the gripping device, comprising jaw frame 87, jaws 89 and set screws 90, is not required, as the torque on drill pipe 91 for drilling is applied through chuck block 95 when locked in box 85, and pipe tongs or similar devices may be utilized for gripping the pipe when disconnecting or adding new joints of pipe.

Figs. 13, 14 and 15 illustrate a modified form of chuck and drill head in which kelly 78 is connected directly to box 85 forming a unit therewith. Box 85 is disconnected from drill head 45, and jaws 89 are altered in form, as shown in Fig. 15, so that they may firmly grip kelly 78 instead of pipe 91. In operation, the thrust of hanger rods 41 and 42, moving in accordance with the movement of pistons 38 and 39, is applied through jaws 89 to kelly 78, which being now directly connected to box 85 will transmit this thrust through box 85 and chuck block 95 to the drill pipe. In this modification, as well as in that earlier described, kelly 78 may be readily withdrawn from rotary bushing 76 in drill head 45 and from bushing 65 in rotary table 63.

By separating drill head 45 from the chuck, as illustrated in Figs. 13, 14 and 15, drill head 45 may be located above rotary table 63, as shown, or may even be located below table 63 if such arrangement is found to be advantageous. In the latter case, however, the stroke of the hydraulic pistons must necessarily be shortened to such a length as will reciprocate drill head 45 between the level of the mouth of the well and the bottom of table 63. In this case, however, the advantages of the novel chuck arrangement will still be preserved.

From the above detailed description, it will be evident that this invention provides a fully assembled rotary drilling machine which is entirely portable and which provides large savings in drilling time and thereby reduces materially the cost of drilling wells.

While the particular apparatus described is shown mounted on a motor truck, it may be mounted entirely on a frame or skid and oper-

ated from the ground level and may then be loaded on a vehicle for transportation from place to place.

Numerous modifications and alterations of size, form and arrangements may be made within the scope of the invention as claimed below.

What I claim and desire to secure by Letters Patent is:

1. A drilling apparatus comprising a drill stem having a threaded portion, a chuck block in threaded engagement with the threaded portion of the drill stem, a sleeve surrounding the drill stem and having a box portion in which the block is detachably mounted, latching means operatively securing the block to the box to cause the block to rotate with the box, a swivel support for said sleeve, means for raising and lowering said support and means for rotating said sleeve.

2. A drilling apparatus comprising a drill stem having a threaded portion, a chuck block in threaded engagement with the threaded portion of the drill stem, a sleeve surrounding the drill stem and having a box portion in which the block is detachably mounted, latching means operatively securing the block to the box to cause the block to rotate with the box, a swivel support for said sleeve, means for raising and lowering said support and means for rotating said sleeve, said sleeve being slidably connected to said rotating means.

3. In drilling apparatus, a rotatable sleeve having a box portion, a drill stem extending into the sleeve, a block detachably secured to the drill stem and removably connected to the box and means for securing the block to the box whereby the block will rotate with the box.

4. In drilling apparatus, a drill stem, a sleeve surrounding said stem and having a box provided with a key-hole slot, a block detachably connected to the drill stem and adapted to be inserted in said slot in connecting the block to the box and means for securing the block against rotation relatively to the box.

5. In drilling apparatus, a rotatable sleeve having a box portion, a hollow drill stem extending into the sleeve, a block detachably secured to the drill stem and removably connected to the box, means for securing the block to the box whereby the block will rotate with the box, a conduit for conveying fluid to the hollow drill stem and a swivel coupling operatively connecting the conduit to the drill stem.

6. In drilling apparatus, a rotatable sleeve having a box portion, a hollow drill stem extending into said sleeve, a block detachably secured to the drill stem and removably connected to the box, means for securing the block to the box whereby the block will rotate with the box, a passageway through said block in communication with the interior of said drill stem, a conduit for conveying fluid to the hollow drill stem through said passageway and a swivel coupling operatively connecting the conduit to the drill stem.

7. A drilling apparatus comprising an upwardly and downwardly movable rotatable sleeve having a box portion, a drill stem extending through the sleeve and having a block which is insertable into and removable from the box portion, means for latching the block to the box portion when the block occupies the box portion and clamping means for securing the sleeve to the drill stem.

8. A drilling apparatus comprising an upwardly and downwardly movable rotatable sleeve having a box portion, a drill stem extending through the

sleeve, a block detachably connected to said drill stem and insertable into and removable from said box portion, means for latching the block to the box portion thereby securing the sleeve to the drill stem and auxiliary clamping means for securing the sleeve to the drill stem.

9. In apparatus of the class described, a chuck for connecting a drill stem to the rotating elements of the apparatus comprising a chuck box, a drill stem extending through said chuck box, a chuck block detachably connected to said drill stem and adapted to be received in locking engagement in said chuck box, latching means for locking said chuck block to said chuck box and means for rotating said chuck.

10. In apparatus of the class described, a device for rotating a drill stem comprising a sleeve surrounding said drill stem, a chuck box attached to the upper end of said sleeve and rotatable therewith, a block detachably attached to the upper end of said drill stem and adapted to be removably engaged in said chuck box, means for locking said block to said chuck box for rotation therewith and means for rotating said sleeve.

11. In apparatus of the class described, a drill stem, means for feeding the drill stem into a well, said means including a drill head, a swivel mounted in the drill head and through which the drill stem passes, a sleeve surrounding said drill stem and connected to said swivel, a chuck fixedly attached to said swivel and comprising a box surrounding said drill stem, a chuck block detachably secured to the drill stem and adapted to be locked in said box, means for locking said chuck block to said box and means for rotating said sleeve.

12. A drilling apparatus comprising a tubular drill stem, a block detachably connected to said stem, a drill head, an upwardly and downwardly movable sleeve surrounding said stem and having a swivel connection with said drill head, a box rigidly united with said sleeve and containing said block, means for latching the block to the box for causing the block to rotate with said sleeve, a conduit for conveying fluid to the drill stem, means including a swivel connection operatively connecting the conduit to said block and means for rotating said sleeve, the sleeve being movable upwardly and downwardly relatively to the rotating means.

13. In a rotary drilling device for rotating a drill string composed of pipe sections secured together, the combination of a kelly surrounding a

portion of said drill string and having a bore through which the pipe sections may pass, a swivel adapted to support said kelly, and means to support said drill string from said swivel independently of said kelly.

14. In a rotary drilling device for rotating a drill string composed of pipe sections secured together, the combination of a kelly surrounding a portion of said drill string and having a bore through which the pipe sections may pass, a swivel adapted to support said kelly, means to support said drill string from said swivel independently of said kelly, and cooperating means associated with the kelly and swivel to automatically effect a driving engagement therebetween upon predetermined movement of the kelly relative to the swivel.

15. In a rotary drilling device, the combination of a drive element having a longitudinal bore, a driven element extending through said bore, a swivel adapted to support said elements independently, and means including a member carried on the swivel to form a rotary drive connection between the two elements, said connection being effected automatically upon relative sequential longitudinal and rotary movement of the two elements.

16. In a rotary drilling device for rotating a drill string, the combination of a kelly, a swivel adapted to support said kelly and drill string independently, said swivel having an intermediate drive member associated therewith adapted to transmit rotary motion from said kelly to said drill string.

17. In a well drilling device a tubular rotary shaft angular in cross section and adapted to be driven by a rotary table, a drill rod within said shaft, J-slots in the walls of said shaft, and means on said drill stem for engaging said J-slots to impart rotation to said drill stem.

18. In a rotary drilling device, the combination of a drive element having a longitudinal bore, a driven element extending through said bore, a swivel adapted to support said elements independently, means including a member carried on the swivel to form a rotary drive connection between the two elements, said connection being effected automatically upon relative sequential longitudinal and rotary movement of the two elements, and means acting automatically to lock said elements against disengagement when the drive connection is completed.

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