APPARATUS FOR CIRCULATING DRILLING FLUID IN ROTARY DRILLING

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Application November 12, 1953, Serial No. 391,448

2 Claims. (Cl. 255—24)

This invention relates to a rotary drilling apparatus and in particular to a method and apparatus for circulating drilling fluid.

It is well known that in rotary drilling of a well into the earth, a drilling fluid is circulated under pump pressure through the drill pipe to wash cuttings made by the drill bit to the top of the bore hole. The fluid containing the cuttings over-flows from the bore hole and is collected in a pond where the cuttings settle out and the fluid, free from cuttings, is re-circulated under pump pressure.

Where circulation is downwardly through the drill pipe and upwardly through the bore hole, the cuttings are washed into the formation through which the well is drilled and often the cuttings plug the producing sands. Also, underground cavities and cave-ins result in lost circulation and velocities so that the cuttings are apt to settle out and not be effectively removed from the bore hole.

The above difficulties are overcome in part by reverse circulation, that is, the water from the pond flows downwardly through the bore hole and is pumped upwardly through the drill pipe by means of a pump which discharges into the pond. The bit, however, often loosen, large rock fragments which are elevated due to the high velocities of the well fluid. Consequently the large rock fragments contained in the drilling fluid are destructive to the pump.

It has been suggested to effect upward circulation by means of an eductor without passing the cuttings, and large fragments, through the pump. However, where the fluid level drops in the bore hole or the fluid is carrying large quantities of solid materials, the eductor in itself may not always produce the desired lift or maintain the required velocity to prevent settling out of the material.

It is therefore a principal object of the present invention to provide for injection of pressure fluid in jets that are directed into the upflow at the lower end of the Kelly rod of the drill pipe.

Other objects of the invention are to provide a simple and inexpensive apparatus for delivering the high pressure fluid to the lower end of the Kelly rod as well as to the eductor, to provide a circulating apparatus wherein only clean fluid is passed through the pump and discharged under high velocities through the eductor and the jets at the lower end of the Kelly; to provide the Kelly with dual swivel heads, one of which supplies ducts that lead downwardly along the sides of the Kelly to the jets and the other connecting the Kelly with the eductor; and to provide the ducts on the Kelly so that they may be used as keys for effecting a driving connection with a drill pipe rotating means.

In accomplishing these and other objects of the invention as hereinbefore pointed out, I have provided an improved structure, the preferred form of which is illustrated in the accompanying drawings, wherein:

Fig. 1 is a perspective view of a portable drilling apparatus equipped with a circulating mechanism embodying the features of the present invention and which includes an eductor connected with the upper end of the Kelly and ejection jets discharging a pressure fluid into the lower end of the Kelly.

Figs. 2 and 2-A are longitudinal sections of the upper and lower portions of the Kelly, particularly illustrating the swivel heads and the ducts leading down the sides of the Kelly and supplying the ejection jets at the lower end of the Kelly.

Fig. 3 is a horizontal section through the Kelly on the line 3—3 of Fig. 2-A.

Fig. 4 is a cross section through the Kelly on the line 4—4 of Fig. 2.

Fig. 5 is a longitudinal section through the eductor particularly illustrating the inner construction thereof.

Referring more in detail to the drawings:

1 designates a drilling apparatus which may be of portable type in that it includes a motor driven vehicle or truck 2, having a bed or platform 3, on which the drilling apparatus is mounted. The drilling apparatus includes a power unit such as a internal combustion engine 4, that is mounted on the platform 3, and drives a winding drum 5, a turntable 6, and a pump 7, also mounted on the platform and driven through a power shaft 8. The winding drum and turntable are connected with the power output shaft 8, by suitable driving connections standard to this type of rig. In the illustrated instance, the drive for the pump 7 is by means of a chain 9 operating over a sprocket 10 on the shaft 8, and a sprocket 11 on the pump 7.

Also carried on the vehicle is a derrick 12 that is adapted to be moved from a horizontal position on the vehicle to the erect position shown in Fig. 1. The top of the derrick (not shown), is provided with the customary crown pulleys for passing a line 13 from the winding drum for supporting and handling the drill pipe 14 as is well understood by those skilled in the art.

The drill pipe 14 carries a drill bit, on the lower end thereof (not shown) that is rotated by means of the turntable 6 to extend a bore hole into the earth formation as when drilling for water or minerals such as oil and gas. The drill pipe 14 includes joints of pipe that are inter-connected by tool joints so that additional joints may be added thereto progressively with the drilling. A driving connection is effected between the drill pipe and the rotary table by means of a Kelly rod 15 (later to be described) that is connected with the upper end of the drill pipe, and carries swivel heads 16 and 17. The swivel head 16 is equipped with a ball 18 that is connected with the line 13 through a tackle 19 and the traveling block hook 20. Connected with the swivel head 16 is a flexible conduit or hose 21 forming the down-leg of a siphon of which the Kelly rod constitutes the up-leg and through which drilling fluid is drawn from the drill pipe by means of an eductor 22. The eductor 22 is preferably mounted on the platform 3, for example, as illustrated in Fig. 1.

The eductor 22 includes a head 23 that is connected with the hose or down-leg 21 of the siphon through a nipple 24 and discharges through an elongated tubular body 25 that is connected to the discharge of the eductor. The tubular body 25 has an inlet portion 25a attached to the discharge end of the eductor and an elongated outwardly flaring discharge portion 25b forming the other end of the body member. The inlet portion 25a provides an elongated mixing chamber in which the ejection fluid is commingled with the drilling fluid at high velocity and the highly agitated mixture is discharged through the flared expansion chamber. An elbow 26 is preferably connected with the discharge
end of the tubular body for directing the educted fluid, cuttings, rock fragments and other solid materials into a pond 27, later to be described.

The high pressure educting fluid is discharged into the eductor through a pipe 28, to produce a suction on the drilling fluid in the drill pipe so that the column of fluid in the drill pipe moves upwardly under high velocity and is discharged with the jetting fluid through the cylindrical and flaring chambers of the elongated body member 25.

The pipe 28 extends upwardly and forwardly above the elongated tubular body member 25 and carries a \( \text{T} \) fitting 29, the \( \text{T} \) fitting 29 being connected with the outlet 7. The pipe 28 is a pipe 31 that extends across to the opposite side of the vehicle and connects by means of a stand pipe 32 with the swivel head 17 also on the Kelly rod 15.

The pipes 28 and 31 are provided on the respective sides of \( \text{T} \) fitting 29 with shut off valves 33 and 34 respectively. The discharge from the pump may be directed through either one of the pipes 28 or 31 or through both pipes as may be desired.

The pump 7 has an inlet 35 that connects, by means of a suction hose 36 with a clean fluid pond 37. The ponds 27 and 37 may be formed in the ground along side of the vehicle at the site of the drilling and inter-connected by a wier 38, substantially at the level of the liquid collecting in the pond 27 whereby the settled liquid from the pond 27 is passed over the wier 38 into the pond 37, the cuttings and solids having settled to the bottom of the pond 27. A part of the liquid, free of solid materials flows from the pond 27 through a flow duct or trench 39. The bore hole is thus kept full of liquid to replace the liquid withdrawn from the drill pipe as later to be described.

The Kelly rod 15 is best illustrated in Figs. 2, 2-A, 3 and 4 and has an elongated tubular body 40, forming an upflow passageway 41 that discharges through a fitting 42 and swivel 16. The body 40 of the Kelly has a collar portion 43 having a depending annular wall 44 spaced outwardly from the body of the Kelly rod to form an annular passage 45. The lower end of the passage 45 is closed about the body of the Kelly rod by arcuate plates 46 having the ends spaced apart to connect with upper ends of channels 47 and 48 (Fig. 4). The channels 47 and 48 each comprise web portions 50 and flanges 51 and 52. The flanges 51 and 52 are welded to the body portion of the Kelly to form longitudinal passageways 53 and 54 as best shown in Fig. 3. The lower end of the channels extend to near the lower end of the Kelly and are closed as at 56 for diverting the pressure fluid laterally through jet ports 57 and 58 as best shown in Fig. 2-A.

Formed in the wall 44 is a circumferential series of ports 59 which register with a pressure fluid connection 60 which is carried by an outer cylindrical casing 61. The casing 61 is placed over the wall portion 44 of the Kelly rod but is spaced between to accommodate packings 62 and 63 on the respective sides of the openings or ports 59. The packing is held between rings 64 which seat within the packing spaces and engage shoulders 65 in the upper and lower portions of the collar 43. The rings are backed by rings 66 and 67 which are in turn retained by rings 68 and 69, the rings 68 and 69 being secured to the ends of the casing 61 by fastening devices such as cap screws 70.

The pressure fluid connection 60, is connected with the stand pipe 32 by means of a hose 71 to allow raising and lowering of the Kelly. The channels 47 and 48 constitute driving keys that are engaged by slips 72 and 73, and seat in the drive bushing 74 of the turntable as shown in Figs. 1 and 2.

Assuming that the drilling apparatus is set up at the site where a bore hole is to be drilled, ponds 27 and 37 are provided alongside the platform 3 in position to receive discharge from the eductor and to discharge the inlet end of the suction hose 36 respectively. A wier 38 is provided between the ponds, and a trench 39 is provided to connect the pond 27 with the bore hole. The ponds are filled with drilling fluid and the inlet of the suction hose 36 is placed within the pond 37.

With the Kelly extending through the turntable and the channels 47 and 48 forming slitting key connections with the slips 72 and 73, the apparatus is placed in position for the bit to begin drilling of the bore hole. The pump 7 draws fluid from the pond 37 and discharges it under pressure through the \( \text{T} \) fitting 29 and pipes 28 and 31, so that a portion of the pressure liquid is discharged into the eductor head 23 to effect a suction on the liquid that rises within the Kelly rod so as to lift the liquid and discharge it through the elongated tubular body member 25 and elbow 26 into the pond 27. As the liquid is lifted, the liquid is replaced in the bore hole by that flowing through the trench 39.

Simultaneously, liquid is discharged under pressure through the pipe 31, stand pipe 32, and hose 71 into the swivel 17, from where the liquid flows through the ports 59 and into the passageways formed by the channels 47 and 48 for discharge through the jet openings 57 and 58 at the lower end of the drilling operation, whereby the excess of the drilling fluid and thereby maintain the velocity required to prevent settling out of any of the cuttings.

The lifting effect of the jets through the jet openings 57 and 58 applies lifting force to assure discharge of any large rock fragments that are loosened by the bit. The relatively volumetric flows can be controlled through the eductor and the jet openings 57 and 58 by regulating the valves 33 and 34. In case the jet openings 57 and 58 are not needed, the valve 33 may be closed to shut off flow of pressure fluids to the Kelly rod, and divert the entire discharge of the pump to the eductor.

As the bore hole deepens, the Kelly moves downwardly through the turntable until the swivel 17 reaches the table whereupon the Kelly rod will be lifted and a section of drill pipe will be connected between the bit and the Kelly to continue the drilling operation.

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

1. In a drilling apparatus for drilling a bore hole from the surface of the ground to substantial depths below said surface and which includes a drilling string composed of customary lengths of intercoupled drill pipe, the Kelly rod having an upflow duct connected with the upper drill pipe and having a downflow duct provided with a jet orifice opening into the lower end of the Kelly, a swivel head on the upper end of the Kelly rod, a swivel connection on the Kelly and having connection with the downflow duct, a bit on the lower end of the drill pipe, means for supplying said fluid to the upper end of the bore hole externally of the drill pipe to cause upward movement of drilling fluid within the drill pipe, means for supplying said fluid to the upper end of the Kelly rod, and means for rotating the Kelly rod, said downflow duct for supplying a fluid under pressure to the eductor for supplying a fluid under pressure to the eductor to
be discharged therefrom for furnishing energy to lift the drilling fluid and cuttings carried therewith through the siphon, means connecting the pump with the swivel connection to supply pressure fluid through the downflow duct to said jet orifice to increase the velocity flow of the drilling fluid and cuttings through the siphon to said eductor, an elongated tubular body member connected to the discharge of the eductor, said body member comprising an inlet portion attached to the discharge end of the eductor, and an elongated outwardly flaring discharge portion forming the other end of the body member and providing an outwardly flaring expansion chamber, whereby an elongated mixing chamber is provided in said elongated body member to provide commingling and high velocity agitation of the drilling and pressure fluids and whereby discharge of the drilling and pressure fluids is effected through the flared expansion chamber.

2. A drilling apparatus as described in claim 1 including means in said duct means which supply the pressure fluids to proportion flow of the pressure fluids to the jet orifice and to the eductor.

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