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2,319,514

APPARATUS FOR CONTROLLING FLUID FLOW THROUGH DRILL STRINGS

Filed Sept. 8, 1941

2 Sheets-Sheet 1

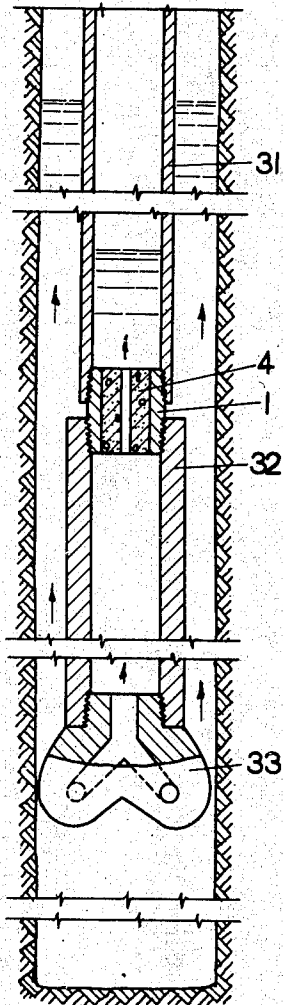


Fig. I

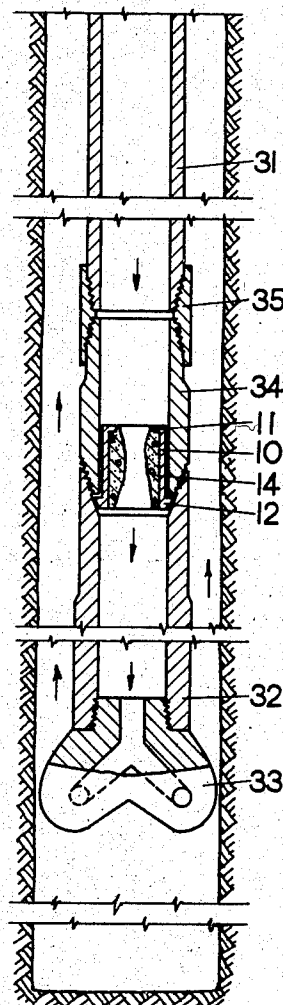


Fig. II

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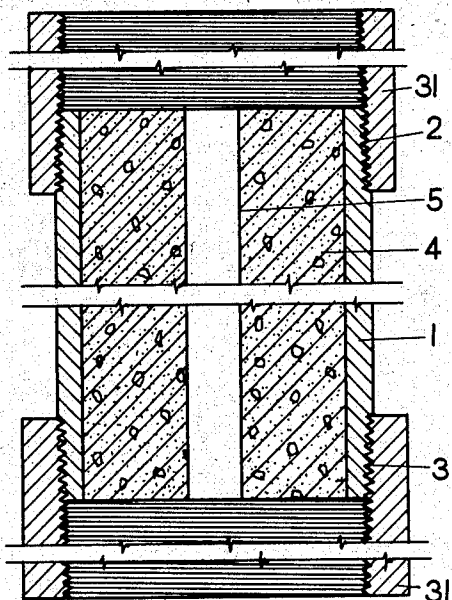


Fig. III

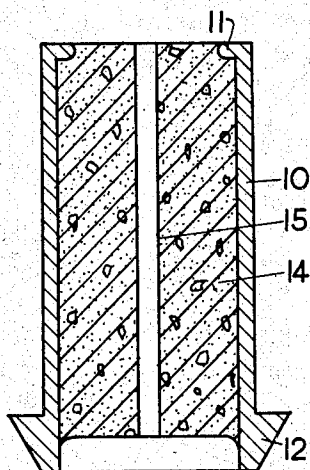


Fig. IV



Fig. V

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UNITED STATES PATENT OFFICE

2,319,514

APPARATUS FOR CONTROLLING FLUID FLOW THROUGH DRILL STRINGS

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3 Claims.

(Cl. 255-28)

The present invention relates to apparatus for drilling oil and gas wells and pertains more particularly to the procedure following in lowering a drill string into a borehole containing mud fluid.

In the drilling of boreholes, and particularly those of small diameter, the annular space between the walls of the hole or casing, and the outside of the bit and drill collars comprising the lower portion of the drill string is frequently so small that when the drill string is lowered into the borehole this lower portion of the drill string acts as a plunger, with the result that the drilling fluid or other circulating medium is forced up with considerable force through the axial bore of the drill string and overflows onto the derrick floor. Obviously, such a condition is highly objectionable in that it creates working hazards and results in drilling time being lost.

It is therefore an object of this invention to provide an apparatus for lowering a drill string into a borehole containing mud fluid, whereby the flow of mud fluid up through the drill string is restricted by orifice means placed in the drill string and removable by subsequent circulation of mud fluid down through the drill string.

It is another object of this invention to provide a method of reinserting a tubular drill string into a borehole containing a mud fluid comprising the step of inserting into the lower portion of said drill string removable means for restricting fluid flow therethrough.

It is a further object of this invention to provide a flow throttling device comprising an axially-perforated plug of a material which is readily eroded or abraded away by flow of mud fluid through the perforation therein, which device may be inserted into the lower portion of the drill string to control the fluid flow therethrough during the operation of lowering said string into a borehole.

Further objects will be apparent from the following description taken in reference to the following drawings wherein:

Figure I is a vertical sectional view of a borehole containing a drill string and mud fluid and illustrates the drill string lowering step of the present method.

Figure II is a vertical sectional view of a borehole containing a drill string and a mud fluid and illustrates the step of removing the restricting plug in the present method.

Figure III is a vertical sectional view of a preferred embodiment of the present drill string flow throttling device.

has been known to maintain a fluid level in the borehole.

Referring to Figure IV, another embodiment of the flow throttling device comprises a pipe nipple 1 having threaded ends 2 and 3, adaptable to be inserted between and to connect adjacent stands or lengths of the drill string, as shown in Figure I. Filling the bore through said nipple 1 is a plug 4, which is axially-perforated as at 5. Suitable materials from which plug 4 may be made include concrete compositions, natural and synthetic rubber or mixtures thereof, Bakelite, soft metals or alloys, soft mineral compositions, hard asphalt or mixtures thereof, etc.; for example, a preferred

embodiment of the present drill string flow throttling device is shown in Figure V. The device is a vertical sectional view of a further embodiment of the present drill string flow throttling device. The method of the present invention is applied when it is desired to lower a tubular drill string into a borehole containing a substantial amount of mud fluid. It will be apparent that the lower limit of the amount of mud fluid in the borehole requiring the use of the present method depends upon various factors, such as the clearance between the lower portion of the drill string and the borehole walls or casing, the speed at which the drill string is lowered, the efficiency of the plunger action, the effective volume of fluid displaced by the drill string, the internal diameter of the drill collar and string and tool joints, the viscosity of the drilling fluid, etc. Generally, however, due to present drilling practices which often allow drilling fluid to stand at the surface or within about 50 feet from the surface and wherein the difference between the borehole and outside drill collar diameter is approximately 1.5 inches or less, it will be found necessary to use the present method, which comprises the steps of first introducing into the lower portion, preferably, of the axial bore of said drill string, while said portion of the string is at the surface, restricting means, such as a perforated plug or annular member formed of a material which is readily eroded away by mud fluid flow, then lowering the drill string into the borehole, whereby the plunger action of the drill bit and collar is prevented by the restricting means from forcing mud fluid up through the drill string and onto the derrick floor; and, finally, circulating mud fluid through the drill string and the restriction under relatively high pressure to erode away and remove said restricting means.

Figure IV is a vertical sectional view of another embodiment of the present drill string flow throttling device.

Figure V is a vertical sectional view of a further embodiment of the present drill string flow throttling device.

The method of the present invention is applied when it is desired to lower a tubular drill string into a borehole containing a substantial amount of mud fluid. It will be apparent that the lower limit of the amount of mud fluid in the borehole requiring the use of the present method depends upon various factors, such as the clearance between the lower portion of the drill string and the borehole walls or casing, the speed at which the drill string is lowered, the efficiency of the plunger action, the effective volume of fluid displaced by the drill string, the internal diameter of the drill collar and string and tool joints, the viscosity of the drilling fluid, etc. Generally, however, due to present drilling practices which often allow drilling fluid to stand at the surface or within about 50 feet from the surface and wherein the difference between the borehole and outside drill collar diameter is approximately 1.5 inches or less, it will be found necessary to use the present method, which comprises the steps of first introducing into the lower portion, preferably, of the axial bore of said drill string, while said portion of the string is at the surface, restricting means, such as a perforated plug or annular member formed of a material which is readily eroded away by mud fluid flow, then lowering the drill string into the borehole, whereby the plunger action of the drill bit and collar is prevented by the restricting means from forcing mud fluid up through the drill string and onto the derrick floor; and, finally, circulating mud fluid through the drill string and the restriction under relatively high pressure to erode away and remove said restricting means.

To carry out the above method, various suitable restricting means may be used. Referring to Figure III, a preferred embodiment of a flow throttling device comprises a pipe nipple 1 having threaded ends 2 and 3, adaptable to be inserted between and to connect adjacent stands or lengths of the drill string, as shown in Figure I. Filling the bore through said nipple 1 is a plug 4, which is axially-perforated as at 5. Suitable materials from which plug 4 may be made include concrete compositions, natural and synthetic rubber or mixtures thereof, Bakelite, soft metals or alloys, soft mineral compositions, hard asphalt or mixtures thereof, etc.; for example, a preferred

composition is a mixture of cement and soap-stone.

Referring to Figure IV, another embodiment of the throttling device comprises a pipe nipple 10 having an internal bead 11 at one end of the axial bore thereof and an external rib 12 on the other end of said nipple. The rib 12 is adapted to fit in the joint between two sections of the drill string such as, for example, between the lowermost drill collar 32 and the double pin substitute 34 which is attached to the drill tubing 31 by coupling number 35, as shown in Figure II. Likewise, in the bore of this nipple 10 is a plug 14 of suitable erodable material such as listed above, for example concrete, having an axial perforation 15 therethrough. The bead 11 serves to hold the plug in place but is insufficient to appreciably impede normal fluid circulation through the drill string after the plugging material is removed.

Referring to Figure V, still another embodiment of the throttling device comprises a centrally-perforated disc 20 of soft metal or alloy such as brass, lead, copper, tin, etc., or a hard plastic composition. Disc 20 is formed with a thickened outer circumferential portion or rib 21, adapted to fit in a joint between two sections of the drill string.

Referring to Figure I and II, in operation, a throttling device such, for example, as that shown in Figure III, is inserted into the lower portion of a drill string, such as between the tubing 31 and the drill collar 32, while said portion of the drill string is at the surface; that is, while the drill string is being made up. The preferred position of the removable throttling device in the drill string is directly above the lowermost drill collar, that is, approximately 50 feet from the drill bit. The maximum possible distance between the throttling device and the bottom of the string is only limited by good practice, for example, within 250 feet of the bit. With the throttling device in the desired position, the drill string is then lowered into the borehole, whereby (as indicated by the small and large arrows in Figure I) the axially-perforated plug 4 restricts the passage of the mud fluid up through the drill string due to the plunger action of the drill collar 32 and bit 33, and thereby prevents the mud fluid from shooting upwards and overflowing onto the derrick floor. Thereafter, mud circulation down through the drill string, which may be applied in a normal way or under somewhat increased pressure to accelerate the effect, quickly abrades or erodes away the soft plugging material of the flow control device. (Figure II shows an intermediate stage in the removal of the plug 14 of the embodiment of Figure IV.) After the plugging ma-

terial is completely removed, the normal full bore of the drill string is again available for circulation of drilling fluid. Thus, the present invention permits the desired operation of restricting flow through the drill string during lowering thereof into a borehole and of quickly reopening the drill string to full bore without requiring any intricate manipulations. Upon withdrawing the drill string from the borehole again, the nipple 1 may be removed from drill string and refilled with a plug of suitable material for reuse.

To illustrate the conditions under which the present method and apparatus are particularly applicable, the following average values which produce the undesirable overflow may be given by way of example: length of drill collars, 175 feet; outside diameter of drill collars, 7 inches; inside diameter of drill collars, 3.5 inches; inside diameter of drilling string, 4.892 or 3.754 inches; tool joints used, internal flush joint; and mud viscosity, 23 centipoises.

I claim as my invention:

1. A throttling device for tubular drill pipe comprising an external annular member, means for anchoring said member within said pipe, and an internal annular member bonded to said external member concentrically within said external member, said internal member being made of abradable material, the axial perforation through said internal member having a diameter substantially smaller than the outside diameter of said external member.

2. A throttling device for tubular drill pipe strings comprising an external metallic annular member, external screw threads on the opposite axial ends of said member for fixedly connecting said member between two drill pipe lengths, and an internal annular member bonded to said external member concentrically within said external member, said internal member being made of abradable material, the axial perforation through said internal member having a diameter substantially smaller than the outside diameter of said external member.

3. A throttling device for tubular drill string comprising an external annular member, an external projecting annular rib on said external member for fixedly clamping said member between two sections of the drill string, and an internal annular member bonded to said external member concentrically within said external member, said internal member being made of abradable material, the axial perforation through said internal member having a diameter substantially smaller than the outside diameter of said external member.

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