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AERATED FLUID DRILLING PROCESS

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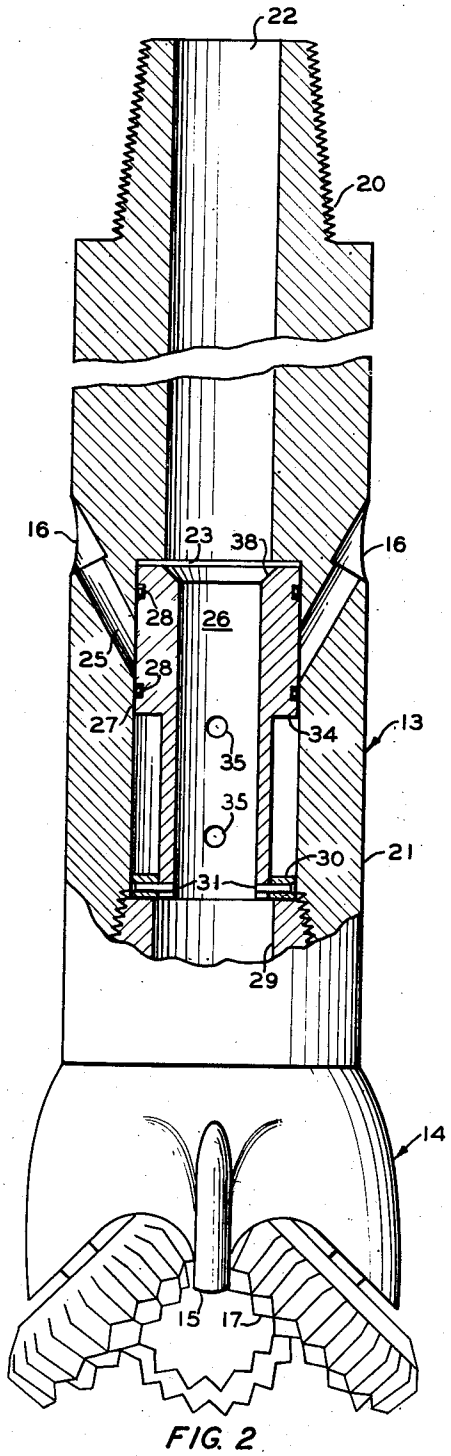

FIG. 2

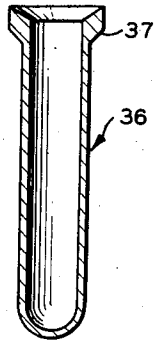

FIG. 3

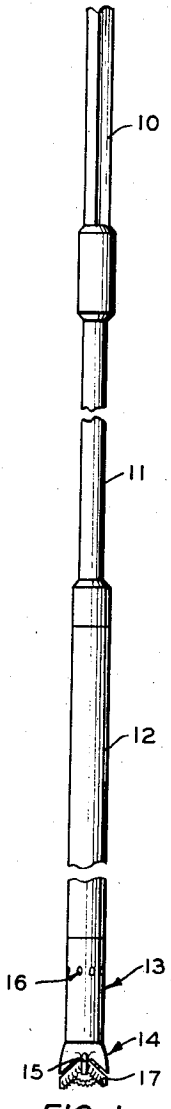

FIG. 1

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AERATED FLUID DRILLING PROCESS

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5 Claims. (Cl. 255—1.8)

This invention relates to an apparatus and process for use in rotary drilling with aerated drilling fluid.

In drilling oil wells, it has been found that using a light weight drilling fluid often increases the drilling rate and reduces the number of bits used, thus decreasing drilling costs. One successful method for obtaining a light weight drilling fluid is to inject air or natural gas into the drilling fluid at the well head. To provide the necessary pressure drop across the drill bit for proper control of the drilling fluid column, it is often necessary to reduce the size and/or number of jets in the drill bit. However, it is necessary to displace the air or gas-lightened fluid with non-aerated fluid before pulling the pipe from the hole. The reduced area for circulation through the bit decreases the circulation rate, thus increasing the waiting time before pulling the pipe and off-setting some of the savings made by using light weight drilling fluid. My invention comprises a method and apparatus for reducing the lost time while displacing air from the hole.

The principal object of the invention is to provide an improved process and apparatus for rotary drilling with aerated drilling fluid. Another object is to provide a method and apparatus for use in rotary drilling which reduces the time required to replace an aerated drilling fluid in the drill string and well-bore annulus with non-aerated drilling fluid. A further object is to provide a method and apparatus for reducing the lost time in rotary drilling when changing the drilling fluid in the drill string and bore hole from an aerated to a non-aerated type. Other objects of the invention will become apparent from a consideration of the accompanying disclosure.

The invention comprises a method and means for rapidly circulating non-aerated drilling fluid out of the drill string and annulus through circulating conduit means larger in cross sectional area than the cross sectional area of the fluid circulating means in the drill bit. This auxiliary circulating conduit means is positioned above the bit near the end of the drill string and preferably between the lowest drill collar and the drill bit. When making hole, the auxiliary circulating conduit means is closed to the flow of drilling fluid but can easily be opened to such flow when it is desired to displace the aerated drilling fluid in the bore hole.

More complete understanding of the invention may be had by reference to the accompanying schematic drawing of which Figure 1 is an elevation showing a drill string including the device of the invention; Figure 2 is a longitudinal cross section of the circulating sub of the invention attached to a rotary drill bit; and Figure 3 is a longitudinal cross sectional view of a shearing dart to be used in combination with the circulating sub shown in Figure 2.

The drill string is illustrated in Figure 1 and comprises kelly **10**, drill pipe **11**, drill collar **12**, circulating sub **13** and drill bit **14**. Drill bit **14** includes one or more circulating jets **15**, while circulating sub **13** includes at least one circulating nozzle **16**.

Figure 2 is a broken cross section of circulating sub **13** and a portion of drill bit **14**. Circulating sub **13** comprises a tubular body **21** having a threaded pin **20** for attachment with drill collar **12**. A central passage **22** extends through pin **20** and body **21** and is enlarged or expanded in a lower section **23** to provide operating means for the hereinafter described valve. One or more ports or passageways **25** in the wall of body **21** connect the upper portion of expanded section **23** with circulating nozzle **16** to provide conduit means from the axial passageway **22** through circulating sub **13** to the annulus surrounding the drill string. The transverse cross sectional area of ports **25** must be greater than that of the corresponding area of jets **15**. A tubular valve member **26** is positioned in expanded section **23** in engaging relation with the wall thereof and is provided with O-ring seals **28** in its outer cylindrical surface **27** which cooperate with the cylindrical wall of section **23** to form a seal between central passage **22** and ports **25**. Drill bit **14** is provided with a pin **29** which is threaded into the lower end of body **21**, and with cones **17** and jets or circulating conduits **15**. A ring **30** is attached to the lower end of valve **26** by shear pins **31** so that ring **30** rests on the upper end of pin **29** to maintain valve **26** in the position shown. The upper portion of valve **26** is larger than the lower portion, thus forming a shoulder **34** which is larger in diameter than the central bore of ring **30**. Openings **35** through the wall of tubular valve **26** below shoulder **34** serve to equalize the pressure in the annular space between the valve and body member **21** and in the central passageway **22**. A shearing dart **36**, illustrated in Figure 3, has a seating surface **37** which is machined to form a seal with surface **38** of valve **26**.

During normal operations, valve **26** is in the position shown and the circulation of air-lightened drilling fluid is from the usual mud circulation equipment (not shown) into kelly **10**, through drill pipe **11** and drill collar **12**, passage **22**, valve **26**, pin **29** and circulating jets **15** and upward within the annular space within the well bore to the surface of the ground. When it becomes necessary to pull the pipe from the well, shearing dart **36** is inserted into the hollow drill string at the surface of the ground and is pumped downward until surface **37** seats on surface **38** thus forming a tight shut off. The force generated by the pressure of the drilling fluid quickly shears pins **31** and forces valve **26** downward until shoulder **34** contacts ring **30**. O-ring seal **28** and the top of valve **26** are below ports **25**, thus opening a larger area for circulation. The circulation rate is then greatly accelerated without additional pressure, thus reducing the time necessary to displace the air from the hole.

It is apparent that the circulating capacity of ports **25** in the wall of sub **21** must be substantially larger than that of the jets or circulating means in the drill bit in order to obtain substantial advantage from the invention. It is desirable to construct the sub so that ports **25** are at least 50% greater in transverse cross sectional area than jets **15** and, preferably, at least 3 or 4 times greater. This may be accomplished by making cylindrical conduits **25** larger in diameter and/or more numerous than jets **15**.

Certain modifications of the invention will become apparent to those skilled in the art and the illustrative details disclosed are not to be construed as imposing unnecessary limitations on the invention.

I claim:

1. A process of rotary drilling with an aerated drilling fluid comprising circulating said fluid through a hollow drill string including a rotary drill bit on its lower end while rotating said string in an earth bore hole until pulling of said string is desired; thereafter closing said string just above said bit to the flow of fluid, opening at least

one port in said string above the level of closure, and displacing said fluid through said at least one port at a faster rate than would be effected through said bit at any given hydrostatic head by injecting non-aerated drilling fluid into the upper end of said string until aerated fluid is displaced from said string above said at least one port and from the surrounding annulus; and thereafter pulling said string.

2. The process of claim 1 wherein said aerated drilling fluid comprises aqueous drilling mud aerated with compressed air.

3. The process of claim 1 wherein said fluid is circulated thru a plurality of said ports.

4. In a process of rotary drilling with a drilling fluid circulating thru a hollow drill string, including a rotary drill bit on the lower end of said string, while rotating said string in an earth bore hole until rapid changing of the drilling fluid in said string is desired; the improvement comprising, closing said string just above said bit

to the flow of fluid therethru and circulating the fluid in the drill string thru at least one port in said string just above the level of closure at a faster rate than would be effected thru said bit at any given hydrostatic head by injecting a second drilling fluid into the upper end of said string until the original drilling fluid is displaced from said string above said port.

5. A process of claim 4 wherein the drill string and annulus surrounding the drill string are filled with an aerated drilling fluid comprising aqueous drilling mud and compressed air, and the second drilling fluid comprises non-aerated aqueous drilling mud.

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