

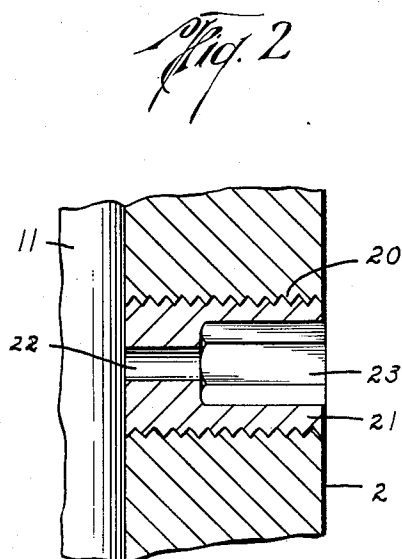
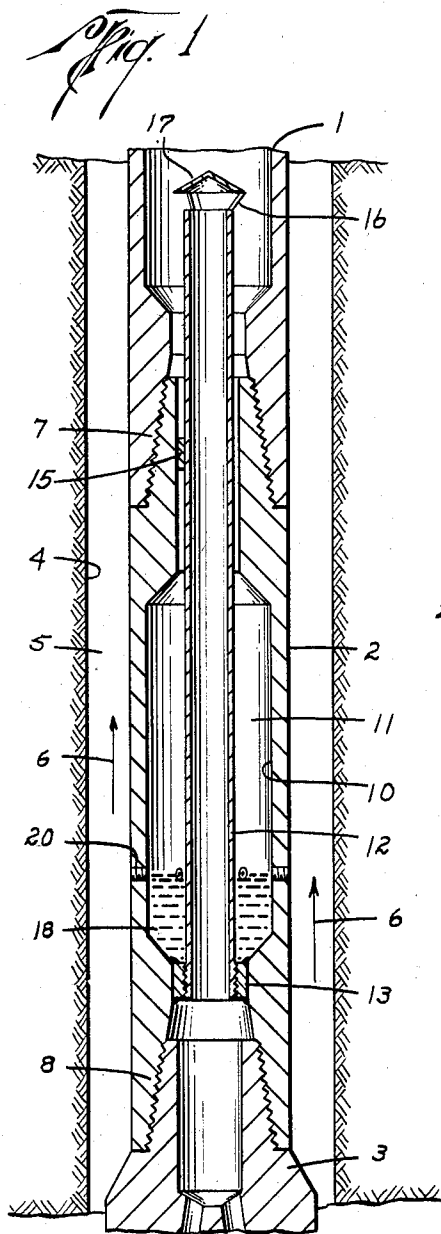
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WATER SEPARATOR FOR AIR DRILLING

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## WATER SEPARATOR FOR AIR DRILLING

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This invention relates to the drilling of earth bores by the rotary method of drilling and more particularly to such drilling wherein the flushing fluid is a gaseous medium pumped downwardly through the drill string and thence outwardly through the flushing fluid passageways in the drill bit and upwardly in the annulus about the drill string to remove cuttings from the bore as drilling advances.

In the drilling of earth bores by the rotary method, for shot holes, wells, and the like, air or other gaseous fluid is frequently used as a flushing fluid to cool the bit and to remove cuttings. In such case a relatively large volume of the gaseous fluid is used to perform its various functions and, since much of the cutting is finely divided a large amount of dust is released at the drilling site as the flushing fluid and entrained cutting are exhausted into the atmosphere. This condition is very undesirable as it adversely affects both personnel and equipment and pollutes the air at and about the drilling operation.

To alleviate this difficulty it has been proposed to add a small amount of water or other liquid to the flushing fluid, such liquid serving to moisten the surfaces of particles of the cuttings and thereby eliminate the dust hazard. Such procedure, however, has been found to effect a plastering of the fine cuttings upon the wall of the bore at and proximate the well drill whereby such cuttings effect a destructive abrasive action upon the well drill.

The primary object of the invention is to provide equipment that enables the use of liquid in the gaseous flushing fluid in a manner that equipment is protected, efficient removal of cuttings from the bore is maintained and the dust hazard at the location of drilling operations is eliminated.

Another and more specific object is to introduce liquid to the moving stream of gaseous fluid and entrained cuttings at a point above the drill bit where conditions are such that there is effective dampening or surface wetting of the particles of cuttings to suppress dust and at the same time to avoid build-up on the wall of the bore at or proximate the bit.

Another object is to provide a special section of drill pipe above and preferably proximate the drill bit, such section of pipe being so constructed as to separate from the stream of flushing fluid moving downwardly in the drill pipe, the liquid introduced into the stream at the surface and to reintroduce such liquid into the upwardly moving stream of flushing fluid and entrained cuttings at a point spaced from the drill bit.

These objects together with other objects and advantages of the invention will be more fully apparent from the following description considered in connection with the accompanying drawings in which:

Fig. 1 is a sectional view through an earth bore showing in section within the bore one form of apparatus embodying the invention;

Fig. 2 is an enlarged detail showing an ejector port for conducting liquid from within the drill string to the an-

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nulus thereabout so that such liquid will produce desired action in removing cuttings from the bore.

Broadly the invention comprehends the introduction of a small quantity of liquid wetting agent, preferably water, to the annulus above the drill bit and about the drill string when a gaseous flushing fluid is used when drilling by the rotary method. One form of device for accomplishing this purpose is shown in the drawings wherein the drill string is shown at 1 provided with a special collar 2 to which the drill bit 3 is attached. The bore hole is shown at 4, there being an annulus 5 about the drill string through which flushing fluid and entrained cuttings move upwardly from the bottom of the bore as indicated by the arrows 6. The collar or sub 2 is attached in the drill string by suitable threaded connections such as those shown at 7 and 8.

The bore in the collar 2 is enlarged centrally at 10 to form a chamber 11 about the hollow standpipe 12 threadedly secured in bushing 13 welded or otherwise secured in the lower end of the collar. To prevent wobble of the standpipe 12 relative to the axis of the assembly a plurality of centering shims 15 are peripherally spaced in the annulus between the standpipe 12 and the collar 2.

The standpipe 12 extends upwardly into the lower end of the section of drill pipe 1 and is surmounted by a plurality of upwardly extending legs 16 to which is secured a small cone shaped canopy 17.

It is intended that the device thus far described will receive a stream of gaseous flushing fluid to which a limited amount of a liquid wetting agent, preferably water, has been added at the surface.

The amount of water added will depend upon a number of factors, suffice it to say that the amount should be sufficient to saturate the gaseous fluid arising in the annulus 5, about the collar 2, plus such additional amount that the cuttings will be properly moistened to suppress dust at the surface but at the same time insufficient to produce destructive and impeding buildup on the walls of the bore 4.

At the upper end of the standpipe 12 the air is diverted and enters the standpipe 12 beneath the canopy 17 whence it moves downwardly to and through the fluid passageways of the bit 3. The liquid on the other hand separates and forms a body of liquid 18 within the chamber 11.

It is desired that as this liquid accumulates it shall be properly exhausted into the annulus 5 so that it will effect desired wetting action upon the cuttings arising within the annulus. To accomplish this we provide a plurality of ejector ports 20 in the walls of the collar 2. Although these ports are shown as six in number any suitable number may be used and may extend radially or nonradially and be inclined upwardly or downwardly, the principal requirement being that they be of such size as to always pass liquid at the rate of its collection within the collar but at the same time to bleed off a minimum of the circulated gaseous flushing fluid.

We find it preferable that the ejector ports 20 comprise stainless steel socket head set screws 21 (Fig. 2) threadedly secured in place in the wall of the collar 2. When using liquid at the rate of, for example, 1½ gallons per 1500 cubic feet of gaseous fluid it is satisfactory to use a ¼-inch drilled hole 22 from the bottom of the socket 23 to the interior of the collar. This construction has been found effective in properly exhausting liquid from within the chamber 11 and at the same time in preventing plugging of the holes with fine cuttings especially when withdrawing the drill string from the well bore 4.

Use of the device of the invention is believed apparent from the foregoing description. By way of summary it is pointed out that gaseous flushing fluid with a selected amount of wetting agent is pumped downwardly in the drill stem 1 during the drilling operation. The gaseous

component enters the standpipe 12 beneath the canopy 17 while the liquid component separates and collects as a body of liquid 18 in the chamber 11. The gaseous fluid exhausts through the ports in the bit 3 where it produces desired cooling action upon the bit and lifts cuttings from the bottom of the bore hole to travel with the flushing fluid as indicated by the arrows 6.

When the fluid exhausts from the bit 3 there is a drop in pressure to substantially atmospheric pressure in the annulus 5. Hence, any residual moisture that may be entrained in the fluid is in vapor form and there is no moistening of the cuttings at this point.

On the other hand the liquid exhausted from the ejector ports 20 is ejected into an area of low pressure and in a manner to produce desired wetting action of the cuttings rising in the annulus 5. It is thus apparent that there can be no build up of cuttings on the walls of the bore hole at or proximate the bit 3, or upon, the bit itself, that destructive and impeding effects may arise.

While specific structure and operating characteristics have been given it is to be understood that same are illustrative only and not limitative of the invention.

The invention claimed is:

1. In a drill string having a drill bit at its lower end for drilling earth bores by the rotary method, a hollow body member connected into the drill string above the bit thereon, an upstanding tubular member having its lower end secured to and closing the passage through the body member, the periphery of said tubular member being spaced from the inner walls of the body member, thereby forming an annular chamber, closed at its lower end, the interior of said tubular member communicating with the bore of the drill string therebelow, means for separating a mixture of liquid and gaseous fluid pumped downwardly through the drill string and directing the liquid component into said chamber and the gaseous component to the interior of said tubular member, and additional means for exhausting said liquid component from the chamber to the exterior of the body member, and above the drill bit.

2. In a drill string having a drill bit at its lower end for drilling earth bores by the rotary method, a hollow body member connected into the string above the bit thereon, an upstanding tubular member secured in said body member and having its lower end closing the passage therethrough, the periphery of the tubular member being spaced from the inner walls of the body member thereby forming an annular chamber closed at its lower

end, the interior of said tubular member communicating with the bore of the drill string therebelow, a closure for the upper end of said tubular member, means forming at least one passage from the exterior to the interior of the tubular member at a point spaced upwardly from the lower end of the tubular member, whereby mixed liquid and gaseous components of fluid pumped downwardly through the drill string are separated, the liquid component collects in said chamber and the gaseous component is directed through the tubular member and downwardly to the drill bit, and means proximate the lower end of said chamber for exhausting said liquid component from the chamber to the exterior of the body member.

3. In a drill string having a drill bit at its lower end for drilling earth bores by the rotary method, a hollow body member connected into the string above the bit thereon, an upstanding tubular member secured in said body member, and having its lower end closing the passage therethrough, the periphery of the tubular member being spaced from the inner walls of the body member thereby forming an annular chamber closed at its lower end, the interior of said tubular member communicating with the bore of the drill string therebelow, a closure for the upper end of said tubular member, means forming at least one passage from the exterior to the interior of the tubular member at a point spaced upwardly from the lower end of the tubular member, whereby mixed liquid and gaseous components of fluid pumped downwardly through the drill string are separated, the liquid component collects in said chamber and the gaseous component is directed through the tubular member and downwardly to the drill bit, and means proximate the lower end of said chamber for exhausting said liquid component from the chamber to the exterior of the body member, said last mentioned means comprising a passage in the wall of the body member, said passage having an inner portion of reduced cross section communicating with said chamber.

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