

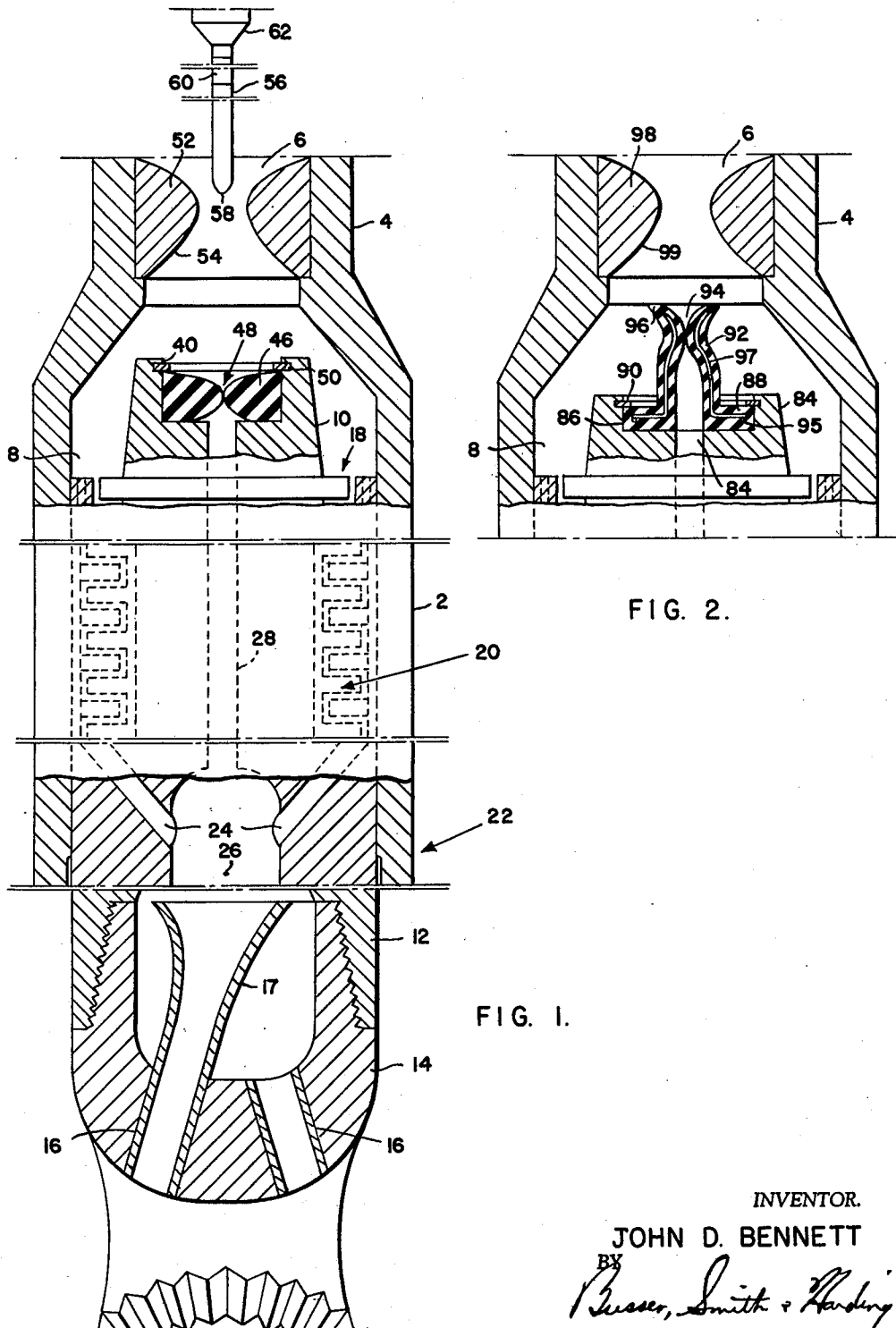
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APPARATUS FOR BORE HOLE DRILLING AND LOGGING

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APPARATUS FOR BORE HOLE DRILLING AND LOGGING

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This invention relates to apparatus for bore hole drilling and logging and, more particularly, to the modification of a turbodrill assembly to permit the projection of a logging assembly below the bit thereof.

Conventional methods of well logging, whether of electrical or other types, involve the absence of the drill stem during the logging operation. This has two serious drawbacks in that not only must special time be consumed in running the well log, during which time the drill stem must be out of the hole, but after a period of drilling, due to the fact that the drill stem must be removed, there is inevitably a delay before the new part of the hole may be logged, during which delay there occurs invasion of the formation by drilling liquid. Since the drilling liquid has physical properties of its own, it may, by penetration of porous layers, greatly change their properties so as to interfere with their detection. For example, in the case of electrical logging, the conductivity of the liquid will effect changes in the apparent conductivity of the formations; and in the case of acoustic logging the absorption and velocity of sound will be changed, etc.

Proposals have been made to effect electrical logging by using the drill bit or one or more other parts of the drill stem as logging electrodes. In line with this it has been proposed to supply special drill stem tubing containing one or more conductors which are electrically connected in the assembly of the drill stem and extend to recording apparatus at the surface. The use of such an arrangement has been found to be impractical because of high cost and wear.

Proposals have also been made to support one or more electrodes on wire lines to be dropped below a core bit into the lower portion of a hole from which the bit has been raised. This procedure has also proved impractical inasmuch as special handling has been required at the surface, but particularly because core bits are not generally desired for the major drilling activities but are used only for special purposes.

In the applications of Mayes and Jones, Serial No. 683,027, filed September 10, 1957, and of Bennett, Chaney, Jones and Mayes, Serial No. 685,717, filed September 23, 1957, there are disclosed methods and apparatus for logging below a drilling bit which methods and apparatus avoid the shortcomings referred to above. In accordance with the disclosure of said applications, the logging methods and apparatus may be used when a drill string is in a bore hole and may be used at any time with a minimum of interruption of drilling. Not only may the logging be accomplished just prior to removal of the drill string for the purpose of changing a bit, but the logging may be carried out to be promptly followed by a continuation of drilling. In brief, a self-contained energizing and recording apparatus may be dropped through a drill string in go-devil fashion or may be pumped down therethrough when the drill string has been lifted to only a limited extent from the bottom of the hole to provide a region for reception of an electrode or other logging assembly. The apparatus particularly includes an assembly of a type suitable to pass through the mud flow openings of a jet bit. These jet openings are generally at relatively small angles with respect to the drill stem axis

and a flexible assembly may, accordingly, be projected therethrough to extend beneath the bit. For electrical logging the assembly is an electrode assembly; for acoustic or other logging it may be of suitable type for exposure to the walls of the hole.

The self-contained assembly which is lowered to the vicinity of the bit contains, for electrical logging, not only means for supplying current to the earth, but also means for recording various potentials at the electrodes of the assembly, the recording being desirably, and as disclosed in said prior applications, effected magnetically.

There has recently come into use a new type of bore hole drill known as a turbodrill involving a turbine rotor connected to a drill bit, the rotor being driven by the drilling fluid. This requires diversion of the fluid from the axis for the driving of the turbine blading and tortuous passages through the blading so that a logging element cannot be passed therethrough to project below the bit. The full flow of drilling fluid must be directed through the turbine and this prevents the use of a central passage through which a logging element might be directed.

It is the general object of the present invention to provide a drilling arrangement through which there is provided a straight or substantially straight passage through which the logging element, for example, a tubular elongated member carrying electrodes, may be passed so as to project beyond a bit during a logging operation. Provision is made in accordance with the invention, to close off this passage to prevent such free flow of drilling fluid as would interfere with proper operation of the turbine.

The foregoing general object of the invention as well as others particularly relating to details of construction and operation will become apparent from the following description, read in conjunction with the accompanying drawing, in which:

FIGURE 1 is a vertical section showing one form of turbodrill assembly which may be provided in accordance with the invention; and

FIGURE 2 is a fragmentary section showing another valve arrangement which may be used.

The logging assembly, per se, forms no part of the present invention and is indicated merely diagrammatically as will more fully appear hereafter. It may be of the form disclosed in detail in the foregoing applications, consisting of a pressure-tight housing in which is located recording apparatus assembled with a "wand" which is adapted to project beyond the bit. For consistency of description, the apparatus will be referred to in the form of an electrical logging apparatus in which the wand carries electrodes arranged for the introduction of alternating current into the earth and for pick up of alternating and direct potentials. It will be understood, however, that other logging apparatus may be employed in which a pick up or energizing element is of elongated type and of sufficiently small diameter to pass through passages such as are hereafter described. The term "wand" has been particularly applied in the applications referred to above because it is flexible but has considerable stiffness to enable it to deflect from a straight condition to pass through the non-axial openings of jet bits. As will appear, in the present case, if the bit is provided with an axial passage the wand may be quite rigid, though because of the length which it will normally have and its relatively small diameter it will be somewhat flexible. Flexibility, however, is not then a requirement. However, if the bit has only diverging, non-axial, mud passages, the wand may be more flexible as described in said prior applications. For consistency of description and reference to said prior applications the term "wand" will be used to describe the element which carries electrodes or other

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energizing or pick up apparatus, whether flexibility is or is not an important characteristic.

Referring first to FIGURE 1, there is shown therein an assembly, which, except for rather minor changes, is a conventional turbodrill. A housing member 2, which is arranged to be secured in conventional fashion to the lower end of a hollow drill stem through which mud is pumped as the drilling fluid, encloses and mounts the turbine, the circulated mud entering its neck 4 through passage 6 and being delivered by a side passage 8 to the turbine. The turbine shaft, indicated at 10, is provided with a suitable extension at 12 to carry the bit 14 which may be of any conventional rotary type and is indicated as of the multiple cone rock type provided with jet openings 16. In such case, guiding means 17 are provided for causing the wand to pass through one of the jet openings as described in said Mayes and Jones application. However, if a bit is used which has a central opening, special guiding means need not be provided, the wand then remaining centrally located.

The bearing arrangement for the turbine shaft is conventional and indicated at 18, comprising rotating and fixed rings lubricated by the drilling fluid and provided with by-pass means to guide the drilling fluid to the blading 20 of the turbine, the blading comprising rotary vanes carried by a hub forming part of the shaft and stationary redirecting vanes carried by the housing member 2. After passage through the blading the fluid flows through passages 24 to a central axial passage 26 and thence to the bit for flow through the jet or other openings therein. A conventional lower bearing arrangement is indicated at 22.

For proper operation of the turbine, the tail passage 26 must be isolated from the entrance region of the fluid above the turbine, and hence conventionally there is not provided an axial passage which, in the present instance, is provided at 28.

In order to close the passage 28 during drilling, the upper end of the turbine shaft is provided with a cylindrical socket 40 within which there is located the rubber valve 46 which is normally closed at 48, being retained in position by the snap ring 50. Differential mud pressure across the valve by compression of the valve normally maintains its opening in closed condition, but a wand may readily penetrate enlarging the opening for its passage.

A converging-diverging diffuser passage 54 is provided in the neck 4 by means of a metal ring 52 to provide a central guide for the wand to cause it to penetrate the valve 46 centrally.

The logging wand 56 may be of the type disclosed in said prior applications, and may be provided, as described therein, primarily by a coiled spring carrying, additionally, electrodes such as 58 and 60 in the case of electrical logging apparatus, the wand being otherwise externally insulated. The wand is carried by the lower end of the housing 62 within which there is located the current-providing and recording apparatus of the type disclosed in said prior applications, or of some other type if the logging is other than electrical. If a continuous axial passage is provided running through the bit, the wand may be essentially rigid, except for the possibility of flexure due to its considerable length which may ordinarily be upwards of twenty feet.

Drilling may be effected in conventional fashion with the drill in the bottom of the hole, mud flow being provided to drive the turbine and thereby rotate the bit.

When it is desired to effect logging, the bit will be raised a suitable distance above the bottom of the hole, and the logging apparatus may then be dropped or lowered through the drill stem and the wand will pass through the guide opening at 54 and then penetrate the valve at 46, passing thence downwardly through the passages 28 and 26 and being guided through the jet opening 16 after deflection by the guiding means 17. In this operation it

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will ordinarily engage the wall of the hole and will be deflected thereby downwardly to extend along the hole, though, of course, it will pass downwardly centrally if the bit is provided with a central opening. The housing 62 may be brought to rest in any suitable fashion, and there may be used a cushioning arrangement such as shown in said prior applications to prevent damage by impact. After the logging apparatus is thus located in position, the drill stem may be raised and logging effected as described in said prior applications, there being noted the corresponding times and depths so that the record made within the housing 62 may be ultimately related to depth. Following completion of the logging operation, the logging apparatus may be pulled up by a supporting wire line, if it has been lowered thereby, may be retrieved by an overshot if it has been dropped or pumped down, or may be left within the drill stem if immediately following the logging the drill stem is to be withdrawn for changing of the bit.

It will be apparent from the foregoing that the apparatus which has been described consistently provides for both operation of the turbodrill and for logging by means of a device which is to be projected through the bit.

Reference may now be made to an alternative valve arrangement which may be used at the upper end of the turbine shaft. In this case, the shaft which is indicated at 84 is provided with a socket 86 arranged to receive a valve 88 which may be made of natural or synthetic rubber and which is molded to provide a stem portion 92 which is constricted as indicated at 94 to close off the opening therethrough, the portion of the extension 92 above the constriction being flared as indicated at 96. The valve is secured in position by a snap ring 90. Above this there is the convergent wand guiding member 98 which may be of the same type as at 52 and which will insure a central position of the lower end of the wand to cause it to enter properly the valve 88 and the central opening therebeneath. The valve arrangement is such that it is normally closed at the constriction 94 and is held tightly closed by reason of the differential mud pressure existing between its exterior and interior. When logging is to be effected, the wand will enter the opening provided by the flared portion of the valve at 96 and the thrust due to the logging apparatus will cause it to open and pass through the valve and into the central opening in the shaft, the wand thereafter passing downwardly in the fashion already described. To insure normal closure of the valve there may be molded into it a metal ring 95 provided with spring fingers 97 tending to move inwardly. These fingers will flex outwardly to permit the wand to pass. The exterior of the valve may also be shaped so that pressure thereagainst due to mud flow will counteract any tendency for opening provided by impact of mud into the flaring mouth of the valve.

It will be evident from the foregoing that other variations of valve construction may be adopted, all for the purpose of providing a free direct passage for the wand while preventing by-pass of the blading of the turbine. The invention is accordingly not to be regarded as limited except as required by the following claims.

What is claimed is:

1. A drill assembly of the type arranged for connection to the lower end of a hollow drill stem, said assembly comprising a bit, means controlled by fluid flowing downwardly through a drill stem to which the assembly may be connected for producing drilling movements of the bit, said means being provided with fluid passages for its operation arranged to receive fluid from a drill stem and of a non-straight type preventing direct passage therethrough of a logging means adapted to operate by projection beyond said bit, said first mentioned means being provided with a passage auxiliary to the first mentioned passage through which such logging means may pass, said auxiliary passage being such that, unless closed,

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it would receive fluid from a drill stem, and means closing said auxiliary passage during drilling to restrict downward flow of fluid therethrough but arranged to be opened for downward passage of said logging means for a logging operation.

2. An assembly according to claim 1 in which said means controlled by fluid flowing through a drill stem comprises a turbine for rotating the bit.

3. An assembly according to claim 2 in which said auxiliary passage is through a shaft of said turbine.

4. An assembly according to claim 1 in which the means closing said auxiliary passage comprises a normally closed valve means of yielding material restricting downward fluid flow and arranged to be opened by downward insertion of said logging means therethrough.

5. An assembly according to claim 2 in which the means closing said auxiliary passage comprises a normally closed valve means of yielding material restricting downward fluid flow and arranged to be opened by

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downward insertion of said logging means therethrough.

6. An assembly according to claim 3 in which the means closing said auxiliary passage comprises a normally closed valve means of yielding material restricting downward fluid flow and arranged to be opened by downward insertion of said logging means therethrough.

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