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J. A. ZUBLIN

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ROTARY TURBINE BIT

Filed Aug. 13, 1942

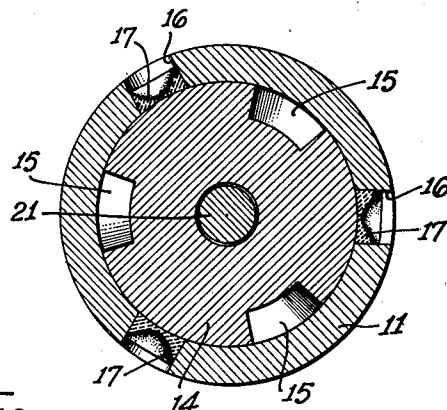
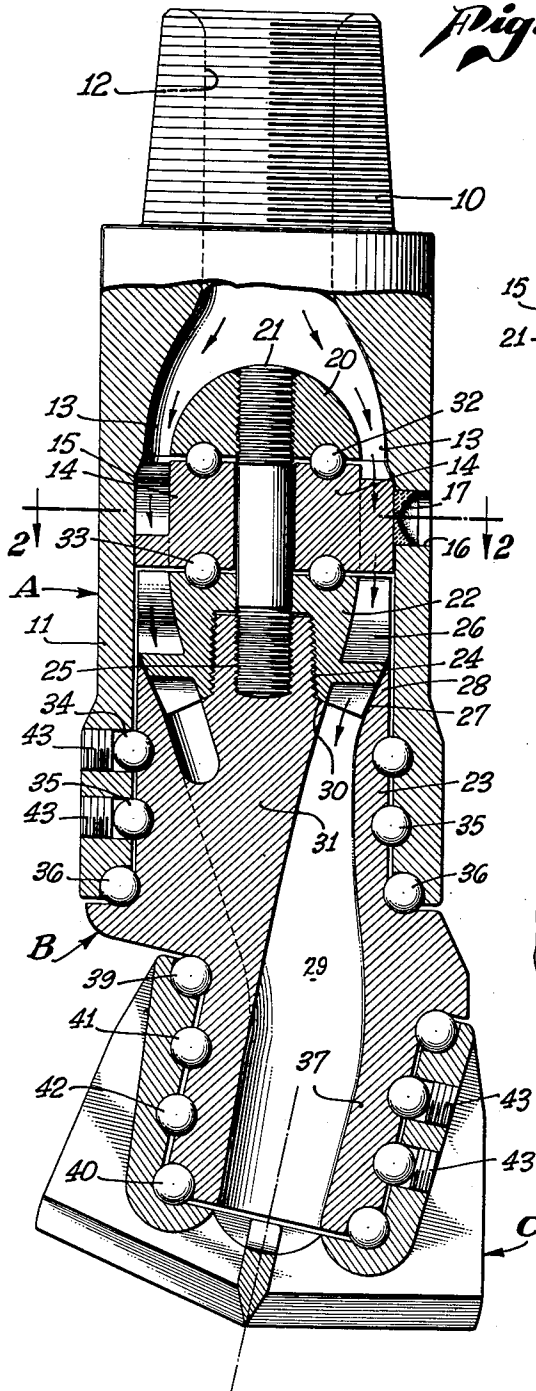


Fig. 2.

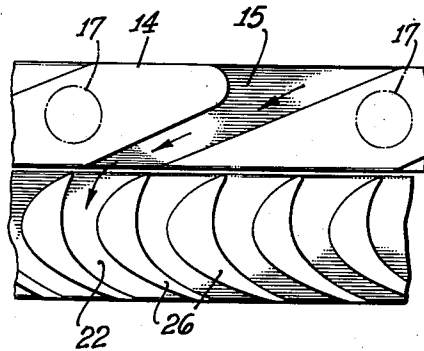


Fig. 3.

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2,336,336

ROTARY TURBINE BIT

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Application August 13, 1942, Serial No. 454,691

2 Claims. (Cl. 255—71)

This invention relates to the drilling of oil wells and more particularly to the drilling of hard formations.

In my co-pending application, Serial Number 440,842, entitled "Method and means for high speed rotary drilling," filed April 28, 1942, of which the present application is a continuation in part, there is described a method of drilling which depends partly on the attainment of a high rotational speed of the bit. The present application is most immediately concerned with the structure employed in attaining high rotational speed of the bit.

In the present instance the energy for rotating the bit is derived from the energy of the fluid pumped down the drill pipe to the bit. The structure for converting the pressure and velocity energy of the drilling fluid comprises essentially a turbine, one element of which is secured to the drilling string and the other element of which is secured to the bit to the rotated.

Because of the nature of the work performed by drilling bits, and because of the nature of the treatment which bits receive, the materials of which the bit and other parts of the drilling string are made are subject to stresses which closely approach the ultimate strength of the material.

For this reason it is an object of the present invention to provide a turbine which is extremely rugged, and thus capable of withstanding the hard usage incident to use in drilling wells.

In my co-pending application I describe the cutting action of a bit as depending in part upon the tendency of the cutter teeth to lift and drop the bit. If this tendency to lift and drop the bit is to utilize the mass of the drilling string, or at least the lower end thereof, it is necessary to provide a means for transmitting the impact and acceleration loads from the cutter to the portion of the drilling string above the bit. Inasmuch as, when a turbine is used, the bit rotates with respect to the drilling string, it can be seen that an extremely efficient bearing mechanism must be employed to resist the axial loads imposed by the tendency of the bit to rise and fall and the resistance to such movement by the mass of the turbine and of the drilling string thereabove.

It is therefore a further object of the present invention to provide a turbine driven bit in which the relatively moving parts of the turbine are strongly supported against axial movement.

The drilling fluid driven down the drill pipe by pumps at the surface has a function apart from the rotation of the bit. It serves to keep

the bit clear of cuttings, lift the cuttings to the surface, and also flush the bottom of the hole so that the bit may always attack the formation unhindered by the presence of detritus. In order to accomplish these results it is necessary that the fluid be discharged as close to the cutting teeth as possible.

It is therefore a further object of the present invention to provide a turbine driven bit in which the fluid is discharged from the apparatus in the most efficient position for cleaning of the well bore and of the bit.

In my prior application, Serial Number 423,227, filed December 16, 1941, I describe the use of a flexible section in the drilling string as closely adjacent as possible to the bit. The flexible section is installed for the purpose of causing the bit to drill curved bores. Because the success of that drilling method requires that the bit and its attachment to the flexible drill pipe be as short as possible, the turbine should be as short as possible. In previous turbines used for drilling straight, or slightly curved wells, length of the turbine was not objectionable, and consequently, lengths of sixty feet or more not unusual. The peculiar cutting action of the high speed bit also enables the use of a considerably shorter turbine.

It is therefore a further object of the present invention to provide a turbine and bit assembly which is as short as possible.

As the drilling fluid is sometimes abrasive, even the hardest materials of which the turbine parts can be made will eventually be cut away by the action of the abrasive material in the drilling fluid. Consequently, means must be provided for renewing the parts of the turbine, which provision must be attained without unduly weakening the structure.

It is therefore a further object of the present invention to provide a structure which can be readily disassembled and reassembled for replacement of the parts of the turbine.

Referring now to the drawing:

Figure 1 is a longitudinal section through one embodiment of the present invention;

Figure 2 is a section taken along line 2—2 of Figure 1; and,

Figure 3 is a development of part of the turbine showing the nozzles and blades of the turbine.

In general, the objects before mentioned have been achieved by the division of the turbine and bit assembly into three main parts; a casing or housing A, which is secured by the threaded pin

10 to the drilling string, and which carries the nozzles of the turbine, a shank member B, carrying the turbine runner and rotatively mounted in the housing A, and the cutter element C, which is mounted to rotate on the shank B about an axis inclined with respect to the axis of rotation of shank B.

The housing A is in the form of a generally cylindrical member 11, carrying the threaded pin 10 for attachment to the drilling string. A watercourse 12 through the pin widens to form the annular passage 13 in cooperation with other parts of the assembly. As was mentioned, it is desirable to have the parts of the turbine removable and at the same time very strong. For this reason, the member 14 is provided, which performs the dual function of partly supporting the shank B and providing nozzle elements for the turbine. This member 14 is, essentially, a cylindrical member with a plurality of angular slots cut in its outer face. These slots 15 form the nozzle passages, in cooperation with the inner surface of the casing A. As shown in Figure 3, these slots are angularly disposed, for the purpose of giving the drilling fluid a circumferential velocity for best action on the runner.

In order to secure member 14 in place, and at the same time permit ready removal, a plurality of openings 16 pass through the wall of the casing A. These openings are spaced to fall between the slots 15 in member 14. It then becomes possible, by applying weld material 17 to the surface of body 14 and the sides of the openings 16, to secure the body 14 rigidly in place. Removal is accomplished by simply drilling the weld material out, which will permit the body 14 to be removed, and replaced if necessary. As a matter of convenience, the shank B can be first mounted on the member 14, as will be described, and the entire assembly welded in place in the housing.

The shank B, as was before described, is rotatably mounted on the housing A. Because of the heavy impact loads, considerable bearing area must be provided between the shank and the housing. At the same time, the eccentric nature of the load imposed by the cutter on the shank requires a bearing to prevent angular displacement of the shank. This, together with the necessity for replacement from time to time, dictates the assembly shown.

The shank B is made in four parts; a cap 20, a shaft 21, a runner 22, and a body 23. The cap 20 is threaded and welded to the shaft 21, as shown. The runner 22 is threaded to the body 23 at 24, and the shaft 23 is threaded into the body at 25.

The runner 22 is provided with a plurality of vanes or blades 26, which convert the energy of the drilling fluid issuing from the nozzle 15 into work to turn the bit. As clearly shown in Figure 1, the runner 22 is conical at its lowermost portion 27, and the body 23 is provided with a tapered ring 28 which both supports the runner blades 26 and serves to direct the spent fluid toward the passage 29 which delivers it to the bit. The lower end of the body of the runner butts against the body at 30.

It is to be understood that the body 23, so far described, is of generally hollow cylindrical configuration, with a support 31 projecting from the inner wall thereof, for the purpose of attachment to the runner and shaft. This support is generally rounded, to offer as little resistance to flow as possible. If desired, a series of spaced, stationary vane members could be used instead of the single support 31.

The above described shank assembly is provided with bearings to permit it to rotate and at the same time prevent the loads from moving it axially or radially. For this reason, races are provided in the cap 20 and the upper surface of member 14, in which balls 32 run, and similar races in the lower surface of member 14 and the upper face of the runner 22 provide for balls 33. The two sets of balls 32 and 33 prevent both radial and axial movement of the shank relative to the casing A.

In addition to the bearings 32 and 33, the body 23 of the shank and the casing A are provided with races to carry balls at 34, 35 and 36. The lowermost set of balls 36 is preferably made to act as a combination thrust and radial bearing by the formation of the faces therefor, but it is to be understood that even the bearings 34 and 35 can carry some of the thrust.

The lowermost end of the shank B is provided with a hollow pin 37, which serves to carry the cutter C. This pin is set at an angle to the axis of the bit as a whole, and the reason for this inclination and the formation of the teeth of the cutter are fully set forth in the parent application mentioned above, Serial Number 440,842. It will be noted that two sets of balls 39 and 40 form combination thrust and radial bearings, to prevent upward movement of the cutter. Bearings 41 and 42 are essentially radial bearings, but they serve the purpose of keeping the cutter in place on the pin 37.

It will be appreciated that means must be provided for insertion of the bearing balls 34, 35, 41 and 42. For this purpose, threaded plugs 43 may be used, or any conventional means desired.

I claim:

1. A hydraulically driven gyratory bit comprising a casing having walls defining a generally cylindrically hollow interior and having a watercourse at its upper end adapted to communicate with the interior of a drilling string, a hydraulic motor in said casing driven by fluid flowing in said watercourse, a shank driven by said motor, radial and thrust bearings between said shank and the walls of said casing to prevent radial and axial movement of said shank relative to said casing, a cutter rotatably mounted on the lower end of said shank for rotation about an axis inclined at an acute angle to the axis of rotation of said shank, and a passageway through said shank for flow of exhaust fluid from said motor to said cutter.

2. A hydraulically driven gyratory bit comprising a casing having walls defining a generally cylindrical hollow interior and having a watercourse at its upper end adapted to communicate with the interior of a drilling string, a hydraulic motor in said casing driven by fluid flowing in said watercourse, a shank driven by said motor, radial and thrust bearings between said shank and the walls of said casing to prevent radial and axial movement of said shank relative to said casing, a cutter rotatably mounted on the lower end of said shank for rotation about an axis inclined at an acute angle to the axis of rotation of said shank, radial and thrust bearings between said shank and said cutter to prevent radial and axial movement of said cutter relative to said shank, and a passageway through said shank for flow of exhaust fluid from said motor to said cutter.

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