July 9, 1963 J. B. STEEN 3,096,834

JETTING DEVICE FOR ROCK BIT

Filed Aug. 26, 1960

Fig. 1.

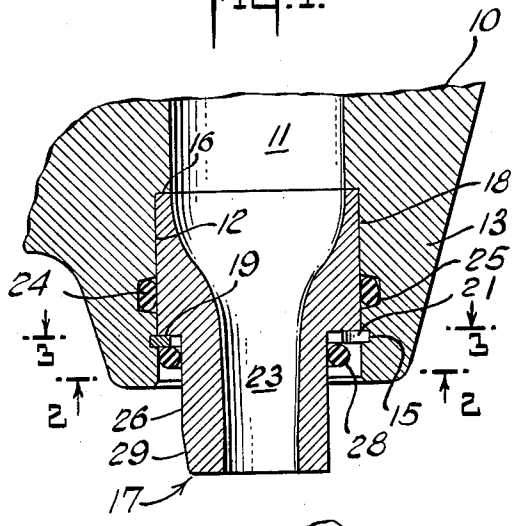


Fig. 3.

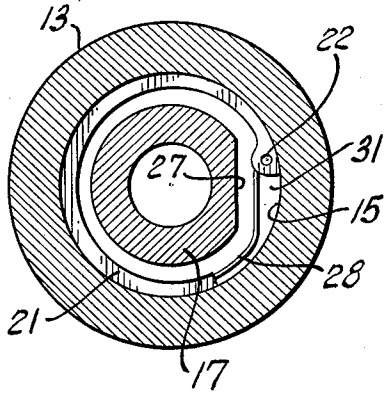


Fig. 2.

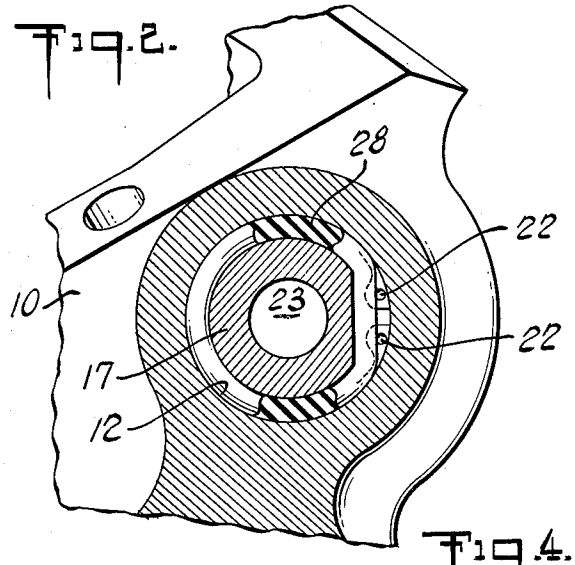


Fig. 5.

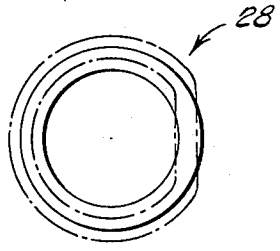
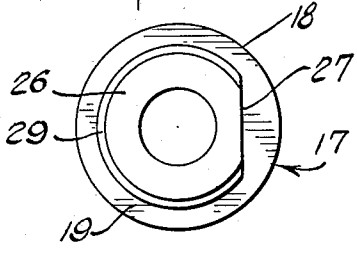


Fig. 4.



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JETTING DEVICE FOR ROCK BIT

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This invention relates to jet nozzle devices particularly of the type employed in earth boring drills to augment the drilling action by discharging a high velocity stream of flushing fluid to the bottom of the bore hole.

It is customary to provide a jet drilling bit with a nozzle made of tungsten carbide alloy or similar wear resistant material, the nozzle being mounted at the outlet end of a jet passageway in the bit head and held by a retaining ring seated in a recess formed in the inner wall or bore of the nozzle housing. The nozzles vary as to the size and shape of the opening which is selected to suit local conditions. In order to permit ready assembly and disassembly, and therefore replacement, of the nozzle in the field, the retaining ring is constructed as a snap ring adapted to be installed into and taken out of the associated recess in the wall of the nozzle housing, the ring being held only along a thin marginal area.

Due to the shape of the opening in the nozzle, which is designed to increase the velocity of the discharging fluid, there is a hydraulic force tending to blast the nozzle out of the bit head to the bottom of the hole being drilled. Normally, this force is effectively counteracted by the retaining ring. However, in drilling areas where abrasion is severe, and under certain adverse conditions, the turbulent drilling mud, carrying with it the entrained chips from the bottom of the hole, re-enters the nozzle housing and causes abrasion of the snap ring and of the adjacent portion of the housing wall. This action wears away the support for the retaining ring with the result that the latter frequently yields to permit the nozzle to be blown from the bit head.

An object of this invention is to prevent the loss or expulsion of a nozzle from its housing, without sacrificing the advantage of replaceability of the nozzle.

Another object is to protect the nozzle retainer from any weakening of its support which might be caused by erosion of the retainer and the adjacent portion of the supporting wall.

A further object is the provision of a shield below the retainer to deflect and seal off any turbulent fluid that may tend to re-enter the bore in which the nozzle is mounted, by reason of a backwash action.

A still further object is to provide improved means for supporting the shield.

A feature of this invention is a nozzle extension projecting below the retainer ring and providing a support for the shield.

Another object of the invention is the provision of a nozzle having a more efficient jet action on the bottom of the hole. In accordance with this object the nozzle extension is elongated to the extent that it projects a substantial distance below the bottom of the nozzle housing causing the issuing fluid to strike the bottom of the hole at closer range and with a greater force.

Other objects and features of this invention will appear more clearly from the following description.

In the accompanying drawing:

FIG. 1 is a longitudinal section of a jet nozzle assembly embodying this invention, including only a fragmentary portion of the bit body;

FIG. 2 is a cross-section of the nozzle assembly on the line 2—2 of FIG. 1, looking upward;

FIG. 3 is a cross-section on the line 3—3 of FIG. 1, looking downward, with one end of the retainer ring broken off;

FIG. 4 is a bottom plan view of the nozzle; and

FIG. 5 is a bottom plan of the rubber shield showing in full lines the shape when disassembled, and in broken lines the shape when the shield is assembled and stretched.

Referring to FIG. 1 the illustrative rock bit comprises a bit head **10** having a plurality of passageways **11** (one shown) extending in an approximately vertical direction and arranged for the discharge of a flushing fluid, such as drilling mud. Each passageway **11** is positioned in an approximately vertical plane lying midway between two cutters (not shown), so that the jet stream will miss the cutters and strike directly against the bottom of the hole. Preferably, although not necessarily, the jet passageways **11** are inclined from the vertical to discharge the jet stream with a circumferentially forward component of direction. As an example of a rock bit having inclined jet passageways and adapted to embody the present invention, reference is made to applicant's co-pending application on a Jet Rock Bit, Serial No. 828,892, filed July 22, 1959, now issued as Patent No. 3,014,544, dated December 26, 1961.

The passageway **11** leads to a cylindrical bore or counterbore **12** formed at the lower end of a nozzle housing **13**. Near its lower end the counterbore, or inner wall of the housing, is provided with an annular recess **15** for a purpose which will be described later. A shoulder **16** extends between the counterbore **12** and the passageway **11** and provides a positive stop for limiting upward movement of a nozzle **17**. The nozzle is slidably inserted into, and removable from, the housing **13** as a replaceable element of the nozzle assembly. It includes a head portion **18** having a diameter closely fitting the nozzle housing bore **12** and an axial length equal to the distance between the shoulder **16** and the upper side of the annular recess **15**. The lower end of the head portion terminates in a transverse shoulder **19** seated on top of a retainer ring **21** which extends into the annular recess **15**. The retainer ring is of a well known type and comprises a snap ring having a pair of holes **22** at its ends for the reception of a tool (not shown) which is adapted to contract the ring to a smaller diameter to permit it to be moved axially within the housing bore **12**. The ring is resilient and, during the assembly operation, upon release of the tool, it expands into the annular recess, and supports the transverse shoulder **19** against downward thrusts caused by the action of the drilling fluid tending to displace the nozzle **17** from the housing bore **12**. By engaging the opposite ends of the head portion **18**, the snap ring **21** and the housing shoulder **16** co-operate to restrain the nozzle against axial movement.

The nozzle **17** consists of a hard, brittle, wear-resistant substance, such as tungsten carbide alloy, and is shaped by molding. It has a central opening **23** forming a continuation of the passageway **11** for the flushing fluid. The opening **23** is so contoured as to provide a streamlined reduction in cross-section, whereby the velocity of the flushing fluid is greatly increased as it passes through the nozzle. As a result, there is a considerable drop in pressure between the inlet and the outlet of the nozzle and this hydraulic condition sets up a force which tends to eject the nozzle from the housing **13**. In a rock bit which is new, or only partly worn, this force is effectively overcome by the retaining ring **21**. At the same time, there is a tendency for the flushing fluid to bypass the nozzle **17** between the housing wall or bore **12** and the outer cylindrical surface of the nozzle head **18**. To avoid such leakage, there is provided a fluidtight shield about the head **18**, consisting of a rubber O-ring **24** mounted in an annular recess **25** in the housing wall **12**.

The jetting device specifically described up to this

point does not differ materially from prior structures except for changes in the shape of the nozzle. In accordance with this invention the nozzle 17 is provided with an extension 26, preferably integral with the head portion 18 and surrounded by the retainer ring 21. The extension is mainly in the shape of a cylinder having a diameter less than the normal (unstressed) inner diameter of the retainer ring 21 with sufficient clearance to permit the ring to be forcibly contracted during the assembly and disassembly operations as described above. On the side of the extension adjacent the ends of the retainer ring, the extension is cut away to provide a flat face 27 spaced from the retainer ends by a sufficient distance to permit the ends to be contracted and also to permit a suitable tool (not shown) to be inserted between the nozzle extension and the housing wall 12 and into the holes 22 in the retainer ring.

One purpose of the nozzle extension is to provide a mounting for a rubber shield 28 underlying the retainer ring 21. The shield 28 as shown is in the shape of a torus, and is made of an elastic abrasion-resistant material, such as synthetic rubber. A conventional O-ring, of proper dimensions, is suitable for this purpose. Ring 28 when disassembled has an inside diameter and an outside diameter slightly less than the diameter of the nozzle extension 26 and counterbore 12 respectively. When assembled it snugly embraces the nozzle extension around both the cylindrical and flat portions thereof and is expanded into contact with the housing wall or bore 12. In order to facilitate stretching of the rubber ring 28 over the nozzle extension the latter is provided at its lower end with a chamfer or frusto-conical surface 29, shown in FIGS. 1 and 4. Preferably the rubber shield 28 engages the lower face of the metal retainer ring 21 and is prevented from falling below the latter by frictional engagement on the outside with the housing bore 12 in addition to the even greater frictional engagement on its inside with the nozzle extension. The rubber shield 28 is under radial compression throughout most of its circumference and thus seals off the retainer ring and the portion of the bore 12 which lies immediately below the ring. In the event of a backwash or reentry of flushing fluid into the housing bore 12, the turbulent fluid will be prevented from impinging against the retainer ring 21 and against the lower edge of the annular recess 15 where it might otherwise cause erosion of the retainer ring and its supporting means with eventual failure of the retainer and consequent expulsion of the nozzle. The shield 28, although exposed to the back wash of the flushing fluid, does not erode under the action of the abrasive particles carried in the fluid, because the resilience of the rubber acts as a cushion to attenuate the force of the abrasive particles.

As pointed out above, one of the functions of the nozzle extension is to serve as a mounting for the rubber shield. In order to perform this function the extension should have a cross-sectional area sufficient to cause the rubber shield to embrace the extension snugly, and an axial length, exclusive of the chamfer 29, sufficient to extend through the retainer 21 and shield 28.

Preferably the nozzle extension 26 has an axial length sufficient to cause the nozzle to project for a substantial distance beyond the lower end of the nozzle housing 13. The elongated extension has a function of moving the outlet end of the nozzle closer to the cutters and closer to the bottom of the hole as compared with conventional nozzles having an outlet disposed within the nozzle housing. In the use of such conventional nozzles the jet stream, after leaving the nozzle, loses velocity rapidly and its effectiveness becomes dissipated as it moves further away from the nozzle outlet. Conversely, an advantage of the elongated nozzle of this invention is a more powerful and efficient jet action, with a higher velocity of the stream upon striking the bottom of the bore hole, this advantage being attained by moving the nozzle outlet

closer to the bottom of the hole. Another advantage is that the jet stream is aimed at relatively close range to the point of contiguity between the toothed surfaces of two adjacent cutters thereby minimizing the danger of the abrasive stream striking the cutters as it passes through the very restricted space between them.

The inclination of the axis of the nozzle in a circumferentially forward direction, as taught in applicant's co-pending application aforesaid, has the effect of moving the nozzle outlet further from the bottom of the hole, measured along the axis of the jet stream. The present invention is of special value when applied to a jet bit of that type because it permits the bit to retain all of the advantages of the slanted stream, as pointed out in that application, without the (partly-offsetting) disadvantages of the longer stream.

The elongated nozzle extension 26 performs an additional and important function in decreasing the back wash in the housing bore 12 by increasing the distance between the retainer ring 21 and the nozzle outlet. By keeping the greater part of the turbulent fluid further away from the place where it might damage the retainer ring, the elongated nozzle of this invention makes it possible to protect the retainer ring in same areas and under same conditions even without the use of the rubber shield 28 or any similar shield as an additional safeguard.

As shown in FIGS. 2 and 3, there is a space 31 between the straight side of the rubber shield 28 and the counterbore 12. This space facilitates replacement of the nozzle by enabling the operator to insert a suitable tool (not shown) such as an open throat pair of pliers. The pointed ends of the pliers may be inserted into the holes 22 in the retainer ring after pushing the rubber ring 28 laterally out of the way if necessary. The dimensions and shape of the nozzle extension 26 are such that they do not obstruct the entry of the pliers. Upon seizure of the ends of the snap ring 21 and contraction of the ring to the diameter of the counterbore, the snap ring and nozzle may be withdrawn together in the usual manner. The rubber shield 28 may be withdrawn along with the snap ring and nozzle or if desired, it may be removed by itself before the snap ring is contracted. If, the nozzle is stuck tight in the counterbore it may be loosened by engaging the flat face 27 with a wrench and turning the nozzle about its axis.

What is claimed is:

1. A jetting device for rock bits and the like comprising a housing having a passageway for the high velocity flow of abrasive fluid and having a bore extending from the passageway through the lower end of the housing, the bore being of enlarged diameter at its lower end providing a shoulder at the upper end of said enlargement, a replaceable nozzle slidably inserted into said bore from the bottom end thereof, the wall of the enlarged portion of the nozzle being made of hard abrasion resistant material, said bore being provided with an annular recess, a resilient split retainer ring supported in part in said recess and projecting in part into the enlarged diameter portion of the bore, said nozzle comprising a cylindrical head portion slidably fitting the bore and having its upper end abutting the shoulder and the nozzle having an integral reduced extension depending from the head portion, the lower end of the head portion having a transverse shoulder defined by the reduced extension seated on the retainer ring, the extension being surrounded by the retainer ring, and means for protecting the retainer ring and adjacent recessed portion of the housing bore from erosion by the back-wash of turbulent abrasive fluid discharged through the nozzle, said protecting means comprising an O-ring shield seated against the underside of the retainer ring in surrounding relation to the nozzle extension and frictionally engaging the surface of the latter, the O-ring being slidable free of the extension upon operating a downward pull thereon sufficient to overcome said frictional engagement.

2. A jetting device according to claim 1, in which the shield consists of a ring of rubberlike material stretched to fit the extension and snugly embracing the latter to provide frictional support for the shield.

3. A jetting device according to claim 2, in which the lower end of the nozzle extension has a chamfer to facilitate stretching of the rubber ring onto the extension, and in which the nozzle extension has a uniform cross section in all planes lying between the chamfer and the retainer ring.

4. A jetting device according to claim 1, in which the shield is made of resilient material having an outer diameter slightly greater than the internal diameter of the housing bore and having an internal diameter slightly less than the outer diameter of the nozzle extension whereby the outer and inner diameter surfaces of the shield are respectively in yieldable pressed engagement with the inner wall of the housing and with the outer surface of the nozzle extension.

5. A jetting device according to claim 4, in which the shield is spaced from the wall of the housing bore for a limited area about the free ends of the retainer ring to provide access to this part of the retainer ring.

6. A jetting device according to claim 5, in which the nozzle extension in cross section is circular around the major portion of its circumference and is non-circular along the remaining portion, and in which the shield when disassembled has a torus shape, said shield being adapted upon stretching around the nozzle extension to follow the contour of the latter.

7. In a jetting device, a nozzle having an opening therethrough for the passage of abrasive fluid, the upper end of the opening being of greater diameter than the lower end, said nozzle comprising a head portion of cylindrical shape at its upper end, an elongated reduced integral extension depending from the head portion, and a transverse shoulder at the base of the head portion, said extension having a flat face extending from the transverse shoulder to the front end of the extension and having a cylindrical surface extending around its circumference except for the flat area, said cylindrical surface having a diameter less than that of the head portion, the upper end of the cylindrical surface lying adjacent the transverse shoulder, and a rubber O-ring fitted upon the extension below the transverse shoulder, the flat face serving to conform the corresponding portion of the rubber O-ring to the form of the flat, and the flat face at the lower end of the extension serving to permit application of a wrench thereto for purposes of turning the nozzle about its axis so as to loosen it when so required.

8. In a drill bit including a downwardly extending passage for discharging flushing fluid from the bottom of the bit, a nozzle disposed in the passage for effecting discharge of the fluid from the bit at high velocity, the nozzle being slidably removable through the discharge end of the passage, an internal abutment in the passage abutting the upper end of the nozzle and thereby determining the upward position of the nozzle in the passage, a reduced extension of the nozzle depending from the underside thereof in the passage and providing a transverse shoulder at the upper end of the extension, an annular groove in the passage intermediately of the ends of the passage, a contractible split snap ring having an outer part seated in the groove and having an inner part abutting the underside of the shoulder whereby the nozzle is stopped from dropping out of the discharge end of the passage, the snap ring having an internal diameter greater than the outer diameter of the extension and being contractible out of the groove to the diameter of the passage upon drawing the free ends of the snap ring toward each other, and a resilient O-ring fitted over the extension seated within the passage against the underside of the inner part of the snap ring guarding the latter from attack by the backwash of fluid discharged from the passage, the snap ring having a pair of radially inturned ears at its free ends, and there being a space between the wall of the passage and the O-ring exposing the ears of the snap ring to view from the discharge end of the passage, the space allowing access of a plier tool to the ears for engaging the snap ring, the snap ring upon being contracted being movable downward on the extension upon the exertion of a downward pull upon the ears, and the O-ring being movable ahead of the snap ring over the extension as the snap ring is drawn downwardly over the extension.

9. In a rock drill bit having a downwardly extending passage for discharging flushing fluid from the bottom of the bit, a nozzle disposed in the passage for effecting discharge of the fluid from the bit at high velocity, the nozzle being slidably removable through the discharge end of the passage, an internal abutment in the passage abutting the upper end of the nozzle and thereby determining the upward position of the nozzle in the passage, a reduced extension of the nozzle depending from the underside of the nozzle in the passage and projecting through the discharge end of the passage, the reduced extension having a transverse annular shoulder at its upper end, an annular groove in the passage intermediately of the ends of the latter, a contractible split snap ring having an outer part seated in the groove and an inner part abutting the underside of the shoulder whereby the nozzle is blocked from dropping out of the discharge end of the passage, the snap ring having an internal diameter greater than the outer diameter of the extension and being contractible out of the groove to the diameter of the passage upon drawing the free ends of the snap ring toward each other, the snap ring having a pair of radially inturned ears at its free ends, and upon being so contracted the snap ring being movable downward over the extension and through the discharge end of the passage enabling thereby removal of the nozzle from the passage, and the extension projecting out of the passage beyond the bottom end of the bit whereby the distance between the snap ring and the discharge end of the nozzle is extended according to the extent of projection of the nozzle beyond the bottom end of the bit.

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