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Sweeney

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[54] **DRILLING APPARATUS WITH DOWN-THE-HOLE MOTOR**

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[73] Assignee: **Tigre Tierra, Inc.**, Puyallup, Wash.

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Related U.S. Application Data

[62] Division of Ser. No. 283,208, Aug. 23, 1972, Pat. No. 3,854,539

[52] U.S. Cl. **175/246**

[51] Int. Cl.[2] **E21B 5/00**

[58] Field of Search 175/58, 92, 105, 236, 257, 175/296, 389, 390; 173/73, 80, 91, 78, 15, 71, 72, 119

[56] **References Cited**

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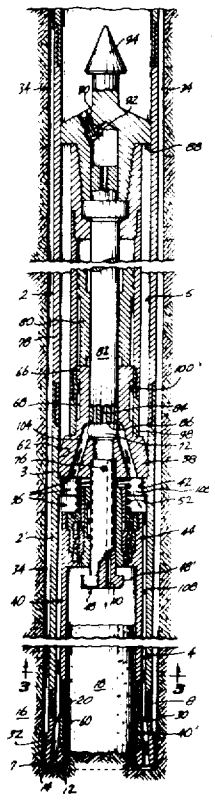
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[57] **ABSTRACT**

The apparatus includes a piston-like means having a hammer mechanism thereon and an elongated excavation means suspended from the piston-like means. It also includes a rotary drill rod comprising an elongated pipe having a longitudinally extending bore therethrough and an annular bit at the distal end thereof. The piston-like means is slidably received in the bore of the pipe through the proximal end thereof, and there is an annular shoulder about the periphery of the bore to receive blows from the hammer of the mechanism adjacent the bit. Also, means define an annular seat about the periphery of the bore between the shoulder and the mouth of the bit, which is of lesser inside diameter than that of the shoulder. The excavation means is slidably received in the distal end portion of the bore through the opening of the shoulder and has one end thereof engaged with the seat. In addition, fluid passage means in the rod extend generally longitudinally of the bore between a point adjacent the shoulder and a point about the periphery of the seat, and porting in the body of the bit, extends generally axially thereof between the fluid passage means and the working face of the bit at the distal end thereof. Together, the fluid passage means and the porting form a passage about the excavation means through which fluid can be released into the working face of the bit from a point adjacent the opposite end of the excavation means. There are also means whereby the released fluid can discharge from the face of the bit toward the proximal end of the pipe on the opposite side of the pipe from the excavation means.

17 Claims, 5 Drawing Figures



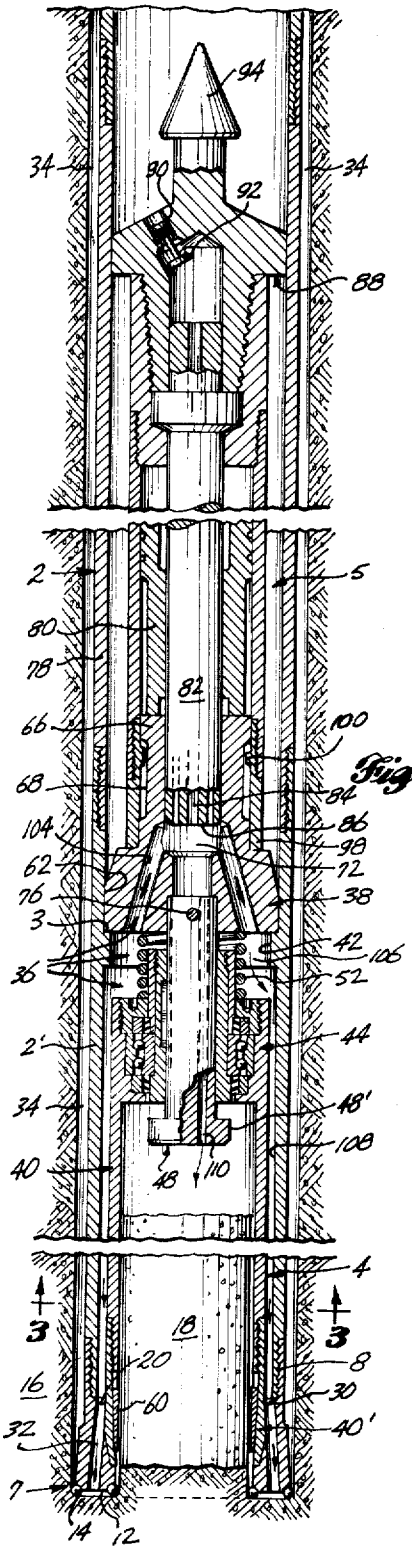


Fig. 1.

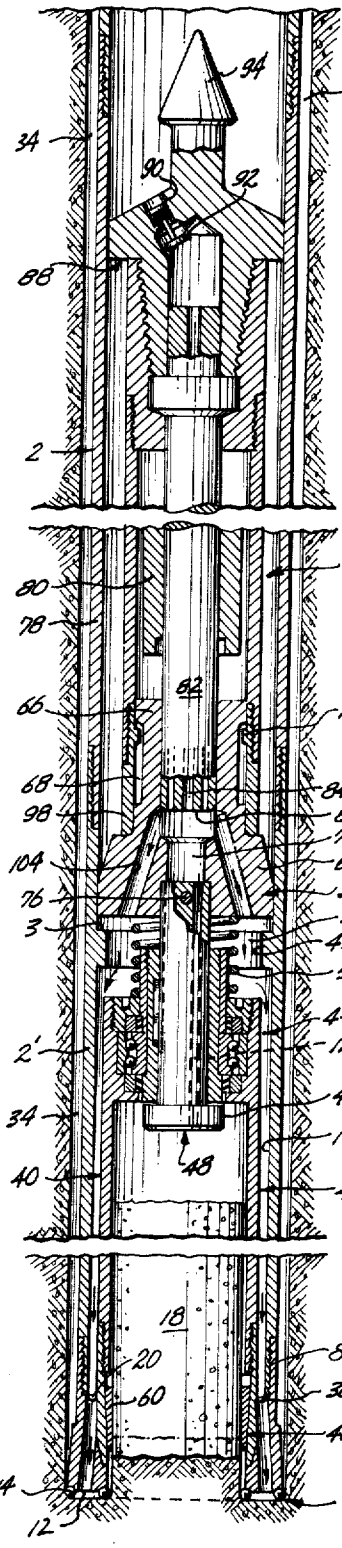


Fig. 2.

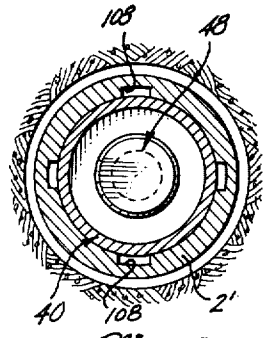


Fig. 3.

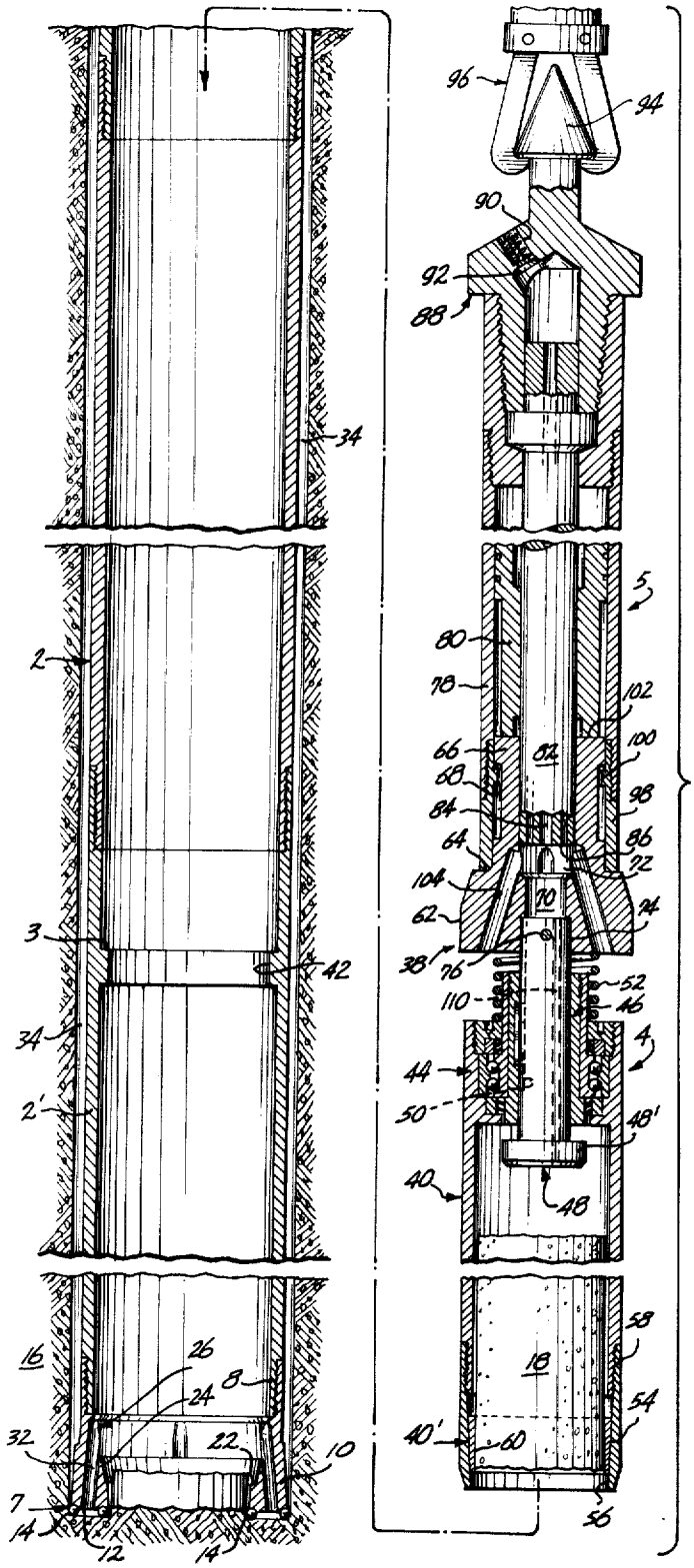

96
94
90
92
88
34
2
3
42
34
2'
16
26
8
24
32
22
10
7
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12
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80
78
102
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82
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68
98
84
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64
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104
70
74
62
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76
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110
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4
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50
48'
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18
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40'
60
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Fig. 4.

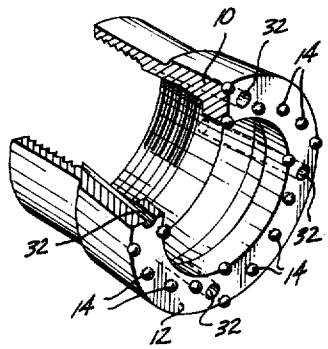

10
32
14
32
32
14
14
12
32

Fig. 5.

DRILLING APPARATUS WITH DOWN-THE-HOLE MOTOR

This is a divisional of application Ser. No. 283,208, filed Aug. 23, 1972 and now U.S. Pat. No. 3,854,539.

THE INVENTION IN GENERAL

According to the invention, the apparatus includes a piston-like means having a hammer mechanism thereon and an elongated excavation means suspended from the piston-like means. It also includes a rotary drill rod comprising an elongated pipe having a longitudinally extending bore therethrough and an annular bit at the distal end thereof. The piston-like means is slidably received in the bore of the pipe through the proximal end thereof, and there is an annular shoulder about the periphery of the bore to receive blows from the hammer of the mechanism adjacent the bit. Also, means define an annular seat about the periphery of the bore between the shoulder and the mouth of the bit, which is of lesser inside diameter than that of the shoulder. The excavation means is slidably received in the distal end portion of the bore through the opening of the shoulder and has one end thereof engaged with the seat. In addition, fluid passage means in the rod extend generally longitudinally of the bore between a point adjacent the shoulder and a point about the periphery of the seat, and porting in the body of the bit, extends generally axially thereof between the fluid passage means and the working face of the bit at the distal end thereof. Together, the fluid passage means and the porting form a passage about the excavation means through which fluid can be released into the working face of the bit from a point adjacent the opposite end of the excavation means. There are also means whereby the released fluid can discharge from the face of the bit toward the proximal end of the pipe on the opposite side of the pipe from the excavation means.

The shoulder may be disposed in the pipe and the excavation means may take the form of a core barrel. Also, the fluid passage means may take the form of fluting in the peripheral wall of the bore.

In certain of the presently preferred embodiments of the invention, the hammer mechanism is fluid operated and there are fluid transmission means for operating the hammer mechanism including means for passing fluid through the piston-like means and means for exhausting the fluid into the fluid passage means after the mechanism has operated. Also, in these embodiments, the invention further comprises means on the piston-like means for generating a pressure differential thereacross longitudinally of the bore, to maintain the hammer mechanism in operative relationship to the shoulder during the application of the blows. In one embodiment, for example, the proximal end portion of the bore is operatively fluid pressurized and the pressure differential generating means is operative to cause a pressure drop across the piston-like means in the direction of the distal end of the bore.

In these presently preferred embodiments, moreover, the piston-like means has an anvil suspended therefrom, and the anvil is interposed in the bore between the hammer and the shoulder to receive and transmit the blows to the shoulder. The excavation means is suspended in turn from the anvil and is axially and/or rotationally displaceable in relation to the anvil. Where the hammer mechanism is fluid operated and there are

fluid transmission means for operating the hammer mechanism including means for passing fluid through the piston-like means and means for exhausting the fluid into the fluid passage means after the mechanism has operated, the anvil may define a passage for the fluid and the fluid exhaust means may be operative to exhaust the fluid through the anvil passage.

In the presently preferred embodiments, moreover, the bit has a greater diameter than the pipe, and the pipe forms the inner periphery of an annulus which is disposed between the pipe and the wall of the excavated hole, to discharge the released fluid therethrough. For example, the outer periphery of the bit may be adapted so that the released fluid can pass thereacross to an annulus formed by the pipe and the wall of the excavated hole.

The bit may be rigidly connected to the distal end of the pipe.

Also, the invention may further comprise attachment means on the proximal end of the piston-like means for releasable engagement by a wire line retriever or the like.

The excavation means may be relatively rotatably engaged with the seat; and may be axially displaceable in relation to the piston-like means and yieldably biased into a stopped position relatively spaced therefrom.

FIG. **1** is a part longitudinal cross-sectional view of one of my presently preferred embodiments of the invention, as it is seen in use for a down-the-hole core drilling operation, and with the hammer mechanism in the bottomed condition thereof;

FIG. **2** is another such view as the hammer mechanism is in the upstroke thereof;

FIG. **3** is a transverse cross-sectional view along the line 3—3 of FIG. **1**;

FIG. **4** is another part longitudinal cross-sectional view when the drive means has been retracted from the drill rod; and

FIG. **5** is a part perspective view of the bit employed in the drill rod.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring to the drawings, it will be seen that the drill rod comprises an elongated, fluid pressurized pipe **2**, which is assembled from equal-diameter sections that are perhaps **10'** in length and threaded and flush-coupled to one another as illustrated. With the exception of the interior of the bottommost or distal end section **2'** of the pipe, the sections are otherwise similar to one another, and are added to and subtracted from the pipe as is necessary during the drilling operation. The distal end section **2'** differs, however, in that it has a stepped or counterbored interior configuration which forms an inner peripheral shoulder **3** at a point near the top thereof. The shoulder serves as an abutment for the drive means **4**, which is retractable from the rod, as shall be explained; and which includes a standard, fluid-operated down-the-hole hammer mechanism **5**.

The pipe is pressurized and driven by a conventional drilling mechanism, such as that shown in U.S. Pat. No. 3,391,543, and is typically driven at slow speeds such as 10 RPM, that is, at speeds simply sufficient to index the percussion bit **7** seen at the bottom or distal end of the pipe. The bit **7** is annular in configuration, and has an interiorly threaded collar **8** at the upper end thereof, that flush-couples to the distal end section **2'** of the

pipe. Below the collar, however, the bit is flared radially outwardly and forms an enlarged head **10** which terminates with a flatfaced annulus **12** at the working end thereof. The annulus has sets of button-like percussion points **14** seated in raised condition thereon, which are spaced apart in angularly spaced, clockwise, convolutional lines that are symmetrically arranged about the axis of the bit. See FIG. **5.** In addition, the endmost points **14** on each line, are seated in the head so as to project slightly inside and outside of the inner and outer peripheries of the annulus, respectively. As a consequence, when the rod is rotated and hammered into an earth formation **16,** the bit excavates an annular recess the outside diameter of which is not only greater than the outside diameter of the pipe itself, but also greater than the outside diameter of the flared head **10** of the bit. Likewise, the core **18** of earth material which is captured within the end of the rod, has an outside diameter of slightly lesser dimension than the inside diameter of the head of the bit.

Otherwise, the bit has a stepped or counterbored interior configuration forming an annular shoulder **20** inside of and about the bottom end of the collar **8.** The interior of the bit also has another annular shoulder **22** therebelow, which is of lesser inside and outside dimensions than the shoulder **20,** by virtue of there being an inwardly chamfered surface **24** at the bottom of the cylindrical socket **26** separating the two shoulders. The lower shoulder **22** and the socket **26** form a seat for a core barreling tube **40** on the drive means, as shall be explained; whereas the upper shoulder **20** has an annular groove **30** recessed therein, from which a series of symmetrically angularly spaced ports **32** open through the body of the head **10** to the working face **12** of the bit, between the points **14** thereon. The ports are also canted to the axis of the head, and are so angled into the shoulder that they open into the socket **26.**

During the drilling operation, the compressed fluid is intermittently discharged to the ports **32** to flush the removed earth material back through the clearance **34** between the pipe **2** and the wall of the excavation. The fluid reaches the ports through a series of passages **36** which are formed within the drive means and the distal end section **2'** of the pipe, as shall be explained more fully hereinafter.

The drive means **4** also includes an annular anvil **38** which is slidably engageable in the upper, thinner walled portion of the distal end section **2',** and sized to seat on the shoulder **3.** The core barreling tube **40** is slidably engageable in the bore **42** of the lower, thicker walled portion of the section **2',** and suspended from the anvil to seat relatively rotatably within the socket **26** of the bit. The tube is equipped with a bushed, ball bearing mounted swivel head **44** on the upper end thereof, and the bushing **46** of the head is slidably engaged on, but rotationally keyed to a flanged swivel pin **48,** which is fastened upright to the underside of the anvil. Moreover the keyway **50** for the bushing, and the length of the bushing, are sized in relation to the pin, to allow for play between the tube and the anvil, axially thereof; and a coiled spring **52** is interposed about the bushing **46,** between the head and the underside of the anvil, to bias the tube in the downward direction, toward the flange **48'** of the pin. Thus, when the drive means **4** is lowered into the bore of the pipe **2,** the tube **40** is urged to seat within the bit, both by the spring **52** and by the force of gravity; yet it is also free to undergo displacement in relation to the anvil, where there is earth material lodged within the bit. The earth material may be dislodged, however, either by the anvil, or by the fluid discharge, or by both, as shall be explained hereinafter.

In addition to being adapted to mate with the bit, the forward end portion **40'** of the tube **40** is also adapted to "lift" or separate the core **18** from the earth formation when the drive means **4** is retracted from the bore of the pipe. The tube **40** is formed in two threaded and flushed-coupled parts, the more forward **40'** of which is chamfered at the end, so as to mate with the chamfered socket **26** of the bit, and form an essentially air tight joint therebetween. The more forward portion **40'** also has an upwardly and outwardly tapered surface **54** formed between the cylindrical mouth **56** and the threaded collar **58** of the same; and when the two parts of the tube are assembled, a tapered wedge-like annular core lifter **60** is inserted within the more forward portion, to perform the core lifting and separating function in conventional fashion.

The outer cylindrical surface **62** of the anvil is closely machined to form a fluid seal with the bore of the pipe. Above the surface, however, the anvil is swaged inwardly and provided with a filleted shoulder **64** thereabout, from which a nipple-like shank or embossment **66** is upstanding on the axis of the anvil, and equipped with a wide circumferential groove **68** thereabout. The bore **70** of the anvil is counterbored from above and below, and the upper counterbore **72** of the same is adapted to interengage with the hammer mechanism, as shall be explained, whereas the lower counterbore **74** provides a socket for the swivel pin **48,** which is secured in the socket by means of a dowel **76.**

The hammer mechanism **5** is a modified version of a standard down-the-hole air hammer mechanism, comprising an outer tubular casing **78** having a pipe hammer **80** reciprocably engaged about a stationary control rod **82** therein. The control rod **82** is ported and infrastructured to enable the compressed fluid to reciprocate the hammer in known manner, and alternately to exhaust through porting **84** in the distal end **86** of the control rod. The fluid enters the control rod through a port or ports **90** in a spear-headed, piston-like cap **88** which is threaded onto the upper end of the casing and adapted to slidably engage with the wall of the bore of the pipe **2,** as illustrated. The ports **90** are equipped with spring-loaded throttle valves **92** that operate to produce a pressure drop between the upper and lower sides of the drive means, so that the fluid can assist in seating the anvil on the shoulder **3** of the pipe.

The anvil is coupled to the hammer mechanism by telescopically engaging a threaded, two-part, inner ribbed collar **98** about the embossment **66** of the anvil **38,** and flush-coupling the collar to the distal end of the casing **78,** the inner circumferential rib **100** of the collar, meanwhile interengaging in the groove **68** of the embossment. The drive means is retracted from the rod by an overhead hoist, such as a standard wire-line retriever, the dogs **96** of which are engaged about the spearhead **94** of the cap.

During the drilling operation, the hammer **80** interfaces with the annulus **102** at the upper end of the anvil, and applies intermittent blows to the anvil, as the pipe **2** is rotated thereabout. Thus, the bit is continually advanced in the axial direction by the percussive effect of the hammer, and at the same time, is continually ro-

tated by the pipe, so that the points **14** of the bit are reindexed with respect to the face of the excavation, each time that the hammer strikes. Moreover, due to the telescoping relationship between the tube **40** and the pipe, and the relatively reciprocable, swiveled relationship between the tube and the anvil, the tube remains substantially stationary with respect to the pipe, as the pipe is rotated and advanced into the formation.

During the drilling operation, moreover, the exhaust porting **84** in the control rod is placed in communication with the passages **36**, so as to exhaust the fluid about the bit. As seen, the distal end portion **86** of the control rod is slidably inserted in the bore **72** of the anvil; and in the bore, there is a series of symmetrically angularly spaced and outwardly slanted ports **104**, which open to the underside of the anvil, opposite the chamber **106** which is formed between the head **44** of the tube and the anvil. From there, the fluid enters a series of symetrically angularly spaced flutes **108** in the bore **42** of the pipe, which commence below the level of the shoulder **3**, and terminate in the distal end of the pipe, to communicate with the groove **30** and the ports **32** in the bit. In the engaged and socketed condition of the tube **40**, the open sides of the flutes are closed by the main body of the tube, and the socket **26** is occupied by the forward portion **40'** thereof, so that the fluid can escape only through the ports **32**. Until the tube is socketed in the bit, however, a portion of the fluid will discharge through the axial opening of the bit, so as to assist in flushing out any accumulated debris which would otherwise prevent the tube from seating in the socket of the bit.

Moreover, in such a case, the spring **52** will be compressed by the tube to the point where the bushing **46** of the swivel head engages the face of the anvil; and thereafter, when the hammer **80** is applied to the anvil, the force of the hammer will operate on the tube only, until the anvil re-engages the shoulder **3** of the pipe. Thus, the operator can be assured that the tube will be properly seated before the drilling operation is begun.

In the seating process, moreover, a passage **110** through the pin **48**, assures that the tube **40** is also pressurized, so that the debris can move only in the direction outward through the clearance **34**.

Of course, as drilling progresses, more and more sections are added to the drill pipe **2**. If necessary or desired, the tube can be changed at the same time to account for wear of the inner points of the bit; or the bit can be changed; or both can be changed.

For overhead or sidewall drilling, the fluid may also be employed as a means of seating the drive means; as for example, where the drive means is run into the rod at a pressure below that at which the valves **92** open, and then the pressure is raised to open the valves and commence drilling.

Where it is desired to drill for a period without coring, a plug-like bit can be substituted for the core barreling tube, and interengaged either with the pipe or with the annular bit, to rotate conjointly with the same.

I claim:

1. In combination, a piston-like means having a hammer mechanism thereon, an elongated excavation means suspended from the piston-like means, a rotary drill rod comprising an elongated pipe having a longitudinally extending bore therethrough and an annular bit at the distal end thereof, the piston-like means being slidably received in the bore through the proximal end thereof and there being an annular shoulder about the periphery of the bore to receive blows from the hammer of the mechanism adjacent the bit, means defining an annular seat about the periphery of the bore between the shoulder and the mouth of the bit, which is of lesser inside diameter than that of the shoulder, the excavation means being slidably received in the distal end portion of the bore through the opening of the shoulder and having one end thereof engaged with the seat, fluid passage means in the rod extending generally longitudinally of the bore between a point adjacent the shoulder and a point about the periphery of the seat, and porting in the body of the bit, extending generally axially thereof between the fluid passage means and the working face of the bit at the distal end thereof, together forming a passage about the excavation means through which fluid can be released into the working face of the bit from a point adjacent the opposite end of the axcavation means, and means whereby the released fluid can discharge from the face of the bit toward the proximal end of the pipe on the opposite side of the pipe from the excavation means.

2. The combination according to claim **1** wherein the shoulder is disposed on the pipe.

3. The combination according to claim **1** wherein the excavation means takes the form of a core barrel.

4. The combination according to claim **1** wherein the fluid passage means takes the form of fluting in the peripheral wall of the bore.

5. The combination according to claim **1** wherein the bit is rigidly connected to the distal end of the pipe.

6. The combination according to claim **1** further comprising attachment means on the proximal end of the piston-like means for releaseable engagement by a wire-line retriever or the like.

7. The combination according to claim **1** wherein the excavation means is relatively rotatably engaged with the seat.

8. The combination according to claim **1** wherein the excavation means is axially displaceable in relation to the piston-like means and yieldably biased into a stopped position relatively spaced therefrom.

9. The combination according to claim **1** wherein the bit has a greater diameter than the pipe and the pipe forms the inner periphery of an annulus which is disposed between the pipe and the wall of the excavated hole, to discharge the released fluid therethrough.

10. The combination according to claim **9** wherein the outer periphery of the bit is adapted so that the released fluid can pass thereacross to an annulus formed by the pipe and the wall of the excavated hole.

11. The combination according to claim **1** wherein the hammer mechanism is fluid operated and there are fluid transmission means for operating the hammer mechanism including means for passing fluid through the piston-like means and means for exhausting the fluid into the fluid passage means after the mechanism has operated.

12. The combination according to claim **11** further comprising means on the piston-like means for generating a pressure differential thereacross longitudinally of the bore, to maintain the hammer mechanism in operative relationship to the shoulder during the application of the blows.

13. The combination according to claim **12** wherein the proximal end portion of the bore is operatively fluid pressurized and the pressure differential generating

means is operative to cause a pressure drop across the piston-like means in the direction of the distal end of the bore.

14. The combination according to claim **1** wherein the piston-like means also has an anvil suspended therefrom and the anvil is interprosed in the bore between the hammer and the shoulder to receive and transmit the blows to the shoulder.

15. The combination according to claim **14** wherein the excavation means is suspended from the anvil.

16. The combination according to claim **15** wherein the excavation means is axially and/or rotationally displaceable in relation to the anvil.

17. The combination according to claim **14** wherein the hammer mechanism is fluid operated and there are fluid transmission means for operating the hammer mechanism including means for passing fluid through the piston-like means and means for exhausting the fluid into the fluid passage means after the mechanism has operated, and wherein the anvil defines a passage for the fluid and the fluid exhaust means is operative to exhaust the fluid through the anvil passage.

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