Jan. 18, 1966 S. L. COLLIER 3,229,776

IMPACT DRILLING TOOL

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Fig. 1

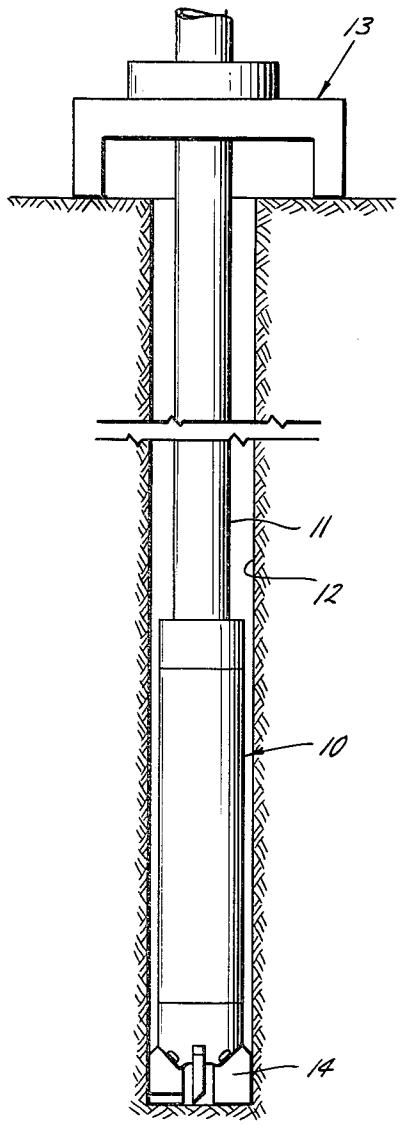
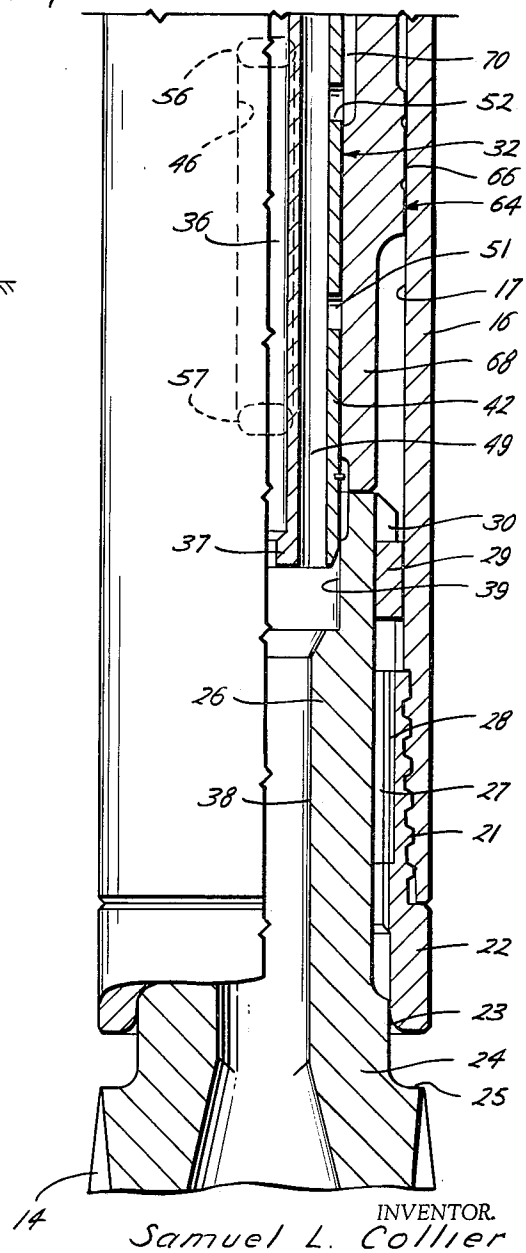


Fig. 4



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Fig. 2

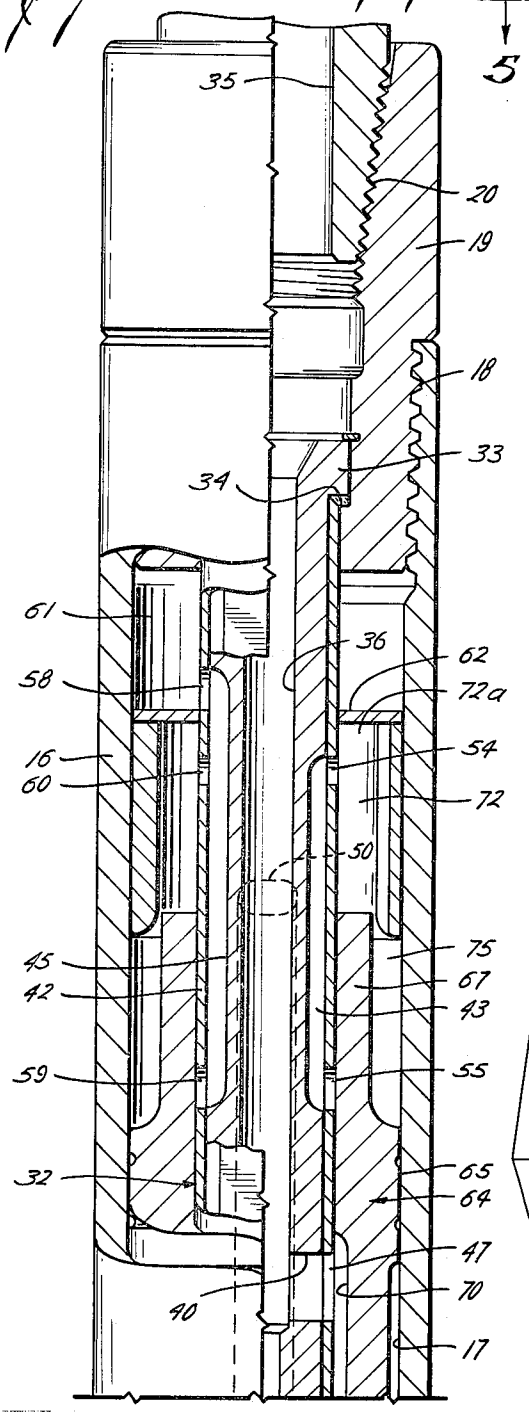
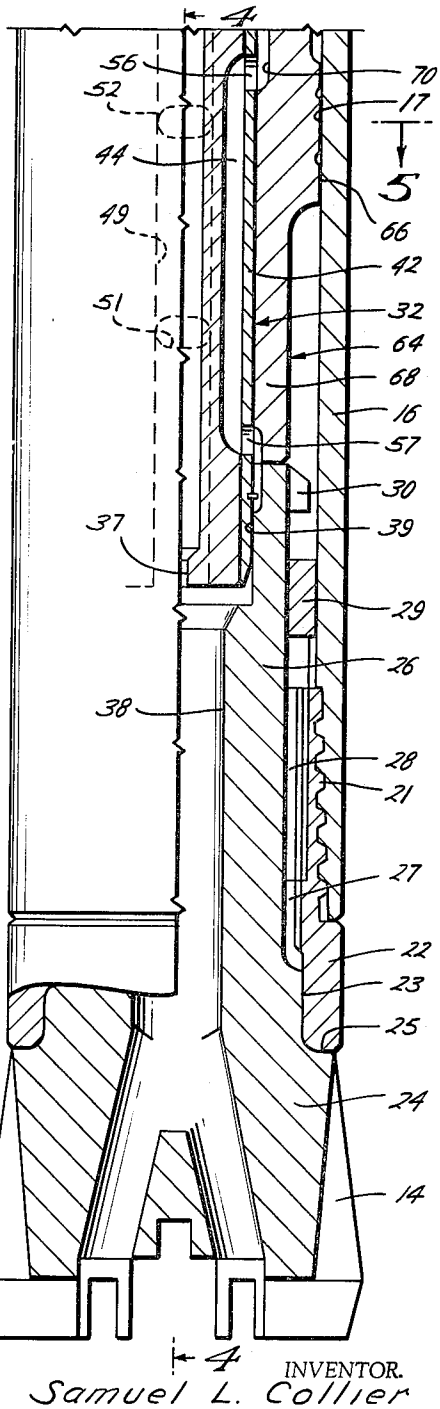


Fig. 3



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Fig. 6

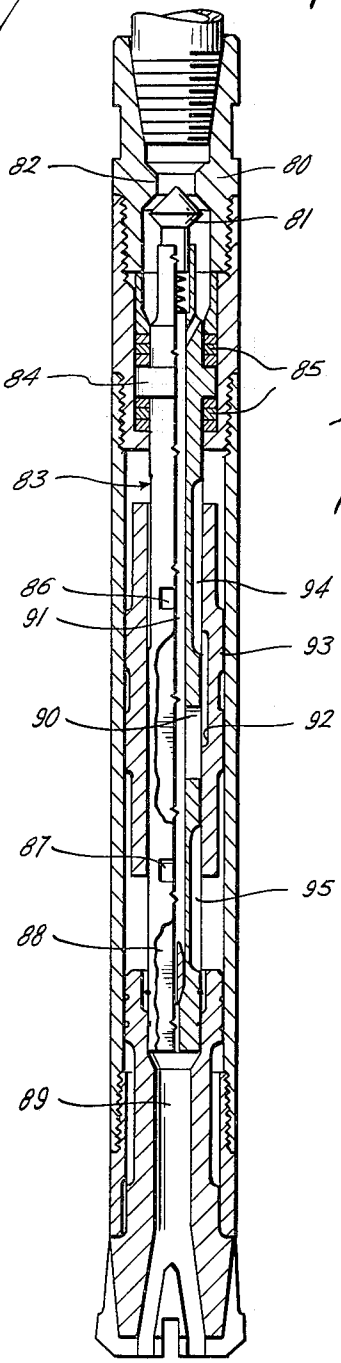


Fig. 5

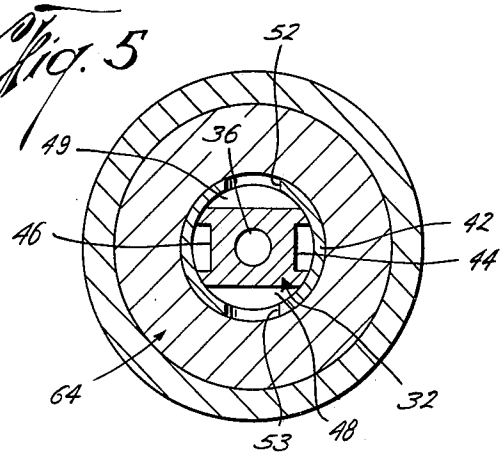
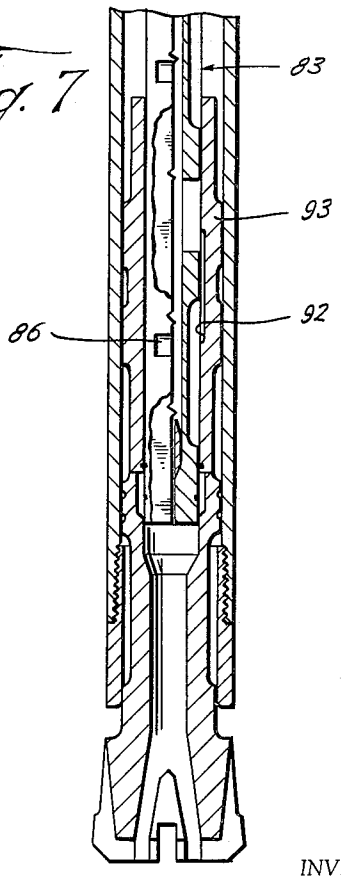


Fig. 7



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3,229,776

IMPACT DRILLING TOOL

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Filed Mar. 11, 1963, Ser. No. 264,351
5 Claims. (Cl. 173—17)

This invention relates to percussion drilling tools and consists in particular in novel means for causing substantially the entire volume of operating fluid to by-pass the working chamber when the tool is suspended off bottom. This application is a continuation-in-part of my copending application Serial No. 73,613, filed December 5, 1960.

It is desirable to provide a percussion drilling tool with means under the control of the operator for causing substantially the entire volume of operating fluid to be discharged through the cutting tool to provide maximum cleaning effect in the hole. Also it is desirable when the tool is inserted into or withdrawn from the hole or simply suspended off bottom to prevent the operation of the percussion motor. Previous apparatus has utilized abnormal shifting of the hammer piston, when the tool is suspended off bottom, to direct the operating fluid through one of the motor pressure chambers directly into the exhaust duct extending through the tool. However, communication of the by-passed or "blow-by" operating fluid with the working chamber of the motor is subject to the disadvantage that movement of the piston or a tapping may continue.

Accordingly, an object of the present invention is to provide novel means in a percussion drilling motor for causing substantially the entire volume of operating fluid to blow through the tool when suspended off bottom.

Another object is to provide a novel percussion drilling motor having means for causing the operating fluid to by-pass the working chamber thereof when the tool is suspended off bottom.

Still another object is to provide novel means for causing the operating fluid to blow-by the working chamber of a percussion tool of the type having a central porting tube, when the tool is suspended off bottom.

These objects and others are obtained by the structure herein disclosed which consists, in general of a percussion drilling motor having a casing which forms a working chamber in which reciprocates an annular hammer piston for beating upon the tool carrying anvil. A central porting tube extends through the working chamber and has exhaust ports and passaging communicating with an exhaust duct extending through the anvil at the bottom end of the working chamber. Also provided in the porting tube is a main pressure port which is connected to an operating fluid connection at the upper end of the casing. The piston has an internal shuttle recess which, during normal operation, alternately connects the pressure chambers at the opposite end of the casing to the main pressure port. However, when the tool is suspended off bottom, the piston drops abnormally so as to cause communication between the mentioned recess in the piston and a blow-by port for causing the operating fluid to completely by-pass the working chamber and pass directly into the exhaust duct. In one form of the invention a separate "blow-by" port opening into the exhaust passage is provided. In another form of the invention one of the normal exhaust ports is positioned to function as the blow-by port as described.

In the accompanying drawings which illustrate the invention,

FIG. 1 is a schematic representation of my novel percussion drilling tool supported in a well bore;

FIGS. 2 and 3 are enlarged side views, partially cut away and sectioned on the longitudinal center line of the tool, showing respectively the upper and lower portions of the tool;

FIG. 4 is a partial side view and section on the longitudinal center line taken at 90° to FIG. 3, the section being substantially on line 4—4 of FIG. 3;

FIG. 5 is a transverse horizontal section taken substantially on line 5—5 of FIG. 3;

FIG. 6 is a vertical transverse center section through a modified form of the percussion drilling tool; and

FIG. 7 is a view of a part of the structure in FIG. 6 shown in a different position.

FIG. 1 shows the percussion drilling tool, generally designated 10, supported from a drill string 11 in a bore hole 12 by means of a platform structure schematically represented at 13. Pressured operating fluid may be introduced into the upper end of the drill string and the exhaust fluid and cuttings withdrawn from the well annulus. A percussion bit 14 is mounted at the bottom of the tool.

The percussion motor, as illustrated in FIGS. 2–5, inclusive, includes a cylindrical casing 16 forming the working chamber 17 and threadedly secured at 18 at its upper end to an upper sub or adapter 19 which, in turn, is threadedly secured to pin 20 at the bottom extremity of the drill string 11. Casing 16, at its bottom extremity, is threadedly attached to a nut or chuck structure 21 having a lower cylindrical portion 22 slidably receiving a cylindrical intermediate part 23 of the combined anvil and bit structure 24 of which bit 14 forms the lower extremity. During normal, on-bottom operation, the bottom of nut portion 22 rests upon a horizontal, annular shoulder 25 on anvil-bit structure 24.

The upper portion 26 of the anvil-bit structure has external splines 27 which mate with internal splines on the nut structure 22 to permit relative longitudinal sliding movements of the anvil and casing, while enforcing joint rotation thereof. A ring 29 lodged against the inner face of the casing guides the anvil in its sliding movements and acts as a stop, cooperating with lugs 30 on the anvil to limit the dropping of the anvil relative to the casing when the tool is suspended off bottom.

A tubular porting structure, generally designated 32, extends axially through the casing 16 and has a shoulder at 33 at its upper extremity resting against and supported by the annular shoulder 34 in upper sub 19. The upper sub, in effect, forms a connection between the interior passages 35 and 36, respectively, of the drill string and the tubular structure. Passage 36 of the tubular structure has a restriction 37 at its lower extremity through which this passage communicates with the exhaust duct 38 which extends centrally through the anvil-bit structure for supplying clean-out fluid to the bit, as is well known. The lower end of the tubular structure is slidably received in the enlarged upper portion 39 of this exhaust duct. Supply passage 36 in the tubular structure communicates intermediately with oppositely directed main pressure supply ports, one being shown at 40 in FIG. 2.

Securely received upon the tubular structure is a relatively thin walled sleeve 42 which cooperates with opposite pairs of aligned longitudinal slots 43 and 44 and 45 and 46 in the tubular structure, to form pressure transfer passages. The respective pairs of slots are centrally separated by lands in the tubular structure and sleeve 42 has ports 47 registering with main pressure ports 40 in these lands. The intervening sides of the tubular structure are segmentally cut away to form exhaust passages 48 and 49 extending from near the top of the tubular structure to the bottom thereof and, at their lower extremities, communicating with exhaust duct 39, 38 in the anvil-bit. Main exhaust ports 50 and 51 in sleeve 42 communicate,

respectively, with exhaust passages 48 and 49. Blow-by exhaust ports 52 and 53 also are formed in sleeve 42 near the central portion of the tubular structure. Transfer passages 43 and 44 terminate, respectively, in ports 54 and 55 and 56 and 57 in sleeve 42. Opposite lower transfer passage 46 also terminates in similar ports (not shown). Upper transfer passage 45 terminates in ports 58, 59 and 60, the former communicating with a separate bumper compartment 61 formed by a transverse partition 62 traversing the upper part of the rear end of the working chamber within the casing.

Reciprocable within the working chamber formed by the casing is the hammer piston member 64 of annular form so as to fit snugly within the annular working chamber. The piston has spaced external sealing pad portions 65 and 66 and also has generally tubular, upward and downward extensions 67 and 68, the latter serving as the anvil striking member. The inner surface of the piston which slides along the tubular porting structure has a central annular shuttle recess 70 designed to alternately connect main pressure ports 40 to pressure transfer passages and thence with the pressure chambers formed at the opposite ends of the working chamber.

When the tool is operating in its normal manner with the cutting edges of bit 14 resting on bottom and nut structure 21, 22 resting on shoulder 25, pressured operating fluid supplied through drill string 11 will pass through the tubular porting structure into main pressure ports 40, thence through the upper or lower sets of transfer passages into the upper or lower pressure chamber, in accordance with the position of the piston. Assuming the piston is in the striking position, as in FIG. 3, the lower pressure chamber will be quickly filled with the operating fluid at working pressure, while the upper pressure chamber will exhaust through upper exhaust ports 50, exhaust passages 48 and 49 in the tubular structure, and exhaust duct 39, 38 in the anvil. The piston will quickly rise, first cutting off the supply of operating fluid to transfer passages 43 and 45 after which the charge of operating fluid in the lower pressure chamber will expand continuing the upward movement of the piston. Ultimately, the lower edge of the piston will uncover lower exhaust ports 51, exhausting the lower pressure chamber, and the upper edge of shuttle recess 70 will pass over pressure transfer ports 55 and 59 to supply operating fluid to the upper pressure chamber 72 through ports 54 and 60 and separate upper pressure chamber 61 through port 58. When upper piston extension 67 covers transfer ports 54 and 60, the total remaining volume of the extreme upper part 72*a* of the upper pressure chamber, to which the piston is exposed is very sharply reduced with the resultant extremely rapid buildup of compression therein. This serves to expedite the turn around of the piston. As the piston descends when its upper edges clears ports 54 and 60, the volume of the upper compression chamber, to which the piston is exposed is again sharply increased and this additional volume of fluid at working pressure is made available to assist the downward motion of the piston. The piston continues to reciprocate in this fashion during on-bottom normal operation of the tool, applying sharp blows to the anvil at a high rate of speed.

In case the tool should be suspended off bottom, as shown in FIG. 4, the anvil-bit structure is permitted to drop until lugs 30 rest upon stop collar 29. At the same time, the piston also drops which permits its shuttle groove 70 to overlap blow-by ports 52, while the lower part of the piston covers bottom transfer ports 57, preventing the supply of operating fluid to the working chamber. Thereupon, the operating fluid is fed directly through exhaust passages 48 and 49, thus entirely by-passing the working chamber and piston. Accordingly, the full volume of working fluid is made available for blowing out debris from the hole, while the piston rests quietly at the bottom of its stroke free of any tendency to reciprocate or "tap."

In the form shown in FIGS. 6 and 7 there is provided in connecting sub 80 for the operating fluid a spring pressed check valve 81 which normally seats upon restriction 82, when the operating fluid is cut off, to prevent the entry of ambient well fluids into the working parts of the motor. The central porting tube structure 83 is adjustably supported by means of a collar 84 resting between make-up rings 85. Upper and lower exhaust ports 86 and 87 communicate through segmental exhaust passages 88 with exhaust duct 89 in the anvil-bit structure, as in the previous form. Similarly, main pressure port 90 connects pressure passage 91 in the porting structure with shuttle groove or recess 92 in piston 93 and thence by means of transfer passages 94 or 95 alternately with the upper and lower pressure chambers causing normal reciprocation of the hammer piston.

However, when this form of tool is suspended off bottom, as illustrated in FIG. 7, shuttle groove 92 in the piston drops down far enough to overlap lower exhaust ports 87 so as to by-pass substantially the entire volume of operating fluid through the exhaust system. Thus, the extra blow-by ports of the previous form are not necessary.

Various features of the percussion motor as herein illustrated and described are not essential and these features may be altered as desired. The exclusive use of all modifications as come within the scope of the appended claims is contemplated.

I claim:

1. A percussion tool comprising a cylindrical casing forming a working chamber and having a connection at one end for working fluid, an anvil slidably received in the other end of said casing, an exhaust duct extending axially through said anvil, a hollow porting stem extending longitudinally through said chamber from said connection into said duct, pressure and exhaust passages extending longitudinally in said stem, respectively, from said connection and into said duct, main pressure port means and additional port means extending respectively from said passages laterally through the wall of said stem, a hollow piston received in said chamber and having a cylindrical inner surface slidable along said stem and shaped to alternately clear portions of said additional port means to exhaust opposite ends of said working chamber, said piston inner surface having intermediate recess structure positioned for alternately connecting said pressure port means to said chamber ends to cause said piston to beat upon said anvil, said piston being shiftable to an abnormal position when the tool is supported off bottom and said recess structure being constructed to overlap a portion of said additional port means at such time to directly connect said pressure port means to said exhaust passage and said duct and to cause the entire volume of working fluid to flow through said duct.

2. Percussion drilling apparatus comprising a casing having a porting tube extending axially therethrough and forming an annular working chamber, an annular piston reciprocable in said chamber in a normal range during normal operation and movable to an abnormal position when the apparatus is suspended off bottom, an operating fluid connecting at one end of said casing, an anvil slidably received in the opposite end of said casing, pressure and exhaust passages extending in said tube, respectively, from said connection and into said duct, main pressure port means and a pair of exhaust ports opening laterally through the tube wall, respectively from said passages, said piston having an inner surface slidable along said tube and shaped to alternately clear said exhaust ports to exhaust the opposite ends of said working chamber through said duct, during normal operation of the apparatus, and having internal recess structure cooperating with said pressure port means during such operation to alternately direct operating fluid to said chamber ends, one of said exhaust ports being positioned to be con-

nected by said piston recess structure to said main pressure port means, during off-bottom operation of the apparatus, to bypass the operating fluid directly through said exhaust passaging and said duct

3. Percussion drilling apparatus comprising cylindrical wall structure forming a working chamber, a connection for operating fluid at one end of said chamber, an anvil slidably received in the opposite end of said chamber, an exhaust duct in said anvil, a hammer piston reciprocable in said chamber and forming pressure chambers at opposite ends thereof, a main pressure port and spaced exhaust ports in said wall structure, passaging in said wall structure connecting said pressure port with said operating fluid connection and also connecting said exhaust ports with said exhaust duct, said exhaust ports being positioned to be controlled by said piston during normal on-bottom operation of the apparatus to alternately exhaust said pressure chambers through said duct, shuttle recess means in said piston and said wall structure positioned to alternately connect said pressure port with said opposite pressure chambers, said piston being shiftable abnormally when the apparatus is suspended off bottom and one of said exhaust ports being positioned to communicate directly with said recess means in said piston during such abnormal shifting of said piston to cause the operating fluid to bypass said working chamber and flow directly into said exhaust passage and said duct.

4. A percussion tool comprising a cylindrical casing forming a working chamber, a connection at one end of said casing for working fluid, an anvil slidably received in the other end of said casing, an exhaust duct extending axially in said anvil, a porting stem extending axially through said chamber from said connection to said duct, a main pressure port and longitudinally spaced exhaust ports opening laterally through the wall of said stem, longitudinal passages in said stem, respectively, connecting said connection to said pressure port and said exhaust ports to said duct, a hammer piston in said casing surrounding such stem and having an internal recess and edge structure for alternately connecting said pressure port to opposite ends of said working chamber while alternately connecting said chamber ends to said exhaust

ports to cause said piston to beat upon said anvil, and an additional port opening from said exhaust passage laterally through the wall of said stem and positioned to directly connect said piston recess and said main pressure port to said exhaust passage and said duct when said tool is suspended off bottom to cause all of the working fluid supplied to said pressure port to bypass said working chamber and to flow directly through said duct to prevent operation of said piston.

5. A percussion tool comprising a casing forming a working chamber, a working fluid connection at one end of said chamber, an anvil slidably received in the other end of said chamber, a porting tube extending axially through said chamber, from said connection to said duct, an annular piston reciprocable in said chamber within a normal range during operation and shiftable abnormally when the tool is suspended off bottom, and means to supply working fluid alternately to the opposite ends of said working chamber and to exhaust the same therefrom to cause said piston to beat upon said anvil, said means including port means and a pressure passage in said tube connecting said port means with said connection, additional port means and an exhaust passage in said tube connecting said latter port means with said duct, and recess structure in said piston positioned for alternately connecting said first port means and said chamber ends during normal operation, said recess means being shaped to overlap a portion of said additional port means when the tool is suspended off bottom for directly connecting said first port means and said exhaust passage and duct independently of said working chamber.

References Cited by the Examiner

UNITED STATES PATENTS

2,837,317	6/1958	Hulshizer	173—17
2,887,989	5/1959	Dulaney	173—17
3,045,768	7/1962	Huffman	173—15
3,105,559	10/1963	Collier et al.	173—78

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