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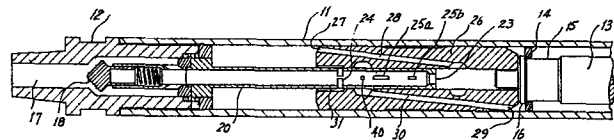
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Bulletin 83/28⑦② Inventor: **Rear, Ian Graeme, 53, Louise Street, Nedlands Western Australia (AU)**⑧④ Designated Contracting States: **DE FR GB SE**⑦④ Representative: **Matthews, Graham Farrah et al, MATTHEWS HADDAN & CO Haddan House 33 Elmfield Road, Bromley Kent BR1 1SU (GB)**⑤④ **Fluid operated hammer having drill bit clearance means.**

⑤⑦ A fluid operated hammer comprising a cylindrical casing (11) having a bore for slidably receiving a piston (26), a top sub (12) mounted at one end, a drill bit (13) mounted to the other end by means of a chuck (14), a feed tube (20) concentrically mounted within the upper end of the bore of the casing and extending downwardly into the casing, said feed tube being connectible to a fluid source through said top sub. The piston is slidably mounted within the bore of said casing over said feed tube (20). The feed tube (20) is provided with at least one aperture (24) in the walls of said feed tube, and at least one port (27, 29) provided at each end of the piston. Each port opens at spaced locations into the bore of the piston to periodically communicate with said aperture (24) as a result of sliding movement of the piston over the feed tube to alternately drive the piston towards and away from the drill bit to impact thereon and to drive the piston away from the drill bit. A further aperture (40) is provided in said feed tube (20) to communicate with the space between said drill bit (13) and said piston (26) when said hammer is in the "blow-down" position. The drill bit (13) is mounted in the chuck (14) in such manner that when in the "blow-down" position there is communication between said space and the exterior of the hammer through the zone between the drill bit and the chuck.



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THIS INVENTION relates to down hole fluid operated hammers and drill bits for use with rock drilling to form bore holes and relates to a means of clearing the drill bit of cuttings.

10 In such hammers and drill bits currently in use the drill bit is normally longitudinally slidably engaged in a drill chuck via a splined arrangement. The slidable engagement enables the hammer to be deactivated when the drill bit is removed from its contact with the bottom of the bore hole while the splined interconnection permits a torque to be applied to the drill bit by the rotating drill stem. During drilling operations it is often necessary to clear cuttings away from the zone surrounding the drill bit and this is done by raising the drill bit from the floor of the bore hole to deactivate the hammer and directing air from the hammer through the drill bit into the bottom of the bore hole. However under such conditions it is often the case that cuttings and the drilling fluid enters into the splines of the drill bit and chuck which are exposed
20 under such conditions and the presence of such material hinders the return of the drill bit to its inner-most position in the chuck and thus can prevent operation of the hammer or at least reduce its operating capacity.

It is an object of this invention to provide means of facilitating clearing foreign matter from the splined interconnection between a drill bit and chuck of a down hole hammer, when said hammer is in its "blow-down" position.

30 In one form the invention resides in a fluid operated hammer comprising a cylindrical casing having a bore for slidably receiving a piston, a top sub mounted at one end, a drill bit mounted to the other end by means of a chuck, a feed tube concentrically mounted within the upper end of

the bore of the casing and extending downwardly into the casing, said feed tube being connectable to a fluid source through said top sub, a piston slidably mounted within the bore of said casing over said feed tube, at least one aperture provided in the walls of said feed tube, at least one port provided at each end of the piston, each port opening at spaced locations into the bore of the piston to periodically communicate with said aperture as a result of slidable movement of the piston over the feed tube to
10 alternatively drive the piston towards the drill bit to impact thereon and to drive the piston away from the drill bit; a further aperture provided in said feed tube to communicate with the space between said drill bit and said piston when said hammer is in the "blow-down" position and said drill bit being mounted in said chuck such that when in the "blow-down" position there is communication between said space and the exterior of the hammer through the zone between drill bit and said chuck.

According to a preferred feature of the invention the
20 communication between said further aperture and said space is via the port provided at the drill bit end of the piston.

The invention will be more fully understood in the light of the following description of several specific embodiments. The description is made with reference to the accompanying drawings of which:-

Fig. 1 is a sectional side elevation of a fluid operated hammer according to the first embodiment in the "blow-down" position;
30 Fig. 2 is a sectional side elevation of the fluid operated hammer of Fig. 1 in the "impact" position;
Fig. 3 is a sectional side elevation of the fluid operated hammer of Figs. 1 and 2 with the hammer in the "raised" position;

Fig. 4 is a sectional side elevation of a fluid operated hammer according to the second embodiment in the "blow-down" position;

Fig. 5 is a sectional side elevation of the fluid operated hammer of Fig. 4 in the "impact" position;

Fig. 6 is a sectional side elevation of the fluid operated hammer of Figs. 4 and 5 with the hammer in the "raised" position;

10 Fig. 7 is a sectional side elevation of a fluid operated hammer according to the third embodiment in the "blow-down" position;

Fig. 8 is a sectional side elevation of the fluid operated hammer of Fig. 7 in the "impact" position; and

Fig. 9 is a sectional side elevation of the fluid operated hammer of Figs. 7 and 8 with the hammer in the "raised" position.

20 The first embodiment of Figs. 1, 2 and 3 is a fluid operated hammer which comprises a cylindrical casing 11 having a substantially uncountoured inner face with a top sub 12 mounted at one end and a drill bit 13 mounted at the other end. The drill bit is mounted within a drill chuck which is threadably engaged in the other end of the casing such that it is longitudinally slidable for a limited degree within the end of the chuck. Such limited slidable movement of the drill bit is facilitated by a bit ring 14 mounted in the inner end of the chuck and which is received within a waisted portion 15 of the innermost end of the drill bit. The innermost end of the drill bit 13
30 which extends beyond the bit ring 14 is formed with an enlarged portion which serves as the anvil 16 for the drill bit 13.

The mounting of the drill bit in the chuck is via a splined arrangement permitting the limited longitudinal

sliding movement of the drill bit in the chuck but ensuring a transmission of torque from the drill stem to the drill bit. When the drill bit is in its inner-most position in the chuck the splined interconnection is such that the interior of the hammer is sealed from the exterior of the drill bit, however on the drill bit dropping to its lower-most position in the chuck (i.e. its blow-down position) the interior of the hammer above the drill bit is in communication with the exterior of the drill bit through
10 the splined interconnection.

The top sub 12 is threadably engaged in the one end of the casing 11 and is provided with a fluid inlet port 17 which communicates with a spring loaded check valve 18 located within the top sub to prevent any reverse fluid flow. The bore of the casing 11 supports a feed tube 20 which is concentrically mounted at the one end of the bore of the casing 11 in abutting relation with the inner end of the top sub 12. The feed tube 20 extends from the one end of the casing for a portion of the length of the casing. The
20 mounting of the feed tube comprises a centralising ring which is accurately, closely and concentrically retained in the one end of the bore. The centralising ring receives the one end of the feed tube and accurately retains the feed tube such that it is concentrically located within the casing 11. A flange at the one end of the feed tube overlies the outer axial face of the centralising ring to be located within a suitably shaped recess formed within the top sub 12. Suitable tolerances are provided between the top sub 12 and the flanged end of the feed
30 tube in order that any mis-alignment of the top sub will not effect the alignment of the feed tube 20 within the casing as established by the spacer ring. Suitable resilient sealing and accommodating means in the form of O-rings are provided in the centralising space between the centralising ring and the flanged of the feed tube and the

top sub 12 and the flanged of the feed tube to prevent any loss of fluid from the junctions therebetween and to allow some movement of the feed tube. The centralising ring provides a means of supporting and centralising the feed tube concentrically within the bore of the casing 11 and thus the piston 26.

10 The free end of the feed tube is provided with a suitably dimensioned choke 23 which permits a controlled continuous flow of fluid down through the drill bit 13. The walls of the feed tube are uncountoured and are formed with three sets of apertures. One set 24 comprises a single aperture which extends for a considerable portion of the circumference of the feed tube but which has a relatively small dimension in the longitudinal axis of the feed tube. Alternatively the one set may comprise a series of circumferentially spaced apertures in the walls of the feed tube which have a relatively small axial dimension. The other set of apertures comprise a pair of longitudinally spaced apertures 25a and 25b located towards the free end of the feed tube from the one set of apertures 24. One aperture 25a of the other set of apertures which is located closest to said one set of apertures 24 is greater in size than the other of said apertures 25b and has a greater axial dimension than the other aperture 25b. A third set of apertures 40 is located between the first and second sets 24 and 25.

30 The hammer further supports within the casing 11 a piston 26 which is longitudinally slidable within said casing 11 and over said feed tube 20. Each end of said piston is provided with a port 27 and 29 which communicates via a passage-way 28 or 30 extending respectively from the top sub end and drill bit end to the internal bore of said piston. The passage-ways 28 and 30 are formed by obliquely boring a hole from the respective end of said pis-

ton to the bore of said piston. In addition the end of the piston adjacent the top sub 12 is counterbored to provide an expanded portion 31 in the bore of the piston which extends for a small portion of the length of the bore.

As shown in Fig. 1 to place the hammer in the "blow-down" position the hammer is moved axially away from the base of the drill hole in order that the drill bit moves to its outermost position in the chuck and the bit ring 14 is engaged with the anvil 16 of the drill bit. When in the "blow-down" mode the piston 26 is retained in contact with the anvil 16. The maintenance of this position is a result of the counter-bored portion 31 at the one end of the hammer 26 being in communication with the one set of apertures 24 to provide fluid communication between the source of fluid pressure and the space located between the one end of the piston 26 and the top sub 12. Fluid pressure is admitted into the space between the piston 26 and the drill bit 13 through the third set of ports 40 and the port 29 in the drill bit end of the piston. However this pressure is vented through the splined interconnection between the drill bit and chuck to prevent the collection of cuttings in the space between the drill bit and chuck during "blow-down". Fluid from the top sub end of the piston escapes to the drill bit via port 27 and the one passage-way 28.

Due to the small axial dimension of the one set of apertures if the piston should for some reason be moved from engagement with the anvil a considerable degree of movement of the piston is required for the one set of apertures to communicate with the drill bit end of the piston through the passage-way 30 and port 29. The small axial dimension of the one set of apertures ensures that there can be no overlap between the counter-bored portion and

the passage-way 28 by the one set of apertures. Therefore, the possibility of back hammer is considerably reduced. In addition, due to the absence of restriction between the one set of apertures and the drill bit other than the counter-bored portion 31 and the passage-way 28 connecting the drill bit end of the piston with the bore of the piston the flow of air to the drill bit during "blow-down" is relatively unrestricted ensuring clearing of drill cuttings.

- 10 When the fluid operated hammer is moved axially towards the base of the drill hole such that the drill bit engages with the base of the bore hole the drill bit 13 moves into the fluid hammer. As a result (as shown in Fig. 2) the counter-bored portion 31 in the one end of the hammer 26 is isolated from the source of fluid pressure and the one passage-way 28 connecting the top sub end port 27 of the piston 26 with the bore of the piston is isolated from the source of fluid pressure while the other passage-way 30 connecting the drill bit port 29 of the piston 26 with
20 the internal bore of the piston is in communication with the one set of apertures 24 in the feed tube 20, as a result fluid pressure from the fluid source is applied to the space between the drill bit end 29 of the piston 26 and the chuck 14. The resultant pressure differential produces a movement of the piston 26 from the drill bit.

The use of an aperture 24 of relatively small axial dimensions and allows a degree of control over the introduction of fluid at a precise point in the travel of the piston 26 and similarly causes the fluid flow to the piston to be
30 shut off rapidly rather than having a gradual decrease as would occur if a longitudinally larger port were used.

If desired the one set of apertures 24 can be positioned to communicate fully with the drill bit end of the piston

when the piston is raised a small distance from the anvil in order to make use of the reactive rebound of the piston after striking the anvil 16 in returning the piston to its position adjacent the centralising ring 21.

When the piston 26 is in its position adjacent the centralising ring 21 (as shown as Fig. 3) the other passage-way 30 between the drill bit port 29 of the piston 26 and the bore of the piston is not in communication with any source of fluid pressure while the one passage-way 28 providing communication between the top sub port 27 of the piston 26 and the bore is in communication with the one aperture 25a of the other set of apertures 25. The resultant increased pressure in the space between the top sub 12 and the corresponding end of the piston produces a thrust on the piston 26 to cause it to move towards the drill bit. The pressure producing the thrust on the piston 26 is reduced once the opening of the one passage-way 28 into the bore of the piston 26 passes the one aperture 25a but is further reinforced when the opening of the one passage-way 28 communicates with the other aperture 25b of the other set of apertures 25 during the movement of the piston 26 toward the drill bit.

By variation of the spacing between the apertures 25a and 25b the frequency and force of impact of the piston 26 on the drill bit can be varied according to the geological conditions in which the hammer is being used or the pressure of the fluid being used. To effect such variation requires the replacement of the feed tube 20 only. In addition, by varying the centralising ring simultaneously or independently with the feed tube the performance characteristics can be optimised to suit the conditions or specifications of the holes being drilled.

By means of the second aperture 25b additional pressure is introduced into the space above the piston to provide an additional thrust on the piston during its movement towards the drill bit and the use of the two apertures 25a and 25b also serves to introduce further fluid into the space above the piston during the movement of the piston from the drill bit.

10 In addition the fluid input into the space between the top sub 12 and the piston 26 during the movement of the piston 26 from the drill bit serves to prevent the impact of the piston 26 with the centralising ring 21.

The second embodiment of Figs. 4, 5 and 6 is a fluid operated hammer which comprises a cylindrical casing 111 having a substantially uncontoured inner face with a top sub 112 mounted at one end and a drill bit 113 mounted at the other end in the same manner as the first embodiment and having the same features as the hammer of the first embodiment including the splined interconnection between the chuck 141 and bit which was described in the description of the first embodiment.

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The casing 111 further supports a feed tube 10 which is concentrically mounted at the one end of the casing 111 in abutting relation with the inner end of the sub 112. The feed tube 20 extends from the one end of the casing for a portion of the length of the casing. The mounting of the feed tube is of the same form as that shown and described in the first embodiment.

30 The free end of the feed tube is provided with a suitably dimensioned choke 123 which permits a controlled continuous flow of fluid down through the drill bit 113. The walls of the feed tube are uncontoured and are formed with three sets of apertures. One set of 124 comprises a sin-

gle aperture which extends for a considerable portion of the circumference of the feed tube but which has a relatively small dimension in the longitudinal axis of the feed tube. Alternatively the one set may comprise a series of circumferentially spaced apertures in the walls of the feed tube which have a relatively small axial dimension. The other set of apertures comprise a pair of longitudinally spaced apertures 125a and 125b located towards the free end of the feed tube from the one set of apertures 124. One aperture 125a of the other set of apertures which is located closest to said one set of apertures 124 and is greater in size than the other of said apertures 125b and has a greater axial dimension than the other aperture 125b. A third set of apertures 140 is located between the first and second set 124 and 125.

The happer further supports within the casing 111 a piston 126 which is longitudinally slidable within said casing 111 and over said feed tube 120. One end of said piston is provided with a port 127 while another port 129 is located at an intermediate position on the piston. Said ports communicate with a passage-way 128 and 130 respectively extending from the respective port to the internal bore of said piston. The passage-ways 128 and 130 are formed by obliquely boring a hole from the position of the respective port of said piston to the bore of said piston. In addition the end of the piston adjacent the top sub 112 is counterbored to provide an expanded portion 131 in the bore of the piston which extends for a small portion of the length of the bore.

The circumferential face of the piston 126 between the position of the other port 129 and the other end of the piston which is adjacent the drill bit is machined to reduced diameter and the outer end of that reduced diameter portion 132 is formed with a rib 133. In addition the

drill bit end of the casing supports a sleeve 134 which extends a small distance beyond the innermost position of the anvil 116 of the drill bit 113. The inner most end of the sleeve 134 is formed with a rib 135 dimensioned such that the rib 133 at the other end of the piston 126 sealingly engages with the rib 135 on the sleeve when they are adjacent each other.

As shown at Fig. 4 to place the hammer in the "blow-down" position the hammer is moved axially away from the base of the drill hole in order that the drill bit moves to its outermost position in the chuck and the bit ring 114 is engaged with the anvil 116 of the drill bit. When in the "blow-down" mode the piston 16 is retained in contact with the anvil 116. The maintenance of this position is a result of the counter-bored portion 131 at the one end of the hammer 16 being in communication with the one set of apertures 124 to provide fluid communication between the source of fluid pressure and the space located between the one end of the piston 126 and the top sub 11. Fluid pressure is admitted into the space between the piston 126 and the drill 113 through the third set of ports 140 and the port 129 in the drill bit end of the piston. However this fluid pressure is vented through the splined interconnection 141 between the drill bit and chuck to prevent the collection of cuttings in the space between the drill bit and chuck during "blow-down". Fluid from the top sub end of the piston escapes to the drill bit via one port 127 and the one passage 128.

Due to the small axial dimension of the one set of apertures if the piston should for some reason be moved from engagement with the anvil a fair degree of movement of the piston is required for the one set of apertures to communicate with the drill bit end of the piston through the passage-way 130 and port 129. The small axial dimension

of the one set of apertures ensures that there can be no overlap between the counter-bored portion and the passage-way 128 by the one set of apertures. Therefore, the possibility of back hammer is considerably reduced. In addition, due to the absence of restriction between the one set of apertures and the drill bit other than the counter-bored portion 131 and the passage-way 128 connecting the drill bit end of the piston with the bore of the piston, the flow of air to the drill bit during
10 "blow-down" is relatively unrestricted ensuring clearance of drill cuttings.

When the fluid operated hammer is moved axially towards the base of the drill hole such that the drill bit engages with the base of the bore hole the drill bit 113 moves into the fluid hammer. As a result (as shown in Fig. 5) the counter-bored portion 131 in the one end of the hammer 126 is isolated from the source of fluid pressure and the one passage-way 128 connecting the top sub end port 127 of the piston 126 with the bore of the piston is isolated
20 from the source of fluid pressure while the other passage-way 30 connecting the drill bit port 129 of the piston 126 with the internal bore of the piston is in communication with the one set of apertures 124 in the feed tube 120. As a result fluid pressure from the fluid source is applied to the space between the reduced diameter portion 132 of the piston 126, the inner end of the sleeve 134 and the casing 111 due to the sealing engagement between the ribs 133 and 135 on the piston 126 and sleeve 134 respectively. The resultant pressure differential
30 produces a movement of the piston 126 from the drill bit.

If desired the one set of apertures 124 can be positioned to communicate fully with the drill bit end of the piston when the piston is raised a small distance from the anvil

in order to make use of the reactive rebound of the piston after striking the anvil 16 in returning the piston to its position adjacent the centralising ring 121.

When the piston 126 is in its position adjacent the centralising ring 121 (as shown at Fig. 6) the other passage-way 130 between the other port 129 of the piston 126 and the bore of the piston is not in communication with any source of fluid pressure while the one passage-way 128 providing communication between the one port 127 of the piston 126 and the bore is in communication with the one aperture 125a of the other set of apertures 125. The resultant increased pressure in the space between the top sub 112 and the one end of the piston produces a thrust on the piston 126 towards the drill bit.

The pressure producing the thrust on the piston 126 is reduced once the opening of the one passage-way 128 into the bore of the piston 126 passes the one aperture 125a but is further reinforced when the opening of the one passage-way 128 communicates with the other aperture 125b of the other set of apertures 125 during the movement of the piston 126 toward the drill bit.

The third embodiment of Figs. 7, 8 and 9 is a fluid operated hammer which comprises a cylindrical casing 211 having a substantially uncountoured inner face with a top sub 212 mounted at one end and a drill bit 213 mounted at the other end in the same manner and having the same features as the hammer of the first embodiment including the splined interconnection 241 between the chuck and bit which is described and shown in the description of the first embodiment.

The casing 211 further supports a feed tube 220 which is concentrically mounted at the one end of the casing 211 in

abutting relation with the inner end of the top sub 212. The feed tube 220 extends from the one end of the casing for substantially the full length of the casing 211 such that its free end is received in the bore of the drill bit 213 when the drill bit 213 is in its innermost position in the casing but it is free of the drill bit when the drill bit is in its outer most position within the casing 211. The mounting of the feed tube to the top sub 212 is of the same form as that shown and described in relation to the first embodiment.

As in the first embodiment, the centralising ring 221 may be readily exchanged with other rings of differing thickness in order that the volume of the space between the upper end of the piston 226 and the top sub may be varied. The walls of the feed tube are uncountoured and are formed with three sets of apertures. One set 224 comprises a single aperture which extends for a considerable portion of the circumference of the feed tube but which has a relatively small dimension in the longitudinal axis of the feed tube. Alternatively the one set may comprise a series of circumferentially spaced apertures in the walls of the feed tube which have a relatively small axial dimension. The other set of apertures comprise a pair of longitudinally spaced apertures 225a and 225b located towards the free end of the feed tube from the one set of apertures 224. One aperture 225a of the other set of apertures which is located closest to said one set of apertures 224 is greater in size than the other of said apertures 225b and has a greater axial dimension than the other aperture 225b. A third set of apertures 240 is located between the first and second set 225 and 224.

Towards the free end of the feed tube 220 the walls thereof are formed with a further aperture or set of apertures 236 having relatively large dimensions. A choke 223 is located in the feed tube between the two sets of apertures

224 and 225 and the further set of apertures 236 to provide a controlled continuous flow of fluid down through the drill bit 213.

10 The hammer further supports within the casing 211 a piston 226 which is longitudinally slidable within said casing 211 and over said feed tube 220. One end of said piston is provided with a port 227 while another port 229 is located at an intermediate position on the piston said ports communicate with a passage-way 228 or 230 respectively extending from the respective port to the internal bore of said piston. The passage-ways 228 and 230 are formed by obliquely boring a passage-way from the position of the respective port on the exterior of said piston to the bore of said piston. In addition the end of the piston adjacent the top sub 212 is counter-bored to provide an expanded portion 231 in the bore of the piston which extends for a small portion of the length of the bore.

20 The circumferential face of the piston 226 between the intermediate position on the other port 229 and the other end of the piston 226 which is adjacent the drill bit is machined to provide a reduced diameter portion wherein the other end portion of that reduced diameter portion 232 is formed with a rib 233. In addition, the drill bit end of the casing supports a sleeve 234 which extends a small distance beyond the innermost position of the anvil 216 of the drill bit 213. The innermost end of the sleeve 234 is formed with a rib 235 dimensioned such that the rib 233 at the other end of the piston 226 sealingly engages with the rib 235 on the sleeve when adjacent each other.

30 As shown at Fig. 7 to place the hammer in the "blow-down" position the hammer is moved axially away from the base of the drill hole in order that the drill bit 213 moves to its outermost position in the chuck and the bit ring 214

is engaged with the anvil 216 of the drill bit. When in the "blow-down" mode the piston 226 is retained in contact with the anvil 215. The maintenance of this position is a result of the counter-bored portion 231 at the one end of the hammer 226 being in communication with the one set of apertures 224 to provide fluid communication between the source of fluid pressure and the space located between the one end of the piston 226 and the top sub 212. Fluid pressure is admitted into the space between the piston 126
10 and the drill bit 113 through the third set of apertures 240 and the post 229 in the drill bit end of the piston. However the pressure is vented through the splined inter-connection 241 between the drill bit and chuck to prevent the collection of cuttings in the space between the drill bit and chuck during "blow-down". Fluid from the top sub end of the piston escapes to the drill bit via port 227 and the one passage-way 229 and the further aperture 236 located towards the free end of the feed tube. The further aperture 236 is dimensioned such that it permits as
20 much flow as is possible into the drill bit to maximise the use of the fluid when in the "blow-down" position to clear cuttings from the bore hole.

Due to the small axial dimension of the one set of apertures if the piston should for some reason be moved from engagement with the anvil a fair degree of movement of the piston is required for the one set of apertures to communicate with the drill bit end of the piston through the passage-way 230 and port 229. The small axial dimension of the one set of apertures ensures that there can be no
30 overlap between the counter-bored portion and the passage-way 228 by the one set of apertures. Therefore, the possibility of back hammer is considerably reduced. In addition, due to the lack of restriction between the one set of apertures and the drill bit other than the counter-bored portion 231 and the passage-way 228 connecting

the drill bit end of the piston with the bore of the piston, the flow of air to the drill bit during "blow-down" is relatively unrestricted ensuring clearing of drill cuttings.

When the fluid operated hammer is moved axially towards the base of the drill hole such that the drill bit engages with the base of the bore hole the drill bit 213 moves into the fluid hammer. As a result (as shown in Fig. 8) the counter-bored portion 231 in the one end of the hammer
10 26 is isolated from the source of fluid pressure and the one passage-way 228 connecting the top sub end port 227 of the piston 226 with the bore of the piston is isolated from the source of fluid pressure while the other passage-way 230 connecting the drill bit port 229 of the piston 226 with the internal bore of the piston is in communication with the one set of apertures 224 in the feed tube 220, as a result fluid pressure from the fluid source is applied to the space between the reduced diameter portion 232 of the piston 226, the inner end of the sleeve
20 234 and the casing 211 due to the sealing interengagement between the ribs 233 and 235 on the piston 236 and sleeve 234 respectively. The resultant pressure differential produces an upward movement of the piston 26 from the drill bit.

The use of an aperture 224 of relatively small axial dimensions is a departure from previous practice and allows a greater control over the introduction of fluid at a precise point in the travel of the piston 226 and similarly causes the fluid flow to the piston to be shut off
30 rapidly rather than having a gradual decrease as would occur if a longitudinally larger port were used.

If desired the one set of apertures 224 can be positioned to communicate fully with the drill bit end of the piston

when the piston is raised a small distance from the anvil in order to make use of the reactive rebound of the piston after striking the anvil 16 in returning the piston to its position adjacent the centralising ring 221.

10 The use of the sleeve 234 in the drill bit end of the casing 211 reduces the volume of the space into which the other port 229 delivers fluid to effect the movement of the piston towards the drill bit. This reduces the volume of fluid required to return the piston to its position adjacent the drill bit.

20 When the piston 226 is in its position adjacent the centralising ring 221 (as shown at Fig. 3) the other passage-way 230 between the other port 229 of the piston 226 and the bore of the piston is not in communication with any source of fluid pressure while the one passage-way 228 providing communication between the one port 227 of the piston 226 and the bore is in communication with the one aperture 225a of the other set of apertures 225. The resultant increased pressure in the space between the top sub 12 and the corresponding end of the piston produces a thrust on the piston 26 to cause it to move towards the drill bit.

The pressure producing the thrust on the piston 226 is reduced once the opening of the one passage-way 228 into the bore of the piston 226 passes the edge of the one aperture 225a but is further reinforced when the opening of the one passage-way 228 communicates with the other aperture 225b of the other set of apertures 25 during the movement of the piston 26 toward the drill bit.

30 It should be noted that the hammer of each embodiment may be used for bore holes disposed at any angle from a work station above and below the horizontal axis.

In each of the embodiments the third set of apertures 40, 140 and 240 provide an additional outlet for fluid from the hammer into the bore hole when the hammer is in its "blow-down" mode. Therefore the flow of high pressure fluid into the bore hole is maximised when the hammer moves to the "blow-down" mode and the resultant sudden flow of fluid facilitates clearance of cutting from the bore hole.

10 This effect of the third set of apertures is of particular relevance in small hammers where for maximum operational efficiency it is desirable to close off the lower end of the feed tube. In such hammers the third set of apertures serve a similar function as a choke in the "blow-down" mode to augment the fluid flow through the centre of the chuck.

Therefore the third set of apertures facilitate clearance of the splined interconnection between the drill bit and chuck but also further augment the fluid flow from the hammer when in the "blow-down" mode.

20 It should be appreciated that the scope of the invention need not be restricted to the particular scope of the embodiments described above and in particular be limited to the particular arrangement of ports passage-ways in the piston or apertures in the feed tube an interrelationship between the piston cylinder, top sub, drill bit and chuck described in relation to the embodiments.

CLAIMS

1. A fluid operated hammer comprising a cylindrical casing (11) having a bore for slidably receiving a piston (26), a top sub (12) mounted at one end, a drill bit (13) mounted to the other end by means of a chuck (14), a feed tube (20) concentrically mounted within the upper end of the bore of the casing and extending downwardly into the casing, said feed tube (20) being connectible to a fluid source through said top sub (12), a piston (26) slidably mounted within the bore of said casing (11) over said
10 feed tube, at least one aperture (24) provided in the walls of said feed tube (20), at least one port (27,29,) provided at each end of the piston, each port opening at spaced locations into the bore of the piston to periodically communicate with said aperture as a result of sliding movement of the piston over the feed tube to alternately drive the piston towards and away from the drill bit to impact thereon and to drive the piston away from the drill bit; a further aperture (40) provided in said feed tube to communicate with the space between said
20 drill bit (13) and said piston (26) when said hammer is in the "blow-down" position and said drill bit (13) being mounted in said chuck such that when in the "blow-down" position there is communication between said space and the exterior of the hammer through the zone between the drill bit (13) and the chuck (14).

2. A fluid operated hammer as claimed at claim 1, characterized in that the communication between said further aperture (40) and said space when the hammer is in the "blow-down" position is via the port (29) provided at the drill bit end of the piston.

3. A fluid operated hammer as claimed at claim 1 or 2 characterized in that the drill bit (13) is capable of limited longitudinal slidable movement in the chuck (14).

4. A fluid operated hammer as claimed at claim 1,2 or 3,
10 characterized in that the drill bit (13) and chuck (14) are provided with matingly engaged longitudinally extending splines on their adjacent circumferential faces.

