United States Patent

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[72] Inventor **Grey Bassinger**
Bedford, Pa.

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[73] Assignee **Rand Engineering Corp.**
San Antonio, Tex.

[54] **FLUID-ACTUATED IMPACT TOOL AND ANVIL DEVICE HAVING VARIABLE CHOKE**
30 Claims, 14 Drawing Figs.

[52] **U.S. Cl.** **175/92,** 173/73, 173/80
[51] **Int. Cl.** **E21b 5/00**
[50] **Field of Search** 175/338, 92, 376; 173/73, 80

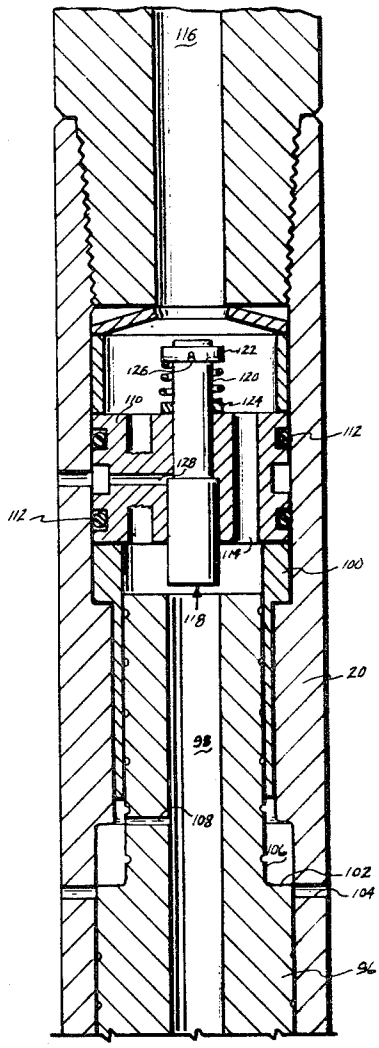
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Primary Examiner—James A. Leppink
Attorney—John C. Stahl

ABSTRACT: The specification discloses a fluid-operated impact-drilling device in which a hammer is reciprocally mounted in a casing and is adapted for impacting on the upper end of an anvil-bit device mounted in the end of the casing. A continuous supply of pressure medium is introduced into the casing on the opposite side of the hammer from the anvil-bit device and any valve arrangement is provided for cyclically varying the pressure acting on opposite ends of the hammer to cause the hammer to reciprocate in the casing. A particular feature of the valve arrangement is a variable choke valve mounted in the hammer end of the anvil-bit device and arranged to offer greater restriction to flow through the anvil-bit device during retracting movement of the hammer and a lesser restriction of flow during advancing movement of the hammer. The anvil-bit device may comprise a conventional bit on the outer end or it may comprise a ball-like bit member rotatable on an inclined shaft connected to the anvil-bit device.



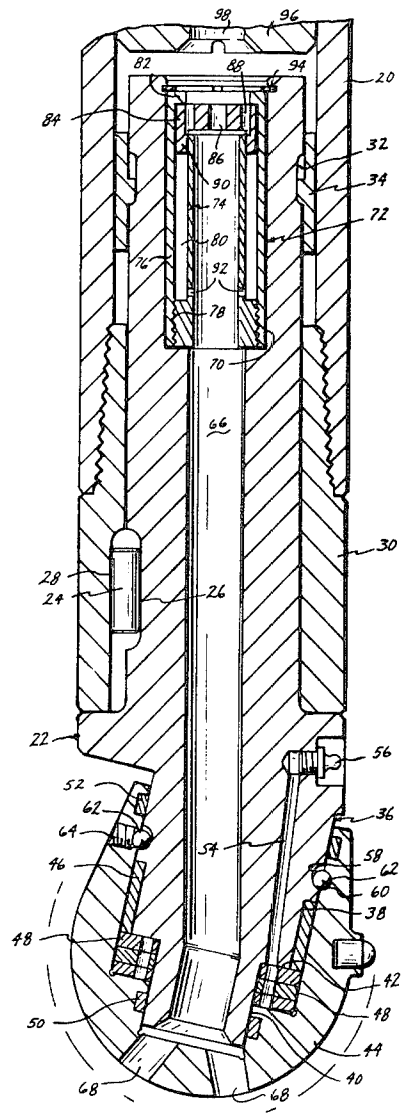


FIG. 1A

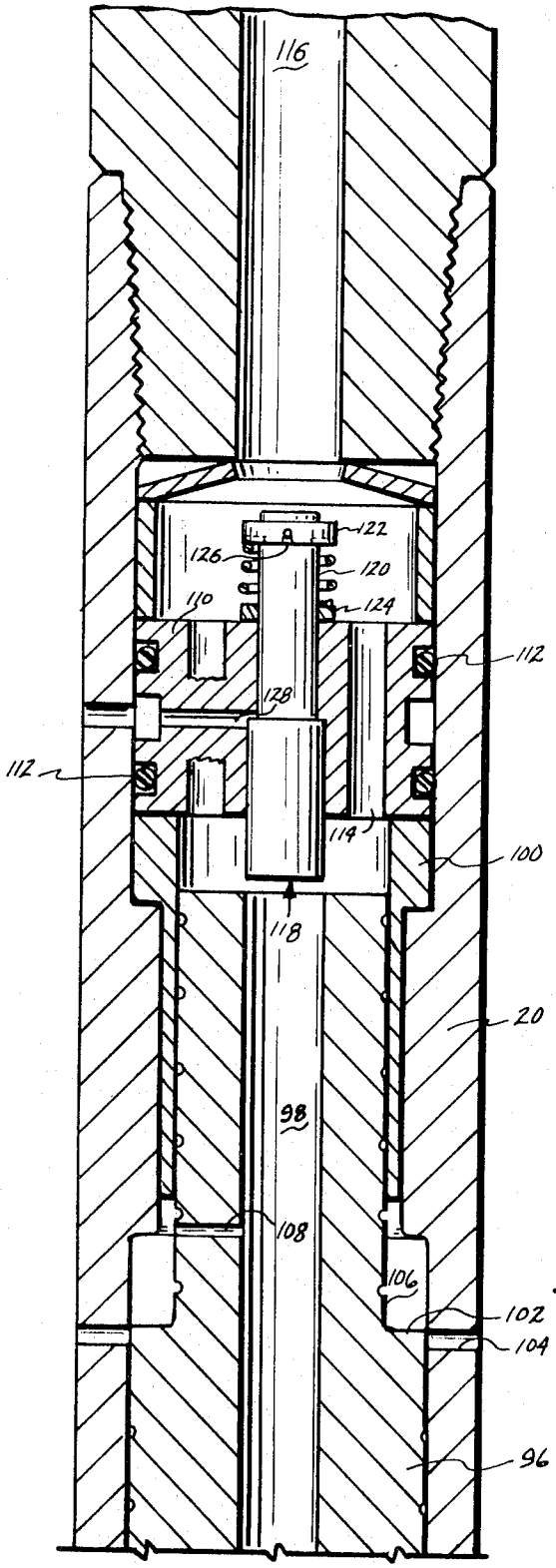
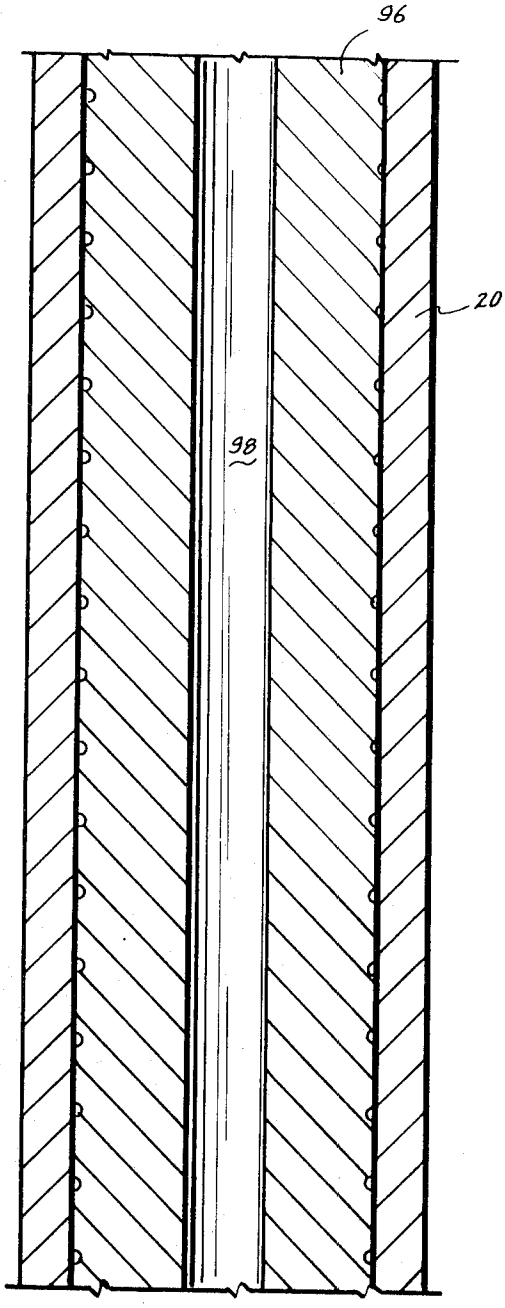


FIG. 1B



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BY John C. Stahl

. ATTORNEY

FIG. 1C

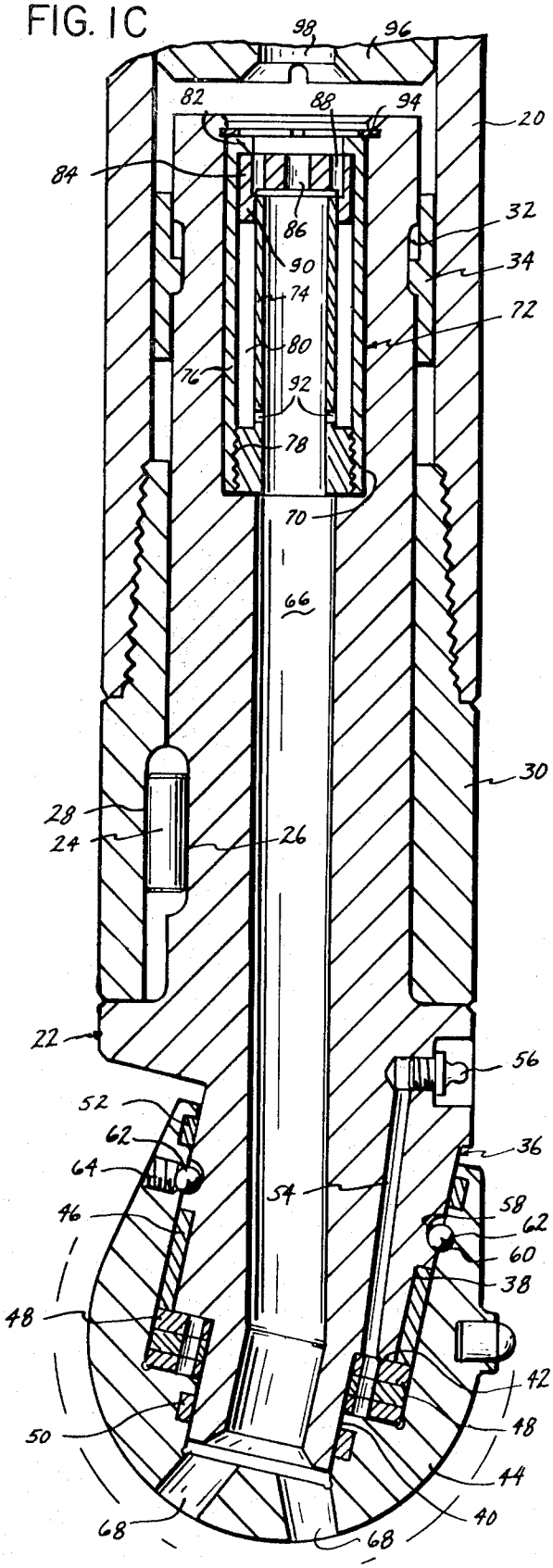
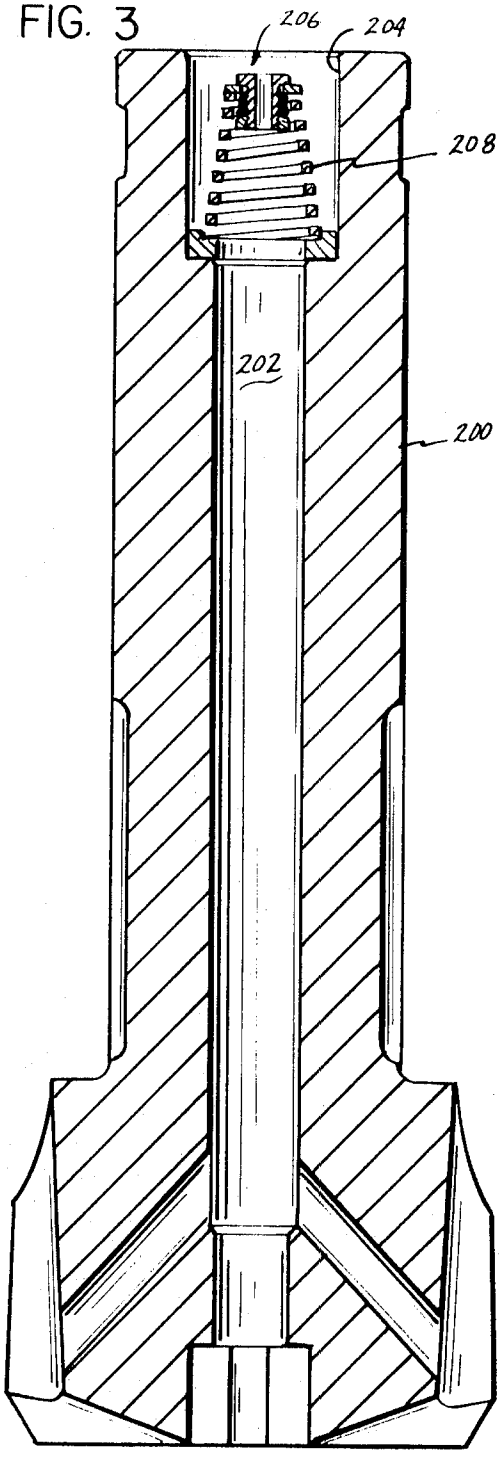


FIG. 3



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FIG. 2

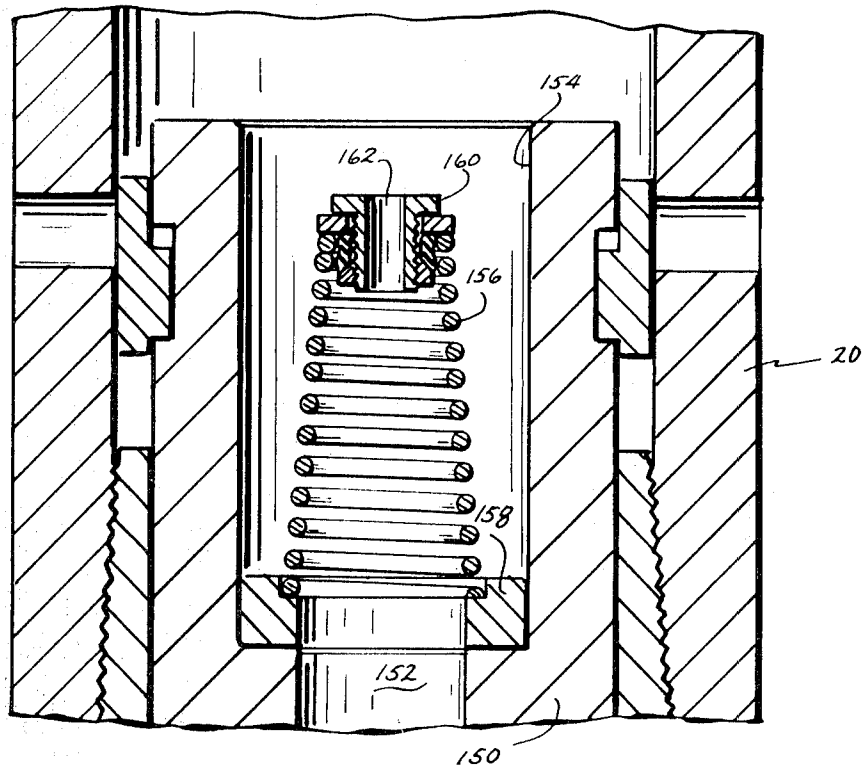


FIG. 4

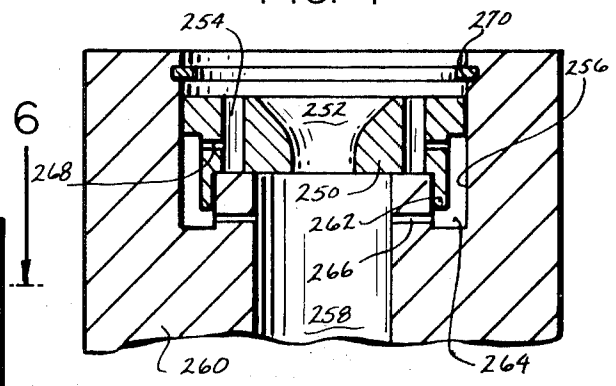
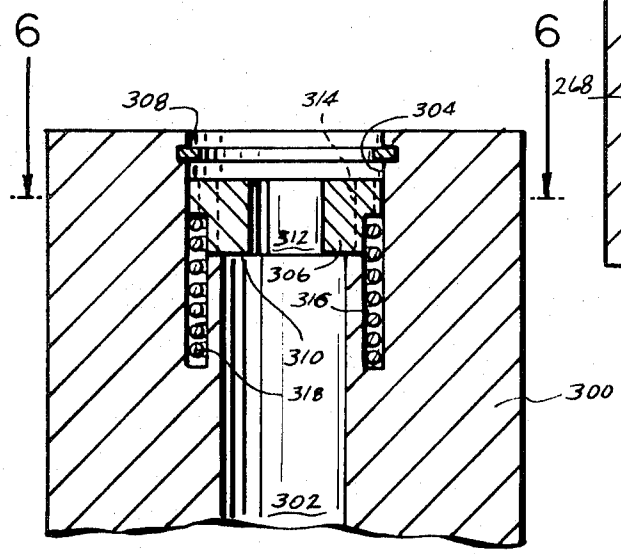


FIG. 5



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FIG. 6

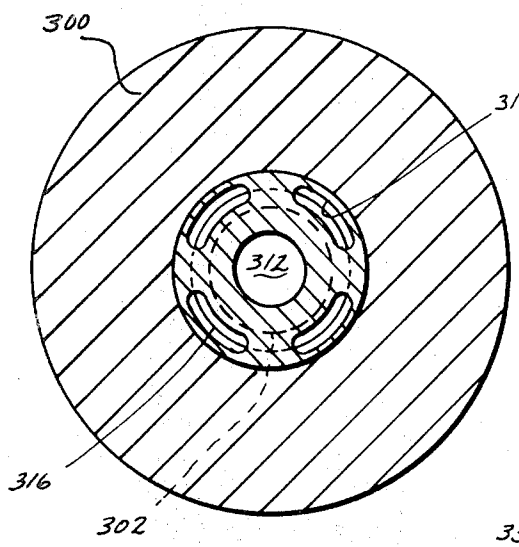


FIG. 7

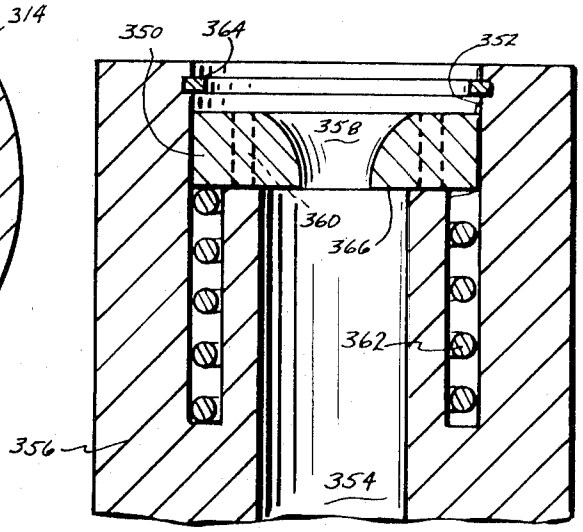


FIG. 9

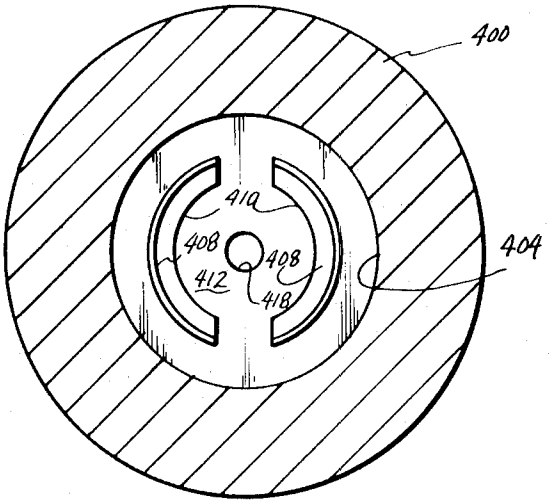
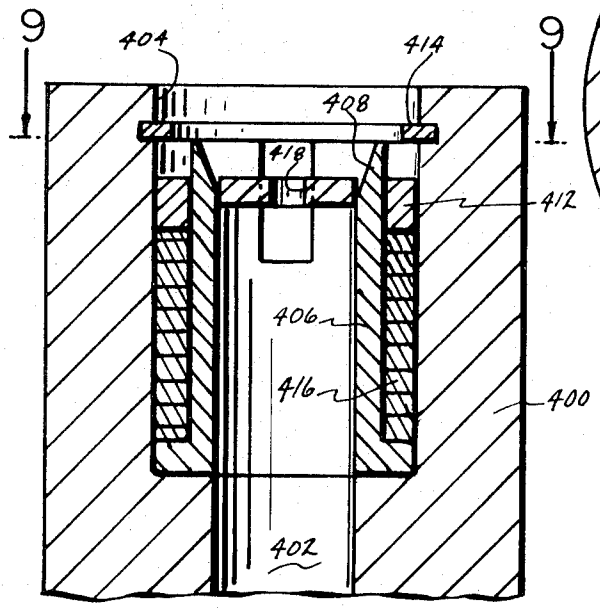


FIG. 8



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FIG. 10

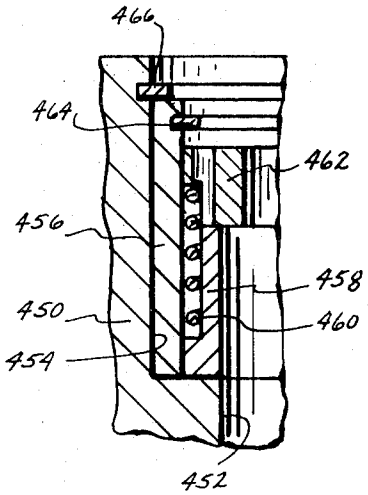


FIG. 12

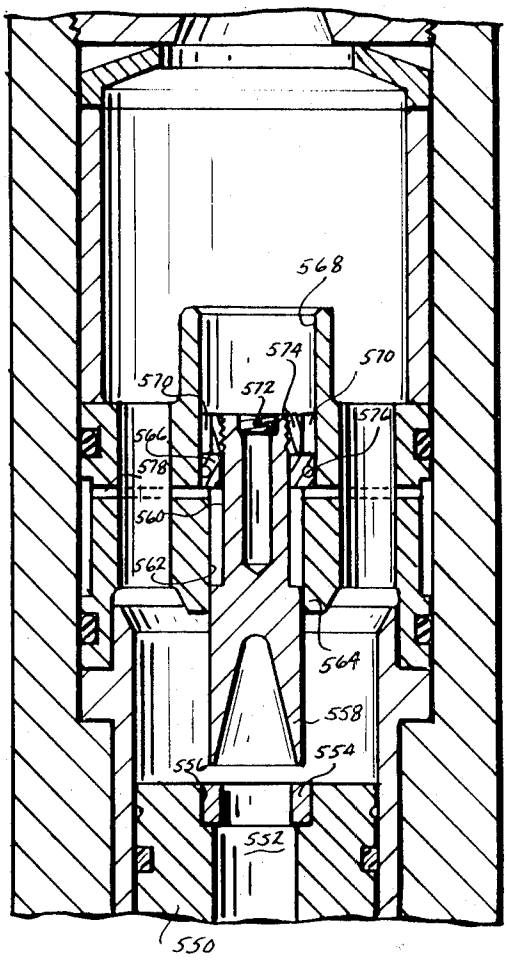
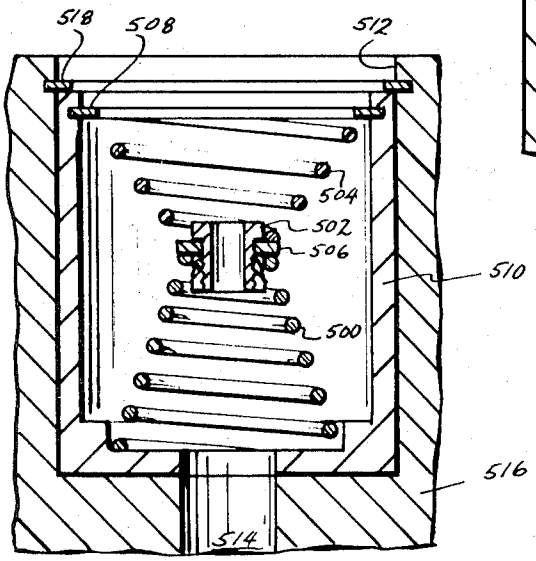


FIG. 11



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INVENTOR.

BY John C. Stahl

ATTORNEY

FLUID-ACTUATED IMPACT TOOL AND ANVIL DEVICE HAVING VARIABLE CHOKE

This application relates to a drilling motor, particularly to a percussion-type drilling motor employing an elastic fluid medium such as steam or compressed air. More particularly still, the present invention relates to a fluid-operated percussion-drilling motor in which a unidirectional flow of actuating fluid through the motor results in operation of the motor.

Fluid-operated percussion-type drilling motors are known, and, in general, comprise a casing having a bit member mounted on one end thereof and a supply of actuating fluid to the other end thereof with a reciprocating hammer mounted in the casing for beating on the inner end of the bit device, or an anvil which is a part thereof or which is attached thereto. In motors of this nature, the hammer is impelled in opposite directions by a compressed fluid medium supplied to the casing, with the pressure in the casing at opposite ends of the hammer varying cyclically in order to produce the reciprocatory movement of the hammer. The working stroke of the hammer occurs when it advances toward the bit or anvil-bit device because it is at the end of this stroke that the hammer impacts on the bit or anvil. Since the hammer advances toward the bit or anvil due to pressure acting on the upper end thereof, it will be apparent that the lower the pressure at the lower end of the hammer, the greater the impact that will be delivered to the bit or anvil by the hammer.

Heretofore, a number of valving arrangements have been employed for controlling the variations in pressure at the opposite ends of the hammer in order to cause reciprocation thereof. In particular, since the hammer does its work on the advancing structure, it is important to provide for relatively rapid release of pressure from the bit end of the hammer during the advancing stroke of the hammer. At the same time, since pressure must be built up on the bit end of the hammer, after it strikes the bit or anvil, to cause it to retract, the bit end of the hammer cannot be freely connected to the atmosphere.

With the foregoing in mind, it is a primary objective of the present invention to provide an improved valve arrangement for controlling the variations in pressure, particularly at the bit end of the hammer, in a device of the nature referred to, thereby to obtain improved operation of the percussion drilling device of which the hammer forms a part.

A particular object of the present invention is the provision of an arrangement for permitting the rapid build up of pressure on the bit end of the hammer at the end of the advancing stroke of the hammer and the rapid release of pressure from the bit end of the hammer at the beginning of the advancing stroke of the hammer.

Percussion drilling devices of the nature referred to embody bits on the lower end having hard wear resistant inserts therein, usually a cemented hard metal carbide for cutting or crushing the formation to which the bit is presented. The bits are ordinarily caused to rotate so as to impact different regions of the area being compacted on successive hammer strokes and, due to the rotating action, considerable wear takes place on the hard inserts in the bits merely due to the rubbing action of the bits on the bottom of the hole being drilled.

With the foregoing in mind, it is a still further object of the present invention to provide a fluid-operated percussion drill motor of the nature referred to which operates at a high rate of speed so that the rubbing action on the hard inserts of the bit is diminished and greater bit life is obtained.

A still further object of the present invention is the provision of a bit arrangement for a fluid-operated percussion drilling motor in which the bit is rotatable independently of the motor so that the hard inserts of the bit body are not subjected to any rubbing action at all.

These and other objects and advantages of the present invention will become more apparent upon reference to the following detailed specification, taken in connection with the accompanying drawings, in which:

FIGS. 1A, 1B and 1C are continuations of one another from top to bottom in the order enumerated of a longitudinal section through a percussion drilling motor embodying the features of the present invention;

FIG. 2 is an enlarged, fragmentary view showing a modified arrangement of the valve in the anvil-bit device;

FIG. 3 is a fragmentary view showing a different type of anvil-bit device having a valve according to the present invention mounted therein;

FIG. 4 is a fragmentary view showing a modification of the valve in the anvil-bit device;

FIG. 5 shows still another modification of the valve device;

FIG. 6 is a sectional view indicated by line 6—6 on FIG. 5;

FIG. 7 shows modification of the valve arrangement somewhat similar to that of FIG. 5;

FIG. 8 shows a still further modification of the valve;

FIG. 9 is a section indicated by line 9—9 on FIG. 8;

FIG. 10 is a fragmentary view showing a valve according to the present invention which can be inserted into the enlarged upper end of the passage in the anvil-bit device as a unit;

FIG. 11 is a view similar to FIG. 2 but showing how the spring forming the variable choke device could be provided with a preload; and

FIG. 12 is a fragmentary view showing a different type valve for use at the upper end of the hammer.

Referring to the drawings somewhat more in detail, in FIGS. 1A, 1B and 1C the illustrated drill comprises a housing or casing 20 and reciprocally mounted in the lower end thereof is an anvil-bit device generally indicated at 22. Drive pins 24 are disposed in grooves 26 formed in the periphery of the anvil-bit device 22 and these extend into registering grooves 28 formed in drive sub 30 conventionally connected to the lower end of casing 20.

Toward its upper end, the anvil-bit device has an annular groove 32 in which is seated a split metal ring 34 by means of which the anvil-bit device is retained reciprocally in the lower end of the housing of the drill. The lower end of the anvil-bit device has an angled off shaft portion 36 with a larger diameter upper portion 38 and a smaller diameter lower portion 40 and with an outwardly, or downwardly, facing shoulder 42 therebetween. A bit body 44 is bored to receive the angled-off shaft 36 and is supported thereon by sleeve bearings 46 and thrust bearings 48 which may consist of a plurality of washers in stacked relation, alternately steel and brass, for example, and drilled axially to facilitate lubrication thereof.

Seals, of Teflon, for example, are provided at 50 and 52 and a lubricant passage 54 is provided in the angular shaft extension which communicates with a grease fitting 56.

The angled-off shaft portion 36 comprises a groove 58 and opposed thereto is a groove 60 in the bore in the bit body so that balls 62 can be introduced into the grooves and thereby retain the bit in place on the angled-off shaft portion 36. The balls 62 can be introduced through a hole that is normally plugged as by a pipe plug 64.

The anvil-bit device has a central axial passage 66 extending completely therethrough and communicating with bores 68 in the bit body. At the upper end, passage 66 has an enlarged portion 70 in which is seated a valve 72 forming a particular feature of the present invention. Valve 72 consists of an inner sleeve portion 74 and an outer sleeve portion 76 with the sleeve portions threadedly interconnected at the bottom at 78. The sleeve portions define therebetween an upwardly opening annular cylinder 80. At its upper end outer sleeve 76 has a radially inwardly extending flange 82 engageable with the top surface of an apertured valve plate member 84. Valve plate member 84 has a central aperture 86 and circumferentially distributed apertures 88 therein both of which freely communicate with the center of inner sleeve 74 when valve plate member 84 is in its outer position in engagement with flange 82.

However, when valve plate member 84 moves inwardly, the upper end of sleeve 74 will engage the underside thereof and substantially close off apertures 88 leaving only central aperture 86 for the passage of fluid. The valve arrangement described is thus an adjustable, or variable, two-position

choke arrangement which offers lesser restriction to fluid flow from above the anvil-bit device into passage 66 when valve plate member 84 is in an upper position and offers greater restriction to the said flow when the valve plate member is in a lower position.

Valve plate member 84 has a dependent peripheral skirt or cylindrical portion 90 receivable in the annular cylinder 80 between sleeve portions 74 and 76. Annular cylinder 80, at the bottom, communicates with the inside of sleeve portion 74 by way of ports 92. There is thus a trapped body of fluid underneath skirt portion 90 of the valve plate member 84 which, as will be seen hereinafter, causes the valve plate member to move upwardly at the proper time during a cycle of the drilling motor.

Sleeve portion 76 may be press fit in enlarged portion 70 of the bore in the anvil-bit device, or it may be retained therein as by a snap ring 94 in the upper end of enlarged portion 70.

Reciprocally mounted in casing or housing 20 above the upper end of the anvil-bit device is a hammer 96 having a larger lower end and a smaller upper end and a central axial bore 98.

The upper end of the hammer is slidably fitted in a sleeve 100 fixed in casing or housing 20. The shouldered portion 102 of the hammer, near the end of the retraction stroke of the hammer, passes by ports 104 in housing or casing 20 and entraps fluid in a chamber 106 which will provide a cushion for the hammer during its retraction stroke and which will also exert a downward force on the hammer to assist in initiation of the advancing stroke of the hammer. The pressure in chamber 106 may exceed the pressure of the pressure medium a substantial amount due to the motion of the hammer.

Chamber 106 is maintained filled with fluid as by permitting fluid to bleed down the side of the smaller end of the hammer from the upper end of the hammer or by the passage means 108 drilled radially in the hammer as illustrated.

Above the upper end of the hammer is a spider member 110 fixedly mounted in the casing or housing 20 and sealed thereto as by sealing rings 112. Extending axially through spider 110 is passage means 114 by means of which an elastic medium under pressure, compressed air or steam, for example, is supplied from a suitable source connected to the passage 116 leading to the top of spider 110.

Spider 110 is availed of for reciprocally mounting a valve member 118 which has a lower end adapted for being received in bore 98 in the hammer while the upper end is reduced in diameter, as at 120, and extends through a bore in the spider and has a collar 122 thereon. Beneath collar 122, and resting on top of spider 110 is a stop collar 124 which determines the stroke of the valve member. Slots 126 in collar 122 prevent collars 122 and 124 from sealing together in the lower position of the valve member.

The shouldered cylinder in the spider 110 in which valve member 118 is reciprocally mounted can be vented to the atmosphere by passage means 128.

In operation, assuming a supply of pressure medium, such as compressed air, or steam, to passage 116 and, further assuming that the hammer is in its lower position resting on the upper end of the anvil-bit device 22, the pressure medium will build up pressure on the lower end of the hammer as well as the upper end thereof and, since the lower end of the hammer is larger in diameter than the upper end, the hammer will move upwardly. At this time, valve plate member 84 is in its lower position and apertures 88 are closed off so that aperture 86 offers a restriction to the flow of fluid into passage 66 of the anvil-bit device thereby causing the pressure underneath the hammer to build up relatively rapidly and cause the hammer to move upwardly in a retracting stroke. When the hammer retracts to the point that valve member 118 commences substantially to restrict the upper end of bore 98, the pressure in bore 98 will drop, thereby permitting the pressure beneath the hammer to commence to drop and also permitting the pressure acting on the upper end of valve member 118 above the spider 110 to drive the valve member downwardly into telescopic engagement with the upper end of bore 98.

At this time, substantially all flow through bore 98 is interrupted and pressure is standing only on the upper end of the hammer and will cause it to be impelled downwardly at a rapid rate. Furthermore, when the sudden drop of pressure occurs at the lower end of the hammer, the pressure medium acting on the lower end of the skirt portion 90 of valve plate member 84 will force it upwardly against flange 82 thereby opening apertures 88, thus reducing the restriction to flow of fluid into the upper end of passage 66.

Still further, the medium which is now compressed in chamber 106 urges the hammer downwardly. The result of the foregoing actions is to cause the hammer to be impelled rapidly downwardly and to impact against the upper end of the anvil-bit device 22.

As the hammer approaches the upper end of the anvil-bit device, valve member 118 leaves the upper end of bore 98 and will quickly return to its upper position due to the pressure acting on the larger lower end thereon. This last-mentioned movement of valve member 118 frees bore 98 in the hammer and air commences to rush therethrough and the velocity of the air emerging from the lower end of bore 98 impinges on valve plate member 84 and drives it to its lower position. Apertures 88 are now closed off and, following impact on the hammer against the upper end of the anvil-bit device, pressure will build up rapidly on the lower side of the hammer and it will be forced upwardly in the retracting direction again.

Adjustments can be made in the amount of travel which the hammer takes and the rapidity with which it cycles in the casing or housing 20 by adjustment of the pressure of the supply of pressure medium thereto and the strokes of the valves and the like. Furthermore, some axial adjustment of the anvil-bit device in the lower end of the casing is possible because it is reciprocally mounted therein and the speed of the cycling of the motor can also be influenced by the axial position of the anvil-bit device in the casing.

FIG. 2 shows a novel modification of the valve device carried in the upper end of the passage in the anvil-bit device. In FIG. 2, the upper end of the anvil-bit device is identified at 150 and the passage therethrough at 152. In the enlarged upper end 154 of the passage there is mounted the variable or adjustable choke valve according to the present invention and which comprises a coiled spring 156. The lower end of the coiled spring is fixed to a metal ring 158 which, in turn, engages the bottom of the enlarged portion 154 of the passage through the anvil-bit device and may be a press fit, or a sliding fit in portion 154. The upper end of coiled spring 156 has a restrictor member 160 mounted therein in any suitable manner and having a central passage 162 of a predetermined size.

In operation, the convolutions of spring 156 are normally spaced from each other giving a large effective area for flow of fluid downwardly into passage 152. However, at a predetermined rate of flow into the upper end of passage 152, the pressure drop between the inside and the outside of the spring is such that the upper end of the spring will move downwardly and the convolutions of the spring will close on each other and central passage 162 in the restrictor is then the only passage available for flow. The spring device illustrated has the advantage of providing an extremely wide opening when extended and it is inexpensive to manufacture and reliable in operation. The spring can be cylindrical but it is of advantage to form it in the shape of a tapered spring as shown in FIG. 2.

FIG. 3 shows a more or less conventional bit member 200 adapted for being mounted in the lower end of the casing or housing of the motor and having a central passage 202 therein with an enlarged upper end 204 in which is seated a variable choke device 206 similar to that illustrated in FIG. 2. The spring of FIG. 3 differs from that of FIG. 2 in that the spring is wound from flat stock or machined as indicated at 208 so that the convolutions take a good bearing on each other when the spring collapses and prevents the spring from deforming laterally.

FIG. 4 shows a modification of the valve of FIG. 1 in which the valve embodies a plate 250 with a central bore 252 and

circumferentially distributed bores or slots 254. The valve member is reciprocally mounted in the enlarged upper end 256 of the central bore 258 in the anvil-bit device 260. The periphery of the valve member 250 extends downwardly at 262 into an annular cylinder 264. Cylinder 264 is supplied with pressure from passages 266 in the anvil-bit device and passages 268 in the valve member so that the pressure in annular cylinder 264 forms the biasing means for urging the valve member upwardly toward its upper stopped position against snap ring 270. When the valve member is in its downward position, circumferentially distributed bores or slots 254 are closed off from bore 258.

Passages 268 admit fluid into cylinder 264 more rapidly than passages 266 exhaust the fluid so that pressure built up in cylinder 264 is effective for returning the valve member upwardly when pressure beneath the hammer drops.

FIGS. 5 and 6 show a modification of the device illustrated in FIG. 1. The upper end of the anvil-bit device is indicated at 300 and the device has a passage 302 extending axially therethrough with an enlarged upper end part 304. Reciprocally mounted in the upper end part is a plate 306 which has an upper stopped position against snap ring 308 and a lower stopped position where it abuts annular shoulder 310.

The valve member is provided with a central bore 312 and circumferentially distributed bores 314. When the valve member is in its upper position, bore 312 and bores 314 all communicate with passage 302 whereas when the valve member is in its lower position, bores 314 are closed off from passage 302 and, instead, can communicate only with the annular chamber 316 in which biasing spring 318 is mounted. The valve arrangement of FIG. 5 utilizes both spring force and compressed fluid for returning the valve member upwardly at the proper time in the cycle of the motor. As will be seen in FIG. 6, bores 314 may be in the form of arcuate slots if so desired.

FIG. 7 shows an arrangement like that of FIGS. 5 and 6 wherein a valve member 350 is reciprocally mounted in the enlarged upper end 352 of the central passage 354 formed in the anvil-bit device 356. Valve member 350 has a central bore 358 and peripheral bores or arcuate slots 360. A spring 362 biases valve member 350 upwardly toward retaining snap ring 364 and, at a predetermined rate of fluid flow downwardly into passage 354, the spring bias is overcome and the valve member moves downwardly against the shoulder 366. Shoulder 366 completely closes off bores or slots 360 at the lower ends thereof so that only the biasing spring 362 urges valve member 350 upwardly.

FIGS. 8 and 9 show a still further modification of the plate type adjustable choke valve. In these figures the anvil-bit device is indicated at 400 and has a central passage 402 with an enlarged upper end part 404. Mounted in the upper end part is a sleeve member 406 having two circumferentially spaced tapered arcuate projections 408 on the upper end. These projections are received in arcuate slots 410 in valve plate 412 when the valve plate moves downwardly from its upper stopped position against snap ring 414.

A spring 416 engages the underside of valve plate 412 and urges it in the upward direction. The valve plate comprises a central bore 418 which is continuously open and the arcuate slots 410 which are restricted by the arcuate projections 408 when the valve member moves downwardly and which, as explained, will occur at a predetermined rate of fluid flow therethrough in the downward direction.

Spring 416 closes when the valve plate is in its lowermost position and provides a stop therefor.

FIG. 10 shows how a valve unit could be constructed so as to form an assembly and be assembled as a unit with the anvil. In FIG. 10 the anvil is indicated at 450 and it has an axial bore 452 therethrough with an enlarged upper end portion 454. Inserted in enlarged upper end portion 454 is a valve assembly comprising an outer sleeve 456 and an inner sleeve 458 interconnected at the bottom and defining therebetween an axial space for receiving spring 460 which biases valve member 462 in the upward direction. A snap ring 464 stops the valve member in its uppermost position in outer sleeve 456 while a snap ring 466 in portion 454 is employed for retaining the assembly in the upper end of the anvil passage. Any of the previously described valves could be constructed in the manner illustrated in FIG. 10 and thereby forming an assembly adapted for being received in the passage of an anvil or anvil-bit device.

In FIG. 11, which shows a valve similar to that of FIG. 2, the spring 500 forming a part of the valve and having a restrictor member 502 mounted in the upper end thereof is maintained under preload by a spring 504 engaging washer 506 carried by the spring 500 at the upper end and a snap ring 508 mounted in the upper end of body 510 in which spring 500 is mounted. Body 510 is received in the enlarged upper end part 512 of the bore 514 extending through anvil 516. The valve assembly is retained in the anvil by snap ring 518. By preloading spring 500 the tendency for the spring to retract to beyond its relaxed position is inhibited and more stable operation results. Furthermore, the preload will prevent the variable choke valve from becoming dislodged from the proper position in enlarged portion 512 of the bore in the anvil.

FIG. 12 shows a modification of the valve at the upper end of the hammer and which does not telescope with the passage in the hammer. In FIG. 12, hammer 550 having an axial passage 552 therethrough includes a bushing 554 mounted in the enlarged upper end portion 556. The bushing may be a hardened steel or it may be a plastic material such as nylon or Teflon.

The valve member at the upper end of the hammer is indicated at 558 and is adapted for seating on the upper end of bushing 554. Valve member 558 has a larger lower end portion and a reduced-diameter upper end portion, the latter being indicated at 560. A bore 562 is provided in spider 564 in which the larger lower end of the valve member is reciprocally mounted. Reduced-diameter portion 560 of the valve member extends through a collar 566 reciprocally mounted in bore 568 of the spider and which bore, as will be seen, is larger in diameter than bore 562. The extreme upper end of portion 560 has a head 570 mounted thereon which is attached by threads, or by threads and a pin 572, to portion 560 of the valve member. Head 570 has axial passages 574 therein, as in the periphery thereof.

Collar 566 is sealed in bore 568 as by sealing rings 576 and bore 562 immediately beneath collar 566 is vented to the atmosphere by passage means 578.

In operation, when hammer 550 is driven upwardly, it engages the lower end of valve member 558 and closes off the supply of fluid to passage 552. The hammer coasts upwardly lifting valve member 558 with it until the pressure above the hammer brings the hammer to a halt whereupon the hammer will commence to move downwardly. When the hammer starts to move downwardly, it will be urged downwardly by the pressure standing on the upper end of the hammer around valve member 558 and in addition thereto by the pressure acting on the upper end of the valve member. The hammer is thus impelled downwardly on its working stroke at high velocity. The valve member 558 will follow the hammer downward during the initial part of the advancing stroke of the hammer until head 570 buttons on collar 566, at which time the valve member will stop and continued movement of the hammer will release passage 552 for fluid flow therethrough. In connection with the valve arrangement of FIG. 12, it will be appreciated that the travel of the hammer after it engages valve 558 can be sufficient to cause the larger lower end part of the valve member to engage collar 566 and lift it upwardly in bore 568 whereby no damage will occur to the valve member or hammer on account of the interengagement thereof. Further, if collar 566 is picked up in the aforesaid manner, the pressure acting on the upper side thereof will also assist in bringing the hammer to a halt and impelling it in the downward direction.

Referring to the various types of choke valves illustrated in the drawings and described in the specification, it will be ap-

preciated that certain ones thereof are entirely fluid operated and others depend on a spring for biasing the choke valve toward its position of lesser restriction. In respect of the choke valves which are biased toward the position of lesser restriction thereof by a body of fluid, a particularly advantageous arrangement results because the valves are sensitive to rate of fluid flow and the operating pressure of the working medium can be adjusted over a wide range without changing the manner in which the valve operates. Those variable choke valves which utilize a spring for movement of the valve member to its position of lesser restriction are more sensitive to changes in pressure in the working medium.

It is contemplated that the drilling motor will operate over a relatively wide range of pressures and pressures of up to 750 pounds per square inch are contemplated.

With regard to the various choke valve arrangements illustrated, under most conditions of operation of the drilling motor, the choke valves are in a position of lesser restriction during the advancing stroke of the hammer and move to a position of greater restriction at about the time of impact of the hammer on the anvil and remain in the position of greater restriction during retracting movement of the hammer until the passage through the hammer is interrupted. However, choke valves of the nature illustrated also have merit in the illustrated construction even if they remain in the position of greater restriction during the major part of the operating time of the drilling motor. In this mode of operation, the variable choke valve cycles when the motor is first being started and then after the motor is in operation with the full supply of pressure medium thereto at the desired pressure, the choke valve may remain in this position of greater restriction during continued operation of the drilling motor. The variable choke valve, in this instance, is effective in getting the motor into operation quickly.

Modification can be made within the scope of the appended claims.

What is claimed is:

1. In a fluid-operated percussion drill motor: a housing, an anvil mounted in one end of said housing and having an inner end, a hammer reciprocally mounted in said housing for advancing toward said anvil and retracting away from said anvil and having one end adapted for beating on said inner end of said anvil at the end of the advance of said hammer, a first chamber in said housing confined between said one end of said hammer and said inner end of said anvil, means forming a second chamber in said housing at the other end of said hammer, first passage means interconnecting said chambers, second passage means leading from said inner end of said anvil to the atmosphere, means for effecting the continuous supply of fluid under pressure to said second chamber, first valve means controlling said first passage means and operable during retraction of said hammer for restricting said first passage means and operable during advancing of said hammer for opening said first passage means, second valve means controlling said second passage means and mounted therein near the inner end of said anvil, second valve means being in the form of a choke valve having a first condition of lesser restriction and a second condition of greater restriction, and means responsive to a predetermined rate of flow of fluid from said first chamber into said second passage means for adjusting said choke valve from its said first condition to its said second condition.

2. A fluid-operated percussion drill motor according to claim 1, in which said anvil is reciprocally mounted in said one end of said housing.

3. A fluid-operated percussion drill motor according to claim 1, in which said one end of said hammer has a larger effective area than the other end thereof.

4. A fluid-operated percussion drill motor according to claim 3 in which said first passage means is in the form of an axial bore extending through said hammer.

5. A fluid-operated percussion drill motor according to claim 2 which included bit means carried by said anvil on the outer end thereof.

6. A fluid-operated percussion drill motor according to claim 5 in which said second passage means extends axially through said anvil and through said bit means whereby fluid from said second passage means blows chips and dust away from said bit means.

7. A fluid-operated percussion drill motor according to claim 5 in which said bit means is rotatable on said anvil.

8. A fluid-operated percussion drill motor according to claim 7 in which said anvil comprises a shaft projecting from the outer end thereof at an angle, and said bit means is rotatably mounted on said shaft.

9. A fluid-operated percussion drill motor according to claim 8 in which said bit means is in the form of a sphere.

10. A fluid-operated percussion drill motor according to claim 9 in which said bit means comprises a spherical body, and rods of hard wear-resistant material distributed on said body and extending radially into and fixed to said body.

11. A fluid operated percussion drill motor according to claim 1 which includes means responsive to reduction in pressure in said first chamber for adjusting said choke valve from its said second condition to its said first condition.

12. A fluid-operated percussion drill motor according to claim 1 in which said second valve means comprises a valve member reciprocal in said second passage means near said inner end of said anvil and having an apertured wall at the end facing said hammer, an annular member stationary in said anvil, said valve member having a first outer position wherein the apertures in said wall are substantially unrestricted and a second inner position wherein at least some of said apertures are restricted by the end of said annular member, biasing means biasing said valve member toward its said first position, said apertures being of such a size that operation of said first valve means to change the rate of fluid flow to said first chamber will effect movement of said valve member between its said first and second positions.

13. A fluid-operated percussion drill motor according to claim 12 in which said biasing means is in the form of a spring.

14. A fluid-operated percussion drill motor according to claim 12 in which said biasing means is in the form of a trapped body of fluid.

15. A fluid-operated percussion drill motor according to claim 1 in which said second valve means is in the form of a coiled spring, said coiled spring having a first extended position wherein at least some of the convolutions thereof are spaced apart for flow of fluid therethrough and a second position wherein at least some of said spaced convolutions are closed on each other to confine the flow of fluid to axial flow through said spring, said spring having one end opening into said second passage means and the other end opening into said first chamber, and the outer periphery of said spring communicating with one only of said first chamber and second passage means.

16. A fluid-operated percussion drill motor according to claim 15 in which said coiled spring is tapered.

17. A fluid-operated percussion drill motor according to claim 16 in which the larger end of said spring opens into said second passage means.

18. A fluid-operated percussion drill motor according to claim 17 which includes means forming a fixed restriction in the smaller end of said spring.

19. A fluid-operated percussion drill motor according to claim 15 which includes means for preloading said spring.

20. A fluid-operated percussion drill motor according to claim 15 in which said spring is formed of flat stock with the major axis of said stock perpendicular to the axis of the spring.

21. An anvil device for use in a percussion drilling tool and adapted for being mounted in one end of the casing of the tool so as to have an inner end inside the casing and adapted for being impacted by a hammer reciprocally mounted in said casing, said anvil having a passage leading therethrough to the atmosphere from said inner end, the improvement which comprises: a choke valve mounted in said passage near said inner end of said tool and having a first condition of lesser restriction of fluid flow into said passage from said casing and a

second condition of greater restriction of fluid flow from said casing into said passage, means normally biasing said choke valve toward its said first condition, and means responsive to a predetermined rate of fluid flow from said casing into said passage for adjusting said choke valve into its said second condition.

22. An anvil device according to claim 21 in which said choke valve is in the form of an apertured member, means biasing said apertured member outwardly in said passage toward said inner end of said anvil device, means carried by said anvil device and located in said passage in position to restrict at least some of the apertures in said member when the member is moved inwardly in said second passage away from the said inner end of said anvil device, said member being moveable inwardly in said passage in response to a predetermined rate of fluid flow into said passage from the said inner end of said anvil device.

23. An anvil device according to claim 22 in which said means biasing said apertured member is in the form of a trapped body of fluid.

24. An anvil device according to claim 23 in which said coiled spring is a spiral spring having its larger end opening directly into said passage and its smaller end adjacent the inner end of said anvil device, means restricting the flow of fluid into the inner end of said coiled spring, and means for retaining said coiled spring in said passage.

25. An anvil device according to claim 24 in which said passage adjacent said inner end of said anvil device is enlarged for receiving said coiled spring.

26. An anvil device according to claim 21 in which said means biasing said apertured member is in the form of a spring.

27. An anvil device according to claim 21 in which said choke valve is in the form of a coiled spring having an extended position wherein at least some of the convolutions of the spring are spaced from each other and having a collapsed position wherein at least some of said spaced convolutions are closed on each other, means restricting one end of said coiled spring to limit the flow of fluid axially therethrough, one end of said spring opening directly into said passage and the other end of said spring opening into said casing, and the outer peripheral portion of said spring communicating directly with one only of said second passage and the inside of said casing.

28. An anvil device according to claim 21 which includes bit means on the outer end thereof.

29. An anvil device according to claim 28 in which said bit means is rotatable on an inclined axis on said anvil device.

30. An anvil device according to claim 29 in which said bit means is ball-like and has hard wear-resistant inserts distributed thereover and projecting radially therefrom.

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