

April 11, 1961

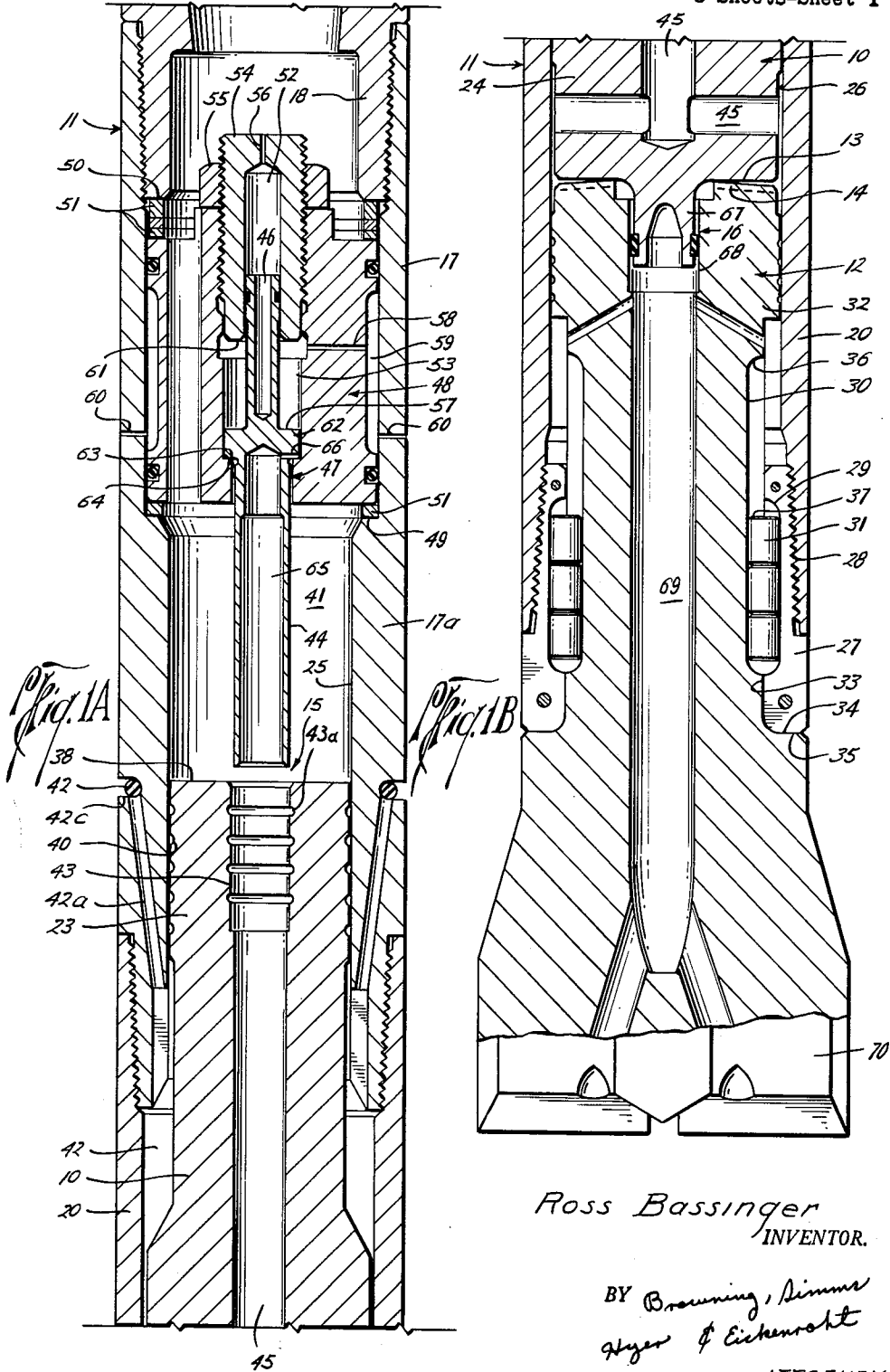
R. BASSINGER

2,979,033

FLUID ACTUATED IMPACT TOOL

Filed Dec. 31, 1958

3 Sheets-Sheet 1



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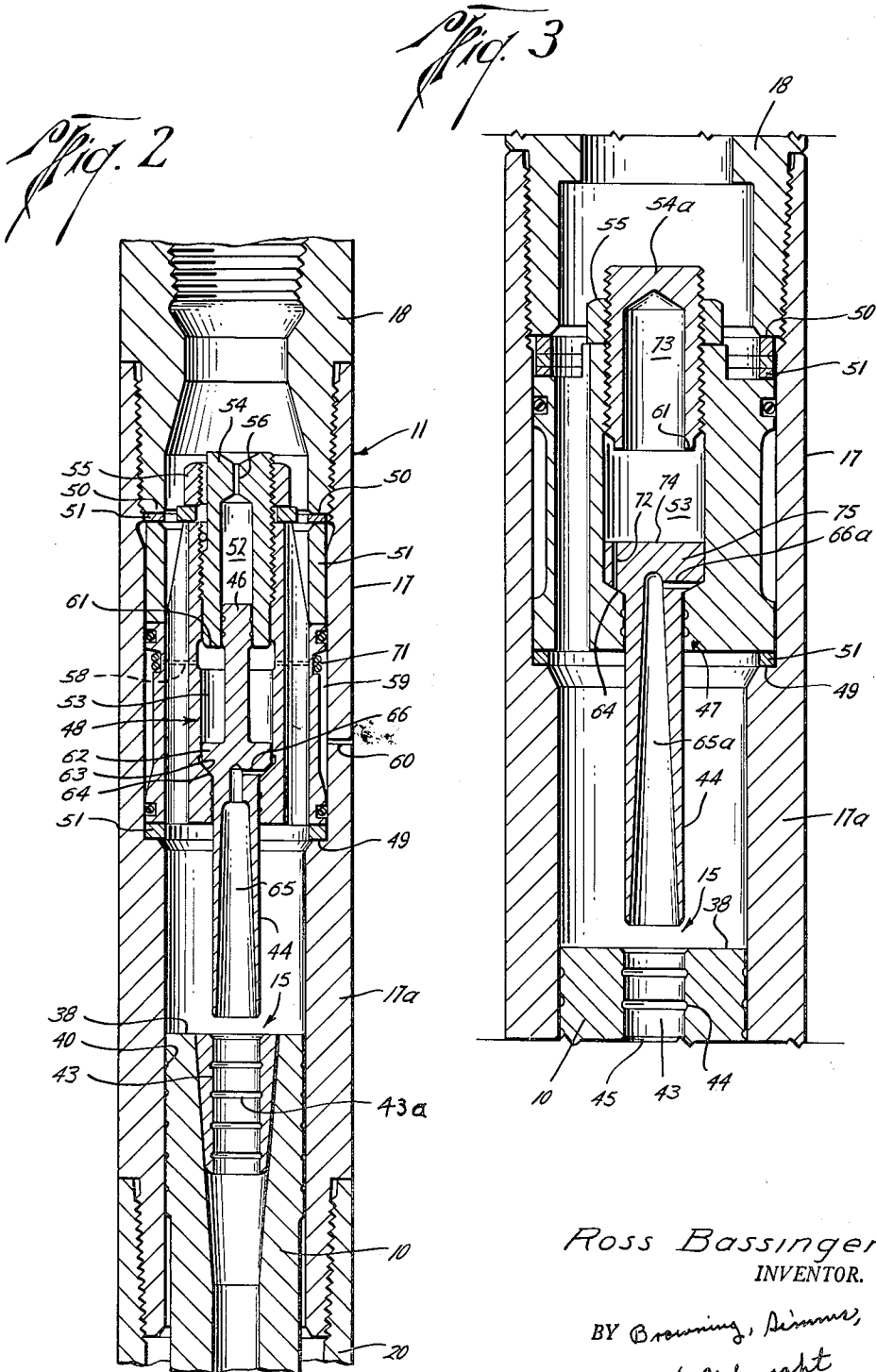
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3 Sheets-Sheet 2



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3 Sheets-Sheet 3

Fig. 4

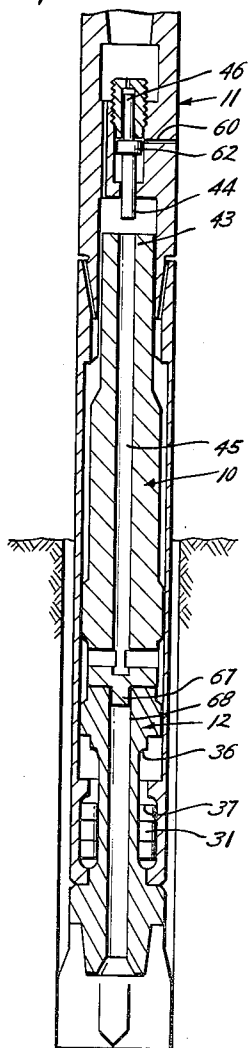


Fig. 5

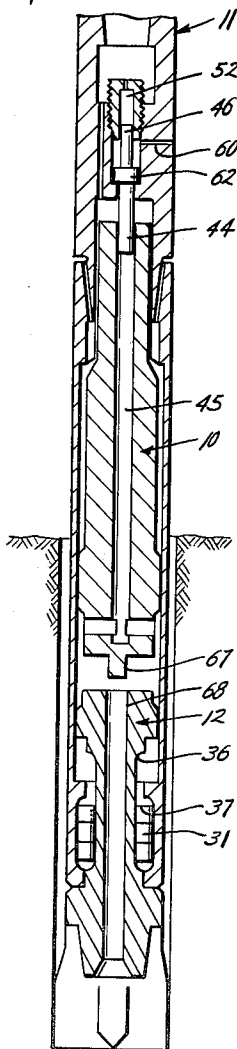
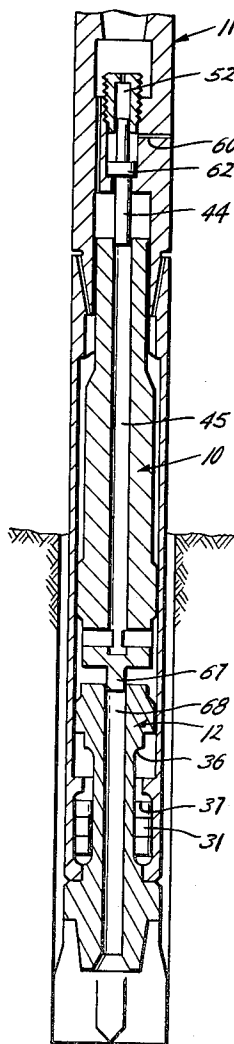


Fig. 6



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2,979,033

FLUID ACTUATED IMPACT TOOL

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14 Claims. (Cl. 121-16)

This invention relates to a fluid actuated impact tool of the type which is particularly adapted to be operated by a pneumatic medium such as compressed air or steam. In one of its aspects, it relates to such a tool having an improved valving arrangement for reciprocating a hammer.

In impact tools of the type to which this invention relates, power fluid is applied to one or more endwise surfaces on a hammer to urge the same in at least one of its power or return strokes. The control of the application of the power fluid to the hammer is by a valving means which causes the power fluid to be effective in driving the hammer in one of its strokes and then to be ineffective so that the hammer can move in its other stroke. For example, it has been suggested that the application of a power fluid to a hammer be controlled by a finger-like valve element which telescopes into and out of a passageway through the hammer to restrict and permit flow therethrough. By virtue of such alternate restriction and permission of flow, the pressure of the power fluid applied to the hammer is alternately increased and decreased so as to move the hammer in one of its strokes and to permit it to return in another stroke. It has also been suggested that such finger be made reciprocal with respect to the hammer so as to increase the portion of the stroke of the hammer during which power fluid is applied to urge it in such stroke. For example, with the reciprocating finger in a retracted position remote from the hammer, the hammer will move toward the finger until the latter begins to enter the passageway through the hammer. Either immediately or shortly thereafter, the finger dives into the hammer passageway a predetermined distance. As a result, the portion of the stroke through which power fluid is applied to the hammer as a result of closing the passageway therethrough is equal to the sum of the hammer over-travel plus the distance the finger moves. (The term "over-travel" is that distance the hammer moves after the passageway therethrough is restricted and before the power fluid reverses its direction of movement.) As a result, it can be stated, therefore, that the length of the stroke of the hammer during which power fluid is applied is increased by the distance the finger is permitted to reciprocate. This permits the use, where desired, of a lower pressure power fluid while yet achieving a sufficient blow with the hammer to satisfy the requirements of the use of the tool.

In such a reciprocating or diving finger valve arrangement, there is the problem of assuring that the movement of the finger will always be positive and properly sequenced with the hammer operation despite variations in the flow and pressure of the power fluid, etc. In other words, for maximum hammer efficiency, the finger must advance and retract at the proper time despite variable operating conditions.

Since the reciprocating frequency of the hammer may amount to as much as several thousand strokes per minute, and since the reciprocating frequency of the finger

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will be equal to that of the hammer, there is also the problem of providing a valve element which will satisfactorily withstand the impact shock loads impressed upon it by its sudden stopping at the end of each stroke.

Even then the valve element is made very light, the impact shocks at the end of its strokes can still be very large because of the relatively high velocity at which the valve element travels. Therefore, there is a problem of reducing the impact load on the valve element to a point where the metals thereof can withstand the same over long periods of operation and yet permitting the valve element to reciprocate in a positive mode of operation at velocities sufficiently high to achieve maximum hammer efficiency.

It is accordingly one object of this invention to provide a fluid powered impact tool wherein a valving mechanism for controlling the application of power fluid to a hammer to move it in one of its strokes is positive in operation despite variations in flow or pressure of the power fluid.

Another object of the invention is to provide such a type of tool in which the reciprocation of a valve element employed to control the application of power fluid to the hammer is rendered substantially independent, at least from a practical standpoint, of the pressure differential existing between the power fluid interiorly and exteriorly of the tool whereby the valve element can be properly reciprocated despite fluctuations of such differential over a wide range.

Another object of the invention is to provide such a tool wherein the valve element is reciprocated solely by pressures existing within the tool and it can therefore be sealed from communication with the exterior tool to thereby reduce the possibility of dirt, cuttings, and the like on the exterior of the tool intruding to interfere with the valve element's operation.

Another object of the invention is to provide a percussion tool in which the portion of the length of one stroke of the hammer through which power fluid is applied to the hammer is increased by employing a valve element reciprocating at a frequency equal to that of the hammer and yet the shock load on the valve element occasioned by its stopping at the end of each of its strokes can be reduced to a reasonable value without interfering with the proper operation of the valve element.

Other objects, advantages and features of this invention will be apparent to one skilled in the art upon consideration of the specification, claims, and the attached drawings, wherein:

Figs. 1A and 1B illustrate, partially in section and partially in elevation, one embodiment of an impact tool constructed in accordance with this invention; it being understood that these figures are continuations, one of the other, with Fig. 1A showing one end of the tool and Fig. 1B showing the other end;

Fig. 2 is a view similar to Fig. 1A showing an alternative arrangement for one portion of the tool, it being understood that the portion shown in Fig. 2 could be substituted for that shown in Fig. 1A;

Fig. 3 shows still another modification of this portion of the tool, it being generally substitutable for the portion shown in Fig. 1A or Fig. 2; and

Figs. 4, 5 and 6 are schematic illustrations of the operation of an impact tool constructed in accordance with this invention.

Like characters of reference are used throughout the several views to designate like parts.

Generally, the illustrated apparatus of this invention includes a hammer 10, mounted for reciprocation relative to a fluid supply conduit means, designated generally by the numeral 11, to deliver impact blows to an anvil 12 by its striking face 13 against anvil face 14. In the

preferred form, the tool includes an upper and a lower valve means 15 and 16 preferably arranged so that upon closing the upper valve means and opening the lower valve means, the hammer is moved by the pressure of power fluid in a power stroke to ultimately deliver a blow to the anvil. Then upon opening of the upper valve means and with the lower one closed, the pressure of the power fluid acts to move the hammer in a return stroke to complete the cycle. In order to conserve power fluid, the arrangement is preferably such, as will be explained below, that at least one of the valve means restricts flow through the tool at substantially all times so that free flow of fluid without exerting a desired actuating force on the hammer is prevented. However, in some instances, it may be desired to permit periods of such free flow in order to expedite the removal of cuttings from a borehole, for example. In such instances, the valve means can be arranged so that both are open for a predetermined portion of the cycle to permit such free flow of fluid.

Turning now to a detailed description of the tool illustrated in Figs. 1A and 1B, the fluid supply conduit means can comprise an upper valve and cylinder sub 17 provided with suitable connecting means at its upper end to connect the same with another sub 18 or even a drill string so that not only can power fluid be conducted to the tool through the drill string but the latter can act to lower the tool into the borehole, rotate it and otherwise govern its operations therein. In the illustrated form, there is also included as a part of the fluid supply conduit means, an extending casing portion made up of an upper cylinder sub 17a (here shown as an integral part of sub 17) and a lower cylinder sub 20.

Hammer 10 is reciprocally disposed within the upper and lower cylinder subs 17a and 20. It is provided with small diameter piston portion 23 and larger diameter piston portion 24 respectively disposed in bores 25 and 26 of the upper and lower cylinder subs so that pressure can act against the piston portions to urge the hammer in opposite directions.

Means are provided for slidably connecting anvil 12 to the casing or cylinder portion of conduit means 11, more specifically to lower cylinder sub 20, in such a manner that the fluid supply conduit means and anvil can have longitudinal movement relative to each other and yet relative rotation therebetween is substantially prevented. Thus, the connecting means can comprise a nut 27 having a threaded connection 28 to the lower or anvil end of the lower cylinder sub 20. The nut is provided with longitudinally extending splineways 29 which are radially aligned with corresponding splineways 30 in the anvil. Bridging elements, such as roller bearings 31, are disposed in the splineways to transmit torque between the lower cylinder sub 20 and the anvil while permitting limited longitudinal movement therebetween. Where the anvil is of one piece construction, as shown, nut 27 can be longitudinally split into two or more sections so that with the bridging elements placed in the anvil splineways 30, the nut sections can be positioned in proper place and then screwed into the lower end of the sub 20.

In order to hold the anvil in proper axial alignment with the lower cylinder sub, it can be provided with an upper piston portion 32 and another portion 33 having close sliding fits within the lower cylinder sub and nut 27. Since portions 32 and 33 are longitudinally spaced apart, they provide axially aligning bearing points maintaining the anvil in axial alignment when the telescoping joint is collapsed as shown in Fig. 1B.

With the type of tool illustrated in the drawings, the beating frequency of the hammer can be made to vary with the distance between the upper valve sub 17 and anvil 12. In order to facilitate field operation of the tool at a desired hammer frequency, stop parts are provided limiting relative longitudinal movement between the anvil and the supply conduit and can take the form of

an endwise shoulder 34 comprising the lower end of nut 27 and an out-turned shoulder 35 on the anvil. Then by merely applying enough force to keep the stop parts 34 and 35 in engagement, the beating frequency of the hammer is fixed, the properties of the power fluid remaining constant, at a predetermined maximum frequency and a minimum of control is required to maintain it at such maximum over long operational periods.

The upper end of spline 30 forms an outturned shoulder 36 on the anvil engageable with the upper end 37 of the bridging elements 31 to support the anvil in the lower cylinder sub as the tool is being lowered into the hole.

To actuate the type of hammer illustrated, it is provided with an area disposed so that pressure fluid from the supply conduit means can effectively act (here shown to act constantly) thereagainst to move the hammer in a power stroke toward the anvil. While it is possible within the scope of this invention to move the hammer in its return stroke by a spring or other mechanical resilient means, it is preferred to provide the hammer with another and larger area disposed in an opposite manner so that pressure fluid derived from the supply conduit means can act on it to urge the hammer in a return stroke away from the anvil. Valve means are also provided to vary the degree of fluid communication between the supply conduit and the larger area and between the larger area and the exterior of the tool. By proper sequential operation of these valve means, the pressure of the power fluid exerted on the larger area can be increased to move the hammer in its return stroke against the force exerted by pressure fluid acting on all or part of the smaller area and then decreased to permit movement of the hammer in its power stroke by pressure fluid acting on the smaller area.

Thus, for the illustrated apparatus, the annular area shown as the upper end 38 of hammer piston portion 23 can serve as the smaller area against which power fluid acts to urge the hammer downwardly in its power stroke. This piston portion 23 can have a plurality of labyrinth grooves 40 to limit flow past the piston from valve chamber 41 into chamber 42. Leakage past the piston portion can be permitted to such an extent that flow will always occur from chamber 42 outwardly through passages 42a irrespective of whether the hammer is moving upwardly or downwardly. This prevents any cuttings from being sucked into chamber 42 when the hammer moves in its power stroke. It is preferred that the passages be closed with a check valve which is shown in Fig. 1A as an O-ring 42b held in place in groove 42c by its own resiliency.

As a part of the valve or flow control means, piston portion 23 is provided with a bore 43 which acts as a valve element cooperating with another valve element, here shown as finger 44, to restrict flow into passageway 45 through the piston. Preferably, finger 44 has a sufficiently close fit with bore 43 as to substantially block flow therethrough and labyrinth grooves 43a can be provided to aid in this stoppage of flow.

In accordance with this invention, the arrangement is such that finger 44 reciprocates between retracted and extended positions, the retracted position being more remote from the hammer than the extended position. Thus, the finger will be in retracted position until the hammer, after it has struck a blow upon the anvil, moves in its return stroke into sufficient proximity with the finger that bore 43 moves into an initial telescoping relation with the finger. Thereafter, upon pressure in passageway 45 dropping sufficiently, the finger will dive into hammer bore 43 until it reaches its extended position. It remains in such a position until the movement of the hammer in its return stroke is reversed and the hammer is moved through at least a portion of its power stroke.

During the final movement of the hammer's power stroke,

bore 43 moves out of telescoping relation with the finger whereupon the latter moves to retracted position.

To provide this action for the finger valve element, it is provided as a portion of a reciprocating means. The reciprocating means also includes a smaller piston in cylinder arranged to urge the finger toward extended position under the influence of power fluid pressure applied from the supply conduit means against the smaller piston. The finger is formed as a part of a larger piston having one end reciprocally disposed in a larger cylinder where it is exposed to a relatively low pressure such as that exteriorly of the tool. The other end of the larger piston is exposed alternately to the pressure of the power fluid in the supply conduit means and the lower pressure in the hammer passageway. The reciprocating means, including the finger, is thus made to reciprocate in a desired sequence with the hammer reciprocation and it cannot move from either its retracted or its extended position until the hammer position dictates such movement.

Referring to Fig. 1A, the smaller diameter piston portion of the reciprocating means is indicated at 46 and the larger diameter piston portion at 47, the latter including the finger 44. The aforementioned cylinders can be provided as a part of a means for mounting the reciprocating element in the fluid supply conduit means such as valve cage 48. The cage is mounted in place between shoulders 49 and 50 in the fluid supply conduit means and may be adjustably positioned at a desired point between the shoulders as by spacing rings 51.

As stated, the mounting means can provide the smaller diameter cylinder 52 and the larger diameter cylinder 53 which reciprocally receive piston portions 46 and 47, respectively. The larger diameter cylinder 53 can be provided as an integral part of the valve cage while the small diameter cylinder 52 can be conveniently provided in a top guide 54 threaded into the valve cage and secured therein by a lock nut 55.

It will be noted that piston 46 is provided with an upper or endwise surface against which pressure in the cylinder 52 acts to urge piston 46 and hence the finger towards the hammer (to extend position). The pressure in cylinder 52 is preferably that in the fluid supply conduit means and hence the cylinder is in fluid communication with the supply conduit. This communication can be provided by a restriction 56 or, less preferably, the cylinder can be bored out through the upper end of top valve guide 54. However, by providing the restriction, a dampening effect is provided as will be discussed in more detail below.

Piston portion 47 has an endwise surface 57 exposed to the pressure in cylinder 53 so that such pressure tends to urge the reciprocating means towards the hammer. The pressure in cylinder 53 is low compared to that in the conduit means and preferably is that exteriorly of the tool and for this purpose, the cylinder is in fluid communication with the exterior of the tool via passage 58, annulus 59 and passages 60.

With the construction as thus far discussed, it will be apparent that with the hammer in anvil-striking position as shown in Fig. 1A, supply conduit pressure will act on piston portion 46 to urge finger 44 downwardly to extended position. At the same time, this same pressure acts upon the downwardly facing surfaces of piston portion 47 to urge the same upwardly. Since the effective cross sectional area of piston portion 47 is larger than that of piston portion 46, the reciprocating means will be moved upwardly to retracted position, that is, until endwise surface 57 strikes the lower end 61 of guide 54. Then upon hammer 10 moving upwardly until finger 44 is adjacent bore 43, pressure in passage 45 will drop to that substantially exteriorly of the tool and the net force on the reciprocating means will be that equal to the supply conduit pressure acting over the area of piston portion 46 minus the exterior pressure acting over

a substantially equal but oppositely facing area, the remainder of the effective endwise areas on the reciprocating means are exterior pressure disposed so that oppositely facing areas are equal to each other and since the same exterior pressure is applied to all these areas, there results a cancellation of endwise forces. As a result, finger 44 will dive into bore 43 until the reciprocating means reaches its extended position as shown in Fig. 1A.

In order to provide a convenient stop part to limit movement of the reciprocating means between extended and retracted positions, an annular flange or shoulder 62 is provided as a part of the piston portion 47 so that its endwise surface 57 and end 61 of guide 54 act as stop parts to limit movement of the reciprocating means to retracted position while the lower side 63 of the flange and an inturned shoulder 64 on the valve cage act as additional stop parts to limit movement of the reciprocating means to extended position. In order to make the area between stop parts 63 and 64 as large as possible and yet provide for positive reciprocation of the finger, a passageway is provided communicating the end of the finger adjacent the hammer with the cylinder 53 on the side 63 of the flange. Such passageway can include an enlarged bore 65 in the finger and a transverse bore 66. By making bore 65 as large as possible, the over all weight of the reciprocating means is reduced.

It will be noted that an area equivalent to the cross sectional area of flange 62 is alternately exposed to pressure in the supply conduit means and to pressure in bore 45 as the hammer and reciprocating means operate.

With the foregoing construction, it will be seen that when the hammer moves to be within sufficient proximity of the upper valve sub, finger 44 will enter bore 43 and remain therein until the upward travel of the hammer is reversed and the hammer is moved through a predetermined portion of its power stroke. In this manner, the supply of power fluid, via passage 45, to the lower end of the hammer to act against the larger pressure area of the hammer is made intermittent. The fluid so supplied must be retained within the lower cylinder sub for a predetermined time and then exhausted so that power fluid acting on the smaller area of the hammer can move it in its power stroke. For this, a lower valve means is provided comprising a lower valve element, such as finger 67, on the hammer in axial alignment with bore 68, which also serves a valve member and leads to an exhaust passage 69 in the anvil for eventual discharge to the exterior of the tool, as by conventional passages in bit 70.

Upon the hammer moving through its power stroke to be within predetermined distance from the anvil, valve member 67 will enter passage 68 and restrict flow there-through and will continue such restriction as the hammer delivers its blow to the anvil and moves away therefrom in its return stroke through a predetermined portion thereof.

For the construction shown in the drawings, it will be seen that with valve means 16 open and valve element 44 disposed in bore 43, fluid from the supply conduit acts on an area equal to the annular area of piston portion 23; the force exerted on the hammer being equal to the differential pressure across piston portion 23 multiplied by the annular area. However, with valve means 15 open and valve member 67 inserted in bore 68, pressure from the supply conduit will act through passage 45 against an annular area equal to the cross sectional area of piston portion 24 minus the cross sectional area of valve member 67, to urge the hammer in its return stroke. At the same time, the pressure fluid also acts across an area equal to the total cross sectional area of piston portion 23 to urge the hammer toward the anvil. However, since the annular area of piston portion 24 is made larger than the total cross sectional area of piston portion 23, there

exists a net differential area acted upon by the pressure fluid to move the hammer away from the anvil.

Another area equal to and oppositely disposed from the differential area is of course isolated from the pressure of the power fluid and is exposed within chamber 42 to a much lower pressure (usually substantially atmospheric).

In order to lift the hammer against gravity, as when the tool is being initially started, the effective differential area mentioned above must be at least large enough that the force exerted by the pressure fluid acting thereagainst is greater than the weight of the hammer. However, in a preferred form of the invention, the upper valve means 15 closes while the hammer is in its return stroke and before the lower valve means is opened in order to trap pressure fluid between the closed valve means. At the instant the upper valve means closes, there does not exist any pressure differential across the cross sectional area of piston portion 23. However, continued upward movement of the hammer increases the volume of the space occupied by the fluid trapped between the upper and lower valve means and consequently the trapped fluid expands and decreases in pressure with the result corresponding delivery of energy to the rising hammer. As a result, pressure differential develops across the net cross sectional area of piston portion 23 tending to resist upward movement of the hammer and this differential of pressure will increase as the hammer moves upwardly. Accordingly, the above noted differential area must be large enough relative to the volumetric change in the trapped fluid that at the minimum pressure of the latter, sufficient upward force is still developed to move the hammer upwardly until the lower valve means opens.

In order to give a fuller explanation of this sequence of operation of the valve means and other parts of the illustration tool, reference is made to Figs. 4, 5 and 6. As the tool is being lowered into operating position, as in a borehole, stop parts 36 and 37 will be in engagement thereby positioning bore 68 a maximum distance away from valve element 44. At this time, fluid can be passed through the tool to flow downwardly through hammer passage 45 to act against the lower end of the hammer and move it upwardly. The hammer will move upwardly until finger or valve element 67 is withdrawn from bore 68 after which the pressure below the hammer will be exhausted. During its upward movement, the hammer has acquired some momentum and will continue upwardly until it is decelerated by gravity. It will then fall downwardly to again move valve member 67 into bore 68 after which the above cycle is repeated. At this time, the pressure in supply conduit 11 acts to move the finger 44 upwardly to the position shown in Fig. 4. It will be apparent that with stop parts 36 and 37 in engagement, finger 44 is positioned sufficiently far enough away from the anvil that the "push-up" stroke of the hammer plus its "over-travel" does not move it sufficiently far to cause finger 44 to move into bore 43. The "push-up" stroke of the hammer may be defined as that distance it moves in its return stroke from anvil-striking position with valve member 67 within bore 68.

As the supply conduit is lowered until stop parts 34 and 35 are placed in abutment, the tool will be placed in its normal operating position. Thus, starting with the parts positioned as shown in Fig. 4, fluid flows down through hammer passageway 45 to act on the under side of the hammer and move it upwardly in its return stroke. As the hammer moves upwardly, it will eventually cause bore 43 to begin telescoping around finger 44 which is in its retracted position. This preferably happens before valve element 67 is moved out of bore 68. At the time the latter happens, the pressure in bore 45 is reduced causing finger 44 to dive into bore 43 as shown in Fig. 5. At this time, the pressure from the conduit means being applied to piston 46 holds the finger in its extended position. After the finger moves into bore 43, the ham-

mer will continue upwardly in its overtravel and then be reversed to begin its power stroke. As it moves through its power stroke, as shown in Fig. 6, valve element 67 will enter bore 68 and eventually the hammer will run away from finger 44 thereby permitting supply conduit pressure to be exerted on the under side of the finger to move it to retracted position as shown in Fig. 4. This completes the cycle of operation.

As indicated above, varying the distance between the supply conduit and the anvil will result in a variation of the beating frequency of the hammer. Thus, by lowering the supply conduit towards the anvil, the upper valve means can be made to close earlier in the push-up stroke so that the extent of hammer travel with fluid trapped between the valve means can be adjusted. However, it should be noted that the return stroke of the hammer will always be equal to the fixed push-up distance plus the over-travel distance. In effect, then, varying the position of the supply conduit changes only the over-travel distance. Thus, a maximum over-travel will be secured when the finger 44 is positioned so that it passes into bore 43 a little before or at substantially the same time the lower valve means is opened. This means the hammer will be operating at substantially a minimum operating frequency. Conversely, when the fluid supply conduit is lowered to a position such that the upper valve means closes during the early part of the return stroke and at a point after which the hammer must continue traveling upwardly a considerable distance before the lower valve means is opened, the pressure trapped between the two valve means will be considerably reduced by expansion below the full supply pressure. As a result, the average force acting to urge the hammer upwardly during the push-up stroke is less and, accordingly, the hammer has less upward momentum at the time the lower valve means opens so that the over travel is decreased. This means the frequency of the hammer will be increased.

As indicated above, means are provided for limiting the impact shock load upon the reciprocating means to a reasonable value. Such means can include restriction 56 which should have a sufficiently low flow capacity that a suitable dampening action is provided for movement of the reciprocating means. The dampening action is herein provided in such a manner so as to not interfere with the proper operation of the valving action of finger 44. Thus, as hammer 10 moves bore 43 out of telescoping relation with finger 44, the resulting application of power fluid to the finger will cause it to snap upwardly until pressure builds up in cylinder 52 to slow it down. However, by this time, the finger is withdrawn sufficiently far from bore 43 so as to not impede flow therethrough and further upward movement of the finger can be at a relatively slower rate to position it in retracted position before the hammer again telescopes with it. Accordingly, the sudden initial snap of the reciprocating means upwardly gets it out of the way of flow to the hammer. Conversely, when the hammer is positioned with finger 44 just entering bore 43, the finger will initially snap downwardly until pressure in cylinder 52 falls to slow the finger down. Nonetheless, the resultant flow of fluid through a restriction 56 into cylinder 52 permits the finger to move to extended position prior to the time the hammer moves bore 43 out of telescoping relation with finger 44.

If desired, passageway 66 can be also restricted to provide additional dampening action, but this usually is not desired because it limits the amount of initial snap action of the finger.

Referring to Fig. 2, a construction similar to that of Fig. 1A is shown. However, certain details do differ. For example, valve cage 48 is terminated much further from shoulder 50 and a much longer spacer ring 51 is employed. With this construction, the position of the valve cage, and hence the position of finger 44 relative to the anvil, can be varied over a much broader range

simply by changing the spacer rings. Additionally, a check valve 71, in the form of a pair of O-rings, is provided at passage 58 to prevent intrusion of dirt or other debris thereinto.

Referring now to Fig. 3, there is shown an upper valve means assembly in which the valve finger is reciprocated without exposing any part of the reciprocating means to pressure exteriorly of the tool. This has the advantage of preventing dirt, debris, or other matter from being sucked into the tool due to the pumping action of the piston connected to the valve finger. In this construction, finger 44 is again provided as a part of a piston portion of a reciprocating means, which piston portion has one end disposed in a cylinder 53, the cylinder being closed except as hereinafter noted. Passageway means provide fluid communication between the end of finger 44 adjacent the hammer and the cylinder 53 on the side of the piston portion therein remote from the hammer. As shown in Fig. 3, such passageway means can be provided by tapering bore 65a, bore 66a and restricted passage 72. The flow capacity of the passageway means, particularly restricted passageway 72, is made such, relative to the volume of cylinder 53, that the pressure in the upper portion of cylinder 53 will vary over a range intermediate the supply conduit pressure and the lower pressure in passageway 45 in the hammer when the finger closes this passageway. To help maintain the cylinder pressure in this range and yet provide restriction 72 large enough not to become easily clogged, a reservoir space 73 can be provided in stud 54a.

Assuming the hammer is in anvil striking position, supply conduit pressure will be applied to move finger 44 to retracted position. While it is in this position, reservoir 73, together with any portion of cylinder 53 above end 74 of the reciprocating means, will increase in pressure due to the flow of power fluid through the passageway means in the finger and restriction 72. As soon as the hammer moves upwardly far enough to telescope with finger 44, the pressure in the passageway means 65a will thereafter drop to essentially that exteriorly of the tool so that the pressure above end 74 will move finger 44 to extended position. While in such position and as the hammer is moving in its over-travel and through the initial portion of its power stroke, the fluid will bleed through restriction 72 into the hammer passageway 45 thereby reducing the pressure above end 74 of the reciprocating means. Then after the hammer runs away from finger 44, supply conduit pressure will be again applied to the finger to move it upwardly and again repressure reservoir 73, etc.

Here again it is convenient to provide stop parts for limiting movement of the reciprocating means by providing an enlargement 75 which engages shoulder 64 and stud end 61 to limit travel of the finger 44. The latter has a sliding seal through one wall of cylinder 53 and passageway 66a communicates with the space between the seal and enlargement 75. Hence this space will alternately be at supply conduit pressure and the pressure exterior of the tool so that the effective area of piston portion 47 becomes equal to that of enlargement 75.

From the foregoing it will be seen that this invention is one well adapted to attain all of the ends and objects hereinabove set forth, together with other advantages which are obvious and which are inherent to the apparatus.

It will be understood that certain features and sub-combinations are of utility and may be employed without reference to other features and subcombinations. This is contemplated by and is within the scope of the claims.

As many possible embodiments may be made of the invention without departing from the scope thereof, it is to be understood that all matter herein set forth or shown in the accompanying drawings is to be interpreted as illustrative and not in a limiting sense.

The invention having been described, what is claimed is:

1. An impact tool powered by a compressible fluid which comprises, in combination, an anvil, fluid supply conduit means, a hammer mounted to beat upon the anvil and having opposing endwise surfaces upon which fluid from the conduit means can act to move the hammer in its power and return strokes, passageway and valve means adapted to communicate one endwise hammer surface with the exterior of the tool during at least a finite portion of the hammer's power stroke and to interrupt such communication during at least a portion of the hammer's return stroke, a passageway in the hammer which when open provides fluid communication between said endwise surfaces of the hammer, a finger reciprocally carried by the conduit means and adapted to telescope into the hammer passageway to restrict flow therein during movement of the hammer in at least an initial portion of its power stroke, and means for reciprocating the finger so that it dives from a retracted position to an extended position in the hammer passageway after the hammer has moved through an initial portion of its return stroke including first cylinder and piston means connected to the finger with the cylinder means in fluid communication with the conduit means so that pressure from the conduit means urges the piston means in a direction to move the finger to extended position, a second cylinder in communication with the exterior of the tool, said finger having an end thereof reciprocally disposed in the second cylinder to provide one endwise surface against which the exterior pressure acts to urge the finger to extended position and an opposite endwise surface alternately exposed to pressure in the conduit means and to pressure in the hammer passageway as the hammer and finger reciprocate out of and into telescoping relation with each other, said opposite endwise surface being sufficiently larger than the first piston means that upon exposure to conduit means pressure, the finger is moved to retracted position.

2. The tool of claim 1 wherein the communication between the first cylinder means and conduit means is restricted sufficiently that the first cylinder and piston means acts as a dampener to the movement of the finger.

3. The tool of claim 1 wherein said one endwise surface of the finger is provided by one side of an annular flange carried by the finger and reciprocally disposed in the second cylinder.

4. The tool of claim 3 wherein the second cylinder encloses both sides of the annular flange, and a passageway in the finger providing fluid communication between the end of the finger adapted to telescope into the hammer passageway and the second cylinder on the side of the flange opposite said one side thereof whereby both the telescoping end of the finger and said opposite side of the flange constitute said opposite endwise surface of the finger.

5. An impact tool which comprises, in combination, an anvil and a fluid supply conduit means and a hammer connected so that the hammer is adapted to reciprocate relative to the conduit means and anvil to strike blows upon the latter; means for moving the hammer in a return stroke away from the anvil; a passageway in the hammer communicating with the conduit means and also with the exterior of the tool; and valving means carried by the conduit means for alternately permitting and restricting flow through the hammer passageway including a reciprocal means having first and second piston portions, the second piston portion being of larger cross section than the first piston portion and having a valving part adapted to telescope into the hammer passageway to restrict flow therethrough, means mounting the reciprocal means for reciprocation between retracted and extended positions with the valving part in alignment with the hammer passageway, said mounting means providing smaller and larger diameter cylinders for the first and second piston portions, respectively, and exposing the first piston portion to pressure in the conduit means to thereby urge the re-

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reciprocal means to extended position toward the hammer and also exposing an end of the second piston portion to pressure exterior of the tool so that the exterior pressure likewise urges the reciprocal means to extended position, the reciprocal means being situated so that with the hammer in anvil-striking position, pressure in the conduit means acts upon the other end of the second piston portion to move the reciprocal means to retracted position and upon the hammer moving through at least a portion of its return stroke, the valving part enters the hammer passageway and the conduit means pressure on the first piston portion moves the reciprocal means to extended position.

6. The tool of claim 5 wherein the second piston portion includes an annular flange disposed in said second cylinder having one side comprising said end of the second piston portion exposed to exterior pressure in such cylinder, and a fluid passageway in the second piston portion providing communication between the other side of said flange and said other end of the piston portion.

7. An impact tool which comprises, in combination, an anvil and a fluid supply conduit means and a hammer connected so that the hammer is adapted to reciprocate relative to the conduit means and anvil to strike blows upon the latter; a passageway in the hammer communicating with the conduit means and also with the exterior of the tool; valve support means carried by the supply conduit adjacent one end of the hammer including a first cylinder and a larger second cylinder intermediate the first cylinder and hammer, the first and second cylinders having their ends remote from the hammer, respectively, in fluid communication with the conduit means and the exterior of the tool, first and second pistons, respectively, in said cylinders and connected together for reciprocal movement, the second piston having an extension comprising a finger aligned with and adapted to telescope into the hammer passageway to restrict flow therethrough, at least the finger providing an endwise surface exposed to pressure in the conduit means when it is out of the hammer passageway and to pressure in the hammer passageway when telescoped therein, said finger being positioned so that when the hammer is in anvil-striking position, the finger and hammer are spaced apart whereby pressure in conduit means moves the finger away from the hammer and upon the hammer moving through at least a portion of its return stroke, the hammer passageway is positioned sufficiently close to the finger to restrict flow into the hammer passageway whereby the pressure applied to the end within a range intermediate that of the conduit means pressure acting on the first piston causes the finger to dive into the hammer passageway.

8. The tool of claim 7 wherein the fluid communication between the conduit means and first cylinder is restricted so that the first piston and cylinder act as a dampener for movement of the finger.

9. An impact tool which comprises, in combination, an anvil and a fluid supply conduit means and a hammer connected so that the hammer is adapted to reciprocate relative to the conduit means and anvil to strike blows upon the latter; a passageway in the hammer communicating with the conduit means and also with the exterior of the tool; valve support means carried by the supply conduit adjacent one end of the hammer and providing a closed cylinder therein, a piston reciprocally disposed in said cylinder, an extension comprising a finger carried by the piston and adapted to telescope an end thereof into the hammer passageway as the hammer respectively moves through portions of its return and power strokes to alternately restrict and permit flow into and out of the hammer passageway, said finger being of smaller diameter than the piston and having a sliding seal through an end wall of the cylinder, a first passageway from said end of the finger to said cylinder on one side of the piston, a second passageway providing fluid communication be-

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tween opposite ends of the cylinder, the second passageway being of sufficiently smaller flow capacity than that of the first passageway so that the pressure in the cylinder on the other side of the piston will be maintained within a range intermediate that of the conduit means and of the hammer passageway when the finger is disposed therein.

10. The tool of claim 9 wherein the second passageway is in said piston.

11. The tool of claim 9 wherein the cylinder has an extended portion and a stop is provided preventing the piston from moving into the extended cylinder portion whereby the latter acts as a reservoir to assure that the pressure therein will be maintained in said range.

12. An impact tool which comprises, in combination, an anvil and a fluid supply conduit means and a hammer connected so that the hammer is adapted to reciprocate relative to the conduit means and anvil to strike blows upon the latter; a passageway in the hammer communicating with the conduit means and also with the exterior of the tool; valve support means carried by the supply conduit adjacent one end of the hammer and providing a closed cylinder therein, a piston reciprocally disposed in said cylinder, an extension comprising a finger carried by the piston and adapted to telescope an end thereof into the hammer passageway as the hammer respectively moves through portions of its return and power strokes to alternately restrict and permit flow into and out of the hammer passageway, and restricted passageway means communicating said finger end with the cylinder on the side of the piston therein most remote from the finger whereby upon reciprocation of the hammer to alternately expose said finger end to pressure in the conduit means and a lower pressure existing in the hammer passageway when the finger is telescoped therein, fluid flows into and one of the cylinder via said restricted passageway, the restricted passageway having a flow capacity such that the pressure in the cylinder is maintained within a range intermediate said conduit means pressure and said lower hammer passageway pressure whereby the finger and piston are caused to reciprocate to lengthen the stroke of said hammer.

13. The tool of claim 12 wherein said piston is provided by an enlargement on the end of the finger within said cylinder, the finger having a sliding seal through an end of the cylinder, and wherein the passageway means also communicates with the cylinder on the side of the piston most adjacent the finger, the restriction being in the portion of the passageway means extending between said remote and adjacent sides of the piston.

14. An impact tool powered by a compressible fluid which comprises, in combination, an anvil, fluid supply conduit means, a hammer mounted to beat upon the anvil and having opposing endwise surfaces upon which fluid from the conduit means can act to move the hammer in its power and return strokes, passageway and valve means adapted to communicate one endwise hammer surface with the exterior of the tool during at least a finite portion of the hammer's power stroke and to interrupt such communication during at least a portion of the hammer's return stroke, a passageway in the hammer which when open provides fluid communication between said endwise surfaces of the hammer, a finger reciprocally carried by the conduit means and adapted to telescope into the hammer passageway to restrict flow thereinto during movement of the hammer in at least an initial portion of its power stroke, and means for reciprocating the finger so that it dives from a retracted position to an extended position in the hammer passageway after the hammer has moved through an initial portion of its return stroke, said means including a chamber, plunger means connected to said finger and reciprocable in said chamber, said plunger means having oppositely-facing surfaces exposed to fluid pressure conditions in said chamber and forming a sliding seal with the wall of said chamber towards said finger,

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a first passage extending longitudinally through said finger into said chamber for exposing said chamber on one side of said plunger means selectively to the conduit pressure or the pressure in said hammer passage according to the position of said finger, and a second passage for providing communication between said conduit and said chamber on the other side of said plunger means, said second passage being more restricted than said first passage for providing a dampening effect upon the finger action.

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14**References Cited in the file of this patent****UNITED STATES PATENTS**

2,580,203	Topanelian	Dec. 25, 1951
2,756,723	Bassinger	July 31, 1956
2,810,549	Morrison	Oct. 22, 1957
2,850,010	Mori	Sept. 9, 1958
2,851,251	Mori	Sept. 9, 1958
2,859,733	Bassinger et al.	Nov. 11, 1958