

[54] **CONCRETE BREAKER CONSTRUCTION AND VALVE MECHANISM**

[75] Inventor: **Stephen E. Crover**, Boring, Oreg.

[73] Assignee: **Ackley Manufacturing Co.**, Clackamas, Oreg.

[22] Filed: **Feb. 11, 1974**

[21] Appl. No.: **441,110**

[52] U.S. Cl. **91/235; 91/290; 91/319; 91/335**

[51] Int. Cl.² **F01B 7/18; F01L 25/04**

[58] Field of Search **91/235, 335**

[56] **References Cited**

UNITED STATES PATENTS

1,679,689	8/1928	Smith	91/235
2,265,989	12/1941	App	91/335
3,399,602	9/1968	Klessig et al.	91/235
3,499,752	3/1970	Vermijs	91/335

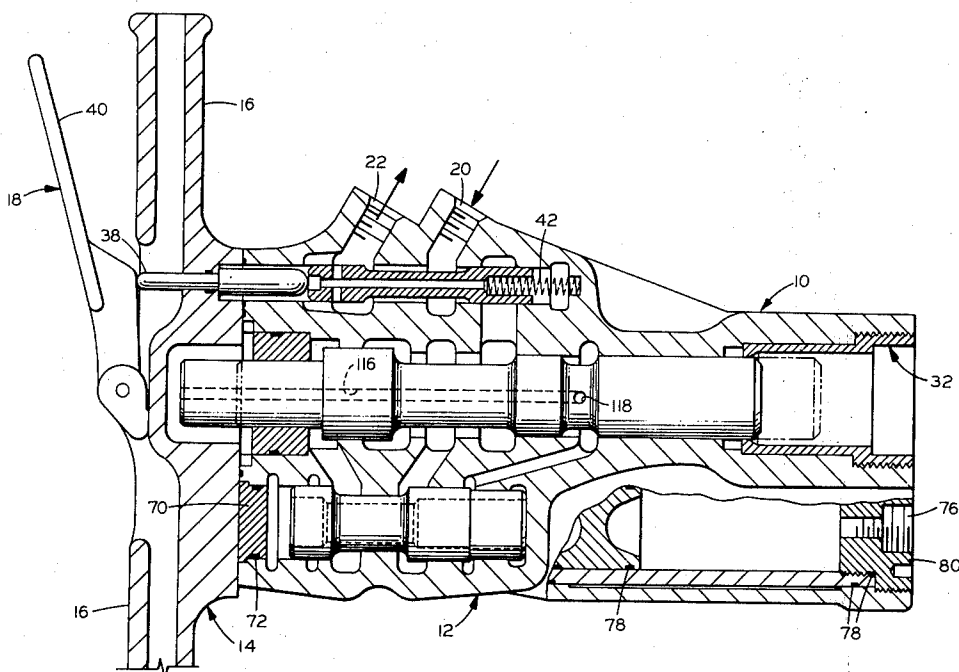
Primary Examiner—Paul E. Maslousky

[57] **ABSTRACT**

A fluid operated breaker is provided which is operable particularly for purposes of imparting repetitive blows to a tool operatively connected thereto whereby to drive the tool into engagement with a surface such as

concrete, asphalt, rock, etc. so as to effectuate a fast easy breaking of the surface. The breaker includes a housing in which there is provided an ON-OFF lever valve, a piston, a reversing spool, an accumulator, and circuit means operable for fluidically interconnecting these components. The lever valve, piston and reversing spool are each supported in the housing of the breaker so as to be movable therein between first and second positions. The circuit means functions to establish fluid flow passages between the lever valve, piston and reversing spool through which fluid is caused to flow to alternately drive the piston in a power stroke and a return stroke. The piston has a stepped design wherein the piston force area is independent of the piston diameter which allows for the use of small force areas and reasonable piston mass to reduce the fluid flow requirements and maintain high levels of energy output. The reversing spool is also provided with a stepped construction which allows for large valve size for free fluid flow, yet retains small switch areas and light weight due to hollow construction. In addition, the breaker is provided within the circuit means thereof with a variable restriction in the circuit to the outlet which can be used to vary the pressure on the return stroke and thus the energy output through variation of the pressure applied to the accumulator.

7 Claims, 3 Drawing Figures



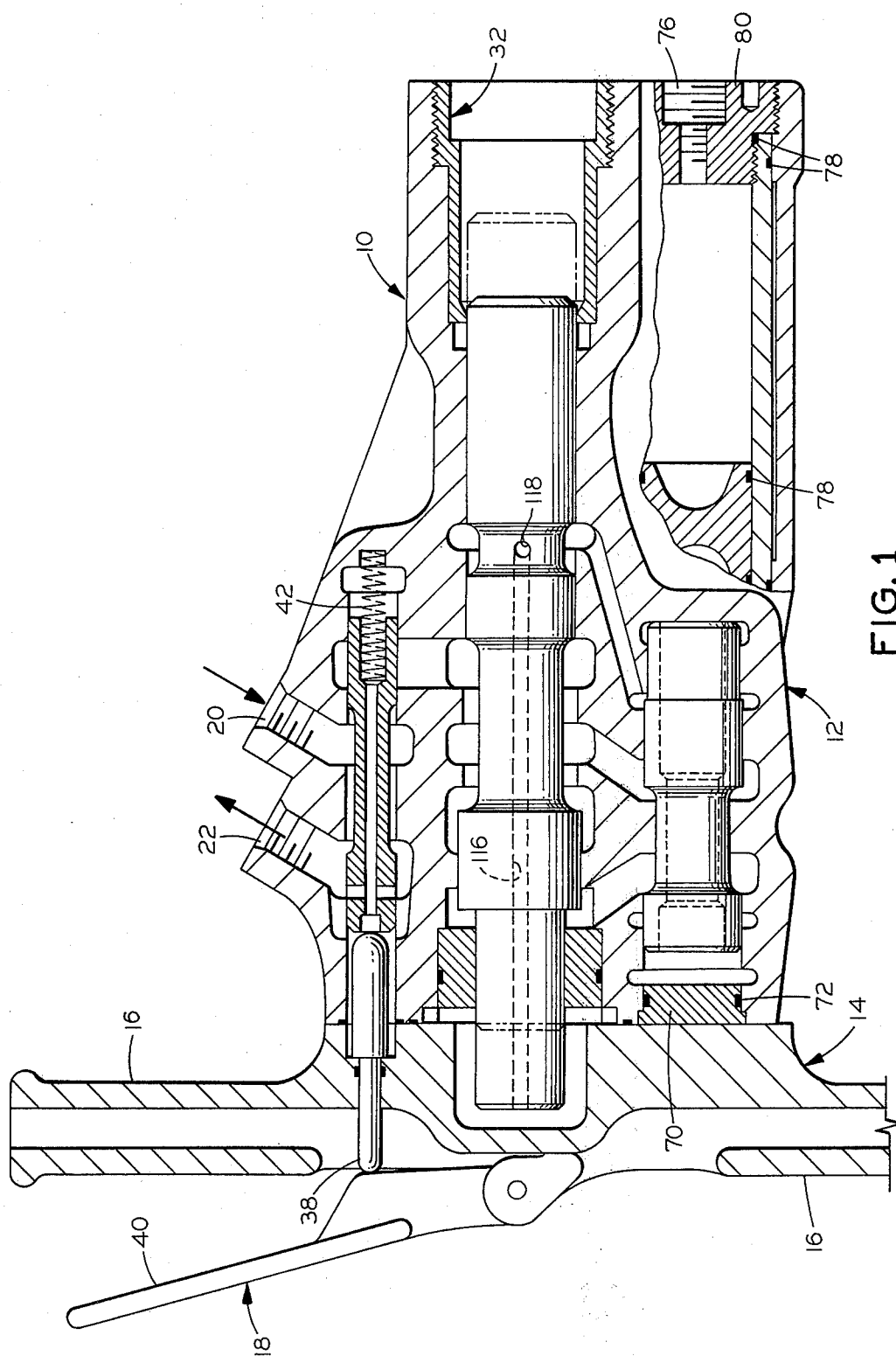
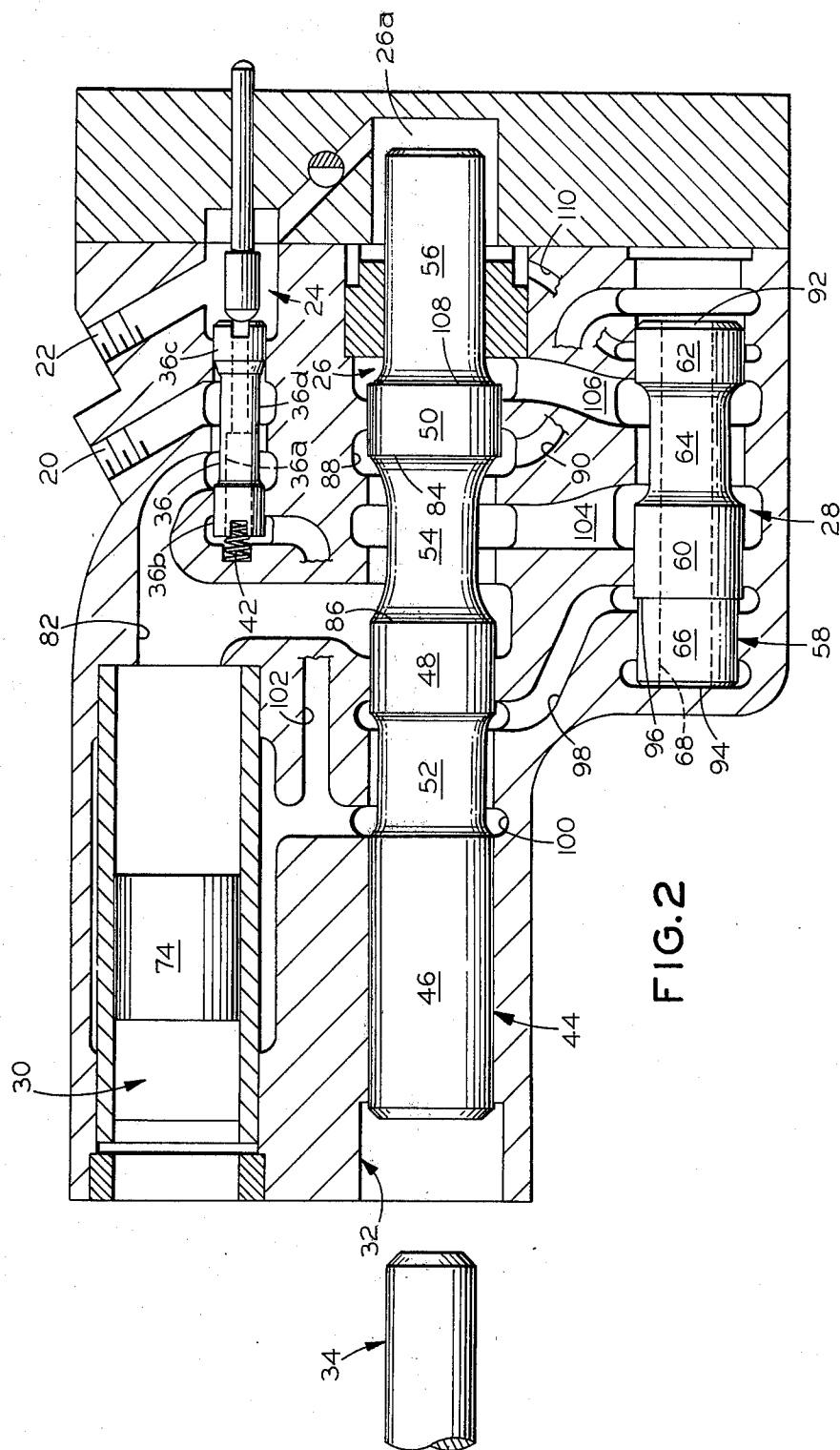
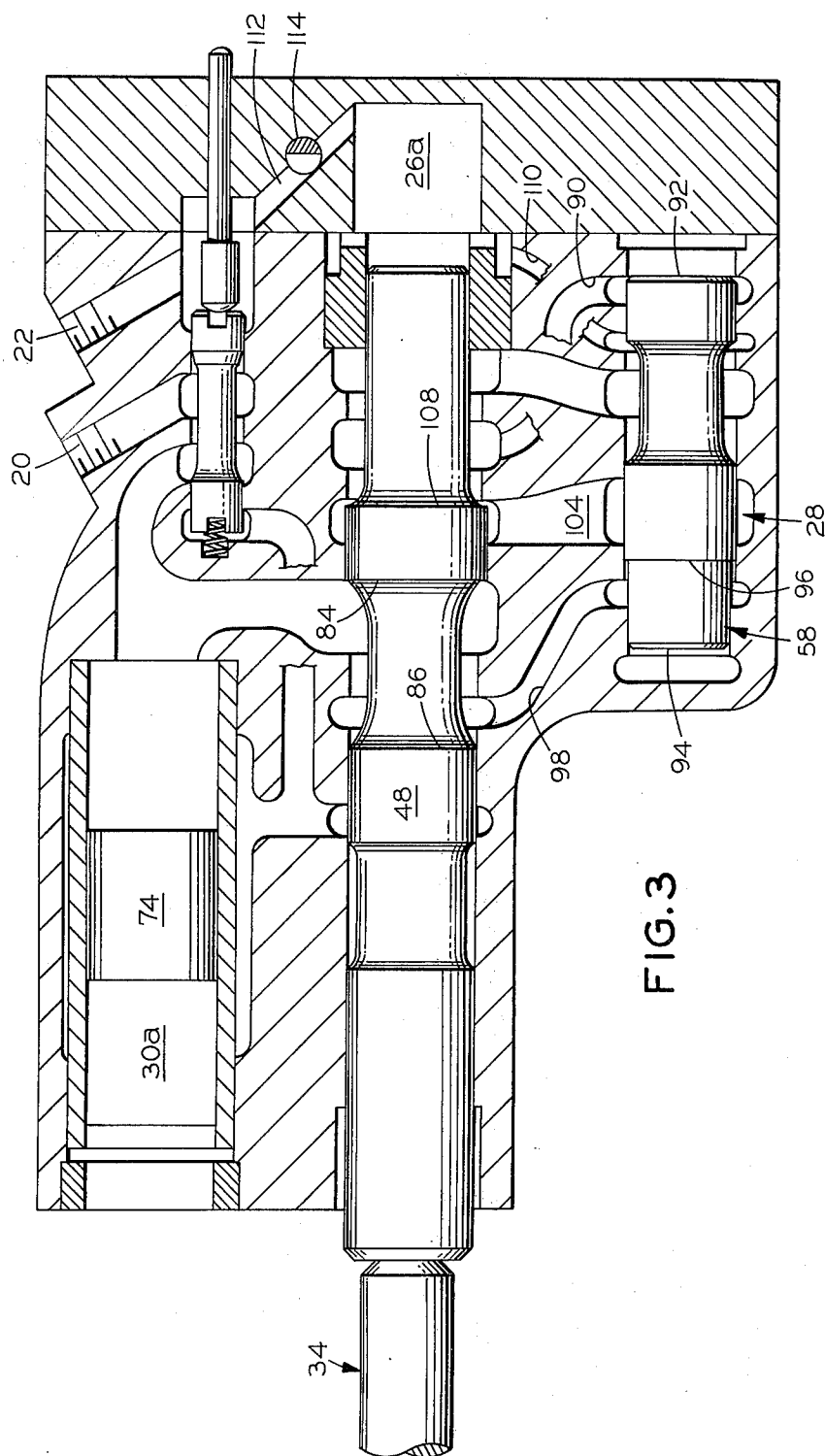


FIG. 1





CONCRETE BREAKER CONSTRUCTION AND VALVE MECHANISM

BACKGROUND OF THE INVENTION

There are a number of features which it is desirable that a fluid operated device should possess, particularly such a device which is primarily intended to be employed as a breaker operable to effectuate the fast easy breaking of a surface such as concrete, asphalt, rock, etc. For example, the breaker should be constructed so as to be capable of providing smooth and dependable operation. Namely, the device should be characterized by a relatively long operating life and by the fact that a minimal amount of maintenance need be performed thereon during the operating life thereof to produce the smooth and dependable operation.

Moreover, such a fluid operated device which is particularly intended to be utilized as a breaker should possess the ability of providing a high level of energy output in order to efficiently and rapidly effectuate the desired breaking of a desired surface. Concomitantly with possessing this capability of providing a high level of energy output, the device should also preferably be of light weight construction. One reason why the latter characteristic is desired in such a breaker is in order to assist in minimizing operator fatigue stemming from the need for the device to be continually handled during the use thereof. To summarize in this regard, it can be said that a highly advantageous characteristic to be sought in a fluid operated device such as a breaker is that it have a high power-to-weight ratio.

Along with the aforementioned characteristics, another feature which it is desired that a fluid operated device such as a breaker should possess is that it not embody complex structure, i.e., that it be of simple construction. Numerous advantages flow from providing a fluid operated device of simple construction. For example, simplifying the construction provides economies of manufacture by virtue of the fact that fewer parts need to be produced and also economies of assembly since less time and effort is required to assemble the components which comprise the device. In addition, by simplifying the construction a further reduction is capable of being achieved in the weight of the device thereby further improving the power-to-weight performance thereof. Moreover, the maintenance requirements with a simple construction are obviously less than those which are to be expected with a more complex structure just by virtue of the increased number of components in the latter structure which need attention from a maintenance standpoint apart from any other considerations which may be applicable in this regard.

A still further advantageous feature which is looked for in a fluid operated device such as a breaker is that the fluid flow requirements thereof be relatively low compared to the fluid flow needs of previously known prior art forms of similarly functioning devices. Obviously, the characteristic of relatively low fluid flow requirements must be achieved consistent with obtaining the desired performance from the device.

A number of fluid operated devices have been provided heretofore in the prior art designed particularly for use as breakers. However, each of these prior art breakers has been found to be lacking insofar as concerns one or more of the characteristics/features described in the preceding paragraphs which it is desir-

able that a fluid operated breaker embody. Therefore, there has existed a need to provide a fluid operated breaker which would possess the characteristics described above as well as having various other advantages in construction, operation and use as compared to the previously known prior art forms of fluid operated breakers.

Accordingly, it is an object of the present invention to provide a novel and improved fluid operated device and more particularly a fluid operated concrete breaker which is operable to effectuate the fast and easy breaking of a surface such as concrete, asphalt, rock, etc.

It is also an object of the present invention to provide such a fluid operated concrete breaker which is characterized by its capability to provide smooth and dependable operation during the relatively long operating life possessed thereby, while yet requiring a minimal amount of maintenance to be performed thereon to achieve such performance.

It is another object of the present invention to provide such a fluid operated concrete breaker which is characterized by its relatively simple construction from which economies of manufacture and assembly are obtained, as well as advantages insofar as concerns improving the power-to-weight performance thereof and reducing the maintenance needs thereof.

Still another object of the present invention is to provide such a fluid operated concrete breaker which has low fluid flow requirements.

A still further object of the present invention is to provide such a fluid operated concrete breaker which includes a piston having a stepped design wherein piston force area is independent of the piston diameter which allows for the use of small force areas and reasonable piston mass to reduce the fluid flow requirements and maintain high levels of energy output.

Yet another object of the present invention is to provide such a fluid operated concrete breaker which includes a reversing spool having a stepped construction which allows for large valve size for free fluid flow, yet retains small switch areas and light weight due to hollow construction.

Yet a further object of the present invention is to provide such a fluid operated concrete breaker which includes circuit means wherein there is provided a variable restriction which can be employed to vary the operating pressure and thus the energy output of the breaker.

SUMMARY OF THE INVENTION

It has now been found that the foregoing and related objects can be readily attained in a fluid operated device particularly adapted to be utilized as a breaker for accomplishing the rapid and easy breaking of a surface such as concrete, asphalt, rock, etc. The fluid operated breaker includes a housing having a plurality of longitudinally extending bores provided therein in spaced relation relative to each other, and formed so that the major axes of each of the plurality of bores lie in substantially parallel planes. An ON-OFF valve spool is supported in one of the plurality of bores for movement between a first position wherein a first operating condition of the breaker is established and a second position wherein a second operating condition of the breaker is established. The breaker also includes a piston and a reversing spool, each of which is positioned in another

one of the plurality of bores formed in the breaker housing and is supported for movement therein between first and second positions. The plurality of bores are fluidically interconnected by a multiplicity of channels which cooperate therewith to provide the breaker with circuit means operable to establish fluid flow passages between the ON-OFF valve spool, piston and reversing spool through which fluid is caused to flow to alternately drive the piston in a power stroke and a return stroke. The circuit means is provided with a variable restriction which can be used to vary the operating pressure and thus the energy output of the breaker. The piston has a stepped design wherein the piston force area is independent of the piston diameter which permits the use of small force areas and reasonable piston mass. The reversing spool is also provided with a stepped construction which allows for large valve size yet retains small switch areas and light weight due to hollow construction.

In accordance with the preferred embodiment of the invention, the breaker is constructed so that with the piston located at a position corresponding to the position occupied by the piston at the termination of the power stroke thereof, depressing the trigger permits incoming pressurized fluid to communicate with the bore in which the piston is positioned, and also with the accumulator with which the breaker is provided. From this point, the fluid flows through the bore in which the piston is positioned to a groove formed therein and through a connecting channel to the bore in which the reversing spool is located and acts on the force area provided by a land formed on the reversing spool intermediate the ends thereof. The force areas provided at opposite ends of the reversing spool, the difference of which is equal to the force area provided by the land, is acted upon by exhaust or low pressure fluid via a channel which interconnects the bore in which the reversing spool is positioned with a portion of the bore in which the piston is located and in which low pressure fluid is present. The pressure differential created by the fluids of differing pressure acting on equal but opposite force areas of the reversing spool cause the latter to move to a second position thereof. In the latter position of the reversing spool, the pressurized fluid acts on a first force area which is provided by one surface of a land with which the piston is provided. By virtue of the pressurized fluid acting on the aforementioned first force area of the piston, the latter is caused to rise in its return stroke. The fluid displaced by the piston as the latter moves in its return stroke retards the return stroke of the piston to provide time for charging the accumulator, the latter comprising an energy storing device which releases that energy during the power stroke of the piston. As the piston ascends, a groove formed in the piston bore is uncovered allowing pressurized fluid to flow therethrough to a connecting channel to the bore in which the reversing spool is located and acts on the force areas provided at the opposite ends of the reversing spool. The force area formed on the reversing spool intermediate the ends thereof is acted upon by exhaust or low pressure fluid via a channel which interconnects the bore in which the reversing spool is positioned with a portion of the bore in which the piston is located and in which low pressure fluid is present. The pressure differential created by fluids of differing pressures acting on equal force areas of the reversing spool causes the latter to move to a first position thereof. In

the latter position of the reversing spool, the pressurized fluid acts on a second force area which is provided by one surface of a land with which the piston is provided, the first force area being provided on the other surface of the land and the second force area being greater than the first force area. The above occurs as a result of the establishment of a fluid flow in a pair of channels which serve to fluidically interconnect the bore in which the reversing spool is located with the bore in which the piston is positioned. By virtue of the pressurized fluid acting on the aforementioned second force area of the piston, the latter is caused to accelerate in its power stroke. As the piston moves in its power stroke, the leading edge of the land on the piston which serves to provide the latter with a first force area thereof goes beyond and closes off one of the pair of channels interconnecting the bore of the reversing spool with the bore of the piston. This causes a reduction in the pressure of the fluid in the other of the aforementioned pair of channels and also in the pressure fluid acting on the ends of the reversing spool. The resultant force differential acting on the reversing spool causes the latter to move to the second position thereof. Meanwhile, the piston continues to move in its power stroke due to its own momentum until striking a tool. At this time the cycle repeats itself.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a cross-sectional view with some parts broken away for purposes of clarity of illustration of a fluid operated concrete breaker constructed in accordance with the present invention, illustrating the relative relationship of the parts thereof with the trigger in the unactuated condition and with the piston shown in phantom line in the at rest position.

FIG. 2 is a cross-sectional view partially in schematic of a portion of a fluid operated concrete breaker constructed in accordance with the present invention, illustrating the relative relationship of the parts thereof with the piston located at the position occupied thereby at the termination of the return stroke thereof; and

FIG. 3 is a cross-sectional view partially in schematic of a portion of a fluid operated concrete breaker constructed in accordance with the present invention, illustrating the relative relationship of the parts thereof with the piston located at the position occupied thereby at the termination of the power stroke thereof.

DETAILED DESCRIPTION OF THE ILLUSTRATED EMBODIMENT

Referring now to the drawings, and more particularly FIG. 1 thereof, there is illustrated therein a fluid operated concrete breaker generally designated by reference numeral 10, constructed in accordance with the present invention and particularly adapted to be employed for purposes of driving a tool operatively connected thereto into engagement with a surface such as concrete, asphalt, rock, etc. whereby to achieve a fast, easy breaking of the latter surface. The fluid operated breaker 10 as illustrated in FIG. 1 includes the main breaker body, i.e., housing 12 having associated therewith at one end thereof a foot assembly (not shown) in a manner well known to those skilled in the art. The aforesaid foot assembly which functions as a mounting means for cooperatively associating a tool with the breaker 10 has been omitted from the drawings in the interest of maintaining clarity of illustration and inas-

much as it is only indirectly related to the inventive subject matter to which this application is directed. For a detailed description and illustration of a foot assembly of the type which is adapted to be employed in a fluid operated breaker, reference may be had to co-pending patent application, Ser. No. 394,518, filed Sept. 4, 1973, now abandoned. At the other end of the breaker housing 12, a handle section 14 is provided. The latter section 14 is suitably secured to the main portion of the breaker housing 12 through the use of any conventional fastening means (not shown) such as, for example, by means of a plurality of threaded fasteners. The handle section 14 includes a pair of handle grips 16 which are integrally formed therewith so as to extend outwardly therefrom substantially at right angles thereto. In a manner well known to those skilled in the art, the handle grips 16 provide a means by which the operator is capable of manipulating the breaker 10. In addition, the handle section 14 also functions as a support for a trigger assembly 18 to which further reference will be had hereinafter.

With regard now more particularly to the details of construction of the main body portion of the breaker 10, i.e., breaker housing 12, reference will be had to FIGS. 1, 2 and 3 of the drawings. As shown therein, the housing 12 has formed therein an inlet port 20 and an outlet port 22. Each of the ports 20 and 22 is threaded for purposes of receiving a conventional fitting (not shown) in threaded engagement therewith. The latter fittings (not shown) function in conventional fashion to permit the interconnection of an inlet hose assembly (not shown) to the inlet port 20 and an outlet hose assembly (not shown) to the outlet port 22 whereby the breaker 10 is capable of being connected to an external source of fluid. In addition, the breaker housing 12 has a plurality of four bores 24, 26, 28 and 30 formed therein. Each of the bores 24, 26, 28 and 30 extends longitudinally within the breaker housing 12 whereby they are arranged so as to be substantially parallel to the plane of the major axis of the breaker 10. The bore 26 as seen in each of FIGS. 1, 2 and 3 communicates at one end thereof with an opening 32 which is formed in one end of the breaker 10. The opening 32 which is formed in the left end of the breaker 10 as viewed with reference to both FIGS. 2 and 3 of the drawings provides a means whereby a tool 34 is capable of being operatively connected to the breaker 10 as will be referred to more fully subsequently. Finally, the breaker housing 12 is also provided with a plurality of channels and grooves, to which specific reference will be had hereinafter in connection with the description of the mode of operation of the concrete breaker 10, which function to fluidically interconnect the inlet port 20 and the outlet port 22 with the four bores 24, 26, 28 and 30.

With further reference to FIGS. 1, 2 and 3 of the drawings the bore 24 is suitably dimensioned whereby to be capable of receiving an ON-OFF valve spool 36 for sliding movement therewithin. In accord with the illustrated embodiment thereof, the valve spool 36 has a hole 36a formed through the center thereof extending the entire length of the valve spool 36. Also, the valve spool 36 is provided with a pair of lands 36b and 36c intermediate of which there is formed thereby a groove 36d. The lands 36b and 36c as well as the groove 36d each are made so as to have a particular length which has been suitably selected whereby to enable the ON-

OFF valve spool 36 to function in accord with a predetermined mode of operation, a description of which will be found set forth hereinafter.

The left end of the ON-OFF valve spool 36, as viewed with reference to FIG. 1 of the drawings, is operatively connected to one end of a trigger push pin 38 by virtue of being spring biased into engagement therewith in a manner yet to be described whereby sliding movement can be imparted to the valve spool 36 as a result of a pushing force being applied to the left end of the valve spool 36 by the pin 38. The trigger push pin 38 along with the trigger 40, which is cooperatively associated therewith, comprise components of the trigger assembly 18. The trigger 40 is suitably mounted on the handle section 14 so that the trigger 40 is capable of pivoting relative thereto between a first, i.e., unactuated position as depicted in FIG. 1 of the drawings and a second, i.e., actuated position (not shown). As best understood with reference to FIG. 1 of the drawings, a spring biasing force is applied to the other, i.e., right end of the ON-OFF valve spool 36. This spring biasing force is operable to bias the valve spool 36 to the left, i.e., to the position thereof illustrated in solid lines in FIG. 1 which comprises the OFF position of valve spool 36, the latter position corresponding to the condition wherein the trigger 40 is not actuated. The spring biasing force is produced by a spring 42, one end of which bears against a seat formed for this purpose at the right end of valve spool 36 as viewed with reference to FIG. 1 of the drawings, while the other end of the spring 42 bears against a seat provided for this purpose at the right end as viewed with reference to FIG. 1 of the drawings of the bore 24. It can thus be seen that by overcoming the biasing force being imparted thereto by the spring 42, the valve spool 36 can be made to move from left to right, as viewed with reference to FIG. 1, as a result of the actuation of the trigger 40 which imparts a force to the trigger push pin 38 and there-through to the valve spool 36.

Referring now again to FIGS. 1, 2, and 3 of the drawings, the longitudinally extending bore 26 formed in the breaker housing 12 is suitably dimensioned whereby to be capable of receiving therein the main piston 44. The piston 44 is provided with a stepped construction comprised by three lands 46, 48 and 50 adjacent to which there exist the grooves 52, 54 and the neck 56, respectively. The lands 46, 48 and 50 as well as the grooves 52, 54 and neck 56 are each formed so as to have a particular length which has been selected whereby to enable the piston 44 to function in accordance with a predetermined mode of operation, a description of which will be found set forth hereinafter. As viewed with reference to FIGS. 2 and 3 of the drawings, the overall length of the piston 44 is such that the latter is movable between a position as shown in FIG. 2 wherein the land 46 of piston 44 is located substantially entirely out of the opening 32 to a position as shown in FIG. 3 wherein the land 46 of piston 44 extends through the opening 32 formed in the breaker housing 12 into engagement with one end of the tool 34.

Turning now to a consideration of the means through the operation of which the piston 44 is made to reverse its stroke, the former means includes a reversing valve spool 58 which is suitably supported in the bore 28 for sliding movement therewithin. As seen with reference to the drawings, a plurality of channels and grooves, to which specific reference will be had hereinafter in con-

nection with the description of the mode of operation of the concrete breaker 10, are formed in the breaker housing 12 whereby to provide fluid flow connections between the bore 28 in which the reversing valve spool 58 is positioned and the bore 26 in which the piston 44 is positioned. The reversing valve spool 58, as best understood with reference to FIGS. 2 and 3 of the drawings, is also provided with a stepped construction. More specifically, the reversing valve spool 58 is provided with a pair of lands 60 and 62 and between the lands and the end of the valve spool 58 there is provided groove 64 and neck 66, respectively. In addition, the reversing valve spool 58 has a hole 68, formed through the center thereof and extending the length of the reversing valve spool 58, capable of communicating with the aforementioned channels and grooves to enable fluid to flow therebetween in a manner which will be described more fully hereinafter. As best seen with reference to FIG. 1 of the drawings, the bore 28 is preferably closed at one end thereof by means of a plug 70 which is received therein. Any suitable conventional method of securing a pair of components together may be employed for purposes of retaining the plug 70 properly positioned within the aforescribed one end of the bore 28. Preferably a suitable gasket 72 is employed in association with the plug 70 to prevent leakage of fluid out of the bore 28 around the plug 70.

The portion of the breaker housing 12 which remains to be described comprises the accumulator section thereof which consists of the bore 30, the accumulator piston 74 which is supported for sliding movement within the bore 30, and the various channels, to which specific reference will be had hereinafter, which function to fluidically interconnect the bore 30 with the bores 26 and 24. As best understood with reference to FIG. 1 of the drawings, one end of the bore 30 is in communication with a threaded port 76, the latter is provided as a means of affording access to the bore 30 from the exterior of the concrete breaker 10 for a purpose such as for example, charging the chamber formed in the bore 30 behind the accumulator piston 74, i.e., to the left of the accumulator piston 74, as viewed with reference to FIGS. 2 and 3 of the drawings, with a suitable compressible gas such as nitrogen. In addition, as will be understood with reference to FIG. 1 of the drawings, suitable sealing means which may take the form of a multiplicity of seals 78 are preferably employed for preventing the fluid and/or the gas which is present in the bore 30 from leaking out of the latter. Moreover, as further depicted in FIG. 1 of the drawings, the bore 30 may be closed at one end by means of a threaded plug 80 through which the aforescribed port 76 is formed. The threaded plug 80 is detachably mounted in the aforescribed one end of the bore 30 through the interengagement of the threads formed on the plug 80 with the threads formed for this purpose in the aforesaid one end of the bore 30.

Turning now to a description of the mode of operation of the concrete breaker 10, reference will be had hereinafter to each of the FIGS. 1, 2 and 3 of the drawings for a understanding of the relative positions which the components of the concrete breaker 10 occupy at different periods during the cycle of operation of the concrete breaker 10. When the trigger 40 is not actuated, the ON-OFF valve spool 36 is positioned as illustrated in FIG. 1 of the drawings which corresponds to the OFF condition of the concrete breaker 10 and the piston 44

is shown in phantom line in the at rest position. Assuming that the latter is connected to a suitable external source of fluid, operation of the concrete breaker 10 is initiated by depressing the trigger 40. When this occurs, the ON-OFF valve spool 36 is caused to move to the position thereof depicted in FIG. 3 of the drawings by virtue of the fact that the force imparted by the trigger 40 through the trigger push pin 38 to the ON-OFF valve spool 36 is sufficient to overcome the biasing force being applied to the valve spool 36 by the spring 42. Thus, with the components of the concrete breaker 10 occupying the positions thereof illustrated in FIG. 3 of the drawings, the operating cycle of the concrete breaker 10 is as follows. Incoming high pressure fluid is supplied through inlet port 20 to the bore 24. From the bore 24, the fluid travels to channel 82 and acts on area 84 of piston 44, the latter area being formed by one side of the land 50. The area 84 is greater than the area 86 of the piston 44, the latter area being provided by one side of the land 48. Thus, the force produced by the high pressure fluid acting on the area 84 of the piston 44 provides the force required for the return stroke of the piston 44, i.e., causing the piston 44 to move to the right as viewed with reference to FIG. 3 of the drawings. During the return stroke, the annular groove 88 in bore 26 is uncovered by the leading edge of the area 84 of piston 44. As a result, high pressure fluid is allowed to flow through bore 26 to channel 90 and act on the area 92, i.e., the right end as viewed with reference to FIG. 2 of the reversing valve spool 58 and also on area 94, i.e., the left end of the reversing valve spool 58 by virtue of the existence of the through hole 68 formed therein. Since area 92 is greater than area 94, the resultant force produced by the high pressure fluid acting on the areas 92 and 94 tends to move the reversing valve spool 58 towards the left end, as viewed with reference to FIG. 2, of the breaker housing 12. The opposing area 96 formed by one side of the land 60 of the reversing valve spool 58 is simultaneously opened to low pressure fluid through its communication with channel 98, bore 26 and annular groove 100 formed in the latter bore, as a result of the position occupied at that moment by the piston 44, and more particularly the position at which the groove 52 formed on the piston 44 is located within the bore 26. Annular groove 100 in turn communicates with channel 102 and therethrough with bore 24 in which the ON-OFF valve spool 36 is disposed. The low pressure fluid travels through the center hole 36a formed in the valve spool 36 to the outlet port 22 and exits therethrough from the breaker 10. With the reversing valve spool 58 having been moved in the manner described hereinabove to the position thereof shown in FIG. 2 of the drawings, high pressure fluid is allowed to flow through channel 82, bore 26 in which piston 44 is positioned, channel 104, bore 28 in which reversing valve spool 58 is disposed, and into channel 106 to act on the area 108 formed by the other side of the land 50 with which the piston 44 is provided. Since the sum of the area 108 and the area 86 is greater than the area 84, the resultant force produced by the high pressure fluid acting thereon causes the piston 44 to be accelerated towards the left end, as viewed with reference to FIG. 2, of the breaker housing 12, i.e., towards the tool 34 until the piston 44 finally impacts with the tool 34. The energy stored in the accumulator section of the breaker housing 12, in a manner which will be described subsequently, is released dur-

ing the aforescribed power stroke of the piston 44 giving the latter a greater amount of kinetic energy than would be possible with just the force produced by the input high pressure fluid flow.

During the power stroke of the piston 44, the reversing valve spool 58 is switched to the position thereof depicted in FIG. 3 of the drawings in the following manner. Channel 104 is cut off from the high pressure fluid source by the leading edge of the area 84 of the piston 44, and as a result the force acting on the area 108 of the piston 44 is also cut off. Due to the momentum of the piston 44, its continued motion causes a volume increase in the portion of the bore 26 located behind the area 108 of the piston 44, i.e., to the right of the area 108 as viewed with reference to FIG. 3 of the drawings, thus creating an area of low pressure. Areas 92 and 94 on the reversing valve spool 58 are in communication with the aforescribed low pressure area in the bore 26 behind piston area 108 through channel 90 which is uncovered by the piston 44 at this time. Concurrently with the pressure fluid cut off, channel 98 is uncovered by the trailing edge of the area 86 provided by one side of the land 48 of the piston 44. This allows high pressure fluid to act upon the area 96 of the reversing valve spool 58 providing the force required to move the latter into the position shown in FIG. 3 of the drawings.

Piston 44 continues its power stroke due to its own momentum until the piston 44 strikes the tool 34 giving up its energy. At this time, high pressure fluid acts on the piston 44 imparting a force which tends to move the piston 44 to the right as viewed with reference to FIG. 3 of the drawings. The reversing valve spool 58, having shifted to the position shown in FIG. 3, allows the fluid present in the portion of bore 26 located behind the area 108 of the piston 44 to flow through channel 106, bore 28, channel 110, and into the chamber 26a formed at the right end of the bore 26, as viewed with reference to both FIGS. 2 and 3 of the drawings. The combined fluid present in the chamber 26a is expelled, as the piston 44 moves to the right with reference to FIG. 3, through channel 112 and restriction 114 to the low pressure outlet, i.e., port 22. The restriction 114 tends to retard the return stroke of the piston 44 allowing excess input energy to be diverted and stored in the accumulator section of the breaker housing 12 by moving the accumulator piston 74 against a compressible gas which is to be found in the portion 30a of the bore 30. This energy is then released during the power stroke of the piston 44 as was noted previously hereinabove. When the piston 44 reaches the position thereof indicated in FIG. 2 of the drawings, the aforescribed cycle of operation of the concrete breaker 10 is once again repeated.

Thus, it can be seen based on the description of the mode of operation of the concrete breaker 10 set forth in the preceding paragraphs that the fluid circuitry of the breaker 10 is such that the area 84 provided by the land 50 of the piston 44 operates to cause the high pressure fluid being applied to the force area 108 of the piston 44 to be cut off prior to the time when the piston 44 impacts against the tool 34. The advantage derived from this feature is that a smoother operation of the breaker 10 is obtained thereby. This is achieved by allowing time for the occurrence of the necessary changes in the fluid flow paths within the breaker 10 to take place to accomplish the return stroke of the piston

44, and by permitting a low pressure circuit for switching to be employed. Also, it assures that pressure is not acting on the piston 44 at the impact thereof with the tool 34. A second feature described above which is possessed by the concrete breaker 10 is the fact that there is embodied therein a variable restriction 114. The latter restriction 114 may be employed to vary the operating pressure and thus the energy output of the breaker 10. Another feature of the concrete breaker 10 to be noted is that the force area 108 of the piston 44 is independent of the diameter of the piston 44. This allows the use of a small force area and large piston mass to lessen the flow demand on the accumulator, which in turn increases the overall efficiency of the concrete breaker 10.

At this point note will be taken of the fact that as shown in FIG. 1 of the drawings, the piston 44 is provided with a central passage 116 formed therein, whereas as shown in FIGS. 2 and 3 of the drawings the piston 44 is not provided with such a central passage 116 which extends from and is in communication with a suitably dimensioned opening (not shown) formed in the end wall of the left end of the piston 44 as viewed with reference to FIG. 1, and which extends to and is in communication with the opening 118 formed in groove 52 of the piston 44. The function of the central passage 116 is to provide a flow path for fluid through the piston 44 between the left end thereof and the opening 118 formed therein. The purpose of including an illustration of the aforescribed central passage 116 in the piston 44 is merely to indicate that it is possible to utilize a piston 44 having such a construction in carrying out the intent of the present invention. However, in accord with the preferred embodiment of the invention, the piston 44 is configured as shown in FIGS. 2 and 3 of the drawings, i.e., with no central passage formed therein. When utilizing the latter form of structure, the path of flow of fluid between the inner end, i.e., the right end of the piston 44 as viewed with reference to FIGS. 2 and 3 of the drawings, and the groove 52 is accomplished by means of suitable located passages formed in the housing 12 of the breaker 10.

Although there has been shown in the drawings and described hereinabove two forms of pistons which may be embodied in a fluid operated concrete breaker constructed in accordance with the present invention, it is nevertheless to be understood that other modifications in the construction of the fluid operated concrete breaker may still be made thereto by those skilled in the art without departing from the essence of the invention. In this connection, some of the modifications which can be made in the subject fluid operated concrete breaker have been alluded to hereinabove while others will become readily apparent to those skilled in the art when exposed to the present description and illustration of the construction of the fluid operated concrete breaker 10. For example, although the breaker housing 12 has been depicted as having a substantially rectangular external configuration, it is to be understood that the breaker housing 12 could take other shapes without departing from the essence of the present invention. In addition, although little mention has been made hereinabove of the embodiment in the concrete breaker 10 of sealing means, it is to be understood that the concrete breaker 10 is preferably provided with suitable means operable for preventing the hydraulic fluid which is utilized in the concrete breaker

10 from undesirable leakage within and/or to the exterior of the breaker housing 12. Also, although the features noted hereinabove which characterize the mode of operation of the concrete breaker 10 have been found to be particularly adapted for employment in a fluid operated device of the type which is primarily intended to be utilized for purposes of imparting repetitive blows to a tool operatively connected thereto whereby to drive the tool into engagement with a surface such as concrete, asphalt, rock, etc. so as to effectuate a fast, easy breaking of the latter surface, it is also to be understood that the aforementioned principles of operation which characterize the mode of operation of the concrete breaker 10 may also be utilized in other forms of fluid operated devices.

Thus, it can be seen that the present invention provides a novel and improved fluid operated device and more particularly a fluid operated concrete breaker which is operable to effectuate fast and easy breaking of a surface such as concrete, asphalt, rock, etc. The fluid operated concrete breaker in accord with the present invention is characterized by its capability to provide smooth and dependable operation during the relatively long operating life possessed thereby, while yet requiring a minimal amount of maintenance to be performed thereon to achieve such performance. Moreover, the fluid operated concrete breaker of the present invention is characterized by its relatively simple construction from which economies of manufacture and assembly are obtained, as well as advantages insofar as concerns improving the power-to-weight performance thereof and reducing the maintenance needs thereof. Also, in accord with the present invention a fluid operated concrete breaker has been provided which has low fluid flow requirements. The fluid operated concrete breaker of the present invention includes a piston having a stepped design wherein the piston force area is independent of the piston diameter which allows for the use of small force areas and reasonable piston mass to reduce the fluid flow requirements and maintain high levels of energy output. Also, in accordance with the present invention a fluid operated concrete breaker is provided which includes a reversing valve spool having a stepped construction which allows for large valve size for free fluid flow, yet retains small switch areas and light weight due to hollow construction. Finally, the fluid operated concrete breaker of the present invention embodies circuit means wherein there is provided a variable restriction which can be employed to vary the operating pressure and thus the energy output of the breaker.

Having thus described the invention, I claim:

1. A fluid operated breaker particularly adapted to be employed for imparting repetitive blows to a tool to drive the tool into engagement with a surface comprising:

a. a breaker housing including inlet means and outlet means, said housing having a multiplicity of bores formed therein and means for mounting a tool member at one end thereof;

b. a piston supported in a first bore for movement therewithin alternately in a power stroke terminating with said piston adjacent said one end of said housing for imparting a blow to the associated tool and a return stroke terminating with said piston spaced from said one end of said housing, said piston having a stepped construction formed by a plu-

ality of lands and grooves formed along the length of said piston providing a multiplicity generally radially extending shoulders, said shoulders providing a first force area facing towards said one end of said housing and a second force area facing oppositely from said one end with said second force area being larger than said first force area all said shoulders providing said force areas being spaced from the ends of said piston, and said housing and piston being cooperatively configured and dimensioned to preclude fluid communication through said first bore between said shoulders comprising said force areas and the ends of said piston whereby the high pressure fluid acting on said shoulders of said piston effects movement in both power and return strokes.

c. switching means including a reversing valve spool having a stepped construction supported in a second bore for movement therewithin alternately between a first position and a second position operable to produce variation in the flow of fluid to said first bore and said second force effective area to cause said piston to alternately switch between movement in said power stroke and movement in said return stroke thereof;

d. fluid circuit means fluidically interconnecting said inlet means, said outlet means and said multiplicity of bores operable to provide alternate fluid flow paths therebetween, said fluid circuit means being operable when said reversing valve spool is in said first position thereof to establish a first flow path for high pressure fluid from said inlet means to said first bore to cause high pressure fluid to be applied against said first force area of said piston and a second flow path for high pressure fluid from said first bore to and from said second bore to cause high pressure fluid to be applied against said second force area of said piston with the resultant force produced by the high pressure fluid acting on said first and second force areas of said piston causing said piston to accelerate in said power stroke thereof, said second flow path for high pressure fluid being cut off by said first force area of said piston as said piston moves in said power stroke thereof to cause the discontinuance of the flow of high pressure fluid against said second force area and thereby to terminate the force being provided by the high pressure fluid against said piston causing said piston to move in said power stroke thereof before said piston imparts a blow to the tool, said fluid circuit means in said second position of said reversing valve spool providing a first flow path for low pressure fluid from said first bore to said second bore to provide an exhaust path for low pressure fluid therebetween and a second flow path for low pressure fluid from said second bore to said outlet means to provide an exhaust path for low pressure fluid therebetween;

e. accumulator means in a third bore in said breaker housing fluidically interconnected by said fluid circuit means with said first bore and operable as a storage means for storing energy therein during said return stroke of said piston and for releasing the energy stored therein during said power stroke of said piston to increase the force with which said piston imparts a blow to the tool; and

f. variable restrictor means in one of said flow paths for low pressure fluid operable to vary the pressure in said low pressure fluid paths and thereby the pressure in the fluid circuit to said accumulator

means to vary the energy stored therein during the return stroke of said piston.

2. The fluid operated breaker as set forth in claim 1 further comprising trigger means including an ON-OFF valve spool mounted in a fourth bore for movement therewithin between a first position establishing the OFF condition of the breaker and a second position establishing the ON condition of the breaker.

3. The fluid operated breaker as set forth in claim 1 wherein said variable restriction means are provided in said second flow path for low pressure fluid operable to vary the output pressure therethrough and thereby the energy output of the breaker.

4. A fluid operated breaker particularly adapted to be employed for imparting repetitive blows to a tool to drive the tool into engagement with a surface comprising:

- a. a breaker housing including inlet means and outlet means, said housing having a multiplicity of bores formed therein and means for mounting a tool at one end thereof;
- b. a piston supported in a first bore for movement therewithin alternately in a power stroke terminating with said piston adjacent said one end of said housing for imparting a blow to the associated tool and a return stroke terminating with said piston spaced from said one end of said housing, said piston being of large mass and having a stepped construction formed by a plurality of lands and grooves providing generally radially extending shoulders along the length of said piston, one of said grooves defining first and third shoulders at the margins thereof with said first shoulder facing towards said one end of said housing and being larger in area than said third shoulder, the differential in area of said shoulders providing a first force area facing towards said one end of said housing, said piston having a second shoulder facing oppositely from said one end, the sum of the areas of said second and third shoulders being larger than that of said first shoulder to provide a second force area larger than said first force area, said first force area being effective to move said piston in said return stroke upon supply of high pressure fluid to said one groove, all said shoulders providing said force areas being spaced from the ends of said piston, and said housing and piston being cooperatively configured and dimensioned to preclude fluid communication through said first bore between said shoulders comprising said force areas and the ends of said piston whereby the high pressure fluid acting on said shoulders of said piston effects movement in both power and return strokes, said first and second force areas being of small size and having dimensions independent of the diameter size of said piston;
- c. switching means including a reversing valve spool having a stepped construction supported in a second bore for movement therewithin alternately between a first position and a second position operable to produce variation in the flow of fluid to said first bore and said second force area to cause said piston to alternately switch between movement in said power stroke and movement in said return

stroke thereof;

d. fluid circuit means fluidically interconnecting said inlet means, said outlet means and said multiplicity of bores operable to provide alternate fluid flow paths therebetween;

e. accumulator means provided in a third bore in said breaker housing fluidically interconnected with said first bore, the fluid flow demands of said accumulator means being lessened as a result of the large mass of said piston and small size of said first and second force areas, said accumulator means being operable as a storage means for storing energy therein during said return stroke of said piston and for releasing the energy stored therein during said power stroke of said piston; and

f. variable restrictor means in said fluid circuit means to vary the pressure in the flow path of fluid being discharged through said outlet means and thereby the pressure in the fluid circuit to said accumulator means to vary the energy stored therein during the return stroke of the piston and thereby the force with which said piston imparts a blow to the associated tool.

5. The fluid operated breaker as set forth in claim 4 wherein said fluid circuit means is operable when said reversing valve spool is in said first position thereof to establish a first flow path for high pressure fluid from said inlet means to said first bore to cause high pressure fluid to be applied in said one groove against said first force area of said piston and a second flow path for high pressure fluid from said first bore to and from said second bore to cause high pressure fluid to be applied against said second force area of said piston with the resultant force produced by the high pressure fluid acting on said first and second force areas of said piston causing said piston to accelerate in said power stroke thereof, said second flow path for high pressure fluid being cut off by said first force area of said piston as said piston moves in said power stroke thereof to cause the discontinuance of the flow of the high pressure fluid against said second force area and thereby to terminate the force being provided by the high pressure fluid against said piston causing said piston to move in said power stroke thereof before said piston imparts a blow to the associated tool.

6. The fluid operated breaker as set forth in claim 4 wherein said fluid circuit means is operable when said reversing valve spool is in said second position thereof to establish a first flow path for low pressure fluid from said first bore to said second bore to provide an exhaust path for low pressure fluid therebetween and a second flow path for low pressure fluid from said second bore to said outlet means to provide an exhaust path for low pressure fluid therebetween, and wherein said variable restriction means are provided in said second flow path for low pressure fluid.

7. The fluid operated breaker as set forth in claim 4 further comprising trigger means including an ON-OFF valve spool mounted in a fourth bore for movement therewithin between a first position establishing the OFF condition of the breaker and a second position establishing the ON condition of the breaker.

* * * * *