United States Patent

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[54] **PRESSURE FLUID CONTROLLED RECIPROCATING MECHANISM**

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[52] **U.S. Cl.** **91/25,** 91/165, 91/235, 91/276

[51] **Int. Cl.**.....**F15b 15/22,** F01b 7/18, F01l 17/00

[58] **Field of Search**.....91/232, 235, 276, 321, 328, 91/392

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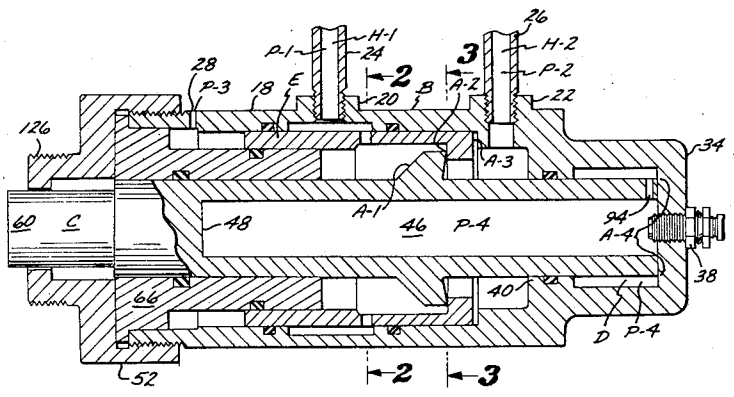
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[57] **ABSTRACT**

A fluid controlled mechanism that includes a reciprocating member that is actuated by stored potential energy, with the member as it moves from a second to a first position providing usable kinetic energy. Two moving parts of the mechanism so distribute fluid at three different pressure levels on a plurality of different sized areas that said member alternately and automatically moves between said first and second positions. The stored potential area may result from a pressurized gas head, a spring, weight means, or the like. The fluid at one of the three pressure levels may be air at the ambient pressure if desired.

The mechanism may be employed for such diverse purposes as a high velocity energy generator in an impact or demolition tool, as well as a reciprocating power source in hammers, chisels and spades, and also as a power source for pumps, boosters, sickle bars, concrete screeds and the like.

9 Claims, 7 Drawing Figures



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2 Sheets-Sheet 1

FIG. 1

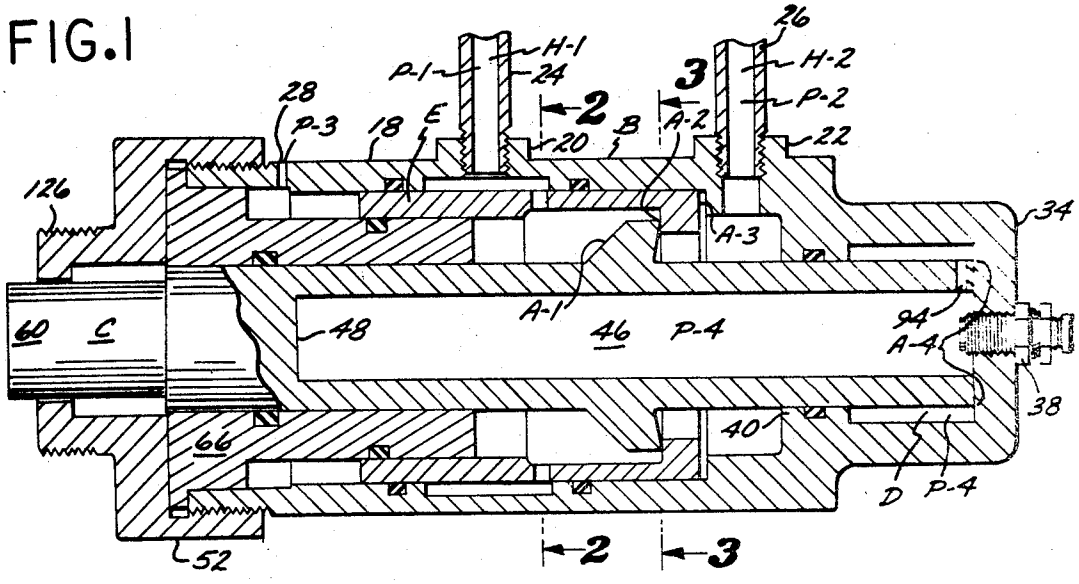
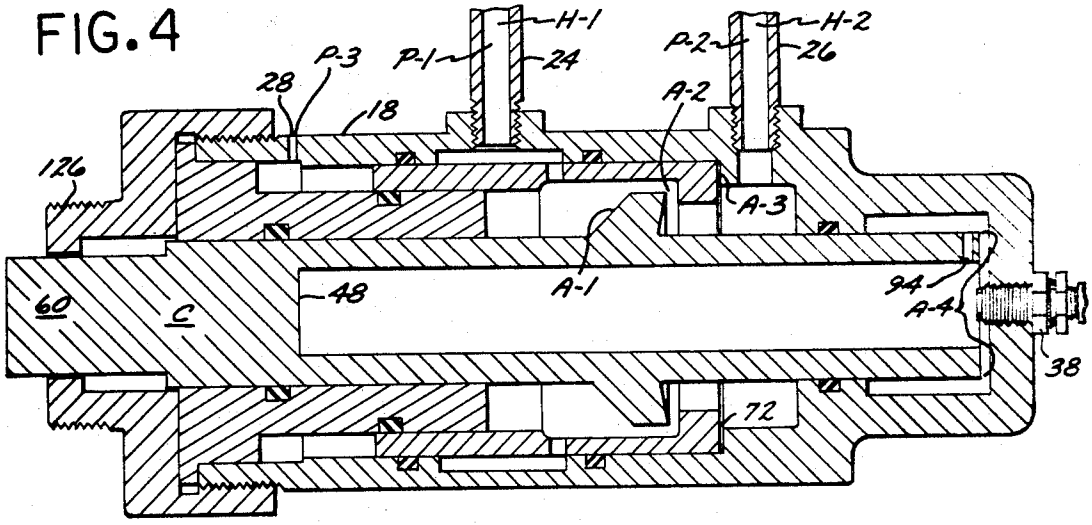


FIG. 4



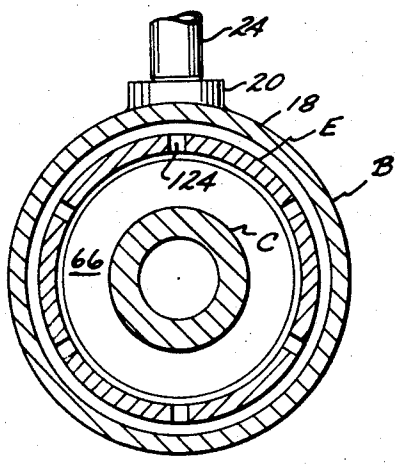


FIG. 2

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FIG. 5

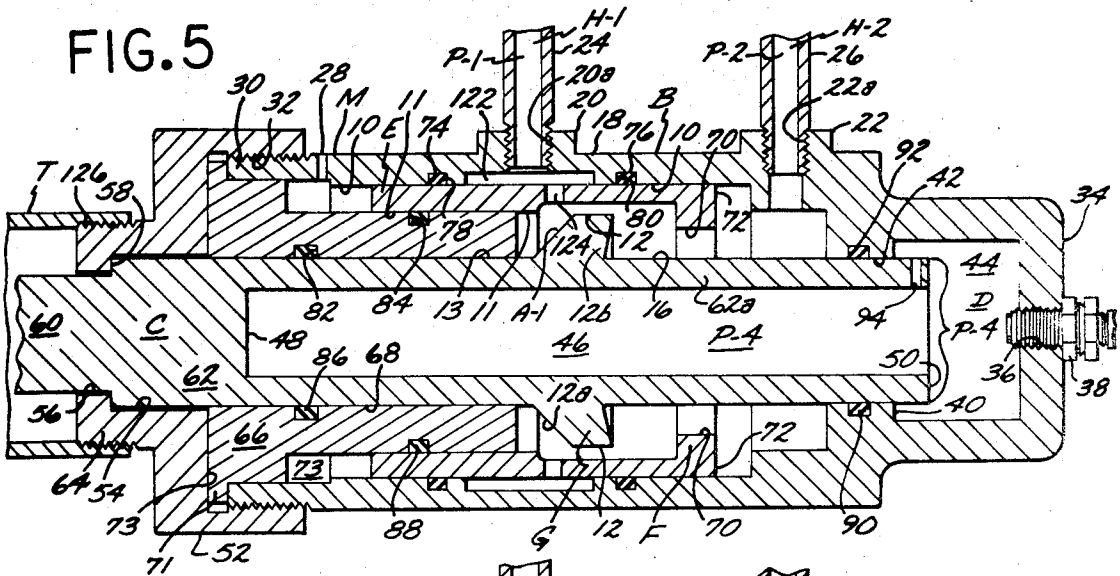


FIG. 6

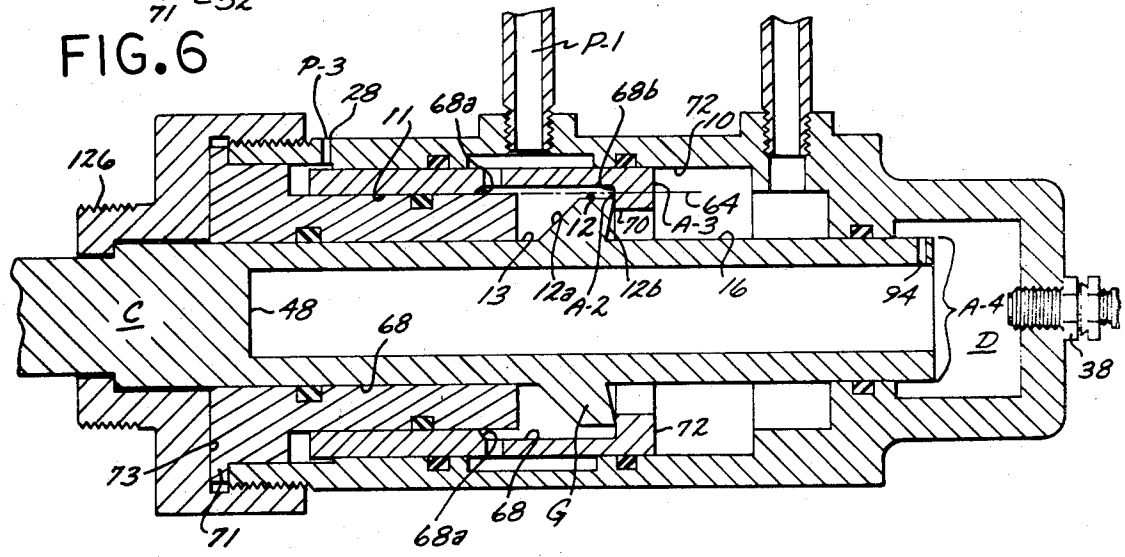


FIG. 3

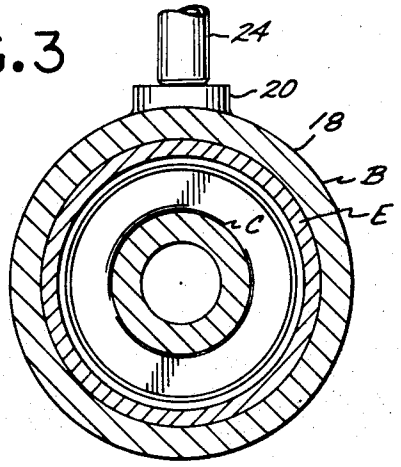
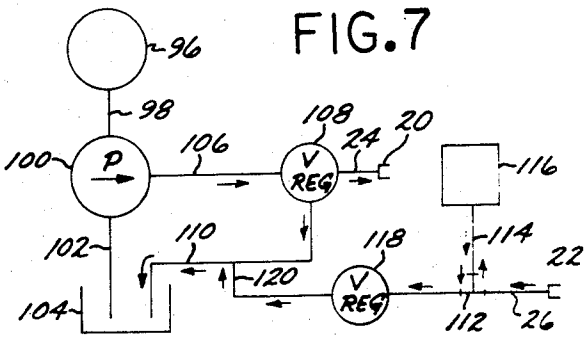


FIG. 7



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PRESSURE FLUID CONTROLLED RECIPROCATING MECHANISM

BACKGROUND OF THE INVENTION

1. Field of the Invention

Pressure fluid controlled reciprocating mechanism.

2. Description of the Prior Art

In the past, various types of reciprocating mechanisms have been developed in which the actuation thereof is a result of hydraulic fluid supplied to the device under pressure. Such devices have had certain operational disadvantages, primarily, that they require one or more sources of high volume, high pressure fluid for the actuation thereof, and are unduly complicated in the interior structure thereof.

The primary purpose in devising the present invention is to supply a fluid controlled reciprocating mechanism, in which the reciprocating member moves alternately between first and second positions, and in moving from the second to the first position is energized by a potential source of energy such as a gas head, spring or weight that forms a part of the mechanism. Two moving parts only, that form a part of the mechanism, so direct fluid at three different pressure levels on areas of various sizes situated within the mechanism to cause the actuation of the reciprocating member. The fluid employed is preferably oil that is supplied by a conventional system, with a back pressure being maintained at the egress by conventional means in the oil return system to the reservoir. This combination together with a vent to the atmosphere supplies fluid pressure at three different levels, with only one input source of hydraulic fluid being required. The kinetic energy supplied by the reciprocating member as it moves from a second to a first position is preferably provided by a precharged inert gas chamber. High energy developing sources may be stored in such a chamber to occupy a relatively small amount of space and with a low weight factor.

SUMMARY OF THE INVENTION

A fluid controlled mechanism that includes a housing in which a reciprocating member is movably supported and is operatively associated with a source of stored potential energy that at all times tends to move said member from a second to a first position. The reciprocating member has a valve member extending outwardly therefrom, and the valve member capable of effecting a seal with a valve seat that forms a part of a sleeve slidably movable in the mechanism. Fluid at first and second pressures are supplied to the interior of the housing with said first pressure being substantially higher than the second pressure. The interior of the housing is vented to the atmosphere or if desired to a source of hydraulic fluid at lower pressure. The venting of the interior of the mechanism to the atmosphere provides the third fluid pressure level, which is less than that of the pressure on the first and second fluids.

The potential energy developing means that moves the reciprocating member from the second to the first position is inert gas at a substantially high pressure, but a pressure lower than that exerted on the first hydraulic fluid. After the reciprocating member has moved from a second to a first position, the slidable sleeve and reciprocating member move in unison towards the second position, with the valve member and valve seat

being in sealing contact. Just after the second reciprocating member has reached the second position, the continued flow of hydraulic fluid at the first pressure results in the sleeve moving in a direction to break the seal between the valve seat and valve member to momentarily over the first pressure in the mechanism to allow the inert gas charge or other source of potential energy to move the reciprocating member from the second to the first position.

A major object of the present invention is to provide a fluid controlled mechanism that has but two movable parts that so control fluid at three different pressures that a reciprocating member that is at all times subjected to potential energy generating means alternately and automatically moves between first and second positions to produce useful work.

BRIEF DESCRIPTION OF THE DRAWING

FIG. **1** is a longitudinal cross sectional view of the mechanism, with the reciprocating member in a second position, and the valve seat supporting sleeve in sealing contact with the valve member;

FIG. **2** is a transverse cross sectional view of the device taken on the line **2—2** of FIG. **1**;

FIG. **3** is a second transverse cross sectional view of the device taken on the line **3—3** of FIG. **1**;

FIG. **4** is a second longitudinal cross sectional view of the device with the valve member and valve seat separated and the reciprocating member just starting to move to the left from the second position as a result of the gas head in the device;

FIG. **5** is a third longitudinal cross sectional view of the device with the reciprocating member having moved to a first position to complete a work producing stroke, and the valve seat and valve member still being separated;

FIG. **6** is a fourth longitudinal cross sectional view of the device, with the reciprocating member in the second position, and the valve seat and valve member in sealing contact with one another; and

FIG. **7** is a diagrammatic atic view of the fluid pressure producing assembly.

DESCRIPTION OF THE PREFERRED EMBODIMENT

The fluid controlled mechanism M as may be seen in FIGS. **1** to **6** inclusive includes a housing assembly B that slidably supports an elongate member C that reciprocates between first and second longitudinally spaced positions. Member C is at all times urged to the first position shown in FIG. **6** by potential energy providing means D.

Housing assembly B slidably supports a sleeve E within the interior thereof. Sleeve E includes a valve seat F that may be sealingly engaged by a valve member G that is a part of member C or mounted thereon.

Housing assembly B includes a side wall **18** that has first and second longitudinally spaced bosses **20** and **22** formed as a part thereof. Bosses **20** and **22** have transverse first and second fluid passages **20***a* and **22***a* extending therethrough. First passage **20***a* is in communication with a first conduit **24** that is supplied with a first fluid H-1, preferably hydraulic oil, at a constant rate and at a first pressure P-1 by conventional means shown in FIG. **7**.

The second fluid passage 22*a* is connected to a second conduit 26 that supplies a second fluid H-2, preferably hydraulic oil, that is maintained at a second back pressure P-2 by conventional means shown in FIG. 7. The first and second fluids H-1 and H-2 must both be alike, either liquids or gases. The side wall 18 has a third transverse passage 28 therein and as shown in FIG. 6 thence the interior housing assembly B to the ambient atmosphere which is at a third pressure P-3.

In detail, the side wall 18 is preferably a cylindrical shell as shown in FIG. 3, and has a first open end portion 20 on which threads 32 are formed. A second end of side wall 18 is closed by an end piece 34 that has a fourth fluid passage 36 therein. A valve 38 is secured in a fixed position to end piece 34 and is in communication with fourth fluid passage 36. The valve 38 permits an inert gas, such as nitrogen under pressure, to be discharged into housing assembly B to supply the potential energy providing means D.

The side wall 18 has a transverse partition 40 therein that is intermediately located between end piece 34 and first end portion 30. Partition 40 has a longitudinal opening 42 therein in which the right hand end portion of reciprocating member C is slidably supported. The side wall 18, end piece 34, partition 40 and member C cooperate to define a compartment 44 in which an inert gas such as nitrogen is contained under a pressure P-4. The pressurized gas constitutes the potential energy providing means D in the mechanism M as illustrated. The right hand portion of member C as viewed in FIG. 5 has a longitudinal recess 46 therein that forms an extension of compartment 44. If desired, the potential energy providing means D may be a mechanical element, such as a compressed spring, or a weight if the mechanism is operated in a vertical position.

The forward end of recess 46 is defined by a transverse face 48. Member C terminates on the right hand end thereof as viewed in FIG. 5 in a ring shaped face 50. Housing assembly B further includes an internally threaded cap 52 that engages threads 32 as shown in FIG. 5. The cap 52 has a longitudinal bore 54 and counterbore 56 therein that define a body shoulder 58 at their junction.

Member C has a first portion 60 that is of less transverse cross section than a second portion 62 thereof. The portions 60 and 62 define a circumferentially extending surface 64 that acts as a stop when it contacts body shoulder 58 as shown in FIG. 5.

A generally cylindrical plug 66 is provided that is disposed in the forward portion of shell 18 as viewed in FIG. 5. Plug 66 has a longitudinal bore 68 therein that slidably supports member portion 62. A circular flange 71 extends outwardly from plug 66 and is gripped between first end portion 30 and the interior surface 73 of cap 52 as shown in FIG. 5.

The outer surface of plug 66 and interior surface 10 of shell 18 cooperate to define an annulus shaped space 73 therebetween in which the sleeve E is longitudinally movable when the sleeve has the interior surface 11 thereof in sliding engagement with plug 66.

Valve member G is of ring-shape configuration and is defined by an outer cylindrical surface 12, a forward ring-shaped surface 12a, and a rearward ring-shaped surface 12b. The second member portion 62 is defined by a first cylindrical surface 13, and a third portion 62a of the member C rearwardly of valve member G as viewed in FIG. 5 by a second cylindrical surface 16. In the drawings, the first and second surfaces 13 and 16 are shown as of the same diameter but this construction is not required. A longitudinal phantom line 64 is extended rearwardly in FIG. 6 from surface 11 to show that the diameter of surface 12 is less than the interior diameter of sleeve E.

The sleeve E as may best be seen in FIG. 6 has an internally, circumferentially extending recess 68 formed therein that on the ends thereof are defined by surfaces 68*a* and 68*b*. The surface 68*b* is defined on the forward surface of the valve seat F. The valve seat F as shown in FIGS. 5 and 6 has an internal cylindrical surface 70 that is radially spaced from the surface 16. The rearward end of the valve seat F is defined by an annulus-shaped surface 72. The valve member G has the surface 12*b* thereof, as may best be seen in FIGS. 5 and 6, extending inwardly and forwardly. As a result only a narrow ring-shaped portion of the valve member G is in sealing contact with the valve seat F when the reciprocating member is disposed as shown in FIG. 6.

The cylindrical side wall 18 has two longitudinally spaced internally positioned grooves 74 and 76 formed therein that are occupied by resilient sealing rings 78 and 80 that are at all times in pressure sealing contact with the exterior surface of the sleeve F. The plug 66 has inner and outer circumferentially extending grooves 82 and 84 formed therein that are occupied by resilient sealing rings 86 and 88. The sealing ring 86 is at all times in slidable sealing contact with the surface 13 of reciprocating member C. The sealing ring 88 is likewise at all times in slidable sealing contact with the interior surface 11 of sleeve E as may be seen in FIGS. 5 and 6. Partition 40 has a circumferentially extending groove 90 projecting outwardly from the opening 42, and this groove being occupied by a resilient sealing ring 92 that is at all times in slidable sealing contact with the surface 16 of reciprocating member C. A transverse port 94 is formed in the rearward portion of the reciprocating member C as viewed in FIG. 5 to at all times maintain communication between the compartment 44 and recess 46, particularly when the reciprocating member is in the second position illustrated in FIG. 1.

The source for the hydraulic fluids H-1 and H-2 is shown in FIG. 7. A prime mover 96 is provided that by rotatable transmission means 90 drives a pump 100. The pump 100 has the suction line 102 thereof connected to an oil reservoir 104. The discharge line 106 of the pump is connected to a constant pressure outlet valve 108 that discharges hydraulic fluid H-1 through a conduit 24 to the bore 20 on shell 18 when mechanism M is operating. Hydraulic fluid flowing to the conduit 106 flows through the valve 108 and is returned to the reservoir 104 by a conduit 110 when mechanism M is not operating. The conduit 26 is connected to the boss 22 and extends to a tee or other suitable fitting 112 that is connected by a conduit 114 to an accumulator 116. The fitting 112 is also connected to a pressure relief valve 118, which valve has the outlet therefrom connected to a conduit 110 by a conduit 120. The accumulator 116 and valve 118 cooperate to maintain a back pressure P-2 on the fluid H-2.

The operation of the device is as follows. In describing the operation of the mechanism M it is convenient to consider certain components thereof as defining particular areas of different magnitude that are exposed to the action of the fluids H-1 and H-2. These fluids will normally be identical in composition, and are only referred to by the notation H-1 and H-2 to clarify the operation of the device. The forward face 12a of the valve member G, between the surface 12 and 13, defines a ring - shaped area that is referred to in the following description by the notation A-1.

A ring-shaped area A-2 is defined on the forward face of the valve seat G that is a projection of the cylindrical surface 12 as well as the phantom line extension 64 thereon. A ring-shaped portion of the surface 72 on the valve member F between the surface 10 and the phantom line 64 is referred to as area A-3.

The ring-shaped face 50 and the face 48 on the rearward end of the reciprocating member C cooperate to provide an area A-4 that is exposed to the pressure P-4 of the gas head in the compartment D. The shape and size of the valve member G may vary from that shown in FIGS. 5 and 6, but increasing the depth of the valve member will only result in a subtraction of the opposing forces produced by the fluid H-2 at pressure P-2 and add a like force to be exerted on the sleeve E at the valve seat F thereon. When the prime mover 96 is operating, the pump 100 is driven and fluid H-1 is supplied to a circumferentially extending recess 122 in the interior of the shell 18 as shown in FIG. 5, which recess is situated between the sealing rings 74 and 76. The sleeve E has a number of circumferentially spaced radially extending ports 124 formed therein as shown in FIGS. 1 and 2 that are at all times in communication with the recess 122 and areas A-1 and A-2. When no hydraulic fluid H-1 is being furnished at a pressure P-1 to the conduit 24, the gas head in the compartment 44 and recess 46 will exert a force on the area A-4 that disposes the reciprocating member C in the first position shown in FIG. 6.

The pressures involved in actuating the mechanism M are substantially different in magnitude. In practice it has been found to operate satisfactorily when the pressure P-1 is 1,000 p.s.i., and the pressure P-2 is 150 p.s.i. The pressure P-3 may be that of the ambient atmosphere, and the pressure P-4, the precharge of the nitrogen in the compartment 44 and 46, may be 765 p.s.i. These pressures are stated merely for the purpose of illustration, and in no sense as a limitation on the pressures involved in the actuation of the device. It will be apparent that either a negative or positive pressure P-3 may be provided, and that the negative pressure would be supplied by a vacuum producing device, and the positive pressure by a body of oil that is maintained at a low pressure. Variations in the magnitude of the four pressures involved will obviously have an appreciable effect on the force at which the member C is reciprocated, and the work produced by the member C as it moves from the second position shown in FIG. 1 to the first position illustrated in FIG. 6.

In FIG. 6, when the reciprocating member C is in the second position it will be seen that a force A-3 times P-2 is exerted on the sleeve E tending to move it to the left, while a force A-2 times P-1 minus P-2 tends to move the sleeve to the right. The force P-3 is that of the ambient atmosphere, and remains constant as the sleeve E is alternately moved longitudinally in the mechanism M. Also, to hold the valve member G in sealing contact with the valve seat F, the force A-3 times P-2 must be greater than the force A-2 times P-1 minus P-2. The forces acting on the valve member F are A-4 times P-4 that tend to move the reciprocating member C to the left, and a force A-1 times P-1 tends to move the reciprocating member C to the right. Here A-1 times P-1 must be greater than A-4 times P-4, plus the forces previously described, since the reciprocating member C must move to the right against these forces too. Also, opposing this movement is P-2 times the area of the surface 12*b* on the valve member G between the surface 12 and 16.

The above described forces result in the valve member C moving from the first position shown in FIG. 6 to the second position illustrated in FIG. 1. When the valve member C is stopped due to the surface 50 contacting the interior surface of the end piece 34, the pressure P-1 increases by demand so that the force A-3 times P-2 on valve seat F is less than the pressure A-2 times P-1 minus P-2 thereon, and the seal between the valve member G and valve seat F is broken by relative movement of the valve seat to the valve member. The reciprocating member C is then released with a force that is equal to the area A-4 times the pressure P-4. Since there is little or no change in displacement in the housing assembly B during this operation, the resistance to this movement of the reciprocating member C to the left is that of the friction of the moving parts and seals. Accordingly, there is high velocity movement of the reciprocating member C to the left that may be utilized to produce useful work or impact on a tool mounted on housing assembly B. However, regardless of how the reciprocating member C is stopped, the action is the same for returning the reciprocating member C from the first position shown in FIG. 6 to the second position illustrated in FIG. 1. In FIG. 5, the reciprocating member C is depicted as being stopped by the surface 64 thereof contacting the surface 58 of the cap 52.

The force acting on the valve seat F when the sleeve E is moving to the left is A-3 times P-2 minus A-2 times P-1, and the velocity of movement is controlled by rate of input of liquid H-1 into housing assembly B. The continued movement of the sleeve E to the left results in the positioning of the reciprocating member C as shown in FIG. 6. The energy providing means D is illustrated in the drawing as being a precharge of inert gas such as nitrogen or the like that is admitted into the compartment 44 and recess 46 by use of the valve 38, which may be located in any convenient portion of the rearward part of the housing assembly B so long as it is to the right of the partition 40 as viewed in FIGS. 5 and 6. The reciprocating member C may be used for any desired work producing purpose. For instance, if desired, an internally threaded tool T may be mounted on threads 126 formed on the cap 52 and the extreme left end of the reciprocating member C (not shown) impacting on the interior of the tool to accomplish a desired result.

The use and operation of the mechanism has been previously described in detail and need not be repeated.

I claim:

1. In a work-producing mechanism having a hollow housing defined by first and second ends and connecting sidewall means and an elongate work producing member slidably supported in said housing, with a first portion of said member projecting outwardly through an opening in said first end, the improvement for causing said member to automatically reciprocate between first and second positions in said housing by first, second and third fluids, said first fluid being pressurized by means exterior of said housing that is in communication with the interior of said housing through a first passage in said sidewall, said means on demand supplying said first fluid to said housing at a first pressure, back pressure means that maintain said second fluid in said housing until a second pressure is reached on said second fluid whereupon said second fluid is discharged from said housing, said second pressure being less than said first pressure, said improvement comprising:

a. potential energy generating means that at all times tend to maintain said member in a first position where said first portion is of maximum length;

b. a cylindrical sleeve slidably supported for longitudinal movement in said housing, said sleeve having first and second ends and an inner cylindrical surface, with said sleeve extending around said member in said housing, and said sleeve having at least one transverse opening therein that is at all times in communication with said first fluid passage;

c. a ring-shaped valve member that projects outwardly from said member and is at all times disposed in said sleeve and in communication with said opening therein;

d. a ring-shaped valve seat that extends inwardly from said second end of said sleeve, with the external diameter of said valve member greater than the internal diameter of said seat, and said valve member and valve seat when said elongate member is in said first position capable of being in sealing contact;

e. first means for maintaining said third fluid at a third pressure in communication with said first end of said sleeve, said third pressure being less than said first pressure, said first fluid after said member has moved to said first position and said valve member and valve seat are in sealing contact exerting a sufficient force on first and second ring-shaped areas defined on said valve member and valve seat as to move said elongate member and valve member towards said second position against the force offered by said potential energy generating means and the force exerted by said second fluid on a third ring-shaped area defined on said valve seat, with said force exerted by said second fluid on said third area being greater than the force exerted by said first fluid on said second area as the movement of said elongate member towards said second position takes place to maintain said valve member and valve seat in sealing contact, and the force exerted by said first fluid on said second area being greater than the force exerted by said second fluid on said third area after said second position is reached to break the seal between said valve member and valve seat to momentarily allow the pressure on said first fluid to drop to said second pressure whereupon said potential energy generating means drives said member from said second to said first position at high velocity, with said sleeve and valve seat thereafter moving towards said first end for said valve seat to seal with said valve member due to the force exerted by said second fluid on said third area being greater than the force exerted by said first fluid on said valve seat and the force exerted by said third fluid on said first end of said sleeve.

2. A work producing mechanism as defined in claim 1 in which said first and second fluids are first and second hydraulic liquids and said third fluid is air at the ambient atmosphere.

3. A work producing mechanism as defined in claim 1 in which said first and second fluids are first and second hydraulic liquids and said third fluid is maintained at a third pressure other than that of the ambient atmosphere and at a magnitude less than that of said second pressure.

4. A work producing mechanism as defined in claim 1 in which said potential energy providing means is a charge of pressurized gas so operatively associated with said housing assembly as to all times tend to move said reciprocating member from said second to said first position.

5. A work producing mechanism as defined in claim 4 which in addition includes:

f. a transverse partition that extends across said sidewall means intermediate said first and second ends, said partition having an opening therein axially aligned with said opening in said first end, said opening in said partition slidably engaged by said reciprocating member, and said second end, partition, and portions of said reciprocating member and sidewall means cooperating to define a compartment in which said charge of pressurized gas is contained.

6. A work producing mechanism as defined in claim 5 in which said elongate member has a longitudinal recess therein that is at all times in communication with said compartment and provides an extension thereof.

7. A work producing mechanism as defined in claim 1 which in addition includes:

g. an impact actuated tool mounted on said housing assembly to intermittently receive blows from said reciprocating member as said reciprocating member moves to said second position.

8. A work producing mechanism as defined in claim 1 which in addition includes:

f. a cylindrical plug that extends inwardly from said first end and slidably engages the interior surface of said sleeve and the exterior surface of said elongate member, with said plug, first end of said housing, a portion of the interior surface of said sidewall means and said first end of said sleeve cooperating to define an annulus-shaped confined space of variable volume in which said third fluid is contained, and said confined space at all times being in communication with a third transverse fluid passage formed in said sidewall means, and said third fluid being air at ambient pressure.

9. A work producing mechanism as defined in claim 8 which in addition includes:

g. a plurality of resilient sealing rings mounted in transverse circumferential grooves in the interior

surface of said sidewall means and the exterior and interior surfaces of said plug to prevent axial flow of said first fluid between said sidewall means and sleeve, the interior surface of said sleeve and the exterior surface of said plug, and the interior surface of said plug and exterior surface of said reciprocating member.

* * * * *