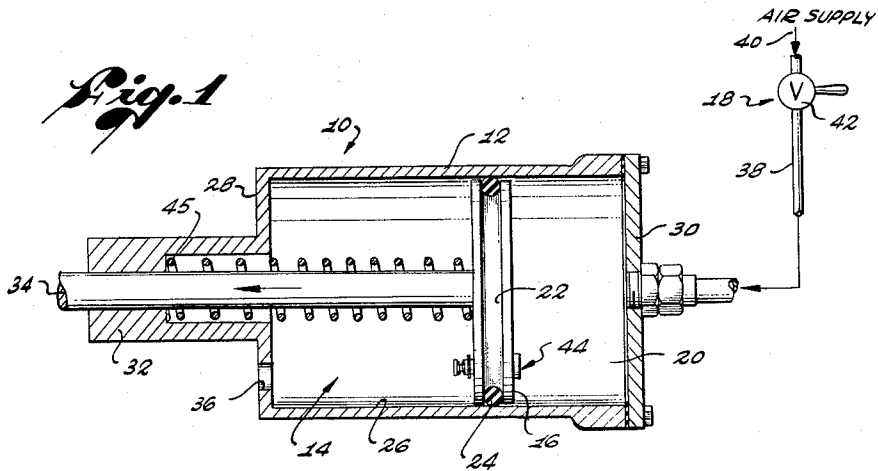
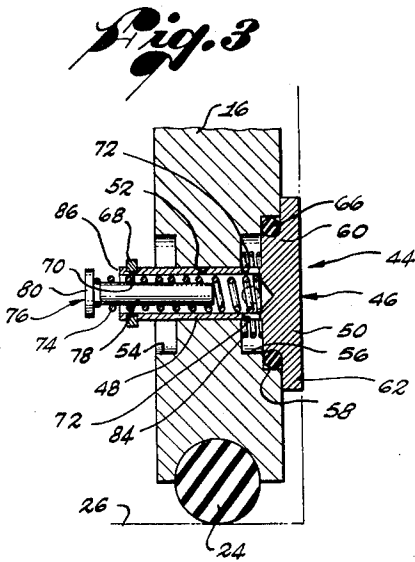
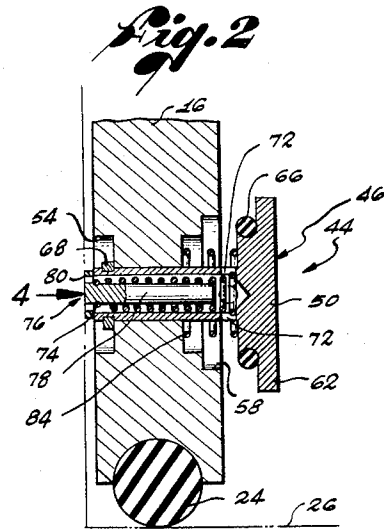
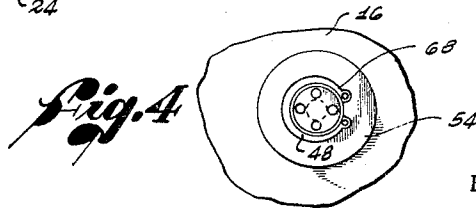


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S. H. CARPENTER
RECIPROCATING HYDRAULIC MOTOR

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INVENTOR.
SCOTT H. CARPENTER
BY *Forrest J. Lilly*
ATTORNEY

1

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RECIPROCATING HYDRAULIC MOTOR

Scott H. Carpenter, Whittier, Calif., assignor to
Donald E. Smiley, Pasadena, Calif.

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This invention relates generally to motors of the class which are powered by fluid pressure and particularly to a novel fluid powered reciprocating motor.

The reciprocating fluid motor of this invention is designed primarily, though not exclusively, for use in intermittently operated devices which require a motor capable of delivering one power stroke and one return stroke during each operation of the device. An example of such a device is a crimping tool for setting or crimping electrical terminals on the end of electrical leads. For instance, a typical fluid pressure operated crimping tool of this type is equipped with a socket for receiving an electrical terminal having one end of an electrical lead inserted therein, indenting jaws engageable with the terminal for tightly crimping the latter about the lead, and a reciprocating fluid motor for operating the jaws so that during the power stroke of the motor, the jaws are engaged with the terminal to crimp the latter and during the return stroke of the motor, the jaws are retracted to permit withdrawal of the crimped terminal.

In the past, various means have been employed for cycling fluid motors in this way, that is, for causing a fluid motor to deliver one power stroke and one return stroke during each operation of the motor.

A general object of this invention is to provide a reciprocating fluid motor embodying a new and improved cycling means for the purpose described.

Another object of the invention is to provide a fluid motor of the character described which is relatively simple in construction, economical to manufacture, reliable in operation, and otherwise ideally suited to its intended purposes.

Other objects, advantages, and features of the invention will become readily apparent to those skilled in the art as the description proceeds.

Briefly, the objects of the invention are attained by providing a reciprocating fluid motor equipped with a housing having a chamber containing a movable pressure wall sealed about its perimeter to the wall of the chamber and means for selectively admitting pressure fluid to the chamber space at one side of the wall to move the latter in its power stroke in the chamber.

According to the present invention, the movable pressure wall has a passage therethrough for venting pressure fluid from said chamber space and carries a novel cycling valve which, during the power stroke of the wall, is retained in seating engagement with a valve seat about the vent passage, to close the passage, by fluid pressure in the chamber space. The cycling valve is automatically opened to vent the chamber space at the end of the power stroke of the pressure wall, and the wall is thereafter returned to the opposite end of its stroke to condition the motor for the next operating cycle. The cycling valve is automatically returned to its closed position at the end of the return stroke of the pressure wall. The invention resides primarily in the unique construction of the cycling valve and its operating means, whereby the valve is opened at the end of the power stroke of the pressure wall, retained open during the return stroke of the wall, and reclosed at the end of the return stroke, thereby to enable the motor to operate in the manner described.

A better understanding of the invention may be had from the following detailed description of a presently preferred illustrative embodiment thereof and from the attached drawing, wherein:

2

FIG. 1 is a longitudinal section through a reciprocating fluid motor according to the invention illustrating the cycling valve of the motor in its closed or seated position;

FIG. 2 is an enlarged section through the cycling valve illustrating the latter in its open or unseated position;

FIG. 3 is a view similar to FIG. 2 with the cycling valve in its seated position; and

FIG. 4 is an enlarged view looking in the direction of the arrow 4 in FIG. 2.

The reciprocating fluid motor 10 illustrated in this drawing comprises a generally conventional basic reciprocating fluid motor structure including a housing 12 containing a chamber 14, a movable pressure wall 16 within and sealed about its perimeter to the wall of the chamber 14, and a means 18 for selectively admitting pressure fluid to the chamber space 20 at the right-hand movement of the pressure wall in the chamber. For convenience, the housing 12 is shown to be a cylinder and the pressure wall 16 is shown to be a piston movable in the cylinder. About the perimeter of this piston is a groove 22 containing an O-ring 24 which provides a fluid seal between the piston and the internal wall 26 of the cylinder.

Cylinder 12 is closed at its ends by end walls 28 and 30. Extending coaxially from the pressure wall or piston 16 and through a bearing 32 in the cylinder end wall 28 is a piston rod 34. A vent passage 36 also extends through the end wall 28 to communicate the chamber or cylinder space at the left of the piston 16 to atmosphere.

Pressure fluid admission means 18 comprises a fluid line 38 which communicates at one end to a pressure fluid supply 40. The other end of the fluid line 38 communicates to the cylinder space 20 at the right-hand side of the piston 16. In the fluid line 38 is a simple two-position manual valve 42. In one position, this valve is open to admit pressure fluid from the supply 40 to the cylinder space 20. In its other position, valve 42 is closed to cut off admission of pressure fluid to the cylinder.

At this point, then, it is evident that if we assume the piston 16 to be located at the right-hand end of its stroke in the cylinder 12, admission of pressure fluid to the cylinder space 20, by operation of the valve 42 to its open position, moves the piston and its rod 34 to the left in the cylinder. This left-hand stroke of the piston is hereinafter referred to as its power stroke. The opposite or right-hand stroke of the piston is referred to as its return stroke.

According to the present invention, the pressure wall or piston 16 carries a cycling valve assembly 44 which is opened automatically at the end of the power stroke of the piston to vent pressure fluid from the cylinder space 20. The piston is then driven to the right in its return stroke by means 45, as will be explained shortly.

Referring now particularly to FIGS. 2-4, the cycling valve assembly 44 of this invention will be seen to comprise a valve 46 including a cylindrical stem 48 and an enlarged valve head or disc 50 on one end of the stem. Extending through the piston 16, normal to the plane thereof, is a bore 52 in which the valve stem 48 is slidably received. The left-hand end of the bore 52 is counterbored at 54. The right-hand end of the bore 52 is counterbored at 56 and is counterbored again, to a somewhat larger diameter, at 58. The valve head 50 is located within the cylinder space 20 so as to be exposed to fluid pressure in this space. The valve head includes an inner cylindrical shoulder 60 having an external diameter somewhat smaller than the diameter of the counterbore 58 and an outer cylindrical flange 62 having an outer diameter somewhat greater than the diameter of the latter counterbore. The axial dimension of the shoulder 60 of the valve head 50 is equal to or slightly less than the axial dimension of the counterbore 58.

About the perimeter of the shoulder 60 is an arcuate groove containing an O-ring 66.

When the valve 46 occupies its closed or seated position of FIG. 3, the cylindrical shoulder 60 is received within the counterbore 58 and the O-ring 66 engages the walls of this counterbore to form a fluid seal between the valve and the piston 16. The flange 62 of the valve head seats against the right-hand face of the piston 16 to limit left-hand movement of the valve relative to the piston. When the valve 46 occupies its open or unseated position of FIG. 2, the valve head shoulder 60 is retracted a distance to the right out of the counterbore 58 so that an annular flow space exists between the valve head 50 and the piston 16. Right-hand opening movement of the valve 46 relative to the piston 16 is limited by engagement of a snap ring 68 on the valve stem 48 with the bottom wall of the counterbore 54.

Extending axially into the left-hand end of the valve stem 48 is a bore 70. Radially through the annular wall of the valve stem 48, immediately adjacent the shoulder 60 of the valve head 50, are a series of ports 72 which open to the right-hand end of the valve stem bore 70. It is evident from FIG. 2 that when the valve 46 occupies its unseated position, bore 70 and ports 72 in the valve stem 48 define a passage through the piston 16 which communicates the cylinder space 20 at the right-hand side of the piston to the cylinder space at the left-hand side of the piston. The cylinder space 20 is thereby vented to atmosphere through the passage 70, 72 and the passage 36 in the left-hand cylinder end wall 28. When the cycling valve is closed, the passage 70, 72 through the piston 16 is sealed by engagement of the O-ring 66 on the valve with the walls of the counterbore 58. These counterbore walls, therefore, provide a valve seat about the latter passage for seating engagement by the cycling valve.

According to the present invention, the valve 46 is retained in its seated position of FIG. 3 by the force of fluid pressure in the cylinder space 20 during the power stroke of the piston 16 and is automatically unseated to vent pressure fluid from the cylinder space 20 to atmosphere at the left-hand end of the power stroke. During the return stroke of the piston, the valve 46 is releasably retained in its unseated position to continuously vent the cylinder space 20 to atmosphere. The valve is then returned to its seated position at the right-hand end of the return stroke. A primary feature of the invention resides in novel means whereby such automatic operation of the cycling valve is accomplished. These means will now be described.

Positioned within the valve stem bore 70 is a coil spring 74 which seats at its right-hand end against the right-hand end wall of the bore. In its normal undeformed condition, the axial length of the coil spring 74 is somewhat greater than the depth of the bore 70 so that the left-hand end of the spring normally protrudes from the open left-hand end of the bore, as shown. A plunger 76 has a stem 78 which extends coaxially through the coil spring 74. On the outer, left-hand end of this plunger is an enlarged head 80, the diameter of which is somewhat greater than the diameter of the bore 70 in the valve stem 48. The left end of spring 74 is secured to the plunger stem 78 adjacent the plunger head 80 and the right end of the spring is secured to the valve stem 48 adjacent the closed end of bore 70 by engagement of coils of the spring in grooves in the plunger stem and valve stem, as shown. At a position near the left-hand end of the power stroke of the piston 16, the plunger 76 contacts the left-hand end wall 28 of the cylinder 12 to cause unseating of the cycling valve 46. During the subsequent right-hand return stroke of the piston, the valve 46 is releasably retained in its unseated position by means 84. In the illustrative embodiment of the invention, means 84 comprises a simple coil spring encircling

the valve stem 48 between the bottom wall of the counterbore 56 and the left-hand face of the valve head 50. This spring, then, acts to urge the valve 46 toward its unseated position of FIG. 2. The force of spring 84 when compressed as in FIG. 3, however, is insufficient to unseat the valve 46 against the fluid pressure normally existing in cylinder space 20 during the power stroke of the piston. For reasons to be discussed presently, spring 84 has a lower spring rate than the plunger spring 74.

In describing the operation of the illustrated fluid motor 10, it will be assumed that the piston 16 is initially located at the right-hand end of its return stroke and the cycling valve 46 occupies its closed or seated position of FIG. 3. To initiate operation of the motor, manual valve 42 is shifted to its open position to admit pressure fluid from the supply 40 to the cylinder space 20 at the right-hand side of the piston 16. The pressure of this fluid retains the cycling valve in its seated position and drives the piston to the left in its power stroke. Piston 16 eventually reaches a position near the left-hand end of its power stroke where the plunger 76 of the cycling valve engages the left-hand end wall 28 of the cylinder 12. Continued left-hand movement of the piston 16 beyond this position initially depresses the plunger 76 into the valve stem bore 70, thereby compressing the plunger spring 74, and finally engages the enlarged head 80 on the plunger with the end face 86 of the valve stem 48, thereby providing a positive connection between the plunger 76 and the valve 46.

At this point, it is evident that during the terminal portion of the power stroke of piston 16, the cycling valve 46 is subjected initially to a resilient right-hand unseating force produced conjointly by the compressed plunger spring 74 and the compressed valve spring 84 and thereafter, upon engagement of the plunger head 80 with the valve stem end face 86, to a positive right-hand unseating force. Plunger spring 74 is selected to have a spring rate such that substantially complete compression of the spring, that is, compression sufficient to bring the plunger head 80 close to the end face 86 of the valve stem 48, or actual contact of the head with the valve stem to produce a positive unseating force on the cycling valve 46, is required to displace the latter from its seat against the force of the fluid pressure existing in cylinder space 20 during the power stroke of the piston. Immediately upon initial separation of the valve 46 from its seat, pressure fluid escapes past the partially unseated valve to atmosphere through passages 70, 72 and 36. The selected spring rates of the springs 74 and 84 are such that the reduction in fluid pressure in cylinder space 20 occasioned by initial unseating of the valve 46 enables the springs to override the reduced fluid pressure force on the valve and thereby abruptly thrust the latter to its fully open position of FIG. 2. Maximum venting of pressure fluid from the cylinder space 20 then occurs, and the cylinder pressure drops to and remains at some minimum level as long as the manual valve 42 is retained in its open position.

According to the preferred practice of the invention, the force exerted on the piston 16 by the piston return spring 45 is insufficient to return the piston to the right against this minimum cylinder pressure. Accordingly, the piston remains at the left-hand end of its stroke as long as valve 42 is retained open to admit pressure fluid to the motor. To effect right-hand return movement of the piston, it is necessary for the operator to reclose the valve 42 and thereby cut off the admission of pressure fluid to the motor. The operator of the tool is afforded with two signals indicating that the piston has reached the left-hand limit of its power stroke. One of these signals is the thump which occurs when the piston bottoms against the left-hand end wall 28 of the cylinder 12. This thump can be both heard and felt by the operator. The second signal is the hiss generated by pressure fluid escaping through the vent passage 36 in the end wall 28.

5

When movement of the piston 16 to the left-hand limit of its power stroke is thus signaled to the operator, he recloses the valve 42. Continued escape of pressure fluid from the cylinder space 20 now results in a further reduction of the fluid pressure in the cylinder to atmospheric pressure, thereby enabling the cylinder return spring 45 to drive the piston in its right-hand return stroke.

In order to permit return of the piston 16 to the right-hand end of its return stroke, it is necessary that the cycling valve 46 remain open throughout the entire return stroke. During such return stroke, of course, the plunger 76 of the cycling valve moves out of engagement with the cylinder end wall 28 so that the right-hand unseating force of the plunger spring 74 on the cycling valve 46 is relieved. The valve spring 84, however, remains effective to retain the valve unseated during return of the piston.

When the piston 16 nears the right-hand end of its return stroke, the valve head 50 contacts the right-hand cylinder end wall 30 so that continued return movement of the piston, under the action of the return spring 45, reseats the valve 46 to reclose the vent passage 70, 72 through the piston. The return spring 45 retains the piston 16 at the right-hand end of its return stroke, and thereby retains the cycling valve 46 in its closed or seated position, until the manual valve 42 is re-opened to initiate the next cycle of operation of the motor. During this next cycle, the piston 16 is again driven to the left in its power stroke and the cycling valve 46 is retained in its seated position by the fluid pressure in cylinder space 20.

The use of two springs, to wit, springs 74 and 84, in the present cycling valve assembly 44 constitutes a highly important feature of the invention. Thus, assume first that the spring 84 is omitted. In this case, the cycling valve 46 would be unseated at the left-hand end of the power stroke of piston 16 in the same manner as described above. However, during the return stroke of the piston, there would be no force on the cycling valve to retain the latter unseated so that the slight fluid pressure existing in the cylinder space 20 during such return stroke would reseat the valve and thereby prevent return movement of the piston. On the other hand, assume that the spring 74 and plunger 76 are omitted so that at the left-hand end of the power stroke of the piston, the valve stem 48 directly contacts the cylinder end wall 28 to unseat the cycling valve. In this case, the remaining spring 84 would have to be selected to have a higher spring rate to fully open the cycling valve against the reduced pressure existing in the cylinder space 20 before closure of the manual valve 42. It was found that when such a single stronger spring 84 was employed on the cycling valve 46, the latter was prone to accidental unseating during the power stroke of the piston, with the result that the piston frequently stopped in its power stroke. According to the present invention, these difficulties are avoided by the use of the two springs 74 and 84 in the cycling valve assembly. Because two springs are employed, the plunger spring 74 can be selected to have a relatively high spring rate sufficient to fully open the cycling valve 46 against the fluid pressure existing in cylinder space 20 prior to closing of the manual valve 42 and the spring 84 can be selected to have a relatively low spring rate just sufficient to retain the cycling valve unseated during the return stroke of the piston without causing accidental unseating of the valve during the power stroke of the piston.

Various modifications of the cycling valve structure are possible, of course, within the spirit and scope of the invention. For example, spring 74 and plunger 76 of cycling valve assembly 44 may be designed to fit about rather than within the valve stem 48. Also, means other than a spring may be provided to drive the piston in its return stroke.

6

Clearly, therefore, the invention herein described and illustrated is fully capable of attaining the several objects and advantages preliminarily set forth.

I claim:

1. A fluid motor comprising:

a housing having a chamber therein,
a movable pressure wall within said chamber and sealed about its perimeter to said housing,

means for selectively admitting pressure fluid to the chamber space at one side of said wall for moving the latter in one direction in the chamber,
said wall having a passage therethrough for venting pressure fluid from said space and a valve seat about said passage,

a valve carried by said wall so as to be held in seating engagement with said valve seat by fluid pressure in said space, thereby to close said passage,

coacting means on said housing and valve for unseating the latter from said valve seat to open said passage and vent said space upon movement of said wall in one direction in said chamber to a given position,

said coacting means including a resilient means which is deformed during terminal movement of said wall to said position to yieldably urge said valve from said valve seat after initial unseating of the valve,

means for returning said wall in the opposite direction in said chamber,

means for retaining said valve unseated during return movement of said wall, and

means for reseating said valve on said valve seat upon return movement of said wall to a given position in said chamber.

2. A fluid motor according to claim 1 wherein:

said resilient means comprises a first spring and said valve retaining means comprises a second spring.

3. A fluid motor according to claim 1 wherein:

said resilient means comprises a first spring and said valve retaining means comprises a second spring having a lower spring rate than said first spring.

4. A fluid motor according to claim 1 wherein:

said resilient means comprises a spring carried by said valve.

5. A fluid motor according to claim 1 wherein:

said housing is a cylinder and said pressure wall is a piston movable in said cylinder.

6. A fluid motor comprising:

a cylinder,

a piston movable in said cylinder,

means for selectively admitting pressure fluid to the interior cylinder space at one side of said piston to move the latter in one direction in the cylinder,

a valve carried by said piston including a stem extending slidably through the piston and a valve head on one end of said stem within said space,

there being a passage through said piston for venting pressure fluid from said space and a valve seat about said passage against which said valve head is held by fluid pressure in said space, thereby to close said passage,

coacting means on said cylinder and the other end of said valve stem for unseating said valve head from said valve seat to open said passage and vent said space upon movement of said piston in one direction in said cylinder to a given position,

said coacting means including a first spring which is compressed between said cylinder and valve stem during terminal movement of said piston to urge said valve head from said valve seat after initial unseating of the valve head,

means for returning said piston in the opposite direction in said cylinder,

a second spring acting between said piston and valve for retaining said valve head unseated during return movement of said piston, and

said valve head being reseated on said valve seat by

engagement with said cylinder during return movement of said piston.

7. A fluid motor according to claim 6 wherein: said second spring has a lower spring rate than said first spring.

8. A fluid motor according to claim 6 wherein: said first spring is carried by said valve stem.

9. A fluid motor comprising:
 a cylinder,
 a piston movable in said cylinder,
 means for selectively admitting pressure fluid to the interior cylinder space at one side of said piston to move the latter in one direction in the cylinder,
 a valve carried by said piston including a stem extending slidably through the piston and a valve head on one end of said stem within said space,
 there being a passage through said piston for venting pressure fluid from said space and a valve seat about said passage against which said valve head is held by fluid pressure in said space, thereby to close said passage,
 a plunger carried by the other end of said valve stem for movement axially of the stem,
 a first spring actuating between said valve stem and plunger for urging the latter away from said valve head, whereby said spring is compressed by depression of said plunger toward said valve head,
 coacting shoulder means on said valve stem and plunger for positively limiting depression of the plunger toward said valve head,
 said cylinder including means engageable with said plunger during movement of said piston in one direction in said cylinder, whereby said spring is initially compressed and said shoulder means are subsequently engaged to positively unseat said valve head from said valve seat and thereby vent pressure fluid from said space through said passage during movement of the piston in said one direction, said spring urging said valve head from said valve seat after initial unseating of said valve head by engagement of said shoulder means,

means for returning said piston in the opposite direction in said cylinder,
 a second spring spacing between said piston and valve for retaining said valve head unseated during return movement of said piston, and
 said valve head being resealed on said valve seat by engagement with said cylinder during return movement of said piston.

10. A fluid motor according to claim 9 wherein: said plunger and spring are contained within a bore in said valve stem.

11. For use in a fluid motor of the character described:
 a piston,
 a valve including a stem extending slidably through said piston and a valve head on one end of said stem, there being a passage through said piston and a valve seat about said passage engageable by said valve head to close the passage upon movement of the valve head toward the piston,
 a first spring acting between said piston and valve for urging said valve head away from said valve seat.
 a plunger carried by the opposite end of said valve stem for movement axially of the stem, and
 a second spring acting between said valve stem and plunger for urging the latter away from said valve head, whereby said second spring is compressed by depression of said plunger toward said valve head.

12. The combination according to claim 11 including: coacting shoulder means on said valve stem and plunger for positively limiting depression of the latter toward said valve head.

13. The combination according to claim 11 wherein: said plunger and second spring are contained within a bore in said valve stem.

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