

[72] Inventor **Patrick W. Conolly**
11712 Appleton, Detroit, Mich. 48239
 [21] Appl. No. **792,584**
 [22] Filed **Jan. 21, 1969**
 [45] Patented **Feb. 2, 1971**

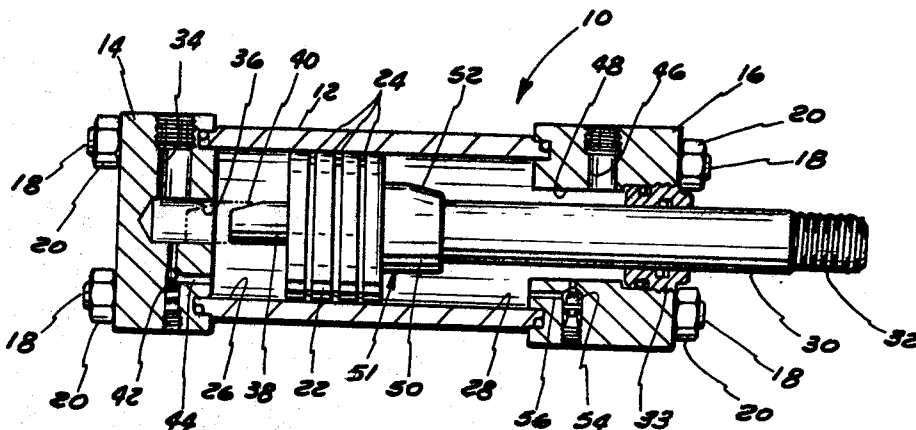
[56] **References Cited**
UNITED STATES PATENTS
 1,671,485 5/1928 Pukeruol 91/394
 3,008,454 11/1961 Wilkins 91/396
 3,247,767 4/1966 Aslon 91/396
 3,336,841 8/1967 Fontaine 91/396

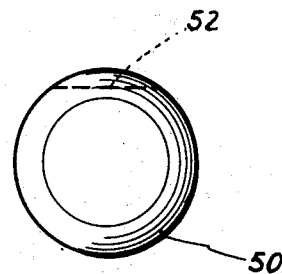
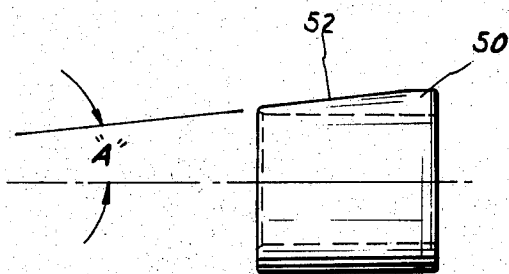
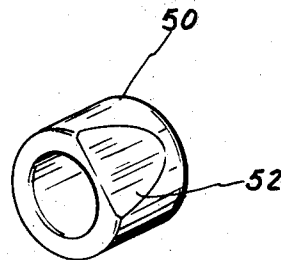
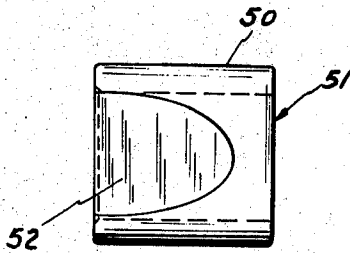
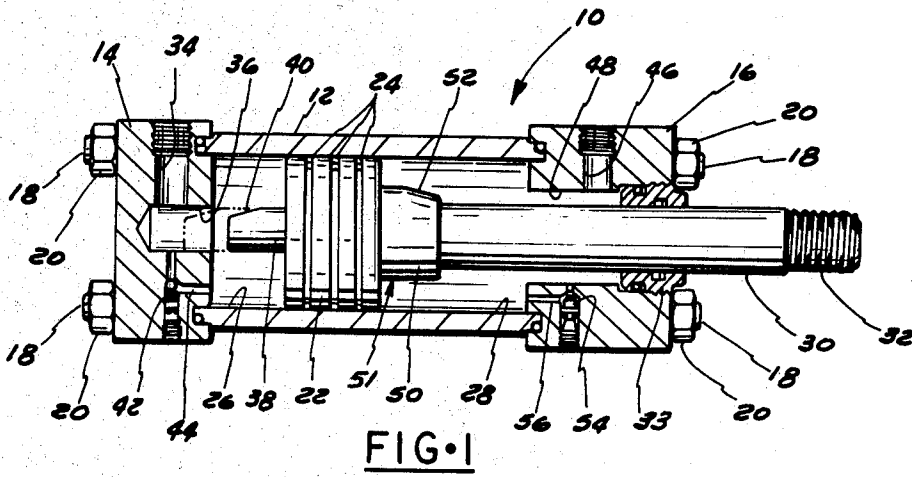
Primary Examiner—Paul E. Maslousky
Attorney—Hauke, Gifford and Patalidis

[54] **HYDRAULIC CYLINDER WITH CUSHIONED STROKE**
6 Claims, 5 Drawing Figs.

[52] U.S. Cl. 91/396,
 91/26
 [51] Int. Cl. F15b 15/22
 [50] Field of Search 91/396,
 395, 394, 26, 25

ABSTRACT: A piston and cylinder hydraulic actuator having a cushioning valve carried by the piston which is received into the fluid discharge port as the piston approaches the end of its stroke. The valve is formed with a flat which progressively restricts fluid discharge to gradually decelerate the piston's velocity.





INVENTOR
PATRICK W. CONNOLLY
BY

Hank Kross Gifford & Patalis
Attorneys

HYDRAULIC CYLINDER WITH CUSHIONED STROKE

BACKGROUND OF THE INVENTION

This invention relates to piston and cylinder fluid actuators, and more specifically to such an actuator having valve means for gradually reducing the piston's velocity relative to the cylinder as it approaches the end of its stroke.

DESCRIPTION OF THE PRIOR ART

A problem related to some commercial hydraulic actuators is that they do not provide adequate means for cushioning the piston's stroke so that the actuated components experience a repetitious shock as the piston is reciprocated. This is in part due to the relative incompressibility of hydraulic fluids and the rate which the piston discharges it from the cylinder.

One well known method for cushioning the piston's stroke of such actuators is to provide a valve that is carried by the piston and telescopically received into the cylinder's fluid discharge port as the piston approaches the end of its stroke. Either the valve or the port is tapered or provided with some other symmetrical configuration which progressively reduces the cross section of the discharge passage as the valve is received into the port. This progressive reduction of the fluid passage is intended to gradually restrict the fluid discharge rate and thereby decelerate the piston's motion as it approaches the end of its stroke. Such cushioning configurations are disclosed in U.S. Pat. Nos. 2,882,869, 2,949,096, and others.

The problem with such conventional valve configurations is related to the inherent expense of machining or otherwise forming close fitting valves and ports with tapered or other symmetrical configurations.

SUMMARY OF THE INVENTION

The broad purpose of the present invention is to provide a cushioning valve structure comprising a cylinder discharge port having a cylindrical bore which telescopically receives a valve carried by the piston. One end of the valve has a cross section that is complementary to the port so that in its fully closed position, the valve blocks fluid discharge through the port. A flat, formed along the side of the valve, is inclined relative to its reception into the port to progressively restrict fluid discharge as it approaches its fully closed position.

It is relatively inexpensive to machine a suitable flat on the head end of the piston rod in order to cushion one end of the piston stroke, and to machine a similar flat on a bushing mounted on the rod end of the piston to cushion the opposite end of the piston's stroke. The angle as well as the length of the flat defines the manner in which the piston's velocity is reduced. Either of these parameters can be established to provide a suitable cushioning action. Furthermore by exchanging the bushing with another having a flat of a different configuration, the cushioning characteristics of the actuator can be changed to accommodate the nature of the work that is being actuated.

The invention is particularly useful for hydraulic actuators as opposed to pneumatic actuators. This is because the compressibility of air often provides a suitable built-in cushion whereas the relative incompressibility of hydraulic fluids does not.

Still further objects and advantages of the present invention will become readily apparent to those skilled in the art to which the invention pertains upon reference to the following detailed description.

DESCRIPTION OF THE DRAWING

The description refers to the accompanying drawing in which like reference characters refer to like parts throughout the several views, and in which:

FIG. 1 is a longitudinal cross-sectional view of a hydraulic actuator illustrating a preferred embodiment of the present invention;

FIG. 2 is an enlarged view of a cushioning valve separated from the rod end of a piston;

FIG. 3 is a view of the bushing of FIG. 2 as seen from the lower side thereof;

FIG. 4 is a right end view of the bushing of FIG. 2; and

FIG. 5 is a perspective view of the preferred bushing.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring to the drawing, wherein a preferred fluid actuator 10 is illustrated in FIG. 1, and comprises a cylinder 12 having a head 14 mounted on one end, and a head 16 mounted on its other end. Tie rods 18 and fasteners 20 connect the two heads to the cylinder 12 to provide a unitary cylinder housing.

A piston 22, provided with rings 24, is slidably mounted in the cylinder 12 between the heads 14 and 16. The piston 22 internally divides the cylinder to form a fluid chamber 26 adjacent the head 14, and a fluid chamber 28 adjacent the head 16. A piston rod 30 extends from one end of the piston 22, and is telescopically supported by the head 16. The rod 30 has a threaded end 32 adapted for connection to a component that is to be moved relative to the cylinder 12. A packing gland 33 provides a sliding fluid seal between the rod 30 and the head 16.

The head 14 has a passage 34 and a port 36 connected to the chamber 26 for either introducing fluid into or discharging fluid from the chamber 26. The port 36 preferably has a cylindrical passage that is coaxial with the longitudinal axis of the cylinder 12.

A valve 38, carried with the piston 22, is telescopically received into the port 36 toward a closed position as the piston is moved toward head 14 to discharge fluid from chamber 26. The valve 38 preferably forms an integral extension of the piston rod 30 that projects beyond the head end of the piston 22. The valve 38 has a circular cross section adjacent the piston that is complementary to the internal cross section of the port 36. A flat 40 is machined along a longitudinal side of the valve 38 from its extreme end toward the piston. The flat 40 is formed at a predetermined angular relationship with respect to the axis of the piston rod so that as the valve 38 is received into the port 36 toward its closed position, it progressively reduces the cross section of the fluid passage through the port.

When the piston 22 is initially moved from its position adjacent head 16 toward the head 14, the fluid passage through the port 36 is unrestricted until the valve 38 commences to be received into the port 36. The velocity of the piston 22 is then progressively decelerated as the valve 38 gradually restricts fluid discharge through the port 36. When the valve 38 is fully closed so as to block fluid discharge through port 36, further motion of the piston 22 toward the head 14 is generally prevented by the fluid remaining in the chamber 26. When fluid is admitted to the passageway 34 to cause the piston 22 to be shifted rightwardly as viewed in FIG. 1, a ball check valve means 42 disposed in a bypass passage 44 permits the entire left hand side of the piston 22 to be exposed to the pressure in a manner which is well-known in the art and commonly used in such cylinders.

The head 16 also has a passage 46 for introducing fluid into or discharging fluid from the chamber 28 through a port 48. Port 48 also defines a cylindrical opening that is coaxial with the longitudinal axis of the cylinder 12. As the piston 22 is moved toward the head 16 to discharge fluid through port 48, fluid is normally introduced through the port 36 into the chamber 28 in a process that is reversed whenever the piston's motion is reversed. A valve 50 carried on the piston rod 30 adjacent the piston is telescopically received into the port 48 as the piston approaches head 16 to discharge fluid from chamber 28. The valve 50 is preferably formed of a bushing 51 having a cross section, adjacent the piston, that is complementary to the cross section of the port 48 so that as the piston closely approaches the head 16, the valve 50 is moved to a closed position in which it blocks fluid flow through the port

48. Bushing 51 is removable from the piston rod 30 and is normally maintained in position adjacent the piston 22 by any suitable means, such as a retainer ring, not shown, as is the common practice in similar commercially available cylinders.

As shown in FIGS. 2 to 4, a flat 52 is formed along the side of valve 50. The flat 52 is inclined with respect to the axis of the piston rod 30 so that as the valve 50 is received into the port 48, the cross section of the fluid discharge passage is progressively reduced thereby progressively restricting the rate fluid can be discharged from chamber 28. A spring-biased check valve means 54 disposed in a passage 56 permits the entry of fluid into the chamber 22 when it is desired to move the piston 22 in a leftward direction. Check valve means 54 functions in a manner similar to the check valve means 42 hereinbefore described.

As with valve 38, the flat 52 is machined in a configuration that provides the piston 22 with predetermined deceleration characteristics. Referring to FIG. 3, the length of the flat 52 together with the angle "A" it forms with the longitudinal axis of the valve determines the manner in which the valve restricts fluid discharge through the port 48. A different deceleration characteristic can be provided by changing either the angle or the length of the flat and thus, by providing several bushings 51, each having a flat with a different angle or length the deceleration characteristics of one cylinder may be varied to accommodate any application.

Thus it can be seen that I have described a novel piston and cylinder fluid actuator, which is of particular utility for cushioning the stroke of a hydraulic actuator because of the relative incompressibility of the working fluid of such actuators. A suitable flat can be machined on a cylindrical element for cushioning a piston stroke much easier than to form either a valve or a port with a symmetrical cross section to provide a similar restriction of fluid discharge through the discharge port.

I claim:

1. In a fluid actuator, the combination comprising:

- a. a cylinder having a head with a port for the discharge of a fluid from the cylinder;
- b. a piston slidably movable in the cylinder toward the head for discharging fluid through the port; and
- c. a valve carried with the piston so as to be telescopically received into the port toward a closed position as the piston is moved toward the head, the valve being formed with a flat surface inclined at a predetermined angular relationship relative to the direction of the valve's reception into the port to progressively restrict fluid discharge through the port as the valve is received therein toward its closed position so that the piston's velocity is progressively decelerated as it is moved toward the head, said valve

having a cross section complementary to the cross section of said port to block fluid flow through the port when said valve is in its closed position.

2. The combination as defined in claim 1, in which the cylinder has a second head longitudinally spaced with respect to the first mentioned head, and a port in the second head for the discharge of a fluid from the cylinder, the piston being movably disposed between the two heads to discharge fluid through the port in the second head as the piston is moved toward the second head, and including a second valve carried with the piston to be telescopically received into the port on the second head as the piston is moved toward the second head, the second valve having a flat surface formed so as to progressively reduce fluid discharge through the port in the second head as the piston is moved toward the second head whereby the piston's velocity is progressively decelerated as it approaches either end of its stroke, said second valve having a cross section complementary to the cross section of said port on said second head to block fluid flow through said last mentioned port when said second valve is in its closed position.

3. The combination as defined in claim 2 in which one of said valves is removably attached to said piston.

4. The combination as defined in claim 3 including a piston rod, said piston rod carrying said piston and extending from one side of said piston through one of said cylinder heads in a sliding engagement, said one of said valves being carried by said piston rod adjacent said one side of said piston.

5. The combination as defined in claim 1, in which the cylinder is adapted to receive a hydraulic fluid.

6. In a hydraulic actuator, the combination comprising:

- a. a cylinder having a head at each end thereof, each head having a port disposed on the axis of the cylinder for either introducing hydraulic fluid into or discharging hydraulic fluid from the cylinder;
- b. a piston slidably disposed in the cylinder between the heads for motion therebetween, the piston being operable to discharge fluid through the port of the head toward which the piston is moved; and
- c. a pair of valves carried on opposite sides of said piston, each valve being telescopically receivable toward a closed valves in the port of a head toward which the piston is being moved, and a flat formed on each valve at a predetermined inclination relative to the axis of the cylinder to progressively restrict fluid discharge through the port in which the valve is being received whereby the piston's velocity is decelerated at a predetermined rate as it approaches either of the heads, each of said valves having a cross section complementary to the cross section of its associated port to block fluid flow through its associated port when said valves are in their closed position.

55

60

65

70

75

UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,559,535 Dated February 2, 1971

Inventor(s) Patrick W. Connolly (VEC-122-A)

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

IN THE SPEC:

Col. 3, line 12 - change "22" to --28--

IN THE CLAIMS:

Col. 4, line 41, after "closed" delete "valves"
and insert --position-- therefore.

Signed and sealed this 8th day of June 1971.

(SEAL)
Attest:

EDWARD M. FLETCHER, JR.
Attesting Officer

WILLIAM E. SCHUYLER, JR.
Commissioner of Patents