

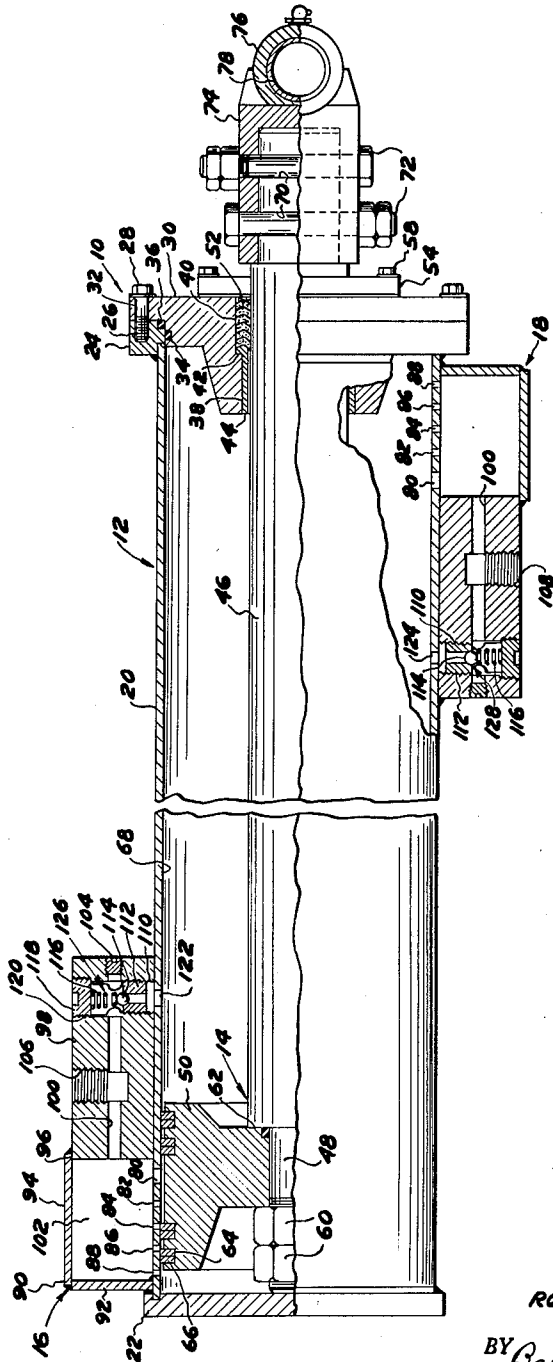
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CUSHIONED-STROKE RECIPROCATORY HYDRAULIC MOTOR

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1

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CUSHIONED-STROKE RECIPROCATORY HYDRAULIC MOTOR

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This invention relates to hydraulic motors and, in particular, to reciprocatory motors.

One object of this invention is to provide a reciprocatory hydraulic motor having a cushioning arrangement for retarding the speed of travel of the motor piston near either or both ends of its stroke, so as to eliminate the shock otherwise occurring at either or both ends of the stroke thereof.

Another object is to provide a cushioned-stroke reciprocatory hydraulic motor of the foregoing character wherein the retardation action is brought about by gradually restricting the discharge from the cylinder as the piston nears the end of its stroke, thereby effecting a gradual slowing down of the speed of the piston as it nears the end of its stroke.

Another object is to provide a cushioned-stroke reciprocatory hydraulic motor, as set forth in the preceding objects wherein the restricted discharge of fluid from the cylinder near the end of the piston stroke is brought by the provision of a plurality of bidirectional fluid flow ports arranged in sequence such that the piston during its travel will cover up these ports sequentially and thereby restrict the discharge of fluid from the cylinder in response to its own travel near the end of its stroke.

Another object is to provide a cushioned-stroke reciprocatory hydraulic motor, as set forth in the preceding object, wherein free discharge flow of hydraulic fluid is provided during the intermediate portions of the stroke of the piston away from either or both ends of the stroke, so that the mechanism operated by the hydraulic motor is actuated in a rapid and efficient manner throughout the major part of its stroke.

The figure shows a cushioned-stroke reciprocatory hydraulic motor with the upper half in central vertical section and the lower half mainly in side elevation, according to one form of the invention.

Referring to the drawing in detail, the figure shows a cushioned-stroke reciprocatory hydraulic motor, generally designated 10, according to one form of the invention as consisting generally of an elongated hydraulic cylinder 12 within which is reciprocably mounted a hydraulic piston 14, the stroke of which is cushioned near its opposite ends by stroke-cushioning devices, generally designated 16 and 18, of similar construction but oppositely-directed and therefore designated in detail with similar reference numerals. The cylinder 12 consists of an elongated tubular barrel portion 20 having an annularly-grooved cylinder head 22 welded to one end thereof in closing relationship therewith and with an annularly-rabbeted attachment ring 24 welded to its opposite end and provided with axially-directed circumferentially-spaced threaded holes 26.

Secured as by bolts or cap screws 28 to the attachment ring 24 of the cylinder 12 is a detachable cylinder head 30 provided with circumferentially-spaced holes 32 aligned with the threaded holes 26 for the passage of the cap screws 28. The attachment ring 24 and cylinder head 30 are suitably rabbeted or grooved to receive sealing gaskets or O-rings 34 and 36 in order to prevent leakage of hydraulic fluid during the operation of the motor 10. The detachable cylinder head 30 is provided with a central axial bore 38 terminating at its outer end in a counter-bore 40 separated therefrom by an annular shoulder 42.

2

Seated in the bore 38 and flanged to engage the annular shoulder 42 is a flanged piston rod bearing bushing 44 receiving sliding engagement of the piston rod 46 upon the reduced diameter portion 48 of which the piston head 50 of the piston 14 is mounted. In order to prevent leakage around the piston rod 46, a suitable packing 52 is provided in the counterbore 40 and adapted to be compressed by the annular gland 54 by means of the bolts 58 extending therethrough and threaded into the cylinder head 30.

The reduced diameter inner end portion 48 of the piston rod 46 is threaded to receive the retaining nut 60 by which the piston head 50 is held securely on the piston rod portion 48 against the annular shoulder 62 between it and the piston rod 46. The piston head 50 is grooved as at 64 to receive piston rings 66 for preventing leakage between the piston head 50 and the cylinder bore 68 within the cylinder barrel 20. The outer or external end of the piston rod 46 is provided with parallel transverse bores 70 adapted to receive transverse bolts 72 securing thereto a cup-shaped coupling member 74 drilled in alignment with the holes 70. The coupling member 74 in turn carries a transverse approximately cylindrical portion 76 bored transversely to receive a bearing bushing 78 which in turn pivotally engages a pivot pin (not shown) by which the piston rod 46 is operatively connected to the dump truck body or other load being moved.

Each stroke-cushioning device 16 or 18 includes a plurality of bidirectional fluid flow discharge ports 80, 82, 84, 86 and 88 which are preferably graduated in width and arranged in sequence in longitudinally-spaced relationship along the cylinder barrel 20 near the opposite ends thereof and adapted to be successively covered by the piston head 50 as it nears each end of its stroke. Thus, the first port 80 to be covered as the piston head 50 nears the end of its stroke is preferably wider than the remaining ports 82 to 88 inclusive so as to be of greater cross-sectional area for the purpose of graduating the discharge of hydraulic fluid. The term "bidirectional fluid flow" is used herein to mean permitting two-way flow of fluid through the ports 80 to 88, i.e. in opposite directions, in contradistinction to the unidirectional or one-way flow permitted through the ports 122 and 124 controlled by the unidirectional check valves 126 and 128 respectively.

Each set of ports 80 to 88 is covered by a valve casing 90 having a radial end wall 92 welded to the cylinder barrel 20 near its junction with the cylinder head 22 and an axial side wall 94 welded to the end wall 92 and to the cylinder barrel 20. The open end 96 of the valve casing 90 is closed by a closure member 98 having a longitudinal bore 100 therein opening into a chamber 102 adjacent the discharge ports 80 to 88 and closed at its outer end by a threaded plug 104. Intermediate its opposite ends the closure member 98 is provided with a transverse threaded service port 106 for the cushioning device 16 and 108 for the cushioning device 18.

The closure member 98 is provided near the outer end of each bore 100 with a transverse threaded check valve bore 110 into which is threaded a tubular ball check valve seat 112 against which a check valve ball 114 is urged by a compression spring 116, the outer end of which is seated against a screw plug 118 threaded into a counter-bore 120 coaxial with the bore 110. These ports collectively constitute the check valves 126 and 128 in the stroke cushioning devices 16 and 18. The cylinder barrel 20 adjacent each of the cushion devices 16 and 18 is provided with a radial port 122 or 124 registering with the bore 110 of its respective check valve 126 or 128, as the case may be.

In the operation of the invention, let it be assumed that the threaded ports 106 and 108 are connected to pipes leading to a conventional four-way control valve (not

shown) and thence respectively to a hydraulic pump or other suitable source of hydraulic pressure fluid (not shown) and a hydraulic fluid reservoir (not shown). Assuming the parts to be in the positions shown in the drawing, with the piston 14 fully retracted within the cylinder 12, to move the piston 14 outward and perform a working stroke, hydraulic pressure fluid is admitted to the service port 106 while the service port 108 is connected to discharge fluid into a suitable reservoir (not shown) by way of the four-way valve. Such reciprocatory hydraulic motor control circuits are well-known among those skilled in the hydraulics art and are beyond the scope of the present invention.

The hydraulic pressure fluid entering the service port 106 presses the ball 114 of the ball check valve 126 downward against its seat 112 and thereby prevents passage of any such fluid through the cylinder barrel port 122 into the cylinder bore 68 beyond the piston head 50. Accordingly, the hydraulic pressure fluid flows first through the port 88 of the cushioning device 16, and acts against the piston head 50 to push it to the right, thereby successively uncovering the remaining ports 86, 84, 82 and 80. With the enhanced flow of hydraulic pressure fluid into the left-hand end of the cylinder 12, the piston 14 gathers speed and performs the work intended for it while moving toward the detachable cylinder head 30.

Meanwhile, the hydraulic fluid behind or to the right of the piston head 50 is forced outward from that portion of the cylinder bore 68 to the right of the piston head 50 not only by passing out through the ports 80 to 88 of the cushioning device 18 and thence through the bore 100 and service port 108 to the reservoir but also through the port 124 and tubular valve seat 112 of the check valve 128, forcing the ball 114 thereof off its seat against the thrust of its respective spring 116, thereby additionally permitting fluid to flow through the left-hand end of the bore 100 into the service port 108 and thence back into the reservoir.

As the piston head 50 of the piston rod 14 nears the right-hand end of its stroke, it first covers the cylinder barrel port 124 and then successively covers the discharge ports 80, 82, 84, 86 and 88 of the cushioning device 18. The consequent gradual cutting off of discharge flow of hydraulic fluid by thus reducing the available discharge port area reduces the speed of the piston head 50 until it has substantially halted as it reaches the right-hand end of its stroke. Meanwhile, the uncovering of the cylinder port 124 by the travel of the piston head 50 to the right permits a portion of the pressure fluid to escape through the port 122 and tubular valve seat 112 of the check valve 128 after forcing the ball 114 thereof off its seat against the thrust of the spring 116, releasing this fluid also through the service port 108.

Reversal of the four-way valve (not shown) converts the service port 108 into a hydraulic pressure fluid supply port and the service port 106 into a hydraulic fluid discharge port, reversing the foregoing operation. As a result, pressure fluid is admitted through the service port 108, bore 100 and sequential ports 80 to 88 of the cushioning device 18 while hydraulic fluid is being discharged from the left-hand end of the cylinder 12 through the ports 80 to 88 of the cushioning device 16 and thence through the service port 106, as well as through the port 122 and tubular valve seat 112, forcing the check valve ball 114 of the check valve 126 temporarily off its seat to permit such flow. As the piston 50 moves to the left and reaches the ports 122 and 80 to 88 of the cushioning device 16, it successively covers them and, in the manner described above, gradually reduces the discharge flow and consequently reduces the speed of travel of the piston head 15 to the left, with the result that shock at the end of the stroke is substantially eliminated.

Also in the manner described above, the piston 50 again uncovers the check valve port 122 of the check valve 126

as it passes by, again permitting bypassing of the pressure fluid through the check valve 125 and service port 106 to the hydraulic fluid reservoir in the manner described above as occurring during the stroke of the piston 14 in the opposite direction.

What I claim is:

1. A cushioned-stroke reciprocatory hydraulic motor, comprising

a cylinder having a tubular cylinder barrel with a cylinder bore therein,

a piston reciprocably mounted in said cylinder barrel, said piston including a piston rod and a piston head on said piston rod engageable with said cylinder bore,

means for admitting hydraulic pressure fluid to said cylinder on one side of said piston head to move said piston along said cylinder,

and means disposed near one end of said cylinder barrel for gradually releasing hydraulic fluid from said cylinder barrel on the opposite side of said piston head, said fluid-releasing means including a first series of bidirectional fluid flow outlet ports in said cylinder barrel arranged in axially-spaced longitudinally-disposed relationship in said cylinder barrel and closed sequentially by said piston head in response to the travel of said piston head along said cylinder bore in one direction.

said fluid-releasing means also including a unidirectional fluid release valve disposed near said cylinder fluid outlet ports and opening outwardly from said cylinder barrel into said cylinder bore in bypassing relationship to said outlet ports.

2. A cushioned-stroke reciprocatory hydraulic motor, comprising

a cylinder having a tubular cylinder barrel with a cylinder bore therein,

a piston reciprocably mounted in said cylinder barrel, said piston including a piston rod and a piston head on said piston rod engageable with said cylinder bore,

means for admitting hydraulic pressure fluid to said cylinder on one side of said piston head to move said piston along said cylinder,

and means disposed near one end of said cylinder barrel for gradually releasing hydraulic fluid from said cylinder barrel on the opposite side of said piston head,

said fluid-releasing means including a first series of bidirectional fluid flow outlet ports in said cylinder barrel arranged in axially-spaced longitudinally-disposed relationship to said cylinder barrel and closed sequentially by said piston head in response to the travel of said piston head along said cylinder bore in one direction,

said fluid-releasing means also being disposed near the opposite end of said cylinder barrel and including a second series of bidirectional fluid flow outlet ports in said cylinder barrel also arranged in axially-spaced longitudinally-disposed relationship in said cylinder barrel but disposed remote from said first series of ports and also closed sequentially by said piston head in response to the travel of said piston head along said cylinder bore in the opposite direction to said one direction,

said fluid-releasing means also including a unidirectional fluid release valve disposed near the opposite ends of said cylinder near the first and second series of said fluid outlet ports and opening outwardly from said cylinder barrel into said cylinder bore in bypassing relationship to said outlet ports.

3. A cushioned-stroke reciprocatory hydraulic motor, comprising

5

a cylinder having a tubular cylinder barrel with a cylinder bore therein,
 a piston reciprocally mounted in said cylinder barrel,
 said piston including a piston rod and a piston head
 on said piston rod engageable with said cylinder bore, 5
 means for admitting hydraulic pressure fluid to said cylinder on one side of said piston head to move said piston along said cylinder,
 and means disposed near one end of said cylinder barrel 10
 for gradually releasing hydraulic fluid from said cylinder barrel on the opposite side of said piston head,
 said fluid-releasing means including a first series
 of bidirectional fluid flow outlet ports in said
 cylinder barrel arranged in axially-spaced longitudinally-disposed relationship in said cylinder 15
 barrel and closed sequentially by said piston head in response to the travel of said piston head along said cylinder bore in one direction,
 a valve casing with a chamber therein being secured 20
 to said cylinder barrel near said one end of said

6

cylinder with said outlet ports opening into said chamber,
 said fluid-releasing means also including a unidirectional fluid release valve disposed near said valve casing and opening outwardly from said cylinder barrel into said cylinder bore in bypassing relationship to said outlet ports.

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