Dec. 10, 1968 M. NADDELL 3,415,169

HYDRAULIC CYLINDER

Filed June 10, 1966 3 Sheets-Sheet 1

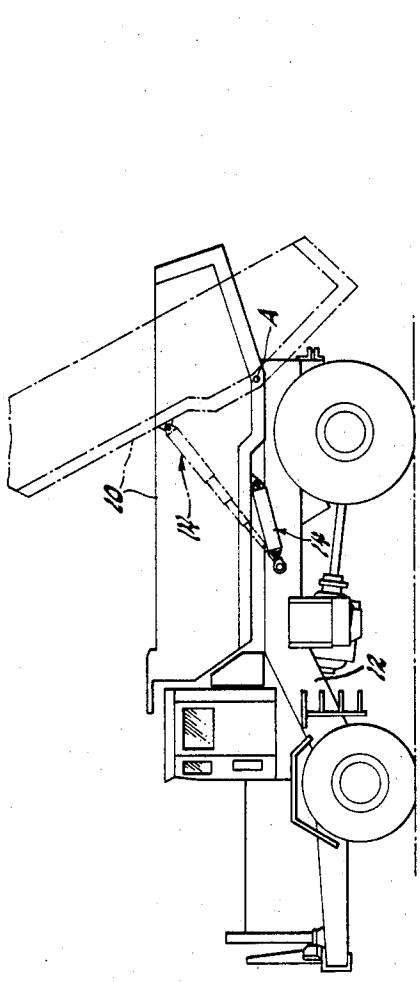


Fig. 1

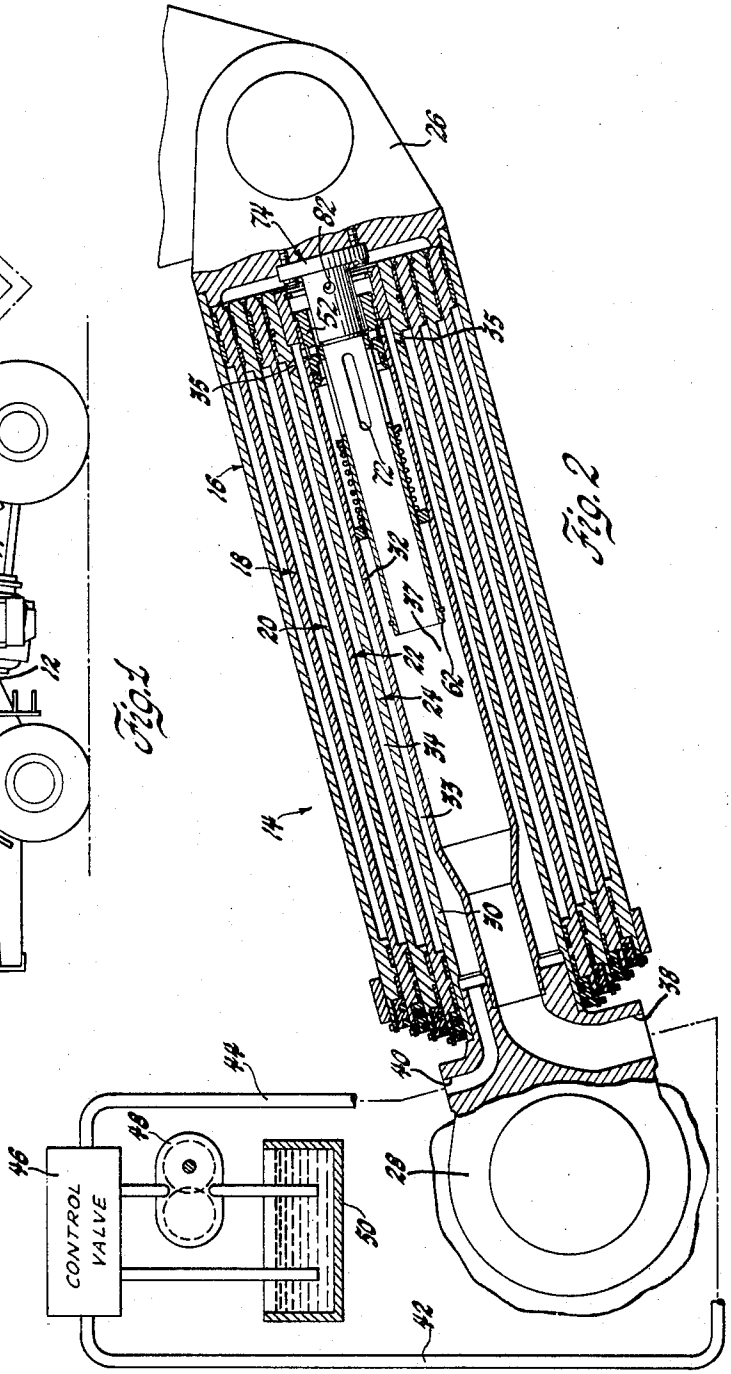


Fig. 2

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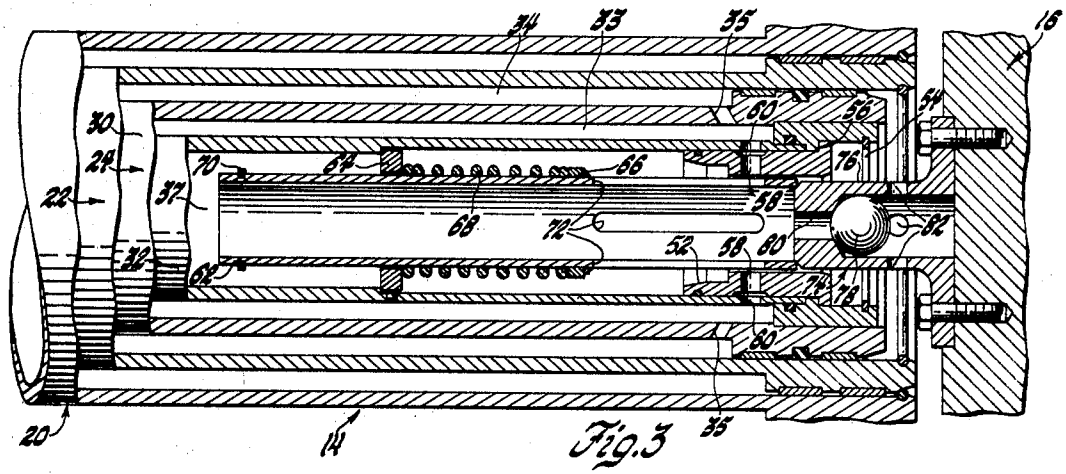


Fig. 3

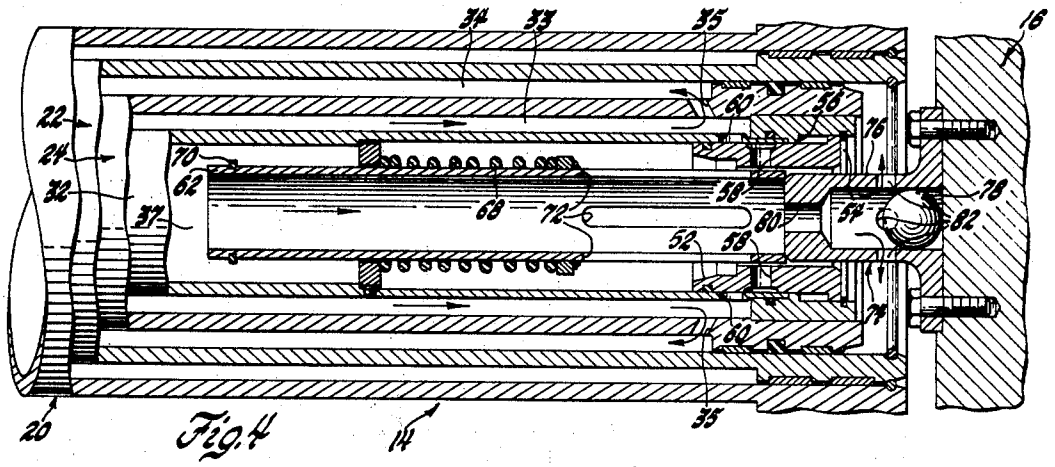


Fig. 4

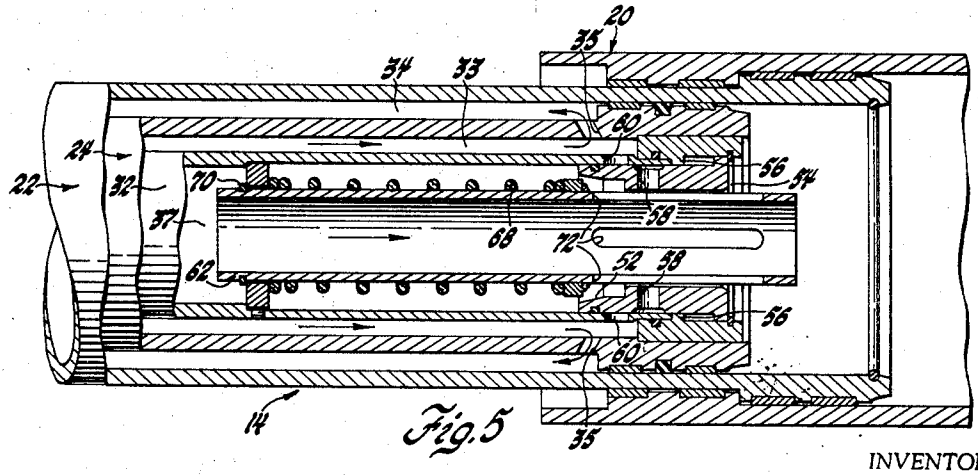


Fig. 5

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HYDRAULIC CYLINDER

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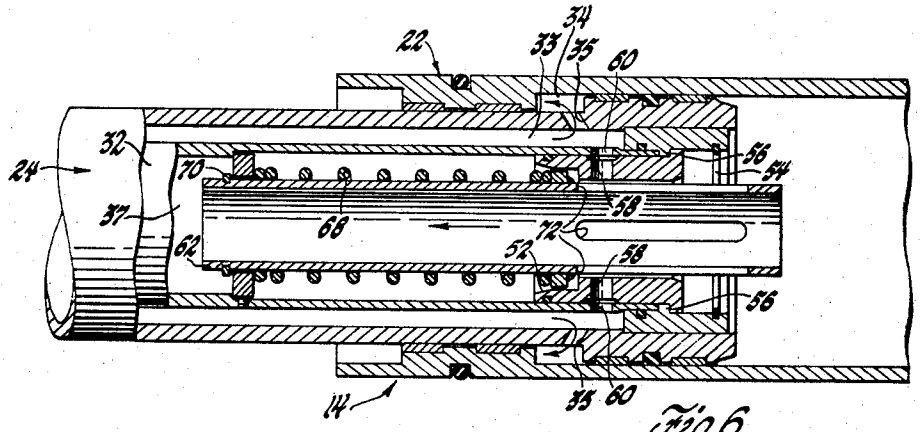


Fig. 6

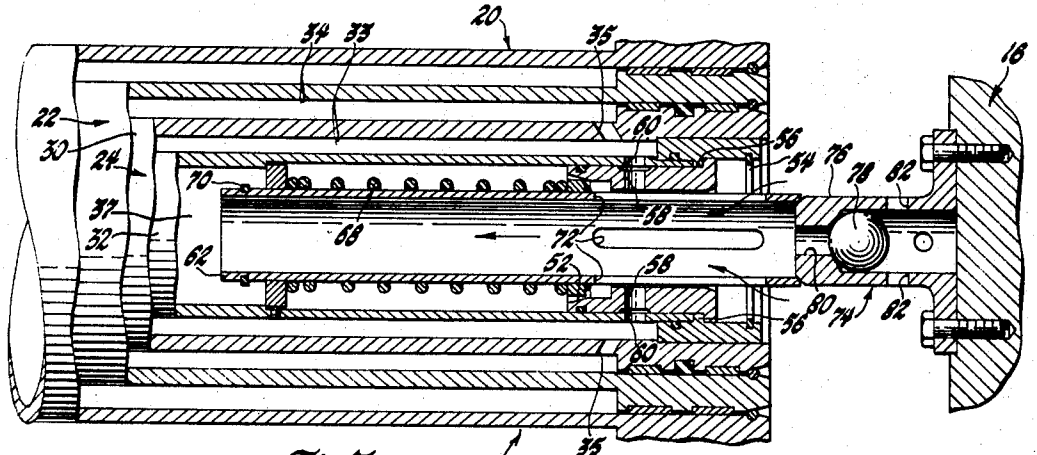


Fig. 7

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HYDRAULIC CYLINDER

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7 Claims. (Cl. 92—85)

ABSTRACT OF THE DISCLOSURE

A hydraulic cylinder having a piston member formed with first and second passages which respectively connect with the piston head end and the rod end of the cylinder. A valve assembly for decreasing the speed of cylinder contraction is located in the first passage and includes an open-ended flow control valve slidably mounted in the passage and formed with a plurality of elongated slots. A spring biases the flow control valve whereby the slots are located outside of the associated passage when the cylinder is expanded. During contraction of the cylinder, a boss formed with the cylinder is adapted to block one open end of the flow control valve and urge the latter against the influence of the spring into the passage so that fluid from the piston head end of the cylinder is exhausted through the slots at a decreasing rate.

This invention concerns a hydraulic cylinder and more particularly a valving arrangement that provides a cushioning effect when the cylinder approaches the end of its stroke.

The invention finds particular applicability, although not exclusive, with a hydraulic cylinder of the type used for raising and lowering the dump body of a dump vehicle. In this connection, when a loaded dump body is raised about its pivotal connection with the vehicle, near the end of the raising cycle the center of gravity of the dump body often moves overcenter so as to cause a quick extension of the hydraulic cylinder. This results in the final stage of the cylinder being jarred when the limits of cylinder expansion are reached and frequently causes damage to occur to the cylinder or the cylinder supports. Similarly, cylinder damage can occur during the lowering cycle because the weight of the dump body will tend to increase the speed of cylinder contraction thereby causing a high vacuum to form at times inside the cylinder with resultant seal damage.

Accordingly, a principal object of the invention is to provide cushioning means for a hydraulic cylinder so as the latter approaches the end of its operating cycle, the speed of expansion or contraction is decreased so as to prevent damage to the cylinder.

Another object of the invention is the provision of a valving arrangement incorporated in a single-acting hydraulic cylinder for cushioning the movement thereof as it approaches the end of its operating cycle.

A further object of this invention is to provide a valving arrangement for a hydraulic cylinder that automatically controls the fluid flow therein so as to reduce the speed of expansion and contraction of the cylinder as it approaches the end of its operating cycle.

A still further object of this invention is the provision of a valve assembly in a single-acting hydraulic cylinder that controls the return of fluid exhaustion during the contracting cycle of the cylinder.

A yet further object of this invention is the provision of a multi-stage hydraulic cylinder having the final stage thereof continuously resisting expansion of the cylinder so as to provide a cushioning effect.

Other objects and advantages of the subject invention will be more apparent from the following detailed description of the invention when taken in conjunction with the drawings in which:

FIGURE 1 shows a rear dump vehicle incorporating a single-acting multi-stage hydraulic cylinder made in accordance with the invention;

FIGURE 2 is an enlarged sectional view showing the details of construction of the hydraulic cylinder;

FIGURE 3 is an enlarged view of the valving assembly which is associated with the final stage of the hydraulic cylinder shown in FIGURE 2;

FIGURE 4 is a view similar to FIGURE 3 but shows the positions of the various components of the valve assembly at the initial expansion of the cylinder;

FIGURE 5 is a view similar to FIGURE 3 but shows the positions of the various parts just prior to the operation of the final stage of the hydraulic cylinder during the expansion cycle;

FIGURE 6 is a view of the final stage of the hydraulic cylinder just after pressurized fluid has been directed thereto for contracting the hydraulic cylinder, and

FIGURE 7 is a view showing the final stage and the valving arrangement associated therewith just prior to the complete contraction of the hydraulic cylinder.

Referring now to the drawings, FIGURE 1 shows a rear dump vehicle of conventional design having a dump body **10** pivotally mounted to a vehicle frame **12** for movement about a transverse axis indicated by the letter A. A single-acting multi-stage hydraulic cylinder **14** which is made in accordance with the invention is connected between the vehicle frame **12** and the underside of the dump body **10** for raising and lowering the latter about the transverse axis.

Referring now to FIGURE 2, the hydraulic cylinder **14** comprises a cylindrical outer casing **16** which encloses a plurality of relatively movable concentric cylinders **18**, **20** and **22** and a rod portion **24** which respectively constitute the first, second, third and fourth stages of the cylinder assembly. The casing **16** of the hydraulic cylinder is provided with a mounting eye portion **26** which is adapted to be pivotally anchored to the underside of the vehicle dump body **10**. The rod portion **24** is also provided with a mounting eye portion **28** which is pivotally connected in a suitable manner to the vehicle frame **12** and rigidly secured to outer and inner concentric cylinder members **30** and **32**, both of which cooperate to define an annular fluid passage **33** within the rod portion **24** that communicates with an annular chamber **34** between the third and fourth stages via ports **35** formed in cylinder member **30**. The interior of cylinder member **32** forms a fluid passage **37** that communicates with a port **38** formed in the eye portion **28**. Similarly, the passage **33** communicates with a port **40** also formed in the eye portion **28** opposite the port **38**. Oil lines **42** and **44** connect the respective ports with a control valve **46** which receives pressurized oil from a pump **48** connected with a reservoir **50**. The control valve **46** is constructed so that it can selectively provide pressurized oil to one or the other line or in the alternative to both lines simultaneously in a manner to be described hereinafter.

As best seen in FIGURE 3, the rod portion **24** includes a sleeve valve **52** which is slidably movable between two positions as limited by a lock ring **54** and a shoulder **56** formed with the rod portion. The sleeve valve **52** is formed as a cylinder and includes a pair of diametrically opposed and radially extending ports **58** which, as seen in FIGURE 3, are adapted to register with corresponding openings **60** formed in the cylinder member **32**. A tubular-

shaped flow control valve **62** has one end thereof concentrically located in the sleeve member **52** while the other end is guided for movement along the longitudinal axis of the assembly by a ring **64** rigid with the inner cylinder membre **32**. An annular stop **66** is fixed with the valve **62** intermediate the ends thereof and serves as a seat for one end of a coil spring **68** which rests on the ring **64** and continuously biases the valve **62** toward the right as seen in FIGURE 3. A snap ring **70** is provided on the control valve **62** to limit the extent of movement of the latter due to the spring **68**. It will also be noted that four oblong ports **72** are provided in the body of the valve **62** for purposes which will be explained hereinafter.

As seen in FIGURES 2 and 3, the hydraulic cylinder is in a fully collapsed or contracted position wherein the right end of the control valve **62** abuts and has the inner passage thereof blocked by a centrally located check valve assembly **74** that includes a boss **76** which forms a portion of the cylinder and extends from and is rigidly bolted to the cylinder casing **16**. The boss **76** is suitably bored and serves to accommodate a ball valve **78** which is normally seated to close a port **80** which serves to direct pressurized oil from the port **38** and passage **37** to the head end of the hydraulic cylinder via radially extending ports **82** formed in the side walls of the boss.

The hydraulic cylinder assembly **14** operates as follows: As seen in FIGURES 2 and 3, the hydraulic cylinder **14** is in the fully collapsed position with the flow control valve **62** engaging the boss **76** and the sleeve valve **52** having its ports **58** aligned with the ports **60** formed in the cylinder member **32**. At such time, the dump body **10** is in the lowered position and when the operator desires the dump body to be raised, the control valve **46** is moved to the raised position so that pressurized fluid is directed through lines **42** and **44** into the hydraulic cylinder interior. Thus, as indicated by the arrows in FIGURE 4, the pressurized fluid flows through the rod portion **24** and the flow control valve **62** to unseat the ball **78** so that the fluid is directed to the piston head portion of the cylinder assembly. Simultaneously, the sleeve valve **52** is shifted toward the right to block off communication between the ports **58** and **60**. As a result, the upper end of the casing **16** moves away from the rod portion **24** and sequentially causes extension of the first, second, and third stages in that order. As seen in FIGURE 5, the valve **62** moves out of the rod portion **24** under the influence of the coil spring **68** and this movement of the valve continues until the lock ring **70** engages the support ring **64**. It will also be noted that as the third stage or cylinder **22** is extended, the piston portion thereof acts against the pressurized fluid supplied to chamber **34** through passage **33** and ports **35**. Therefore, as the hydraulic cylinder approaches the final phase of its extension which would normally occur as the center of gravity of the load moves to the right of a vertical line passing through the pivot axis A or, in other words, when the dump body moves overcenter, the usual damaging pull on the hydraulic cylinder is substantially eliminated by the cushioning effect which is provided by the line pressure in the chamber **34**.

After the dump body **10** is fully raised, it can be lowered by moving the control valve **46** to the power-down position at which time fluid is directed to the hydraulic cylinder through line **44** only with line **42** serving as a vent to reservoir **50**. Thus, as seen in FIGURE 6, the fluid flows as indicated by the arrows so as to cause the fourth stage or the rod portion **24** to move into the third stage or cylinder **22** at a slow rate until the center of gravity of the dump body moves overcenter or to the left of the imaginary vertical line through pivot axis A. At the same time, the sleeve valve **52** reassumes its original position wherein its ports **58** register with the ports **60** so that oil can flow from passage **37** to chamber **34**. Thus, any accelerated collapsing movement of the hoist assembly does not result in a vacuum being formed in the chamber **34** or the other chamber between the cylinders. As the hydraulic cylinder approaches its fully collapsed or contracted position, the flow control valve **62** is again engaged by the boss **76** of the check valve arrangement **74** as seen in FIGURE 7 and the existing fluid causes the ball **78** to close port **80**. Hence, the rate of collapsing movement of the hydraulic cylinder is immediately decreased inasmuch as the fluid at the piston head end can exit only through the slots **72** in the fluid control valve **62**. Thus, as the casing **16** of the hydraulic cylinder continues to move toward the fourth stage, flow restriction of the existing fluid slowly increases as the fluid control valve **62** moves further into the fourth stage with the result that a cushioning effect is realized as the dump body approaches the fully lowered position.

I claim:

1. In combination, a hydraulic cylinder having relatively movable piston and cylinder members, a first fluid passage in said piston member serving to connect a source of pressurized fluid with the piston head end of the cylinder for expanding the latter and also serving as an exhaust passage, a second fluid passage and porting formed in said piston member serving to continuously connect said source of pressurized fluid with the rod end of said piston head for cushioning the piston of said cylinder during the expansion thereof, and a valve assembly including a spring biased tubular valve member slidably mounted in said first passage, said valve having elongated slots formed therein and having an open end engaged and blocked by a portion of the cylinder for closing the normal flow through said valve and for urging the latter into said first passage so that fluid from the piston head end of the cylinder is exhausted through said elongated slots at a decreasing rate as the cylinder contracts so as to provide a cushioning effect.

2. In combination, a single-acting hydraulic cylinder having relatively movable piston and cylinder members, a fluid passage in said piston member serving to connect a source of pressurized fluid with the piston head end of the cylinder for expanding the latter and also serving as an exhaust passage during the contraction of the cylinder, cushioning means for decreasing the speed of cylinder contraction, said cushioning means comprising a tubular flow control valve member slidably mounted in said passage and having a plurality of elongated slots formed therein, means biasing said flow control valve whereby the elongated slots are located outside of the passage when the cylinder is in the expanded position, and means formed on the cylinder for blocking an open end of the flow control valve to close the normal flow through the flow control valve and for urging the latter against the influence of said biasing means into said passage so that fluid from the piston head end of the cylinder is exhausted through the elongated slots at a decreasing rate as the cylinder contracts.

3. The hydraulic cylinder of claim **2** wherein said means biasing said flow control valve is a spring.

4. The hydraulic cylinder of claim **2** wherein said slots are formed with their major axes substantially parallel to the longitudinal axis of said flow control valve.

5. The hydraulic cylinder of claim **2** wherein said means on said cylinder for closing normal flow comprises a boss having an outer diameter greater than the inner diameter of said flow control valve.

6. The hydraulic cylinder of claim **5** wherein said boss has a ball check arrangement for permitting fluid to flow therethrough only during expansion of said cylinder.

7. In combination, a hydraulic cylinder having relatively movable piston and cylinder members, a first fluid passage in said piston member serving to connect a source of pressurized fluid with the piston head end of the cylinder for expanding the latter and also serving as an exhaust passage during contraction of the cylinder, a second fluid passage and porting formed in said piston

member serving to continuously connect said source of pressurized fluid with the rod end of the piston head for cushioning the piston during expansion of the cylinder, cushioning means located in said first fluid passage for decreasing the speed of cylinder contraction, said cushioning means comprising a tubular flow control valve member slidably mounted in said first passage and having a plurality of slots formed therein, means biasing said flow control valve whereby the slots are located outside the associated passage when the cylinder is in the expanded position, a boss formed on the cylinder for blocking an open end of the flow control valve to close the normal flow through the flow control valve and for urging the latter against the influence of the biasing means into said passage so that fluid from the piston head end of the cylinder is exhausted through the slots at a decreasing rate as the cylinder contracts, and means including a sleeve valve connecting said first passage with said second passage and permitting fluid to flow therebetween and to said rod end of the cylinder through said porting so as to make up any deficiency in fluid in said rod end of the cylinder while the latter is contracting.

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92—53, 117; 91—405, 440; 188—96