June 10, 1952 J. A. DENTON 2,599,899

SERVOMOTOR

Filed June 15, 1949 2 SHEETS—SHEET 1

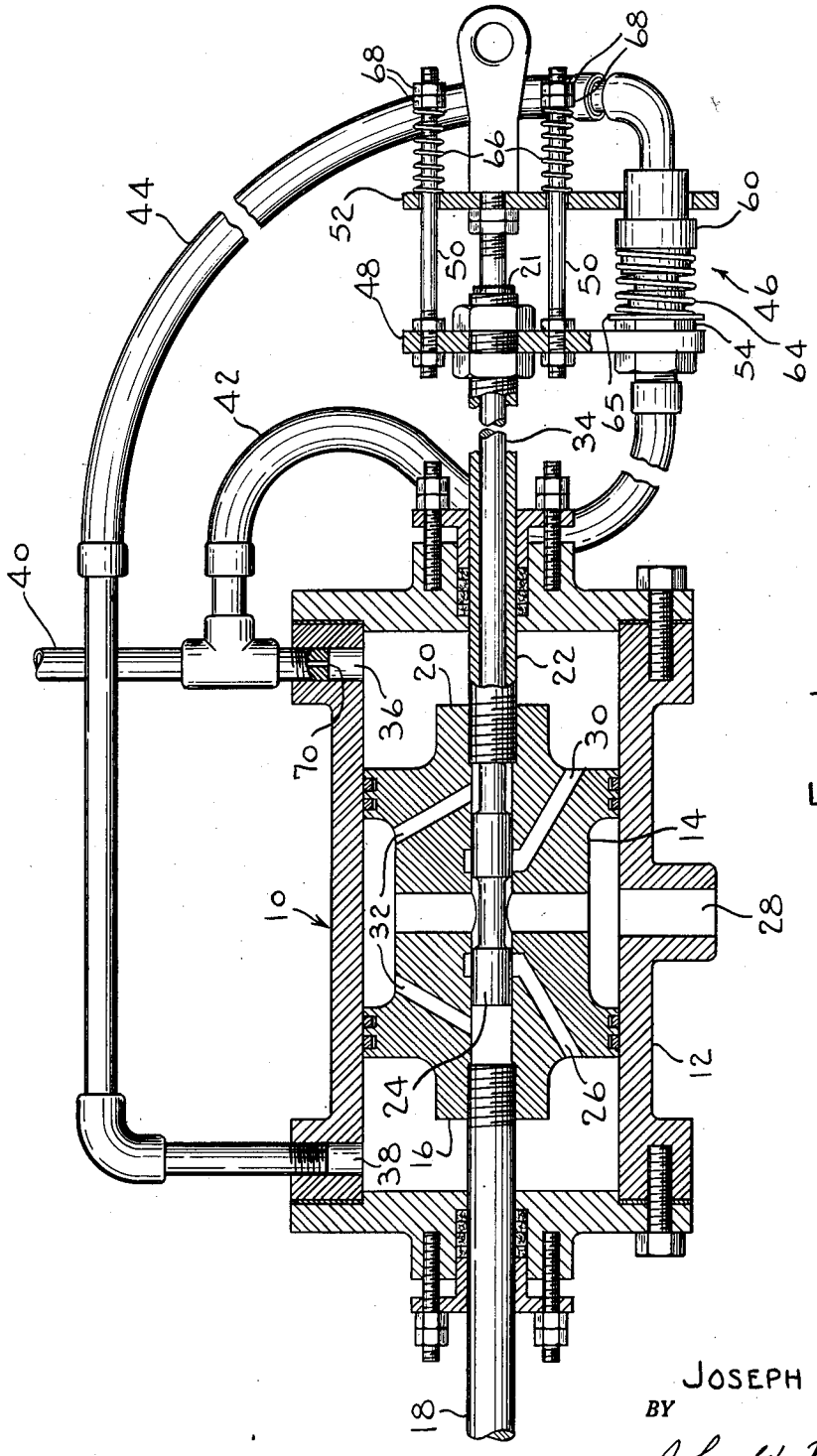


FIG. 1

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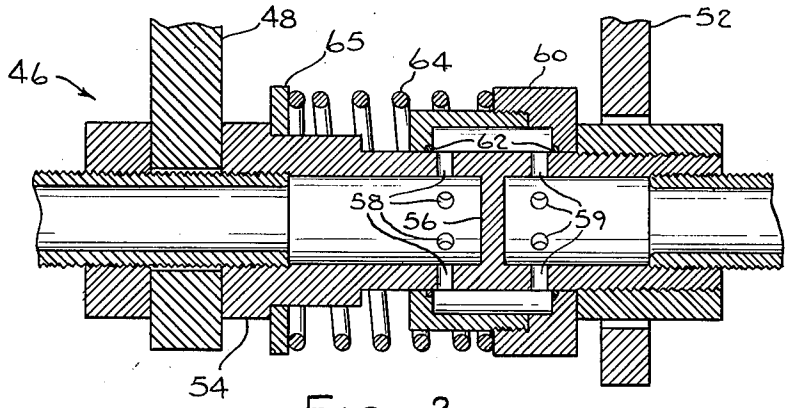


FIG. 2

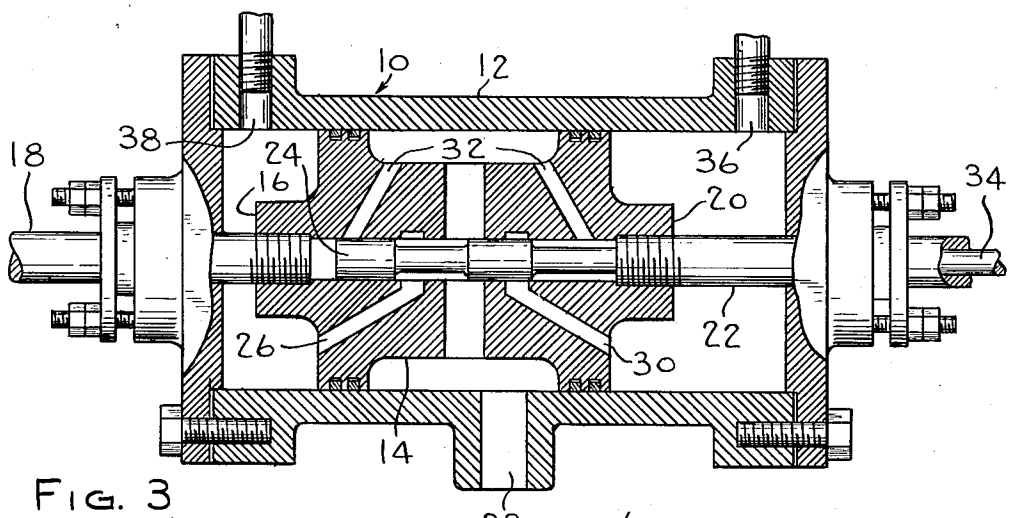


FIG. 3

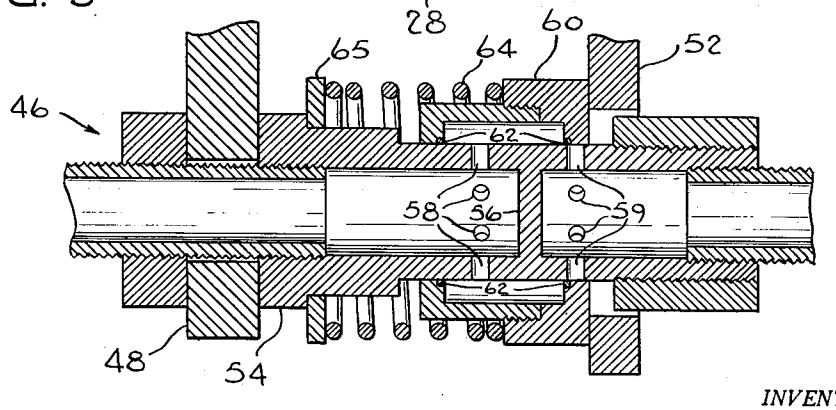


FIG. 4

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UNITED STATES PATENT OFFICE

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SERVOMOTOR

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Application June 15, 1949, Serial No. 99,137

5 Claims. (Cl. 121—41)

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This invention relates to improvements in servomotors for the control of mechanism in which a work-gripping member is moved into variably positioned work-gripping stations and thereafter caused to continuously assert work-gripping pressure.

Servo-motors embodying a cylinder and a piston with a manually controlled exhaust valve therein have been used, for example, to control the valves for the steam feeds of sawmill carriages. In these motors gas, such as steam or air, under pressure was constantly supplied to both ends of the cylinder and the exhaust valve selectively connected either one of the ends of the piston to atmosphere or exhaust to cause the piston to be forced toward the desired end of the cylinder. One disadvantage, however, of such motors was the loss of the gas when the piston was continuously forced in one direction to supply a continuing pressure. Another disadvantage was the sudden manner in which the piston slammed forward when attempting to advance to a selected position.

It is an object of this invention, therefore, to provide a servo-motor which will supply a continuing work-gripping pressure without undue loss of the power-supplying gas.

Another object of the invention is to provide a servo-motor which will control the positioning of a work-gripping member so as to prevent the slamming of the work thereby as such member is advanced and which will also supply a continuing pressure to such member when it has engaged the work.

The first of these objects is obtained by inserting a biased to open control valve between the piston retracting end of the servo-motor cylinder and the source of gas under pressure, mounting such control valve so that it bodily moves with the piston of the motor, and operatively connecting such control valve with the exhaust valve so that such valve is automatically closed after the exhaust valve has been partly opened. With this arrangement the exhaust valve controls the placement of the piston within its range of travel until its movement is resisted by the contact between the work and the work-gripping member. When this occurs the exhaust valve upon being further opened closes the control valve thus shutting off the retracting end of the cylinder from the source of gas under pressure. Thereafter the gas is supplied only to the advancing end of the cylinder. Thus the work-holding force of the motor is accomplished without continual loss of gas.

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The second object is obtained by inserting a restricted opening between the piston advancing end of the cylinder and the source of gas under pressure. When the exhaust valve is moved toward piston advancing position, even though the size of the opening for escape of gas to atmosphere is larger than the restricted opening, the restricted inflow of such gas will advance the piston slowly and in small increments. This step like stop and start advance of the piston prevents the accumulation of momentum which would cause the work-gripping member to slam against and damage the work. However, the rate of retraction is not so retarded by such restricted opening.

The novel features, which are considered characteristic of the invention, are set forth with particularity in the appended claims. The invention itself, however, both as to its organization and its method of operation, together with additional objects and advantages thereof, will best be understood from the following description of a specific embodiment when read in connection with the accompanying drawing, in which:

Fig. 1 is a view in cross section of a servo-motor embodying the present invention with the control valve thereof shown in plan;

Fig. 2 is an enlarged fragmentary cross sectional view of the control valve of Fig. 1;

Fig. 3 is a cross sectional view of the piston and cylinder of the servo-motor of Fig. 1 in piston advancing position; and

Fig. 4 is a fragmentary enlarged cross sectional view of the control valve shown in Fig. 2 when said valve is moved to closed position.

Referring to the drawings by reference numerals, the servo-motor 10 is of conventional construction and has a fixed cylinder 12 in which is reciprocably mounted a piston 14. The detailed structure of the cylinder and the piston is substantially identical to that described in U. S. Patent 2,270,059, issued January 13, 1942, to The Filer & Stowell Company, assignee of this application, and reference is made to such patent for such details. The piston 14 has extending from its retracting end 16 a piston rod 18 which is adapted to be connected with a work-gripping member (not shown) such as the feed rolls of a band saw. The advancing end 20 of the piston is connected with a false hollow piston rod 22. Both piston rods extend outwardly from the cylinder 12 through conventional stuffing boxes. In the interior of the piston 14 there is slidably mounted an exhaust valve 24 which

when moved toward the retracting end 16 connects such end through passageway 26 to the cylinder exhaust opening 28. When the exhaust valve 24 is moved toward the advancing end 20 such end is connected to the exhaust opening 28 by passageway 30. Subsidiary passageways 32 connect the ends of the exhaust valve chamber with the exhaust to eliminate development of back pressure during the shifting of valve 24. In order to move the exhaust valve 24 relative to the piston 14 an exhaust valve stem 34 extends outwardly through the hollow piston rod 22, a customary packing gland 21 sealing the end of the hollow piston rod 22 and the exhaust valve stem 34.

The cylinder 12 has a piston-advancing inlet 36 and a piston-retracting inlet 38. A source of gas under pressure, such as steam or compressed air, is supplied through the main pipe 40 to the advancing inlet 36. This same source is normally connected to the retracting inlet 38 by sections of flexible piping 42 and 44 connected with a normally open control valve 46. When the valve stem 34 is moved to the left by manually operated control levers or the like the retracting end 16 is connected to the exhaust opening 28 and the piston 14 will advance until it meets with resistance to its movement or until it advances relative to the exhaust 24 to close off passageway 26. When the valve stem 34 is moved to the right, the advancing end 20 is connected to the exhaust opening 28 and the piston will retract until it meets with resistance to movement or until it retracts relative to the exhaust valve 24 to close the passageway 30.

In many instances it is desirable not only to move the work-gripping member to a desired position but also to continue it to supply gripping force to such member after it has reached the desired position in contact with the work. With the servomotor constructed as heretofore described, to supply such continuous force there will be a steady loss of gas under pressure through the retracting end 16, passageway 26, and exhaust opening 28. In order to prevent such loss, the normally open control valve 46 is closed after the advancing motion of the piston has been arrested by engagement between a work-gripping member operated by the piston rod 18 and the work. To effect such opening and control of the control valve 46, a crosshead 48 is secured to hollow piston rod 22 and supports a pair of guide rods 50 and the control valve 46. A second crosshead 52 is fixedly secured on the valve stem 34 and is guided by the guide rods 50 extending through openings therein. The second crosshead 52 also has an opening which loosely encircles the body of the control valve 46 so that such crosshead is in alinement with and may engage the operating member 60 of such valve. The valve 46 consists of a main body 54 which has an internal wall or partition 56. Adjacent the left-hand side of such wall there are a plurality of openings 58 extending from the interior to the exterior of the body 54. Adjacent the right-hand side of such wall are a plurality of openings 59 which also extend from the interior to the exterior of such body. An operating member 60 encircles the body 54 and is slidably sealed with relation thereto by packing rings 62 to provide an enclosed space normally enclosing both sets of openings 58 and 59. The operating member 60 is continually urged into normal valve open position by a coil spring 64 reacting between a washer 65 on the body 54 and such operating member. In the normal position of the control valve 46, gas under pressure passes out through the openings 58 into the space within operating member 60 and inwardly through openings 59. However, as the operating member 60 is moved to the left against the compression in spring 64, the right-hand end of such member will close the openings 59 (see Fig. 4) thus shutting off the communication between the source of gas under pressure and the retracting inlet 38. With the exhaust valve 24 in a neutral position (Fig. 1), the second crosshead 52 is adjusted in its position on the stem 34 so that it is spaced approximately a quarter of an inch from the operating member 60. Such spacing permits the valve stem 34 to be moved to the left a sufficient amount to connect the retracting end 16 with the exhaust opening 28 without operating the normally open control valve 46.

The operation of the servo-motor is manually controlled by the usual levers (not shown). As the valve stem 34 is moved toward the left, the piston 14 and piston rod 18 will also continue to move toward the left until the work-gripping member operated by such piston rod contacts the work. At such time the advance of the piston is stopped and advancing pressure will be maintained on the piston by reason of the escape of gas under pressure from the retracting end 16 to the exhaust opening 28. If more force is desired, the valve stem 34 is moved farther to the left so that the crosshead 52 engages the operating member 60 closing the control valve 46 (see Fig. 4) and further opening the connection between the retracting end 16 and the exhaust opening 28. The effect of this is to substantially eliminate all pressure on the retracting end 16 and place the full unbalanced force of the gas under pressure against the advancing end 20 of the piston. While in this position only such gas will be lost as might escape through imperfect fits between the various glands, connections, and valve seats. When it is desired to remove the gripping and the advancing pressure, the valve stem 34 is moved to the right with respect to the hollow piston rod 22 to let the control valve 46 move to normally open position (Fig. 2) and to move the exhaust valve 24 to neutral position (Fig. 1). Such neutral position is determined by the engagement between the crosshead 52 and a pair of adjustable springs 66 positioned on the guide rods 50 between the second crosshead 52 and adjusting nuts 68 on the outer ends of such rods. Thereafter further movement of the valve stem 34 to the right will be accomplished by slightly compressing the springs 66 which gives a "feel" to the operator while actuating the valve stem. This further movement to the right opens the passageway 30 between the advancing end 20 and the exhaust opening 28 thus causing the piston 14 to retract toward the right end of the cylinder 12.

In some uses of the servo-motor it might be desirable to have the piston automatically advance whenever it is not being manually retracted. To accomplish this, the nuts 68 are tightened so as to move the springs 66 towards the left thus putting those springs under sufficient tension to always move the valve stem 34 a small distance to the left of center. In making such adjustment the gap between the operating member 60 and the second crosshead 52 is eliminated. With the servo-motor so adjusted, the exhaust valve 24 normally opens passageway 26 and the piston 14 is automatically ad-

vanced to the left so that a work-carrying member actuated thereby would be automatically moved to work-gripping position. Whenever it is desirable to supply work-gripping pressure, the valve stem **34** is manually advanced farther to the left relative to the piston **14**, thus closing the control valve **46** with the resulting action heretofore explained.

By utilizing an operating lever and linkage arrangement for the valve stem **34**, and incorporating with such lever a quadrant with positioning notches or with a friction drag, the relative positioning of the piston **14** within the cylinder **12** may be regulated and controlled. The exhaust valve **14** always seeks neutral position unless it is influenced by some outside force. Hence by moving such operating lever to a selected position where it is held by the action of the quadrant or friction drag, the piston **14** will advance to the desired position and when such position is reached the exhaust valve **24** being fixed will be in neutral position as the result of movement of the piston **14** and this will stop the further advance of the piston.

A restricted opening **70** having an internal diameter of substantially one-eighth of an inch is placed in the advancing inlet **36** to limit the rate of flow of gas under pressure into the advancing end of the cylinder. This restricts the rate at which the piston **14** advances and causes it to advance slowly and in short steps. The effect of this is to prevent the piston from obtaining so much momentum that it advances beyond the desired position thereby causing the work-gripping member to slam against the work and damaging it. However, there is no restriction in the retracting inlet **38** and hence the rate of flow of the gas to retract the piston is not retarded and it will quickly retract. The combination of the slow advance and the quick retraction makes the motor more adaptable for the use of various applications.

In the embodiment described herein, the control valve **46** is more particularly adapted for the use with compressed air rather than with steam vapor. In the event it becomes necessary to use the servo-motor with steam, a poppet type of valve may be substituted for the sleeve type valve **46**, thereby eliminating the packing glands which would not be efficient for use with steam. The essential features of any control valve is that the valve be placed in the line between the source of gas under pressure and the retracting inlet **38** and that it be operated by the exhaust valve stem from a normally open position to a closed position.

Although only one embodiment of the invention is shown and described herein, it will be understood that this application is intended to cover such changes or modifications as come within the spirit of the invention or scope of the following claims.

I claim:

1. A servo-motor comprising a cylinder having a piston retracting inlet at one end and a piston advancing inlet at the other end, a piston movable between said inlets and having a retracting end and an advancing end, an exhaust outlet for said cylinder communicating with both said retracting and advancing ends, a piston rod fixed to said piston, an exhaust valve movable in one direction to connect said advancing end with said exhaust outlet and to disconnect said retracting end from said exhaust outlet and movable in an opposite direction to disconnect said advancing end from said exhaust outlet and connect said retracting end to said exhaust outlet, an exhaust valve stem connected with said exhaust valve and movable relative to said piston rod to control the movements of said exhaust valve, a source of gas under pressure continually connected to said advancing inlet, a control valve connected between said source and said retracting inlet and normally biased to open position during advance and retraction of said piston whereby said piston is advanced when said exhaust valve connects said retracting end of said piston to said exhaust outlet and is retracted when said exhaust valve connects the advancing end of said piston to said exhaust outlet, and means for closing said control valve to disconnect said source from said retracting inlet whenever said piston rod while said exhaust valve connects said retracting end to said exhaust outlet is restrained from advanicng and thereby prevent undue losses through said exhaust outlet while advancing force is being maintained on said piston.

2. A servo-motor comprising a fixed cylinder having a piston retracting inlet at one end and a piston advancing inlet at the other end, an exhaust outlet for said cylinder located between said inlets, a piston and exhaust valve therefor movable between said inlets, a piston rod fixed to said piston and adapted to be engaged with a work-gripping member, an exhaust valve stem connected with said exhaust valve and movable relative to said piston rod to control the movement of said exhaust valve, a source of gas under pressure continuously connected to said advancing inlet, a normally open control valve connected between said source and said retracting inlet whereby said piston is advanced when said exhaust valve connects the retracting end of said piston to said exhaust outlet and is retracted when said exhaust valve connects the advancing end of said piston to said exhaust outlet, and means for closing said control valve to disconnect said source from said retracting inlet whenever said piston rod by reason of contact between the work and the work-gripping member is restrained from advancing while said exhaust valve connects the retracting end of said piston to said exhaust outlet and thereby prevent undue losses through said exhaust outlet while advancing force is being maintained on said piston.

3. A servo-motor and control as claimed in claim 2 in which said advancing inlet has a restricted opening to allow only enough gas to flow therethrough during the time the exhaust valve is connecting the retracting end of said piston to said exhaust outlet to advance said piston slowly enough so that a work-gripping member motivated thereby is prevented from slamming against the work.

4. A servo-motor comprising a cylinder having a piston retracting inlet at one end and a piston advancing inlet at the other end, a piston movable between said inlets and having a retracting end and an advancing end, an exhaust outlet for said cylinder communicating with both said retracting and advancing ends, a piston rod fixed to said piston, an exhaust valve movable in one direction to connect said advancing end with said exhaust outlet and to disconnect said retracting end from said exhaust outlet and movable in an opposite direction to disconnect said advancing end from said exhaust outlet and connect said retracting end to said exhaust out-

let, an exhaust valve stem connected with said exhaust valve and movable relative to said piston rod to control the movements of said exhaust valve, a source of gas under pressure continually connected to said advancing inlet, a control valve connected between said source and said retracting inlet and normally biased to open position during advance and retraction of said piston whereby said piston is advanced when said exhaust valve connects said retracting end of said piston to said exhaust outlet and is retracted when said exhaust valve connects the advancing end of said piston to said exhaust outlet, a crosshead on said piston rod, said control valve being carried by said crosshead, said control valve having an operating member shiftable axially of said piston rod, and a second crosshead carried by said exhaust valve stem in overlapping normally spaced relationship with said operating member and abutting with said member to close said control valve when said second crosshead is moved relative to said piston rod while said exhaust valve connects said retracting end to said exhaust outlet.

5. A servo-motor as claimed in claim 4 in which there is an adjustably positioned spring for resisting movement of said exhaust valve stem outwardly relative to said piston rod whereby the relative positions of said piston rod and exhaust valve stem may be determined by action of said spring whenever any extraneous exhaust valve stem operating force is removed.

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