

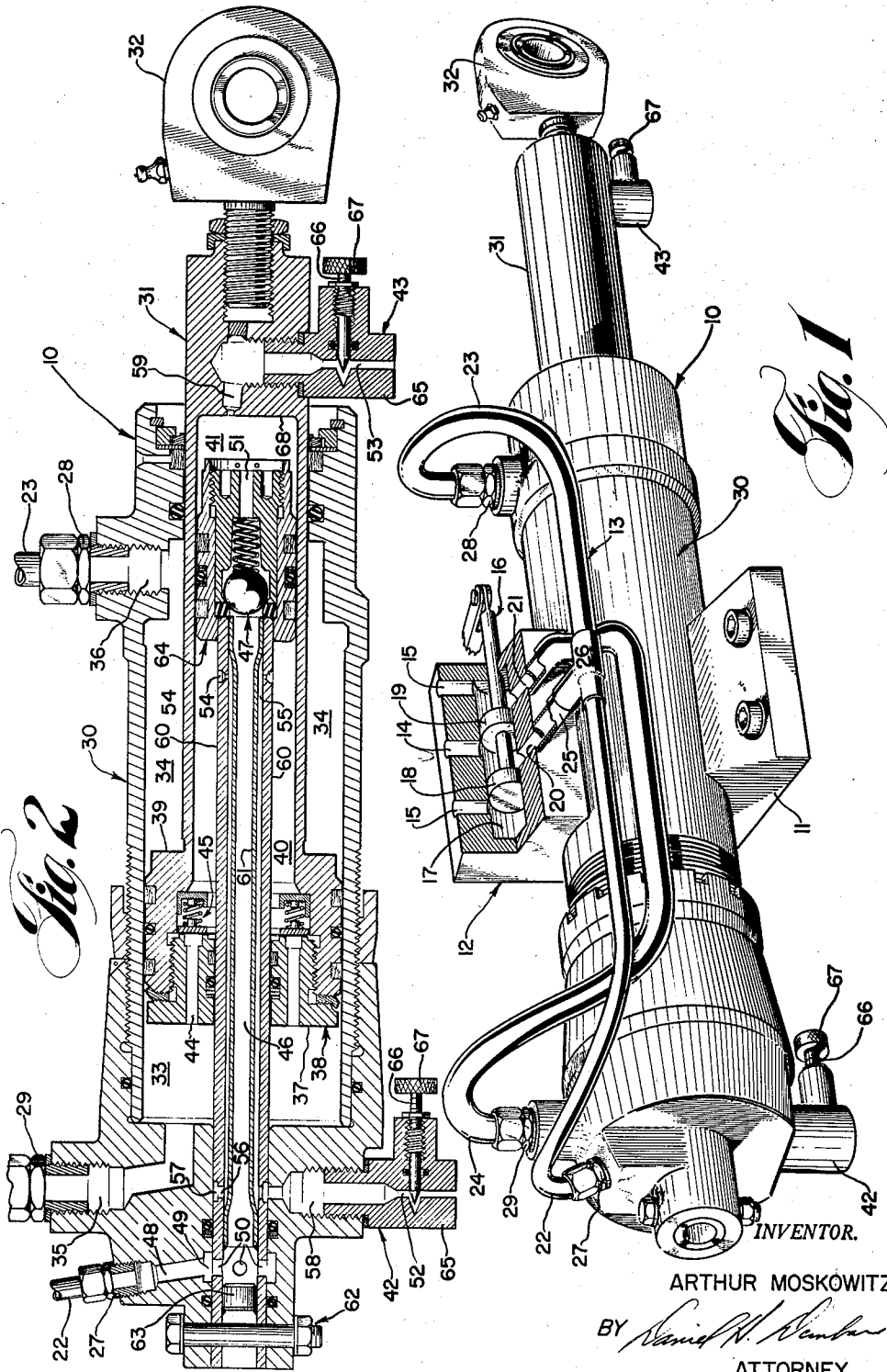
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DOUBLE-ACTING ACTUATOR MEANS

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DOUBLE-ACTING ACTUATOR MEANS

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This invention pertains generally to a double-acting actuator, and specifically relates to a novel pneumatic actuator means having improved operating characteristics.

Typical pneumatic actuators have heretofore been provided with various means for controlling movement of an extendible rod portion thereof. However, such actuators have not proved entirely adequate with respect to the incorporation of suitable means for limiting over-movement of the extendible rod portion. This problem has been particularly acute with respect to double-acting actuators which use high-pressure gaseous operating fluids. Such actuators have also proved deficient in that gas quantities previously stored therein for restricting movement of the rod portion have often been lost during extended periods of non-use through leakage and inadequate sealing. The occurrence of a leakage situation has materially affected the operating characteristics of such an actuator. Further, such actuators generally have a characteristic of not being totally inert or dormant during periods of non-use.

The actuator means of this invention contemplates the use of primary chamber portions for receiving high-pressure gas to cause movement of an extendible rod portion in either of two operating directions. Additionally, the actuator of this invention utilizes separate integral compression chamber portions for controllably restricting movement of that rod portion. Adjustable metering means are preferably provided for controlling the rate of gas flow from the compression chamber portions to a low-pressure region.

It is, therefore, an object of this invention to provide a pneumatic actuator means having a double-acting operating characteristic, and having features incorporated therein for causing improved movement control of an extendible rod portion.

Another object of this invention is to provide a pneumatic actuator having primary chamber portions for use in causing movement of a relatively extendible rod portion, and having separate integral compression chamber portions for use in retarding movement of that rod portion.

Another object of this invention is to provide an actuator means arrangement wherein the compression chamber portions provided for controlling movement of an extendible rod portion are at least partially defined by that rod portion.

A further object of this invention is to provide a double-acting actuator having self-contained features for causing improved movement control of a rod portion essentially only during movement of that rod portion.

Another object of this invention is to provide an actuator having means for restricting the flow of gas from a compression chamber, provided for controlling movement of an extendible rod portion, to the source of that gas.

Another object of this invention is to provide an actuator means having metering means for controlling the rate of movement of an extendible rod portion.

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Another object of this invention is to provide a double-acting pneumatic actuator which does not utilize previously stored gas quantities for achieving movement control.

5 A further object of this invention is to provide a double-acting pneumatic actuator having movement control features which are substantially inert and dormant during periods of non-use.

Another object of this invention is to provide an improved double-acting pneumatic actuator which is extremely compact, which may be utilized to effect substantial weight savings over functionally equivalent forms of actuators, and which has an extremely high degree of operational reliability.

Other objects and advantages of my invention will become apparent during consideration of the specification and drawing portions of this application.

In the drawings, wherein like numerals are employed to reference like components throughout the same:

Fig. 1 is a perspective view of a double-acting pneumatic actuator which incorporates features of this invention; and

Fig. 2 is a schematic sectional view of the actuator means illustrated in Fig. 1.

The reference numeral 10 of Fig. 1 is utilized to generally designate a double-acting pneumatic actuator which incorporates the features of this invention. Actuator 10 is supported by the mounting bracket 11, and further cooperates with the valve means 12 and the line means designated generally as 13. Valve means 12 is provided for controlling the direction of movement of the extendible rod portion of the actuator, and line means 13 is provided for conducting the flow of gas as between valve means 12 and actuator 10.

In Fig. 1 a portion of valve means 12 has been removed to illustrate inlet passageway 14, outlet passageways 15, and the spool component 16 contained in chamber portion 17. Passageway 14 is provided for association with a source of high-pressure gas, and outlet passageways 15 are provided for exhausting gas from within the valve means to a low-pressure region. Valve pistons 18 and 19 are associated with spool 16 for directing the proper flow of gas through passageways 14 and 15, chamber portion 17, and the passageways 20 and 21.

Line means 13 is connected to passageways 20 and 21, and is comprised of line portions 22, 23, 24, and 25 together with the T 26. Each of line means 22 through 24 communicates with the interior of actuator 10 through the various fittings designated 27, 28, and 29, respectively. It should be noted that the illustration of Fig. 1 is schematic in nature, and in an alternate arrangement valve means 12 and line means 13 might be provided integral with the actuator 10.

Actuator 10 is essentially comprised of a multi-piece body portion 30 and a cooperating extendible rod portion 31. A connector 32 may be provided in association with rod 31 for operatively connecting the actuator 10 to a movable load. In a further alternate arrangement, rod portion 31 may be connected to a structural component in the manner of bracket 11. In such an arrangement the body 30 is caused to move relative to the rod portion 31, and must be connected to the movable load. This latter arrangement generally requires the use of flexible line means for connecting valve means 12 to a source of high-pressure gas.

Further details of actuator 10 are illustrated in Fig. 2. As noted therein, actuator body portion 30 is provided with internal primary chamber portions 33 and 34 for receiving high-pressure gas to cause movement of rod portion 31 relative to the body 30. High-pressure gas is received in chamber 33 from valve means 12 through

line 24, fitting 29, and the connecting passageway 35. Primary chamber portion 34 receives high-pressure gas from valve means 12 through line 23, fitting 28, and the connecting passageway 36. Because of the operating characteristics of valve means 12, primary chambers 33 and 34 are never simultaneously subjected to the same pressure condition. If chamber portion 33 is connected to a high-pressure gas source, chamber 34 will be in communication with a low-pressure region. Conversely, if chamber portion 34 receives high-pressure gas from valve means 12, primary chamber 33 will be vented to a low-pressure region.

Thus, an unbalanced pressure acting upon the face 37 of piston component 38 (connected to rod 31) will cause the rod to move from its Fig. 2 position to an extended position. If high-pressure gas is alternately ported to chamber 34, unbalanced forces acting upon face 39 of the piston-rod element 38 will cause the rod to be moved from an extended position to the retracted position of Fig. 2. Because the gas pressures often employed in connection with pneumatic actuators are very high in magnitude, extension and retraction of the rod portion may be undesirably rapid and may be accompanied by an unacceptably high net force.

Therefore, actuator means 10 is provided with integral compression chambers 40 and 41 to retard movement of rod portion 31 during operation of the unit. As will hereinafter be noted, the actuator 10 is preferably provided with metering means 42 and 43 for regulating the flow of gas from compression chambers 40 and 41 to a low-pressure region.

Compression chamber 40 is connected to the source of high-pressure gas through primary chamber 33, passageway 44, and the spring-biased check valve means designated generally as 45. Compression chamber 41 is connected to the source of high-pressure gas which supplies primary chamber 34 through line 22, fitting 27, passageway 46, and the check valve means designated generally as 47. Passageway 46 cooperates with the interior of fitting 27 through passageway 48, annular chamber 49, and the openings 50. Further, chamber 41 communicates with the passageway 46 through passageway 51.

Chambers 40 and 41 cooperate with the passageways 52 and 53 of metering means 42 and 43, respectively, for venting each chamber to an exterior low-pressure region. Compression chamber 40 communicates with passageway 52 through openings 54, annular passageway 55, openings 56, annular chamber 57, and the passageway 58. Compression chamber 41 cooperates with the passageway 53 of metering means 43 through the passageway designated 59. Annular passageway 55 is defined by the inner surface of the hollow stem 60 and by the outer surface of the tubular insert 61. Insert 61 is enlarged at each end, and each enlargement serves to secure the insert to stem 60 in a manner which will prevent gas leakage therebetween. Further, stem 60 is secured to body portion 30 through the fastener means referenced generally as 62, is provided with a plug component 63, and is also provided with the attached piston means 64.

Each metering means is comprised by a body portion 65, a cooperating valve member 66, and a knurled knob portion 67 secured to the valve member. Rotational movement of knob means 67 will cause the end portion of valve member 66 to vary the opening in passageway 52 or 53. By such motion, the resistance offered to gas flow from each of chambers 40 and 41 may be varied from a minimum to a maximum value.

Various seals are illustrated in Fig. 2 for the purpose of preventing gas leakage as between the various chamber portions and passageways. Further, Fig. 2 illustrates packings and other means provided for proper lubrication of the actuator unit. Such features are believed to be obvious to those skilled in the art, and therefore no detailed description of their function is provided.

It should be noted that the check valve means 45 and

47 are of typical construction. In each instance the valve member is properly spring-loaded to maintain a closed-bias relation with respect to the valve seat. It is preferred that the spring means of each check valve component be selected so that only a minimum pressure differential is required to move the valve to an open condition. Referring to Fig. 2, the valve means 45 is moved to an open condition whenever the pressure in chamber portion 33 exceeds the internal pressure of chamber 40 by a minimum differential. Likewise, the valve means 47 is moved to an open condition whenever the pressure in passageway portion 46 exceeds the pressure condition of chamber 41 by the preselected minimum differential. Whenever the pressure in the compression chamber portions are equal to or greater than the pressure conditions of the gas source for such chambers, the valve means will be in a closed condition.

Operation of the actuator means of this invention may be described with reference to Figs. 1 and 2 in the following manner. Initially, all chamber portions and passageway portions of actuator 10 and line means 13 are in communication with a low-pressure region, and, therefore, the actuator means is totally dormant or inert. To move the rod portion 31 of actuator 10 from its Fig. 2 position to an extended condition, the valve member 16 is moved to port high-pressure gas from passageway 14, through chamber 17, and into the passageway 21. The high-pressure gas then flows through line means 24 and into the primary chamber portion 33. A substantial pressure differential is thereby established as between chamber portion 33 and compression chamber 40, the check valve means 45 is opened, and gas also flows from chamber portion 33, through the passageway 44, and into compression chamber 40. The gas received in chamber 40 thereafter flows through the openings 54, passageway 55, openings 56, chamber 57, passageway 58, and metering means 42 to a low-pressure region. By properly positioning the valve member 66 of metering means 42, the flow of gas through passageway 58 to the low-pressure region is controllably restricted. The pressure in chamber portion 40, therefore, is caused to be raised to a level which approaches the level of pressure in chamber 33, and when the minimum designed differential is established the check valve means 45 is caused to close.

As rod portion 31 is moved to its extended position, the forces acting upon the face 37 of piston means 38 are opposed by forces established by the pressure of gas being compressed in chamber 40. The rate of movement of rod portion 31 to its extended position is controlled through adjustment of the valve member of metering means 42. It should be noted that during such rod movement the chamber portion 34 is vented to a low-pressure region through passageway 36, fitting 28, line means 23, T 26, stub 25, passageway 20, chamber 17, and an outlet passageway 15 of the valve means 12. The exhausting of gas from chamber 34 to the low-pressure region by this arrangement is substantially without restriction.

To move rod portion 31 from an extended position to the retracted position of Fig. 2, the valve spool 16 is moved to a reversing position. In this instance high-pressure gas is ported from passageway 14 into the primary chamber portion 34, and simultaneously therewith chamber portion 33 is vented to a low-pressure region through line means 24 and the cooperating outlet passageway 15. High-pressure gas is also ported into compression chamber 41 through line means 22, fitting 27, passageway 48, chamber 49, openings 50, passageway 46, check valve means 47, and passageway 51. When the pressure conditions in chambers 41 and 34 are substantially balanced, the check valve means 47 will be moved to a closed condition. Unbalanced forces acting upon the face 39 of piston means 38 causes the rod portion to move in a leftward direction (Fig. 2). Simultaneously therewith, opposing forces are created in the

compression chamber 41 to act upon the surface 68 to retard movement of rod portion 31. The rate of escape of gas from chamber 41 and through passageway 59 is controlled by properly adjusting the valve member 66 of metering means 43.

When rod movement in either direction is completed, the valve means 12 may be actuated to completely block inlet passageway 14 and to vent chambers 33 and 34 to a low-pressure region. Chambers 40 and 41 are continually vented to a low-pressure region through metering means 42 and 43. Thus, during periods of non-use the actuator is completely inert and dormant. Previously stored quantities of gas are not utilized in making compression chambers 40 and 41 effective, thus adverse leakage conditions are completely avoided.

From the foregoing description it will be observed that this invention provides a double-acting pneumatic actuator having improved control means for governing movement of its extendible rod portion. Such is accomplished through the use of separate integral compression chamber portions for establishing opposition forces to retard movement of the rod portion. Further, it is important to note that control of rod portion movement is effected essentially through the use of compression chambers which are directly associated with the rod portion.

Also, it should be noted that the actuator means of this invention does not utilize previously stored gas quantities for achieving movement control, and further, the actuator is substantially inert and dormant during periods of non-use. Other advantages of this invention have heretofore been noted in this description.

It is to be understood that the forms of the invention herewith shown and described are to be taken as preferred embodiments of the same, but that various changes in the shape, size, and arrangement of parts may be resorted to without departing from the spirit of the invention or the scope of the subjoined claims.

I claim:

1. An actuator having a rod portion for movement in a first direction and in a second direction, and which includes: a first primary chamber portion for receiving pressurized gas to move said rod portion in said first direction, a separate compression chamber portion located within said actuator for containing pressurized gas to oppose movement of said rod portion in said first direction, passageway means connected to said primary chamber portion and to said compression chamber portion, and metering means connected to said compression chamber portion for restricting the flow of gas from said compression chamber portion to a low-pressure region to maintain a pressurized condition in said compression chamber during movement of said rod portion, said passageway means conducting gas from said primary chamber portion to said compression chamber portion when pressurized gas is initially received in said primary chamber portion.

2. The actuator defined in claim 1, wherein there is included a check valve means, said compression chamber portion communicating with said primary chamber portion through check valve means, said check valve means being combined with said passageway means intermediate said primary chamber portion and said compression chamber portion and being provided to prevent the flow of gas from said compression chamber portion to said primary chamber portion during movement of said rod portion.

3. The actuator defined in claim 1, wherein said rod portion includes an internal cavity, said rod portion internal cavity having said compression chamber portion located substantially therein.

4. An actuator having valve means for controlling directional movement of a rod portion in a first direction and in a second direction, comprising: a first primary chamber portion for receiving pressurized gas to move said rod portion in said first direction, a second primary

chamber portion for receiving pressurized gas to move said rod portion in said second direction, an integral compression chamber for receiving pressurized gas to restrict movement of said rod portion in one of said directions, gas conducting means connected to said compression chamber and connected to one of said primary chamber portions, and metering means connected to said compression chamber for limiting the rate of flow of pressurized gas from said compression chamber to a low-pressure region, said valve means directing a substantially unrestricted flow of gas from said second primary chamber portion to a low-pressure region when directing high-pressure gas to said first primary chamber portion, and directing a substantially unrestricted flow of gas from said first primary chamber portion to a low-pressure region when directing high-pressure gas to said second primary chamber portion.

5. In an actuator having an extendible rod portion for attachment to a load to be moved in the first direction and in a second direction: a first primary chamber portion for receiving high-pressure gas to move said rod portion in said first direction, a second primary chamber portion for receiving high-pressure gas to move said rod portion in said second direction, a first compression chamber portion for receiving gas to establish a force opposing movement of said rod portion in said first direction, a second compression chamber portion for receiving gas to establish a force opposing movement of said rod portion in said second direction, first passageway means connected to said first primary chamber portion and connected to said first compression chamber portion, second passageway means connected to said second primary chamber portion and connected to said second compression chamber portion and flow control means connected to each said compression chamber portion for limiting the rate of flow of gas therefrom to a low-pressure region during movement of said rod portion to thereby control the magnitude of said opposing forces.

6. The actuator defined in claim 5, wherein said rod portion includes an internal cavity, said rod portion internal cavity having said first and second compression chamber portions located substantially therein.

7. The actuator defined in claim 5, wherein each said passageway means is combined with a check valve means, one of said check valve means being held in its closed condition by pressurized gas when said rod portion is moved in one of said directions, and the other of said check valve means being held in its closed condition by pressurized gas when said rod portion is moved in the other of said directions.

8. The actuator defined in claim 5, wherein there is provided valve means for directing the flow of pressurized gas to said primary chamber portions and for directing a substantially unrestricted flow of gas from said primary chamber portions to a low-pressure region, said valve means directing pressurized gas to said first primary chamber portion when directing a substantially unrestricted flow of gas from said second primary chamber portion, and directing pressurized gas to said second primary chamber portion when directing an unrestricted flow of gas from said first primary chamber portion.

9. An actuator having a body portion, a piston means, a rod portion connected to said piston means and projecting from said body portion for controlled movement in a first direction and in a second direction, a primary chamber defined by said body portion and by said piston means, a continuously vented variable-volume compression chamber portion located interiorly of said rod portion for containing pressurized gas to control movement of said rod portion in said first direction, and valved passageway means connected to said primary chamber means and to said compression chamber portion, said chamber portion being varied in volume during movement of said rod portion in said first direction in proportion to the degree of movement of said rod portion.

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10. The actuator defined in claim 9, wherein a stem means is attached to said body portion for use in venting said chamber portion to the low-pressure region, said stem means projecting interiorly of said rod portion.

11. An actuator having a body portion, separated primary chambers which are partially defined by said body portion, a rod portion projecting from said body portion for extension and retraction relative thereto, a continuously vented first compression chamber portion located interiorly of said rod portion for containing pressurized gas to control extension of said rod portion, a continuously vented second compression chamber portion located interiorly of said rod portion for containing pressurized gas to control retraction of said rod portion, and separate passageway means each connected to a primary chamber means and to one of said compression chamber portions, said first and second compression chamber portions varying in volume during extension and retraction of said rod portion in proportion to the degree of said extension and retraction.

12. The actuator defined in claim 11, wherein there is

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provided piston means for at least partially separating said first compression chamber portion from said second compression chamber portion, said piston means being attached to said body portion and located interiorly of said rod portion.

13. The actuator defined in claim 11, wherein a stem means is attached to said body portion for cooperation with the interior of said rod portion, said stems means having passageways contained therein for use in supplying gas to one of said compression chamber portions, and for use in venting the other of said compression chamber portions to a low-pressure region.

References Cited in the file of this patent

UNITED STATES PATENTS

2,664,859	Green	Jan. 5, 1954
2,676,572	Perry	Apr. 27, 1954
2,677,933	Topkinson	May 11, 1954
2,699,018	Carman	Jan. 11, 1955
2,778,343	Crosetto	Jan. 22, 1957