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54 Rotary actuator.

57 The force exerted by the spring 21 on the piston assembly 5 as the latter moves away from the end closure member 3 is at least partly balanced by introducing pressurised fluid into a space 29 in the casing 16 between the end closure member 4 and the piston 20.

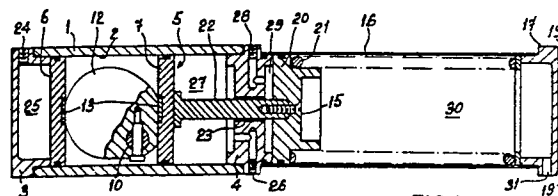


FIG.1

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Rotary actuator

This invention relates to a pressure fluid-operated rotary actuator of the kind comprising a housing with a cylindrical bore, a piston assembly comprising a pair of spaced-apart pistons coupled together for simultaneous sliding movement within said cylindrical bore, a cam situated between the two pistons and secured to a shaft rotatable about an axis fixed relative to the housing and disposed substantially at right angles to the longitudinal axis of said cylindrical bore with the peripheral surface of the cam engaging the confronting surfaces of the two pistons of said piston assembly, spring means urging said piston assembly in a first direction towards a limit position within said cylindrical bore, and means for supplying pressurised fluid to a space in said cylindrical bore for moving said piston assembly away from said limit position in a second direction opposite to said first direction.

By supplying a pressurised fluid, usually compressed air, to said space, the resulting movement of the piston assembly away from said limit position in said second direction is converted by said cam into a rotary movement of said shaft, and this rotary movement is employed to operate one or more mechanical or electrical devices. For example, the shaft may operate various forms of rotary fluid-control valves or be used to control the opening and closing of doors or the setting of the air vanes in an air conditioning plant. Again, the rotation of the shaft may be employed to control the actuation of one or more electrical switches which in turn control some form of electrical apparatus. The spring means of the actuator returns the piston assembly to said limit position when the supply of pressurised fluid to said space is cut off and the space is connected to exhaust, and acts as a fail-safe device in the event of failure of the supply of pressurised fluid to the actuator. Return of the piston assembly to said limit position may be assisted by supplying pressurised fluid to a second space in said cylindrical bore.

A disadvantage of rotary actuators of the kind referred to

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is that more and more energy is used in loading the spring means the farther the piston assembly moves away from said limit position in said second direction. Consequently, the torque available at the shaft of the actuator decreases the
5 farther the piston assembly moves from said limit position in said second direction.

The present invention aims to provide a rotary actuator of the kind referred to in which the torque available from said shaft is more nearly constant throughout the movement of the
10 piston assembly from said limit position in said second direction.

According to the invention, a rotary actuator of the kind referred to is characterised in that the force exerted by the spring means on the piston assembly as the latter moves from
15 said limit position in said second direction is at least partly balanced by a third pressurised fluid-operated piston acting on the spring means.

Said third piston may be slidable in said cylindrical bore in which case a fluid-tight partition would be provided in the
20 housing to divide the cylindrical bore into two coaxial compartments in which the piston assembly and the third piston, respectively, would be located, a rod slidable in a fluid-tight manner in said partition being interposed between said piston assembly and said third piston. Preferably, however, said third piston
25 is slidable in a hollow cylindrical casing secured to said housing. In this last-mentioned case, it is preferred that said cylindrical casing should be mounted on one end of said housing, preferably with the longitudinal axes of the housing and casing in alignment with one another. In this case, a
30 common end closure may be provided for both the housing and said cylindrical casing, a rod slidable in a fluid-tight manner in said common end closure member being interposed between the piston assembly and said third piston.

The spring means of the actuator is preferably a helical

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spring and the movement of the piston assembly from said limit position in said second direction may place the spring under tension. Preferably, however, the spring is arranged so that movement of the piston assembly from said limit
5 position in said second direction places the spring under increasing compression.

The invention will now be described, by way of example, with reference to the accompanying drawing, in which

Figure 1 is a sectional side view of one embodiment of
10 a rotary actuator in accordance with the invention,

Figure 2 is a partly sectioned plan of the actuator of Figure 1,

Figure 3 is a sectional view taken on the line III-III of Figure 2, and

15 Figure 4 is a partly sectioned schematic side view of a second embodiment of a rotary actuator in accordance with the invention.

The rotary actuator shown in Figures 1 to 3 comprises a housing 1 having a circular cylindrical bore 2 therein and
20 end closure members 3 and 4. Slidable within the bore 2 is a piston assembly, generally designated by the numeral 5, which comprises two pistons 6, 7 held together in spaced-apart relationship by tubes 8 to which the pistons are secured by screws 9.

25 A shaft 10 is rotatably mounted in bearings 11 in the walls of the housing 1, the axis of the shaft being disposed between the pistons 6, 7 at right angles to the longitudinal axis of the bore 2. A disc cam 12 is secured to the shaft 10 and has its peripheral surface bearing against discs 13 of
30 low friction material, for example polytetrafluoroethylene, secured in the confronting surfaces of the pistons 6, 7.

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The numeral 16 designates a hollow cylindrical casing which is secured between the closure member 4 and an end cap 17 by means of tie rods 18 and nuts 19, the longitudinal axis of the casing 16 being aligned with the longitudinal axis of the bore 2. A piston 20 is slidable in the casing 16 and a helical spring 21 is housed in the casing 16 between the piston 20 and the end cap 17. A rod 22, which is slidable in a fluid-tight bearing 23 in the end closure member 4, has one end connected to the piston 20 by a screw 15 and its other end abutting the piston 7.

The end closure member 3 has a screw-threaded through-bore 24 for attachment of a conduit (not shown) by means of which compressed air can be supplied to, or exhausted from, the cylinder space 25 between the piston 6 and the end closure member 3. The end closure member 4 has a first screw-threaded through-bore 26 for attachment of a conduit (not shown) by means of which compressed air can be supplied to, or exhausted from, the cylinder space 27 between the piston 7 and the end closure member 4. The end closure member 4 has a second screw-threaded through-bore 28 for attachment of a conduit (not shown) by means of which compressed air can be supplied to, or exhausted from, the cylinder space 29 between the piston 20 and the end closure member 4. The cylinder space 30 between the piston 20 and the end cap 17 is connected to atmosphere by a through-bore 31 in the end cap 17.

Figure 1 shows the actuator with the piston assembly 5 in the limit position into which it is urged by the spring 21. If compressed air is supplied to the cylinder space 25, with the cylinder space 27 connected to exhaust, the piston assembly 5 will be moved to the right (as viewed in Figure 1) to cause rotation of the cam 12 and its shaft 10 in a clockwise direction (as viewed in Figure 1). The profile of the cam 12 is designed so that it always makes contact with the inwardly-facing surface of the piston 6 substantially

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at the centre of this surface. If the action of the spring 21 is ignored, this means that a substantially constant output torque would be delivered by the shaft 10 as the piston assembly 5 moves from left to right as viewed in Figure 1. However, as the piston assembly moves more and more to the right, the spring 21 is compressed more and more by the piston 20, via the rod 22, with the result that more and more of the energy of the compressed air is used in compressing the spring 21 and less and less of the energy is converted into a useful output torque at the shaft 10. However, if at the same time as compressed air is supplied to the cylinder space 25, further compressed air is supplied via the bore 28 to the cylinder space 29, this further compressed air will force the piston 20 to the right (as viewed in Figure 1) and at least partly balance the restoring force of the spring 21. Different situations can arise depending on various parameters of the actuator, in particular the strength of the spring 21 and the pressure of the compressed air supplied to the cylinder space 29. If these parameters are such that the supplying of compressed air to the space 29 results in the rod 22 no longer bearing against the piston 7, then the piston assembly 5 is entirely relieved of the restoring force of the spring 21 and a substantially constant torque is delivered by the shaft 10 throughout the movement of the piston assembly 5 from its position shown in Figure 1 to a position in which the piston 7 comes up against the end closure member 4. On the other hand, if these parameters are such that the rod 22 still bears against the piston 7 when compressed air is supplied to the cylinder space 29, then the piston assembly 5 will not be entirely relieved of the restoring force of the spring 21. Consequently, there will be a decrease in the torque delivered by the shaft 10, as the piston assembly 5 moves to the right, as viewed in Figure 1, but this torque will be more nearly constant than in the case in which compressed air is not supplied to the cylinder space 29.

Although different sources of compressed air may be used

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to supply the cylinder spaces 25 and 29, it is usually suitable to supply air from the same compressed air supply to the two spaces.

In order to return the piston assembly 5 from its displaced position back to the position shown in Figure 1, it is only necessary to cut off the supply of compressed air to the spaces 25 and 29 and connect the bores 24 and 28 to exhaust. The spring 21 will then re-assert itself and return the piston assembly 5 to the position shown in Figure 1. However, in order to assist the return of the piston assembly, compressed air may be supplied via the bore 26 to the cylinder space 27.

In a modified embodiment of the rotary actuator shown in Figures 1 to 3, the casing 16 is formed integrally with, and as an extension of, the housing 1, as indicated by the chain lines 16b in Figure 2. In this case, the end closure member 4 may be formed as a partition wall in the combined casing and housing.

In the embodiment of the rotary actuator shown in Figure 4, the spring 21 of the embodiment of Figures 1 to 3 is replaced by a tension spring 21a housed in a spring casing 16a mounted at the opposite end of the housing 1 compared with the casing 16 of Figures 1 to 3.

In the embodiment of Figure 4, the housing 1, the piston assembly 5, the cam 12 and the shaft 10 are of the same construction as in the embodiment of Figures 1 to 3. The end closure member 3 of the housing 1 serves as a common end closure member for the housing 1 and the casing 16a. A piston 20a is slidable in the casing 16a, and this piston is connected to the piston 6 of the piston assembly 5 by a rod 22a. The rod 22a is slidable in a fluid-tight bearing 33 in the end closure member 3. The tension spring 21a has one of its ends secured to the end cap 17 and its other end secured to the piston 20a. The cylinder space 30 is open to

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atmosphere and a bore 34 communicating with the cylinder space 29 would be connected to a conduit (not shown) for supplying compressed air to, and withdrawing it from, the cylinder space 29. In use of the embodiment of the rotary actuator shown in Figure 4, movement of the piston assembly 5 away from the end closure member 3 results in tensioning of the spring 21a, and tensioning of the spring is assisted by supplying compressed air via the bore 34 to the cylinder space 29.

10 Although the above description is concerned with rotary actuators operated by compressed air, it will be appreciated that the invention is also applicable to actuators operated by other pressurised gaseous or liquid media, for example oil.

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CLAIMS

1. A pressure fluid-operated rotary actuator comprising a housing (1) with a cylindrical bore (2), a piston assembly (5) comprising a pair of spaced-apart pistons (6, 7) coupled together for simultaneous sliding movement within said cylindrical bore, a cam (12) situated between the two pistons and secured to a shaft (10) rotatable about an axis fixed relative to the housing and disposed substantially at right angles to the longitudinal axis of said cylindrical bore with the peripheral surface of the cam engaging the confronting surfaces (13) of the two pistons of said piston assembly, spring means (21; 21a) urging said piston assembly in a first direction towards a limit position within said cylindrical bore, and means (24) for supplying pressurised fluid to a space in said cylindrical bore for moving said piston assembly from said limit position in a second direction opposite to said first direction, characterised in that the force exerted by the spring means (21; 21a) on the piston assembly (5) as the latter moves from said first limit position in said second direction is at least partly balanced by a third pressurised fluid-operated piston (20; 20a) acting on the spring means.

2. An actuator according to claim 1, characterised in that said third piston (20; 20a) is slidable in a hollow cylindrical casing (16; 16a) secured to said housing (1).

3. An actuator according to claim 2, characterised in that said cylindrical casing (16; 16a) is mounted on one end (4; 3) of said housing (1).

4. An actuator according to claim 3, characterised in that the longitudinal axes of the housing (1) and the casing (16; 16a) are in alignment with one another.

5. An actuator according to claim 4, characterised in that a common end closure member (4; 3) is provided for both the housing (1) and said cylindrical casing (16; 16a), a rod (22; 22a) slidable in a fluid-tight manner in said common end

closure being interposed between the piston assembly (5) and said third piston (20; 20a).

6. An actuator according to claim 1, characterised in that said third piston (20; 20a) is slidable in said cylindrical bore (2).

7. An actuator according to claim 6, characterised in that a fluid-tight partition is provided in the housing (1) to divide the cylindrical bore (2) into two coaxial compartments in which the piston assembly (5) and the third piston (20; 20a), respectively, are located, a rod (22; 22a) slidable in a fluid-tight manner in said partition being interposed between said piston assembly and said third piston.

8. An actuator according to any of the preceding claims, characterised in that said spring means (21; 21a) is a helical spring.

9. An actuator according to claim 8, characterised in that the movement of the piston assembly (5) from said limit position in said second direction places the spring (21a) under tension.

10. An actuator according to claim 8, characterised in that the spring is arranged so that movement of the piston assembly (5) from said limit position in said second direction places the spring (21) under increasing compression.

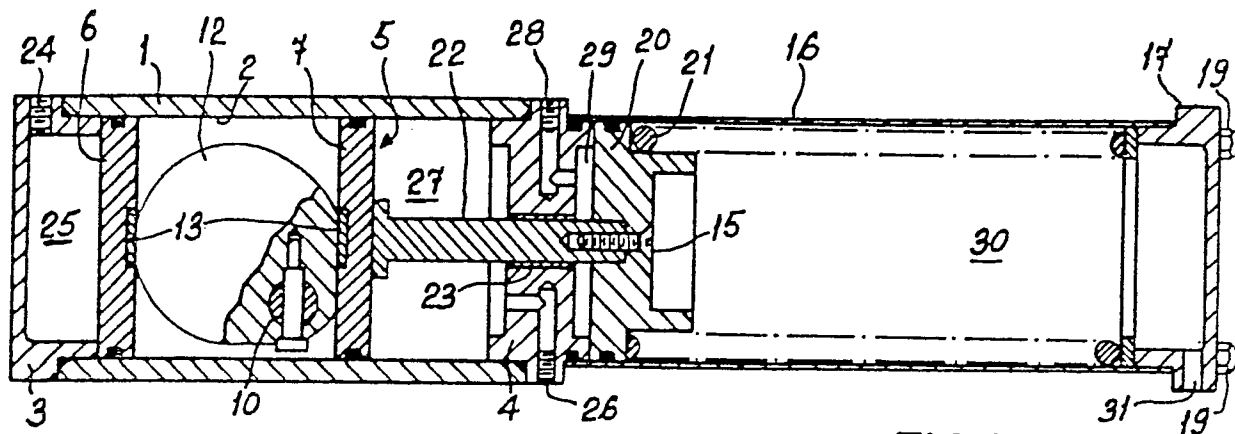


FIG. 1

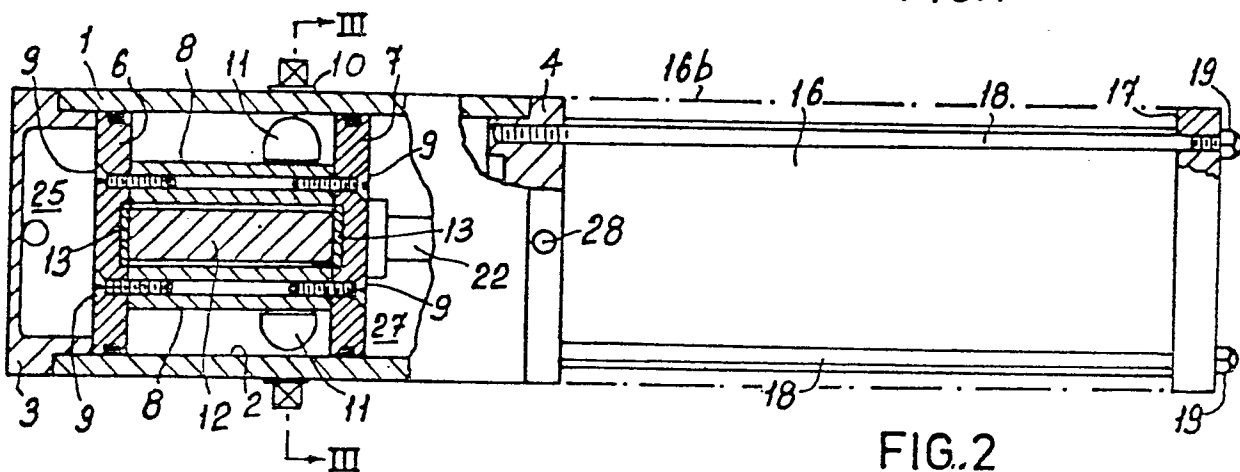


FIG. 2

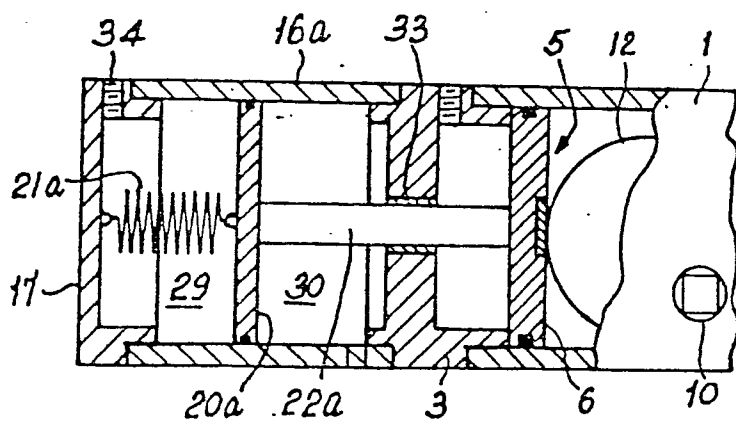


FIG. 4

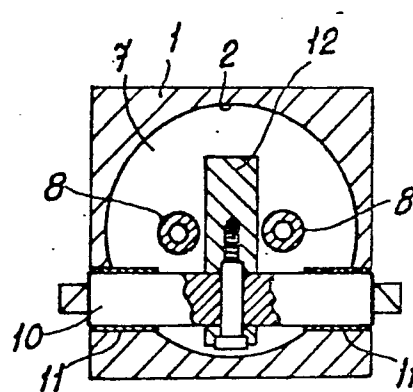


FIG. 3



European Patent
Office

EUROPEAN SEARCH REPORT

0034882

Application number

EP 81 30 0305

DOCUMENTS CONSIDERED TO BE RELEVANT			CLASSIFICATION OF THE APPLICATION (Int. Cl. ³)
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	
X	<u>DE - A - 2 012 765</u> (SERK) * Page 2, lines 13-22 * --	1-8, 10	F 15 B 15/08
X	<u>US - A - 4 087 074</u> (MASSEY) * Column 1, lines 27-43 * --	1-8, 10	
X	<u>FR - A - 2 321 059</u> (GACHOT) * Page 6, lines 13-24 * --	1-8, 10	
A	<u>FR - A - 2 041 511</u> (VIAUD) & GB - A - 1 287 528 ----		
			TECHNICAL FIELDS SEARCHED (Int. Cl. ³)
			F 15 B F 16 K
			CATEGORY OF CITED DOCUMENTS
			X: particularly relevant A: technological background O: non-written disclosure P: intermediate document T: theory or principle underlying the invention E: conflicting application D: document cited in the application L: citation for other reasons
☒ The present search report has been drawn up for all claims			&: member of the same patent family, corresponding document
Place of search The Hague		Date of completion of the search 10-04-1981	Examiner KNOPS