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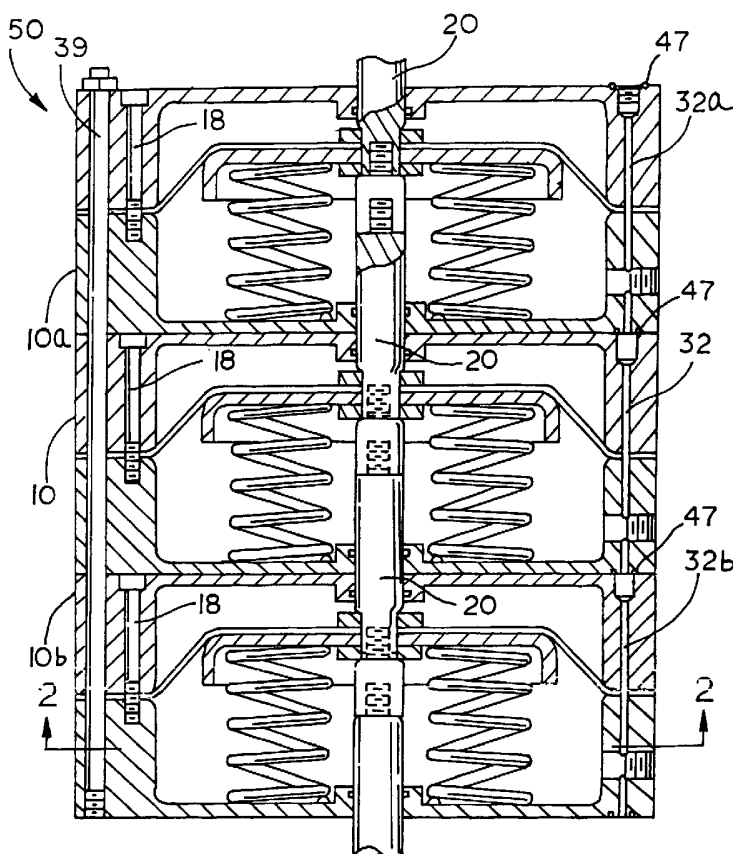
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(54) Title: REVERSIBLE, MODULAR FLUID ACTUATOR WITH AN INTEGRATED FLUID MANIFOLD



(57) Abstract: A modular, reversible actuator (10) contains an integrated manifold, eliminating the need for external tubing and increasing the area of the diaphragm (24), thus providing a greater actuating force. The actuator comprises a housing (12) with two interior chambers (14a, 14b) divided by a diaphragm assembly (24, 26, 28). Located internally within the housing are at least two circumferentially spaced longitudinal ports (36, 38) to supply and/or vent a pressurized fluid into the chambers and thereby actuate the diaphragm assembly. A biasing element (30a, 30b) provides the actuator with a fail-safe position. The actuator is capable of being combined or stacked with other actuators (10a, 10b) to further increase the force. The actuator may be reversibly attached to a machine element to change the position that the machine element is biased towards.



European patent (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IT, LU, MC, NL, PT, RO, SE, SI, SK, TR), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

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REVERSIBLE, MODULAR FLUID ACTUATOR WITH AN INTEGRATED FLUID MANIFOLD

Technical Field

The present disclosure relates to fluid actuators, and more particularly to a
5 reversible, modular actuator with an integrated fluid manifold and a biasing element
to bias the actuator in a fail-safe position.

Background

Pneumatic actuators have been utilized in a variety of different applications
and situations, including, for example, in fluid actuated tools as shown in U.S. Patent
10 Nos. 3,323,346 and 5,522,302. Pneumatic actuators are typically comprised of a
sealed housing with a diaphragm or piston connected to a piston rod, wherein a fluid
is capable of being injected into one chamber of the housing to actuate the diaphragm
or piston, and subsequently the piston rod, to a new location following simple fluid
mechanics. The displacement motion of the piston rod may then be harnessed by any
15 number of mechanical linkages to perform a variety of desired operations.

One such way to utilize an actuator is described in U.S. Patent No. 3,323,346,
which discloses a fluid actuated hand tool which may be employed to crimp the
ferrule portion of electrical connectors to their conductors. The crimping tool is
comprised of a housing with a cylindrical bore therein which is closed at both ends.
20 Multiple pistons and piston rods are provided within the bore and are mounted for
reciprocation within the bore. A pressure inlet port is drilled into the housing to
communicate with the bore and the inlet port is adapted to accept an external fluid
pressure source. Porting between the pistons is achieved by way of ports located
within the piston rods. Pressure exhaust ports are also provided to connect to an
25 external exhaust source. Movement of the piston is effected by pressurizing fluid into
the actuator. By relying upon porting between the piston chambers via holes located

within the piston rods to distribute the fluid pressure, the larger piston rods reduces the piston area available, making the actuator less efficient.

Another utilization of an fluid filled actuator is described in U.S. Patent No. 5,522,302, which discloses a multi-piston fluid actuator with longitudinal

5 circumferentially spaced ports carried within a cylindrical housing. The pressurizing fluid is delivered and exhausted through the ports carried in the housing. Additional add-on-units with complementary longitudinal porting may be added to increase the force available to the actuator. The actuator utilizes fluid pressure to actuate the pistons within the housing. In other words, movement of the pistons is only effected

10 by pressurizing fluid into the specific chambers of the actuator. By relying upon pressurizing fluid to actuate the pistons, however, the actuator piston becomes stationary in the event of fluid pressure loss, making the actuator vulnerable during pressure failures.

Brief Description of the Drawings

15 FIG. 1 is a longitudinal cross sectional of a pneumatic actuator illustrating an embodiment of the disclosed apparatus.

FIG. 2 is a cross sectional view of the pneumatic actuator taken along line 2-2 of FIG. 1.

FIG. 3 is a longitudinal cross sectional view of a pneumatic actuator in

20 operation.

FIG. 4 is a longitudinal cross sectional view of an assembly of three actuators.

FIG. 5 is a cross sectional view of a pneumatic actuator illustrating an alternative embodiment of the disclosed apparatus.

Detailed Description

The actuator shown in the accompanying drawings is biased to a predetermined position for use in a mechanical application requiring a "fail-safe" position in the event of a fluid pressurization failure. The disclosed actuator contains
5 an integrated manifold, eliminating the need for external tubing and increasing the area of the diaphragm, thus providing a greater actuating force. Additionally, by circumferentially aligning the supply/vent ports, the actuator is capable of being combined or stacked with other actuators to further increase the force provided by the actuator depending upon the size required for a specific application. Moreover, by
10 providing an integrated manifold, the actuator may be reversed to change the biasing direction by merely changing the configuration of the actuator and without purchasing a new actuator.

Referring now to the drawings, and specifically to FIG. 1, there is illustrated an example of a fluid actuator 10. As shown, the fluid actuator 10 may have, for
15 example, a generally cylindrical housing 12 defining a chamber 14. In the illustrated embodiment, the housing 12 is comprised of a first housing segment 12a and a second housing segment 12b. The two housing segments 12a and 12b may be formed by an extrusion process, including for example, extruded plastic or extruded aluminum. It will be understood that the two housing segments 12a and 12b may be formed by any
20 known, or yet to be developed manufacturing method as would be appreciated by those of ordinary skill in the art, including, by way of example, die casting, lost wax casting, or machining. Each housing segment 12a and 12b may have a housing end plate 13a and 13b respectively. The housing end plates 13a and 13b may be integrally formed with their respective housing segments 12a and 12b, or alternatively, the
25 housing end plates may be separate elements joined to their respective housing

segment 12a and 12b by any appropriate means, including for example, welding, heat sealing, or bolting with gasketing. As illustrated in FIG. 2 and FIG. 4, circumferentially spaced assembly bores 16 may be provided within the housing segments 12a and 12b to accept an assembly fastener, for example an assembly bolt 5 18 which allows for the two housing segments 12a and 12b to be joined in complementary coaxial relation to each other.

Referring again to FIG. 1, located within the actuator 10 is an actuator stem 20 generally aligned with the housing 12 along the longitudinal axis. The actuator stem 20 extends through the housing 12 and is constructed so as to permit the actuator stem 10 20 to connect to an actuator stem of a second actuator, or alternatively, to connect to any number of mechanical linkages to perform a variety of desired operations.

Housing end plates 13a and 13b are provided with flanges 22 which hold and support the actuator stem 20 in fluid-tight relation to the housing 12. Dividing the chamber 14 into a first chamber 14a and a second chamber 14b, in this example, is a diaphragm 15 assembly which may be comprised of a flexible diaphragm 24, a stem seal 26, and a diaphragm plate 28. The flexible diaphragm may be manufactured of any flexible material, including for example, fabric reinforced rubber, viton, nitrile, EDPM, or silicone. It will be further understood that the diaphragm assembly may be any motivating element including, for example a piston or other similar element, in lieu of 20 the flexible diaphragm. The diaphragm 24 may be mounted between the first housing segment 12a and the second housing segment 12b in fluid-tight relation by assembly bolts 18, as illustrated in FIG. 4. Similarly, stem seals 26 hold the actuator stem 20 in fluid-tight relation to the two chambers 14a and 14b. Attached between the diaphragm plate 28 and at least one of the housing end plates 13a and 13b may be 25 at least one biasing element, for instance a first spring 30a and a second spring 30b. It

will be appreciated by those of ordinary skill in the art that biasing element may be any element suitable for biasing the diaphragm assembly to a predetermined position, including a diaphragm 24 made of a resilient biased material.

Formed within the housing 12 is an integrated supply/vent port 32 and an
5 integrated supply/vent port 34. The integrated supply/vent ports 32 and 34 are circumferentially spaced within the housing 12, and in one example, illustrated in FIG. 2, the supply/vent ports 32 and 34 may be circumferentially spaced by one hundred and eighty degrees (180°). Returning to FIG. 1, connecting the supply/vent ports 32 and 34 to the first and second chambers 14a and 14b respectively are tunnel
10 ports 36 and 38. Tunnel plugs 40 and 42 may be inserted into the tunnel ports 36 and 38 to form a fluid-tight seal, while supply/vent port plugs 44 and 46 may be inserted into one end of supply/vent ports 32 and 34 to form a fluid-tight seal. Channels 47 may be provided around the supply/vent parts 32 and 34 within the housing 12 to accept any o-ring or similar gasket which, as will be described later, allow the
15 supply/vent ports 32 and 34 to be operatively connected in fluid tight relation to other supply/vent ports. The open end of supply/vent ports 32 and 34 may also be attached to an external fluid supply/vent source (not shown). The fluid supplied by the external source may be, for example, oil, water, air, or other similar fluid.

Referring now particularly to FIG. 3, the actuator 10 is shown in normal
20 operation. In the illustrated example, a fluid is supplied to supply/vent port 34 via the external supply source (not shown). The fluid enters and pressurizes the chamber 14b, causing a pressure force to be exerted upon the diaphragm 24. Once the pressure force is sufficient to overcome the biasing force of springs 30a and 30b, the diaphragm assembly and the attached actuator stem 20 traverses to the actuated
25 position illustrated, thereby compressing the springs 30a and 30b. Meanwhile, as the

chamber 14b pressurizes and the diaphragm assembly traverses to the illustrated position, the movement of the diaphragm assembly forces the fluid within the chamber 14a to exit the chamber 14a via the supply/vent port 32 to the external vent (not shown) which may be attached to the supply/vent port 32.

5 In order to return the actuator 10 to the original, non-pressurized state shown in FIG. 1, the process is reversed, and a fluid is returned under pressure into the chamber 14a via supply/vent port 32. The fluid pressurizes the chamber 14a and causes a pressure force to be exerted upon the diaphragm 24. The pressure force, in conjunction with the biasing force, causes the diaphragm assembly, and the attached
10 actuator stem 20, to transverse to the original position, thereby allowing the springs 30a and 30b to decompress. Simultaneously, as the chamber 14a pressurizes and the diaphragm assembly traverses to its original position, the movement of the diaphragm assembly forces the fluid within the chamber 14b to exit the chamber 14b via the supply/vent port 34 to the external vent (not shown) which may be attached to the
15 supply/vent port 34.

 In an alternative embodiment, the actuator may be allowed to return to the original, non-pressurized state under the influence of the biasing element only. In this example, the fluid present in the chamber 14b is allowed to vent via the supply/vent port 34 until pressure force in the chamber 14b is overcome by the biasing force to
20 cause the diaphragm assembly to return to its original position.

 If, for any reason, the actuator 10 loses pressure within the supply/vent port 32, for example the external fluid supply becomes detached or damaged, or the chamber 14b loses its fluid-tight seal, the diaphragm 24 will actuate to its original biased position, by, in this example, the springs 30a and 30b. By biasing the
25 diaphragm 24, the movement of the diaphragm assembly effectively returns the

actuator 10, the actuator stem 20, and any mechanism operated by the actuator to a fail-safe position. Furthermore, by adjusting the size of the biasing force, and the size and configuration of the actuator stem 20, the actuator 10 may fail in any number of varying positions, with a variety of failure forces.

5 By integrating the supply/vent ports 32 and 34 within the housing 12, the biased actuator 10 becomes reversible, so that the fail-safe position may be changed from a first fail-safe position, closest to an actuated tool, to a second fail-safe position, furthest from an actuated tool, by changing the point at which the actuator 10 attaches to the tool in question. For example, in a first configuration, a tool (not shown)
10 requiring actuation may be operatively connected to the actuator 10, at the housing end plate 13a. By attaching the tool in this configuration, if the actuator should fail, the actuator stem 20 will be biased to a first fail-safe position (FIG. 1) farthest away from the housing end plate 13a and farthest away from the tool itself. This first position may cause the tool to fail such that it causes the tool to cease operation in a
15 safe manner. For example, if the attached tool is a tire brake pad, the first fail-safe position may cause the brake pad to close, thereby stopping the tire from rotating. Alternatively, the same actuator 10 may be operatively connected with the tool located at the housing end plate 13b. In this instance, if the actuator should fail, the actuator stem 20 will be biased to a second fail-safe position (FIG. 1) farthest away
20 from the housing end plate 13a but now closest to the tool. For example, if the attached tool again is a tire brake pad, the second fail-safe position may cause the brake pad to open, thereby allowing the tire to continue rotating.

In still another example, if the attached tool is a control valve, the first fail-safe position may cause a control valve plug to plug into its seat, closing the flow
25 passage and stopping the flow of fluid through the valve and associated downstream

5 piping. For instance, if the control valve is located within a fuel distribution system and a fire causes the actuator to fail, the first fail-safe position may shut off the flow of fuel, limiting the fire potential. Alternatively, if the attached tool again is a control valve, and the actuator 10 is operatively connected with the tool located at the housing end plate 13b, the second fail-safe position may open the control valve plug, allowing the flow of fluid (e.g., fire quenching fluid) thereby aiding in the quenching of the fire.

Referring to FIG. 4, the modular capability of the actuator 10 is illustrated by a cross sectional view of an actuator assembly 50 assembled by combining three
10 actuators 10, 10a and 10b into one integrated unit. The three actuator units 10, 10a and 10b may be joined in coaxial relation, aligning the actuators supply/vent ports 32 and 34 (not shown). As is shown, the supply/vent port plugs 44 are removed from the actuators 10 and 10a, to form one continuous supply/vent ports 32a, 32 and 32b. Although not illustrated, the supply/vent port 46 may be removed from the
15 supply/vent port 34 to also form a continuous supply/vent port. An o-ring or other gasket may be inserted within the channels 47 to form a fluid tight seal around the supply/vent bores 32 and 34. Furthermore, the actuator stems 20 may be connected to form one continuous actuator stem. The three actuator units 10, 10a and 10b may be joined via a number of different means, including, for example, by providing
20 circumferentially spaced stacking bores 37, shown in FIG. 2, within the housing 12 to accept stacking fasteners, for example a bolt 39. The supply/vent ports 32 and 34 may then be connected to an external supply/vent source to operate in the same manner as a single actuator 10, and to provide an increased actuator output force according to known mathematical relationships.

As in the example of only one actuator 10, the actuator assembly 50 is also reversible. For example, by operatively positioning a tool at one end of the actuator assembly 50, the actuator assembly 50 may cause the tool to fail in a first fail-safe position, while if the tool is positioned at the other end of the actuator assembly 50, the tool may fail in a second fail-safe position. Thus, the same actuator assembly may have differing effects on the tool, depending on the positioning of the tool.

In another embodiment shown in FIG 5, the housing 12 is constructed with a different cross sectional profile, reducing the wall thickness of the housing 12. Similar to the previously described embodiment, circumferentially spaced assembly bores 16, circumferentially spaced stacking bores 37, and circumferentially spaced supply/vent ports 32 and 24 may be provided within the housing 12.

Although certain actuators have been disclosed and described herein, the scope of coverage of this patent is not limited thereto. On the contrary, this patent covers all embodiments fairly falling within the scope of the appended claims, either literally or under the doctrine of equivalents.

What is claimed is:

1. A fluid actuator for actuating a machine element, the actuator comprising:
 - 5 a housing having a generally cylindrical longitudinal interior extending through the housing, and having a first end and a second end;
an actuator stem longitudinally aligned with the housing and extending through the housing;
 - a motivating element supporting the actuator stem and dividing the housing
10 into two chambers;
a first tunnel bore longitudinally carried in the housing and opening on each end of the housing;
 - a second tunnel bore longitudinally carried in the housing, opening on each end of the housing and circumferentially spaced from the first tunnel bore;
 - 15 a first traverse tunnel port connecting one of the chambers to the first tunnel bore;
 - a second traverse tunnel port connecting the other one of the chambers to the second tunnel bore;
 - a biasing element for biasing the actuator stem towards the first end of the
20 housing; and
 - wherein the actuator may be reversibly connected to the machine element so as to bias the machine element in a fail-safe position.
2. A fluid actuator according to claim 1, wherein the motivating element
25 comprises a stem seal and a flexible diaphragm.

3. A fluid actuator according to claim 2, wherein the motivating element further comprises a diaphragm plate.

4. A fluid actuator according to claim 1, wherein the motivating element
5 is a rigid piston.

5. A fluid actuator according to claim 1, wherein the first tunnel bore is circumferentially spaced from the second tunnel bore by one hundred and eighty degrees (180°).

10

6. A fluid actuator according to claim 1, wherein the biasing element is a spring.

7. A fluid actuator according to claim 1, wherein the motivating element
15 comprises a stem seal and a resilient diaphragm, and wherein the biasing element is the resilient diaphragm.

8. A fluid actuator according to claim 1, wherein the housing is formed by an extrusion process.

20

9. A fluid actuator according to claim 1, wherein the housing is formed of extruded plastic.

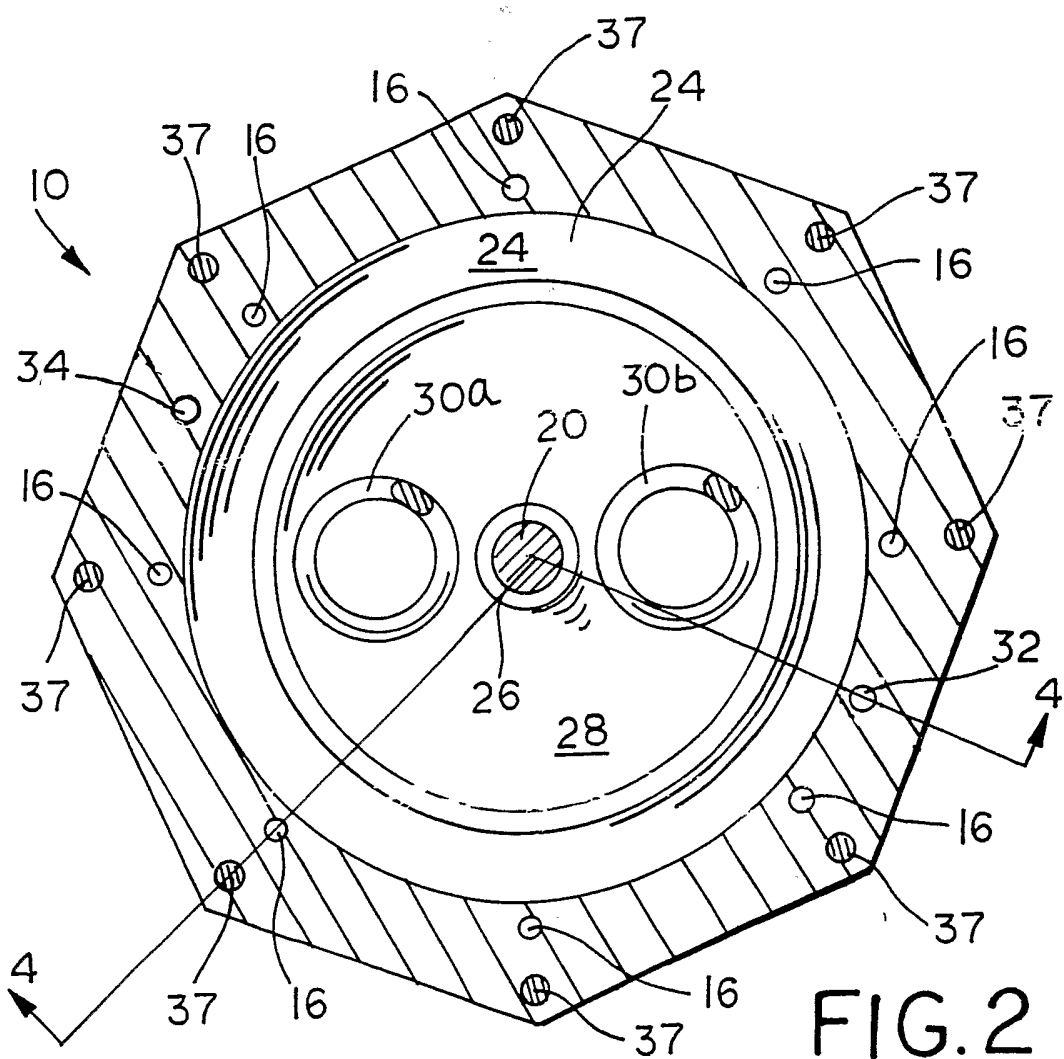
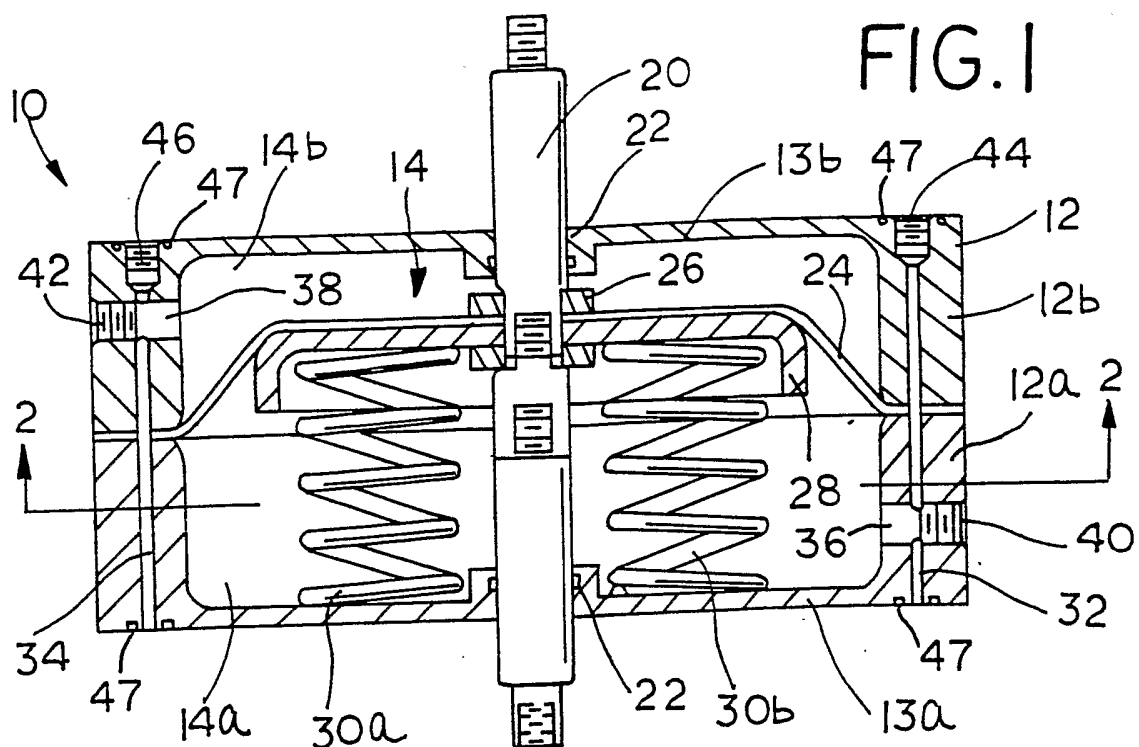
10. A fluid actuator according to claim 1, wherein the housing is formed of
25 extruded aluminum.

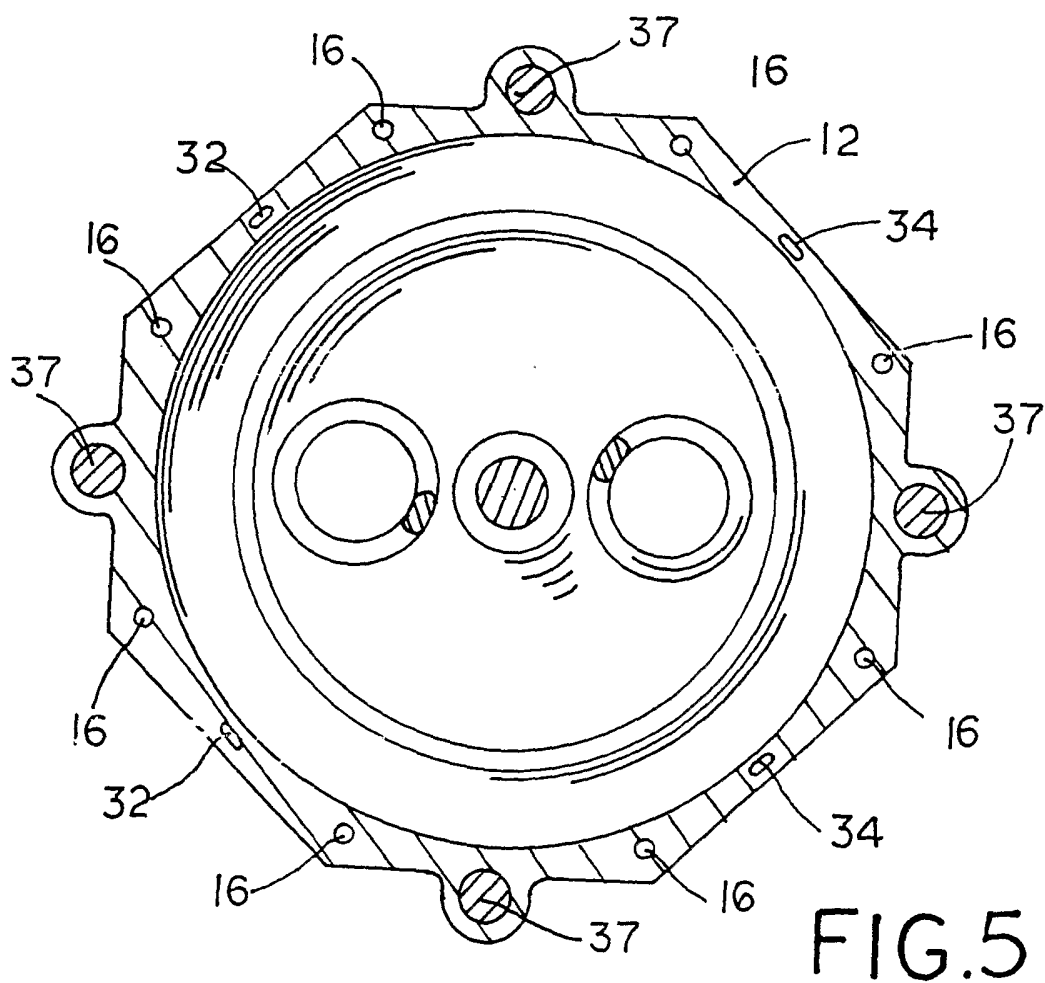
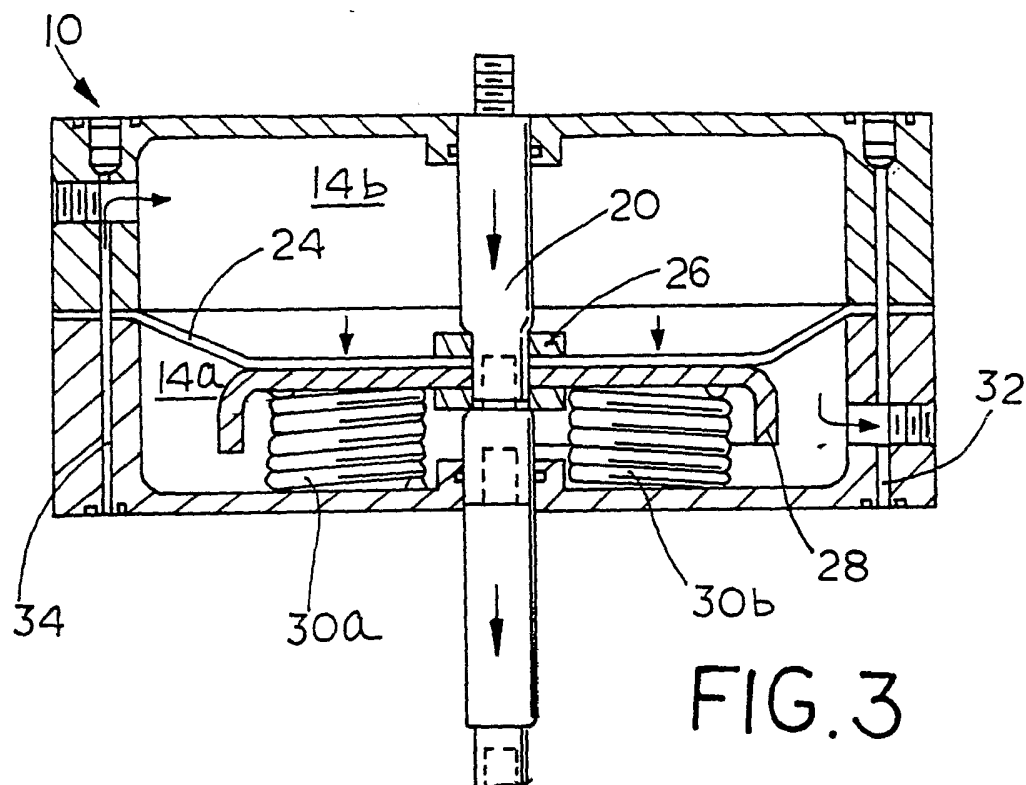
11. A reversible fluid actuator assembly for actuating a machine element.
the actuator comprising:

- a plurality of actuators coaxially aligned and operatively connected, wherein
the actuator assembly may be reversibly connected to the machine element so as to
5 bias the machine element in a fail-safe position, each of the actuators comprising:
- a housing having a generally cylindrical longitudinal interior extending
through the housing, and having a first end and a second end;
- an actuator stem longitudinally aligned with the housing and extending
through the housing;
- 10 a diaphragm assembly supporting the actuator stem and dividing the
housing into two chambers;
- a first tunnel bore longitudinally carried in the housing and opening on
each end of the housing;
- a second tunnel bore longitudinally carried in the housing, opening on
15 each end of the housing and circumferentially spaced from the first tunnel bore;
- a first traverse tunnel port connecting one of the chambers to the first
tunnel bore;
- a second traverse tunnel port connecting the other one of the chambers
to the second tunnel bore; and
- 20 a biasing element for biasing the actuator stem towards the first end of
the housing.

12. A fluid actuator assembly according to claim 11, wherein the
diaphragm assembly comprises a stem seal and a flexible diaphragm!

13. A fluid actuator assembly according to claim 11, wherein the diaphragm assembly comprises a stem seal and a resilient diaphragm and wherein the biasing element is the resilient diaphragm.
- 5 14. A fluid actuator assembly according to claim 11, wherein the first tunnel bore is circumferentially spaced from the second tunnel bore by one hundred and eighty degrees (180°).
- 10 15. A fluid actuator assembly according to claim 11, wherein the biasing element is a spring.





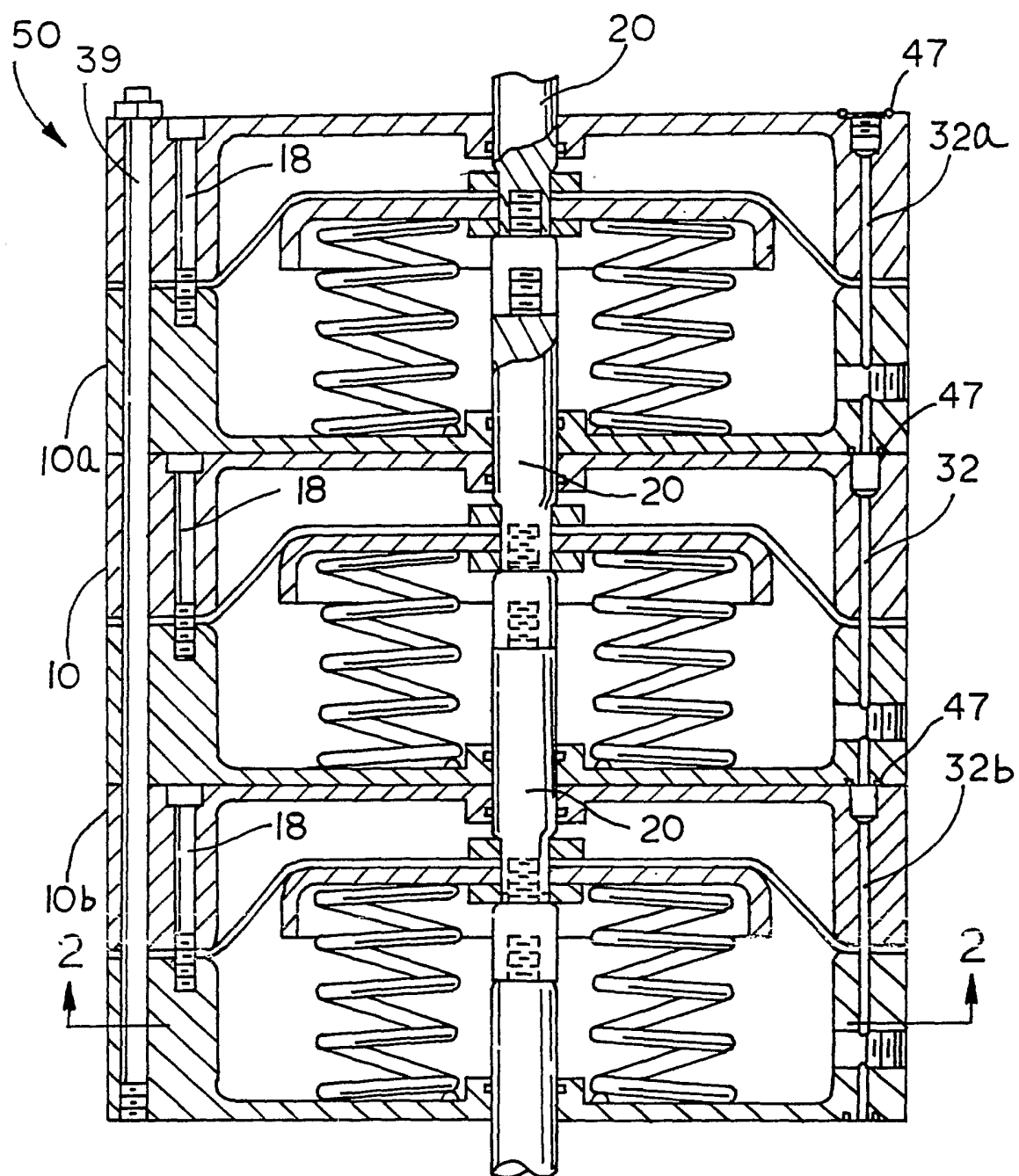


FIG. 4

INTERNATIONAL SEARCH REPORT

International Application No

PCT/US 03/23023

A. CLASSIFICATION OF SUBJECT MATTER

IPC 7 F15B11/036 F15B15/10 F15B20/00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 7 F15B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	DE 89 05 529 U (KETTNER) 24 August 1989 (1989-08-24)	1-6, 8-10
Y	claims 1,2,4 figures 1-3	11, 12, 14, 15
Y	PATENT ABSTRACTS OF JAPAN vol. 017, no. 026 (M-1354), 19 January 1993 (1993-01-19) & JP 04 248085 A (FUJIKURA RUBBER LTD), 3 September 1992 (1992-09-03) abstract; figure 1 -/--	11, 12, 14, 15



Further documents are listed in the continuation of box C.



Patent family members are listed in annex.

* Special categories of cited documents:

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INTERNATIONAL SEARCH REPORT

Intel International Application No

PCT/US 03/23023

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	WO 00 29753 A (TOKKYOKIKI CORP ;YASUDA MASASHI (JP)) 25 May 2000 (2000-05-25) figures 4,11 & US 6 604 451 B1 (YASUDA) 12 August 2003 (2003-08-12) column 13, line 11 - line 22 column 7, line 66 -column 8, line 9 figures 4,11 -----	1-3,5,7, 11-14
A	US 5 522 302 A (KEATON) 4 June 1996 (1996-06-04) cited in the application abstract; figures 1,6,7 -----	1,11
A	DE 20 04 212 A (FELDER) 5 August 1971 (1971-08-05) figures 2-4 -----	2-4,7, 12,13
A	US 3 323 346 A (SCHMIDT) 6 June 1967 (1967-06-06) cited in the application -----	
A	US 4 186 649 A (SUNDSTROM NILS E) 5 February 1980 (1980-02-05) column 3, line 1 - line 37 -----	1,11
A	DE 91 13 805 U (KETTNER) 2 April 1992 (1992-04-02) -----	
A	US 6 422 530 B1 (WILLIAMS III) 23 July 2002 (2002-07-23) -----	
A	PATENT ABSTRACTS OF JAPAN vol. 2000, no. 25, 12 April 2001 (2001-04-12) & JP 2001 208013 A (FUJIKURA RUBBER LTD), 3 August 2001 (2001-08-03) abstract -----	1,11
A	JP 54 010865 A (INDIAN HEAD INC) 26 January 1979 (1979-01-26) -----	

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No
PCT/US 03/23023

Patent document cited in search report		Publication date	Patent family member(s)	Publication date
DE 8905529	U	24-08-1989	DE 8905529 U1	24-08-1989
JP 04248085	A	03-09-1992	JP 2801420 B2	21-09-1998
WO 0029753	A	25-05-2000	WO 0029753 A1	25-05-2000
			US 6604451 B1	12-08-2003
US 5522302	A	04-06-1996	NONE	
DE 2004212	A	05-08-1971	DE 2004212 A1	05-08-1971
US 3323346	A	06-06-1967	NONE	
US 4186649	A	05-02-1980	SE 396639 B	26-09-1977
			CA 1069396 A1	08-01-1980
			DE 2708991 A1	08-09-1977
			DK 91877 A	04-09-1977
			FR 2343284 A1	30-09-1977
			GB 1571046 A	09-07-1980
			IT 1125756 B	14-05-1986
			JP 52106075 A	06-09-1977
			SE 7602985 A	04-09-1977
DE 9113805	U	02-04-1992	DE 9113805 U1	02-04-1992
US 6422530	B1	23-07-2002	NONE	
JP 2001208013	A	03-08-2001	NONE	
JP 54010865	A	26-01-1979	NONE	