

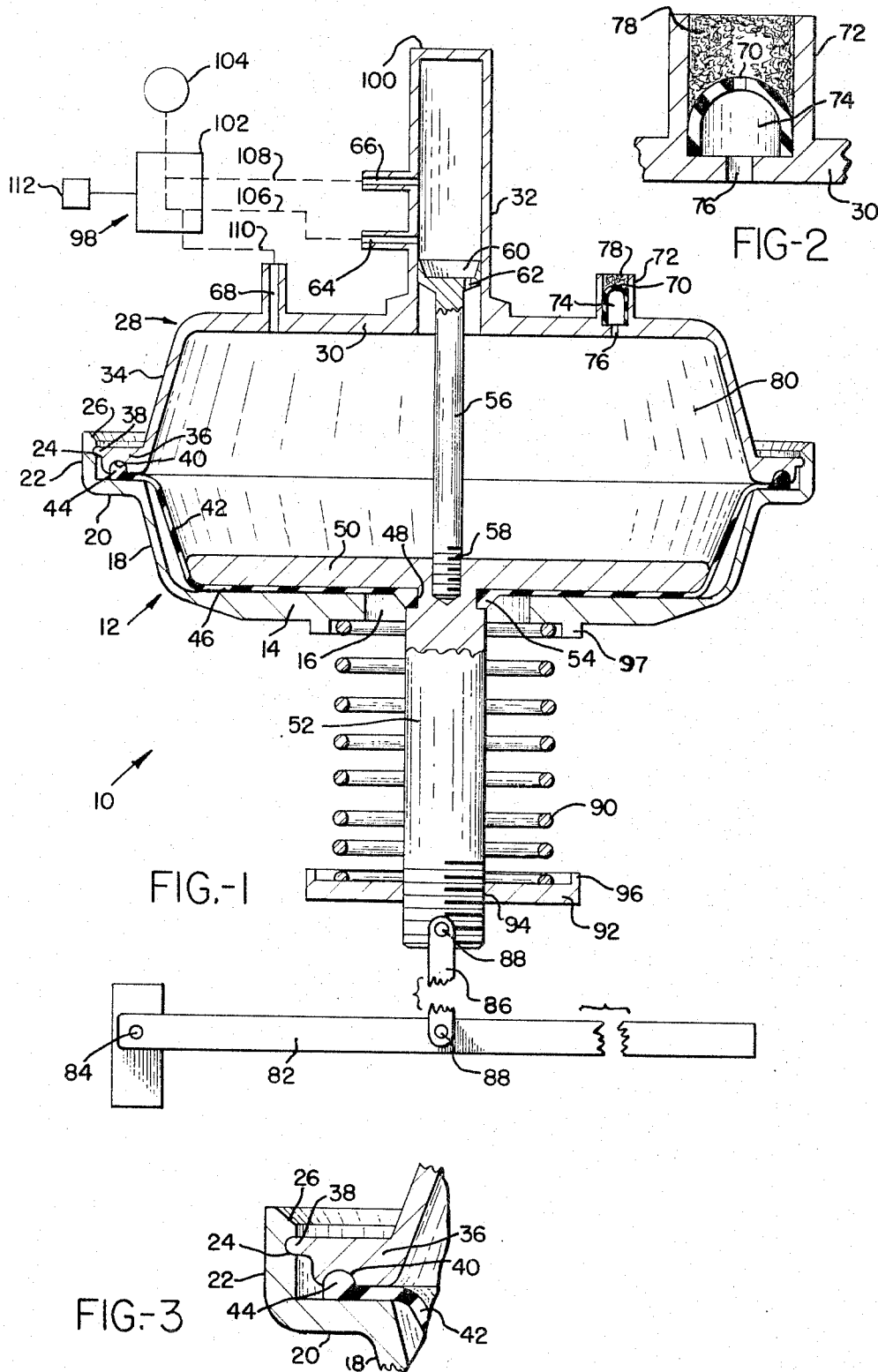
**Aug. 8, 1967**

R. W. HOUSER

3,334,545

# MULTIPLE POSITION VACUUM ACTUATOR

Filed March 10, 1965



1

3,334,545

**MULTIPLE POSITION VACUUM ACTUATOR**  
Roy W. Houser, Fullerton, Calif., assignor to Robertshaw Controls Company, Richmond, Va., a corporation of Delaware

Filed Mar. 10, 1965, Ser. No. 438,661  
15 Claims. (Cl. 91-49)

This invention relates to a multiple position vacuum actuator.

According to this invention, a casing is provided having a bottom with a centrally located casing shaft opening, the casing having a top with a centrally located upwardly directed cylinder. A diaphragm has its rim sealed and held by the casing with the diaphragm having a central opening. A plunger shaft construction is connected and sealed to the diaphragm opening and has its lower end extending through the casing shaft opening. The plunger construction also has a piston construction at its upper end extending into the cylinder. The piston has a fluid flow opening, and the cylinder has a plurality of suction fluid flow openings opened and closed by the piston to regulate the distance of travel of the piston construction.

Other features are apparent from this description, the appended claimed subject matter, and/or the accompanying drawings in which:

FIGURE 1 is a diagrammatic cross section of the actuator and showing connections to a vacuum means and to an actuated member.

FIGURE 2 is an enlarged cross section of a portion of the actuator of FIGURE 1.

FIGURE 3 is an enlarged cross section of another portion of the actuator of FIGURE 1.

Certain words indicating direction, relative position, and the like have been used for the sake of brevity and clearness of description. However, it is to be understood that such words are used in connection with the positions shown in the drawing, and that in actual use, such direction, relative position and the like may be entirely different, as is obvious. Samples of such words are "upwardly," "downwardly," "side" and the like.

A multiple position vacuum actuator, according to this invention, may include an actuator casing 10 which may include a cup shaped casing member 12 having a flat bottom 14 with a centrally located casing shaft opening 16 in the flat bottom 14. The flat bottom 14 may be connected to an upwardly directed and outwardly flared side wall 18. The side wall 18 may have a flat outwardly directed rim 20 which has an upward flange 22. The flange 22 may have an inwardly directed groove 24.

The flange 22 may be slightly resilient, so that it can be outwardly sprung a slight amount. The upper end of the flange 22 may be outwardly flared at 26.

The actuator casing 10 may also have an inverted cup-shaped casing member 28. The member 28 may have an inverted flat bottom 30 which may have a centrally located upwardly directed cylinder 32. The inverted casing flat bottom 30 may also be connected to a downwardly directed and outwardly flared side wall 34. The outwardly flared side wall 34 may have a flat outwardly directed flange 36 with an outwardly directed bead 38, which bead engages the inwardly directed groove 24.

The groove 24 and the bead 38 may be snapped together by downwardly pushing the bead 38 past the outward flange 26, to lock the flange 36 and flange 22 together.

The outwardly directed flange 36 has a downwardly directed groove 40. A flexible diaphragm 42 may have an outer rim bead 44 which is held in and between the downwardly directed groove 40 and the outwardly directed rim 20. The diaphragm 42 has a normally flat central diaphragm portion 46. The central diaphragm portion 46 has a central plunger receiving opening 48.

2

A plunger construction may include a flat plate 50, which engages the central flat portion 46 of the diaphragm.

The plunger construction also includes a downward shaft 52 which engages and is sealed to the central diaphragm opening 48 by the enlarged flexible inner bead 54 of the central diaphragm opening 48, which engages a corresponding groove in the shaft 52. The downward shaft 52 also passes through the casing shaft opening 16 and extends downwardly below the casing 10.

The plunger construction also includes an upward piston shaft 56 which is connected to the flat plate 50, for example, by a threaded construction 58. The piston shaft 56 has a piston 60 at its upper end, and which piston is located in the cylinder 32 and has a fluid flow opening 62. If desired, the piston 60 may be cup shaped, as shown.

The cylinder 32 has two axially spaced fluid flow openings 64 and 66 which are opened and closed by the piston 60, as it is moved up and down in the cylinder by the movement of the flat diaphragm portion 46, the plate 50, and the shaft 56. The inverted flat bottom 30 also has a fluid flow opening 68. The fluid flow openings 64, 66 and 68 are formed by cylindrical extensions, which may be integral to the cylinder 32 and the bottom 30, if desired.

The inverted cup shaped casing member 28 may be integral with the cylinder 32, as shown.

The piston 60 may be placed in the cylinder 32 after the diaphragm 42 has had its bead 44 inserted in the groove 40. The diaphragm may also have its inner bead 54 inserted in the opening or groove of the shaft 52 which receives the diaphragm 48 which is provided where the flat plate 50 joins the downward shaft 52. The shaft 52 may be inserted through the opening 16 of the cup shaped member 12, and then the resilient upward flange 22 and the outward flange 36 may be snapped together, to snap the bead 38 into the groove 24 and secure the parts together. An efficient and easily made construction is thus provided.

The parts so far described may be made of metal or plastic material particularly in the casing members 12 and 28. If desired, the plate 50 and plunger shaft 52 may be made of metal or plastic material.

A small opening 70 may be provided in the inverted cup shaped casing member 28. This may be formed by the cylindrical extension 72 in which is placed the small cup shaped member 74, which is placed over the small casing opening 76. If desired, a filter or filter material 78 may be placed over the small opening 70, to prevent any dust particles from entering the opening 70.

A vacuum may be produced in the cavity 80 of casing 10. When such vacuum is produced in the cavity 80, atmospheric pressure of the air entering the opening 16 pushes the diaphragm 42 and the flat plate 50 upwardly and thus upwardly moves the shaft 52. The shaft 52 may be connected to any member to be controlled by the movement of the shaft 52. For example, a damper or lever 82 may be hinged at 84. The damper or lever 82 may be connected by a link 86 and the fulcrum pins 88, so that upward and downward movement of the shaft 52 likewise causes upward and downward movement of the lever or damper 82.

The piston construction may be downwardly biased, for example, by a compression spring 90, which may be applied at any desired place. For example, the upper end of the spring 90 may engage the flat bottom 14, and the lower end of the spring 90 may engage a nut construction 92 which may be adjustably and threadedly engaged at 94 with the lower end of the shaft 52. An upward rim 96 may be provided to prevent the lower end of the spring 90 from moving sideways. If desired, a similar, but downwardly directed rim 97 may also be provided on the flat bottom 14 also to prevent the upper end

of the spring 90 from moving sidewise. However if desired, the rim 97 may be omitted.

The bias of the spring 90 may be applied by any other means. For example, the lever 82 may be downwardly biased, which imparts a downward bias on the shaft 52 through the link 86. Also, a compression spring may be placed inside the casing 10, with the lower end of the spring, not shown, engaging the plate 50, and the upper end of the spring engaging the inerted flat bottom 30.

A fluid suction means, or vacuum means 98 may be provided, and such means may be connected to the openings 64, 66 and 68, so that a vacuum may be selectively applied to any of the openings 64, 66 and 68 as desired.

For example, if a suction or vacuum is applied to the opening 64, fluid will flow outwardly through the opening 64 to the suction means 98, this fluid being also drawn through the opening 62 and from the cavity 80 so that a vacuum is produced in cavity 80, and the flat diaphragm portion 46 and plate 50 are moved upwardly by the atmospheric pressure at the opening 16. The flow of air through the small opening 70 is much less than is capable of being produced by the suction means 98, so that a vacuum is produced in cavity 80. However, when the plunger 60 covers the opening 64, no further upward movement of the plate 50 and the diaphragm portion 46 is produced, since a balanced condition is reached where a slight flow of fluid out through the opening 64, as throttled by the piston 60 balances the inward flow of air through the opening 70.

Preferably, the fluid suction means or vacuum means 98 is of a character that it selectively applies a suction action to only one of the openings 64, 66 or 68, and prevents any fluid flow inward through the unselected openings 64, 66 and 68.

In view of this, if the suction means 98 applies a suction to the opening 66, instead of the opening 64, the diaphragm portion 46, plate 50 and piston 60 will rise until the piston 60 closes the opening 66, or throttles it to the point where any outward flow of fluid at 66 balances the inward flow of air at 70.

However, if the suction means 98 applies a suction or vacuum to the opening 68, while sealing the openings 64 and 66, then the diaphragm portion 46 and plate 50 are moved upwardly until the upward limit of movement of these members is reached. Such upward limit may be produced by having the upper portion of the piston 60 engage the closed top 100 of the cylinder 32. The length of the shaft 56 may be chosen, so that the piston 60 engages the top 100, before the plate 50 can engage the inverted bottom 30, so that the plate 50 will at all times be spaced from the opening 68.

Any suitable fluid flow selecting means may be provided selectively to connect the suction means to the fluid flow openings 64, 66 and 68. For example, a program member, a multiple position valve, or any similar selecting means 102 may be provided, so that the suction means or vacuum pump 104 may be selectively connected to the passageways 106, 108 and 110, respectively, with the openings 64, 66 and 68. If desired, the program member 102, or selecting valve or the like, may be so constructed that it connects only one of the openings 64, 66 or 68, while at the same time preventing any vacuum action from being produced on the other and unselected openings. If desired, the selection may be produced by any suitable control member 112, which may be a thermostat, a motor drive for a program member, or any suitable control member that may cause the member 102 to select and connect any one desired opening 64, 66 and 68, while closing the other openings as may be required by the environment or other selecting medium that is operative on the control member 112.

It is to be understood that, if desired, all of the appropriate parts disclosed in the drawings may have a circular

cross section transversely of the axis which passes through the center of the cylinder 32, and shafts 52 and 56. However, any other desired cross sectional shape may be provided, as desired.

It is thus to be seen that a relatively simple but very efficient actuating member has been provided, which may be assembled in a simple and effective manner, and which provides a selective actuation of a control member by selectively applying a vacuum to any one of a plurality of fluid flow openings, such as 64, 66 and 68.

While the form of the invention now preferred has been disclosed as required by statute, other forms may be used, all coming within the scope of the claimed subject matter which follows.

What is claimed is:

1. In combination: a cup shaped casing member having a flat bottom with a centrally located casing shaft opening in said bottom and connected to an upwardly directed and outwardly flared side wall with a flat outwardly directed rim with an upward flange having an inwardly directed groove; an inverted cup shaped casing member having an inverted flat bottom with a centrally located upwardly directed cylinder and connected to a downwardly directed and outwardly flared side wall with a flat outwardly directed flange with an outwardly directed bead engaging said inwardly directed groove to lock said cup shaped casing members together, said outwardly directed flange having a downwardly directed groove; a flexible diaphragm having an outer rim bead held in and between said downwardly directed groove and said outwardly directed rim, and having a normally flat central diaphragm portion with a central plunger receiving opening therein; a plunger construction including a flat plate engaging said flat central diaphragm portion, a downward shaft connected to said plate engaging and sealed to said central diaphragm opening and passing through said casing shaft opening, and an upward piston shaft connected to said flat plate and having a piston reciprocating in said cylinder and having a fluid flow opening in said piston, said cylinder having two axially spaced fluid flow openings opened and closed by said piston, and said inverted flat bottom having a fluid flow opening.

2. A combination according to claim 1 including a fluid suction means; and a fluid flow selecting means selectively connecting said suction means to said fluid flow openings.

3. A combination according to claim 1 in which a bleed hole for inward flow of atmospheric air is provided in said inverted cup shaped casing member, said bleed hole being of less capacity than said fluid suction means.

4. A combination according to claim 2 in which said fluid flow selecting means selectively connects said suction means to one of said fluid flow openings while it simultaneously stops fluid flow in said other fluid flow openings.

5. A combination according to claim 1 in which said upward flange is outwardly flared at its upper end.

6. In combination: a cup shaped casing member having a flat bottom with a centrally located casing shaft opening in said bottom and connected to an upwardly directed and outwardly flared side wall with a flat outwardly directed rim with an upward flange having an inwardly directed groove; an inverted cup shaped casing member having an inverted flat bottom with a centrally located upwardly directed cylinder and connected to a downwardly directed and outwardly flared side wall with a flat outwardly directed flange with an outwardly directed bead engaging said inwardly directed groove to lock said cup shaped casing members together, said outwardly directed flange having a downwardly directed groove; a flexible diaphragm having an outer rim bead held in and between said downwardly directed groove and said outwardly directed rim, and having a normally flat central diaphragm portion with a central plunger receiving opening therein;

5

a plunger construction including a flat plate engaging said flat central diaphragm portion, a downward shaft connected to said plate engaging and sealed to said central diaphragm opening and passing through said casing shaft opening, and an upward piston shaft connected to said flat plate and having a piston reciprocating in said cylinder and having a fluid flow opening in said piston, said cylinder having a fluid flow opening opened and closed by said piston.

7. A combination according to claim 6 in which another fluid flow opening is provided in said inverted cup shaped casing member.

8. A combination according to claim 7 including a fluid suction means; and a fluid flow selecting means selectively connecting said suction means to said fluid flow openings.

9. In combination: a cup shaped casing member having a bottom with a centrally located casing shaft opening in said bottom and connected to an upwardly directed side wall with a lower casing rim; an inverted cup shaped casing member having an inverted flat bottom with a centrally located upwardly directed cylinder and connected to a downwardly directed side wall with an upper casing rim; means to lock said rims together; a flexible diaphragm having an outer diaphragm rim held between said casing rims, said diaphragm having a central diaphragm opening; a plunger shaft construction connected and sealed to said diaphragm opening and having its lower end extending through said casing shaft opening, said plunger shaft construction having a piston at its upper end extending into said cylinder and having a fluid flow opening in said piston, said cylinder having a suction fluid flow opening opened and closed by said piston.

10. In combination: a casing having a bottom with a centrally located casing shaft opening in said bottom, said casing having a top with a centrally located upwardly directed cylinder; a flexible diaphragm having an outer diaphragm rim sealed and held by said casing, said diaphragm having a central diaphragm opening; a plunger shaft construction connected and sealed to said diaphragm opening and having its lower end extending through said casing shaft opening, said plunger shaft construction having a piston at its upper end extending into said cylinder and having a fluid flow opening passing through said piston inboard of the outer periphery of said piston, said cylinder having a suction fluid flow opening opened and closed by said outer periphery of said piston.

11. In combination: a casing having a bottom with a centrally located casing shaft opening in said bottom, said casing having a top with a centrally located upwardly directed cylinder; a flexible diaphragm having an

6

outer diaphragm rim sealed and held by said casing, said diaphragm having a central diaphragm opening; a plunger shaft construction connected and sealed to said diaphragm opening and having its lower end extending through said casing shaft opening, said plunger shaft construction having a piston at its upper end extending into said cylinder and having a fluid flow opening in said piston, said cylinder having a suction fluid flow opening opened and closed by said piston; said casing having a small bleed hole for inward limited flow of atmospheric air above said diaphragm.

12. A combination according to claim 11 in which a suction means is connected to said suction fluid flow opening of sufficient capacity to produce a vacuum above said diaphragm.

13. A combination according to claim 12 in which a second suction opening is provided in said casing above said diaphragm and said suction means is connected to said second suction opening.

14. A combination according to claim 13 in which selective means are provided selectively to connect one of said openings to said suction means while simultaneously disconnecting the other of said openings.

15. In combination, a casing means having wall means, a flexible diaphragm cooperating with said wall means to define a chamber therebetween, said wall means defining a cylinder means disposed in fluid communication with said chamber, and a piston means carried by said diaphragm and having outer peripheral means axially movable in said cylinder means in unison with movement of said diaphragm, said cylinder means having a fluid flow opening opened and closed by said outer peripheral means of said piston means, said piston means having an opening passing therethrough inboard of said outer peripheral means to permit fluid communication between said fluid flow opening and said chamber when said piston means is disposed between said fluid flow opening and said chamber and said outer peripheral means is not closing said fluid flow opening.

#### References Cited

##### UNITED STATES PATENTS

|           |        |               |        |
|-----------|--------|---------------|--------|
| 2,895,455 | 7/1959 | Clowes        | 91—357 |
| 2,924,199 | 2/1960 | Lawson et al. | 91—357 |
| 2,986,125 | 5/1961 | Young et al.  | 91—357 |
| 2,997,027 | 8/1961 | Ingres        | 92—99  |
| 3,072,108 | 1/1963 | Cripe         | 91—357 |
| 3,125,001 | 3/1964 | Cripe         | 91—357 |

50 MARTIN P. SCHWADRON, *Primary Examiner*.  
PAUL E. MASLOUSKY, *Examiner*.