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3,077,186

MULTI-STROKE FLUID POWER ACTUATOR

Filed April 19, 1961

2 Sheets-Sheet 1

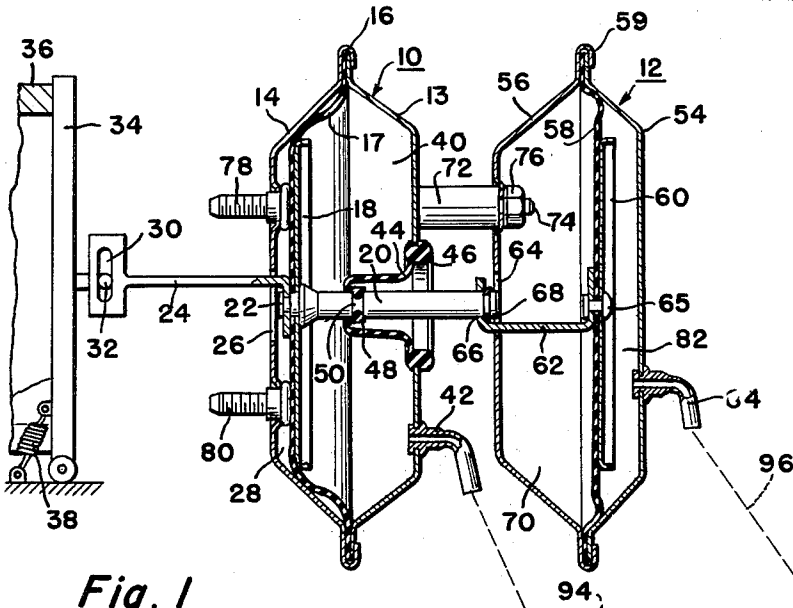


Fig. 1

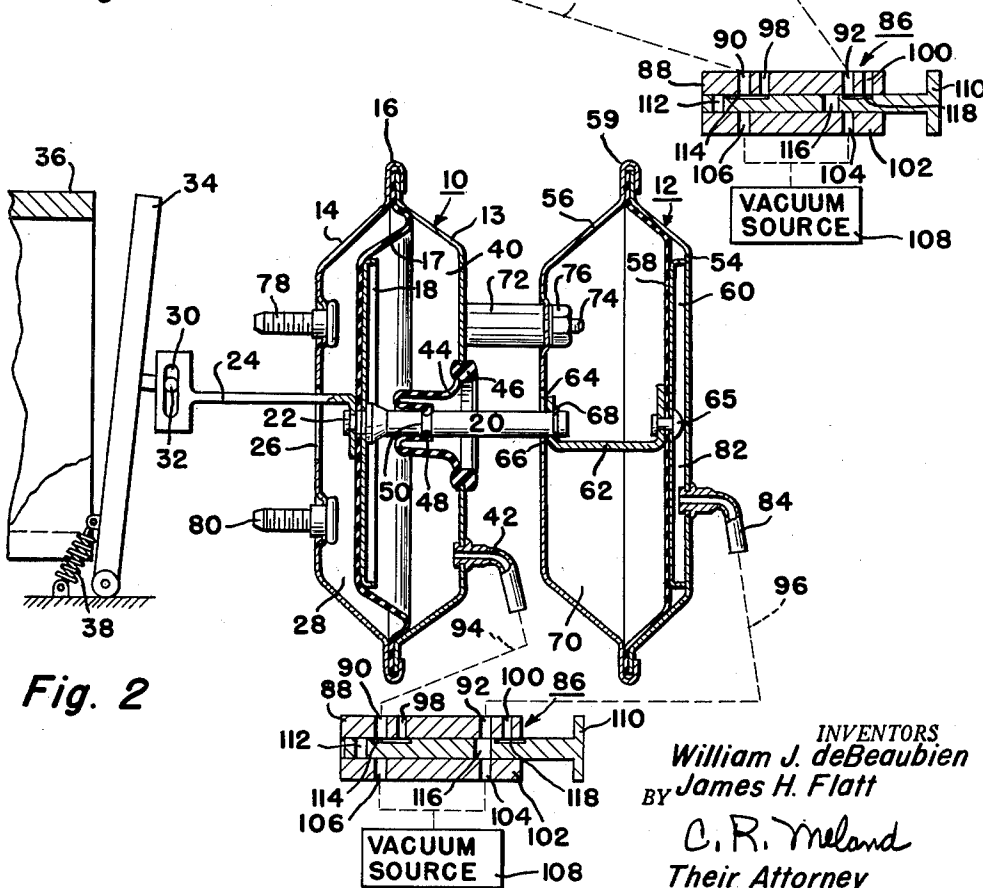


Fig. 2

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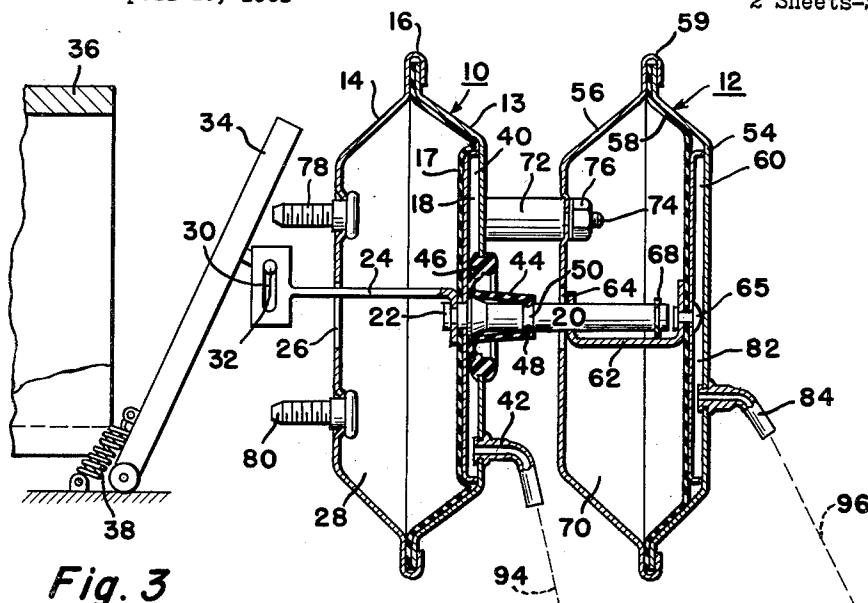


Fig. 3

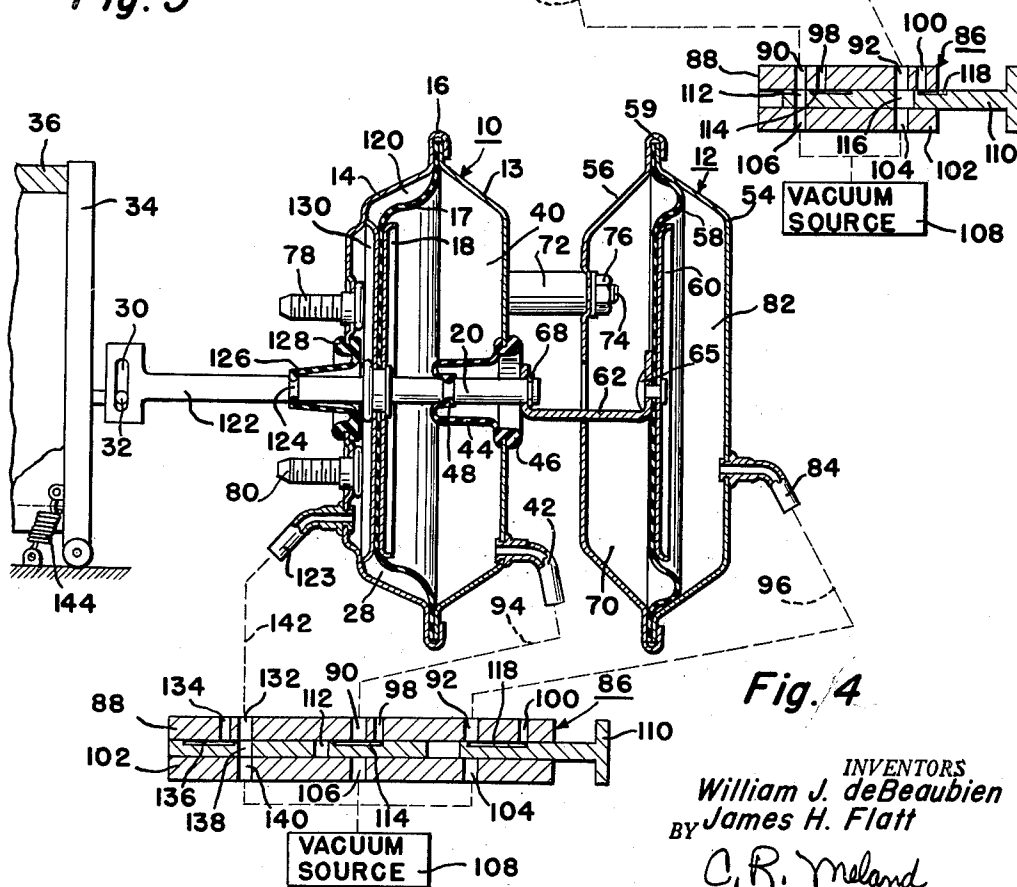


Fig. 4

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MULTI-STROKE FLUID POWER ACTUATOR

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This invention relates to fluid power actuators and more particularly to a fluid power actuator that is capable of delivering a step-wise actuation of a part to be moved.

One of the objects of this invention is to provide a fluid power actuator wherein an actuating rod is moved in steps by a pair of shiftable piston means that are connected by a lost motion connection.

Another object of this invention is to provide a multi-stroke actuator that includes a pair of vacuum units having their casings rigidly connected and their diaphragms connected by a lost motion connection.

A further object of this invention is to provide a fluid power multi-stroke actuator that is simple in construction and economical to manufacture.

Further objects and advantages of the present invention will be apparent from the following description, reference being had to the accompanying drawings, wherein a preferred embodiment of the present invention is clearly shown.

In the drawings:

FIGURE 1 is a sectional view of a fluid power actuator made in accordance with this invention.

FIGURE 2 is a view similar to that of FIGURE 1 but showing one of the vacuum units that make up the fluid power actuator in a shifted position.

FIGURE 3 is a view similar to FIGURES 1 and 2 but illustrating the position of the parts of the fluid power actuator in still another shifted position.

FIGURE 4 is a sectional view of a modified fluid power actuator made in accordance with this invention.

Referring now to the drawings and more particularly to FIGURE 1, the reference numerals 10 and 12 have been used to generally designate vacuum units which form component parts of the fluid power actuator of this invention. The vacuum unit 10 is made up of metal casing parts 13 and 14. The casing 14 has a portion 16 which is crimped over an annular rim of the casing 12 and which also serves to hold a diaphragm 17 in place which is located between the annular portions of the casings 13 and 14. The diaphragm 17 may be made of any suitable flexible material such as rubber and it is seen that this diaphragm carries a metal plate member 18. The metal plate member 18 is secured to the diaphragm 17 by heading over a rod 20 as at 22. The heading over of the portion 22 also serves to hold the actuating link 24 in place. It thus is seen that the diaphragm 17 actually carries the plate 18, the rod 20 and the actuating link 24.

The actuating link 24 extends through an opening 26 formed in the casing 14 and this casing has other openings so that the chamber 28 defined by the casing 14 and the diaphragm 17 will always be at atmospheric pressure. The link 24 is formed with a slot 30 which receives a pin 32 connected with a pivotally mounted damper valve 34. The damper valve 34 may be used for example to control the amount of air coming into a motor vehicle through a conduit 36 and might be arranged in other ways to accomplish this purpose. As an example of this, the damper valve might be pivoted at its center and located within conduit 36. The damper valve 34 is constantly urged to a closed position by the spring 38.

The casing part 13 and the diaphragm 17 form a

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chamber 40 which can be connected with a source of vacuum through the fitting 42. It is seen that a rolling seal 44 formed of resilient material such as rubber is provided which has an annular portion 46 fitting an opening in the casing 13 and has another annular portion 48 which tightly fits within a groove 50 formed in the rod 20. It thus is seen that the chamber 40 is substantially air tight and that when vacuum is applied to the chamber 40, the diaphragm 16 will be moved rightwardly in FIGURE 1 and will carry the rod 20 and link 24 with it.

The second vacuum unit 12 includes casings 54 and 56 which are secured together as by crimping a portion 59 of casing 56 over the casing 54. As can be seen, this crimping also serves to secure the diaphragm 58 in place in the vacuum unit. The diaphragm 58 carries a metal plate member 60 and an actuating link 62. The plate 60 and actuating link 62 are held to the diaphragm 58 by one or more rivets 65. The actuating link 62 extends through an opening 64 formed in the casing member 56 and this actuating link has an opening 66 which receives one end of the rod 20. A snap ring 68 is provided to prevent relative movement between the rod 20 and the actuating link 62 in one direction of movement. It is seen that the rod 20 can move rightwardly with respect to link 62 but cannot move leftwardly with respect to this link when the snap ring 68 is in engagement with the actuating link 62. It can be seen that this forms a lost motion connection between the rod 20 and the link 62. The chamber 70 which is defined by the casing part 56 and the diaphragm 58 is at atmospheric pressure due to its connection with atmosphere through the opening 64. The casing 56 may be provided with other openings which insure that the chamber 70 is always at atmospheric pressure.

The vacuum units 10 and 12 are rigidly connected together by a plurality of spacers 72 which are welded to the casing part 13 and which have integral threaded parts 74 upon which are threaded the nuts 76. It will of course be appreciated that other devices might be used to insure that the casings of the vacuum units 10 and 12 are rigidly connected together. The apparatus illustrated in FIGURE 1 may be secured as a unit to a support by means of the threaded studs 78 and 80 which are fixed to the casing 14.

It is seen from FIGURE 1 that the chamber 82 defined by diaphragm 58 and casing part 54 is air tight and is connected with fitting 84 which is to be connected with a suitable source of vacuum when it is desired to actuate the vacuum unit 12. It, of course, is appreciated that the application of vacuum to chamber 82 will cause the diaphragm 58 to move rightwardly in FIGURE 1.

If neither chamber 40 nor chamber 82 of vacuum units 10 and 12 are connected with vacuum, the parts of the fluid power actuator will be as shown in FIGURE 1. In other words the spring 38 will return the diaphragms to the FIGURE 1 position and will cause the damper 34 to be in a closed position.

If vacuum is applied to the chamber 82, the diaphragm 58 will be shifted rightwardly in FIGURE 1 to the position illustrated in FIGURE 2. In moving rightwardly, the link 62 is moved rightwardly and it will carry the rod 20 and diaphragm 17 to the position illustrated in FIGURE 2. This will, of course, partially open the valve 34 and will give one position of actuation.

If the chamber 40 of vacuum unit 10 is connected with vacuum, the diaphragm 17 will move to the position illustrated in FIGURE 3. This will, of course, open the valve 34 to a greater extent and during this rightward movement it can be seen that the rod 20 will move relative to the link 62.

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It can be seen from the foregoing that the vacuum units 10 and 12 provide two open positions for the damper valve 34, namely the FIGURE 2 and the FIGURE 3 positions. This, of course, makes it possible to control the inlet air coming in to a motor vehicle for heating and ventilating purposes.

In order to illustrate how the vacuum units can be controlled in FIGURES 1, 2 and 3, a valve device generally designated by reference numeral 86 is shown. This valve device comprises a plate member 88 having ports 90 and 92 which are connected respectively with conduits 94 and 96 that are in turn connected with fittings 42 and 84. The plate 88 is also provided with ports 98 and 100 which lead to atmosphere. A second plate 102 is provided which has ports 104 and 106. Ports 104 and 106 are connected with a source of vacuum which is designated by reference numeral 108. This source of vacuum may be the intake manifold of an internal combustion engine where the fluid power apparatus is used to actuate some device on a motor vehicle.

Fitted between the plates 88 and 102 is a shiftable valve member 110 which has ports 112, 114, 116 and 118. It can be seen that in the FIGURE 1 position of the valve member 110, the ports 90 and 98 are connected with atmospheric ports 98 and 100. It therefore is seen that both chambers 40 and 82 will be at atmospheric pressure so that the spring 38 holds the valve 34 in a closed position.

If the valve 110 is shifted to the FIGURE 2 position, it is seen that the port 116 now connects the ports 92 and 104 so that vacuum is applied to the chamber 82 of vacuum unit 12. The chamber 40 still remains at atmospheric pressure due to the connection of ports 90 and 98 so that the diaphragm 58 now moves to the FIGURE 2 position and therefore opens the valve 34 to the FIGURE 2 position.

If the valve 110 is now moved to the FIGURE 3 position, it is seen that the port 112 connects the ports 90 and 106 so that vacuum is applied to the chamber 40. This will cause the diaphragm 17 to move to the FIGURE 3 position with the further actuation of the valve 34 to the FIGURE 3 position.

If the valve is moved from the FIGURE 3 to the FIGURE 2 position, the diaphragms 17 and 58 will be returned to their FIGURE 2 position. If the valve is moved back to the FIGURE 1 position, all of the parts will return to the FIGURE 1 position.

It will, of course, be appreciated that other types of valves and valving arrangements could be used with the fluid power apparatus of this invention without departing from the spirit and scope of this invention.

Referring now more particularly to FIGURE 4, a modified fluid power apparatus is illustrated. In FIGURE 4, the parts of the two vacuum units in many respects are identical with the parts of the vacuum illustrated in FIGURES 1 through 3 and where the parts are identical or equivalent the same reference numerals have been used. The main difference between the apparatus of FIGURE 4 and that illustrated in FIGURES 1 through 3 is that another air tight chamber 120 has been provided which may be connected with vacuum via the fitting 123. It is seen that in FIGURE 4, the actuating rod 20 has a cylindrical extension 122 formed with a groove 124. The groove 124 receives an annular part of a boot or rolling seal 126 formed of resilient material. This rolling seal 126 has an annular portion 128 which fits within an opening formed in the casing 14. The diaphragm 17 in addition to carrying the metal plate 18 also carries another metal plate 130. It can be seen from the foregoing that the chamber 120 which corresponds to chamber 28 of the apparatus illustrated in FIGURES 1 and 3, has been arranged so that it no longer is connected with atmosphere but rather can be connected with vacuum through the fitting 123.

In FIGURE 4, the parts diaphragms of the vacuum

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units 10 and 12 may be returned to their position illustrated in FIGURE 4 by the application of vacuum to the chamber 120. This is the difference between the apparatus illustrated in FIGURE 4 and that illustrated in FIGURES 1 through 3. In order to provide for the application of vacuum to the chamber 120, a slightly modified valve apparatus is illustrated in FIGURE 4. The right side of this valve apparatus is identical to the valve apparatus illustrated in FIGURES 1 through 3 but additional ports 132, 134, 136, 138 and 140 have been added. Thus, in the FIGURE 4 position of the shiftable valve 110, it can be seen that the chamber 120 will be connected to vacuum via ports 132, 138 and 140 together with the connecting conduit 142. As the valve 110 is shifted rightwardly where it corresponds to the position of the valve illustrated in FIGURE 2, it is seen that the conduit 142 will be connected with atmosphere via the atmospheric port 134. When the valve 110 moves still further rightwardly where it corresponds to the FIGURE 3 valve position, the conduit 142 is still connected with atmosphere so that the chamber 120 will be connected with atmosphere. In other words, with the arrangement of FIGURE 4, the chamber 120 is always connected with atmosphere except when it is desired to return the diaphragms to their FIGURE 4 position whereupon the chamber 120 is connected with vacuum.

In FIGURE 4, a different reference numeral 144 has been used to designate the spring that returns the valve 34 to its closed position. This spring 144 may have a force that is considerably less than the force of spring 38 since the diaphragms of the vacuum units are returned to the FIGURE 4 position by the application of vacuum to chamber 120.

While the embodiments of the invention as herein disclosed constitute a preferred form, it is to be understood that other forms might be adopted.

What is claimed is as follows:

1. A multi-stroke actuator comprising, a first chamber defined by a first diaphragm and a first casing, a second chamber defined by a second diaphragm and a second casing, said first and second diaphragms moving in the same direction when either said first or second chamber is connected with vacuum, said first casing having a wall limiting the movement of said first diaphragm in one direction, said second casing having a wall limiting the movement of said second diaphragm in the same direction, means rigidly connecting said casings, an actuating means connected with said first diaphragm, and a lost motion connection connecting said first diaphragm and said second diaphragm, said lost motion connection permitting a movement of said first diaphragm relative to said second diaphragm when said second diaphragm has moved to its limit of movement.

2. A multi-stroke actuator comprising, a first vacuum unit including a first casing means and a first diaphragm dividing said first casing means into a first vacuum chamber and a first atmospheric chamber which is permanently connected with atmosphere, a second vacuum unit including second casing means and a second diaphragm dividing said second casing means into a second vacuum chamber and a second atmospheric chamber which is permanently connected with atmosphere, means rigidly connecting said first and second casing means together, said first and second vacuum chambers being so positioned that said diaphragms move in the same direction when either of said vacuum chambers is connected with vacuum, and a lost motion connection directly mechanically connecting said first and second diaphragms.

3. A multi-stroke actuator comprising, a first chamber defined by a first diaphragm and a first casing, a second chamber defined by a second diaphragm and a second casing, said diaphragms moving in the same direction when either of said chambers is connected with vacuum, said second casing having a wall limiting the movement of said second diaphragm in one direction, means rigidly

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connecting said casings, and a motion transmitting means directly connecting said first and second diaphragms, said motion transmitting means permitting a movement of said first diaphragm relative to said second diaphragm when said second diaphragm has moved to its limit of movement.

4. A multi-stroke actuator comprising, a first chamber defined by a first diaphragm and a first casing, a second chamber defined by a second diaphragm and a second casing, means rigidly connecting said casings, means limiting movement of said second diaphragm in one direction, and motion transmitting means directly connecting said first and second diaphragms, said motion transmitting means being so constructed and arranged that said second diaphragm pulls said first diaphragm a predetermined amount when said second chamber is connected with vacuum and being constructed and arranged to permit said first diaphragm to move relative to said second diaphragm when said second diaphragm has reached its limit of movement.

5. A multi-stroke actuator comprising, a first vacuum unit having first casing means and a first diaphragm dividing said first casing means into a first vacuum chamber and an atmospheric chamber which is permanently connected with atmosphere, a second vacuum unit having second casing means and a second diaphragm dividing said second casing means into a second vacuum chamber and an atmospheric chamber which is permanently connected with atmosphere, said vacuum chambers being so positioned with respect to each other that said diaphragms move in the same direction when vacuum is applied to either of said vacuum chambers, means rigidly securing said first and second casing means together, actuating means connected with said first diaphragm for shifting a part to be actuated, and motion transmitting means connecting said first and second diaphragms, said motion transmitting means causing said first diaphragm and its connected actuating means to be positively shifted by the movement of said second diaphragm when said second vacuum chamber is connected with vacuum, said motion transmitting means permitting said first diaphragm and its connected actuating means to move relative to said second diaphragm when first vacuum chamber is connected with vacuum.

6. Actuating apparatus comprising, a first vacuum unit including casing means and a diaphragm separating said first vacuum unit into first and second sealed chambers, a second vacuum unit including casing means and a sec-

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ond diaphragm dividing said casing means into third and fourth chambers, said third chamber being sealed and said fourth chamber being permanently connected with atmosphere, a lost motion connection connecting the diaphragms of said two vacuum units, means for selectively connecting said first and second chambers with vacuum or with atmosphere, and means for connecting said third chamber selectively with vacuum or atmosphere.

7. Actuating apparatus comprising, a first vacuum unit including casing means and a diaphragm separating said vacuum unit into first and second chambers that are to be connected respectively with vacuum, a second vacuum unit including casing means and a second diaphragm dividing said casing means into third and fourth chambers, said third chamber being adapted to be connected with vacuum and said fourth chamber being connected permanently with atmosphere, and a lost motion connection interconnecting the diaphragms of two vacuum units.

8. Actuating apparatus comprising, first and second vacuum units each having casing means and a diaphragm, the casing means and diaphragm of said vacuum units defining first and second separate chambers, means rigidly connecting the casing means of said vacuum units together, a lost motion connection connecting the diaphragms of said vacuum units, and means for selectively applying vacuum to said chambers.

9. Actuating apparatus comprising, a first vacuum unit including first casing means and a first diaphragm, a second vacuum unit including second casing means and a second diaphragm, means rigidly connecting said first and second casing means, the first diaphragm and first casing means of said first vacuum unit defining a first chamber and the second casing means and second diaphragm of said second vacuum unit defining a second chamber, means for selectively connecting said chambers with vacuum, and means connecting said diaphragms whereby movement of said second diaphragm causes said first diaphragm to move therewith and movement of said first diaphragm causes a relative motion between said diaphragms.

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