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MULTI-POSITION VACUUM MOTOR

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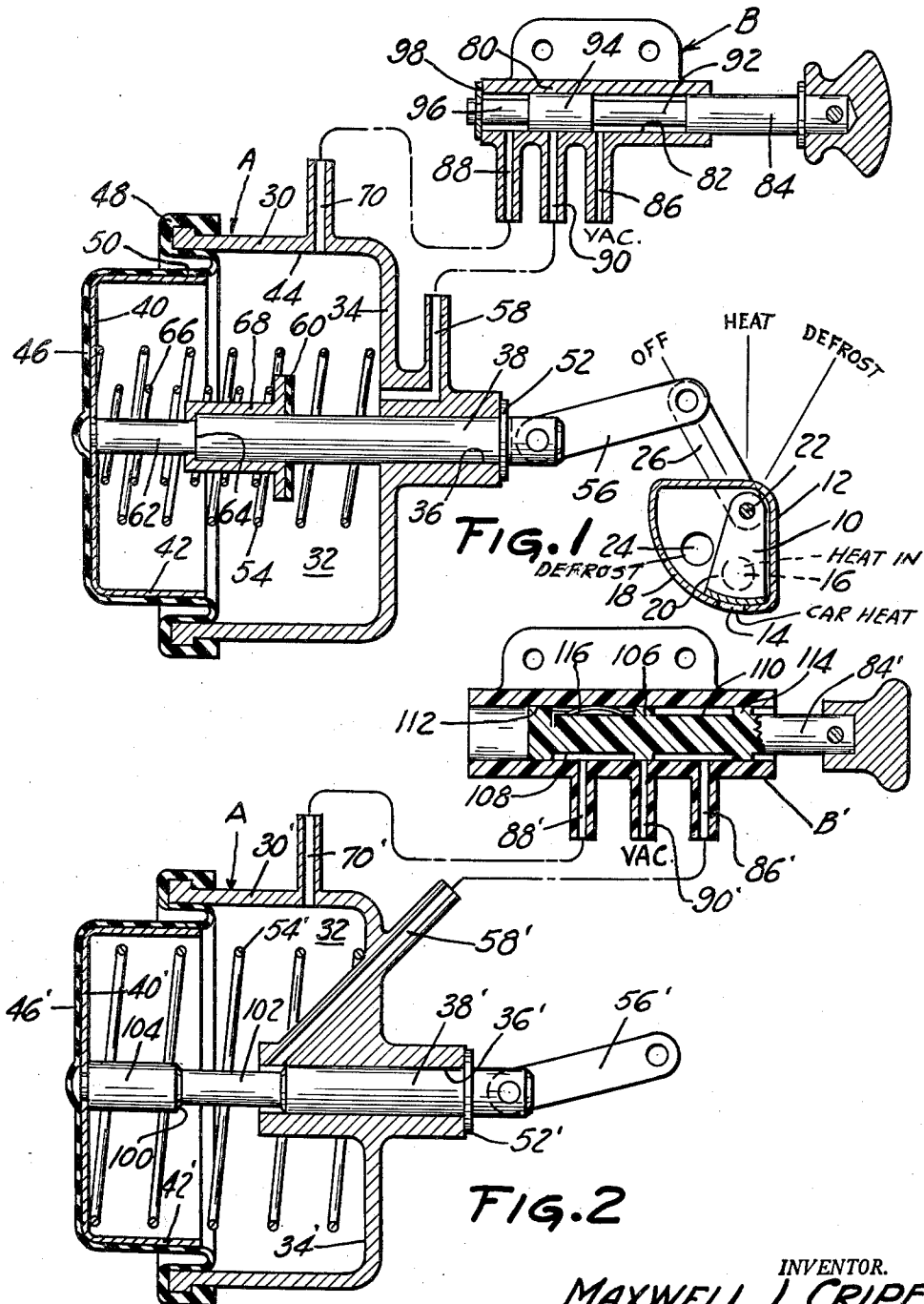


FIG. 2

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MULTI-POSITION VACUUM MOTOR

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The present invention relates to a vacuum motor control system which will move driven elements from a normal position to more than one actuated position; and more particularly to a vacuum motor having substantially no frictional hysteresis, and an abruptly seating valve arrangement which will accurately position the driven elements.

An object of the present invention is the provision of a new and improved vacuum motor having a normal position and a plurality of actuated positions which is simple in design, inexpensive to manufacture, and precise in its operation.

A further object of the present invention is the provision of a new and improved multi-position vacuum motor of the above described type generally comprising a cup-shaped housing the open end of which is closed off by means of a curtain diaphragm structure and which further includes an abruptly closing valve arrangement for closing off vacuum communication to the motor in at least one of its actuated positions.

The invention resides in certain constructions and combinations and arrangements of parts; and further objects and advantages of the invention will become apparent to those skilled in the art to which it relates from the following description of several preferred embodiments described with reference to the accompanying drawing forming a part of this specification, and in which:

FIGURE 1 is a somewhat schematic view of a multi-position vacuum motor control system embodying principles of the present invention, and in which portions are shown in section; and

FIGURE 2 is a somewhat schematic view similar to FIGURE 1 showing another embodiment of multi-position vacuum motor control system, and in which portions are shown in section.

The vacuum motor control system shown in FIGURE 1 is depicted as being used to actuate a valving structure 10 in the plenum chamber 12 of an automotive heating system. The plenum chamber 12 is an elongated structure having a cross section that is generally a sector of a circle. A heat outlet port 14 is located across the curved section of the plenum chamber adjacent its vertical end wall; and heated air is fed into the plenum chamber through a circular inlet 16 in one end wall of the plenum chamber 12. Valve structure 10 has a circular end portion 18 adapted to slide over and close off the outlet port 14, and an end actuating arm portion 20 which overlies the inlet 16 in the end wall of the plenum chamber and is fastened to an actuating shaft 22. The valving structure 10 is shown in its off position wherein heat is prevented from entering the plenum chamber 12. The heater control shown is also provided with a defrosting connection 24 in its end wall adjacent the heat inlet 16. The defrosting connection 24 is located to the side of the normal position of the valving structure 10 shown in the drawing, and is adapted to be closed off by the end arm 20 as the valving structure is moved from the off position, shown, to a car heat position wherein the circular portion 18 is open with

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respect to the outlet port 14. The position just described wherein the car heat port is open and the defroster port is closed forms the first actuated position of the valving structure 10. Valving structure 10 is adapted to be moved into still a second actuated position spaced clockwise from the first actuated position above described, and wherein both the defrosting connection 24 and the heat outlet port 14 are opened. The shaft 22 is rotated by means of an arm 26; and the normal, first actuated position, and second actuated position of the arm 26 is indicated in the drawings by "Off," "Car Heat" and "Defrost," respectively.

The arm 26 is adapted to be moved into each of its three positions by means of a vacuum motor A which in turn is controlled by means of a remotely located valve structure B. The vacuum motor A generally comprises a cup-shaped housing 30 having a generally axially extending integral chamber 32 which communicates with the open end of the cup-shaped housing 30. The closed or bottom end wall 34 is provided with an axially extending opening 36 therethrough, through which a shaft 38 is sealingly guided for reciprocatory motion. The inner end of the shaft 38 is suitably fastened to a cup-shaped movable wall 40 whose sidewalls 42 project into the internal chamber 32 and have a generally predetermined clearance with respect to the sidewalls 44 of the chamber 32. The internal chamber 32 is closed off by means of a diaphragm 46. The center portion of diaphragm 46 overlies the movable wall 40, and the outer portion of the diaphragm 46 is sealingly snapped over the radial flange 48 of the housing member 30 adjacent its open end. The diaphragm 46 is provided with an annular curtain portion 50 having a generally U-shaped cross section, the sides of which lie up against the sidewalls 42 and 44 respectively. Inward movement of the movable wall 40 therefore causes one leg of the curtain portion of the diaphragm 50 to roll out of engagement with the sidewalls 42 and into engagement with the sidewalls 44 of the internal chamber 32. The shaft 38 is provided with an annular abutment washer 52 suitably affixed to its outer end; and the abutment washer 52 is normally biased into engagement with the end surface of the housing 30 by means of a piston return spring 54 interpositioned between the movable wall 40 and the inner end wall 34 of the housing member. Reciprocatory motion of the shaft 38 is transmitted to the arm 26 of the heater control structure by means of a drag link 56, the ends of which are suitably pivoted to shaft 38 and arm 26 respectively. The shaft 38 and arm 26 are caused to move from their normal positions shown in the drawing to their first and second actuated positions by admitting vacuum to the internal chamber 32 of the housing. These first and second actuated positions are labeled "Heat" and "Defrost" in the drawing.

According to principles of the present invention, the movable wall 40 is caused to move into, and be held in, a position between its extreme opposite end positions by a valving structure which abruptly closes off vacuum communication to the internal chamber 32 when the movable wall 40 reaches the intermediate or first actuated position. In the embodiment shown in FIGURE 1, vacuum is communicated to the internal chamber 32 through a vacuum valve port 58 in the end wall 34 adjacent the shaft 38. The inside surface of the end wall 34 which surrounds the vacuum valve port 58 forms a valve seat against which an annular poppet 60 abuts to close off the valve port 58. Annular poppet 60 may be carried by the shaft 38 in any

suitable manner which will permit the poppet member 60 to be normally positioned at a predetermined location on the shaft 38 and will about the wall portions surrounding the valve port 58; and which thereafter will permit the shaft 38 to move with respect to the poppet member 60 until the shaft 38 reaches its second actuated position. As shown in the drawing, the inner end of the shaft 38 is provided with a reduced diameter section 62 which terminates in a shoulder 64 against which poppet member 60 is normally biased by means of the coil spring 66. As shown in the drawing, the poppet member 60 is generally a cup-shaped member, the bottom end of which abuts the shoulder 64, and the sidewalls 68 of which support the poppet member about shaft 68 and support the coil spring 66.

The second actuated position of the shaft 38 is accurately located by suitable abutment means conveniently provided by the engagement of the inner end of the sidewalls 42 of the movable wall 40 with the end wall 34 of the housing 30. The movable wall 40 is caused to move from its first actuated position to its second actuated position by means of a second vacuum inlet 70 so arranged that no portion of the vacuum motor will close off the inlet 70, and so that vacuum communicated to the chamber 32 through the inlet port 70 will hold the inner edge of the sidewalls 32 in engagement with the bottom 34 of the housing 30.

Vacuum may be communicated to the ports 58 and 70 by any convenient valving arrangement that selectively applies vacuum to one of the valve ports. One such valve arrangement is shown at B and is formed by means of a valve housing 80 having a longitudinal bore 82 therethrough which is sealingly engaged by a valve slide 84. Vacuum is communicated to the longitudinal bore 82 through a vacuum inlet 86 located in the center section of the bore 82. The second vacuum inlet 70 of the motor A is connected to the bore 82 adjacent one end thereof, through the valve port 88; and the valve port 58 of the motor A is connected to the bore 82 by means of a valve port 90 positioned between the valve ports 86 and 88. The valve slide 84 is provided with a reduced diameter section 92 adjacent its center section, and the reduced section 92 is of such a length as to be capable of overlying all three vacuum ports 86, 88 and 90. The outer end of the valve slide 84 at all times closes off the outer end of the bore 82; and the land portion 94 of the slide formed inwardly of the reduced diameter section 92 is of such a length as to cover only the valve port 90 when the inner end of the reduced diameter section 92 just overlies the vacuum inlet connection 86. The inner end of the shaft 84 also has a reduced diameter section 96 to allow air to enter the valve port 88 in the "Off" position of the slide 84, shown in the drawing. A suitable stop 98 is provided on the end of the valve slide 84 to prevent withdrawal of the slide 84 beyond the above referred to "Off" position.

In the normal "Off" position of the slide 84 above referred to, the vacuum from the inlet port 86 of the valve structure B is prevented from being communicated with either of the valve ports 88 or 90; while atmospheric pressure is communicated to the valve port 88 and hence to the inlet chamber 32 of the vacuum motor A to cause its movable wall 40 and shaft 38, under the action of the return spring 54, to move to the "Off" position shown in the drawing. By forcing the valve slide 84 inwardly until the land portion 94 moves out of registry with the valve port 90, vacuum is communicated to the motor inlet port 58 causing air pressure on the diaphragm 46 to move the movable wall 40 inwardly until the poppet member 60 abuts the end wall 34 and closes off further vacuum communication through the inlet port 58. Inasmuch as the control valve B is of the slide valve type, and inasmuch as a sliding fit is depended upon between the shaft 38 and the motor housing 30, a slight amount of air leakage occurs which enters the internal chamber 32 of the housing

30 and is throttled out through the valve port 58 by a very slight reciprocatory movement of the shaft 38. Inasmuch as substantially no sliding friction is involved in the rolling action of the diaphragm 46, substantially no further movement of the shaft 38 takes place after the poppet 60 closes off the inlet port 58; and the slight amount of air leakage above referred to assures that the shaft 38 will be maintained in the first actuated position above described.

When it is desired to move the arm 26 into its second actuated position, the valve slide 84 is moved inwardly until its land portion 94 communicates vacuum from the inlet port 86 with the valve port 88; whereupon full vacuum is communicated to the internal chamber 32 of the vacuum motor A, and the end surface of the sidewalls 42 of the movable wall 40 are moved into and held in positive engagement with the bottom end 34 of its housing 30.

The return movement of the arm 26 to the "Off" position is produced by the piston return spring 54 which has sufficient force to overcome the friction involved. The valve slide 84 is pulled to its extreme out position, wherein atmospheric pressure is communicated to the valve port 88 to in turn allow air pressure to enter the internal chamber 32 and cause the movable wall 40 under the action of its return spring 54 to move to its normal position. Thereafter the movable wall 40 can be caused to move into its first actuated position in the manner previously described.

The embodiment of vacuum motor control system shown in FIGURE 2 corresponds, generally, in construction and operation to the system shown in FIGURE 1; but differs principally therefrom in the construction of the valving arrangement within the vacuum motor that is used to hold the motor in its first actuated position. The system also differs in the construction of the remotely located valve structure that is used to govern the operation of the vacuum motor. Those portions of FIGURE 2 which correspond generally to similar portions of FIGURE 1 are designated by a like reference numeral characterized further in that a prime mark is affixed thereto.

In the embodiment shown in FIGURE 2, the vacuum valve port 58' is caused to enter the axially extending opening 36' which receives the shaft 38' adjacent the internal chamber 32' of the vacuum motor A'. The shaft 38' has a shoulder 100 formed by a reduced diameter section 102, and is so located as to close off the end of the opening 36' in the first actuated position of the motor. The inner end 104 of the shaft 38' is of the same diameter as the outer end so as to effect a sliding seal with respect to the bore 36', and so permit movement from the first actuated position of the motor to the second actuated position of the motor, wherein the inner end of the sidewalls 42' also engage the bottom of the end wall 34' of the housing 30'.

In the embodiment of control valve structure B' shown in FIGURE 2, the vacuum inlet 90' enters the longitudinal bore 82' between the valve ports 86' and 88'. The valve slide 84' has a center land portion 106 which closes off the vacuum port 90' in the normal "Off" position shown in the drawing; and has inner and outer reduced diameter sections 108 and 110 which are adapted to communicate ports 88' and 90', and 90' and 86' respectively. The inner end of the slide 84' is provided with a land portion 112 adapted to prevent atmospheric pressure from entering the port 88' in the normal "Off" position of the slide shown in the drawing. The outer end of the slide 84' is also provided with a similar land 114 adapted to prevent atmospheric communication with the valve port 86' in the normal "Off" position of the slide shown in the drawing. Inward movement of the slide 84' from the position shown in the drawing communicates vacuum from the port 90' to the port 86', and hence the internal chamber 32', to cause the movable wall 40' to move into its "First Actuated" position wherein the land 106 just seals off the inner end of the shaft opening 36'. The throttling action there-

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after maintains the movable wall in its "First Actuated" position in substantially the same manner described for the embodiment of FIGURE 1. Outward movement of the slide 84' from the "Off" position shown in the drawing communicates vacuum from the inlet 90' to the port 88' to cause the movable wall 40' to move until it engages the end wall 34'. Extreme outward movement of the slide 84' communicates atmospheric pressure with the valve port 88' to allow the return spring 54' to move the structure to the normal "Off" position shown in the drawings. A suitable friction spring 116 is provided in the slide 84' to hold it in its various positions.

It will be apparent that the objects heretofore enumerated as well as others have been accomplished; and that there has been provided an improved vacuum motor of inexpensive construction having generally frictionless operation, and which can accurately be positioned through an internal positive valving arrangement by a simple remotely located valve structure.

While the invention has been described in considerable detail, I do not wish to be limited to the particular embodiments shown and described; and it is my intention to cover hereby all novel adaptations, modifications and arrangements thereof which come within the practice of those skilled in the art to which the invention relates.

I claim:

1. In a vacuum motor control system: a cup-shaped housing having a generally closed bottom end wall and an internal chamber opening outwardly of the open end of said cup-shaped housing; a movable wall in said internal chamber, the sides of said movable wall having a predetermined clearance with respect to the sidewalls of said internal chamber; a curtain diaphragm overlying said movable wall with a rolling U-shaped portion extending into said predetermined clearance to roll between the sidewalls of said chamber and the surface of said movable wall during movement of said movable wall, and its outer edge sealingly fixed to the sidewalls of said housing; a driven shaft extending through said end wall of said housing and operatively connected to said movable wall; means biasing said movable wall to a normal position adjacent the open end of said internal chamber; a first vacuum valve port in the end wall of said internal chamber adjacent said shaft; valve shut-off means carried by said shaft for closing said vacuum valve port when said movable wall moves from its normal position inwardly to a first actuated position; abutment means limiting inward movement of said movable wall to a second actuated position wherein said movable wall is spaced inwardly from said first actuated position; a second vacuum port opening into said internal chamber and which is not closed off by said movable wall; said valve shut-off means remaining closed as said movable wall moves from said first actuated position to said second actuated position; and valve means for selectively applying vacuum to respective first and second valve ports.

2. In a vacuum motor control system: a cup-shaped housing having a generally closed bottom end wall and an internal chamber opening outwardly of the open end of said cup-shaped housing; a movable wall in said internal chamber, the sides of said movable wall having a predetermined clearance with respect to the sidewalls of said internal chamber; a curtain diaphragm overlying said movable wall with a rolling U-shaped portion extending into said predetermined clearance to roll between the sidewalls of said chamber and the surface of said movable wall during movement of said movable wall, and its outer edge sealingly fixed to the sidewalls of said housing; a driven shaft extending through said end wall of said housing and operatively connected to said movable wall; means biasing said movable wall to a normal position adjacent the open end of said internal chamber; a first vacuum valve port in the end wall of said internal chamber adjacent said shaft; said shaft having an outwardly facing shoulder positioned in said internal chamber with a reduced diameter section of

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said shaft positioned outwardly of said shoulder; a valve closure member spring biased inwardly against said shoulder for closing off said first vacuum valve port when said movable wall is in its first actuated position, said valve closure member being slidable outwardly on said shaft; abutment means limiting inward movement of said movable wall to a second actuated position wherein said movable wall is spaced inwardly from said first actuated position; a second vacuum port opening into said internal chamber and which is not closed off by said movable wall; said valve shut-off means remaining closed as said movable wall moves from said first actuated position to said second actuated position; and valve means for selectively applying vacuum to respective first and second vacuum ports.

3. In a vacuum motor control system: a cup-shaped housing having a generally closed bottom end wall and an internal chamber opening outwardly of the open end of said cup-shaped housing; a movable wall in said internal chamber, the sides of said movable wall having a predetermined clearance with respect to the sidewalls of said internal chamber; a curtain diaphragm overlying said movable wall with a rolling U-shaped portion extending into said predetermined clearance to roll between the sidewalls of said chamber and the surface of said movable wall during movement of said movable wall, and its outer edge sealingly fixed to the sidewalls of said housing; an opening through said end wall; a driven shaft extending through said opening in said end wall of said housing and operatively connected to said movable wall; means biasing said movable wall to a normal position adjacent the open end of said internal chamber; a first vacuum valve port in the sidewalls of said opening in the end wall of said internal chamber adjacent said shaft; said shaft having a reduced diameter section with an outer section of said shaft adapted to slide into and close off said opening in said end wall when said movable wall is in a first actuated position spaced inwardly from said normal position; abutment means limiting inward movement of said movable wall to a second actuated position wherein said movable wall is spaced inwardly from said first actuated position; a second vacuum port opening into said internal chamber and which is not closed off by said movable wall; said valve shut-off means remaining closed as said movable wall moves from said first actuated position to said second actuated position; and valve means for selectively applying vacuum to respective first and second vacuum ports.

4. In a vacuum motor control system: a housing having an internal chamber; a movable wall in said chamber; a curtain diaphragm overlying said movable wall, said diaphragm having its outer edge fixed to the sidewalls of said housing; a driven shaft projecting from said housing and operatively connected to said movable wall; means biasing said movable wall to a normal position adjacent an end of said internal chamber; a first vacuum valve port in said housing leading to said internal chamber; valve shut-off means carried by said shaft for closing said first vacuum valve port when said movable wall moves to a first actuated position; abutment means limiting inward movement of said movable wall to a second actuated position spaced from said first actuated position; a second vacuum port opening into said internal chamber, which second valve port is open to said chamber regardless of the position of said movable wall; and valve means for selectively applying vacuum to respective first and second valve ports.

5. In a vacuum motor control system: a housing having an internal chamber; a movable wall in said internal chamber, the sides of said movable wall having a predetermined clearance with respect to the sidewalls of said internal chamber; a curtain diaphragm overlying said movable wall, said diaphragm having its outer edge sealingly fixed to the sidewalls of said housing; a driven shaft projecting from said housing and operatively connected to said movable wall, said shaft having an outwardly facing

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shoulder positioned in said internal chamber with a reduced diameter section of said shaft positioned outwardly of said shoulder; means biasing said movable wall to a normal position adjacent the open end of said internal chamber; a first vacuum valve port in said housing leading to said internal chamber; a valve closure member spring biased to abut with said shoulder of said shaft for closing off said first vacuum valve port when said movable wall is in its first actuated position, said valve closure member being slidable outwardly on said shaft; abutment means limiting inward movement of said movable wall to a second actuated position wherein said movable wall is spaced inwardly from said first actuated position; a second vac-

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uum port opening into said internal chamber and which is not closed off by said movable wall; and valve means for selectively applying vacuum to respective first and second vacuum ports.

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