Jan. 13, 1959 E. E. MODES 2,868,459

VACUUM CONTROL DEVICES

Filed Feb. 8, 1956

Fig. 1

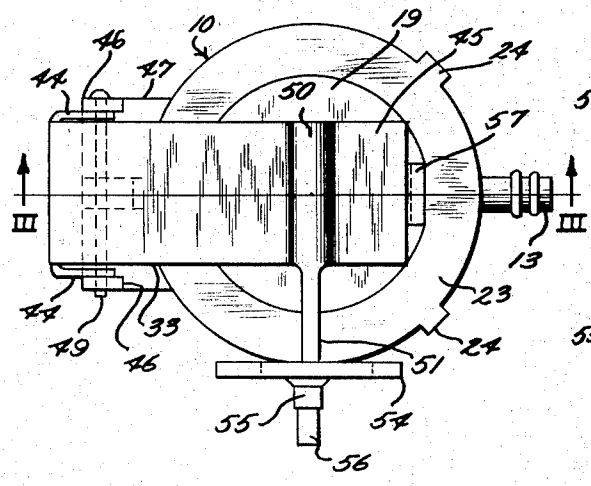


Fig. 2

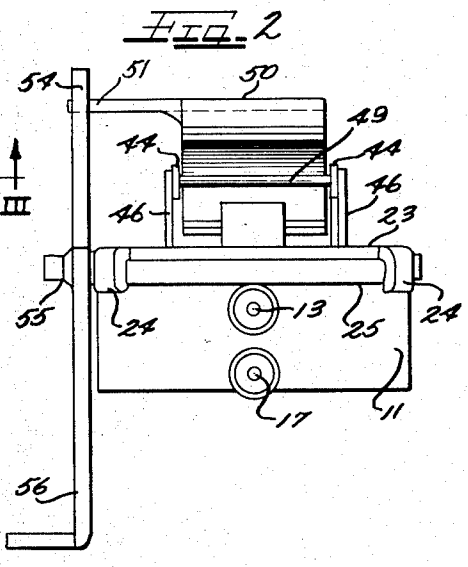
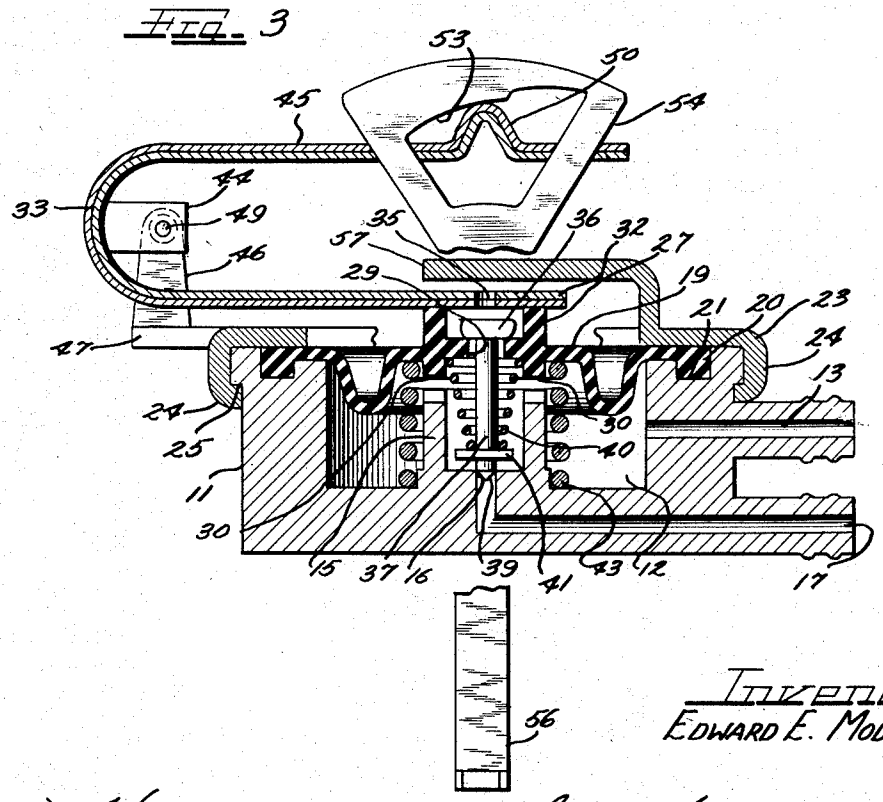


Fig. 3



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VACUUM CONTROL DEVICES

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This invention relates to improvements in vacuum control devices and more particularly relates to an improved form of vacuum control device controlling the vacuum from the intake manifold of an internal combustion engine to a vacuum motor in accordance with temperature conditions.

A principal object of the invention is to provide a novel and improved form of vacuum control device arranged to cope with the variable vacuum conditions encountered in internal combustion engines and to control the vacuum to a vacuum motor in accordance with temperature conditions and the setting of the device.

Another object of the invention is to provide a new and improved form of vacuum equalizing and control valve arranged to equalize the vacuum supplied by the intake manifold of an internal combustion engine and to vary the vacuum in accordance with variations in temperature determined by the setting of the device.

A further and more specific object of my invention is to provide a novel form of vacuum control device in which a bi-metal temperature sensitive element works against a pneumatic two-valve force balancing device and applies a compressive force thereto to control the vacuum in accordance with the temperature setting of the bi-metal element.

These and other objects of the invention will appear from time to time as the following specification proceeds and with reference to the accompanying drawings wherein:

Figure 1 is a top plan view of a vacuum control device constructed in accordance with my invention;

Figure 2 is an end view of the device shown in Figure 1; and

Figure 3 is a partial fragmentary sectional view of the device shown in Figure 1 and looking substantially along line III—III of Figure 1, but showing a portion of the control cam therefor in side elevation.

In the drawings, a vacuum control valve **10**, which may be mounted within the passenger compartment of an automotive vehicle, is shown as comprising a valve casing **11** having a vacuum equalizing chamber **12** therein with an inlet or vacuum output passageway **13** leading into said chamber through a wall thereof and adapted to be connected to a vacuum motor and the like (not shown) to supply vacuum thereto to operate the same. The vacuum equalizing chamber **12** has a central annular wall **15** extending upwardly from the bottom thereof and encircling a port **16** connected with a source of vacuum through an outlet passageway **17**. The outlet passageway **17** may be connected with the intake manifold of an internal combustion engine, which serves to supply vacuum to the chamber **12** and the inlet or vacuum output passageway **13**.

The opposite end of the vacuum equalizing chamber **12** from the port **16** is shown as being closed by a diaphragm **19** having a depending annular rib **20** recessed within an annular recessed portion **21** of the top wall of the valve casing **11** and sealed thereto as by a retainer yoke **23**

generally annular in form and extending about the diaphragm **19** and crimped or otherwise secured to the valve casing **11** by ears **24** crimped into engagement underneath a shouldered portion **25** of said casing.

The diaphragm **19** is shown as having an annular wall **27** extending upwardly therefrom concentric with the center thereof and encircling a central port **29** leading therethrough into the vacuum equalizing chamber **12**. The diaphragm **19** also has a depending annular stop **30** in alignment with the annular wall **15** and engaging said annular wall to form a stop to limit inward movement of the diaphragm upon high vacuum conditions.

The wall **27** of the diaphragm **19** is abutted at its outer end by a leg **32** of a generally U-shaped bi-metallic thermal element **33**, applying a compressive force to said diaphragm. The leg **32** has a passageway **35** leading therethrough concentric with the port **29**, for the passage of air at atmospheric pressure within the chamber **12** to balance the vacuum within said chamber, as will hereinafter more clearly appear as this specification proceeds.

The port **29** is engaged by a valve **36** having a stem **37** extending through said port. The inner end of the stem **37** is shown as being generally conical in form and as forming a valve **39** engaging the port **16** and closing the chamber **12** to a source of vacuum. A conical spring **40** encircles the stem **37** and is interposed between the underside of the diaphragm **19** and a collar **41** on said stem to bias the valve **36** in a closed position, and to accommodate opening of said valve and the port **29** upon inward movement of the diaphragm **19**, effected by operation of the thermal element **33** upon increases in temperature, or effected by high vacuum conditions within the chamber **12**, drawing the diaphragm **19** within said chamber. The spring **40** is under sufficient compression to bias the valve **36** to seal the port **29** tightly.

A helical spring **43** is shown as encircling the annular wall **15** and as being seated in the bottom of the chamber **12** at one end and as engaging the underside of the diaphragm **19** at its opposite end, to tend to move the diaphragm **19** against the leg **32** of the bi-metallic thermal element **33**. The helical spring **43** is loaded sufficiently to exert an outward force on the diaphragm equivalent to maximum atmospheric pressure times the effective area of the diaphragm.

The bi-metal thermal element **33** is shown as having ears **44** extending inwardly from the base of the U between the leg **32** and an upper leg **45** thereof. The ears **44** are pivoted to lugs **46** extending upwardly from a bracket **47** formed integral with the yoke **23** and extending outwardly therefrom. A pivot pin **49** pivotally connects the ears **44** to the lugs **46**.

The upper leg **45** of the bi-metallic thermal element **33** is shown as having a rib **50** formed therein and extending thereacross and upwardly therefrom. The rib **50** terminates into an arm **51** extending laterally therefrom and forming a cam rider engaging an internal cam face **53** formed in a pivoted cam member **54**. The cam member **54** is pivoted intermediate its ends on a pivot pin **55** extending outwardly from the valve casing **11**. The cam member **54** has an arm **56** depending from the pivot pin **55**, to which may be connected an actuator for adjusting the position of the cam member **54** and the operating range of the bi-metal thermal element and for holding said cam in its adjusted position.

The bi-metal thermal element **33** is formed with its high expanding side on the inside of the element. Thus, upon increases in temperature the compressive force against the diaphragm **19** will increase and tend to move said diaphragm against the spring **43** in a direction to unseat the valve **36** and open the port **29** to admit air at atmospheric pressure into the chamber **12**. Thus, if the cam member **54** is moved in the clockwise direction, the ten-

sion on the bi-metal thermal element 33 and the force with which said bi-metal thermal element bears against the inner wall 27 of the diaphragm 19 will be increased. The temperature at which said bi-metal thermal element operates to unseat the valve 36 from the port 29 will thus be reduced.

In a contrary manner, as the cam member 54 is moved in a counter-clockwise direction, the tension of the bi-metallic thermal element 33 and the compressive force, exerted by said thermal element against the diaphragm 19 will be decreased resulting in a longer travel of said thermal element to unseat the valve 36 from the port 29. This will raise the temperature at which the thermal element 33 operates to unseat the valve 36 to admit air at atmospheric pressure into the chamber 12.

A stop 57 is shown as extending from the yoke 23 inwardly along the upper side of the leg 32 of the bi-metal thermal element to limit excessive deflection of the diaphragm 19 and the leg 32 of the bi-metal thermal element 33 outwardly with respect to the casing 11 by the spring 43, when the source of vacuum drops to zero.

In operation of the device the controlled vacuum within the chamber 12 will attain a value between zero and that of the vacuum source, such that the downward force of the vacuum on the diaphragm 19 times the effective diaphragm area plus the downward force of the leg 32 of the bi-metal thermal element 33 on the diaphragm is equal to the upward force of the helical spring 43. The vacuum in the chamber 12 will thus be a function of the downward force of the leg 32 of the bi-metal element acting against the diaphragm 19.

Where a condition of equilibrium exists at the temperature to which the bi-metallic thermal element 33 has been set and the vacuum value in the chamber 21 is between zero and the vacuum value at the source of vacuum, if the temperature to which the bi-metal thermal element 33 is subjected increases, the balance between the bi-metal thermal element 33 and the diaphragm 19 will be disturbed. The leg 32 of the bi-metal thermal element 33 will then deflect the diaphragm 19 against the spring 43. This will cause the diaphragm to move away from the valve 36 and unseat said valve and open the port 29. Air at atmospheric pressure will then flow through the passageway 35 in the leg 32 of the bi-metal thermal element 33 and through the port 29 into the chamber 12 and reduce the vacuum therein.

As the vacuum is reduced in the chamber 12, the spring 43 will move the diaphragm 19 upwardly. This will deflect the leg 32 of the bi-metal element 33 upwardly until the port 29 is again closed. A new condition of equilibrium will then exist at a lower vacuum value and at a higher bi-metal temperature.

If the temperature to which the bi-metal thermal element 33 is subjected decreases, the leg 32 will move away from the diaphragm 19. The spring 43 will then force the diaphragm to follow the leg 32. This will lift the valve 39 from the port 16. The vacuum source will then draw air from the chamber 12 to increase the vacuum value therein until the diaphragm is again returned to its equilibrium position in which the ports 16 and 29 are closed.

While I have herein shown and described one form in which my invention may be embodied, it will be understood that various modifications and variations of the invention may be effected without departing from the spirit and scope of the novel concepts thereof.

I claim as my invention:

1. In a temperature responsive vacuum control valve, a valve casing having a valve chamber therein, a port leading from said chamber and adapted to have connection with a source of vacuum, an inlet into said chamber adapted to have connection with a vacuum motor and the like to supply vacuum to operate the same, a diaphragm extending over said chamber and having an annular wall extending outwardly therefrom, a port leading through said diaphragm within the margins of said wall for venting said chamber to atmosphere, valve means within the margins of said wall in association with said ports and operated by movement of said diaphragm inwardly and outwardly of said chamber and biased to close said port leading through said diaphragm, a bi-metal thermal element generally U-shaped in form, pivoted adjacent the base of the U and having generally parallel legs extending over said diaphragm, and means reacting against one of said legs to retain said legs from outward movement with respect to the other of said legs and biasing the other of said legs into engagement with said wall in outwardly spaced relation with respect to said valve means and normally balancing said diaphragm to maintain both of said ports closed upon balanced conditions of the vacuum within said chamber in accordance with the temperature setting of said thermal element, the high expanding side of said thermal element being on the inside thereof to effect movement of said leg engaging said wall in a direction to move said diaphragm with respect to said valve means to open said port leading through said diaphragm upon predetermined increases in temperature, and accommodating movement of said diaphragm in an opposite direction to engage said valve means and close said port within said wall and open said port leading from said chamber upon predetermined reductions in temperature.

2. In a temperature responsive vacuum control valve, a valve casing having a valve chamber therein, a port leading from said chamber and adapted to have connection with a source of vacuum, an inlet into said chamber adapted to have connection with a vacuum motor and the like, a diaphragm extending over said chamber and forming a movable wall thereof, and having a port therein opening from said chamber to atmosphere, said diaphragm having an annular wall encircling said port and extending outwardly therefrom, valve means within said annular wall in association with said diaphragm and ports, for closing both of said ports upon balanced conditions of vacuum within said chamber, a bi-metal thermal element U-shaped in form, pivoted adjacent the base of the U and having legs extending over said diaphragm in vertically spaced relation with respect to each other, the lower of said legs having engagement with said annular wall in outwardly spaced relation with respect to said valve means, the high expanding side of said thermal element being on the inside thereof to effect movement of the lower of said legs in a direction to move said diaphragm with respect to said valve means and open the port therethrough upon predetermined increases in temperature, an adjustable cam means engaging the upper of said legs and stressing said thermal element to bias the lower of said legs into engagement with said annular wall, said cam means being adjustable to vary the force of engagement of the lower of said legs with said diaphragm and the temperature range of operation of said thermal element, and a helical spring within said chamber having engagement with said diaphragm and balancing said thermal element for a condition of equilibrium within said chamber in accordance with the temperature setting of said thermal element.

3. In a temperature responsive vacuum control valve, a valve casing having a valve chamber therein, a port leading from said chamber and adapted to have connection with a source of vacuum, an inlet into said chamber adapted to have connection with a vacuum motor and the like, a diaphragm extending over said chamber and sealed thereto and having a port therein opening from said chamber to atmosphere, said diaphragm also having an annular wall encircling said port and extending outwardly therefrom, a single valve member extending through said port leading to said diaphragm and having a valve on the outside thereof within the limits of said annular wall and engageable with said port leading through said diaphragm, said valve member also having

a second valve spaced from said first valve within said chamber and engageable with said first port leading from said chamber, spring means biasing said first valve into engagement with said port leading through said diaphragm, a bi-metal thermal element generally U-shaped in form having its high expanding side on the inside thereof and pivoted adjacent the base of the U and having vertically spaced legs extending over said diaphragm, means reacting against the upper of said legs and forming a reaction member for said thermal element and stressing said thermal element to bias the lower of said legs into engagement with said wall in spaced relation with respect to said first mentioned valve and reacting against said diaphragm with a compressive force to move said diaphragm inwardly upon predetermined increases in temperature to open said first valve and admit air at atmospheric pressure within said chamber, and a helical spring seated

within said chamber and engaging said diaphragm and biasing said diaphragm outwardly with respect to said chamber against the lower of the legs of said thermal element, to effect opening of said second valve and the increase of vacuum within said chamber upon predetermined reductions in temperature.

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