United States Patent [19]

Franz et al.

[11] **3,789,811**

[45] **Feb. 5, 1974**

[54] **EMISSIONS REDUCTION VACUUM CONTROL VALVE**

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[73] Assignee: **Eaten Corporation,** Cleveland, Ohio ; by said Franz and Freismuth

[22] Filed: **Nov. 3, 1971**

[21] Appl. No.: **195,239**

[52] **U.S. Cl.** ..... **123/117 A,** 137/80

[51] **Int. Cl.** **F02p 5/04,** F16k 17/38

[58] **Field of Search** . 123/117 A, 117 R; 137/80, 79

[56] **References Cited**

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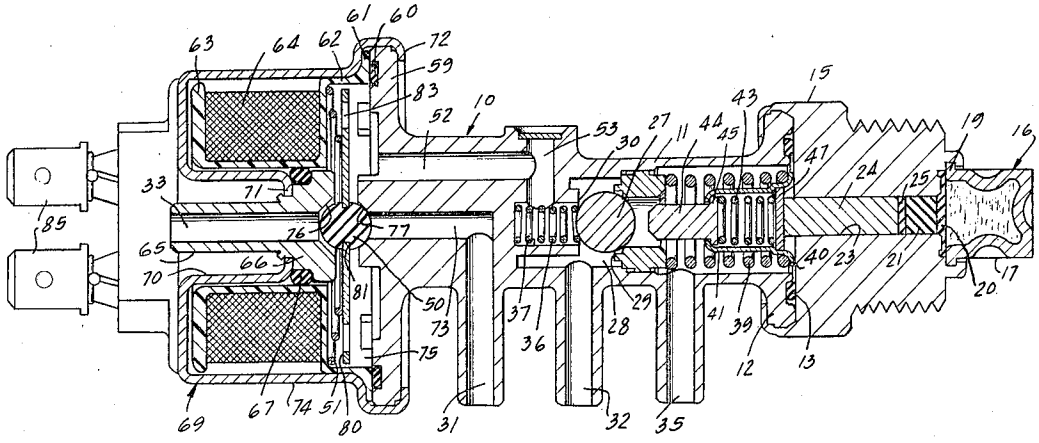
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[57] **ABSTRACT**

Spark advance vacuum control valve arranged to reduce the emission of noxious gases from the internal combustion engines of automotive vehicles. A solenoid energized by an electric switch in association with the transmission operates a valve effective to vent the distributor to atmosphere as the engine is started and the transmission is shifted into high gear. When the transmission is in high gear, the solenoid is deenergized to connect the distributor to effect advance of the spark by carburetor vacuum. A manifold port, distributor port and vent port lead into the valve housing through a wall of the housing while the carburetor port is at an end of the valve housing. A valve chamber within the housing has communication with the manifold vacuum port, the distributor port, the vent port and the carburetor vaccum port under the control of a thermally responsive valve. The thermally responsive valve is operated by overheating of the engine to advance the spark by manifold vacuum and increase the speed of the engine.

10 Claims, 3 Drawing Figures



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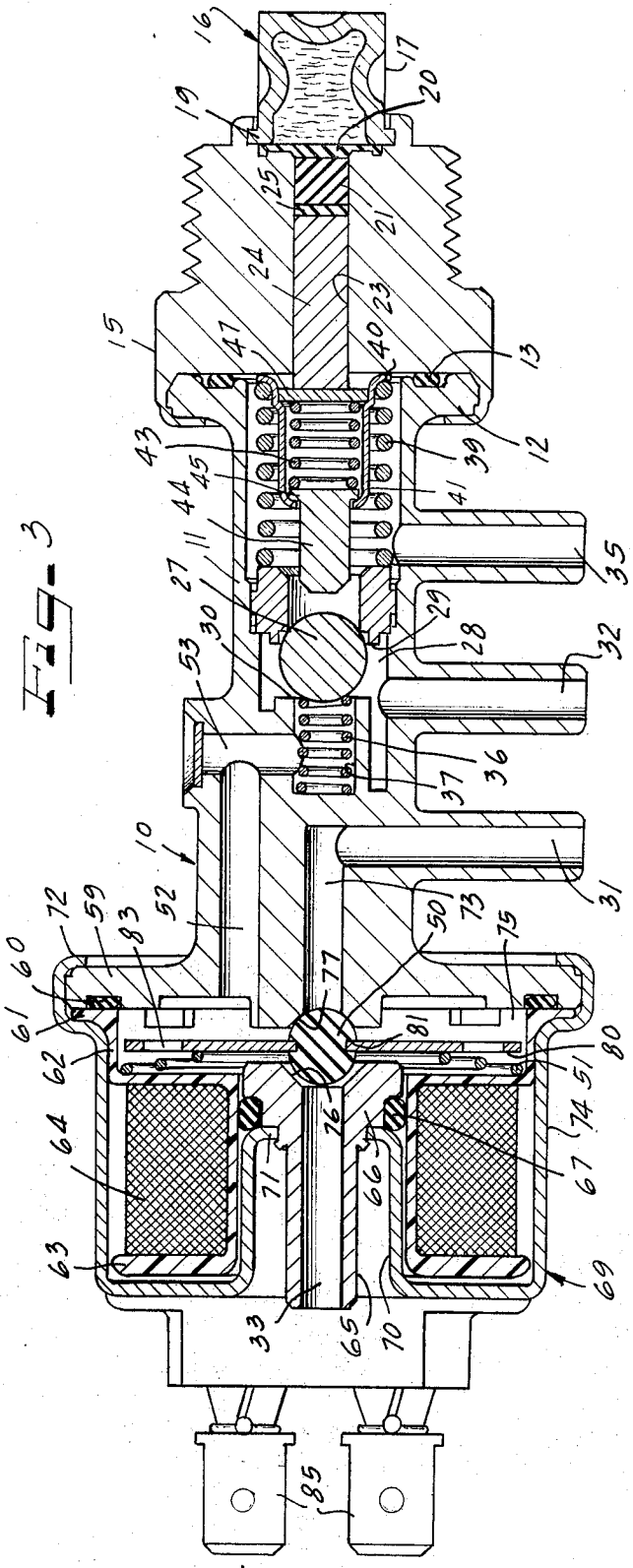


Fig. 3

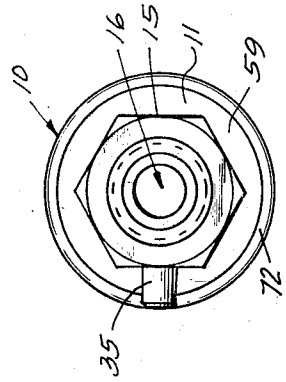


Fig. 2

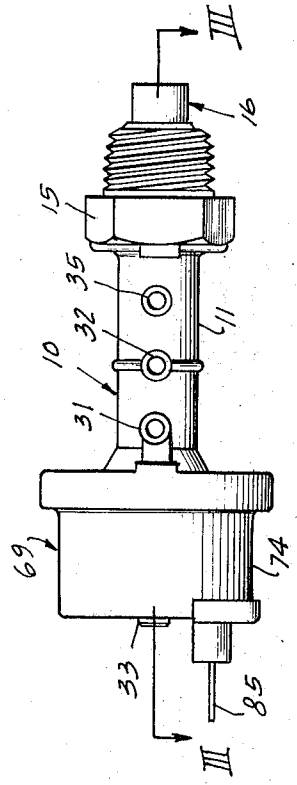


Fig. 1

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EMISSIONS REDUCTION VACUUM CONTROL VALVE

FIELD OF THE INVENTION

Undesirable emissions reduction internal combustion engine spark advance control valve.

BACKGROUND, SUMMARY AND OBJECTS OF THE INVENTION

In the operation of automotive vehicles, it has been found that more undesirable emissions are given off from the internal combustion engine of the vehicle if the spark is advanced when shifting the transmission through the low speed gear ranges into high gear than when it is not advanced until the transmission is in high gear.

In order to prevent the advance of the spark before the transmission is shifted into high gear, a solenoid operated vacuum control valve, controlled by the transmission gearing, controls the automatic spark advance and prevents the advance of the spark before the transmission is in its high speed gear position. The solenoid when energized prevents carburetor vacuum from advancing the spark and vents the distributor to atmosphere. As the transmission shifts into its high speed drive range, the solenoid coil is deenergized and the valve is effective to provide communication between the distributor and carburetor vacuum. The spark advance then functions normally on carburetor vacuum.

An advantage of the present invention is the reduction of the noxious gases discharged to the atmosphere from an internal combustion engine of an automotive vehicle when starting the engine and shifting from low into high gear.

A further advantage and object of the invention is to retard the spark of an internal combustion engine when starting and shifting through the low gear range of the transmission of an automotive vehicle, and to advance the spark as the transmission is shifted into its high gear range, to reduce the emission of noxious gases when the vehicle is coming up to its high gear running speed.

Another object of the invention is to provide a new and improved form of vacuum control valve, controlling the advance of the spark of an internal combustion engine, dependent upon a predetermined gear reduction range of the transmission of the engine, to reduce the emission of noxious gases during shifting of the transmission into its high speed gear range.

Still another object of the invention is to provide a solenoid controlled valve, reducing air pollution by reducing the amount of noxious gases discharged to the atmosphere from an internal combustion engine during operation of the engine in the low speed gear range of the transmission of the automotive vehicle.

Still another object of the invention is to provide a noxious gas reduction vacuum control valve controlling the advance of the spark of an internal combustion engine, arranged with a view toward utmost simplicity and efficiency in construction and operation.

Other objects, features and advantages of the invention will be readily apparent from the following description of a preferred embodiment thereof, taken in conjunction with the accompanying drawings, although variations and modifications may be effected without departing from the spirit and scope of the novel concepts of the disclosure.

DESCRIPTION OF THE DRAWINGS

FIG. 1 is a view in side elevation of a vacuum control valve constructed in accordance with the principles of the present invention.

FIG. 2 is an end view of the valve looking at the valve toward the thermally responsive element in the bottom of the valve housing; and

FIG. 3 is a sectional view taken substantially along line III—III of FIG. 1.

DESCRIPTION OF PREFERRED FORM OF THE INVENTION

In the drawings, we have shown a vacuum control valve **10** including a valve housing **11** having a radial flange **12** at its lower end having a seal **13** recessed therein and extending thereabout and having sealing engagement with the plane upper face of a threaded coupling member **15**, adapted to be threaded in the cylinder head of an internal combustion engine, to position a thermally responsive element **16** on the end of said coupling in the water jacket of the engine. The coupling **15** is crimped or otherwise secured to the flange **12**, to retain the seal **13** in sealing engagement with the coupling **15** and thereby provide an air tight connection between said flange and coupling.

The thermally responsive element **16** is shown as being a solid fill or power type of thermally responsive element including the casing **17** containing a fusible thermally expansible material, such as a wax or a mixture of wax and a powdered metal heat conducting material, with or without a binder, to attain a material which will expand in its fusion range, at a temperature range selected for operation of the valve, in a manner well-known to those skilled in the art so not herein shown or described further.

As shown in FIG. **3**, the casing **17** has a radial flange **19** extending outwardly from the upper wall thereof and abutting a resilient diaphragm **20**. The flange and diaphragm are sealed to the coupling member **15** by crimping an axially extending annular portion of the coupling member over the flange **19**. A piston **21** is slidably guided in a bore **23** of the coupling member **15** and is spaced from an extensible power member **24** movable along the bore **23**, as by a spacer **25**.

The extensible power member **24** as moved by the thermally expansible material in the casing **17** in an extensible direction upon increases in temperature, unseats a ball-type valve **27** in a valve chamber **28** from a valve seat **29** and seats said valve on a vertically spaced valve seat **30** to block communication between a vent port **31** and a distributor port **32** and between a carburetor port **33** and the distributor port **32**.

Unseating of the valve **27** from the seat **29** and seating said valve on the seat **30** affords communication between a manifold vacuum output port **35** and the distributor input port, to effect advance of the spark and increase the running speed of the engine and the amount of air flowing over the engine through the fan and also increasing coolant circulation to effect cooling of the engine to its normal operating temperature, in cases where the engine has become overheated sufficiently to effect extensible movement of the power member **24** to operate the valve **27**.

A spring **36** seated in a passageway **37** leading from the valve chamber **28** and seat **30**, biases the ball **27** in engagement with the seat **29**, at normal engine temper-

atures at which time the fusible expansible material has contracted and the power member is retractably moved by a spring **39**. The spring **39** is seated on the undersurface of the seat **29** at one end and on a radially extending shoulder **40** extending radially outwardly of the lower end of a bell-like cage **41** at its opposite end. The cage **41** forms a cage for an overtravel spring **43**, abutting the bottom of a plunger **44** engageable with the valve **27** upon extensible movement of the power member **24**.

The downwardly opening bell-like cage **41** slidably extends along the plunger **44** and is retained to said plunger by the overtravel spring **43** and a shouldered portion **45** of said plunger, engaged with an inturned upper end portion of the bell-like cage by the overtravel spring **43**. The lower end of the overtravel spring **43** is seated on a disk **47** abutting the extensible power member **24** and engaging a shouldered portion of said bell-like cage adjacent the lower end of said cage. The spring **43**, therefore, accommodates overtravel of the extensible power member **24** as the plunger **44** engages the valve **27** and seats said valve on the valve seat **30**, to prevent damage to the thermally responsive element upon temperature conditions sufficiently high to cause overtravel of said temperature responsive element.

The valve **27** is thus movable along the valve chamber **28** to connect the distributor port **32** with the manifold vacuum port **35** to connect the distributor to manifold vacuum to effect advance of the spark by manifold vacuum at high temperature conditions of the engine and is normally biased by the spring **36** to block the connection between said distributor input port and manifold vacuum output port, to accommodate the connection of the distributor to the vent port **31** when it is desired that the spark be retarded, or to the carburetor vacuum output port **33** to effect advance of the spark by carburetor vacuum under the control of a solenoid controlled valve **50** in a valve chamber **75** formed between a casing **69** for a solenoid coil **64**, and the opposite end of the valve housing from the thermally responsive element **16**.

The valve **50** is biased by a spring **51** to engage a seat **77** on the end of a passageway **73**, extending axially along the housing **11** from the vent port **31** to open end of said housing, and block the venting of the distributor port **32** through the vent port **31** and to connect the distributor port **32** with the carburetor vacuum port **33** through a passageway **52** extending parallel to the passageway **73** and opening to the same end of the valve housing as the passageway **73**. The passageway **52** has communication with the valve chamber **28** through a passageway **53** leading from the inner end of the passageway **52** to the passageway **37** opening into the valve chamber **28** through the seat **30**.

The end of the valve housing adjacent the carburetor vacuum port **33** has a widened radial flange **59** extending outwardly therefrom having a sealing ring **60** recessed in its outer face and extending thereabout. The seal **60** is engaged by a foot or flange **61** extending radially outwardly of an annular leg **62**, depending from a spool or bobbin **63** for the solenoid coil **64**. The carburetor vacuum port **33** is defined by a fitting **65** and extends along said fitting. The fitting **65** has a widened base **66**, shouldered to form a seat for a sealing ring **67** having sealing engagement with the interior wall of the spool **63**.

The casing **69** for the solenoid coil **64** has an inwardly dished interior portion **70**, extending along the inner wall of the spool **63** and having an inturned annular lower end portion **71**, extending inwardly along a shoulder formed by the upper or outer surface of the widened portion **66** of the fitting **65**. The fitting **65** is shown in FIG. **3** as being staked to the inturned end portion **71** of the dished portion **70** of the casing, securing said fitting to said casing and retaining said fitting in axial alignment with the passageway **73** leading axially along the valve housing from the vent port or passageway **31**.

The casing **69** has an exterior cylindrical wall portion **74** encasing the spool **63** and solenoid coil **64**. The wall **74** extends downwardly along the annular leg portion **62** of the spool **63**, and is turned outwardly into abutting engagement with the upper surface of the flange **61** and outwardly therefrom. The outwardly extending portion of the cylindrical wall **74** is curled about the flange **59** and extends along the underside thereof as indicated by reference numeral **72**, to retain the casing **69** to the valve housing and to provide an air tight seal between the flange **59** and undersurface of the flange **61** in cooperation with the seal **60**. The bobbin or spool **63** and solenoid coil **64** wound about said spool are thus sealed to the carburetor fitting **65** and to the flange **59** by the seal **60**, to prevent dirt and moisture from getting into the region of the solenoid coil, and to define the closed valve chamber **75** at the end of the valve housing **11**. The widened portion of the carburetor output fitting **65** has a frusto-conical seat **76** opening to the bottom thereof in axial alignment with the passageway **73** and forming a seat for the ball valve **50**, to close the carburetor output port upon energization of the solenoid coil **64**. The passageway **73** leading from the vent port **31** also has a frustoconical seat **77** opening into the valve chamber **75**. The valve **50** is normally biased into engagement with the seat **77** by the conical spring **51** seated at its large diameter end on the underside of the lower flange of the bobbin or spool **63** and seated at its opposite end on a metallic disk **80** forming the armature of the solenoid.

The valve **50** is shown as being a resilient ball-type valve made from rubber or one of the well-known substitutes for rubber, having a recessed portion **81** extending about the center thereof, and forming a mounting for the disk-like armature **80**. The disk-like armature **80** has passageways **83** leading therethrough, to facilitate communication between the carburetor intake port **33** and the passageway **52** having communication with the valve chamber **28**, under control of the valve **27**.

The solenoid coil **64** has the conventional terminals **85**, which may be connected with a switch (not shown) controlling energization of said solenoid coil. The switch, for example, may be a pressure switch in the transmission for the vehicle and effecting energization of the solenoid coil **64**, to move the valve **50** to seat along the seat **76** and block the connection of vacuum through the distributor port **32** drawn by the carburetor port **33** by carburetor vacuum, and to connect the distributor port to the vent **31**, to effect retarding of the spark until closing of the vent port and opening of the carburetor port, by deenergization of the solenoid coil **64**, as the transmission shifts into high gear.

As the internal combustion engine is started and the automotive vehicle is put in gear to start operation of

the vehicle, the solenoid coil **64** is energized. The armature carrying the resilient valve **50** will then be attracted toward the solenoid coil and seat on the seat **76,** and hold air from being drawn from the valve chamber **75** and distributor by carburetor vacuum. This will effect opening of the seat **77** connecting the distributor to the atmosphere, to sense atmospheric pressure and prevent vacuum spark advance.

As the transmission is shifted into its high drive gear range, the solenoid coil **64** will be deenergized and the spring **51** exerting pressure on the armature **80** will engage the valve **50** with the seat **77.** The distributor port **32** will thn be connected with the carburetor vacuum port **33** and the spark advance will function normally on carburetor vaccum.

Upon overheating of the engine, expansion of the fusible thermally expansible material in the casing **17** for the thermally expansible element **16,** will effect extension of the power member **24** and plunger **44** to push the valve **27** into engagement with the seat **30.** This will seal off the vent passageway **32** and carburetor vacuum port **33.** The distributor will then be connected directly to the manifold port **35,** and the higher manifold vacuum acting upon the spark system will increase the engine speed, with a resultant increase in coolant circulation and increase in fan speed and the amount of air flowing over the engine, to cool the engine to its normal operating temperature. The fusible thermally expansible material will then contract and the valve **27** will return to its normal position with spark advance controlled by carburetor vacuum.

We claim as our inventions:

1. In a vacuum control valve adapted to control the advance of the spark of an internal combustion engine having an intake manifold,

a carburetor and a distributor,

a valve housing having a widened flanged end,

a distributor port leading into said housing and adapted to be connected with the distributor of the engine,

a vent port spaced along said housing from said distributor vacuum port and leading into said housing from the side thereof,

a passageway leading from said vent port and extending axially of said housing and opening to said end thereof,

a carburetor vacuum port including a fitting leading from said end of said housing and directly aligned with and spaced from said passageway,

a casing closing the end of said valve housing and forming a mounting for said carburetor fitting,

a valve chamber formed between said end of said valve housing and said casing and having communication with said vent port, said carburetor vacuum port and said distributor port,

a valve disposed in said valve chamber between the end of said passageway and adjacent the end of said carburetor port fitting, said valve normally biased to close said passageway to afford communication between said distributor port and said carburetor vacuum port,

a spool carried within said casing concentric with said carburetor port fitting and sealing said fitting at its inner periphery, said inner periphery defined by an interior cylindrical wall having a seal extending thereabout in sealing engagement with said fitting, said spool having a top radial flange extending radially of said valve housing flanged end, a bottom radial flange beneath said top flange, an annular axially extending leg defining said interior wall and extending beneath said bottom radial flange, a third radial flange extending outwardly from the bottom of said axially extending leg,

said casing extending along said annular leg and having abutting engagement with said top radial flange and being crimped thereabout to retain said spool to said casing and to said end of said valve housing,

an annular seal recessed in and extending about said flanged end of said valve housing and abutted by said top radially extending flange of said spool to effect the sealing of said flanged end of said valve body by said spool, and

electrically energizable means including a solenoid coil wound about said spool for moving said valve into position to block the passage of vacuum from said distributor port through said carburetor vacuum port and to afford communication between said vent port and said distributor vacuum port.

2. In a vacuum control valve adapted to control the advance of the spark of an internal combustion engine having an intake manifold,

a carburetor and a distributor,

a valve housing,

a distributor port leading into said housing and adapted to be connected with the distributor of the engine,

a vent port spaced along said housing from said distributor vacuum port and leading into said housing from the side thereof,

a passageway leading from said vent port and extending axially of said housing and opening to an end thereof,

a carburetor vacuum port including a fitting leading from an end of said housing and directly aligned with and spaced from said passageway,

a casing closing the end of said valve housing and forming a mounting for said carburetor fitting,

a valve chamber formed between the end of said valve housing and said casing and having communication with said vent port, said carburetor vacuum port and said distributor port,

a valve disposed in said valve chamber between the end of said passageway and adjacent the inner end of said carburetor port fitting, said valve normally biased to close said passageway to afford communication between said distributor port and said carburetor vacuum port,

said valve being a resilient ball-like valve,

an annular metallic disk extending about said ball and recessed therein,

electrically energizable means including a solenoid coil contained within said casing concentric with said fitting for moving said disk and ball toward said carburetor fitting to close said carburetor port, and block the passage of vacuum from said distributor port through said carburetor vacuum port and to afford communication between said vent port and said distributor vacuum port, and

a spring interposed between said solenoid coil and said disk to bias said resilient valve into engagement with the end of said passageway leading from said vent port.

3. The vacuum control valve of claim **2,**

wherein the fitting defining the carburetor port has a central passageway leading therealong,
wherein a flared frusto-conical wall diverges from the lower end of said central passageway and forms a seat for said valve, and
wherein a frusto-conical wall diverges from the upper end of said passageway leading to said vent port coaxially of said carburetor vacuum port and forms a seat for said ball to accommodate the tight sealing of said vent passageway by the bias of said spring.

4. The vacuum control valve of claim **3**,
including an annular flange extending radially of the end of said housing adjacent said carburetor port,
a seal recessed in said flange and extending thereabout,
a spool having a radially extending flange abutting said seal,
wherein the solenoid coil is wound about said spool,
wherein the casing is curled about said radially extending flange of said spool and said radial flange of said housing and presses said radially extending flange into sealing engagement with said seal, and
wherein said spool has an interior cylindrical wall and a resilient gasket is provided between said interior cylindrical wall and said carburetor fitting to cooperate with said first mentioned seal and provide a sealed valve chamber.

5. A vacuum controlled valve comprising,
a valve housing,
at least two ports spaced along said housing,
a first being a vent port,
a second port adapted to draw vacuum into the housing,
a fitting spaced from an end of said valve housing and defining a third port adapted to be connected to a source of vacuum,
a first passageway leading from said vent port to the open end of said housing and opening to the same end of said housing as said fitting and extending coaxially of said fitting,
a second passageway leading from the end of said housing and having communication with said second port,
a solenoid coil encircling said fitting,
a spool having said solenoid coil wound therearound, said spool having top and bottom radial flanges, an annular axially extending leg extending beneath the bottom radial flange and having a third radial flange extending outwardly from the bottom thereof, said top flange abutting the end of said valve body defined as a widened radial flange,
a casing carrying said spool and said solenoid coil and closing said flanged end of said valve housing and the end of said solenoid coil with the space between said flanged end of said housing and said solenoid coil defining a valve chamber, said casing also forming a mounting for said fitting,
a resilient valve member in said valve chamber in alignment with and between said third port and said first passageway leading from said vent port,
an armature carrying said resilient valve member, spring means biasing said valve member to close said vent port, whereby energization of said solenoid coil will open said vent port and close said third port, and provide communication between said vent port and said second port,
an annular seal recessed in said flanged end of said valve housing and abutted by said top flange of said spool, and
said casing being crimped about said top radial flange of said spool and said widened radial flange of said housing to retain said casing to said valve housing and seal the open end of said valve housing to provide communication between said third port and said second port under the control of said valve.

6. The vacuum control valve of claim **5**,
wherein the resilient valve is a ball-like valve,
wherein frusto-conical seats for said valve are provided on the adjacent ends of said fitting and said passageway leading from the end of said vent port, and
wherein said fitting is sealed to said spool and casing.

7. A solenoid-energized, thermally responsive valve for controlling vacuum to the spark advance mechanism of a distributor used in an internal combustion engine to control hydrocarbon emissions therefrom, said valve comprising:

a. a valve housing having first and second flanged ends, a longitudinally extending first valve chamber opening at one end to said first flanged end and a first valve seat at the opposite end of said chamber, a distributor and a manifold vacuum port communicating with said first chamber, a passageway in said housing opening from said second flanged end and communicating with said first valve seat, a second valve seat in said second flanged end and a vented port communicating with said second valve seat;
b. a first casing section containing a thermally responsive unit sealingly crimped over said first flanged end, a piston extending from said unit into said first chamber;
c. a plunger and third valve seat in said first chamber actuated by said piston, a first resilient valve member between said first and third valve seats and spring means normally biasing said first valve member into sealingly engagement with said third valve seat to seal communication between said manifold port and said distributor port;
d. a second annular casing section sealingly crimped over said second flange to define a second valve chamber therebetween, said casing containing an annular spool, a solenoid coil wound around said spool and a fitting defining a carburetor vacuum port extending therethrough and sealed therein, said fitting having an end formed into a fourth valve seat disposed opposite that of said second valve seat in said second valve chamber; and
e. a second resilient valve member in said second valve chamber, and spring means in said second chamber normally biasing said second resilient valve member into sealingly engagement with said second seat.

8. The solenoid-energized, thermally responsive valve of claim **7**, wherein said armature of said solenoid comprises an annular metallic disk in said second valve chamber, said second and fourth valve seats are frusto-conical in shape and said second resilient valve member is ball-shaped to sealing seat in said frusto-conical seats and grooved thereabout to receive said armature.

9. A solenoid actuated valve comprising,
a housing defining an open-ended valve chamber therein,

a first frusto-conical valve seat sealingly disposed at one open end of said chamber,

a second frusto-conical valve seat sealingly disposed at the other end of said chamber,

said chamber further having an outlet opening remote from said valve seats and disposed in said open end containing said first valve seat, and an outlet port in said housing communicating with said outlet opening,

a first inlet in said housing at a first pressure communicating with said first valve seat,

a fixed fitting in said housing defining a second inlet at a second pressure communicating with said second valve seat,

a solenoid coil and spool encircling said fitting,

a resilient ball-like valve member disposed in said valve chamber between said first and second valve seats and having a circumferentially extending recess formed thereabout,

an annular metallic disk defining the armature of said coil, said disk received within said recess so as to be secured to said resilient valve member and disposed entirely in said valve chamber,

spring means in said valve chamber normally biasing said armature and said valve member into sealing contact with said first valve seat to permit communication of said second inlet with said outlet port, and

said housing further including a first casing section having a flanged end and a second annular casing section receiving said fitting and said spool,

said spool having top and bottom radial flanges, an annular axially extending leg extending beneath said bottom radial flange about which said coil is wound and having a third radial flange extending outwardly from the bottom thereof, said second casing extending along said annular leg and having abutting engagement with said top radial flange and being crimped about said top radial flange and said housing flanged end, and

said valve chamber defined by said flanged end of said valve housing and said top and bottom flanges of said spool.

10. The solenoid actuated valve of claim **9** wherein an annular seal is received within a recess in said flanged end of said first casing section and abutted by said top radial flange of said spool to effect sealing of said valve chamber when said second casing is crimped about said flanged end of said first housing.

* * * * *

UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,789,811 Dated February 5, 1974

Inventor(s) Rudolph J. Franz et al.

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

On the cover sheet, in the heading, item [73] Assignee:

"Eaten Corporation" should read -- Eaton Corporation --.

Signed and sealed this 14th day of May 1974.

(SEAL)
Attest:

EDWARD M.FLETCHER,JR.
Attesting Officer

C. MARSHALL DANN
Commissioner of Patents

FORM PO-1050 (10-69)

USCOMM-DC 60376-P69
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