United States Patent [19]

King

[11] **3,745,984**

[45] **July 17, 1973**

[54] **PURGE CONTROL VALVE AND SYSTEM**

[75] Inventor: **Jack B. King**, Royal Oak, Mich.

[73] Assignee: **General Motors Corporation**, Detroit, Mich.

[22] Filed: **Dec. 27, 1971**

[21] Appl. No.: **211,991**

[52] **U.S. Cl.** **123/136**, 123/121, 251/11

[51] **Int. Cl.** **F02m 21/00**

[58] **Field of Search** 123/136, 121; 251/11

[56] **References Cited**

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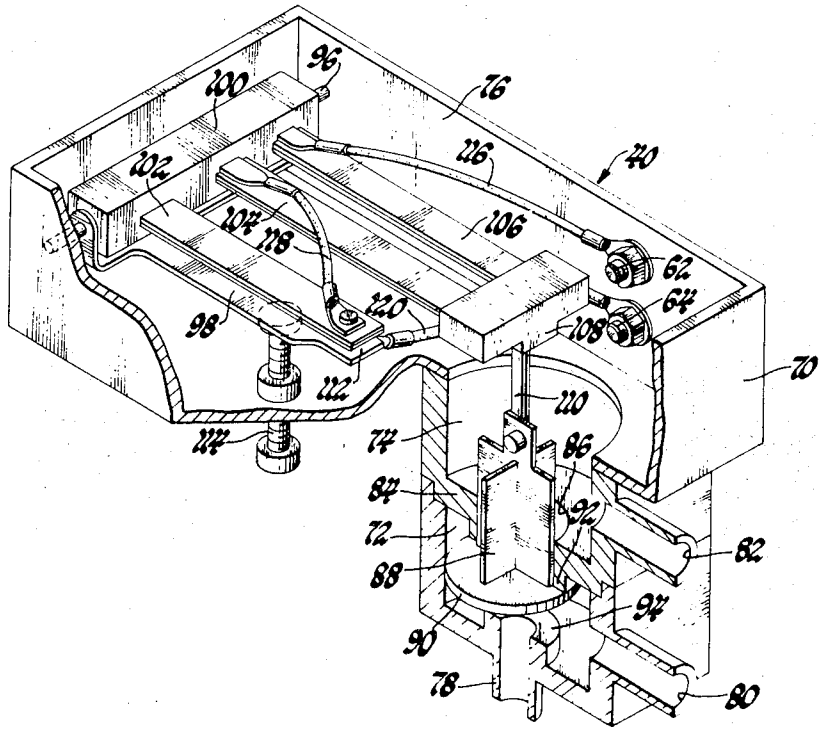
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Primary Examiner—Laurence M. Goodridge
Assistant Examiner—Cort Flint
Attorney—J. L. Carpenter and Robert J. Outlard

[57] **ABSTRACT**

A purge control valve adapted to control the purge of fuel vapors from storage means into the engine induction system. The valve is preferably connected to the engine starting means and closes in response to an electric current during engine starting to prevent vapors entering the induction system immediately after starting, after which the system is gradually opened to permit normal purge flow. Application of the valve to an engine having crankcase fuel vapor storage is disclosed, although other applications are possible. The valve structure includes electrically heated bimetallic elements, a cutout mechanism to prevent overheating and means for adjusting the valve preload, combined in a single actuating mechanism.

4 Claims, 2 Drawing Figures



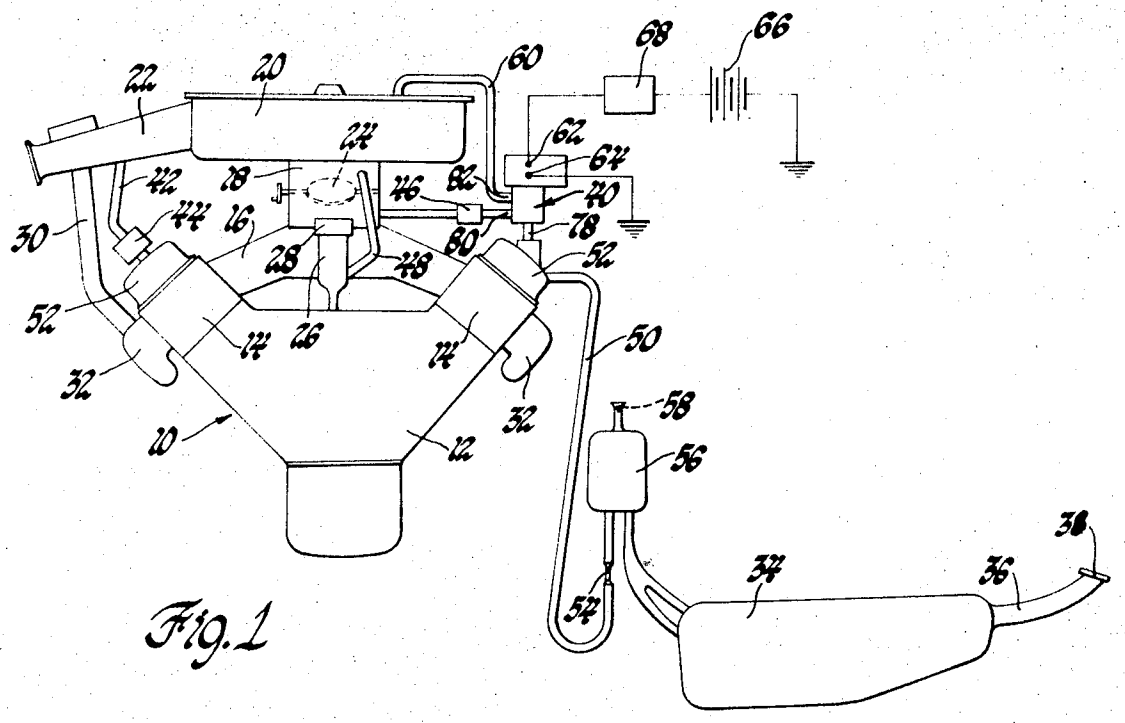


Fig. 1

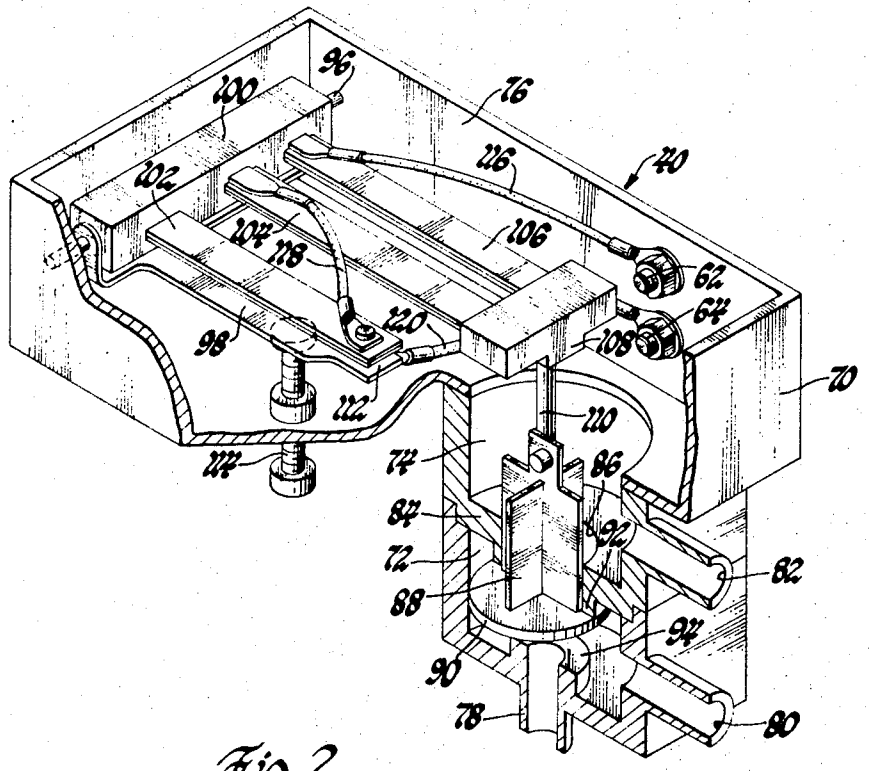


Fig. 2

INVENTOR.
Jack B. King
BY
Robert J. Outland
ATTORNEY

PURGE CONTROL VALVE AND SYSTEM

FIELD OF THE INVENTION

This invention relates to internal combustion engines and, more particularly, to means for controlling the purge of stored fuel vapor from the storage means into the engine induction system. In its more specific aspects, the invention relates to a crankcase fuel vapor storage system for an internal combustion engine and to the structure and operation of a purge control valve for such a system.

SUMMARY OF THE INVENTION

The present invention provides a purge control valve, for use in conjunction with an internal combustion engine and associated fuel vapor storage means, to control the purge of fuel vapor into the engine during operation, and especially immediately after starting.

The engine of the present invention is arranged to receive into its induction system, stored fuel vapors from a container such as the engine crankcase. The valve of the present invention includes means responsive to a signal from the engine starting system or the like to cut off the purge of fuel vapors into the induction system in the period immediately after starting so as to prevent engine stalling after startup. The valve then gradually returns the system to a normal purge condition so as to dissipate the fuel vapors from the container. While useful for other purposes, the valve is particularly adapted for use in engine crankcase storage systems in which it is desirable to permit a continuous flow of vapors from the engine crankcase into the engine induction system so as to ventilate the crankcase under all operating conditions, except for the temporary shutoff immediately after starting, which is not detrimental.

The invention further provides a closed crankcase ventilation system combined with means for storage of fuel tank and carburetor bowl fuel vapors in the engine crankcase during engine shutdown with purge of the vapors after startup as controlled by the purge control valve. Various unique structural and operating features of the purge control valve are also provided.

These and other features and advantages of the present invention will be more apparent from the following description of a preferred embodiment, taken together with the accompanying drawing.

BRIEF DESCRIPTION OF THE DRAWING

In the drawing:

FIG. **1** is a diagrammatic view of an internal combustion engine as installed in a vehicle with an associated fuel tank and having a crankcase ventilation and purge control system, including a purge control valve, all according to the present invention; and

FIG. **2** is a pictorial cross-sectional view of a preferred embodiment of purge control valve according to the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENT

In the drawing, numeral **10** generally indicates an internal combustion engine having the usual frame, defining a crankcase **12** and including cylinder heads **14** into which a fuel mixture is drawn for burning in the engine. The fuel mixture is supplied through an induction system which includes an inlet manifold **16** connected with the cylinder heads, a carburetor **18** mounted on the inlet manifold and an air cleaner **20** mounted on the carburetor and having a conventional inlet snorkel **22** for the admission of air into the air cleaner. The induction system is divided into low vacuum upstream and high vacuum downstream portions by a throttle member **24** located within the carburetor **18.**

The engine is provided with an oil filler pipe **26** which connects with the crankcase and is closed by a sealed cap **28.** An air conduit **30** extends between one of the engine exhaust manifolds **32** and the inlet snorkle to supply heated air to the engine during warmup.

As illustrated, the engine is installed in a vehicle which includes a fuel tank **34** in which fuel is stored and from which it is delivered to the carburetor **18** through means, not shown, for mixing with the inlet air to form a combustible mixture for burning in the engine. The fuel tank includes the usual filler neck **36** closed by a sealed cap **38.**

The engine of the present invention includes two interrelated systems, each of which is in part controlled by the purge control valve **40** of the present invention.

The crankcase ventilation system includes an air inlet conduit **42** which connects the snorkel **22** through a filter **44** with the engine crankcase **12** for the purpose of admitting fresh air to the engine crankcase or permitting the escape of blowby vapors into the inlet snorkel to avoid pressurization of the crankcase during certain conditions of operation. This system further includes a crankcase ventilation valve or PCV valve **46** which connects with the engine induction system downstream of the throttle **24** and with the engine crankcase through the purge control valve **40.** PCV valve **46** may be of any suitable type, an example being disclosed in U.S. Pat. No. 3,359,960 Pittsley. Its purpose is to meter the flow of vapors from the crankcase so as to match the requirements of the engine induction system and thereby provide adequate crankcase ventilation without adversely affecting engine operation.

The fuel vapor storage system, the second of the two systems previously referred to, includes conduit means **48, 50,** respectively, connecting the carburetor fuel bowl, not shown, and the vehicle fuel tank **34** with the engine crankcase **12.** As illustrated, conduit **48** connects directly into the oil filler pipe **26** which leads to the crankcase and conduit **50** connects directly into one of the engine rocker covers **52** that are mounted on the cylinder heads and define crankcase connected enclosures. Conduit **50** includes a restricted orifice **54** to limit the rate of flow of fuel vapors from the fuel tank to the engine, a vapor liquid separator **56** and a pressure relief valve **58** to prevent the development of excessive pressures within the fuel tank.

Additional connections to the purge control valve **40** which have not been previously described and are shown in FIG. **1** include a conduit **60** which connects with the air cleaner **20** to provide a source of clean air for a purpose to be subsequently described. A pair of electrical terminals **62, 64** are also provided on the valve, the positive terminal being connected to a voltage source **66,** such as the vehicle battery, through a switch **68** which, as will be seen, is preferably the vehicle starter solenoid. The negative terminal **64** is grounded.

Referring now to FIG. **2** of the drawings, there is shown the construction of the purge control valve **40** installed in the engine system of FIG. **1.** Valve **40** includes a housing or body **70** which is preferably formed

of a suitable plastic insulating material. Body **70** defines a pair of flow chambers **72, 74** and an adjacent actuator chamber **76.** Flow chamber **72** includes an inlet connection **78** which is connected with the engine crankcase **12** and an outlet connection **80,** which connects with the engine induction system through PCV valve **46.** Flow chamber **74** includes an inlet connection **82** which is connected with conduit **60** to receive fresh air from air cleaner **20.**

A wall **84** separates the flow chambers **72, 74** and includes an opening **86** in which there is reciprocably disposed a valve element **88.** Valve element **88** includes a plate portion **90** which seats in its upper position, as shown in the drawings, on a valve seat **92** surrounding the chamber **72** side of opening **86** so as to close the opening. In the lower position of the valve element, plate portion **90** seats against a valve seat **94** surrounding the inner end of the inlet connection **78** so as to cut off flow through this connection.

Within the actuator cavity **76** there is provided an actuator assembly, certain elements of which are pivotally carried on a shaft **96** fixed within the housing **70.** The pivotally carried elements include a reaction member **98** and an insulating block **100.**

Block **100** fixedly supports the ends of three bimetallic elements **102, 104, 106.** Bimetallic elements **104, 106** are insulatingly supported at adjacent ends by the block **100** and have their opposite ends mechanically and electrically joined by a connector block **108.** Block **108** is in turn actuatingly connected with the valve element **88** through a link **110.**

Bimetallic element **102** is cantilevered from the insulating block **100** and extends generally parallel to the elements **104, 106** and in opposed relation to an extending portion of the reaction member **98.** The end of element **102** opposite the block **100** is adapted to engage the outer end **112** of the reaction member **98** for purposes which will be subsequently described. An adjusting screw **114** is mounted in a wall of the actuator chamber **76** and is adapted to engage the reaction member **98** for adjusting its position within the housing.

An electric circuit is established within the valve **40** by suitable electric connecting means. These include a wire **116,** which connects the inner end of terminal **62** with the block-supported end of bimetallic element **106.** A second wire **118** connects the block-supported end of bimetallic element **104** with the free end of bimetallic element **102.** A third wire **120** connects the end **112** of reaction member **98** with the inner end of the negative terminal **64.** These connections establish an electric circuit from terminal **62** through the two bimetallic elements **106, 104** which are connected in series by block **108** and thence through the ends of element **102** and reaction member **98,** when they are in contact, back to the negative terminal **64.** The bimetallic elements within the valve are matched and are all arranged so that when heated they deform in an increasingly downwardly curving arc.

OPERATION

The setting and operation of the purge control valve, as shown in FIG. **2,** are as follows. Adjusting screw **114** is turned so that at ambient temperature the reaction element **98** is forced upwardly with its end **112** in contact with the outer end of bimetallic element **102.** The adjustment is such that the bimetallic element **102** is resiliently deformed slightly upwardly and the bimetallic elements **104, 106** are slightly deformed downwardly, causing the valve plate **90** to seat against valve seat **92** and placing a slight preload on the valve through deformation of the elements **102, 104, 106.** With this setting, flow is permitted between connection **78** and **80** but is blocked from connection **82** to **80.**

Should there be changes in the ambient temperature, for example a temperature increase, this will cause the bimetallic elements **102, 104, 106** to increase their curvature slightly in a downwardly convex direction. If uncompensated, such action in bimetallic elements **104, 106** would cause a reduction in the preload force that holds the valve plate **90** against its seat **92.** However, the change in curvature of bimetallic element **102** rotates the insulating block **100** about its pivot in an amount which offsets or takes up the change in curvature of the bimetallic elements **104, 106,** thereby maintaining the preload force on the valve constant.

When a suitable electric voltage is applied across terminals **62, 64,** the flow of current through the bimetallic elements **104, 106** heats these elements, causing them to increase their downward curvature. This allows the valve element to move downwardly until the valve plate **90** seats against the lower valve seat **94.** In this position, flow through inlet connection **78** is cut off, while flow is permitted from inlet **82** to outlet **80.**

Thereafter, further heating of the bimetallic elements causes rotation of the insulating block **100,** which lifts the bimetallic strip **102,** breaking its contact with the end **112** of reaction member **98.** When this occurs, the electric circuit is broken so that excessive heating of the bimetallic elements is prevented. Normal cooling of the heated elements **104, 106** then follows, which, assuming removal of the applied voltage, results in the gradual return of the valve element from its position against valve seat **94** upwardly and into its original position against valve seat **92.**

With the above described operation of the valve in mind, the operation of the engine and its associated systems is as follows. When the engine is stopped, fuel vapors in the associated fuel tank and carburetor fuel bowl are directed through their associated conduits **50, 48** to the engine crankcase **12** for storage.

Upon initiating cranking of the engine to start it, the starter solenoid **68** is closed, applying battery voltage across the terminals **62, 64** of the purge control valve, thereby moving it, as previously described, into its no-purge position. In this position, fuel vapors in the crankcase are prevented from passing through the valve into the engine induction system and, instead, fresh air through conduit **60** is permitted to flow through the PCV valve **46** and into the engine induction system in place of the fuel vapors. This condition remains for a short time after starting of the engine, during which time any pressure occurring in the crankcase is relieved by flow through the conduit **42** into the air inlet snorkel.

After a short period of engine operation, the purge control valve gradually returns to its normal position, as previously described, whereby flow is permitted from the engine crankcase through the PCV valve and into the engine induction system downstream of the throttle **24.** At this time flow from the conduit **60** to the induction system is cut off. Thereafter fuel vapors in the crankcase are purged into the engine for burning and for the remainder of the engine operating period crankcase ventilation flow through the PCV valve oc-

curs in a normal manner, with fresh air being drawn through the conduit 42 to flush out and ventilate the crankcase.

While the invention has been described by reference to a preferred embodiment chosen for purposes of illustration, it should be apparent that numerous changes could be made within the scope of inventive concepts disclosed. For example, a purge control valve of the type and construction described could be utilized in a cannister storage system or with a sealed fuel tank rather than in the crankcase storage system disclosed. These and other changes that might be made without departing from the teachings of this invention should be considered to be within its scope as defined by the language of the following claims.

I claim:

1. The combination with an internal combustion engine having an induction system, the induction system including a throttle, of

fuel containing means associated with said engine,

means connecting said fuel containing means with said induction system downstream of said throttle to draw fuel and crankcase vapors into the engine for burning, and

a purge control valve connected in said connecting means and arranged to normally permit vapor flow therethrough, said valve including electrically heated actuating means operable upon being electrically heated to temporarily shut off vapor flow through said connecting means and to gradually return to the normal flow condition upon cooling following termination of such electrical heating.

2. The combination of claim 1 wherein said purge control valve means is connected for actuation through means controlled by an engine starting signal.

3. In combination with an internal combustion engine having a crankcase and an induction system, the induction system including a throttle,

fuel containing means associated with said engine,

means connecting said fuel containing means with said crankcase to direct fuel vapors thereto for storage or disposal,

first ventilating means connecting said crankcase with said induction system upstream of said throttle to supply ventilating air to said crankcase and to permit the relief of crankcase pressures into the induction system,

second ventilating means connecting said crankcase with said induction system downstream of said throttle to draw fuel and crankcase vapors into the engine for burning,

a purge control valve disposed in said second ventilating means and arranged to normally permit vapor flow therethrough,

air conducting means connecting said purge control valve with said induction system upstream of said throttle, said valve connecting said air conducting means with said second ventilating means but normally blocking air flow through the connection,

said purge control valve having electrically actuatable means operable upon electric actuation to temporarily close said second ventilating means to vapor flow from said crankcase while permitting air flow from said air conducting means into said second ventilating means, said valve means being operative upon termination of such electrical actuation to gradually return to said normal flow conditions

4. A purge control valve in combination with an internal combustion engine having a crankcase utilized as a storage reservoir for fuel vapors during engine shutdown, an induction system having a throttle and electrical starting means, said purge control valve comprising

a valve housing having first and second inlet means and an outlet means, said first inlet means being connected with said crankcase, said second inlet means being connected with said induction system upstream of said throttle and said outlet means being connected with said induction system downstream of said throttle,

a valve element in said housing and movable between first and second positions in which flow to said outlet means is blocked from said second and first inlet means, respectively, while flow is permitted from the other of the respective inlet means, and

electrically actuated operating means connecting with said valve element, said operating means being effective to normally maintain said valve element in said first position and said operating means being connected with said electrical starting means and responsive to an electrical signal therefrom to move said valve element into said second position, said operating means acting to gradually return said valve element to said first position following termination of said electrical signal.

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