PURGE CONTROL VALVE AND SYSTEM

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References Cited
UNITED STATES PATENTS
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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
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, via 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 shut off 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 snorkle 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. 3,529,960 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 reciprocally 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 elements 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 the 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 the inlet connection 82 is 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 started, 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 canister 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 of 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 actuable 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 shut-down, 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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