Feb. 16, 1971 J. R. CLARKE 3,563,007

FUEL VAPOR CONTROL

Filed Oct. 7, 1968

FIG. 1

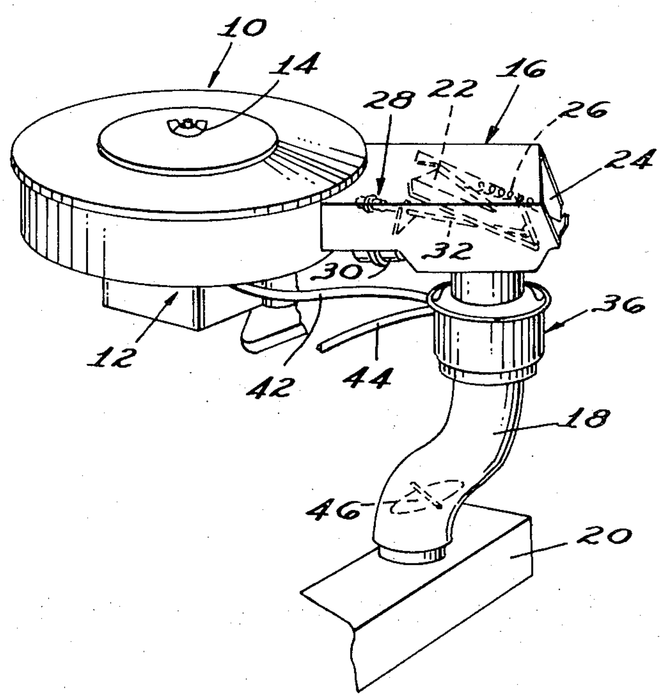
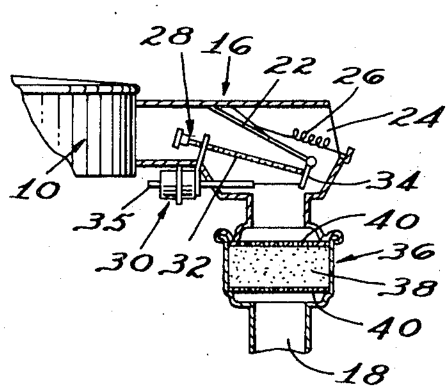



FIG. 2

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FUEL VAPOR CONTROL

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ABSTRACT OF THE DISCLOSURE

During an internal combustion engine hot soak cycle, fuel tank and carburetor bowl fuel vapors are absorbed by carbon in a canister located in a hot air duct portion of the engine air cleaner; normal engine operation purges the vapors from the canister into the air cleaner except during high load engine operation, when the hot air duct is closed to avoid unnecessary restrictions to air flow.

This invention relates, in general, to an internal combustion engine. More particularly, it relates to an apparatus for controlling the emission of fuel vapors from a fuel tank or reservoir.

One of the objects of the invention is to provide an apparatus that is especially useful during the hot soak cycle of an internal combustion engine to absorb excess fuel vapors that may be produced during this time.

Another object of the invention is to provide an apparatus that, during the normal running operation of an internal combustion engine, will desorb or purge a device of fuel vapors adsorbed thereby.

A further object of the invention is to provide an internal combustion engine with a fuel vapor recovery system that includes an activated carbon bed filter associated with the engine air cleaner hot air supply such that, during a hot soak cycle of the engine, excess fuel vapors given off by the carburetor fuel bowl and vehicle gasoline tank are adsorbed by the activated carbon particles and stored thereon until the engine again begins operating, at which time the flow of warm air through the carbon bed desorbs the fuel vapors therefrom and carries them into the air cleaner to be subsequently burned in the engine.

It is a still further object of the invention to provide an apparatus of the type described above in which first movable valve means is provided to selectively automatically control the purging operation described, the valve moving to a position closing the hot air duct containing the carbon bed filter when a less restricted air flow is desired, and an additional valve responsive to changes in temperature of the air flowing through the duct to shut off the hot air to the duct above a predetermined temperature level to prevent oxidation and attrition of the activated carbon.

Other objects, features and advantages of the invention will become more apparent upon reference to the succeeding detailed description thereof, and to the drawings illustrating a preferred embodiment thereof; wherein,

FIG. 1 is a perspective view, with parts broken away and in section, of an apparatus embodying the invention; and,

FIG. 2 is a cross-sectional view of a portion of the FIG. 1 showing.

The drawings show, schematically, the air inlet air cleaner portion of an internal combustion engine, and



additional elements associated therewith forming a part of the invention.

FIG. 1 shows the cylindrical-like covered housing of an annular air cleaner **10**. It is secured over and to the air horn portion of a conventional downdraft type carburetor **12**, in a known manner, by a bail member, not shown, and a wing nut **14**. The details of construction and operation of the air cleaner per se are not shown since they are known and believed to be unnecessary for an understanding of the invention. Suffice it to say, however, that the air cleaner could be of the conventional dry element type having an annular ring-like filter element through which air taken into the air cleaner through a snorkel **16** flows on its way into the carburetor inlet.

The snorkel-like inlet **16** is open at its outer end to communicate with ambient air in the engine compartment of the motor vehicle, not shown. Joined to the snorkel on its lower side is a flexible duct **18** adapted to contain engine compartment air heated by passage over the engine exhaust manifold. More specifically, a shroud **20** is adapted to closely surround a portion of the engine exhaust manifold, but is spaced sufficiently therefrom to permit the passage of engine compartment air through the space between the two into the hot air duct **18**. The air thus is heated as it passes over the manifold. The heated air then passes into the snorkel **16** on its way into the air cleaner proper.

Snorkel **16** in this case contains a flap valve **22** that is pivotally mounted as shown in FIG. 2 for alternate movement between positions closing the ambient air temperature inlet **24** or the hot air duct **18**. The door is biased by a spring **26** to the position shown closing inlet **24**. It is moved towards the opposite extreme position to close duct **18** either by a thermally sensitive assembly **28** or a vacuum controlled servo **30**.

More specifically, a temperature responsive, linearly expandable-contractible member **32** is slidably secured to a projection **34** depending from the flapper valve door, as shown. The thermostatic element is calibrated so that as the temperature increases, the element **32** elongates to move the door **22** towards a position closing the hot air duct.

The vacuum controlled motor **30** is an override control. It consists of a known type of vacuum motor having a central flexible diaphragm that is spring biased to the right with a force sufficient to normally urge the lower extension **34** of flapper door **22** against the force of spring **26** to close the hot air duct **18**. The diaphragm divides the servo housing into an atmospheric pressure chamber, and a vacuum chamber. The vacuum chamber is connected to the internal combustion engine intake manifold vacuum by a tube **35** so as to be responsive to the changes thereof. When there is sufficient depression in the intake manifold, corresponding to high load engine operation, the decay in vacuum permits the vacuum motor spring to move the flap door to close hot air duct **18**. This permits a less restricted supply of air to flow into the air cleaner through inlet **24**. During normal operation, the vacuum in the intake manifold generally is of a level sufficient to maintain the stem of the servo motor withdrawn so as not to affect the operation of the flapper valve.

As thus far described, the above is known, and is shown and described in U.S. 3,450,119 to Ralph E. Sendelbach, Air Cleaner Air Inlet Construction. Further details of construction and operation, therefore, may be had by reference to the latter application.

Turning now to the invention, the hot air duct **18** in this case contains a cylindrical-like canister **36** containing a bed of activated carbon particles **38**, as shown. It is filled, for example, with, say 525 grams of activated carbon that is tightly packed between a pair of steel mesh plates **40**. The lower portion of the canister is open to the hot air duct **18**, and the upper portion, as stated previously, opens into the snorkel **16**. The fuel vapors from the carburetor fuel bowl and from the gasoline storage tank or reservoir in this case are directed to the carbon canister through a pair of conduits **42** and **44**, as shown. The fuel vapor conduits are shown as being connected to a central portion of the carbon bed; however, it will be clear that they could be connected to any suitable portion of the bed so long as adequate distribution of the fuel vapors among the carbon particles is provided.

In order to protect the carbon particles from oxidation and attrition due to excessively high temperatures on exposure to the exhaust manifold, a thermally sensitive butterfly valve **46** is pivotally mounted in duct **18** between the manifold shroud **20** and canister **36**. The valve plate would consist of a bimetallic, thermostatic element. Below a predetermined temperature level, the valve would be rotated to open duct **18** and permit the normal passage of fuel vapors from canister **36**. If, for some reason, the temperature at shroud **20** should become excessive, the expansion of one of the bimetallic elements of valve **46** at a faster rate than the other would rotate the valve to shut duct **18** and stop the flow of hot air therethrough. The increased depression in the snorkel **16** would, in this case, cause an opening of flap door **22** by the air pressure at inlet **24**, against the force of spring **26**.

In operation, an initial engine start under cold ambient temperature conditions will cause the thermostatic element **28** to move the snorkel flapper door **22** to close the cold or ambient air entrance portion **24** and open wide the hot air duct **18**. Accordingly, as soon as the engine is started and air flow occurs past the exhaust manifold shroud **20**, hot air in the duct will flow through the canister among the carbon particles and desorb the latter of fuel vapors previously adsorbed by them. This purge flow then passes through the snorkel **16** into the air cleaner proper and from there into the inlet of the carburetor, in a known manner.

Therefore, during normal engine operation at low temperatures, fuel vapors adsorbed in the canister are purged therefrom. As soon as the engine compartment air temperature rises to the desired level, the thermostatic member **28**, in this case including a wax element, will cause the flapper door **22** to move to close off the hot air duct and permit substantially all of the air to enter by the ambient air temperature inlet **24**. This provides the air cleaner with less restriction to flow than occurs with flow only through the hot air duct. This results in greater air flow, which is desired for maximum engine performance.

If, during cold temperature operation, wide open throttle conditions of the engine are desired, a sudden decrease in vacuum by depression of the vehicle throttle pedal is reflected in the vacuum servo so that the spring therein then is capable of forcing the flapper valve **22** to close the hot air duct **18** and permit only cooler, denser air into the air cleaner. This immediately stops the purging of fuel vapors absorbed by the carbon bed. However, this is not disadvantageous at this time since under these operating conditions, the fuel vapor emission influence is minimized.

When the engine shuts down for a period that includes a large ambient temperature variation, or is operated at high speeds for a period of time, the temperature increase at the carburetor fuel bowl and the vehicle gasoline tank or reservoir may be considerable, causing increased fuel vaporization and increased fuel vapor pressure. This causes a flow of fuel vapors through the tubes **42** and **44** to the carbon bed to be adsorbed by the carbon therein. Therefore, during the "hot soak" cycle, the fuel tank and fuel bowl vapors will not be passed freely into the atmosphere, but are adsorbed in the carbon bed. At this time, the flapper valve **22** generally will be closed by means of the wax pellet type thermostatic control **28**, so that maximum adsorption efficiency is obtained by the vapors being contained in the hot air duct **18**.



Accordingly, it will be seen that vapors that are given off by the fuel tank or reservoir and the carburetor fuel bowl, and any other fuel vapor source, flow into the canister **36** containing the carbon bed and are adsorbed thereby; and, that during the normal operation of the engine, the fuel vapors are desorbed from the canister and passed into the air cleaner and therefrom into the engine.

From the foregoing, therefore, it will be seen that the invention provides a simple and economical method of containing fuel vapors vented from the vehicle fuel tank or carburetor fuel bowl. It will also be seen that the invention provides purging of the fuel vapors from the canister containing the carbon granules in a manner that does not interfere with the normal operation of the engine. It will also be seen that loss of engine power due to restriction of air from the carbon bed is eliminated by the function of the manifold vacuum motor **30** bypassing the carbon bed at low manifold vacuum and high volume air intake. It will further be seen that the exhaust manifold heat will optimize desorption of vapors from the activated carbon to maximize the working capacities of the carbon.

While the invention has been described and illustrated in its preferred embodiments, it will be clear to those skilled in the arts to which it pertains that many changes and modifications may be made thereto without departing from the scope of the invention.

I claim:

**1.** An apparatus for controlling the emission of vapors from the fuel tank and carburetor fuel bowl of a motor vehicle engine having a source of intake manifold vacuum, comprising, an engine air cleaner assembly including a casing having an air inlet having branch first and second air inlet portions operatively connected thereto said first portion comprising a duct containing heated air said second portion comprising an ambient temperature air duct, valve means movably associated with said inlet portions for varying the proportionate flow of air from said ducts into said air cleaner as a function of the position of said valve means, engine intake manifold vacuum responsive means connected to and moving said valve means at times in response to the decay of vacuum to a predetermined level to block the flow of air from said heated air duct into said cleaner, fuel vapor adsorption means in said heated air duct comprising a canister containing activated carbon particles and having an air inlet and outlet at opposite ends thereof, and conduit means containing fuel vapors connected to said vapor adsorption means, the desorption of vapors from said adsorption means into said air cleaner occurring in response to the rise of said vacuum above said predetermined level effecting a movement of said valve means to open said heated air duct.

**2.** An apparatus as in claim **1**, including second movable valve means in said heated air duct posterior of said vapor adsorption means for blocking said heated air duct at times to prevent the pasasge of heated air therethrough.

**3.** An apparatus as in claim **1**, including thermostatic means in said heated air duct responsive to a predetermined temperature rise therein for blocking said heated air duct.

4. An apparatus as in claim **1**, including temperature responsive valve means in said heated air duct posterior of said canister for blocking said duct in response to a predetermined temperature rise of the air therein.


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