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SPECIFICATION

(54) Title of the Invention

Fuel Evaporation Preventing Device

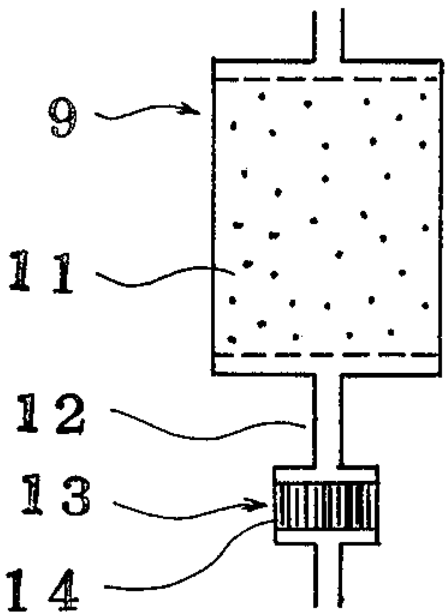
(57) Abstract

[Means for Resolution]

A fuel evaporation preventing device for an automobile, wherein: in a canister that adsorbs gasoline vapor produced from a fuel tank while an automobile is stopped, and that reuses, as fuel, gasoline adsorbed through air intake by an engine while running, a second canister is connected in series through a pipe or through a similar structure after a canister. Here a case wherein an orifice is provided in the pipe that connects to the first canister and the second canister is also included in the present invention. A honeycomb activated carbon is used as the adsorbent of the second canister, and the volume thereof is at least 2% and not more than 20% of the volume of the first canister.

[Effects]

The use of a fuel evaporation preventing device according to the present invention causes a significant suppression in the speed at which the gasoline that is adsorbed in the canister moves due to adsorption equilibration to the air discharge port, enabling a reduction in the evaporative loss of gasoline to about 1/10, even if an automobile is stopped for an extended period of time, without increasing the volume of the canister and without an increase in the performance of the activated carbon.



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[SCOPE OF PATENT CLAIMS]

[CLAIM 1]

A fuel evaporation preventing device for an automobile, wherein: in a canister that adsorbs gasoline vapor produced from a fuel tank while an automobile is stopped, and that reuses, as fuel, gasoline adsorbed through air intake by an engine while running, a second canister is connected in series through a pipe or through a similar structure after a canister.

[CLAIM 2]

A fuel evaporation preventing device for an automobile, wherein: in a canister that adsorbs gasoline vapor produced from a fuel tank while an automobile is stopped, and that reuses, as fuel, gasoline adsorbed through air intake by an engine while running, an orifice and a second canister are connected in series by a pipe after a first canister.

[CLAIM 3]

A fuel evaporation preventing device for an automobile according to Claim 1, wherein:

the capacity of the second canister is at least 2% and not more than 20% of the capacity of the first canister.

[Detailed Explanation of the Invention]

[0001]

[FIELD OF TECHNOLOGY OF THE INVENTION]

The present invention relates to a so-called canister that is a fuel evaporation preventing device for an automobile, and to a device that is equipped in an automobile to adsorb, recover, and reuse vapor of evaporated gasoline from a fuel tank, wherein, through the addition of an orifice or a small-volume second canister to an ordinary canister, has the effects of significantly reducing the loss of gasoline while an automobile is stopped for a long period of time and also of preventing pollution.

[0002]

[PRIOR ART]

Vapor that is evaporated from a gasoline tank when the engine of an automobile is stopped is conventionally released into the atmosphere without being recovered. However, in consideration in relation to pollution in recent years, a method has been adopted in which a collector filled with an adsorbent is attached midway in an exhaust pipe to the atmosphere to adsorb evaporated gasoline vapors, after which air flows in a reverse direction when the engine is running to cause desorption, such that the gasoline vapor is supplied to the engine and reused. Moreover, activated carbon is generally used as the gasoline adsorbent, and a single collector filled internally with activated carbon has been used.

[0003]

To date there have been numerous proposals for reducing of the amount of evaporation by improving the adsorption performance of the activated carbon or from the perspective of the canister structure. However, these ideas have primarily focused on improving the "working capacity" (W. C.), or in other words, the adsorption and desorption capability, as well as the durability so that degradation does not occur through use over an extended period of time. As a result, these have not always been effective at reducing gasoline vapors leaked from the canister when an automobile is stopped for a long period.

[0004]

In particular, some states of the United States adopted new evaporation regulations pertaining to automotive fuel beginning in 1995, and in 1996, these new regulations were enforced nationwide. According to the new regulations, even if there is surplus capability in the W. C. of the canister in terms of the 72-hour Diurnal Breathing Loss (DBL), envisioning a case in which an automobile is stopped for an extended period of time, if the automobile is stopped for an extended period of time, there are cases in which the amount released into the atmosphere will increase to exceed the regulation value, as a result of gasoline adsorbed in the canister concentrating and diffusing in the adsorption layer as time elapses, and thus, countermeasures are needed.

[0005]

[PROBLEM SOLVED BY THE PRESENT INVENTION]

In consideration of the need for Diurnal Breathing Loss (DBL) countermeasures, canisters that have conventionally used activated carbon as an adsorbent have a problem in that the amount of leakage of gasoline vapors increases as time elapses when an automobile is stopped for an extended period of time. Given this, a new canister able to suppress the amount of leakage of gasoline vapor, even when an automobile is stopped for an extended period of time, by means such as changing the configuration of the canister, without increasing the canister volume and without increasing the performance of the activated carbon, and without a loss of economic efficiency, has been developed and provided.

[0006]

[MEANS FOR SOLVING THE PROBLEM]

The canister is a system that recovers and reuses evaporated gasoline by adsorbing, in activated carbon, gasoline vapors produced from a fuel system, such as a gasoline tank, due to the temperature of the outside air when an automobile is stopped, and then using a portion of the engine intake when the automobile is traveling for desorption of the adsorbed gasoline. The inventors have focused their attention on the point that, with regard to the configuration of the engine, the amount of air that can be used for desorption by the canister is quantitatively restricted since it is a portion of the air intake, and thus approximately half, and in some cases even more, of the adsorbed gasoline and is left in the adsorbed state in the activated carbon in the activated carbon, rather than being desorbed.

[0007]

Moreover, the concentration distribution of gasoline adsorbed in the activated carbon layer in the canister has a gradient with the concentration thereof being high at the gasoline vapor entrance side and low at the exhaust side; however, because the activated carbon in the canister is a single continuous layer of activated carbon, the gas phase concentration of the section having a large adsorption amount of gasoline vapor at the entrance side is higher than at the exit side, and thus, due to adsorption equilibration, as time elapses the adsorbed gasoline moves to the exit side where the gas phase concentration is low, so that the concentration of the gasoline adsorbed in the activated carbon layer gradually becomes uniform.

[0008]

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The inventors of the present invention discovered that, because of the increase in the gas phase concentration at the exit side due to this type of mechanism, gasoline vapor leakage more readily occurs when an automobile is stopped for an extended period of time. Further, the inventors also learned that the components of the gasoline vapor that leaks from the canister are primarily propane and butane, and these components are leaked in small amounts, and thus that the provision of a separate small second canister as a dedicated leak countermeasure is effective in adsorbing these, and arrived at the present invention based thereon.

[0009]

That is, this is fuel evaporation preventing device for an automobile, wherein, in a canister that adsorbs gasoline vapor produced from a fuel tank while an automobile is stopped, and that reuses, as fuel, gasoline adsorbed through air intake by an engine while running, a second canister is connected in series through a pipe or through a similar structure after a canister. Here a case wherein an orifice is provided in the pipe that connects to the first canister and the second canister is also included in the present invention. Moreover, with this fuel evaporation preventing device, a honeycomb activated carbon is used as the adsorbent of the second canister, and the volume thereof is at least 2% and not more than 20% of the volume of the first canister.

[0010]

Here, the “through a pipe or through a similar structure" means having a constricted structure such that when the second canister is connected after the canister, the activated carbon layer is not in a continuous state, but rather is separated, and the gas flow between the two canisters is suppressed. As described below, this structure is adopted in order to suppress movement of the gasoline in the canister to the second canister through adsorption equilibration. Hereunder, the present invention is described in detail.

[0011]

The fuel evaporation preventing device for an automobile of the present invention is an improved structure of a canister that is used conventionally, and thus particularly has the function of decreasing evaporation loss of gasoline when an automobile is stopped for an extended period of time.

[0012]

In the past, vapors of evaporated gasoline from gasoline tanks of automobiles with stopped engines, at gas stations, and the like, have been released into the atmosphere rather than being recovered. However, recently, photochemical smog, oxidants, and other pollution problems have become serious, and hydrocarbons found in gasoline that are released into the atmosphere are thought to be one of the main causes thereof, and thus reducing the amounts released has become an important issue. Given this, a method is being adopted to recover gasoline vapors produced from automobiles by attaching a so-called canister, which is a collector filled with an adsorbent, midway in an exhaust pipe to the atmosphere to adsorb evaporated gasoline, after which air is caused to flow in a reverse direction during travel to cause desorption, to supply to the engine.

[0013]

However, because typically the canister adsorbs and desorbs gasoline vapor using a single continuous activated carbon layer, when an automobile is stopped for an extended period of time, as described above, if there is a difference in concentrations of gasoline adsorbed in the activated carbon layer, the gasoline vapor will gradually move to the exit side, due to adsorption equilibration, to thus be released, so an increase in evaporation loss is unavoidable. The fuel evaporation preventing device of the present invention was developed to resolve this problem, wherein a second canister is connected in series through a pipe or a similar structure after the ordinary first canister.

[0014]

The activated carbon layer of the second canister must be connected in series through a pipe or a similar structure in order to maintain a separated state without being in a state that is continuous with the first canister. When the two canisters are separated and connected by a pipe, movement of gasoline vapors due to adsorption equilibration is significantly inhibited when compared to a single continuous activated carbon layer, and even if a small volume second canister with a volume that is 10 to 20% that of the first canister is used, as illustrated by the embodiments described below, results are produced wherein the amount of evaporation of the gasoline vapor can be decreased sharply to about one-tenth.

[0015]

Moreover, the provision of an orifice between the two canisters further prevents flow of the gasoline vapors, thus enabling a reduction in the amount of evaporation; however, there is a drawback in that this increases pressure loss. Moreover, more preferably the volume of the second canister is no less than 2%, and no greater than 20%, of the volume of the first canister. If the volume of the second canister were no greater than 2% of the first canister, the benefit of newly providing a second canister would decrease sharply, and if the volume thereof were 20% or greater, the extent of improvement of the effect thereof would tend to decrease rapidly.

[0016]

Note that that while there is no particular limitation on the shape of the activated carbon for filling the second canister, a honeycomb activated carbon is preferred since pressure loss tends to increase with a configuration wherein a second canister is added, so this shape is well suited for this configuration due to its high adsorption speed.

[0017]

[DESCRIPTION OF THE PREFERRED EMBODIMENT]

One example of a concentration distribution of adsorbed gasoline in an ordinary canister is shown in FIG. 1. As shown in FIG. 2, the configuration is with a single continuous activated carbon layer, and the gasoline concentrations were measured at the points represented by 4 to 8 between the entrance side and the exit side, as depicted in the drawings, in order to examine the concentration distribution of gasoline adsorbed in the activated carbon layer.

[0018]

As shown by the distribution curve 1, the concentration distribution of gasoline immediately following adsorption has a gradient with the concentration being high at the gasoline vapor entrance side and low at the exit side.

[0019]

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However, as time elapses, the adsorbed gasoline moves to the exit side due to adsorption equilibration based on the concentration difference between the entrance side and the exit side thereof, with the atmosphere around the adsorbent acting as a medium, producing, after 24 hours the state represented by distribution curve 2. Furthermore, when the engine is started and the automobile begins to travel, the gasoline adsorbed in the canister is desorbed by the air intake, and when this occurs, the concentration distribution shown by the distribution curve 3 results.

[0020]

However, while a portion of the air intake of the engine is used for the desorption of the adsorbed gasoline, the amount of air that can be used is restricted by the configuration of the intake and exhaust gas systems of the engine. When the volume of activated carbon of the canister is about 2 liters, the amount of air that can be used is limited to 100 to 300 times the volume of the activated carbon, and the extent of desorption thereby is insufficient, and thus, as shown by the gasoline concentration distribution curve 3 of FIG.1, a state in which the adsorbed gasoline is sufficiently desorbed cannot be reached.

[0021]

Even with an ordinary canister configuration, the amount of gas flowing out from the canister when the automobile is in a stopped state for an extended period of time is a small, and the main components thereof are propane and butane. Accordingly, the object of adsorbing these components can be achieved by providing a small second canister to adsorb these.

[0022]

However, if an activated carbon having the same shape as the activated carbon that is filled in the canister were used, in the second canister, which has a small volume, the inner diameter thereof would generally be small, and thus there would be a problem in that the pressure loss would be increased because the air flow speed would be increased dramatically. Given this, when honeycomb activated carbon or activated carbon having large voids is used in the second canister, the pressure loss can be reduced to a usable range, and leakage of gasoline vapor can be significantly reduced.

[0023]

Moreover, while the second canister is small in volume, the amount of air passing therethrough at the time of desorption is the same as that of the first canister, and thus desorption can be performed adequately and adsorption performance can be maintained with only a small-volume second canister.

[0024]

An example of the relationship between a purge air amount after adsorption by the canister and the gasoline leak concentration is shown next. FIG. 3 shows a cross-sectional view of a canister having a volume of 1 liter with granulated carbon having a particle diameter of 2 mm filled into a 127 mm long container with a diameter of 100 mm. After gasoline was adsorbed in the canister until breakthrough, the respective amounts of air passage were changed, and the adsorbed gasoline was purged. After the unit was then left in air for 24 hours at a temperature of 30, and the concentration of the gasoline leaking from the canister was measured with an airflow at a rate of 1 liter/min. from the gasoline vapor entrance side of the canister.

[0025]

The resulting relationship between the amount of air used in purging and the concentration of gasoline that leaks when air is caused to flow from the gasoline vapor entrance side after the canister had been left in the air environment is shown in Table 1.

[0026]

[TABLE 1]

	Amount of Purging Air (Activated Charcoal Volume Ratio) (Multiplier)	Leakage Concentration after 24 Hours (Hydrocarbon total: ppm)
No. 1	100	25000
2	200	15000
3	300	12000
4	1000	1420
5	5000	440
6	10000	290

[0027]

It is understood from these results that when the amount of air that is used for purging is 1000 times or greater than the volume of the activated carbon, the concentration of the gasoline that leaks decreases significantly.

[0028]

The fuel evaporation preventing device of the present invention has a small-volume second canister that is added in series after an ordinary canister. Even when using the ordinary amount of air that can be used in purging, which is approximately 300 times the first canister, the evaporation preventing device of the present invention is able to reduce the concentration of gasoline leaked to about the same level as when 1000 to 5000 times the amount of air is used with an ordinary canister, as shown in Embodiments 2 to 10, described below. Accordingly, the amount of gasoline that is leaked becomes approximately 1/10 or even less, and an extremely significant effect is seen.

[0029]

[EMBODIMENTS]

Hereunder, the present invention is described in more detail by way of embodiments.

[0030]

FIG. 4 shows a configuration of one embodiment of a fuel evaporation preventing device for automobiles of the present invention. The first canister shown in the drawing has a 127 mm-long container with a diameter of 100 mm filled with 1 liter of granulated carbon having a particle diameter of 2 mm, and after the first container, a small-volume second canister filled with honeycomb activated carbon is connected in series by a pipe. Note that the spacing between the first canister and the second canister is 20 mm, and the two canisters are connected by a pipe having an inner diameter of 10 mm. Moreover, the shape and volume of the activated carbon filled into the second canister is shown in Table 2. Instead of the honeycomb activated carbon, granulated activated carbon or crushed activated carbon, wherein there are large voids and wherein the pressure loss is low, can be used in the second canister.

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[0031]

[TABLE 2]

	No. 1 Canister Volume mL	Orifice Dia. mm	No. 2 Canister Size L x W x H mm	No. of Cells	Butane W.C. g/canister	Leak Concentration (Hydrocarbon Total ppm) After 10 minutes	After 24 hours	After 48 hours	After 72 hours	Pressure Loss 20 L/min mmAq
Example 1	1000		45 x 45 x 20 40 mL	500	48.2	300	1030	1150	1500	47
Example 2	1000		65 x 65 x 20 84 mL	500	48.5	270	940	1100	1550	47
Example 3	1000		45 x 45 x 40 81 mL	500	48.7	240	810	990	1330	47
Example 4	1000		65 x 65 x 10 126 mL	500	49.0	220	830	960	1260	47
Example 5	1000		45 x 45 x 10 20 mL	500	48.2	450	1900	2500	3600	47
Example 6	1000		Activated carbon 40 ml 3 mm granular carbon		50.0	190	770	950	1280	50
Example 7	1000		Activated carbon 40 ml 8/28 mesh crushed carbon		50.1	180	720	970	1200	52
Example 8	1000	2	45 x 45 x 20 40 mL	500	48.2	300	990	1130	1680	2000
Example 9	1000	4	45 x 45 x 20 40 mL	500	48.2	320	2600	4200	6000	200
Example 10	1000	6	45 x 45 x 20 40 mL	500	48.2	380	4200	7300	14000	100
Comparative Example 1	1000		None		48.0	820	12000	18000	24000	47
Comparative Example 2	1040		None		49.5	850	13000	20000	27000	48

[0032]

As shown in Table 2, in Embodiments 1 to 5, the second canister is filled with honeycomb activated carbon with volumes from 20 to 126 ml, individually, where in Embodiment 6, the canister is filled with granular activated carbon with a grain size of 3 mm, and in Embodiment 7, the canister is filled with crushed activated carbon with a mesh of 8 through 28. Moreover, in Embodiments 8 through 10, filling is with honeycomb activated carbon with a value of 40 ml, and orifices with the opening diameters shown in Table 2 were inserted at the midpoint of the pipes connecting the first canisters to the second canisters.

[0033]

Furthermore, for comparison with Embodiments 1 to 5, the fuel evaporation preventing devices of Comparative Examples 1 and 2 were not provided with the second canister, and the gas at the exit of the first canister was released directly.

[0034]

Gasoline vapors were adsorbed in these fuel evaporation preventing devices until the breakthrough point, after which 300 liters of air (300 times the volume of the activated carbon of the first canister) were passed through, and the gasoline adsorbed by these devices was purged. The devices were then left in air for 24 hours at a temperature of 30°C, and after a state was reached in which the residual gasoline had moved within the fuel evaporation preventing device due to adsorption equilibration, the concentration of gasoline that was leaked when air was flowed at a rate of 1 liter/min. from the gasoline vapor entrance side of the device was measured. The measurement results thereof, the butane W. C. (working capacity) of the filled activated carbon layer, and the pressure loss of the device when the air flow rate was 20 liters/min. are shown together in Table 2.

[0035]

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