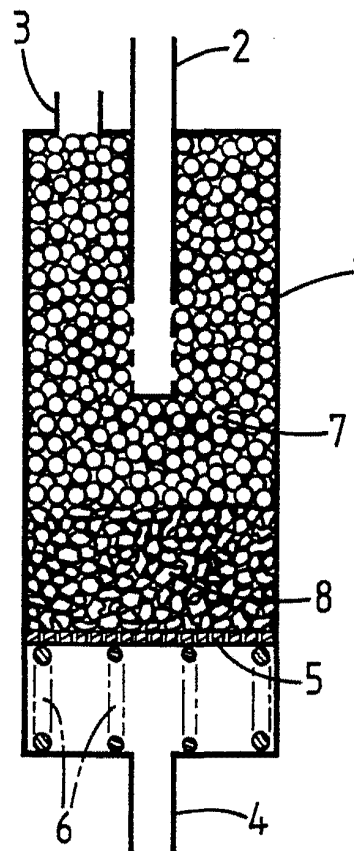


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(54) Title: APPARATUS AND PROCESS FOR VAPOUR RECOVERY

(57) Abstract

A canister (1) for attachment to a vehicle fuel tank to reduce hydrocarbon emissions comprises a gas inlet (2), gas outlet (3) and vent (4) and contains a bed of adsorbent polymer (7) and a bed of carbon (8). The vent opens into the carbon bed and the gas inlet and outlet open into the polymer bed.



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APPARATUS AND PROCESS FOR VAPOUR RECOVERY

The present invention relates to the recovery of gasoline vapours from mixtures of gasoline vapour and air.

Gasoline vapour is emitted from motor vehicles powered by gasoline engines as a consequence of displacing gasoline vapour from the fuel tank during refuelling (refuelling losses). It is also emitted as a consequence of evaporation from the engine and fuel system either when the vehicle is in operation or when standing after use (diurnal losses). The emission of gasoline vapour is considered to be undesirable.

Manufacturers already fit carbon canisters to eliminate the diurnal losses and such an arrangement is disclosed for instance in GB 1 416 336. The carbon adsorbs the vapour emitted when the engine is stationary after use. The carbon canister is then regenerated by drawing air through the canister using the vacuum generated in the engine inlet manifold so that the gasoline vapour recovered from the canister is mixed with the normal air/fuel mixture to the engine. The vapour emission when the vehicle is stationary is quite small so that a canister having a capacity of about 1 litre is thought to be satisfactory. During normal vehicle operation the vapours emitted are continuously returned to the engine.

Refuelling an almost empty tank involves displacing a large amount of gas (corresponding to the volume of the fuel tank if it is being completely refilled) saturated with gasoline vapour although this only occurs approximately once every 600 km. This is equivalent to approximately 150-200 g of vapour for a typical

European car (60 L tank) depending on the composition of the vapour.

There are proposals both in the US and in Europe to impose legal restrictions on the amount of gasoline vapour which may be released into the atmosphere during refueling. One method proposed to meet such legal requirements is the recycling of the vapour from the fuel tank connected to the engine back to the storage tank from which the vehicle is refueled. This however is an expensive procedure in view of the complex equipment needed, and the work required at numerous refueling stations, often with underground storage tanks. It would be desirable to find a simple method of dealing with the problem by an extension of the use of adsorbent canisters mounted in vehicles. There is however a problem in trying to eliminate gasoline vapour emission during refuelling by the use of canisters carried in the vehicle. Although the overall weight of the gasoline vapour to be adsorbed is quite small the requirement to trap this during the 2-3 minutes that it takes to fill a normal saloon car tank would make it necessary to use as much as 5 litres of the carbons currently in use. Such large quantities of carbon can not be conveniently be provided in the restricted engine compartment of modern saloon cars.

One approach to reducing the size of the canister is to use a carbon with a high adsorptive capacity. However we have found that such carbons are not easily regenerated in use by drawing air through the carbon bed. They would adsorb a large quantity of gasoline vapour on the first cycle, but only small quantities thereafter. The optimum active carbon the adsorption of gasoline vapours is one which has a high pore volume with pores in the small mesopore range (approximately 2 nm diameter). This maximises both the adsorption capacity of the carbon and the regenerability resulting in the largest possible working capacity. However the working capacity for typical gasolines is still limited to approximately 5% weight predominantly by the difficulty of regenerating the bed.

GB 1 416 336 discusses some of the disadvantages of the use of carbon and proposes to overcome them by replacing the carbon by a

particulate macroreticular, substantially non-ionogenic, water-insoluble polymer having a specified surface area, porosity and average pore diameter. Among the polymers which may be used are polymers of divinyl benzene.

5 However we have found that such porous polymers are not satisfactory for use as gasoline adsorbents. The porous polymers have a good saturation capacity for gasoline vapour and are easily regenerated. However the lower molecular weight components of the gasoline vapour, such as propane and butane, are not held strongly
10 enough on the polymer and thus break through the adsorbent bed and escape into the atmosphere after a comparatively short time thereby restricting the working capacity of the bed.

 In principle it is always preferably to prepare an adsorbent from a single material so as to simplify the manufacturing process.
15 We have however found that the use of two different adsorbent materials give sufficiently marked advantages to justify the increased complexity.

 According to the present invention a canister for attachment to a vehicle fuel tank, said canister comprising a body adapted to
20 receive an adsorbent, and having a gas inlet adapted to be connected to a gasoline storage tank, a gas outlet adapted to be connected to a gasoline engine, and a vent to the atmosphere, is characterised in that the canister contains a bed of adsorbent polymer and a bed of carbon arranged such that the vent opens into the bed of carbon and
25 the gas inlet and gas outlet open into the bed of adsorbent polymer.

 The present invention further provides a motor vehicle with a gasoline engine having a canister defined as above.

 According to the present invention a method of adsorbing gasoline vapour from air comprises passing the mixture of air and
30 gasoline vapour through a first bed of adsorbent polymer, and then through a bed of adsorbent carbon, and subsequently regenerating the adsorbent beds by passing a stripping gas first through the bed of adsorbent carbon and then through the bed of adsorbent polymer.

 According to another aspect of the present invention a process
35 for operating a gasoline engine of a motor vehicle comprises passing

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