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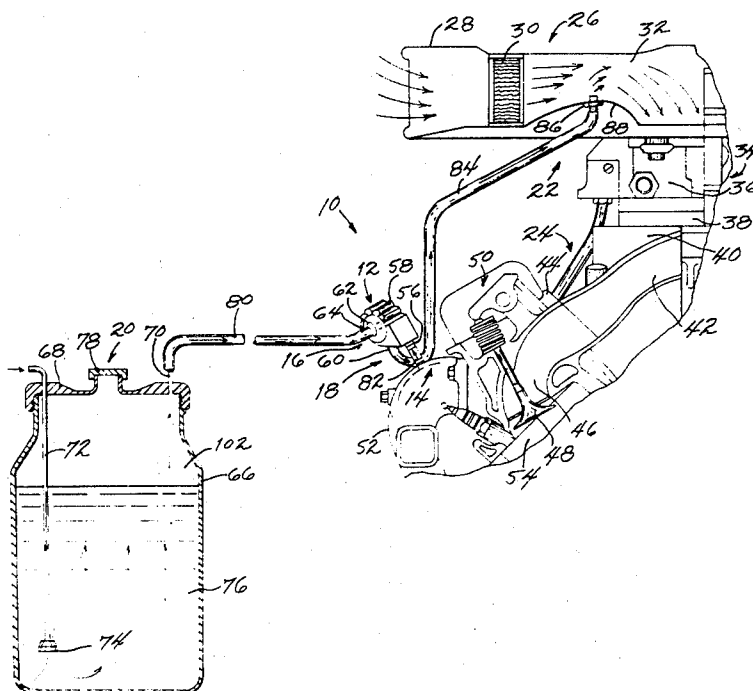
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[54] **VAPOR INJECTOR SYSTEM**
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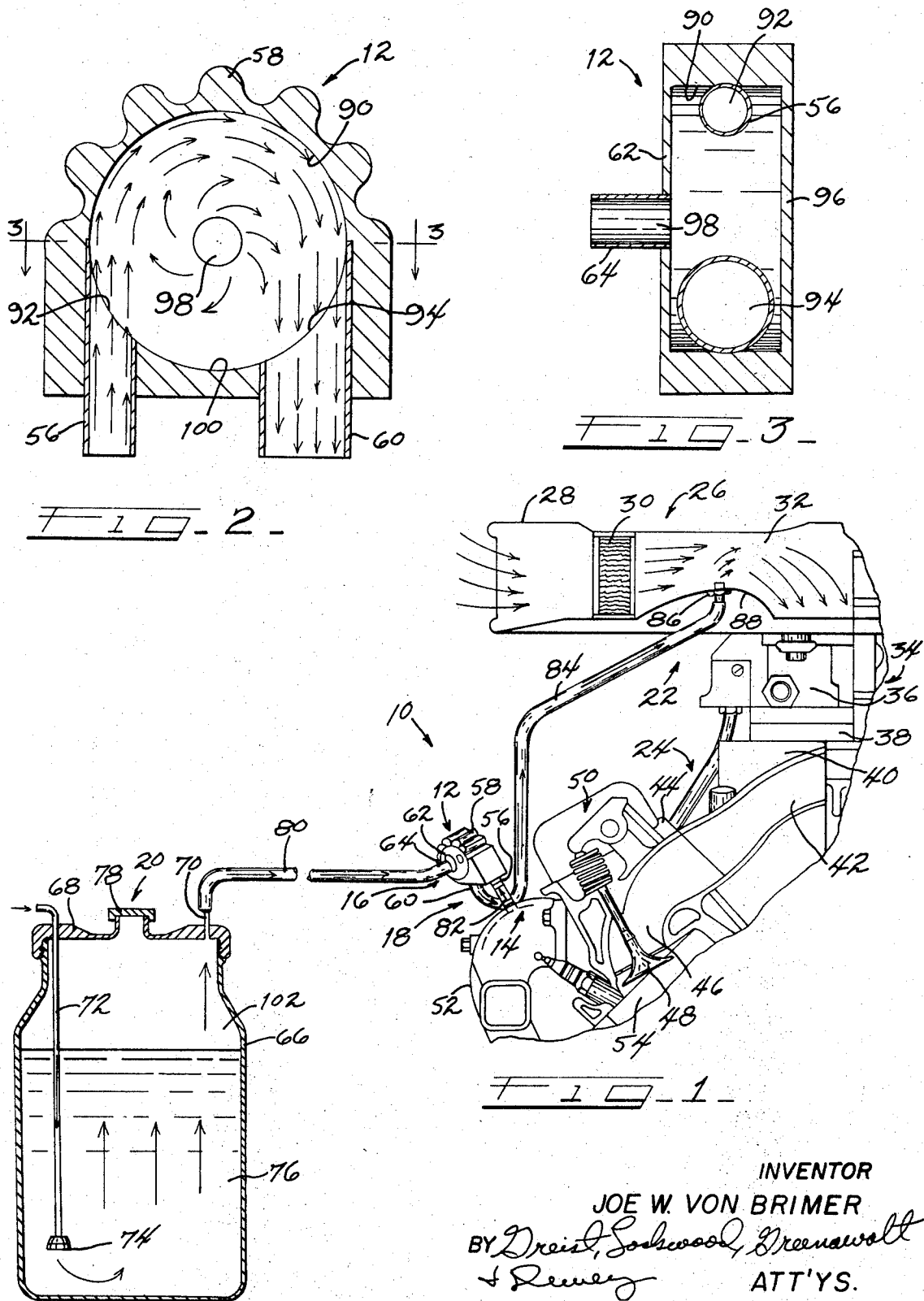
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ABSTRACT: A vapor injector system including a vacuum chamber with a pair of end walls, combustion gas inlet means, gas-vapor outlet means, and a curvilinear side wall extending between the inlet and the outlet, an opening in one of the end walls, and means for supplying exhaust gases from an internal combustion engine to the inlet means, for guiding gases flowing through the chamber from the outlet means into the intake air stream of the engine, and a container and conduit for supplying vaporizable fluid to a vapor inlet opening in the end wall of the chamber, so that gases flowing through the chamber along the wall, by centrifugal force, create a vacuum which pulls vapors from the container and entrains them in a vapor-gas stream which is supplied to the intake air stream of the engine. The vapors are preferably water-alcohol mixtures or other compositions having a high latent heat of vaporization and good anti-detonation qualities.



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VAPOR INJECTOR SYSTEM

BACKGROUND OF THE INVENTION

1. Field of the Invention

The field of the present invention is that of auto engine accessories, and particularly those designed to allow entraining or injection of vaporizable fluids having a high latent heat of vaporization and other desirable qualities into the air intake stream of an internal combustion engine.

More specifically, the field is that of so-called vapor injectors, sometimes known as "water injectors" or "water-alcohol injectors" injectors having the function of introducing water, alcohol, mixtures thereof, or the like into the air intake stream or an engine for cooling the air intake stream, increasing the density thereof, and for using the characteristics of such liquids and vapors to prevent unduly high temperatures and unduly rapid temperature rises from taking place within the combustion chamber of an engine, to reduce or eliminate so-called ping or preignition, or stated differently, to increase the apparent octane number or rating of the fuel for such an engine.

The invention utilizes a vacuum chamber for imparting a centrifugal flow pattern to a portion of engine exhaust gases, and a vaporizable fluid supply from which vapors are taken and entrained in the gases for subsequent passage into the intake air stream of the engine.

2. Description of the Prior Art

Fluid injection systems for injecting or entraining fluids, vapors or gases into the air intake streams of internal combustion engines are well known. These systems have been used, for example, in the aircraft field, to reduce preignition and allow higher effective power setting to be used with aircraft engines, for example, at take-off when maximum power is required for a short time. Normally, an alcohol water mixture is used, since the alcohol and water mixture is volatile has an extremely high latent heat of vaporization.

So-called water injectors or the like have also been used with automobile engines, but because of the design thereof, these units have met with little success, for reasons which will now be discussed. In prior art injection systems, the rate of injection or entrainment of the fluid into the air stream was dependent on vacuum developed in the intake manifold, that is, in the area between the intake valves and the throttle butterfly. It is well known, however, that maximum vacuum is drawn in the intake manifold of an engine only when the engine is idling or when the engine is turning relatively rapidly with the throttle butterfly in a relatively closed position. This is obvious, since opening the throttle butterfly allows increased amounts of the air-fuel mixture passing through the carburetor to pass into the intake manifold and reduce or eliminate the vacuum therein. On the other hand, the tendency of an engine to undergo preignition, "knock," or "ping" is greatest when the engine is operated at a relatively wide open throttle setting, and particularly when owing to cam shaft timing and the like, maximum torque is being developed. Preignition tendencies are also great when there is high resistance to engine acceleration, that is, for example, when an auto is operating slowly in a high gear with a wide open throttle setting, when an auto is at top speed operating against high wind resistance with the throttle wide open, and the like.

Accordingly, prior art systems have generally failed to deliver the water-alcohol mixture to the air stream in large quantities when such quantities are most needed, and in small quantities when less mixture is needed.

Other attempts to introduce water, alcohol or like mixtures into air intake means by positive mechanical means have been unsatisfactory, owing to the presence of unduly complex mechanical parts, the need for sensing devices, the corrosive nature of alcohol-water mixtures exposed to machine parts, and for other reasons.

SUMMARY OF THE INVENTION

Accordingly, in view of the shortcomings of prior art of vapor injector devices, it is an object of the present invention to provide a simple vapor injector which is responsive to the need of the engine for vapor injection.

Another object is to provide a vapor injection system having no moving parts, which is responsive to the engine condition from time to time.

Another object is to provide a vapor injector which provides superior mixing of the vapor into the air stream.

Another object is to provide an injector unit in which injection of the vapor mixture takes place above the venturi and throttle butterfly of an engine equipped with one or more carburetors.

A further object is to provide a vapor injection system which is not harmful to the engine even if the supply of vaporizable fluid is depleted or exhausted during operation.

A still further operation is to provide a vapor injection system which includes means for recirculating a limited amount of combustion gases through the intake system of an engine.

Still another object is to provide a vapor injector system which will not affect the intake manifold vacuum characteristics of a conventional engine.

A still further object is to provide a vapor injector which includes a vacuum chamber which creates a vacuum by imparting a centrifugal flow pattern to exhaust gases, and uses the vacuum to pull vapors into the vacuum chamber for entrainment into the exhaust gases to create a gas-vapor stream, and which also includes means for directing the gas-vapor stream to the intake air stream of the engine.

The present invention achieves these objects, and other objects which are inherent therein, by providing a vapor injection system which includes a vacuum chamber with an at least partially curvilinear side wall portion, two end wall portions, inlet and outlet means disposed at a tangent to the side wall for receiving a portion of the combustion gases of an engine and imparting a centrifugal flow pattern thereto, an opening in the side wall for allowing gases and vapors to enter the chamber, where a vacuum is created by the centrifugal action of the gas flow, and conduits or connectors arranged so as to conduct combustion gases into the chamber, vaporizable fluid from a container into the chamber, and exhaust gases with vapors entrained therein into the intake air stream of an internal combustion engine.

The manner in which this invention achieves these objects will become more clearly apparent as the description proceeds, and particularly when reference is made to the accompanying drawings, in which like reference numerals indicate corresponding parts throughout.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a partially diagrammatic view, partly in elevation, partly in section, and with portions broken away, showing the vapor injection system of the invention and its relation to certain portions of an internal combustion engine;

FIG. 2 is a vertical sectional view of one embodiment of the vacuum chamber, and inlet and outlet means therefor, of the present invention; and

FIG. 3 is a horizontal sectional view, taken along lines 3-3 of FIG. 2, showing the vacuum chamber of FIG. 2.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Before describing the preferred embodiments of the present invention in detail, it will be understood that as reference is made herein, and in the claims, to water, or water-alcohol mixtures, that the same are merely illustrative, and that the exact shapes and sizes of the components herein are not essential to the invention unless otherwise indicated, since the invention is described with only reference to embodiments which are simple and straightforward, and it will be obvious

that variations in one or more details thereof may be made by those skilled in the art. The terms "vapor", and "gas" are used herein in a non-technical sense, and are intended to include finely dispersed liquids in an air stream, true vapors, true gases, and the like, without regard to the critical temperatures or pressures thereof, or the like.

Referring now to the drawings, FIG. 1 shows the vapor injector system generally indicated at 10 to comprise a number of principal elements, namely, a vacuum chamber 12, combustion gas inlet means 14, vapor inlet means 16, gas-vapor outlet means 18, a container 20 for a supply of vaporizable fluid, and gas-vapor conduit means 22 for directing a stream of gas, including vapors therein, into the air intake stream of an internal combustion engine generally represented at 24.

Referring now to the engine 24 in greater detail, an air cleaner and silencer 26 is shown to include an outer inlet duct 28, an air filter 30, and a clean air chamber 32. A carburetor 34, disposed beneath said air cleaner and silencer 26, includes a float chamber and venturi section 36 and a throttle butterfly housing or throttle body 38. An intake manifold 40 includes a plurality of passages 42 in communication with the openings of the throttle body 38. A cylinder head 44 includes an intake port 46 therein, communicating with a passage 42 of the manifold 40, and an intake valve 48, as well as conventional valve gear generally indicated at 50. The valve gear 50 includes valve springs, rocker arms, rocker arm shafts, stands, pushrods, and other elements which are conventional and which need not be further described herein.

The engine 24 also includes an exhaust manifold 52 which, as is well known, receives high temperature, high velocity exhaust gases flowing out of the combustion chamber 54, and directs them into the remainder of the exhaust system, such as headpipes, mufflers, tailpipes or the like.

Referring now to the vacuum chamber 12, this unit includes an exterior cover 58 of a finned construction, a relatively smaller combustion gas inlet tube 56, a relatively larger gas-vapor outlet tube 60, a circular end cover plate 62, and a vapor inlet tube 64 disposed centrally of said end cover plate 62.

Referring again to FIG. 1, the container 20 for vaporizable fluid is shown to include a body 66, a cover 68 fixed in relatively vapor-tight relation to the body 66. A vapor outlet tube 70 extends through said cover 68, an air inlet tube 72 extends downwardly through said cover 68, and the tube 72 has an end portion 74 thereof disposed normally below the normal level of the vaporizable fluid or liquid 76 disposed in the body 66 of container 20. The removable cap 78 maintains the cover 68 in a vapor-tight relation to the body 66, but allows the supply of fluid 76 to be replenished as needed.

A vapor conduit 80 extends between the container outlet 70 and the vapor inlet tube 64. A short combustion gas conduit 82 connects the exhaust manifold 52 to the combustion gas inlet tube 56. A gas-vapor conduit 84 connects the gas-vapor outlet tube 60 in the body of the chamber 12 to a fitting 86 disposed in a bottom wall portion 88 of the clean air chamber 32 of the air cleaner and silencer 26.

Referring now to FIGS. 2 and 3 it can be seen that the vacuum chamber 12 includes the outer finned surface 58, and a curvilinear inner side wall portion 90, which, in this case, forms an arc of a circle and extends between the combustion gas inlet port 92, which forms a part of or registers with the tube 56 and the gas-vapor outlet port 94, which forms a portion of, or is in registry with the gas-vapor outlet tube 60. The ports 92, 94 are generally circular in cross-section for the embodiment described, although this is not a necessary feature of the invention.

Referring now to FIG. 3 it is shown that the curvilinear inner side wall 90 of the chamber 12 is flat in one dimension, and that the end cover plate 62 on one side and the end cover plate 96 on the other side are also flat and generally parallel to each other. Although flat end walls and side walls provide the greatest economy in manufacture, the exact shape of the end walls 62, 96 is not a necessary feature of the invention, since

they may be bowed, domed, concave or other desirable shape. The vapor inlet port 98 disposed in the end cover plate 62 registers with, or forms a part of the vapor inlet tube 64, and enters the vacuum chamber 12 at a point spaced radially inwardly from the walls 90, preferably centrally of the chamber 12. Except where the ports 92, 94, 98 enter, the chamber 12 is relatively airtight. Preferably the chamber and the tubes 56, 60, 64 attached thereto are made from a high melting point metal such as steel or aluminum, and the finned cover portion 58 of the chamber 12 may be made of aluminum or other like material to enhance the cooling characteristics thereof.

The formation of the curvilinear wall 90 is such that gases entering the tube 56 at high velocity are directed along a circular or arcuate path, and then out the enlarged vapor-gas outlet 60. Not all the gases entering the tube 56 need follow this exact pattern; however, a substantial proportion of such gases do, and those that do not may be diffused about the interior of the chamber 12, or may flow along other portions of the wall, for example, the portion 100 disposed between the ports 92, 94.

In the operation of the device, when the engine is started, exhaust gases flowing through the conduit 82 with a high velocity pulsating motion, are directed at high speed around the curvilinear wall 90 and out the outlet tube 62. The velocity of these gases is such that the arcuate or curvilinear flow pattern imparted thereto, because of centrifugal force, draws a substantial vacuum in the center of the chamber 12, or at other points within the chamber which are spaced radially inwardly from the curvilinear wall 90, 100. Accordingly, a partial vacuum is drawn on the port 98, and fluid vapors are drawn from the headspace 102 above the liquid 76 in the container 66, through the conduit 80 and into the chamber 12, where they are entrained in the combustion gas stream passing through the chamber 12, forming a gas-vapor stream which is directed out of the chamber 12, through the port 94 and the gas-vapor outlet tube 60. The gas-vapor mixture thus formed passes through the conduit 84 and is directed into the air stream in the region, normally a low pressure area, above the carburetor 34, that is, in the clean air region 32 of the air cleaner and silencer 26. As vapors are withdrawn from the headspace 102, air is bled into the end 74 of the tube 72 beneath the liquid level, and this air, with the aid of a screen or other mechanical emulsifier in the end portion 74, is finely divided and bubbled to the surface, relatively saturated with vapor. The headspace 102 remains rich in vapor because of the mechanical action of the bubbling, the inherent vapor pressure of the alcohol-water or like mixture, and because of the vacuum being exerted through the opening 70 in the cover 68.

An important feature of the invention is that as the throttle of the engine is opened, the amount of exhaust gases, and the velocity thereof, increases and the centrifugal force of such gases passing through the chamber 12 increases, causing a higher vacuum, and thus entraining more vapor or vaporizable fluid in the gas-vapor stream passing to the intake air stream above the carburetor 34. When little or no vapor injection is needed, as when the throttle is closed, or the engine is idling, exhaust pressures and velocities are low, vacuum in the chamber 12 is low, and little, if any, vapor injection takes place. However, a relatively minor but still significant proportion or amount of exhaust gas is recirculated from the engine through the combustion chambers 54, since the system always remains open to the passage of exhaust gases through the chamber 12. Studies have shown that such recirculation, in amounts of up to about 10 to 12 percent of the exhaust gases created by engine operation, is beneficial to the operation of the engine since such recirculation results in very significant reduction of hydrocarbon, nitrogen oxides and like air-polluting emissions.

Another important feature of the invention is that the conduit 84 has an end portion thereof, such as the fitting 86, disposed in the air stream upstream of or above the carburetor 34, and particularly above the throttle body 38. The force of

the exhaust gases passing through the chamber 12 feeds the gas-vapor stream to this upstream area, where it is entrained in the intake air stream. Therefore, it is not necessary to place this vapor-gas vapor conduit into the carburetor receiving portion of the intake manifold 40, or in the passages 42 thereof, or the like. This feature of the invention overcomes a serious disadvantage of prior art systems since, if gas-vapor injection were to be made at a point downstream of the carburetor, even if not dependent on vacuum for injection thereof, an adverse effect on the air-fuel mixture of the engine would result, since mixing would take place after the air-fuel mixture ratio had been established, that is, at the venturi disposed within the float chamber and venturi portion 36 of the carburetor 34. Furthermore, in the event the fluid supply 76 in the container 66 is exhausted, or reaches too low a level, the result would be to supply additional air into the intake manifold 40, causing a too-lean mixture, excessively fast idling, excessively rapid fuel burning, possibly resulting in preignition detonation, burn out of valves, pistons, spark plugs, or the like.

In addition, such free passage would cause loss of manifold vacuum for use in operating windshield wipers, or other accessory systems, and would render the engine difficult to tune and maintain.

The invention has been illustrated by showing the conduit 84 disposed in the clean air region 32 of the air cleaner 26, but it is understood that disposing the end of the conduit 84 any place above the venturi area 36 of the carburetor 34, and within the intake air stream is acceptable.

The vacuum chamber 12 has been illustrated as having the tubes 56, 60 disposed with a 180° angle therebetween. However, other angles, such as 90° for example, are operative, as are larger angles. In the case of significantly larger angles, say 360° or more, the tubes 56, 60 may be offset from each other axially of the chamber, and somewhat inclined with respect thereto, so that the flow pattern may extend around the circumference of the chamber one or more times before leaving the outlet 60. The exact location of the components in relation to the motor is also not a critical part of the invention, the drawing illustrating merely an exemplary form thereof. By the terms "vapor" and "fluid" are understood to be meant liquids, vapors, gases or mixtures thereof, the exact physical form of the material injected or the composition thereof not being critical to the invention, provided that the vapors or fluids used have the effect desired, are used as described herein. Likewise, the words "injection" or injector are used in their trivial sense and are intended to include any form of entrainment of the gases, liquids or vapors into the air stream of the engine.

It will thus be seen, from a consideration of the foregoing, that the present invention provides a novel vapor injection system having a number of novel advantages and characteristics, including those hereinbefore pointed out and others which are inherent in the invention.

I claim:

1. A vapor injection system for an internal combustion engine, said system comprising, in combination, means for holding a supply of vaporizable fluid, means for imparting a curvilinear flow pattern to a stream of combustion gases from the exhaust system of an internal combustion engine, so that the centrifugal force resulting from said flow pattern creates a vacuum region adjacent the curvilinear flow region, means for receiving vapors from said means holding said fluid and for supplying said vapors to said vacuum region for entrainment into said stream of combustion gases, and means for supplying the stream of combustion gases with the vapors entrained therein to the intake air stream of an internal combustion engine.

2. A vapor injection system as defined in claim 1 wherein said means for imparting said curvilinear flow pattern comprises a chamber having a curvilinear side wall portion.

3. A vapor injection system as defined in claim 1 wherein said means for imparting said curvilinear flow pattern comprises a chamber having a curvilinear side wall portion, and

wherein said means further include inlet and outlet means for said stream of gases, said inlet and outlet means being disposed tangentially to said side wall portion.

4. A vapor injection system as defined in claim 1 wherein said means for imparting said curvilinear flow pattern comprises a chamber having a curvilinear side wall portion, wherein said means further includes inlet and outlet means for said stream of gases, said inlet and outlet means being disposed tangentially to said side wall portion, and wherein said means for supplying said vapors to said vacuum region includes a vapor inlet opening in a portion of said chamber which is disposed radially inwardly from said side wall portion.

5. A vapor injection system for an internal combustion engine, comprising, in combination, an enclosed vacuum chamber having an at least partly curvilinear side wall portion and two end wall portions, combustion gas inlet means for directing combustion gases into said chamber and along said side wall portion substantially tangentially thereof, vapor inlet means disposed in one of said end wall portions of said enclosed vacuum chamber and spaced radially inwardly from said curvilinear wall portion, gas-vapor outlet means in said enclosed vacuum chamber disposed substantially tangentially to another portion of said curvilinear side wall portion for directing combustion gases and vapors outwardly from said enclosed vacuum chamber, fluid supply means for holding a supply of vaporizable fluid to be entrained in the air intake stream of an internal combustion engine, vapor conduit means connecting said vapor inlet means to said fluid supply means, combustion gas conduit means for connecting a source of combustion gases to said combustion gas inlet means, and gas-vapor conduit means extending from said gas-vapor outlet means, said gas-vapor conduit means having an end portion adapted to be disposed in the intake air stream of an internal combustion engine, whereby combustion gases flowing from the exhaust system of an engine into said chamber and along said curvilinear wall portion thereof create a partial vacuum in said vacuum chamber, to draw the vapor through said vapor conduit means from said vaporizable fluid supply means and entrain said vapor in said gas flowing through said gas-vapor outlet means so that the resulting gas-vapor mixture may be directed into the intake air stream of an internal combustion engine.

6. A vapor injection system as defined in claim 5 in which said gas-vapor outlet means and said combustion gas inlet means have an included angle of about 180° therebetween.

7. A vapor injection system as defined in claim 5 in which said gas-vapor conduit means is of larger cross-sectional area than said combustion gas inlet means.

8. A vapor injection system as defined in claim 5 in which said at least partly curvilinear side wall portion is in the form of an arc of a circle.

9. A vapor injection system as defined in claim 5 in which said vapor inlet means includes a tube disposed in the center of said one of said end wall portions of said chamber, and in which said tube has a cross-sectional area approximately equal to the cross-sectional area of said combustion gas inlet means.

10. A vapor injection system as defined in claim 5 in which said fluid supply means is adapted to receive a liquid and includes an air inlet tube having an end portion thereof disposed so as to lie below the normal liquid level of a liquid disposed in said fluid supply means, whereby withdrawing vapors from above said liquid within said fluid supply means will cause a flow of air through said tube and below the surface of the liquid disposed in said fluid supply means.

11. A method of introducing vapors into the intake air stream of an internal combustion engine, said method comprising imparting a curvilinear flow pattern to a stream of combustion gases from the exhaust system of said engine to create a vacuum in a region adjacent the region of curvilinear flow by reason of the centrifugal force created thereby, directing vapors into the vacuum region thus created for entrainment into said stream of combustion gases to form a gas-vapor stream, and directing said gas-vapor stream, thus formed into the intake air stream of said engine.