United States Patent

[11] 3,545,416

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[21] Appl. No. **756,591**
[22] Filed **Aug. 30, 1968**
[45] Patented **Dec. 8, 1970**

[54] **CRANKCASE VENTILATOR**
10 Claims, 4 Drawing Figs.

[52] **U.S. Cl.** **123/119,** 123/198; 230/92, 230/95
[51] **Int. Cl.** **F02m 25/06;** F04f 5/16
[50] **Field of Search** ..... 123/119(A), 119(B), 119, 198(C), 198; 230/92.95

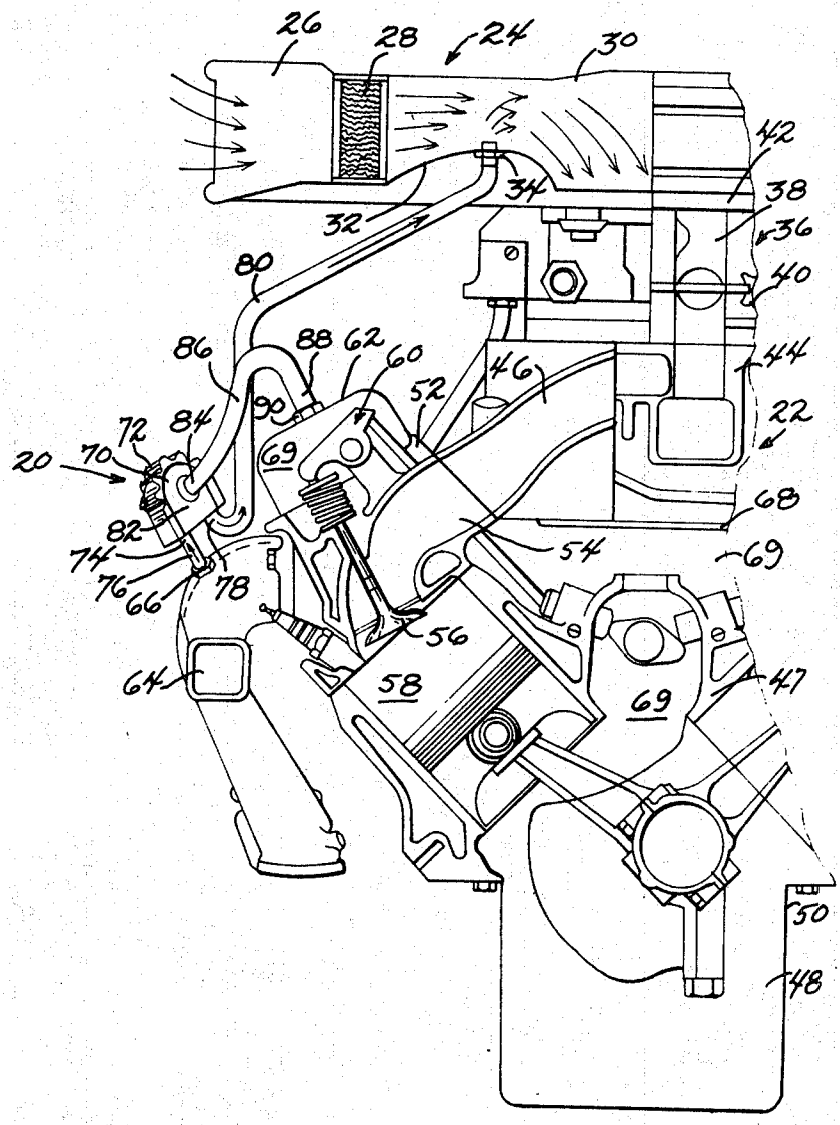
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ABSTRACT: A crankcase ventilator or positive crankcase ventilation system in which a portion of the exhaust gases created by an internal combustion engine are passed through a vacuum chamber wherein an at least partially curvilinear flow pattern is imparted thereto, and wherein the centrifugal force associated with such flow pattern creates a vacuum which is used to draw vapors, fumes, and the like from the engine crankcase and entrain them into the exhaust gas stream flowing through the chamber, and wherein the vapor-gas stream thus formed is directed to the intake airstream of the engine for recirculation through the combustion chamber and exhaust system of the engine. Thus, when the engine is operated at high throttle settings, high vacuum is created, so that when maximum crankcase pressure would otherwise tend to build up, and when crankcase vapors are being generated in the greatest amounts, exhaust recirculation and vapor extraction from the crankcase are also at a high level.



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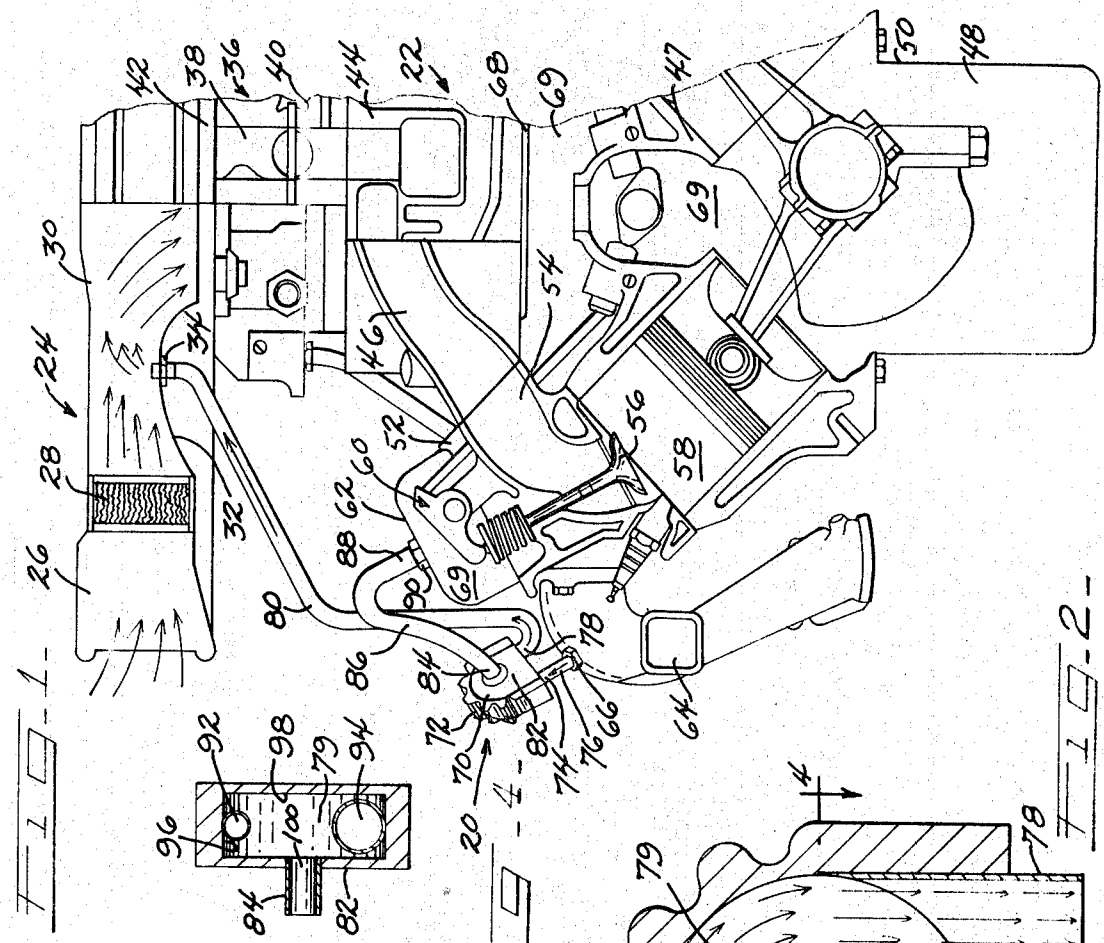


FIG-1-

FIG-4-

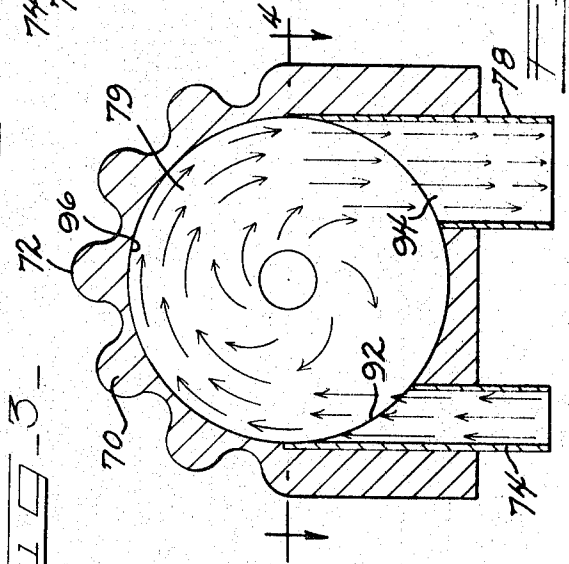


FIG-2-

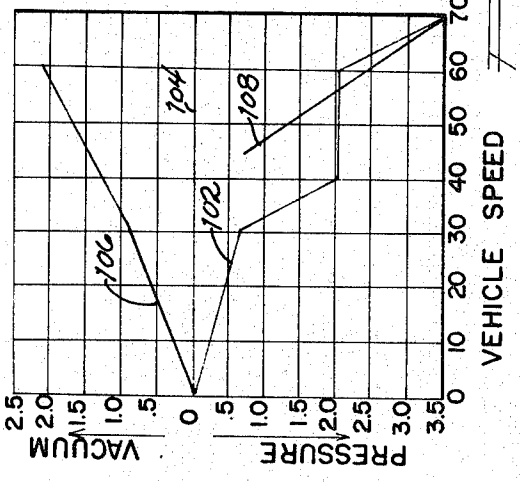


FIG-3-

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CRANKCASE VENTILATOR

BACKGROUND OF THE INVENTION

1. Field of the Invention

The field of the invention is that of accessories for internal combustion engines, and particularly that of crankcase ventilation systems for use in extracting crankcase vapors from the crankcase and recirculating them through the combustion chamber and exhaust system of the engine after they have been extracted. The field is also that of devices for imparting a curvilinear flow pattern to fast moving gas streams and for utilizing the vacuum created by the centrifugal force associated with the flow pattern of such gas streams for extracting vapors from engine crankcases, and entertaining them in the streams for recirculation into the combustion chamber of the engine.

2. Description of the Prior Art

Recently, there has been an increased awareness of the need for positive crankcase ventilation (PCV) systems, since studies have shown that considerable air pollution may be caused by the entry into the air of various combustion products and byproducts, including oxides of nitrogen, burned and unburned hydrocarbon residues, oil vapor, and other combustion products, such as acids and the like. Most crankcase ventilation devices of the prior art, and particularly those which are presently in large scale use, utilize intake manifold vacuum for drawing the crankcase vapors from the crankcase, generally through an opening in a portion of the cover for the valve rocker arms, and moving such vapors through a gravity-operated, normally closed needle valve, and allowing them to enter the intake manifold of the engine, generally immediately below or downstream of the venturi area or throttle body of the carburetor.

However, then systems have certain drawbacks. Most objectionable crankcase vapors are caused by "blowby", that is, passage of high-pressure combustion gases downwardly toward the crankcase between the cylinders and the piston ring assembly. Blowby is at a maximum when cylinder pressures are highest, and cylinder pressures are greatest when relatively high or wide open throttle settings are used, both under conditions of acceleration and high engine or vehicle speed. Since, when throttle settings are at the highest, manifold vacuum is the lowest, the minimum recirculation of crankcase vapors, and in many cases no circulation, takes place just when the largest amount of vapors are being created. When manifold vacuum is high, a vacuum effect may be present in the manifold and in the crankcase, but no significant or seriously damaging amounts of vapors are then being generated.

Accordingly, prior crankcase-ventilating systems of this type have not been free of difficulty, are characterized by this inherent relation of vacuum-to-blowby, and have included at least one movable part, the valve.

In addition, prior art PCV systems have required frequent servicing, and it's known by manufacturers that neglect of maintenance on PCV systems creates many problems, such as increased gas and oil consumption, oil dilution and other adverse effects.

SUMMARY OF THE INVENTION

Accordingly, in view of the drawbacks of crankcase ventilator devices of the prior art, an object of the invention is to provide a crankcase ventilation system which is responsive to the condition of the engine so to provide maximum extraction and recirculation of crankcase vapors when maximum blowby is occurring, as well as a certain amount of exhaust gas recirculation.

A further object is to provide a crankcase ventilation system which has no mechanical moving parts and which is simple and reliable in use.

Another object of the invention is to provide a crankcase ventilation system which includes a vacuum chamber operatively associated with the crankcase, and in which vacuum is created by circulating exhaust gases through the chamber and into the intake airstream of the engine. A further object is to provide a crankcase ventilator in which recirculated exhaust gases are entrained in the airstream of the carburetor of the engine.

Another object of the invention is to provide crankcase ventilator in which recirculated crankcase vapors are evenly diffused in the intake airstream.

Another object is to provide a crankcase ventilator system which includes means for ventilating the crankcase and for simultaneously recirculating a significant portion of the exhaust gases through the engine.

Another object of the invention is to provide a crankcase ventilation system which will not affect the vacuum condition of the intake manifold of the engine.

The present invention achieves these objects, and others which are inherent therein, by providing a vacuum chamber having at least partially curvilinear sidewall portion, two end wall portions, combustion gas inlet means disposed tangentially to the sidewall, crankcase vapor inlet means in an end wall of the chamber at a point spaced radially inwardly from the sidewall, an outlet means in the chamber for supplying the exhaust gases with the crankcase vapors entrained therein to the intake airstream of an engine for recirculating vapors and gases therethrough.

The exact manner in which this invention achieves the above-stated objects, and other objects which are inherent therein, will appear more clearly when reference is made to the description of the preferred embodiments of the invention, and to the drawings, in which like reference numerals indicate corresponding parts throughout.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a vertical sectional view, partly diagrammatic, and having portions broken away, showing a portion of an internal combustion engine and the crankcase ventilator unit of the invention associated therewith.

FIG. 2 is a vertical sectional view of the vacuum chamber portion of the crankcase ventilator of the invention.

FIG. 3 is a graph showing the vacuum characteristics obtainable with the crankcase ventilator of the invention.

FIG. 4 is a horizontal sectional view taken on lines 4–4 of FIG. 2, showing the vacuum chamber thereof. DESCRIPTION OF THE PREFERRED EMBODIMENTS

Before describing the invention in greater detail, it will be understood that as used herein, the terms "gas", "vapor", and the like are used in an ordinary understood and not in a technical sense, that is, it is not implied that the gases or vapors, or mixtures thereof, are so characterized because of critical temperature, pressure or the like, but are so characterized because of ordinary references thereto by such terms.

Referring now to FIG. 1, the crankcase ventilator **20** of the invention is shown to be associated with an internal combustion engine, generally indicated at **22**. The engine **22** includes an air cleaner and silencer assembly **24** having an air intake duct **26**, an air filter **28**, an inner, fresh air chamber **30**, a bottom wall portion **32** supporting a fitting **34** which surrounds an opening in the bottom wall position **32** of the assembly **24**.

The engine **22** also includes a carburetor, generally shown at **36**, and the carburetor **36** includes a float chamber and venturi section **38**, a throttle body portion **40** and an intake air horn portion **42**. An intake manifold **44**, has a plurality of passages **46** situated between the carburetor **36** and the combustion chamber of the engine **22**. The engine **36** includes an engine block assembly **47**, having an oil sump area **48** defined by an oil pan **50**, a cylinder head **52**, which includes an intake port **54** in registry with the manifold passage **46**, an intake valve **56**, a combustion chamber **58**, a valve train assembly **60**, which includes conventional valve gear such as push rods, rocker arms shafts and stands, valve springs and the like. A valve cover unit **62** covers the open portion of the top of the

cylinder head **52**. An exhaust manifold **64**, having an opening **66** therein, which will be described more fully herein, is included for guiding the exhaust gases leaving the combustion chamber **58** into the remainder of the exhaust system (not shown), which is conventional and may include head pipes, mufflers and the like. In reference to the engine **22**, it will be understood that the portions of the engine beneath the camshaft cover member **68**, and beneath the valve cover **62** as well as in the area surrounded by the oil pan **48**, and other portions on the interior of the engine, are in a substantially air-tight relation to the exterior of the engine, in keeping with modern engine design practices directed to minimizing or eliminating air pollution. Therefore, this area, namely those portions of the engine which are in vapor communication with the oil sump, is collectively referred to as the crankcase **69** for purposes of description herein. Thus the crankcase includes all internal portions of the engine, excluding only the combustion chambers, intake and exhaust ports and manifolds, and coolant passages and the like.

Referring now to the crankcase ventilator unit **20** in greater detail, the unit **20** is shown to include a body **70**, having a finned exterior surface **72**, a combustion gas inlet tube **74**, to which is attached a gas conduit **76**, a gas-vapor outlet tube **78**, to which is connected a gas-vapor conduit **80**, and an end cover plate **82** having a vapor inlet tube **84** extending therethrough. The vapor inlet tube **84** is connected to a conduit **86** having an end **70 88** which terminates in a fitting **90**, which attached to the valve cover **62**, thus placing the interior of the crankcase in communication with the interior of the conduit **86**. The gas-vapor conduit **80** extends between the gas-vapor outlet **78** and the fitting **34** disposed in the bottom wall portion **32** of the clean air chamber **30** of the air cleaner and silencer assembly **24**.

Referring now to FIG. **2**, it is shown that the body **70** includes a combustion gas inlet port **92**, forming a part of or being in registry with the gas inlet tube **74**, a gas-vapor outlet port **94** forming a part of or being in registry with the gas-vapor outlet tube **78**, and an at least partially curvilinear inner sidewall portion **96**, extending between the inlet and outlet ports **92**, **94** for directing gases entering the tube **74** along the wall **96** and out the port **94** and tube **78**.

Referring now to FIG. **4**, it will be seen that the ports **92** and **94** are circular in cross section, that the curvilinear sidewall **96** is flat, and that the end walls **82**, **98** are also generally flat. The vapor inlet port **100** is disposed centrally of the cover plate **82** and is formed as a part of or in registry with the vapor inlet tube **84**. However, the areas, sizes and shapes of the body **20** of the vacuum chamber portion **79** are not critical, it being understood that description herein is made only of a simple, representative form of the invention which is economical to manufacture and dependable in use.

Referring again to FIG. **2**, with a stream of gases entering the tube **74** at high velocity and assuming the disposition shown by the arrows, a vacuum occurs in the center and in other portions of the body **20** which are spaced radially inwardly from the sidewall **96**, since the curvilinear flow pattern forces the gas molecules toward the wall **96** by centrifugal force, thereby creating a low-pressure area in the middle of the chamber **20**. Vapors are pulled from the crankcase through the opening in the valve cover **62** which is defined by the fitting **90** and the end portion **88** of the conduit **86**. The gas-vapor mixture thus formed in the chamber **20** is directed into the clean air portion **30** of the air cleaner and silencer assembly **24**, where it is entrained into airstream above or upstream of the air horn **42** of the carburetor **36**.

As a result, a minor but significant portion of the exhaust gases which would otherwise be directed into the exhaust manifold **64** are recirculated through the carburetor **36** and into the combustion chamber **58**. Studies have shown that, in the interest of greatly reducing hydrocarbons, nitrogen oxides, and other like residues which cause significant air pollution, it is beneficial to recirculate up to about 12 percent of the exhaust gases from an engine back into the intake airstream. Accordingly, this invention accomplishes an object of recirculating combustion or exhaust gases and has a further advantage of being a greatly improved positive crankcase ventilator for reasons which will now be discussed.

Referring now to FIG. **3**, there is illustrated in graphic form the relation between vehicle speed, and crankcase pressure or vacuum. The line **102** shown below the horizontal or "zero" reference line **104** represents actual measurements made on the crankcase of a used auto in average good condition, utilizing a conventional positive crankcase ventilation recirculation system of the type in use today, with the needle valve removed, and the line **106** represents measurements made on the crankcase of an auto equipped with the crankcase ventilator of the present invention.

As can be seen from line **102**, contrary to expectations, an actual vacuum condition does not ordinarily exist in a typical engine crankcase under normal conditions. The closest approach to an actual vacuum condition occurs when the auto is going slowly with moderate throttle settings, and when, as shown at line **108** of the graph, the throttle is closed and the engine is allowed to decelerate. As a result, it can be seen that with the prior art PCV system, if vapors are tending to leave the crankcase, they are doing so at a limited rate, since they exist in sufficient quantity to cause the overpressure shown, namely, up to about 3.5 inches of water. Although the invention herein is not intended to be limited by any particular theory of operation, particularly in regard to prior devices, it is believed that in normal use, the manifold vacuum developed in an engine under conditions wherein most crankcase vapors are generated, and when the need for crankcase ventilation is therefore most important the blowby volume exceed that which is able to be entrained into the intake manifold below the throttle body. As a result, more blowby is created therein than can be accommodated by manifold vacuum, it being understood that conditions of high-speed, open throttle operation and rapid acceleration create least amount of manifold vacuum and the greatest amount of blowby.

On the other hand, as may be seen by reference to line **106** in FIG. **3**, the amount of actual crankcase vacuum able to be obtained by the crankcase ventilator of the present invention depends primarily on the velocity and volume of the exhaust or combustion gases. Since the velocities and volumes increase as engine speed increases and as the throttle is more fully opened, more vacuum is available as more blowby tends to be created, and accordingly, the crankcase ventilator of the present invention is able to maintain a negative pressure (gage) or partial vacuum in the crankcase at all times of significant vapor generation, and at high speeds, the actual vacuum may be 2 inches of water or more. In reference to this description, it will be understood that the vacuum which is being measured is actual crankcase vacuum, not manifold vacuum.

A further advantage of the present invention is that much wider distribution and much better mixing of recirculated exhaust gases in the intake airstream is made possible. Thus, in prior art PCV systems the fuel-air mixture established at the carburetor was susceptible to being altered by bleeding crankcase vapors into the manifold below the throttle body. In addition to changing the mixture, there was a danger that if the hose or tube leading to the manifold were to be accidentally removed, or developed a leak, air would enter the manifold, causing an excessively lean mixture and presenting the possiblity of excessively fast idle speed, detonation or preignition, and consequent damage to valves, pistons, and the like.

However, the present invention enables the vapor-gas mixture to be delivered to the airstream above or upstream of the carburetor, so that these elements, namely, crankcase vapors and exhaust gases, are already in the intake airstream when the air-fuel mixture ratio is established at the carburetor venturi. In addition, the gas-vapor mixture is distributed better then it would be if it were allowed to enter the manifold at a point beneath the carburetor, because of the greater distance to the intake ports, the turbulence induced by the venturi, etc.

In addition, a reduced amount of undesirable emissions through the exhaust systems is made possible, since, in the present invention the amount of recirculated exhaust or combustion gas is approximately directly proportional to the speed and power output of the engine, rather than being dependent on manifold vacuum, and accordingly, having an inversely proportional degree of recirculation.

Referring now to FIGS. 2 and 3, it is shown that approximately a 180° angle exists between the tubes **74** and **78**. Likewise, the chamber **20** has been described with reference to the shape shown in FIGS. **2** and **3**. However, the tubes **74**, **78** may be separated to a greater or lesser degree, provided only that a curvilinear flow is imported to a stream of the exhaust gases. If more than one turn (360°) of the gas stream within the chamber **79** is desired, the tubes **74, 78** may be offset from each other along the axis of the chamber and inclined slightly toward each other. The end walls **82, 98** and the sidewall **97** need not be flat, but may be of any other suitable shapes, and the ports **92, 94** may have cross-sectional shapes other than circular. The gas vapor mixture is preferably entrained in the airstream above the carburetor, but it need not be disposed in the air cleaner exactly as shown. Although the size and number of the ventilator units are not a critical feature of the invention, the ventilator has performed excellently with the vacuum chamber **79** having an inside diameter of about 3 inches, and width of 1 ½ inches. The conduits **76, 80, 86** were typically of about three-eights of an inch, three-quarters of an inch and ½ an inch diameters, respectively. As pointed out above, since the unit has no moving parts, mechanical failure, clogging, etc., are of minimal likelihood of occurence.

It will thus be seen, by reference to the foregoing, that the present invention provides a novel crankcase ventilator having numerous advantages and characteristics, including those hereinbefore pointed out, and others which are inherent in the invention.

I claim:

1. A crankcase ventilator system for an internal combustion engine, said system comprising, in combination, 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 region of curvilinear flow, means for connection to the crankcase of an engine for supplying crankcase vapors generated by said engine to said vacuum region to entrain said crankcase vapors into said stream of combustion gases, and means for supplying the stream of combustion gases, with the crankcase vapors entrained therein to the intake airstream of an internal combustion engine.

2. A crankcase ventilator system as defined in claim **1** in which said means for imparting said curvilinear flow pattern comprises a chamber having a curvilinear sidewall portion.

3. A crankcase ventilator system as defined in claim **1** in which said means for imparting said curvilinear flow pattern comprises a chamber having a curvilinear sidewall portion and wherein said means further includes inlet and outlet means for said stream of gases, said inlet and outlet means being disposed tangentially to said sidewall portion.

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

5. A crankcase ventilator system for an internal combustion engine, comprising, in combination, an enclosed vacuum chamber having an at least partly curvilinear sidewall portion and two end wall portions, combustion gas inlet means for directing combustion gases into said chamber and along said sidewall portion substantially tangentially thereof, crankcase 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 sidewall portion for directing combustion gases and crankcase vapors outwardly from said enclosed vacuum chamber, means for connection to a portion of the crankcase of an internal combustion engine to afford communication with the interior of said crankcase, crankcase vapor conduit means connecting said crankcase vapor inlet means to said means for connection to said crankcase, 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 airstream 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 crankcase vapors through said crankcase vapor conduit means from said means for connection to said crankcase and entrain said vapors in said gas flowing through said gas-vapor outlet means so that the resulting gas-vapor mixture may be directed into the intake airstream of an internal combustion engine.

6. A crankcase ventilator 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 crankcase ventilator 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 crankcase ventilator system as defined in claim **5** in which said at least partly curvilinear sidewall portion is in the form of an arc of a circle.

9. A crankcase ventilator system as defined in claim **5** in which said crankcase 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 method of recirculating crankcase vapors into the intake airstream 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 airstream of said engine.