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[54] **AUXILIARY VACUUM GENERATOR AND
REGULATOR**
14 Claims, 4 Drawing Figs.

[52] U.S. Cl. **123/119,**
123/198, 230/92, 230/95

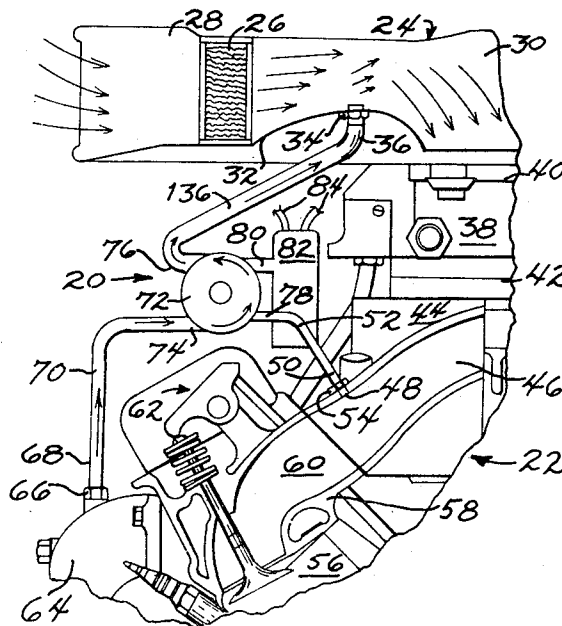
[51] Int. Cl. **F02n, 25/06;**
F02f9/00; F04f5/16

[50] Field of Search 123/198C,
198, 119A, 119B, 119; 230/92, 95

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ABSTRACT: An auxiliary vacuum generator and regulator assembly for an internal combustion engine, comprising means for imparting a curvilinear flow pattern to a stream of combustion gases from the exhaust system of an engine so that centrifugal force creates a vacuum in a first region, such as a vacuum chamber, a second vacuum region, such as a chamber, for disposition between a vacuum supply tank and a source of vacuum associated with the engine, means between the first and second vacuum regions for communication therebetween, a first valve disposed between the regions or chambers and a second valve disposed in the second chamber for opening and closing the connection between the vacuum source and second chamber. The valves and chambers are so disposed and arranged that when the vacuum at the first chamber exceeds that in the second chamber, the valve between the chambers will open so as to place the first and second chambers in communication and draw vacuum on the vacuum tank or supply through the second chamber, while the valve between the second chamber and the engine vacuum source will close to avoid reverse flow in the conduit connected to the intake manifold or other vacuum source. Means are provided, in one embodiment, for recirculating the exhaust gases which create the vacuum into the intake airstream of the engine, preferably upstream of the carburetor within the air cleaner.



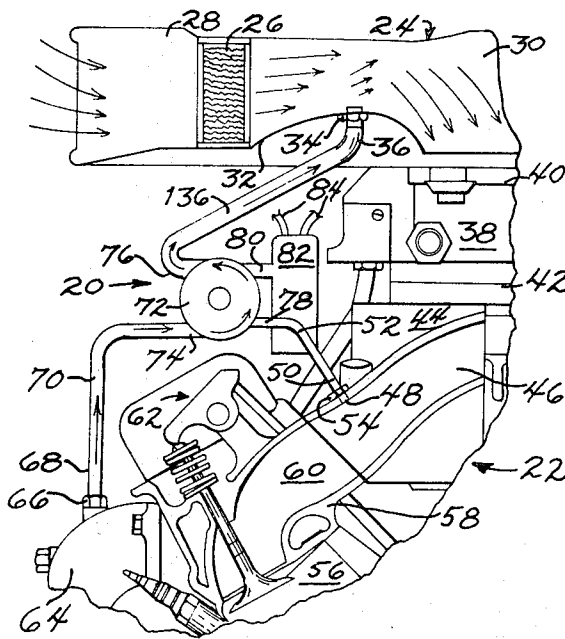


FIG. 1

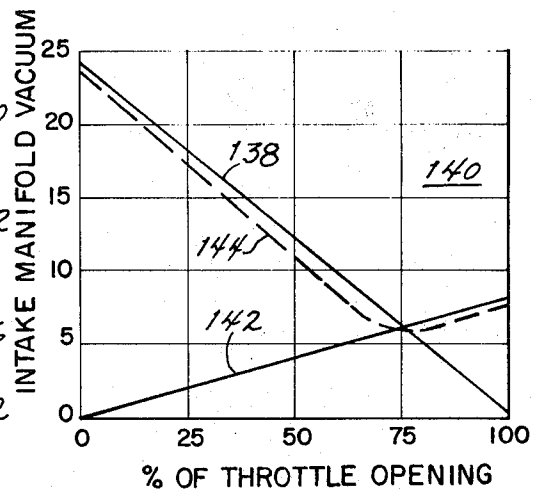


FIG. 4

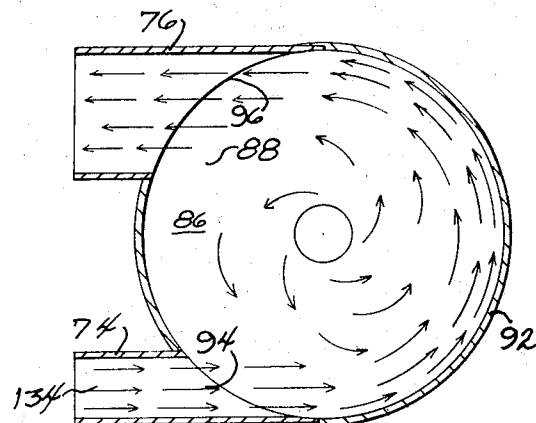


FIG. 3

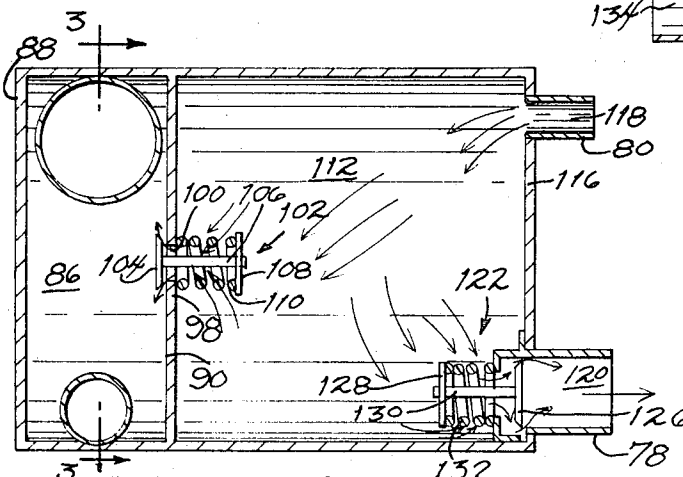


FIG. 2

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AUXILIARY VACUUM GENERATOR AND REGULATOR

BACKGROUND OF THE INVENTION

1. Field of the Invention

The field of the present invention is that of internal combustion engine accessories, and particularly those designed to ensure that the vacuum level in a vacuum supply tank which operates automobile accessories will not fall below a predetermined level, and that a vacuum may be drawn which is proportional to engine speed and throttle opening to augment or complement vacuum created in the intake manifold or the like.

The field is also that of combination units for drawing a vacuum used to augment or supplement the vacuum coming from the intake manifold, as well as to provide limited recirculation of exhaust gases through the intake system and into the combustion chamber of an engine.

In particular, the field of the invention is that of simple devices comprising two vacuum chambers and means for connecting them to a vacuum source, a vacuum supply tank, and having valves disposed therein so as to regulate the vacuum and to supply vacuum to the tank from whichever of two sources is generating or creating greater vacuum from time to time.

2. Description of the Prior Art

Vacuum generator systems for use with automobiles are well known in the prior art, the intake manifold, for example, being often used as a source of vacuum to operate windshield wipers, windshield washers, power windows, power brakes, and the like. In the past, vacuum operated windshield wipers, windshield washers, and the like have been attractive from the standpoint of economy, but in some cases, have proved unsatisfactory, since an increase in throttle opening, such as occurs in rapid acceleration or high speed operation, particularly uphill or against strong head winds or the like, may decrease manifold vacuum below the level which is required to operate the windshield wipers or other auto accessories. However, electric or hydraulic systems for operating auto accessories, including wipers, washers, and the like, have been considerably more expensive, without being entirely reliable in use. Accordingly, in recent years, with the advent of larger displacement engines, the use of manifold vacuum as a source for operating automobile accessories has increased. Substantial improvements have been made, but, for the reasons referred to above, intake manifold vacuum is inherently not a completely satisfactory means of operating auto accessories. In addition to the inherent characteristics of known vacuum systems, namely their dependance on intake manifold vacuum, which in turn depends on throttle opening, engine speed and operating conditions of the automobile, the vacuum systems of the present day autos are susceptible, particularly in borderline cases, to unsatisfactory operation when slight leaks or imperfections occur therein.

Thus, although intake manifold vacuum is satisfactory for the majority of normal operating conditions, vehicles pulling trailers up hills, or accelerating rapidly because of traffic conditions and the like, do not have entirely satisfactory vacuum-powered accessory performance.

Accordingly, prior art vacuum systems, although operable, and normally satisfactory in ordinary use, have had room for improvement, particularly when such improvement is available without adding considerable expense to existing systems or calling for new technology.

Another attempt that has been made in the prior art to solve this problem is the provision of so-called booster pumps associated with the fuel pump or the like for creating additional vacuum. Although these units have met with limited success, the output thereof is proportional only to engine speed, and accordingly, boosters of this type provide relatively little additional vacuum at low engine speed with relatively higher throttle settings.

SUMMARY OF THE INVENTION

Accordingly, in view of the shortcomings of prior art vacuum supply systems, and accessories operated thereby, it is an object of the present invention to provide a simple and effective auxiliary vacuum generator and regulator which is responsive to the needs of the automobile for operation of the accessory systems.

Another object is to provide a vacuum generator and regulator system having a minimum of moving parts.

Another object is to provide an auxiliary vacuum generator and regulator which provides means for recirculating a certain portion of exhaust gases through the intake airstream of the engine.

Another object is to provide a vacuum generator and regulator unit which creates vacuum in response to the speed or power setting of the engine without regard to the intake manifold vacuum of the engine at any time.

Still another object of the invention is to provide a vacuum generator and regulator system which will create additional vacuum but which will not affect the intake manifold characteristics of a conventional engine.

A still further object is to provide an auxiliary vacuum generator and regulator which includes a first vacuum chamber having an outer end wall, a curvilinear sidewall, inlet and outlet means for exhaust gases, an intermediate wall portion having a first vacuum responsive valve therein, a second vacuum chamber disposed adjacent thereto with the valve providing communication between said chambers, means for connecting the second chamber to a vacuum source and to vacuum supply means, and a second vacuum operated valve disposed between the second chamber and the vacuum source.

The present invention achieves these and other objects which are inherent therein, by providing an auxiliary vacuum generator and regulator which includes means for receiving a stream of combustion gases and imparting a curvilinear flow pattern thereto to create a first vacuum region, means for defining a second vacuum region and establishing communication between the second region and a vacuum supply and a vacuum source, and means disposed between said first and second regions for opening and closing communication therebetween in response to changes in vacuum levels in the first and second regions, and means in the second region for opening and closing communication between the second region and the vacuum source.

The manner in which the invention achieves these objects and others which are inherent therein, 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 auxiliary vacuum generator and regulator system of the present invention and its relation to certain portions of an internal combustion engine;

FIG. 2 is an enlarged vertical sectional view through one embodiment of the generator and regulator body of the present invention;

FIG. 3 is a vertical sectional view, taken along lines 3-3 of FIG. 2, showing gas flow through one vacuum chamber of the invention; and

FIG. 4 is a graph showing the relation of intake manifold vacuum to throttle opening in a conventional system and the characteristics of the vacuum obtainable with the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Before describing the preferred embodiments of the invention in detail, it will be understood that, as reference is made herein, and in the claims, to "gases", "vacuums", and the like, that reference is to these terms in their trivial or ordinarily understood sense, without relation to absolute values, vapor pressures, critical temperatures or the like. The invention will be described with respect to an intake manifold vacuum-type vacuum supply system normally used to operate the accessories of a production automobile engine.

Referring now to the drawings in greater detail, FIG. 1 shows the relation of the vacuum generator and regulator unit 20 of the invention to an internal combustion engine 22. The engine 22 is shown to include an air cleaner and silencer unit 24 having a filter 26, an inlet duct 28, a clean air region 30, and a bottom wall portion 32, with a fitting 34 receiving the end portion 36 of a conduit or tube to be described more fully herein. The engine 22 also includes a carburetor 38 having an air horn portion 40 and a throttle body 42. Disposed below the carburetor 38 is an intake manifold 44 having an intake passage 46, in which is disposed an opening 48 for establishing communication with the end portion 50 of a vacuum line 52 held in place in the intake manifold 44 by a fitting 54. The engine 22 also includes a combustion chamber 56 disposed partly within and partly below a cylinder head 58 which also includes an intake port 60, conventional valve gear 62, and an exhaust manifold 64, which includes a fitting 66 thereon for receiving an end portion 68 of an exhaust gas conduit 70 which will be described in further detail herein.

Referring again to the vacuum generator and regulator unit 20, this unit 20 includes a body 72, combustion gas inlet tube 74, a combustion gas outlet tube 76, an intake manifold inlet tube 78 and a vacuum tank inlet tube 80. The vacuum tank 82 is connected to the tube 80, and the tank 82 includes a plurality of lines or hoses 84 for connection to conventional vacuum operated accessories.

Referring now to FIGS. 2 and 3, other elements of the assembly are shown, namely a first vacuum chamber 86 which is defined by an outer end wall 88, a divider or intermediate wall 90, and a curvilinear sidewall portion 92. A combustion gas inlet port 94 forms a part of, or is in registry with, the inlet tube 74, and a combustion gas outlet port 96 forms a part of, or is in registry with, the combustion gas outlet tube 76. The intermediate wall 90 includes a valve seat 98 defining an opening 100 in the wall 90. A regulator valve assembly 102 is disposed therein, with the head 104 of the valve enclosed inside the first vacuum chamber 86. The stem 106 of the valve contains a keeper 108 at the end thereof, and a valve spring 110 is disposed between keeper 108 and the wall 90. The spring 110 operates to maintain the valve in normally closed condition, unless the vacuum in the first chamber 86 is higher than the vacuum on the other side of the wall 90.

The second chamber 112 forms the other portion of the body 72 and is defined by a sidewall portion 114 and an end wall portion 116. A vacuum supply port 118 forms a part of or is in registry with the supply tube 80, and a vacuum source port 120 is disposed in communication with or in registry with forms a part of a vacuum source tube 78. The port 118 affords open communication between the second chamber 112 and the vacuum tank 82 through the vacuum tank tube 80.

A shutoff valve assembly 122 is provided for opening and closing communication between the second chamber 112 and the passages 46 of the intake manifold 44. A valve seat 124 provides a seating surface for the valve head 126, and a keeper 128 on the end of the valve stem 130 retains a spring 132 in place between the keeper 128 and the valve seat 124. This valve assembly 122 is also biased closed, but is moved to an open position whenever the vacuum in the passage 46 of the intake manifold 44 is greater than the vacuum in the second chamber 112, whereas, when the vacuum in the chamber 112 is higher, the valve head 126 closes against the seat 124. Thus, both the valve assemblies 102, 122 are biased closed valves

which may be opened by vacuum on the valve seat side thereof, as will be further set forth herein. These valves might be referred to an "normally closed", except that, most of the time the engine is operating, valve assembly 122 is open, although it remains open against the force of the spring 132.

Referring now to FIG. 3, the principle of operation of the unit is shown. When the engine is operating, the stream of combustion or exhaust gases schematically represented by the arrows 134, passes from the exhaust manifold 64 through the conduit 70, enters the first vacuum chamber 86, and the passage thereof around the curvilinear wall portion 92 of the chamber 86 at high velocity creates a vacuum in the center portion of the chamber 86, because of the centrifugal force of the gases. The gases, after passage through the chamber as shown, exit through the port 96 and are directed from the tube 76 through a conduit 136, end portion 36 of which terminates in the fitting 34. Thus, exhaust or combustion gases flowing through the chamber 86 are recirculated into the intake airstream of the engine 22 upstream of the air horn 40 of the carburetor 38, preferably by passage into the clean air portion 30 of the air cleaner and silencer assembly 24. This action creates a vacuum in the chamber 86, especially in the center thereof, and in the other portions thereof which are spaced radially inwardly from the curvilinear sidewall 92.

Referring now to FIG. 4, a straight line 138 extending from the upper left-hand corner of the graph 140 shows that the intake manifold vacuum drops as the percent of throttle opening is increased. A second solid line 142 shows that vacuum in the first vacuum chamber 86 increases as the percentage of throttle opening increases. The dotted line 144 shows the average amount of vacuum available from the auxiliary vacuum generator and regulator system of the present invention when used in combination with an engine having an intake manifold system. Thus, in a typical embodiment, when the throttle opening is less than 75 percent, a principal amount of vacuum for operating the accessories is supplied from the intake manifold system. However, at throttle openings greater than 75 percent, when manifold vacuum drops below the level at the intersection of the lines 138, 142, the predetermined vacuum level provided by the auxiliary generator and regulator of the present invention is always sufficient to operate all the accessories, and accordingly, vacuum in an engine so equipped never falls below such predetermined level.

Referring again to FIGS. 1 and 2, under ordinary conditions, the vacuum in the intake manifold 44 is sufficient to cause air to flow into the intake manifold as shown by the directional arrows in FIG. 2. In this case, air is withdrawn from the vacuum tank 82 as shown by the arrows, and a vacuum is maintained therein. However, as throttle opening increases, an engine speed increases, the increased velocity of the stream of gases flowing through the first chamber 86 creates a greater vacuum therein than that available in the second chamber 112. When the two vacuums are approximately equal, or the vacuum in the chamber 86 is greater, the valve assembly 102 is opened, air moves through the opening 100, and is entrained in the combustion gas stream in the chamber 86 and removed therefrom. This action serves to maintain a vacuum at the port 118 and in the vacuum tank 82. However, since air flows from the chamber 112 into the chamber 86, a greater vacuum exists in the chamber 112 than in the intake manifold 44. Accordingly, in response to this condition, the valve assembly 122 moves to the closed position. In this manner, no intake manifold gases or vapors are drawn into the chamber 112 and the higher of the two vacuum levels, namely that in the manifold 44 and in the chamber 86, is maintained on the chamber 112 and the tank 82 which is in communication therewith.

Thus, when the valves are adjusted so as to open and close in the described sequence, a regulating action is provided which is sufficient to ensure that as much vacuum as is available from either source is always maintained in the chamber 112 for maintaining the vacuum in the tank 82, whereas gases are not entrained from the intake airstream into the exhaust

stream, or vice versa, except by passage through the conduit 136.

An incidental but very beneficial feature of the present invention is that the exhaust manifold gases are circulated back into the intake airstream of the engine, whether or not such gases are useful in developing a vacuum sufficient to overcome the intake manifold vacuum. Research has shown that such recirculation of gases provides a decrease in nitrogen oxides, carbon monoxide, and other harmful emissions, lowering the octane requirement of gasoline being used, and increasing the economy of the engine, without substantial loss of power throughout almost all of the operating range of the engine. With the present invention, recirculation of the gases through the engine does not harm the air-fuel mixture, even when significant amounts of exhaust gases are circulated therethrough, since the gases are entrained in the intake airstream above the carburetor, before the air-fuel mixture is established.

Another feature of the present invention is that, since the velocity of the exhaust gases generally depends on throttle opening more than on engine speed, relatively high vacuums can be obtained with open throttle settings, even when engine speed is low. This feature is not characteristic of mechanically boosted vacuum system, such as those referred to above.

The amount of engine gases recirculated into the intake airstream is minor, but significant, varying between about 3 percent up to about 12 percent. Although the valve assemblies 102-122 may be set for a different type of operation, or may provide for significant differential pressure before becoming operative, the mode of operation described is preferred, but not absolutely essential to the operation of the combination vacuum generator and regulator of the invention.

The ports 94, 96, and the tubes 74, 76, 78, 80 have been described and shown herein as being round, and the tubes 78, 80 are shown as being disposed in end wall 116 of the second chamber 112. However, the exact shape or size of any of these components is not essential to the invention, provided only that the tubes 74, 76 provide for a flow of combustion gases around an at least partially curvilinear sidewall portion, and are directed thereagainst in a generally tangential manner. Likewise, the sidewall 92 has been shown as being flat, but it may be curved, or of other configuration. The end walls 88, 116, and the intermediate wall 90 of the body 72 are shown as being flat, but these shapes are also only illustrative. The illustrated shapes provide one of the most simple, economical and easily understood embodiments of the invention. When used as described, the vacuum generator and regulator of the present invention provides a system whereby a minimum vacuum level is always available, regardless of the operating characteristics of the engine, and which is simple, reliable and inexpensive in use.

It will thus be seen that the present invention provides a novel vacuum generator and regulator assembly having a number of advantages and characteristics, including those hereinbefore pointed out and others which are inherent in the invention.

I claim:

1. An auxiliary vacuum generator and regulator assembly for an internal combustion engine, 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 first vacuum region adjacent the region of curvilinear flow, means defining a second vacuum region, means for connecting said second vacuum region to vacuum supply means, means for connecting said second vacuum region to vacuum source means operatively associated with said internal combustion engine, means for opening and closing said means for connecting said second vacuum region to said vacuum source means, means for connecting said first vacuum region to said second vacuum region, and means for opening and closing said means for connecting said first and second vacuum regions, said means for opening and closing said connecting means being operable in

response to vacuum levels in said first and second vacuum regions.

2. An auxiliary vacuum generator and regulator assembly as defined in claim 1 in which said means for imparting a curvilinear flow pattern comprises a chamber having an at least partially curvilinear sidewall portion.

3. An auxiliary vacuum generator and regulator assembly as defined in claim 1 in which said means defining said second vacuum region comprises a vacuum chamber, and in which said means for connecting said first vacuum chamber to said second vacuum region comprises a wall separating said two regions, said wall having portions defining an opening therein, and in which said means for opening and closing said connecting means comprises a valve disposed in said opening.

4. An auxiliary vacuum generator and regulator assembly as defined in claim 1 in which said means for connecting said second vacuum region to said vacuum supply means and to said vacuum source means comprise conduit means for connection to a vacuum tank and to an engine intake manifold, respectively.

5. An auxiliary vacuum generator and regulator assembly for an internal combustion engine comprising, in combination, an enclosed first vacuum chamber having an at least partly curvilinear sidewall portion, and at least one end wall portion, combustion gas inlet means for directing combustion gases into said chamber and along said sidewall portion substantially tangentially thereof, means in said end wall portion defining an opening therein, said opening being disposed radially inwardly of said sidewall portion, combustion gas outlet means disposed substantially tangentially to a portion of said curvilinear sidewall portion for directing combustion gases outwardly from said enclosed first vacuum chamber, an enclosed second vacuum chamber, means for connecting said enclosed second vacuum chamber to vacuum supply means, means for connecting said enclosed second vacuum chamber to vacuum source means associated with said engine, means for connecting said opening in said end wall portion to said second enclosed vacuum chamber, vacuum responsive valve means for opening and closing said means for connecting said opening to said second chamber, and vacuum responsive valve means disposed in said means for connecting said enclosed second chamber to said vacuum source means, whereby, in use, said vacuum supply means will be placed in operative communication with the higher vacuum level of the vacuum levels generated in said vacuum source means and said first vacuum chamber.

6. An auxiliary vacuum generator and regulator assembly as defined in claim 5 in which said combustion gas outlet means and said combustion gas inlet means have an included angle of about 180° therebetween.

7. An auxiliary vacuum generator and regulator assembly as defined in claim 5 in which said partly curvilinear sidewall portion is in the form of an arc of a circle.

8. An auxiliary vacuum generator and regulator assembly as defined in claim 5 in which said enclosed second vacuum chamber is at least partially defined by said end wall portion of said first vacuum chamber.

9. An auxiliary vacuum generator and regulator assembly as defined in claim 5 in which said vacuum responsive valve means for opening and closing said means for connecting said opening to said second vacuum chamber comprises a valve disposed within said opening in said end wall portion.

10. An auxiliary vacuum generator and regulator assembly as defined in claim 5 in which said means for connecting said second vacuum chamber to said vacuum source means and to said vacuum supply means comprise conduits which are relatively small in volume compared to the volume of said second vacuum chamber.

11. An auxiliary vacuum generator and regulator assembly as claimed in claim 5 in which said first vacuum chamber and said second vacuum chamber are generally circular in cross section, are of substantially the same diameter, and are disposed within the same housing, said first and second cham-

bers each having an outer end wall and in which said one end wall portion is a common wall partly defining and separating said first and second chambers from each other.

12. An auxiliary vacuum generator and regulator assembly as defined in claim 5 in which said combustion gas outlet means includes a conduit having an end portion adapted to be disposed in the intake airstream of an internal combustion engine.

13. A method of supplementing the vacuum drawn on vacuum supply means operatively associated through connecting means to a vacuum source associated with an internal combustion engine, comprising imparting a curvilinear flow pattern to a stream of combustion gases from the exhaust

system of said engine to create a vacuum region adjacent the region of curvilinear flow by reason of the centrifugal force created thereby, and establishing communication between said vacuum region and said vacuum supply means when the vacuum level in said vacuum region is greater than the vacuum level drawn from said vacuum source means.

14. A method as defined in claim 13 which includes closing off communication between said vacuum supply means and said vacuum source means when establishing said communication between said vacuum region and said vacuum supply means.

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