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AIR POLLUTION INHIBITING MEANS IN THE FORM OF A FUEL RECIRCULATING APPARATUS FOR AN INTERNAL COMBUSTION ENGINE

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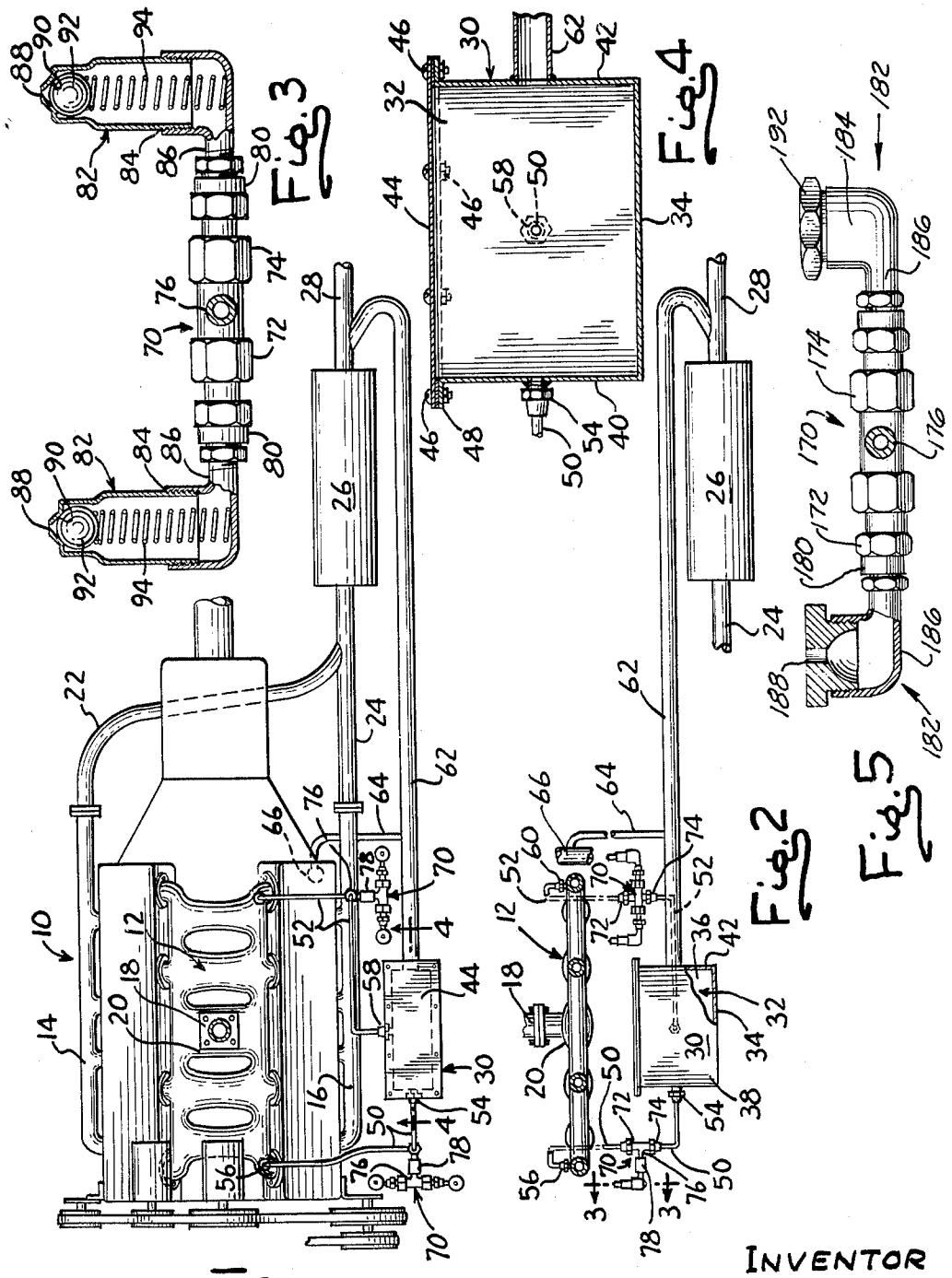


Fig. 1

Fig. 2

Fig. 3

Fig. 4

Fig. 5

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AIR POLLUTION INHIBITING MEANS IN THE FORM OF A FUEL RECIRCULATING APPARATUS FOR AN INTERNAL COMBUSTION ENGINE

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The present invention relates generally to internal combustion engines and has particular reference to a fuel recirculating apparatus for appreciably reducing the amount of incompletely burned fuel that is discharged by an internal combustion engine to the atmosphere through the exhaust system of such engine.

Research in the field of smog control during recent years has established the fact that air pollution in many geographical areas is largely attributed to the unburned hydrocarbons that emanate from the exhaust systems of automotive-type internal combustion engines and are exhausted to the atomsphere, particularly during coasting of the vehicles in which the engines are installed. These unburned fractions, when subjected to the catalytic action of sunlight, under certain conditions, result in an injurious, irritating, smog-laden atmosphere. Not only do the unburned and partially burned fractions in the exhaust gases represent a menace to the health and comfort of the community by polluting the atmosphere, but they also manifest relative inefficiency in the operation of the internal combustion engines which produce them and thus represent an economic loss in fuel consumption.

The present invention is designed to overcome the above-noted limitations that are attendant upon the operation of an automotive vehicle and, accordingly, it is an object of the invention to provide a new and improved apparatus for appreciably minimizing the quantity of unburned hydrocarbons that is discharged into the atmosphere by the internal combustion engine of the vehicle, particularly under conditions of coasting of the vehicle.

It is a further object of the invention to provide an improved apparatus for returning exhaust gases containing unburned hydrocarbons to the intake system of an internal combustion engine under conditions which will assure combustion of such unburned hydrocarbons, thereby increasing engine efficiency and greatly diminishing the amount of unburned fuel that is discharged to the atmosphere by the engine.

A further object of the invention is to provide a smog-inhibiting apparatus which requires no chemical treatment of the exhaust gases, as, for example, the use of catalytic or other additives, and, therefore, is economical in its operation.

Another object of the invention is to provide an anti-smog apparatus which is of the character heretofore mentioned and is capable of installation in the engine compartment of an automotive vehicle where it consumes but little space and is entirely concealed from view.

A still further object of the invention is to provide an improved apparatus for reducing appreciably the percentage of unburned hydrocarbons that are emitted from the exhaust system of an internal combustion engine, the apparatus being of a simple nature and economically constructed and containing no moving parts other than such relatively small shifting parts as are associated with certain check valves forming parts of the apparatus.

The provision of a smog-inhibiting apparatus which is of extremely simple construction and, therefore, may be manufactured at a low cost; one which, being possessed of no moving parts as stated above, is unlikely to get out of order; one which is capable of being installed as original equipment on an automotive vehicle or, alternatively, may be readily applied to an existing automotive vehicle; one which is silent in its operation; and one which otherwise is well-adapted to perform the services required of it, are further desirable features which have been borne in mind in the production and development of the present invention.

Numerous other objects and advantages of the invention, not at this time enumerated, will readily suggest themselves as the following description ensues.

In the accompanying single sheet of drawings forming a part of this specification, one illustrative embodiment of the invention is shown.

In these drawings:

FIG. 1 is a fragmentary plan view of an automotive internal combustion engine having applied thereto a smog-inhibiting apparatus embodying the invention, the view representing a typical installation of the apparatus;

FIG. 2 is a fragmentary side elevational view of the structure that is shown in FIG. 1;

FIG. 3 is an enlarged sectional view taken substantially on the line 3—3 of FIG. 2;

FIG. 4 is an enlarged sectional view taken substantially on the line 4—4 of FIG. 1; and

FIG. 5 is a sectional view similar to FIG. 3, but showing a slightly modified form of the apparatus.

Referring now to the drawings in detail and in particular to FIGS. 1 and 2, the improved smog-inhibiting apparatus of the present invention is illustrated in these views as being operatively installed on an internal combustion engine **10** which is of conventional or standard design and in the form selected for illustration herein, is an automotive vehicle engine of so-called V-eight character. The vehicle chassis which supports the engine **10** is illustrated in the drawings.

The engine **10** is of conventional construction and its illustration in FIG. 1 is largely schematic in its representation. Among the illustrated associated parts or adjuncts of the engine are the intake manifold **12**, the exhaust manifolds **14** and **16**, and the carburetor mounting **18**, the latter being disposed on one of the cross-over legs **20** of the intake manifold **12**. The products of combustion from the right bank of the engine cylinders are discharged into the exhaust manifold **14** and flow through a crossover exhaust pipe **22** to the main engine exhaust pipe **24** which leads rearwards from the left bank of engine cylinders as shown in FIG. 1. From the exhaust pipe **24** the products of combustion flow successively through the usual exhaust system muffler **26** and the tailpipe **28**, and then emerge into the surrounding atmosphere. The arrangement of the exhaust gas system thus far described is purely conventional and no claim is made herein to any novelty associated with the same. Such arrangement is purely exemplary of one form of exhaust system to which the present invention is applicable. The invention may, by suitable modification if necessary, be applied to any other type of exhaust system as required.

Still referring to FIGS. 1 and 2, the apparatus of the present invention involves in its general organization a box-like mixing tank **30** which may be fixedly mounted on a stationary portion of the framework of the vehicle chassis that is in associated relation with the engine **10**, and the interior of which establishes a plenum or mixing chamber **32** (see FIG. 4). The tank **30** is shown as being of rectangular design although it may be of any other suitable configuration. As its components, the tank embodies a bottom wall **34**, upstanding side walls **36** and **38**, upstanding end walls **40** and **42**, and a removable cover plate **44**. The cover plate **44** is removably secured over the open rim of the tank **30** by means of nut and bolt assemblies **46** which cooperate with an outwardly extending flange **48** on the upper marginal portion of the side and end walls of the tank.

The mixing chamber **32** is adapted to be placed under sub-atmospheric or vacuum pressure at such time as the engine **10** is in operation, particularly at such times as the vehicle with which the engine is assocated is in a coasting or standing condition. Accordingly, this mixing chamber is operatively connected through sectional vacuum lines **50** and **52** to the intake manifold **12** of the engine. One end of the vacuum line **50** is in communication with the mixing chamber **32** by way of a fitting **54** which extends through and is connected to the tank end wall **40** and the other end of the vacuum line **50** is connected to the intake manifold **12** by means of a similar fitting **56**. Similarly, the vacuum line **52** has one end thereof in communication with the mixing chamber **32** by way of a fitting **58** on the tank side wall **36** and its other end connected to the intake manifold **12** by means of a fitting **60**. The particular points of connection to the intake manifold **12** are not critical and for the sake of convenience and to maintain as short vacuum lines as possible, both points of connection are made on the same side of the manifold **12**.

The tank **30** is connected to the tailpipe **28** by means of a main conduit **62**, the front end of such conduit passing through the end wall **42** of the tank **30** and communicating with the mixing chamber **32**. A branch conduit **64** establishes communication between the main conduit **62** and the usual breather tube **66** which depends from the engine crankcase.

The vacuum lines **50** and **52** have interposed therein three-way fittings **70** by means of which atmospheric air is admitted to these lines so that the oxygen content thereof may be admixed with the unburned hydrocarbons which are pulled from the tailpipe **28**, and also with any combustible vapors which may be drawn from the breather tube **66**. The three-way fittings have associated therewith check valve arrangements, the nature and function of which will be set forth presently. The two three-way fittings **70** and their associated check valve arrangements are identical in construction and mode of operation.

Each fitting **70** includes two horizontally extending axially aligned legs **72** and **74** and an intermediate leg **76** at right angles to the legs **72** and **74**. The intermediate legs of the two fittings constitute bleeder lines and they are connected through collars **78** to their respective vacuum lines **50** and **52**. The axially aligned legs **72** and **74** of each fitting **70** are connected through suitable nipple connectors **80** (see FIG. 3) to upstanding conventional check valve assemblies **82** by means of which air may be drawn into the fitting **70** and thereafter conducted through the vacuum lines **50** or **52**, as the case may be, to the intake manifold **12**.

The check valves **82** are identical in construction and each includes a vertically extending housing **84** having a laterally extending discharge nipple **86** at its lower end and an intake port **88** at its upper end. The discharge nipple **84** communicates with and is connected to the associated nipple connector **80** and the intake port **88** surmounts an annular valve seat **90**. A ball **92** is urged upwards by a helical compression spring **94** against the seat **90** and serves normally to close the intake port **88**. At such time as a predetermined degree of minimum subatmospheric pressure is attained within the associated vacuum line, the ball **92** will move from the seat **90** against the action of the spring **94** to admit air into the line through the valve casing **84** and associated parts.

The operation of the herein described apparatus is entirely automatic and requires no manual controls. Upon starting of the internal combustion engine **10**, varying degrees of subatmospheric or vacuum pressure are applied to the mixing chamber **32** through the vacuum lines **50** and **52**, depending, of course, upon operating conditions and especially upon the engine load. When the engine is idling, the degree of subatmospheric pressure

within the mixing chamber **32** is particularly great. The subatmospheric pressure which is thus applied to the chamber **32** is transmitted through the main conduit **62** to the tailpipe **28** where unburned hydrocarbons are drawn from the latter and conducted through the conduit **62** to the chamber **32**. Combustible vapors from the breather pipe **66** are also drawn into the chamber **32** by way of the branch conduit **64** and the main conduit **62** and these vapors are intimately mixed in the chamber **32** with the unburned hydrocarbons that are drawn into the mixing chamber from the tailpipe **28**.

The springs **94** of the check valves **82** are relatively weak in compression with the result that the balls **92** are easily unseated from their respective annular valve seats **90**. Thus, even a slight degree of vacuum in the lines **50** and **52** is sufficient to draw air into these lines through the check valves for further mixture with the previously mixed unburned hydrocarbons and vapors passing from the mixing chamber **32** to the intake manifold. The oxygen content of such air is thus at all times sufficient to support combustion of all of the fuel constituents that are recirculated from the tailpipe and the breather pipe **66**. The three gaseous constituents which are thus drawn into the intake manifold through the vacuum lines **50** and **52**, namely, unburned hydrocarbons from the tailpipe **28**, the vapors from the breather pipe **66**, and the air that is drawn through the check valves **82**, are mixed in the intake manifold with fresh vaporized or gaseous fuel issuing from the carburetor and this mixture is drawn into the engine cylinders, compressed, and burned in the usual manner of internal combustion engine operation.

From the above description, it will be apparent that there has been provided an apparatus which appreciably reduces the unburned and incompletely burned hydrocarbons that are discharged from the engine exhaust system to the atmosphere. Moreover, the apparatus assures a more complete combustion of the fuel-air mixture being fed to the engine cylinders. In connection with operation, the apparatus serves to eliminate smog conditions and air pollution at the location where the engine **10** is in operation.

In FIG. 5, a slightly modified form of the invention is shown. In this form of the invention, the various check valves **82** have been dispensed with, and in their stead, there have been substituted air-restricting devices **182**, the remainder of the apparatus remaining substantially unchanged from that described in connection with FIGS. 1 to 4, inclusive. To avoid needless repetition of illustration and description, only one of two fittings **170**, which are substituted for the two fittings **70** of FIGS. 1 and 2, is illustrated in FIG. 5 and similar reference numerals but of a higher order are applied to the corresponding parts as between the disclosures of FIGS. 3 and 4.

Each air restricting device **182** includes a housing **184** and nipple **186** corresponding to the housing **84** and nipple **86** of a check valve **82**. A restrictor nipple **192** is threadedly received in each housing and has a restricted orifice **188** through which air may be drawn from vacuum conditions exist within the housing **184**. The orifice **188** is sufficiently small that only an insignificant amount of gases may be expelled therefrom when vacuum conditions no longer prevail.

The invention is not to be limited to the exact arrangement of parts shown in the accompanying drawings or described in this specification as various changes in the details of construction may be resorted to without departing from the spirit or scope of the invention. Therefore, only insofar as the invention has particularly been pointed out in the accompanying claims is the same to be limited.

Having thus described the invention what I claim as new and desire to secure by Letters Patent is:

1. A combined fuel recirculating and smog-eliminating

apparatus for an internal combustion engine of the type that has an intake manifold and an exhaust pipe, said apparatus comprising a tank providing a chamber, a vacuum line connecting the chamber to the intake manifold, a conduit connecting the chamber to the exhaust pipe, and a bleeder line connected to the vacuum line and communicating with the atmosphere, said vacuum line and chamber being responsive to subatmospheric pressure in said intake manifold and operative when subjected to such subatmospheric pressure to draw unburned fuel constituents from the exhaust pipe through said conduit to said chamber and from thence through the vacuum line to the intake manifold, said vacuum line being effective to draw atmospheric air through said bleeder line for mixture with the unburned fuel constituents issuing from the chamber prior to their introduction into the intake manifold.

2. A combined fuel recirculating and smog-eliminating apparatus for an internal combustion engine of the type that has an intake manifold and an exhaust pipe, said apparatus comprising a tank providing an internal chamber, a vacuum line connecting the chamber to the intake manifold, a conduit connecting the chamber to the exhaust pipe, and a bleeder line connected to the vacuum line, a check valve in said bleeder line, said bleeder line communicating with the atmosphere through said check valve, said chamber and vacuum line being responsive to subatmospheric pressure in said intake manifold and operative when subjected to such subatmospheric pressure to draw unburned fuel constituents from the exhaust pipe through said conduit to said chamber and from thence through the vacuum line to the intake manifold, said vacuum line being effective to draw atmospheric air through said bleeder line and check valve for mixture with the unburned fuel constituents issuing from the chamber prior to their introduction into the intake manifold.

3. The combination with an internal combustion engine having an intake manifold, a breather tube, and an exhaust pipe, of a fuel recirculating apparatus for returning unburned fuel constituents from said exhaust pipe and vapors from the breather tube to the intake manifold, said apparatus comprising a mixing tank providing an internal mixing chamber, a vacuum line connecting said mixing chamber to the intake manifold, a main conduit connecting said mixing chamber to the exhaust pipe, and a branch conduit connecting the main conduit to the breather tube, said vacuum line and mixing chamber being responsive to subatmospheric pressure in said intake manifold and operative when subjected to such pressure to draw unburned fuel constituents from the exhaust pipe through the main conduit and to draw vapors from the breather tube through the branch and main conduits for intermixture in the mixing tank and conduction through the vacuum line to the intake manifold.

4. The combination with an internal combustion engine having an intake manifold, a breather tube, and an exhaust pipe, of a fuel recirculating apparatus for returning unburned fuel constituents from the exhuast pipe and vapors from the breather tube to the intake manifold, said apparatus comprising a mixing tank providing an internal mixing chamber, a vacuum line connecting said mixing chamber to the intake manifold, a main conduit connecting the mixing chamber to the exhaust pipe, a bleeder line connected to the vacuum line and communicating with the atmosphere, and a branch conduit connecting the main conduit to the breather tube, said vacuum line and mixing chamber being responsive to subatmospheric pressure in said intake manifold and operative when subjected to such pressure to draw unburned fuel constituents from the exhaust pipe through the main conduit and to draw vapors from the breather tube through the branch and main conduits for intermixture in the mixing chamber and conduction through the vacuum line to the intake manifold, said vacuum line being effective to draw atmospheric air through said bleeder line for mixture with the mixed unburned fuel constituents and vapors issuing from the mixing chamber.

5. The combination with an internal combustion engine having an intake manifold, a breather tube, and an exhaust pipe, of a fuel recirculating apparatus for returning unburned fuel constituents from the exhaust pipe and vapors from the breather tube to the intake manifold, said apparatus comprising a mixing tank providing an internal mixing chamber, a vacuum line connecting said mixing chamber to the intake manifold, a main conduit connecting the mixing chamber to the exhaust pipe, a bleeder line connected to the vacuum line, a check valve in said bleeder line, said bleeder line communicating with the atmosphere through said check valve, and a branch conduit connecting the main conduit to the breather tube, said vacuum line and mixing chamber being responsive to subatmospheric pressure in said intake manifold and operative when subjected to such pressure to draw unburned fuel constituents from the exhaust pipe through the main conduit and to draw vapors from the breather tube through the branch and main conduits for intermixture in the mixing chamber and conduction through the vacuum line to the intake manifold, said vacuum line being effective to draw atmospheric air through said check valve and bleeder line for mixture with the mixed unburned fuel constituents and vapors issuing from the mixing chamber.

6. The combination with an internal combustion engine having an intake manifold, a breather tube, and an exhaust pipe, of a fuel recirculating apparatus for returning unburned fuel constituents from the exhaust pipe and vapors from the breather tube to the intake manifold, said apparatus comprising a rectangular box-like mixing tank having a bottom wall, upstanding side and end walls and a removable cover, a first vacuum line operatively connected at one end to the mixing tank through one end wall thereof, a second vacuum line operatively connected at one end to the mixing tank through one side wall thereof, the other ends of said vacuum lines being operatively connected to the intake manifold at spaced points thereon, a three-way fitting interposed in each vacuum line and including aligned legs connected in the associated vacuum line and a lateral leg communicating with the atmosphere, a main conduit connected at one end to the mixing tank through the other end wall thereof and at its other end to the exhaust pipe, and a branch conduit connecting the main conduit to the breather tube, said vacuum lines and mixing tank being responsive to subatmospheric pressure in said intake manifold and operative to draw unburned fuel constitutents from the exhaust pipe through the main conduit and to draw vapors from the breather tube through the branch and main conduits for intermixture in the mixing tank and conduction through the two vacuum lines to the intake manifold, said vacuum lines being effective to draw atmospheric air through the lateral legs of the three-way fittings for mixture with the mixed unburned fuel constituents and vapors issuing from the mixing tank.

7. The combination with an internal combustion engine having an intake manifold and an exhaust pipe, of a fuel recirculating apparatus for returning unburned fuel constituents from the exhaust pipe to the intake manifold, said apparatus comprising a rectangular box-like tank having a bottom wall, upstanding side and end walls and a removable cover, a first vacuum line operatively connected at one end to the tank through one end wall thereof, a second vacuum line operatively connected at one end to the tank through one side wall thereof, the other ends of said vacuum lines being operatively connected to the intake manifold at spaced points thereon, a three-way fitting interposed in each vacuum line and including aligned legs connected in the associated vacuum line and a lateral leg communicating with the atmosphere, a con-

duit connected at one end to the tank through the other end wall thereof and at its other end to the exhaust pipe, said vacuum lines and tank being responsive to subatmospheric pressure in said intake manifold and operative to draw unburned fuel constituents from the exhaust pipe through the conduit to said tank and from thence through the vacuum lines to the intake manifold, said vacuum lines being effective to draw atmospheric air through the lateral legs of the three-way fittings for mixture with the unburned fuel constituents issuing from the mixing tank.

8. The combination set forth in claim **7** and including, additionally, a check valve in the lateral leg of each three-way fitting.

References Cited by the Examiner

UNITED STATES PATENTS

1,525,621	2/1925	Schaviak	123—119
1,766,673	6/1930	Moore	123—119

KARL J. ALBRECHT, *Primary Examiner.*