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 [21] Appl. No. **718,848**
 [22] Filed **April 4, 1968**
 [45] Patented **Oct. 13, 1970**

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[54] **CRANKCASE VENTILATION SYSTEM**
6 Claims, 4 Drawing Figs.

[52] U.S. Cl. 123/119
 [51] Int. Cl. F02f 9/00
 [50] Field of Search 123/119(B)

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ABSTRACT: The particular embodiments described herein as illustrative of one form of the invention utilize a condenser in the air cleaner of an internal combustion engine to condense crankcase vapors and return the condensate to the crankcase. Noncondensibles are passed into the engine air-fuel intake system to be burned in the cylinders.

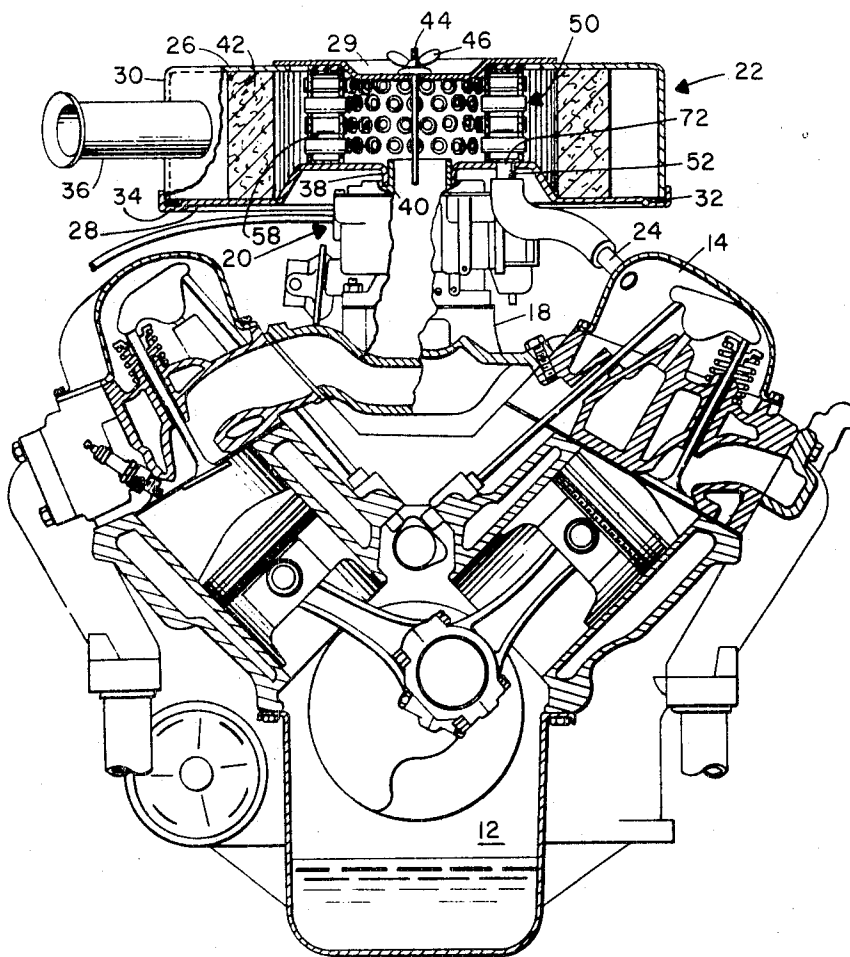


FIG. 1

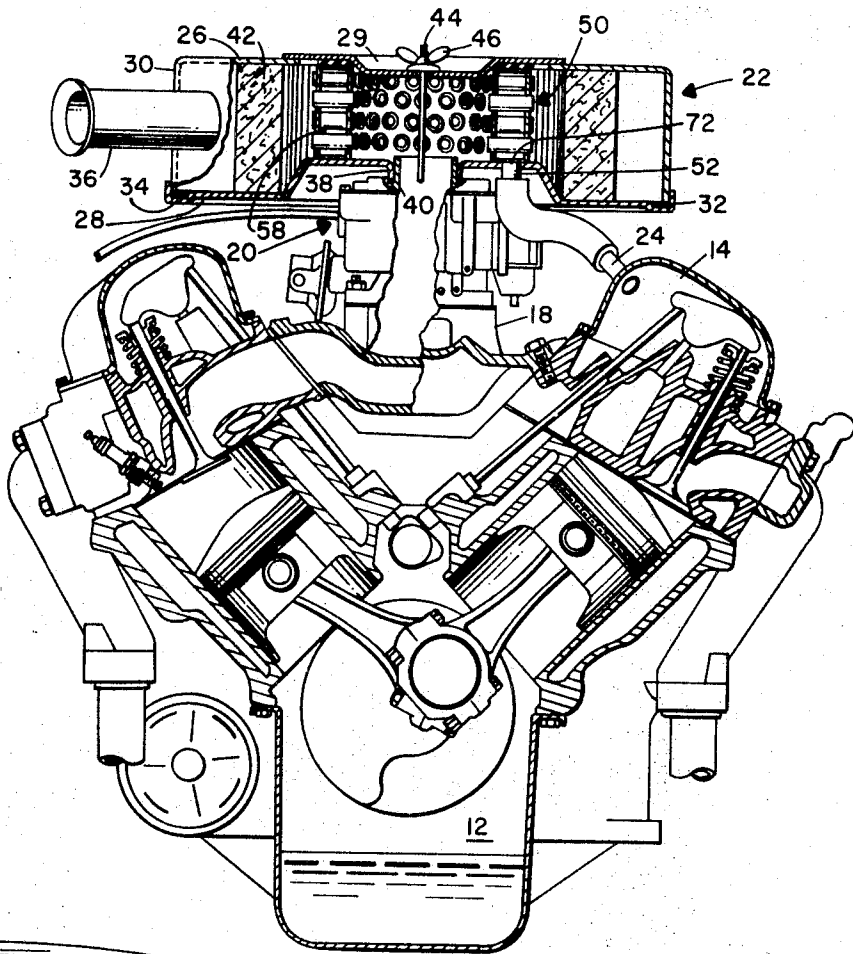
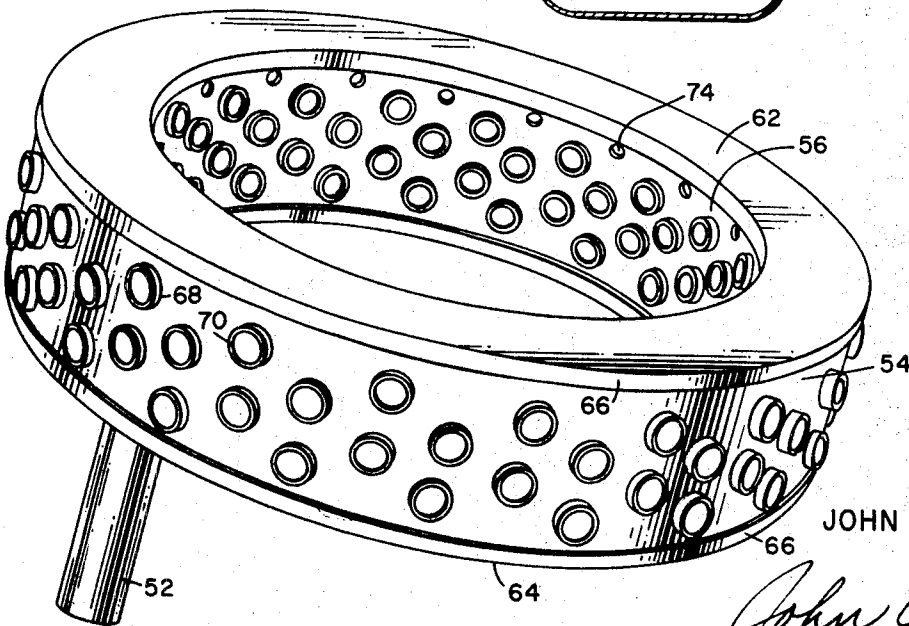


FIG. 3



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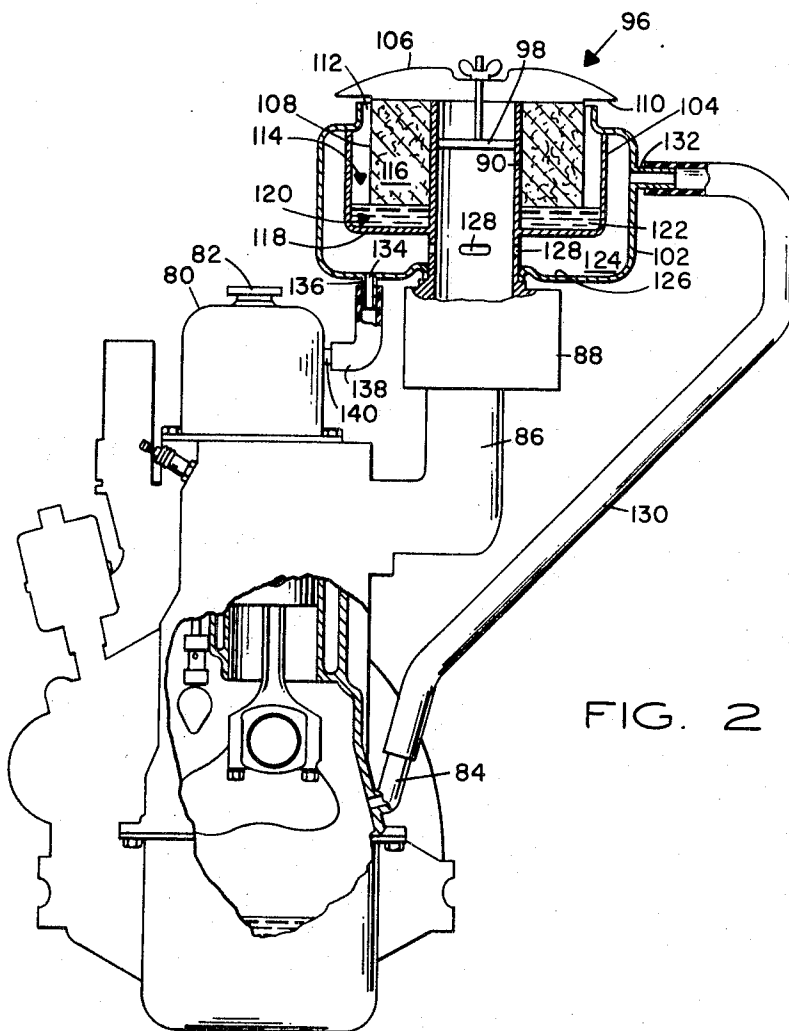


FIG. 2

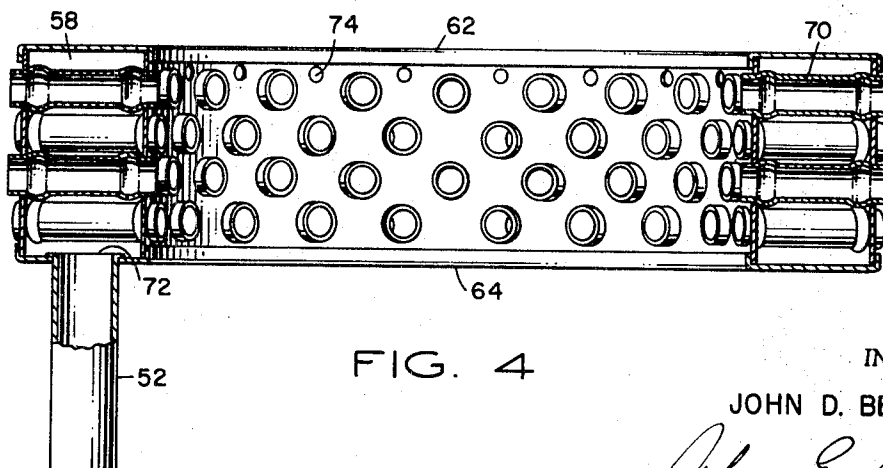


FIG. 4

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CRANKCASE VENTILATION SYSTEM

BACKGROUND OF THE INVENTION

This invention relates to a crankcase ventilation system for internal combustion engines, and more particularly, to an apparatus for condensing crankcase vapors for return to the crankcase. Noncondensibles are passed into the engine air-fuel intake system to be burned in the cylinders.

Crankcase ventilation is necessary to provide a neutral pressure condition in the crankcase. Just as upward motion of the piston compresses the air-fuel mixture, the downward motion tends to compress air in the crankcase. Neither pressure nor vacuum is desirable in the crankcase for reasons to be described herein.

Crankcase ventilation is also necessary to remove harmful elements from the crankcase. It is virtually impossible to keep water out of the crankcase. Drops of gasoline also seep into the crankcase, especially during warm up. Some combustion gases blow past the piston rings into the crankcase. Vapors also originate from the lubricating oil in the crankcase. When such oil vapors are introduced into the atmosphere by any system, they naturally create smog, the undesirable effects of which need not be elaborated upon, since the problem of air pollution is well known. If such oil vapors are induced into the intake manifold for burning in the cylinders, the oils may not burn well at the compression ratios used in internal combustion engines and therefore they emerge through the exhaust system as nonburned hydrocarbons which results in contamination of the atmosphere. In addition, the injection of lubricating oil vapors into the intake manifold tends to destroy the proper fuel-air ratio of the combustible mixture and thereby causes inefficient combustion of fuel in the engine cylinders. These factors, as well as the presence of additives in the oil vapors may contribute to fouling of the spark plugs.

Another problem relates to the use of multiple weight or all-weather types of motor oil in an internal combustion engine crankcase. Such oils have properties which permit a portion of the oil to remain at a low viscosity, even during low temperature conditions. These less viscous portions of the oil tend to vaporize more readily than the heavier portions, and therefore after such oils have been in use for a period of time the lighter portions have tended to vaporize and escape either to the atmosphere or into the engine cylinders where they are burned, so that the oil remaining in the crankcase is of a higher viscosity, and therefore does not afford the advantages of multiple weight range oil.

An additional problem with present day crankcase ventilation systems is that oxygen, which is drawn into the crankcase with the present positive crankcase ventilation systems, can provide a mixture in the crankcase which is explosive. Also, the presence of such oxygen tends to promote the formation of harmful acid sludges in the crankcase.

A notorious problem in the automotive field is the increased oil consumption in older automobiles. Such consumption is ultimately in the form of the release of unburned hydrocarbons into the atmosphere. This increased oil consumption in older engines occurs because of worn or broken rings surrounding the piston head. Since the lubricating oil in the crankcase is always under some pressured gradient, the lubricating oil is forced up between the piston head and the cylinder wall past the formerly tight fitting rings into the compression chamber from whence they are exhausted through the outlet valve into the exhaust system of the automobile. Pressure in the crankcase will also force oil past the crankshaft oil seals and up the dipstick tube. If the crankcase can be operated at nearly atmospheric pressure, such conditions can be minimized.

The two systems generally in use in present day automotive engines for ventilating crankcases are: (1) Air enters the engine through the oil filler cap, circulates inside the crankcase, and exhausts through a road draft tube extending out of the crankcase. The road draft tube works only when the vehicle is in motion at speeds above 20 m.p.h. (2) Crankcase gases are

induced into the fuel-air induction system by various means, and are burned in the cylinders. This system, termed PCV (Positive Crankcase Ventilation) depends on a balanced flow rate of air circulation through the crankcase to prevent excessive pressure or vacuum from occurring in the crankcase. Too fast a circulation rate adversely effects oil oxidation in the engine. Also, any alteration of the PCV upsets carburetion and leads to poor gas mileage and rough idling. Imbalance in the carburetor leads to incomplete burning of the mixture in the cylinders and a resulting discharge of unburned hydrocarbons to the atmosphere.

The present systems for crankcase ventilation do not solve the problems associated with crankcase vapor control, some of which have been set forth above. It is therefore an object of the present invention to provide a new and improved crankcase ventilation system.

SUMMARY OF THE INVENTION

With this and other objects in view, the present invention contemplates a crankcase ventilation system for disposing of crankcase vapors. The system includes means for venting vapors from the crankcase into a condenser for transforming the vapors to the liquid state whereupon they are returned to the crankcase. Portions of the vapor which are not condensed are permitted to escape into the air-fuel intake manifold for burning in the engine's cylinders. Embodiments of the condenser apparatus shown herein utilize air entering the air cleaner to cool the crankcase vapors. Either a separate line or the vapor input line itself is used to return the condensed crankcase fluids to the oil system of the engine.

In addition, the vapors which are condensed and returned to the crankcase are kept separate from the cooling air in the condenser apparatus. Intake air to the crankcase passes from the air cleaner through the cylinders to the crankcase.

A complete understanding of this invention may be had by reference to the following detailed description, when read in conjunction with the accompanying drawings illustrating embodiments thereof.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a cross-sectional view of an internal combustion engine embodying principles of the present invention;

FIG. 2 is a cross-sectional view of an internal combustion engine showing an alternative arrangement of the present invention;

FIG. 3 is a perspective view of a vapor condenser apparatus which is illustrative of one form of the present invention; and

FIG. 4 is a cross-sectional side elevation view of the vapor condenser of FIG. 3.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring to FIG. 1 of the drawings, an engine is shown including a crankcase 12 and rocker covers 14 partially defining rocker chambers 16 communicating with the crankcase 12. The engine further includes a combustion fluid inlet 18 having a carburetor 20 and air cleaner 22 mounted thereon. A tubular conduit 24 extends from the rocker cover to provide a vent for vapors within the cover. This vent in turn provides a convenient path of communication for crankcase vapors which are formed within the engine crankcase. The conduit or vent 24 could be connected directly to the crankcase and be equally within the scope of this invention. Hereafter, the vent which is shown in FIG. 1 as extending from the rocker cover, will be described as a crankcase vent whether the vent actually communicates directly with the crankcase, or whether it communicates directly with the rocker cover, and thus indirectly with the crankcase by means of passages within the engine which connect the rocker cover and crankcase. One such communicating passage within the engine is provided for the cam follower rod which operates the rocker arms within the rocker cover.

The air cleaner 22 includes parallel, generally circular upper and lower covers 26 and 28 respectively. The upper cover 26 having a cylindrical wall portion 30 extending downwardly therefrom and engaging a resilient seal 32, disposed in a channel 34, formed around the periphery of the lower cover 28. An air inlet duct 36 extends outwardly from wall portion 30. A downwardly extending cylindrical portion 38 of the lower cover forms a flange for sealingly engaging the air inlet horn 40, extending upwardly from the carburetor 20. An annular air filter element 42 is concentrically disposed within the air cleaner 22 so as to sealingly engage upper and lower covers 26 and 28. An opening is formed in the upper cover 26 and is provided with a cover plate 29 which sealingly engages the upper cover 26 when assembled thereto. A small opening is provided in the center of the cover plate for receiving the upper end of a bolt 44, which extends upwardly from the air inlet horn. Bolt 44 is threaded at its upper end for receiving a wing nut 46 to hold the cover plate over the opening in the air cleaner upper cover. The air cleaner arrangement described above is basically similar to the type of air cleaner found on most late model automotive type internal combustion engines.

In accordance with the present invention, a condenser apparatus is provided in the crankcase ventilation system, which condenser, in the embodiment of FIG. 1, is arranged for positioning within the air cleaner device 22 shown in FIG. 1. The condenser which is generally indicated by the reference numeral 50 is in the form of an annular chamber, which is sized for reception within the air cleaner between the air filter element 42 and the air inlet horn. The condenser has a conduit 52 extending downwardly therefrom, through a complementary shaped opening in the lower cover 28 of the air filter. Sealing means, such as gaskets, may be provided above and below the top and bottom surfaces respectively of the condenser for providing a sealing engagement between the condenser and the upper and lower covers 26 and 28 respectively, of the air filter.

Further details of the construction of the condenser unit may best be described with reference to FIGS. 3 and 4 of the drawings. The condenser is comprised of inner and outer circular wall members 54 and 56 respectively, which by way of different diameters are spaced from one another to form an annular passage or chamber 58 having a central vertical opening 60. The chamber is enclosed by top and bottom annular cover plates, 62 and 64 respectively. The cover plates have their edges bent downwardly and upwardly respectively to form lip portions 66 thereon, which are arranged to fit over the inner and outer wall members 54, 56. A plurality of openings 68 are formed in spaced rows about the periphery of the inner and outer wall members. When the wall members are assembled with the cover plates, the openings in the inner wall members are axially aligned with the openings in the outer wall members to permit the insertion of tubular members 70 between aligned pairs of such openings. The tubular members are then swaged or otherwise attached at their ends to form a connection between the tubular members and the inner and outer wall members. A vapor inlet opening 72, which is provided in the bottom cover is flush with the surface of the bottom cover so that condensed fluids collecting on the bottom cover may drain into the inlet opening 72 and conduit 52.

A plurality of small diameter openings 74 are provided in the top of the inner wall 54, which openings provide communication between the interior of the annular chamber 58 and the central vertical opening 60 within the condenser. The small openings 74 at the top of the inner wall are sized to pass noncondensed vapors from the interior of the chamber to the central opening while being small enough to choke off the flow, in the opposite direction, of fire and extreme heat into the interior of the chamber so that any backfire from the carburetor cannot get into the crankcase ventilation system. The openings 74 may be situated in the condenser at any location which will provide for communication of noncondensed

vapors from the condensing chamber to the combustion chambers of the engine. The optimum placement of the openings will depend, of course, on the design of the air cleaner. Also, the small openings 74, as well as the tubular members 70 extending through the condenser chamber need not be circular in cross section, but may be shaped in any manner to provide the desired results. The tubular members 70 in the annular chamber may be vertically staggered as shown in FIG. 4 to provide more effective condensing within the chamber. Again, this arrangement may be modified to provide desired results.

In the operation of the apparatus described above, crankcase vapors within the engine are communicated with the chamber 16 of the valve or rocker cover 14 on top of the cylinder head. These vapors are emitted through the vent 24 on the valve cover, and pass upwardly therefrom through the conduit 52 connecting with the inlet opening 72 on the condenser. Vapors from the engine are then communicated with the interior of the condenser chamber 58. Air entering the air cleaner 22, after passing through the air filter element 42, must pass through the interior bores of the condenser tubular members 70 before entry of the air into the air inlet horn of the carburetor. As the crankcase vapors pass about the tubular members 70, they are condensed by the cooling effect provided by air flow into the air cleaner through the tubular members. The condensed vapors collect on the bottom plate 64 of the condenser and drain by gravity into the inlet opening 72 for return to the rocker cover and eventual return to the crankcase. Noncondensable fluids will continue to rise upwardly within the condenser chamber where they are expelled through the small openings 74 into the central opening 60 for passage into the air inlet of the carburetor. These noncondensed fluids are mixed with the carburetor inlet air and then burned within the combustion chambers of the engine.

Referring now to FIG. 2, an illustrative conventional internal combustion engine arrangement is shown. The engine arrangement comprises an engine block having cylinders, a crankshaft, and a crankcase enclosing oil pan. Cylinder heads are suitably fastened to the engine blocks and a rocker arm cover 80. Passages are provided between the crankcase and rocker arm cover for receiving rocker arm follower rods and for permitting the drainage of oil from the rocker arm cover into the crankcase. An oil filler tube and cap 82 are positioned in the rocker arm cover.

Normally the filler cap also acts as a breather tube to admit a small amount of air to the crankcase. In the engine arrangement shown here, however, the cap is sealed to prevent the normal entry of air through the tube. Additionally, in some engines, a suitable output for vapors in the lubricating system is provided, sometimes in the form of a suction producing downdraft tube (not shown) extending from the crankcase. In the present illustrative engine, an outlet 84 is provided on the top side of the crankcase, for purposes which will be described later. Although such vent may be described hereinafter as a crankcase vent, it is to be understood that such a vent may be located on the rocker arm cover or any other part of the engine which is in communication with crankcase vapors.

A conventional intake manifold is located at 86, and a conventional charge forming device, such as a carburetor, is indicated at 88. The charge forming device is of any conventional design, such as a downdraft carburetor having an air inlet tube 90 at its upper end, and an air-fuel mixture outlet at its lower end, which outlet communicates with the intake manifold. The quantity of air-fuel mixture delivered to the manifold is controlled by a butterfly type throttle valve in a conventional manner. A conventional air cleaner filtering unit 96 is mounted on the carburetor and has a filtered air outlet 98 in communication with the air inlet of the carburetor in order to supply filtered air for combination with the fuel to form a combustible mixture.

The type of conventional air cleaner unit illustrated is normally referred to as an oil bath air cleaner. The cleaner comprises a cylindrical metal shell 102, a vertical inner wall, 104,

and a filter insert 106 with portions thereof serving as a removable cover. The outer vertical side wall 108 of the insert is impervious to the flow of air, and when assembled, an insert lid 110 is spaced from the top of the air cleaner shell to provide an air inlet passage 112. The impervious wall 108 of the filter provides a flow path 114 between the wall 108 and the inner surface of the parallel vertical inner wall 104. The bottom portion of the insert 106 is open to expose a filtering element 116 therein so that the air flow path 114 causes entry of air beneath the impervious wall 108 through the filtering element 116. An annular horizontal baffle plate 118 is connected to the bottom of the inner wall 104 of the air cleaner and is spaced downwardly from the vertical wall 108 of the filter element to provide a transverse air flow path 120 beneath the vertical wall 108. The baffle plate 118 also provides a sump in the air cleaner for oil 122 so that the incoming air passing around the lower end of the impervious vertical wall of the filter must flow through the oil sump, thereby providing a liquid filter for removing particles from the air.

A muffler chamber 124 is formed in the air cleaner housing in a space between the air cleaner shell 102 and the inner wall 104 and baffle plate 118 of the air cleaner. The lower part of the muffler chamber 124 between the baffle plate and bottom of the shell has an annular concavity 126 which forms a sump therein. The above described chamber 124 forms an annular space surrounding the carburetor air inlet tube 90. Openings 128 in the air inlet tube 90 communicate the interior bore of the tube with the chamber 124.

The present embodiment of the invention utilizes a tubular conduit 130, which may be in the form of a flexible tubing or the like, for connecting the crankcase vent outlet 84 with an inlet tube 132 extending from the muffler chamber 124 in the air cleaner. An outlet 134 is provided in the annular concavity 126 at the bottom of the chamber 124 and includes a downwardly extending member 136 which provides means for connecting a conduit 138 between such outlet and an inlet tube 140 on the rocker arm cover 80.

It should be emphasized that the particular air cleaner design illustrated is not essential to the invention, nor is an air cleaner essential to the invention. The crankcase ventilating system described is applicable to any air-fuel inlet structure. For practical purposes, when used with an air cleaner, the system would be arranged to fit the various air cleaner designs, or adapted to existing designs currently in use by making necessary modifications to existing air cleaners. It should also be understood that the subject system is applicable to any of a variety of types of engines, and that the engine and engine components shown are for illustrative purposes only. The vapor outlet conduit may be connected to the engine in the most convenient manner which will provide communication with crankcase vapors, and likewise, the return line from the air cleaner may be connected to the engine at any place where oil introduced therein will be eventually returned to the crankcase.

In the operation of the apparatus described above, vapors which are formed in the crankcase will emanate through the outlet 84 and conduit 130 into the air cleaner shell by way of the inlet tube 132 in the muffler chamber 124 of the air cleaner. Air entering the air cleaner unit flows past the inner wall 104 of the filter and tends to cool the inner wall. Therefore, vapors which enter the muffler chamber 124 will be cooled, whereupon condensation takes place. Condensed fluids will gravitate to the lower portion of the chamber which is in the form of the annular concavity 126. These fluids will then flow through the outlet 134 and conduit 138 into the rocker arm cover 80 for return to the engine crankcase.

Various constituents of the crankcase vapor, particularly those having a lower dewpoint, will not be condensed in the muffler chamber. These vapors will pass through the openings in the air inlet tube where they are mixed with inlet air to the engine combustion chambers for burning. Gasoline, which has a much lower dewpoint than lubricating oil, will therefore tend not to condense in the muffler chamber, and thus will be

passed into the engine for burning. In the systems described, the constituents of crankcase vapors which will readily burn in the engine, i.e., gasoline, will be passed into the combustion chambers; while the lubricating grade fluids which do not readily burn will be returned to the crankcase. Such a process will therefore aid in eliminating the emission of noncombustible hydrocarbons to the atmosphere, which emissions are a contributing factor to smog. In addition, the viscosity of the lubricating oil will be maintained at a more constant level since diluting fluids such as gasoline will vaporize and be passed from the crankcase, and the lower viscosity oils, which normally vaporize first from the lubricating oil, will be returned to the crankcase. This in turn will result in multiple viscosity oils holding their viscosity range for a longer operating period.

The closed crankcase system described above, which provides for inlet air to the system only through the combustion chambers, has advantages relating to smog control and engine life. Since the oil filler cap does not have a breather, vapors cannot escape from this point. The vapor-condenser-air filter arrangement does not readily permit the escape of crankcase vapor even when the engine is shut down. Such vapors escaping from the crankcase after engine shutdown will be trapped in the air cleaner between the filter and combustion fluid inlet, so that any vapors escaping from the system would necessarily pass through the filter element and thus the heavier air pollutants would be substantially stripped from the vapors.

The closed system also offers the advantage of preventing an excess of air and thus oxygen from entering the crankcase. Oxygen, when combined with certain hydrocarbon components will form an acid sludge in the crankcase, which in turn leads to corrosion of engine parts. This same prevention of excess air to the system also deters the entry of moisture to the crankcase, the harmful effects of which are well known. The lack of excess oxygen in the crankcase will also prevent crankcase explosion which is not uncommon in positive crankcase ventilation systems.

It is readily seen that numerous advantages are offered by the system described above. It is pointed out, however, that portions of the system have advantages when taken alone, and do not necessarily depend upon all the features of the system to provide an advance in the state of crankcase ventilation systems.

It is also pointed out that while the condenser embodiments shown utilize the engine air intake system for cooling vapors, other systems could be used for cooling. For example, the vapors could be fan cooled, or water cooled, with condensed fluids being returned to the crankcase and noncondensed fluids vented to the intake manifold. In addition, various combinations of the systems shown and described herein may be used within the scope of this invention.

Therefore, while a particular embodiment of the present invention has been shown and described, it is apparent that changes and modifications may be made without departing from this invention in its broader aspects and the aim of the appended claims is to cover all such changes and modifications as fall within the true spirit and scope of this invention.

I claim:

1. In an apparatus for use with an internal combustion engine, wherein the engine is provided with air filter means including an element and housing for filtering and producing fresh air into the air-fuel intake system of the engine, the combination of means for disposing of crankcase vapors emitting from the crankcase of the engine, which means comprises: condenser means having annular inner and outer side walls and top and bottom covers which when assembled form an annular hollow chamber having a central opening therethrough; said condenser means being sized for reception within the air filter housing between the filter element and the air intake system; first port means for passing crankcase vapors into the chamber and for returning condensed fluids to the crankcase; second port means for passing noncondensed fluids from said chamber into the air intake system; and a plurality of laterally

arranged tubular members for communicating the exterior of the inner and outer walls of said chamber, said tubular members being arranged to prevent the direct fluid communication of air in said tubular members with the interior of said chamber and to pass fresh air from said air filter means into the air-fuel intake system of the engine.

2. In an apparatus for use with an internal combustion engine, wherein the engine is provided with an air filter element and housing for filtering air into the air-fuel intake system of the engine, the combination of means for disposing of crankcase vapors emitting from the crankcase of the engine, which means comprises: condenser means having annular inner and outer side walls and top and bottom covers which when assembled form an annular hollow chamber having a central opening therethrough; said condenser means being sized for reception within the air filter housing between the filter element and the air intake system; first port means for passing crankcase vapors into the chamber and for returning condensed fluids to the crankcase; second port means for passing noncondensed fluids from said chamber into the air intake system; and air passage means for communicating the exterior of the inner and outer walls of said chamber, said passages being arranged to prevent the direct fluid communication of air in said passage means with the interior of said chamber said top and bottom covers being arranged for sealing engagement with the top and bottom of the air filter housing, and said air passage means includes a plurality of hollow tubular members for

passing air from the outer wall of said chamber to said central opening.

3. The apparatus of claim 2 wherein said second port means are formed by openings in the upper portion of said chamber which openings provide for fluid communication between the interior of said chamber and said central opening.

4. The apparatus of claim 3 wherein said openings are at the top of said inner wall.

5. An apparatus for use in an internal combustion engine for condensing crankcase vapors including an annular chamber for positioning about the air-fuel intake of the engine; a plurality of lateral passages passing through said chamber and having inlet and outlet ends, said outlet ends terminating in said air-fuel intake, the interior of said passages being isolated from the interior of said chamber, said passages being arranged to pass fresh air into said air-fuel intake; means confining the passage of air from said outlet end to the air-fuel intake so that all the air passing through said lateral passages enters said intake; and means for passing crankcase vapors into the interior of said chamber.

6. The apparatus of claim 5 wherein said annular chamber has top, bottom, inner and outer wall portions, said inner wall being arranged peripherally about said intake to confine air passing thereinto to said air-fuel intake, said lateral passages connecting said inner and outer wall portions, and further including a plurality of openings in the inner wall portion for passing noncondensable crankcase vapors into the air-fuel intake.

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