United States Patent [19]

Hecht

[11] **3,880,130**

[45] **Apr. 29, 1975**

[54] **CONTROL VALVE**

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[22] Filed: **Apr. 23, 1973**

[21] Appl. No.: **353,902**

[52] **U.S. Cl.** ..... **123/119 B**; 137/539.5

[51] **Int. Cl.** **F02f 9/02**

[58] **Field of Search** ..... 123/119 B; 137/539.5, 480

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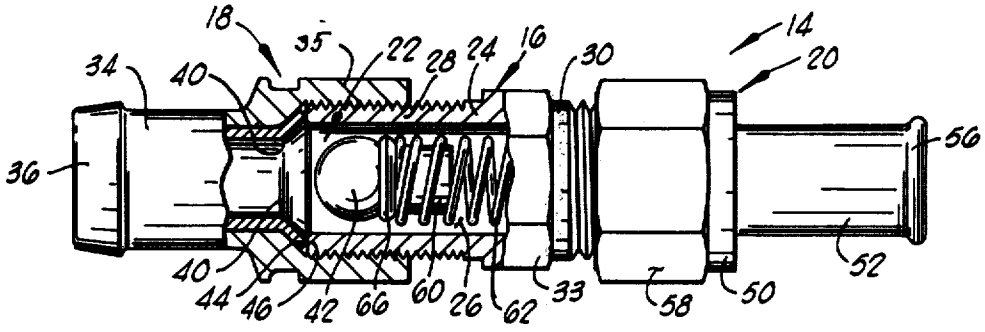
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Attorney, Agent, or Firm—John H. Widdowson

[57] **ABSTRACT**

A control valve is resiliently urged to a normally closed position. The valve is connected in a line between the crankcase and intake manifold of an engine, and in use the valve is open when there is normal operating pressure in the intake manifold. The valve closes when the intake manifold pressure rises above normal to prevent flow from the crankcase into the intake manifold.

1 Claim, 4 Drawing Figures



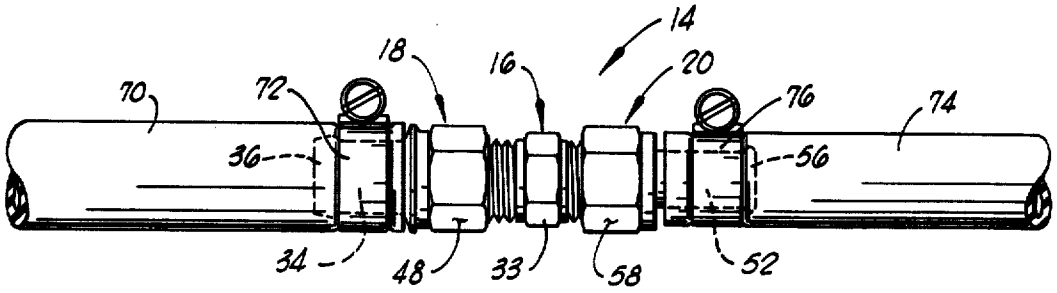


FIG. 1

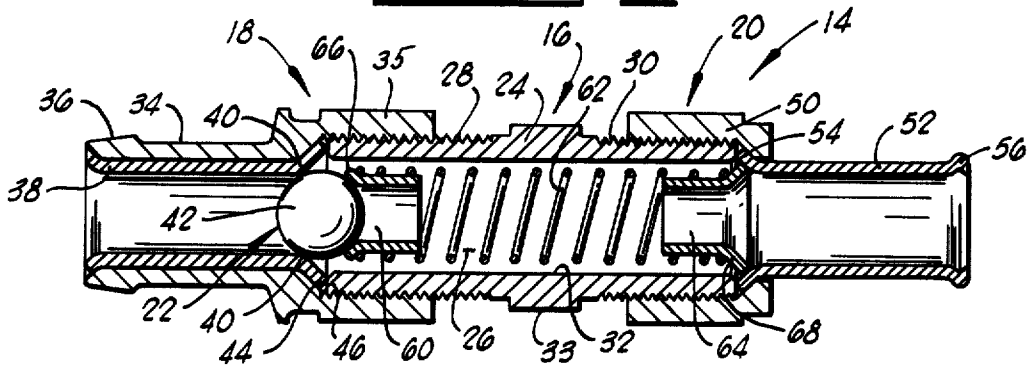


FIG. 2

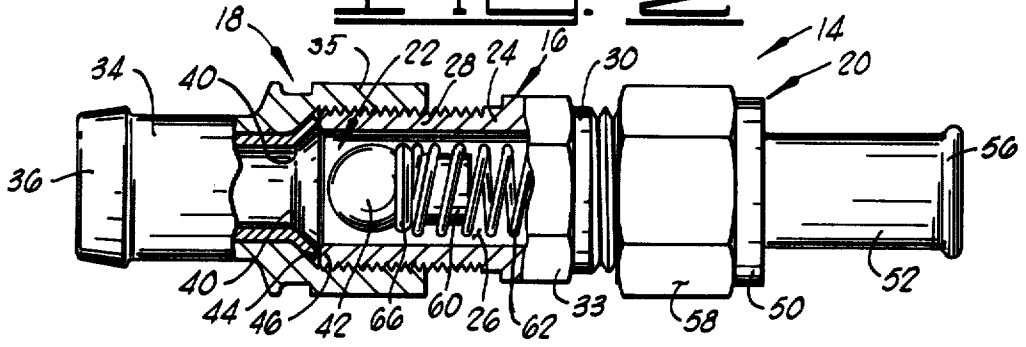


FIG. 3

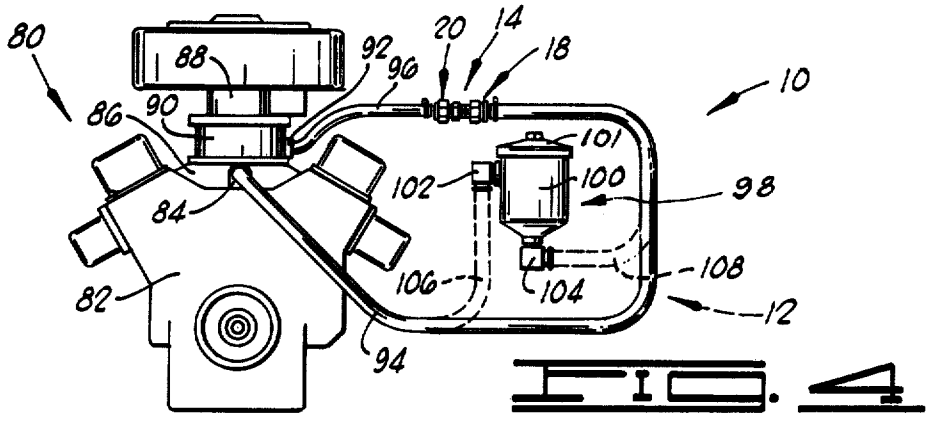


FIG. 4

CONTROL VALVE

Different types of control valves and pressure operated relief valves are known in the prior art as operable to open or relieve pressure when pressure on the valve reaches a predetermined point and also numerous types of valves or the like are known in the prior art as operable to control the passage of vapor flow in an internal combustion engine between the cavity of the crankcase and the intake manifold. In these prior art devices known as positive crankcase ventilation devices and are used with combustion engines to function to vent the engine crankcase of vapors and prevent a substantial reversal of flow or a substantial increase in pressure in the crankcase due to backfiring of the engine. These prior art control devices do not regulate the flow between the crankcase and the intake manifold, they provide an essentially and open connection therebetween. In the art of internal combustion engines, no control device is known which is adapted to limit the operating pressure in the intake manifold portion of the engine. In a normally aspirated internal combustion engine the intake manifold thereof is at a pressure below atmospheric pressure or a so called vacuum pressure and such becomes increasingly below atmospheric pressure as the engine slows down or decelerates from a high operating speed once the throttle control valves in the carburetor are closed. Deceleration of the engine and the drop in intake manifold pressure causes an excess of gasoline or fuel to be pulled into the intake manifold through the idle circuit portion of the carburetor until the engine reaches the idle speed and pressure in the intake manifold reaches a constant level. An excess of fuel passed through the engine at this time causes an increase in objectionable exhaust emissions during such deceleration.

In one preferred specific embodiment a control valve structure includes a valve body having an inlet and an outlet with a valve seat in the inlet, a valve seat closure member in a cavity in the valve body and resiliently maintained in a normally engaged position with the valve seat. The control valve is adapted to in use be in a normally closed position a openable when pressure at the outlet thereof reaches a substantial and predetermined differential valve relative to the inlet. The control valve is adapted to be used with an internal combustion engine, having the inlet thereof in communication with the crankcase or the like and the valves outlet in communication with the intake manifold or the like, preferably below the carburetor. The control valve retains a normally closed position until pressure in the intake manifold is substantially below atmospheric pressure and at a predetermined value then the control valve is opened to pass air and the crankcase vapors from the crankcase into the intake manifold.

In another preferred specific embodiment, a control valve is provided as described above and is connected with a sump trap. The sump trap is an openable enclosure with a reservoir portion therein having an inlet and an outlet the inlet connected with the crankcase and the outlet connected with the inlet of the control valve. The sump trap is adapted to in use to trap liquid portions of the crankcase vapors and prevent same from passing through the control valve and into the engine. The control valve and sump trap of this embodiment of this invention are adapted to during use of the engine maintain the reduced pressure in the intake manifold at no greater than a predetermined pressure and trap liquid portions such as oil and the like in the crankcase vapors as they pass into the intake manifold.

One object of this invention is to provide a control valve and a control valve with a crankcase vapors trap overcoming the before mentioned disadvantages of the prior art devices.

Still, one other object of this invention is to provide a control valve structure having a valve body with an inlet and an outlet and a cavity therebetween, a valve seat in the inlet, a valve closure member in the cavity resiliently urged to a normally engaged position with the valve seat, the control valve being adapted to open when there is a substantial and predetermined differential pressure between the inlet and the outlet thereof.

Still, one other object of this invention is to provide a control valve usable with an internal combustion engine having a crankcase or the like, an intake manifold or the like mounting a carburetor or the like with the control valve connectable between the crankcase and the intake manifold below the carburetor.

Yet, another object of this invention is to provide a control valve communicably connectable between the crankcase and the intake manifold of an internal combustion engine, the valve being open at an idle position and open at a condition of increased engine speed and open during deceleration of the engine and closable during acceleration of the engine.

Yet, another object of this invention is to provide a control valve having an inlet end member, a main valve body member, and an outlet end member with a resiliently urged ball valve member therein the main body member normally engaged in a valve seat in the interior of the inlet end member, the valve being openable when a predetermined differential pressure between the inlet and the outlet is reached.

Yet, another object of this invention is to provide a control valve and a crankcase vapors sump trap usable in combination with an internal combustion engine to remove vapors from the crankcase of the engine passing same through the sump trap to remove liquid portions therein and passing the resulting vapors through the control valve into the engines intake manifold when the control valve is open such as during a period of decelerating or decreasing engine speed.

Yet, another object of this invention is to provide a control valve and crankcase vapors trap having a crankcase vapors sump trap including an openable enclosure with an inlet and an outlet.

Various other objects, advantages, and features of the invention will become apparent to those skilled in the art from the following discussion taken in conjunction with the accompanying drawings and in which:

FIG. 1 is an elevation view of the control valve having the inlet thereof and the inlet thereof connected with flexible hoses;

FIG. 2 is an enlarged cross-sectional elevation view of the control valve having the ball thereof shown in full view and in the closed position;

FIG. 3 is an enlarged elevation view of the control valve with portions thereof cutaway for clarity and exposing the center thereof with the control valve in an open position; and

FIG. 4 is a pictorial diagram of an internal combustion engine connected with the control valve and sump trap, having the sump trap and connecting lines therefor shown in dashed lines.

The following is a discussion and description of preferred specific embodiments of the control valve structure of this invention, such being made with reference to the drawings, whereupon the same reference numerals are used to indicate the same or similar parts and/or structure. It is to be understood that such discussion and description is not to unduly limit the scope of the invention.

The control valve of this invention as desclosed therein includes two embodiments of the control valve in a connected relationship with the internal combustion engine. In one embodiment of the invention, (1), the control valve has the inlet thereof communicably connected with the engine crankcase and the outlet thereof communicably connected with the intake manifold of the engine. In another embodiment, (2), of the control valve of this invention it has a crankcase vapors trap or collector connected with the control valve wherein the inlet to the trap is communicably connected with the engine crankcase, the outlet of the trap is connected with the inlet of the control valve and the outlet of the control valve is communicably connected with the intake manifold of the engine. The control valve alone is the same in both herein disclosed embodiments of the invention. The control valve is normally closed and is opened by a differential pressure between its inlet and outlet with the pressure at the outlet being the lower pressure. The crankcase vapors sump trap is an openable reservoir type container adapted to receive vapors directly from the engine crankcase and remove a portion of the liquid portions of the vapors and passing the resultant vapors therefrom. Both embodiments of the invention are shown in FIG. 4 with the embodiment, (1), utilizing the control valve alone shown in the solid lines of FIG. 4 and generally indicated at the numeral **10**; and the embodiment, (2), utilizing the control valve and the crankcase vapors sump trap shown in FIG. 4 with the crankcase vapors sump trap connected by the dashed lines and indicated generally at **12** by the arrowhead with the dashed line.

FIG. **1**, **2** and **3** show in detail the structure of the control valve alone. The control valve alone is indicated generally at **14** and includes a main valve body at **16**, an inlet end member generally indicated at **18**, an outlet end member generally indicated at **20** and a ball and seat therein the inlet end, generally indicated at **22**. As shown in FIG. **2**, the cross-sectional view of the control valve, the inlet end member **18** and the outlet end member **20** are threadedly engaged with the valve body **16**. The control valve body **16** has a generally cylindrical side wall **24** and defining therein a cavity **26** therein. The inlet end portion of the valve body **16** is indicated at **28** and such is threaded on the exterior to receive and mount the inlet end member **18**. The outlet end portion of the valve body **16** is indicated at **30** and it is threaded on the exterior thereof to receive and mount the outlet end member **20**. The cavity **26** is preferably provided with a cylindrical interior wall indicated at **32**; with the cavity **26** extending completely through the valve body **16** opening on the ends thereof.

The inlet end member **18** has an extended inlet conduit like portion **34** integral with a collar-like portion **35**. The collar-like portion **36** is threaded on the interior thereof to engage the inlet end **28** of the valve body **16**. The extended portion **24** is a relatively short conduit like having a barbed portion or raised portion **36** on the extreme end thereof as shown. The barbed portion **38** of the conduit extended portion **34** is adapted to be used in securing a flexible hose or the like to the control valve inlet member **18**. The interior of the extended inlet portion **34** has a liner member **38** therein as shown. The valve seat indicated at **40** is on the inner end portion of the inlet member **18**, specifically the valve seat surface is on an inner portion of the liner **38**. The valve seat **40** is circular to engage the exterior surface of the valve closure member or the ball **42**. The valve seat **40** preferably has the contacting surface thereof at the point indicated by the juncture of the ball **42** and the liner **38** in FIG. **2** with a substantially small flat surface (not shown in the drawings) on which the outer surface of the ball **42** will rest when it is in the seated position. The extreme inner end of the liner **38** is flared and indicated at **44** so the inner end of the liner conforms with the interior shape of the inlet member **18** as shown. The inner end **44** of the liner **38** is in contact with the outer end **46** of the valve body inlet end portion **28**. The collar-like portion **35** of the inlet member **18** is provided with a multiple sided, preferably hexagonal, exterior surface **48** to provide for easy turning of same when it is threadedly engaging same with the valve body **16**.

The outlet member **20** of the control valve **14** is shown in cross-section in FIG. **2** and in full view in FIG. **3**. In FIG. **3** the valve **14** is open with the ball **42** in the position it would be in if the longitudinal axis of the valve was in a generally vertical direction; if the valve **14** was oriented with its longitudinal axis in a generally horizontal direction the ball **42** would be in a position in contact with the interior wall **32** of the cavity **26**. When the valve **14** is open and in the generally horizontal position the ball **42** would not necessarily be seated in the ball contact member **60** as shown in FIG. **3**. The outlet member **20** includes a collar-like member **50** and an extended or conduit like outlet member **52** connected with the collar-like member **50**. The inner end of the outlet extended member or conduit member **52** is flared as shown to be engaged with a tapered portion of the interior of the collar member **50**. The outlet end of the conduit **52** has a raised portion **56** used to retain the extended outlet portion **52** in a flexible hose or the like. The interior of the outlet collar member **50** is threaded to engage with the threaded outlet end portion **30** of the valve body **16**. On the exterior of the collar member **50**, such has a multi-sided shaped surface, indicated at **58**, preferably hexagonally shaped to be used when engaging or disengaging the collar-like member **50** with the threaded exterior of the valve body **16**.

The interior of the valve body **16** including the interior portions of the inlet member **18** and the outlet member **20** enclose the ball and seat assembly **22**. The ball and seat assembly **22** includes the ball **42**, a ball contact or follower member **60** a resilient member or spring **62** and a resilient member or spring support **64**. FIG. **2** shows the ball and spring assembly **22** in the closed position with the ball **22** in contact with the valve seat **40**. FIG. **3** shows the control valve including the ball and spring assembly **22** in an open position with the ball **42** in a spaced position relative to the valve seat **40**. The ball contact or ball follower member **60** is a cylindrical member having a flared end portion **66** contacting the surface of the ball **42** as shown. The spring **62** is preferably a helical spring retained in a com-

pressed position when the ball and spring assembly **22** is in the closed position as shown in FIG. **2.** One end of the helical spring **62** slips over the cylindrical wall of the ball follower member **60** with the extreme end thereof resting on the flared portion **66.** The spring support member **64** is a cylindrical and hollow member as shown with a flared end portion **68** contacting the outlet conduit member **52** and the supporting end of the helical spring **62.** The spring **62** slips over the exterior of the hollow support member **64** with the extreme end thereof on the flared portion **68** as shown. The support member **64** is necessarily hollow preferably pass from the cavity into the outlet conduit **52.** The amount of compressive force required to further compress the spring from the position shown in FIG. **2** is the amount of force necessary to open the control valve **14.** The strength of the spring **62** or the amount is the means by which the opening and closing functions of the valve are controlled or regulated. In the use of the control valve in the herein described applications the spring **62** is preferably of such a strength such that the control valve will open when the differential pressure between the inlet of the valve and the outlet of the valve is approximately 4, inches of mercury. The spring **62** can be substituted with other springs so the valve will open at a different differential pressures as desired by the user. It is to be understood that the spring **62** can be replaced by other resilient devices to exert force on the ball follower **60** or directly on the ball **42** to maintain same in a normally closed position in contact with the valve seat **40** without departing from the scope of the invention.

The inlet member **18** and the outlet member **20** are provided as shown in the drawings in order to mount flexible hoses or the like for connecting the control valve **14** with an engine. FIG. **1** shows the control valve connected to the flexible hoses. The inlet member **18** is connected with a flexible hose **70** which is secured to the inlet member **18** by clamp **72.** The outlet member **20** is connected with a flexible hose **74** and secured by a clamp **76.** The raised portions **36** and **56** on the inlet member **18** in the outlet member **20** respectively aid in retaining the flexible hoses with the control valve **14.** The inlet member **18** and the outlet member **20** are shown and described herein as mountable with flexible hoses or the like; however, it is to be understood that the inlet portion of the inlet member and the outlet portion of the outlet member **20** can be constructed with fittings other than those shown to connect the control valve **14** with pipes, conduits, or other fittings as desired by the user. The use of flexible hoses or the like to connect the control valve **14** with an engine is preferred because of the economy of same and the easy connectability of same.

In the use and operation of this embodiment, (1), of this invention, such as illustrated in FIG. **4.** FIG. **4** shows an internal combustion engine generally indicated at **80** connected with the control valve apparatus of this embodiment, **10** of this invention. The engine **80** includes a crankcase indicated generally at **82** with a crankcase vent outlet **84,** an intake manifold **86** with a carburetor **88** mounted thereon. For purposes of connecting the control valve **14** of this embodiment **10** with the engine a connecting member **90** is shown between the carburetor **88** and the intake manifold **86.** The connecting member **90** has an opening **92** which forms an auxiliary inlet to the intake manifold. The connecting member **90** may or may not be necessary depending upon the structure of the specific intake manifold or carburetor on which the conntrol valve of this invention is used. Some internal combustion engines have auxiliary aperatures in the intake manifolds and carburetors and some do not. The only function of the connecting member **90** is to provide an auxiliary aperture connected with the internal opening or openings of the intake manifold which is a feature necessary for the proper connection of the control valve apparatus **10.** A flexible hose **94** is connected with the crankcase vent outlet **84** on one end and on the other end connected with the control valve inlet member **18.** A flexible hose **96** forms the outlet conduit from the control valve **14** and it is connected on one end with the aperture **92** and on the other end thereof with the control valve outlet member **20.**

Fluid flow through the control valve **14** depends upon whether or not it is open or closed. In the closed position no vapors from the crankcase can flow through the control valve **14.** When the control valve **14** is in the opened position vapors from the crankcase flow through the crankcase vent outlet **84,** through the conduit **94,** through the control valve **14,** through the conduit **96,** through the apertures **92** in the connector member **90** and into the internal cavities of the intake manifold **86.** For an internal combustion engine of the type currently used in automobiles the operating pressure in the intake manifold during operation of the engine is substantially below atmospheric pressure. During the idling or steady state operation of such an engine without the control valve apparatus of this invention the intake manifold pressure is approximately **16** to **18** inches of mercury below atmospheric pressure. When an automobile having such an engine is rapidly decelerated from a highway driving speed, the pressure in the intake manifold will change to approximately **35** to **40** inches of mercury below atmospheric pressure. During periods of significant acceleration of an automobile having such an engine, the pressure in the intake manifold becomes essentially atmospheric pressure. During the normal operation of the internal combustion engine **80,** the pressure in the crankcase is atmospheric pressure. When the engine is in operation air is pulled into the combustion chamber through the carburetor **88** and passes through the intake manifold **86** and during a steady state operation of the engine or an accelerating operation of the engine, the amount of fuel flowing through the carburetor **88** is theoretically in proportion to what the engine needs for operation. However, when the engine decelerates or slows down from a high speed, there is normally a rapid decrease in pressure in the intake manifold that causes an excess of fuel to be drawn into the intake manifold through the idle circuit of the carburetor **88,** this is excess of fuel is not needed by the engine and produces an excess amount of oxides of nitrogen in the exhaust of the engine. It has been found that during such deceleration of the engine **80** the products have combustion thereof have an undesirably high content of atmospheric polluting materials therein.

When the engine **80** shown in FIG. **4** is equipped with the control valve apparatus **10** of this invention it is connected as shown and as previously described. When the engine **80** with the control valve apparatus of this invention is in operation the control valve **14** will alter the pressure in the intake manifold **86.** The control **14**

is constructed and adapted to open when the pressure at the inlet is approximately 4 inches of mercury below the pressure at the outlet. Therefor, during use and operation of the engine with the control valve apparatus **10**, the control valve **14** will be in a closed condition during periods when the engine is being accelerated and it will be opened during periods of idling, steady state of operation and deceleration. With the control valve **14** connected as shown by the solid lines in FIG. **4** it will open when differential pressure between its inlet which is connected to the crankcase and its outlet which is connected to the intake manifold is at a differential pressure of approximately 4 inches of mercury. In practice of the applicants invention by the applicant, it has been found that the control valve **14** when open will prevent pressure in the intake manifold **86** from dropping below approximately 23 to 24 inches of mercury below atmospheric pressure at substantially all times when the engine is in operation. In the connected relationship shown, crankcase vapors exit the crankcase **82** through the outlet **84**, pass through the control valve inlet conduit **94**, through the control valve **14**, and through the control valve outlet conduit **96** into the connector member **90** and into the intake manifold **86**. During periods of significant acceleration the control valve **14** is closed and there is not fluid flow through the conduits **94** and **96**. During deceleration of the engine the control valve is opened and it provides for the introduction of the crankcase vapors into the intake manifold **86** for substantially reducing the increase of differential pressure that would be present without the control valve apparatus **10**. The lessening of the differential pressuring during deceleration of the engine **80** prevents an excess of fuel of being drawn into the engine through the idle circuits of the carburetor **88** thereby preventing excessively rich products of combustion from being formed by the engine **80** and this intum reduces the objectionable oxides of nitrogen, carbon monoxide, carbon dioxide, hydrogen cloride and other know atmospheric polluting materials usually formed by an engine due to an excess of fuel.

In use and operation of the control valve apparatus **10**, it has been found that the idle circuit of the carburetor **88** can be adjusted to a leaner fuel flow setting with it installed relative to the setting thereof without the control valve apparatus **10**. The leaner setting in the idle circuit of the carburetor **88**, has an additional advantage in that a lesser amount of fuel is introduced into the engine during its operation at idle speed.

Another embodiment, (2), of the control valve apparatus of this invention such includes a crankcase vapor sump trap in the conduit circuit with the control valve. The control valve apparatus of this embodiment, (2), as shown in FIG. **4** and generally indicated by the arrow with the dashed lines and the numeral **12**. The control valve apparatus of this embodiment, (2), includes the control valve **14**, a crankcase vapors sump trap, indicated generally at **98**, and conduits to connect same in a series between the crankcase of the outlet of the engine in an inlet to the intake manifold thereof. The control valve **14** is the same as the control valve described and shown herein and functions in exactly the same manner with generally the same overall result in regard to operation of the engine. The function of the crankcase vapors sump trap **98** is to function a liquid-gas separator for the vapors coming from the crankcase.

FIG. **4** shows generally the structure of the crankcase vapors sump trap **98** in its connected relation with the engine **80** and the control valve **14**. The crankcase sump trap **98** is indicated at **100** and is an openable reservoir type of vessel adapted to receive the crankcase vapors, separate a portion of the liquid portion thereof from the gaseous portion thereof and to pass the resulting gaseous portion thereof from the outlet end thereof. The vessel **100** is a container adapted to operate with the pressure therein and below atmospheric pressure. As shown, the container or vessel **100** is provided with a removable lid or a cover **101**, an inlet fixture **102** and an outlet fixture **104**. The interior of the container **100** is substantially opened with the inlet fixture **102** adapted to pass vapors through the side wall. The outlet fixture **104** is preferably a stand pipe like member extending to the upper portion of the container with an inlet thereto in its upper portion. Vapors entering the container or vessel **100** pass in to same through the inlet fixture and circulate about in the open cavity portion with the solid or liquid portions thereof falling to the bottom of the container and the gaseous portions thereof passing through the inlet of the outlet fixture in the upper interior portion of the cavity and on out of the outlet fixtures outlet.

FIG. **4** shows in detail the connected relationship of the control valve apparatus **12** of this embodiment, (2), of this invention. The engine **80** is the same as described previously and includes a crankcase **82**, crankcase vent outlet **84**, intake manifold **86**, a carburetor **88** with the connector member **90** having an inlet **92** mounted therebetween the carburetor **88** and the intake manifold **86**. The crankcase vent outlet **84** is connected with the crankcase vapors sump trap **98** by a conduit indicated at **106**. The crankcase vapors trap **98** has an outlet conduit indicated at **108** connecting same with the control valve **14**. The conduit **96** connects the control valve **14** and the connector member inlet **92**. The crankcase vapors sump trap is preferably mounted near the engine **88**, such as in the engine compartment of the vehicle, and connected by conduits such as flexible hoses.

Flow through the vapors trap **98** and the control valve **14** depends upon whether or not the control valve is opened or closed. In the closed position no vapors from the crankcase flow through the vapors trap **98** or the control valve **14**. When the control valve **14** is opened vapors from the crankcase flow through the conduit **106** into the crankcase vapors trap **98** via the inlet fixture **102** and the resulting vapors pass from the trap **98** through the conduit **108**, through the control valve **14**, through the conduit **96**, through the aperture **92** in the connector member **90** and into the internal cavity of the intake manifold **86**. The vapors entering the crankcase vapors trap **98** are substantially heavily oiled ladened vapors that contain atomized oil and some products of combustion which flow by or pass over the pistons along the cylinder walls and from the combustion chamber between the valve stems and the valve guides into the cavity of the crankcase **82**. These crankcase vapors also contain a substantial quantity of so called heavy hydrocarbons or so called sludge which is not significantly combustible if passed into the combustion chambers of the engine. As these vapors pass in through the crankcase vapors sump trap **98** the liquid fluid portions thereof drop out in a condensing or separating manner within the enclosure of the con-

tainer or vessel **100** and drop to the bottom portion thereof where they are retained for storage or removal at a later time. The resulting vapors, namely the crankcase vapors less a substantial amount of heavy liquid portions thereof, pass from the trap **98** through the outlet fixture **104** into the conduit **108** and to the control valve inlet **18.** When the control valve **14** is opened, a resulting vapors pass from the control valve outlet **20,** through the conduit **96** into the connector member **90** at its inlet **92** and are pulled into the air-fuel mixture passing through the cavity of the intake manifold **86.** The resulting vapors passing from the crankcase vapors trap **98** have substantially small amounts of liquid particles herein and will not clog or block the control valve **14.** Additionally, the resulting vapors due to there small liquid contents can be passed to the combustion chamber portion of the engine **80** without sticking to or accumulating on the valves, the pistons or the walls of the combustion chamber. The quantity of oil or oil-like substance removed by the crankcase vapors trap can be removed from the container or vessel **100** thereof by removing the cover member **101** and withdrawing the liquid by any suitable means.

During use and operation of the control valve apparatus **12** of this embodiment, (2), of this invention, such functions substantially similar to the control valve apparatus **10** of the first embodiment, (1), of this invention in regard to the operating periods in which vapors flow through the conduits thereof and times during which the control valve is opened or closed. The crankcase vapors and resulting vapors will flow through the conduit circuits of the control valve apparatus **12** when the engine is idling, when it is steady state operation and when the engine is decelerating to the idling speed from an operating speed. The control valve will be closed and crankcase vapors will not flow through the conduit circuit when the engine is significantly accelerating or speeding up. The crankcase vapors sump trap **98** provides for the passing of substantially clean vapors into the intake manifold of the engine via the control valve **14** when the differential pressure on the control valve is as stated, the four inches of mercury differential pressure. In practice it has been found that the crankcase vapors sump trap **98** provides a sufficient cleaning or filtering action on the crankcase vapors passing therethrough to reduce by a significant amount, the materials dispersed into the atmosphere by the introduction of substantially non-combustible materials into an engine.

Since the vapors from the crankcase are generally ladened with substantially non-combustible liquid particles and the particles are removed by the crankcase vapors sump trap **98** before passing the vapors into the engine thus these exhaust gases containing products of combustion of the engine are substantially less atmospheric polluting than exhaust gases of engines having other vapor recirculating apparatus' which do not clean or filter the vapors before recirculating same.

In the use and operation of the control valve apparatus **12** of this embodiment, (2), of this invention, it has been found that when it is connected with an internal combustion engine it will provide an engine which will operate without producing the quantity of atmospheric polluting exhaust gases which would be produced if the control valve apparatus **12** was not connected with the engine. In practice it has been found that the crankcase vapors sump trap **98** will remove a substantial quantity of non-burnable liquid materials from the crankcase vapors before passing same through the engine of the control valve **14.** In practice it has been found the control valve **14** allows the idle circuit of the carburetor **88** to be adjusted to a leaner fuel flow setting which reduces the amount of fuel introduced to the engine when it is operating at the idle speed as compared to the carburetor setting required for the engine operating without the control valve apparatus **12** of this invention. The control valve of the apparatus **12** is adapted to be open during normal operating conditions except when accelerating to pass vapors from the crankcase of the engine to the crankcase vapors sump trap, removing liquid portions therefrom and passing the vapors through the control valve to the intake manifold with the effect of reducing the amount of objectionable and atmospheric polluting materials produced by the engines exhaust.

In the manufacture of the control valve structure of this invention in the two herein and disclosed embodiments thereof, it is obvious that the control valve apparatus could be easily constructed to achieve the end product. The control valve structure can be constructed by a valve producing techniques common to the art and constructed of materials which are inexpensive and easily produced. The crankcase vapors sump trap is an openable vessel easily manufacturable in the art and same can be constructed to be easily openable and closable and constructed of materials not effected by the crankcase vapors.

In the use and operation of the control valve structure of this invention, it is seen that same provides a control valve apparatus in one embodiment that is connectable between the crankcase and the intake manifold of an internal combustion engine to remove vapors from the crankcase of the engine and pass same into the intake manifold. In another embodiment the control valve structure of this invention includes a crankcase vapors sump trap and a control valve connectable in series between the crankcase of an internal combustion engine and an intake manifold thereof for the purpose of removing and separating liquid portions and vapor portions of the crankcase vapors and passing the resulting vapors into the intake manifold. The use and operation of the control valve devices of this invention they function similarly being open during normal operating conditions and closed when the engine is substantially accelerated.

As it will become apparent from the foregoing description of the applications control valve structures such provides a significant improvement in the art and such is a relatively inexpensive and simple means to remove vapors from the crankcase of an internal combustion engine and pass them into the intake manifold thereof. The control valve structures are economical to manufacture, simple in operation, easily connectable with an internal combustion engine and do not require direct powering by the engine for their operation.

While the invention has been described in conjunction with preferred specific embodiments thereof, it will be understood that this description is intended to illustrate and not to limit the scope of the invention, which is defined by the following claims.

I claim:

1. An improved internal combustion engine having a crank case, or the like, a carburetor, or the like, and an intake manifold mounting the latter, wherein the im-

provement comprises: a flexible conduit connecting between said crankcase and said intake manifold to place same in fluid communication with each other, a valve body mounted in said conduit and having an inlet and an outlet and a cavity communicably connected between said inlet and said outlet, said valve body including a main valve body, an inlet end member, an outlet end member, and an outlet collar member, said inlet end member threadably engages said main valve body member, said collar member mounting on said outlet end member and threadably engages said main valve body member to interconnect said outlet end member and said main valve body, said inlet end member said main body member and said outlet end member being generally aligned with a common axis, a valve seat in said valve body inlet end member, a valve seat closure member in said cavity in a normally engaged position with said valve seat, means in said cavity in contact with said outlet end member to resiliently urge said valve seat closure member into said normally engaged position, said valve seat closure member being a ball member, said valve seat has a generally annular surface to engage said ball member, said means to resiliently urge said ball member to a closed position includes a hollow ball follower member in contact with said ball and a helical spring in contact with said ball follower member, said spring being in compression, said inlet member has said valve seat on the inner end portion thereof, said inlet member and said outlet member each has elongated outer end portions constructed and adapted to be mounted with said flexible conduit, said spring has a spring retaining member on the end thereof opposite said ball contact member, said spring retaining member being in contact with an inner end portion of said outlet end member, said valve body is operable at a pressure differential in the range of 3 to 5 inches of mercury between said outlet and said inlet, and a crankcase vapors trap communicably connected in said conduit before said inlet of said valve, said crankcase vapors trap including an openable container with an inlet and an outlet with means to circulate vapors therein and a reservoir therein, said crankcase vapors trap is constructed and adapted to in use receive crankcase vapors, remove liquid portions therein and pass the resulting vapors to said valve body to prevent fluids from entering said valve, said control valve body being constructed, adapted and connected in said conduit to in use be open when said engine has normal operating pressure in said intake manifold to permit passage of fluid from said crankcase to said intake manifold, and to close when the engine operating pressure in said intake manifold increases to a pressure above normal.

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