Jan. 11, 1966 A. C. KORTE ETAL 3,228,523

FUEL SUPPLY CONTROL UTILIZING VENTING MEANS

Original Filed Aug. 28, 1958 2 Sheets-Sheet 1

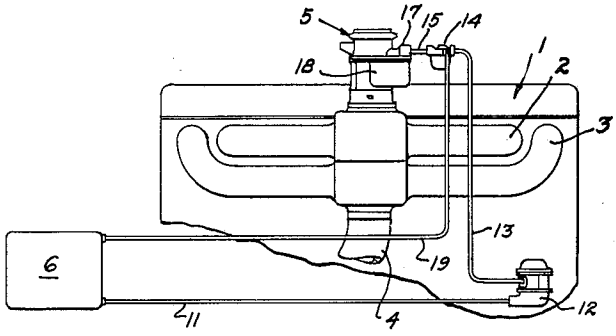


FIG. 1.

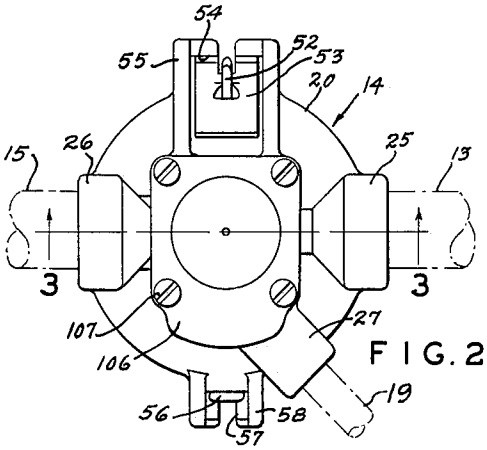


FIG. 2.

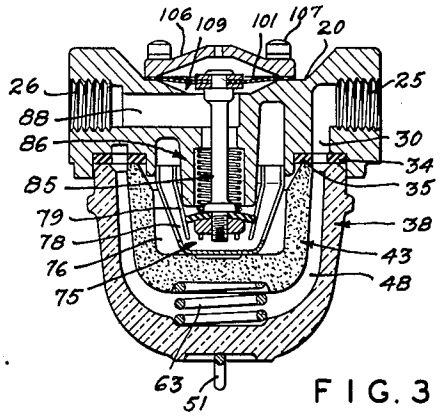


FIG. 3.

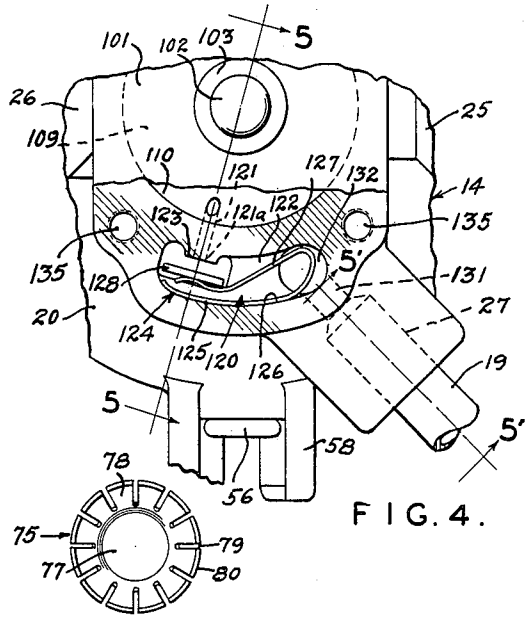


FIG. 4.

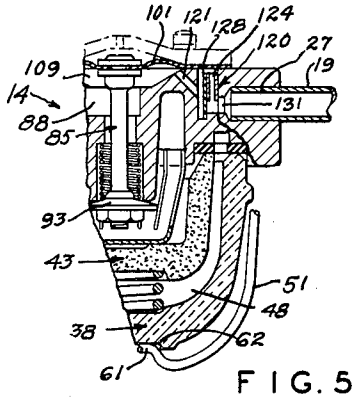


FIG. 5.

FIG. 6.

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FUEL SUPPLY CONTROL UTILIZING VENTING MEANS

Original Filed Aug. 28, 1958 2 Sheets-Sheet 2

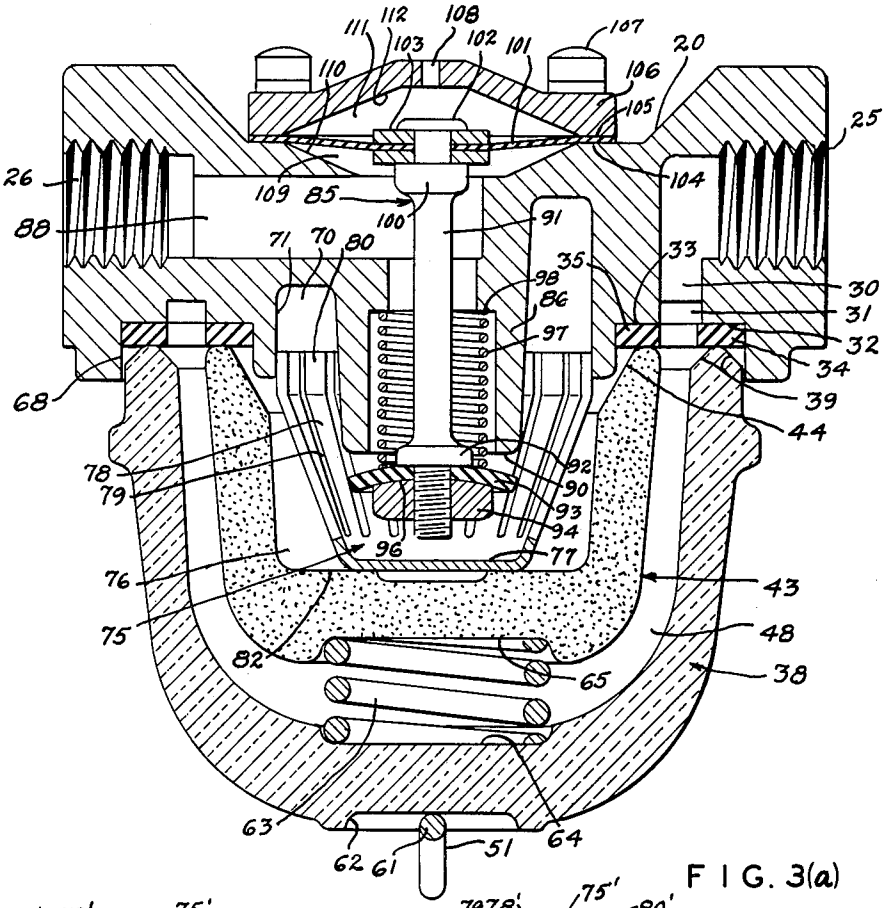


FIG. 3(a)

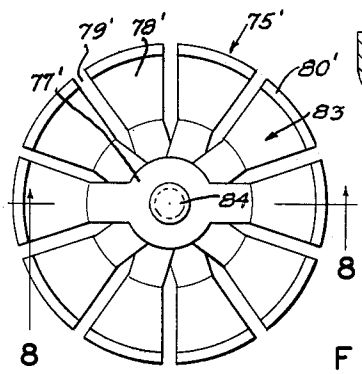


FIG. 7.

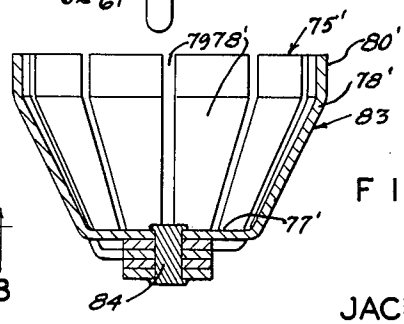


FIG. 8.

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3,228,523

FUEL SUPPLY CONTROL UTILIZING VENTING MEANS

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Original application Aug. 28, 1958, Ser. No. 757,849, now Patent No. 3,106,527, dated Oct. 8, 1963. Divided and this application Oct. 29, 1962, Ser. No. 233,852
7 Claims. (Cl. 210—137)

This application is a division of our co-pending application Serial No. 757,849, filed on August 28, 1958 by Alfred C. Korte and Jack M. White, now U.S. Patent No. 3,106,527.

This invention relates to an improved fluid handling device especially suitable for use in internal combustion engine fuel supply systems, and particularly to an improved pressure control and filter device.

The fluid handling device of this invention is of the type which may advantageously be used in conjunction with the fuel supply system of an internal combustion engine. Prior to entering a carbureting apparatus and being charged into an engine combustion chamber, fuel should be filtered to remove foreign matter, such as water, grit, sand, metallic particles, and the like. Such filters are often equipped with mechanical filter elements such as a ceramic filtering element, or the like, which is usually constructed as finely as possible without overly retarding the flow of fuel through the filter. Some of the metallic particles to be filtered from the fuel are magnetizable, such as iron and steel, and a portion of these particles are usually sufficiently fine to pass through the mechanical filter element. In many present day fuel filters, magnets are so located as to affect only a small portion of the fuel, and some are difficult to remove. When the magnetic is installed in an obscure location in the device, or is difficult to remove, it is likely that it will be retained in service until it is so loaded with magnetizable material as to become relatively ineffective.

Should the fuel become hot before reaching the engine's carbureting device, as when the engine has been in operation, especially on a hot day, or when the engine has been stopped and no fuel is flowing from the tank to the carbureting device, thereby exposing a small quantity of fuel to hot conduits, or a hot fuel pump, filter, and the like, for an extended period of time, the fuel may be sufficiently heated that its pressure is substantially increased. Such excessive pressure may result in erratic performance of the carbureting device, and is likely to damage the carbureting device, or to flood the engine. For example, in a conventional carburetor having a float actuated needle valve for admitting fuel to the carburetor, an excessive pressure in the line leading to the needle valve may force the valve open, even to the extent of bending the actuating mechanism, and the pressure of the fuel may force it through the carburetor and into the intake manifold, flooding the engine.

Furthermore, under hot conditions, certain fuels may vaporize, reducing the actual quantity of fuel reaching the engine, and thereby reducing the engine output, or a vapor lock may occur in the fuel system.

It is, therefore, an object of this invention to provide an improved fluid handling device which acts as a regulator.

Another object of this invention is to provide an improved and compact fluid handling device which may be easily serviced.

Still another object of this invention is to provide an improved pressure regulation, vapor elimination, and filter device.

A further object of this invention is to provide an improved filtering device. Other objects are to provide an improved mounting assembly for filters, an improved filtering device incorporating an improved magnetic filtering element, and an improved magnetic filtering element.

Another object of this invention is to provide an improved pressure control device. Other objects are to provide an improved pressure regulating device, an improved shut-off valve, an improved venting assembly, and combinations thereof. Further objects are to provide an improved venting device responsive to pressure, and an improved venting device responsive to pressure, and an improved venting device responsive to both temperature and pressure. Still another object of this invention is to provide an improved filtering device incorporating a controlled vent.

Additional objects and advantages of this invention will be apparent from the following description and drawings, in which:

FIG. 1 is a side view of an internal combustion engine illustrating an operative environment of an embodiment of the improved fluid handling device.

FIG. 2 is a top view of the improved fluid handling device illustrated in FIG. 1.

FIG. 3 is a sectional elevation view taken on the line 3—3 in FIG. 2, and FIG. 3(*a*) is to enlarged scale.

FIG. 4 is a fragmentary top view of a portion of the improved fluid handling device with parts removed and broken away, and to an enlarged scale.

FIG. 5 is a sectional elevation view taken primarily on the line 5—5 in FIG. 4, and in part on the line 5'—5' in FIG. 4.

FIG. 6 is a top view of an embodiment of an improved magnetic filtering element incorporated in the fluid handling device.

FIG. 7 is a top view of another embodiment of an improved magnetic filtering element incorporated in the fluid handling device.

FIG. 8 is a sectional elevation view taken on the line 8—8 in FIG. 7.

Briefly, the invention relates to a fluid handling device incorporating a magnetic filtering element which may be maintained in position in the device by a ceramic filtering element, or the like, and in which the entire mass of fluid passing through the device must pass through both filtering elements, and in close proximity to the poles of the magnetic filtering elements. Of particular interest is the magnetic filtering element which is generally cup-shaped, with the walls of the cup having narrow gaps defining fingers, each of the fingers being magnetized with an opposite polarity. The device further incorporates a pressure regulating assembly arranged concentrically with the filtering elements and actuated by a diaphragm type pressure responsive motor responsive to pressure of the fluid in the outlet passage of the fluid handling device. In addition to regulating the pressure of the fluid in the outlet passage, the valve also shuts off the flow of fluid into the outlet passage if the pressure therein becomes excessively high. The outlet system of the device is provided with a vent incorporating a resilient temperature and pressure responsive element for opening the vent should the temperature of the device become excessive, and for permitting the escape of fluid from the outlet system should the pressure of the fluid become excessive.

When the fluid handling device is used in conjunction with a vaporizing fuel, the vent inlet is so arranged that fluid vapors tend to escape through the vent and fluid liquid tends to remain in the passage leading to the outlet of the device. Should the pressure regulating system become inoperative, and in the event of an extremely high pressure on the outlet side of the filters, the vent may open to prevent backflow through the filter.

The fluid handling device of this invention may be used in conjunction with numerous fluid handling systems, such as liquid lubricant systems, refrigeration systems, fuel systems utilizing a fluid fuel, and the system is particularly useful with liquid fluids which could vaporize within the range of temperatures which may be encountered by the fluid handling system. For purposes of illustration and description, and without so limiting the invention, the device will be described in conjunction with an internal combustion heat engine utilizing a fluid liquid fuel subject to vaporization, such as gasoline.

Referring to FIG. 1 of the drawings, a conventional internal combustion engine **1** has an intake manifold **2**, and an exhaust manifold **3** which discharges into an exhaust pipe **4**. A carburetor **5** is secured to the intake manifold **2** in a conventional manner, and is supplied with fuel which is drawn from a tank **6** through the conduit **11** by a fuel pump **12**. The fuel then passes through a conduit **13** to the improved fluid handling device **14**, to be more fully described hereinafter. During normal operation fuel passes from the fluid handling device **14** through a conduit **15** and into a conventional float bowl **18** of the carburetor **5** through a carburetor fuel inlet **17**. Conduit **19** is a return line from the fluid handling device **14** to the fuel tank **6** and is operative under certain conditions which will be fully described hereinafter.

FIG. 2 illustrates a top view of the fluid handling device **14** with the inlet conduit **13**, the outlet conduit **15**, and the return conduit **19**, illustrated in phantom lines. A body member **20**, preferably of non-magnetic material, receives the conduits in any conventional manner. The inlet conduit **13** is screwed into an inlet connection **25**, the outlet conduit **15** is screwed into an outlet connection **26**, and the return conduit **19** is sweated into, or otherwise connected to, a return connection **27**.

Referring now to FIG. 3, and more particularly to enlarged FIG. 3(*a*), the inlet **25** in the body member **20** connects with an inlet passage **30** which, in turn, opens into a circumferential groove **31** and chamber **48**. Immediately adjacent the groove **31** are a pair of offsets **32** and **33**, each receiving a resilient sealing washer **34** and **35**, respectively. An imperforate closure or fuel bowl **38**, which may be fabricated of any appropriate material, such as glass, plastic metal, or the like, has an upper, tapered sealing edge **39** which engages the sealing washer **34**. A mechanical filter element **43** of ceramic material, or the like, is concentric with the bowl **38** and has a tapered upper sealing edge **44** which engages the sealing washer **35**. A chamber **48** is defined by the inner surface of the bowl **38** and the outer surface of the ceramic filter element **43**, and is in communication with the circumferential groove **31** in the body member **20**. If desired, the resilient sealing washers **34** and **35** may be a single unit with appropriate openings for the passage of fluid from the circumferential groove **31** into the chamber **48**. The fuel bowl **38** is clamped tightly against its sealing washer **34** by a U-shaped bale **51**. The bale **51** is pivotally attached to the body member **20** by a hook or eye **52** on one end of the bale which engages through a hole in a plate **53**, the plate **53** being freely received against a shoulder **54** on an attaching fixture **55** formed integrally with the body member **20**. The other end of the bale **51** has a loop **56**, or other appropriate transverse projection, which is received in a slot **57** in a second attaching fixture **58** formed integrally with the body member **20**. The bight portion of the U-shaped bale **51** has an inwardly offset portion **61** engaging in a socket **62** in the bottom of the outer wall of the bowl **38**. A compression spring **63** has one end received in a socket **64** formed in the inner wall of the bowl **38**, and its other end is received in a socket **65** formed in the outer wall of the ceramic filter **43**. Spring **63** urges the sealing edge **44** of the ceramic filter into tight sealing engagement with the resilient washer **35**. The offset **32** in the body member **20** is provided

with a vertical wall **68** which conforms to the size of the bowl **38** and provides lateral support for the bowl.

Referring to FIG. 6, in addition to FIG. 3 and FIG. 3*a*, a magnetic filter element **75** is received in a cup-shaped cavity **76** in the ceramic filter element **43**, and in a socket **70** having vertical side walls **71** in the body member **20**. The magnetic filter element **75** is of generally frusto-conical, cup-shaped configuration, and preferably has a solid base or bottom wall **77** to retain any magnetic particles which may fall thereon, and side wall gaps or slots **79** to form a plurality of fingers **78**. The top of the fingers **78** are bent form a cylindrical portion **80**. The fingers **78** preferably have sufficient resiliency, and the cylindrical portion **80** is of such size that the fingers grip the wall **71** of the socket **70** with a sealing fit and to temporarily retain it in the socket during assembly.

FIGS. 7 and 8 illustrate another embodiment of a magnetic filter element **75′**, again of generally frusto-conical cup-shaped configuration having a hollow and a solid base or bottom wall **77′**, a plurality of generally U-shaped magnetized bars or strips **83** having opposite polarities at opposite ends. The bars or strips are joined together at their bight portions as by a rivet **84**. The resilient strips **83** are shaped to provide fingers **78′** and gaps **79′**. The free ends of the legs of the strip are bent to form a cylindrical portion **80′**, and, as shown, the bight portion of the U-shaped members are shaped to provide a solid base **77′**.

The magnetic filter elements are preferably formed of a material such as that known in the trade as "Cunico," which is an alloy containing about 50 percent copper, 21 percent nickel, and 29 percent cobalt, although other materials such as that known in the trade as "Alnico," an alloy containing, basically, aluminum, nickel, cobalt, and iron, may also be used. When fabricated from "Cunico," the metal is preferably about .020 inch thick and the gaps **79** are about .040 inch wide.

In both embodiments, the magnetic filter element is magnetized in such a manner that adjacent fingers have opposite polarities. A magnetic flux field is therefore provided between opposite edge faces of the fingers and through the gaps between the fingers. The gaps **79** or **79′** should project toward the bases **77** or **77′** only to the extent that an adequate magnetic flux field exists in the gaps. As the free ends of the fingers **78** or **78′** are in sealing engagement with the socket wall **71**, the entire mass of fuel flowing through the filter must pass through the magnetic flux fields in the gaps **79** or **79′**. By fabricating the body member **20** of a non-magnetic material, the portions of the fluid handling device adjacent the magnetic filter will not be coated with magnetized particles, and it is therefore merely necessary to remove the magnetic filter to remove all of the magnetized particles.

The magnetic filters **75**, or **75′**, can be used without the ceramic filter **43**, but it is positively retained in the socket **70** through engagement of the outer face of its bottom **77** with the inner face **82** of the bottom of the cup-shaped socket **76** in the ceramic filter **43**, which also maintains proper spacing between the filters. It should be noted that the cylindrical portion **80** of the magnetic element **75** is free to slide vertically into socket **70** in the body member **20** so that a precision fit between the magnetic filter element **75**, the ceramic filter element **43**, and the resilient washer **34**, is not necessary.

Still referring to FIGS. 3 and 3(*a*), a pressure regulating and shut-off valve assembly **85** is mounted in the body member **20** and is concentric with the bowl **38**, ceramic filter **43**, and magnetic filter **75**. Valve assembly **85** is received inside a cylindrical boss **86** formed integrally with, and projecting outwardly from, the body member **20**. The cylindrical boss **86** is concentric with the socket **70** and groove **31** in the body member or head **20**. The hollow boss **86** opens at its top end and forms a part of an outlet passage **88** which, in turn, opens into the outlet connection **26**. The bottom of the cylindrical

boss 86 provides a valve seat 90, and opens into the hollow in the cup of the magnetic filter element 75 or 75'.

The outer surface of the boss 86 acts as a baffle in causing the fuel entering through the top of gaps 79 to flow into intimate contact with the magnetic poles, and causes the fuel to flow along the poles to the valve seat 90, thus providing more efficient filtration of any magnetizable particles remaining in the fuel after the fuel has passed through the gaps 79.

A valve stem 91 is concentric with the cylindrical boss 86, and passes therethrough. The bottom portion of the valve stem 91 has a flange 92 and receives a resilient valve washer 93, which may be fabricated of synthetic rubber, leather, or the like. The washer 93 is clamped between the flange 92 and a nut 94 threaded onto the bottom end of the valve stem 91. The nut 94 is larger than the flange 92, and the upper face of the nut has a convex, arcuate, generally spherical surface 96. The resilient valve washer 93 is therefore arched to provide an improved sealing engagement with the valve seat 90 formed by the inner edge of the bottom of the cylindrical member 86. The arching of the valve washer 93 is aided by a compression spring 97 which engages the valve washer 93 and a shoulder 98 formed in the cylindrical member 86. The spring 97 is of greater diameter than the flange 92, but smaller than the nut 94. The upper end of the valve stem 91 is provided with a flange 100. A diaphragm 101 is clamped on the upper end of the valve stem 91 between the flange 100 and a peened-over clamping portion 102. A pair of rigid disks or washers 103 embrace opposite faces of the diaphragm 101 between the shoulder 100 and the peened-over portion 102. The periphery of the diaphragm 101 is clamped between the top face 104 of the body member 20 and a flat face 105 on a cap 106. The cap is tightly clamped to the body member 20 by bolts 107. A vent 108 is provided in the crown of the cap. The outlet passages 88 opens into a chamber 109 formed by the bottom face of the diaphragm 101 and a substantially frusto-conical face 110 in the body member 20. A second chamber 111 is formed between the upper face of the diaphragm 101 and the inner generally frusto-conical face 112 of the cover 106. The upper chamber 111, being vented through vent 108, offers no substantial resistance to the movement of the diaphragm 101, although the vent 108 may, if desired, be calibrated to a sufficiently small size that the upper chamber 111 would act to dampen movement of the diaphragm 101. Pressure regulation in the outlet passage 88 is normally determined by calibration of the spring 97 and the effective area of the diaphragm 101. It should be noted that the valve, valve stem, and diaphragm form a rigid assembly with no relatively moving parts such as pivots or sliding links and, therefore, this assembly will give satisfactory service for a prolonged period of operation.

FIGS. 4 and 5 illustrate a valved vent assembly 120, which is responsive to ambient temperature as well as the pressure in the outlet passage 88 and, more particularly, in the diaphragm chamber 109. FIG. 4 shows the top of the fluid handling device with the diaphragm cover 106 removed and a portion of the diaphragm 101 broken away. In FIG. 5, the cover 106 and bolts 107 are shown in phantom lines. FIG. 4 is to an enlarged scale, and it should be noted that in FIG. 5 the section is taken principally on the line 5—5 in FIG. 4 and that the passage 131, connecting portion 27, and return conduit 19 are sectioned on the line 5'—5' in FIG. 4, with this section including the wall 126 of the chamber 122. The leg 125 of the generally U-shaped thermostatic spring member 124 is shown in the major plant 5—5. It should also be noted that in FIG. 3 the valve assembly 85 is shown in an open position, whereas, in FIG. 5 the valve assembly 85 is shown in the closed position. A passage 121 preferably opens through the upper region of the frusto-conical wall 110 and connects the diaphragm chamber 109 with a chamber 122 in the body member 20. Therefore, liquid, or any vapors which inherently tend to collect in the upper reaches of the outlet system 26, 88 or 109, are removed by the vent, thereby tending to prevent vapor lock. The passage 121 is preferably about 10 percent to 15 percent of the area of the seat of the float controlled needle to cause the majority of the liquid to flow to the carburetor 5. The needle valve seat is normally the smallest restriction in the passage system from the chamber 109 to the float bowl 18. The passage 121 could open into other portions of the outlet system, or into the inlet side of the valve 90, 96, but it is preferable that the vent system remove vapor and excess pressure in the outlet system, as in the above-described preferred arrangement. Adjacent either end of the chamber 122 are threaded sockets 135 which receive bolts 107. The passage 121 has a valve seat 123 at the end opening into the chamber 122. The valve mechanism includes a temperature responsive, bimetallic, resilient strip 124 of general U-shape, having a leg 125 conforming to and closely engaging a wall 126 of the chamber 122. The other leg 127 is provided at its free end with a resilient valve member 128 of synthetic rubber, leather, or the like. As shown in FIG. 4, the valve is open. The return conduit 19 is received in the body member connecting portion 27 by a fluid-tight sweat fit, although it may be connected therein in any appropriate manner. The connecting portion 27 opens into a passageway 131 which, in turn, opens into the chamber 122. The bottom wall of the chamber 122 adjacent the passage 131 is provided with a sump 132 to facilitate the free flow of fluid from the chamber 122 into the passageway 131.

When used in a gasoline system, the bimetallic spring 124 is calibrated to open between about 80° F. and 110° F., and to be tightly closed at about 60° F., when the passageway 121 is exposed to substantially normal operating pressures in the chamber 109 and outlet passage 88. Whether or not the valve assembly 120 is open or closed is of no particular significance for normal outlet pressures when the thermostatic spring 124 is at temperatures between about 60° F. and 100° F.

The valve assembly 120 also opens responsive to fluid pressure in the outlet system, and particularly in passage 121. As illustrated in FIG. 4, the pressure in chamber 109 which will open the valve 128 may be adjusted by varying the size of the mouth 121*a* of the passage, without disturbing the balance between the carburetor needle valve seat and metering restriction 131. The thermostatic spring 124 should be so calibrated that a pressure slightly above the normal desired outlet pressure will open the valve member 128 when the ambient temperature of the thermostatic spring is below the calibrated opening temperature, as previously described. Both temperature and pressure act together to open and close the valve, and therefore a slightly higher pressure is required to open the valve when the ambient temperature is relatively low, which may be desirable, as there is less likelihood of vapor lock under these conditions.

OPERATION

Under normal operating conditions, fuel is drawn from the fuel tank 6 through line 11 and into the fuel pump 12, from which it is discharged into the conduit 13 at a pressure of between approximately 2½ and 4 pounds. The fuel is pumped through the conduit 13, into the fluid handling device inlet connection 25 and passage 30, then into groove 31, past gaskets 34 and 35, and into chamber 48. The fuel then passes through the ceramic filter element 43 and into the chamber 76. All of the fuel then passes through the slots 79 of the magnetic filter element 75. In passing through the slots 79, substantially the entire mass of fuel passes through the magnetic fields between the opposite poles of each adjacent arm 78, and thus, any fine, magnetizable particles which may pass through the ceramic filter 43 are removed from the fuel.

Under normal operating conditions, the valve **85** is open and fuel passes through the inside of cylindrical boss **86** and into the outlet passage **88**, from which it is discharged through the outlet connection **26** into conduit **15**, and then into the carburetor fuel bowl through the carburetor inlet **17**. The diaphragm **101** is exposed to the fuel pressure in the outlet system **26**, **88**, and **109**, and accurately limits the pressure of the fuel delivered to the carburetor fuel inlet **17**, irrespective of the resistance to fluid flow of the valve **96** and valve seat **90**, or the resistance to fluid flow of the filters **43** and **75**, which may vary with different filters, or after continued use, because of clogging of the filters, and the like. Should the pressure of the fuel in the outlet system of the fluid handling device begin to rise, the pressure on diaphragm **101** will be increased, moving the diaphragm **101** and valve washer **96** upwardly from the position shown in FIG. 3 toward the position shown in FIG. 5. Such a rise in pressure is particularly likely to occur when the engine speed is decreased very rapidly, so that the inertia of the fuel in conduit **13** forces the fuel into the fluid handling device at a relatively high pressure after the engine's demand for fuel has diminished and the float controlled needle valve in the carburetor has closed. The pressure is also likely to increase when the engine has been run hot, particularly on a hot day, and then has been stopped, resulting in a small quantity of fuel in the conduits **13** and **15**, and in the fluid handling device **14**, being exposed for an extended period of time to a high temperature, during a so-called "hot soak." Whatever the cause of the increased pressure, the valve assembly **85** will be at least partially closed, reducing the pressure in the outlet system **26**, **88** and **109**. When the engine is stopped, the outlet pressure may become so high that the valve will close entirely, although this could occur during operation of the engine.

When the temperature and pressure responsive vent valve assembly **120** is closed, that is, when the valve member **128** tightly engages seat **123**, the bimetallic spring element **124** is exposed to the ambient temperature in the chamber **122** and the wall **126**. The bimetallic element **124**, as mentioned previously, is calibrated to open at a temperature of between 80° and 110° F. under substantially normal pressure conditions in the outlet system of the fluid handling device, this pressure being controlled and maintained normally constant at about 3½ to 4 p.s.i. by valve assembly **85**, irrespective of the action of the vent, and for a fuel having a vaporizing temperature of about 95° to 100° F. at normal operating pressures. When the valve assembly **120** opens, the bimetallic spring element **124** is then also exposed to the temperature of the fuel, or vapor, or both, passing from the chamber **109** through the passage **121** into chamber **122** and out passage **131** into return conduit **19**. As passage **121** opens into the upper portion of the outlet system, through wall **110** of diaphragm chamber **109**, fuel vapors which inherently rise from the liquid fuel will tend to be removed from the outlet system through the vent, rather than liquid fuel. As illustrated in FIG. 1, the return conduit **19** discharges into tank **6**, although it could, alternatively, discharge into fuel supply conduit **11**, but then excessive pressure in conduit **11** would be reflected in chamber **122**. Normally, the valve assembly **85** controls the pressure in the outlet system **26**, **88** and **109** of the fluid handling device, but when the valve assembly **85** is shut, that is, when valve washer **93** tightly engages valve seat **90** and, particularly, when the engine is stopped and not using fuel, the pressure in conduit **50**, passage **88** and chamber **109**, may become so excessive as to tend to force the float control needle valve in the carburetor open and flood the engine **1**. Should the pressure become this high, say, 15 to 20 pounds, as an example only, with the temperature responsive valve assembly **120** closed, the pressure applied through passage **121** will open the valve, permitting the excessive pressure to escape back to the tank **6** through the conduit **19**.

DISASSEMBLY AND REASSEMBLY

The fluid handling device of this invention is extremely simple to service in the field, and merely requires removing the offset portion **61** of the resilient bale **51** from the socket **62**, whereupon the bale will pivot out of the way, permitting the bowl **38** to be removed along with the ceramic filter element **43**. The magnetic filter element **75** may then be withdrawn manually by the fingers from socket **70**. The magnetic filter element **75** may be cleaned by wiping off the magnetized particles adhering thereto and removing any deposits. The ceramic filter element may be cleaned in a manner which is well understood in the art, or, preferably, it may be replaced. In reassembling the device during field service, the magnetic filter element **75** is lightly inserted into the socket **70**, and will be temporarily retained therein by the resiliency of the arms **78**. With the bowl **38** in an upright position, the spring **63** is inserted in the bowl socket **64**, and the ceramic filter element **43** is inserted into the bowl **48** with the top of the spring **63** received in the filter socket **65**. This assembly is then inserted into the filter body member **20** with the top of the outer wall of the bowl **38** engaging the vertical wall **68** in the body member **20**. The resilient bale **51** is then pivoted around the bowl **38**, and the eye **56** is again engaged in the slot **57**, completing the assembly. It should be noted that the bale has an offset portion **61** received in socket **62** in the bottom of the bowl to prevent accidental disengagment.

Should it be desired to completely disassemble the fluid handling device, it should preferably be removed from the engine, although the dissasembly may be effected while the device is installed on an engine. Following the routine for the field service disassembly, the bolts **107** are removed, and the diaphragm cover **106** may then be removed. The nut **94** retaining the valve washer **93** on the stem **91** is next removed, and to facilitate this operation, the head **102**, or the end of the threaded portion of the valve stem **91** may be provided with a slot or other means to receive a tool for holding the stem stationary. The valve washer **93** and spring **97** may then be removed, and the diaphragm and stem **91** may be withdrawn through the top of the body member **20**. Should disassembly to this extent be desirable, it would be desirable to replace the diaphragm **101** and the stem **91**, in which event, care would not have to be taken to protect the diaphragm when removing the nut **94**. The thermostatic element **124** and valve **128** may be removed after removal of the diaphragm by merely withdrawing the parts from the chamber **122**, being careful not to damage the face of the valve **128**.

The fluid handling device is reassembled by inserting the thermostatic element **124** into the chamber **122**, replacing the valve stem **91** through the cylindrical portion **86**, inserting the spring **97**, and then placing the valve washer **93** on the stem **91**, and tightening down the nut **94**. Care should be taken to align the holes in the diaphragm with the holes **135** in the body member **20**. The cover **106** is then replaced and clamped to the body member **20** by bolts **107**. The sealing washers **34** and **35** may be replaced, if desired, and the remainder of the fluid supply control is assembled a previously described.

Although this invention has been described with particular reference to certain embodiments, particular features, materials, and functional relationships, the disclosed embodiments are intended only to facilitate a clear and concise description. Various changes, and other embodiments and modifications, will be apparent to one skilled in the art, and the invention is, therefore, not to be limited to the particularly described embodiments, features, materials, or functional relationships, except as set forth in the appended claims.

We claim:

1. In a fuel system including, a regulated device having a body with inlet, and outlet connections, and a vent, said inlet and outlet connections adapted to receive con-

duits for delivery of fuel to said device, and from said device under pressure, said device comprising in combination; passages in said body interconnecting said inlet and said outlet connections, and, said outlet connection and said vent, filter means positioned in the passage interconnecting said inlet and outlet connections, a pressure responsive valve means normally closed against the pressure in the outlet connection to open and close said vent, said valve means including resilient temperature responsive means acting on said valve means for closing said vent at a predetermined pressure within a predetermined range of temperatures.

2. A fuel filter comprising a body structure formed with an inlet opening and an outlet opening and a fuel passage connecting said openings, a cup-like ceramic filter, means sealing the lip of said cup-like ceramic filter around the periphery of the inner surface of said fuel passage, a tubular conduit forming a portion of said fuel passage and having one end extending into and enclosed by said cup-like ceramic filter, a normally open valve mounted for movement into contact with said one tubular conduit end to close said fuel passage, means within said fuel passage responsive to a predetermined fuel pressure therein for moving said valve into a closed position, said body structure including a bleed outlet and bleed passage extending from said fuel passage between said valve and said outlet opening to said bleed outlet, and a normally closed valve means closing said bleed passage and responsive to fuel pressure within said outlet opening greater than said predetermined pressure to open said bleed passage, said valve means including a bypass valve and a bimetallic thermally responsive spring biasing said bypass valve into a bleed passage closing position and responsive to a predetermined ambient temperature to relieve said spring bias and permit opening of said bleed passage by fuel pressure.

3. A combined filter and regulator device for a fuel supply system comprising a body including a wall structure, a filter attached to said body at one side thereof, fuel inlet and outlet openings in said body, passage means in said body for the movement of fuel from said inlet through said filter and to said outlet, a hollow tubular boss in said body between said inlet and outlet openings and forming a portion of said passage, a chamber formed in said body between said tubular boss and said outlet opening, said chamber being axially aligned with said tubular boss and opening into said passage, a movable wall defining one side of said chamber, a valve seat on said hollow tubular boss, a valve operating on said valve seat, spring means for urging said valve off of said seat, means for operatively connecting said movable wall and said valve for urging said valve towards its seat when pressure in said passage increases to limit output pressure in said passage, a second chamber formed in the wall of said body having an outlet opening, a vent formed in the wall of said body connecting said first and second chambers, and a normally seated pressure responsive valve positioned in said second chamber controlling said vent to relieve excessive back pressure in said first chamber when said first-mentioned valve is closed.

4. The structure of claim 3 characterized in that thermostatic means are provided in said second chamber for influencing the pressure responsive valve controlling said vent.

5. In a fuel filtering assembly, a body member including a wall structure defining a first chamber, a filter member associated with said body member, an inlet opening for supplying fluid to said first chamber, a pressure relief valve for controlling the flow of fluid into said first chamber to maintain a predetermined pressure therein, a first outlet opening in said body member for delivering fluid from said first chamber, passage means through said chamber, body member and filter member connecting said inlet and outlet openings, a second chamber formed in the wall of said body member, a vent connecting said passage means with said second chamber, an outlet opening from said second chamber, a normally closed valve in said second chamber for closing said vent to prevent the flow of fluid from said passage means to said second chamber, and valve actuating means responsive to ambient temperature of said body member above a predetermined amount and a predetermined pressure of fluid in said passage means or combined influence of said temperature and said pressure to operate said valve actuating means to control the passage of fluid through said vent to said second chamber.

6. The structure of claim 5 characterized in that the second chamber formed in the wall of said body member opens outwardly through said wall and is closed by a removable cap.

7. The structure of claim 5 characterized in that the valve actuating means responsive to ambient temperature and predetermined fluid pressure comprises a U-shaped bi-metallic thermostatic element, one leg of which abuts the wall of said second chamber and the other leg of which mounts said normally closed valve.

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