

April 29, 1958

F. E. PILLING
LIQUEFIED PETROLEUM GAS HEAT EXCHANGER
AND PRESSURE REGULATOR

2,832,204

Filed Aug. 17, 1953

2 Sheets-Sheet 1

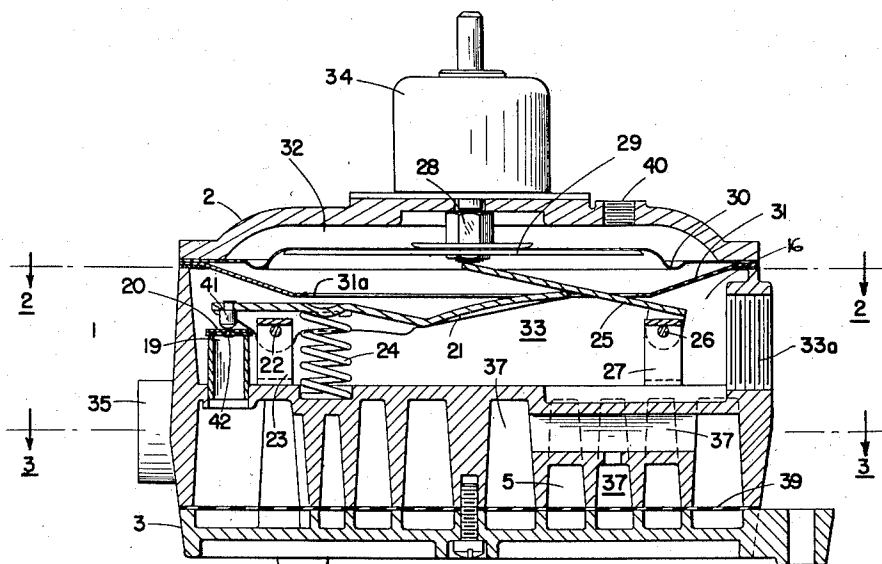


FIG. 1

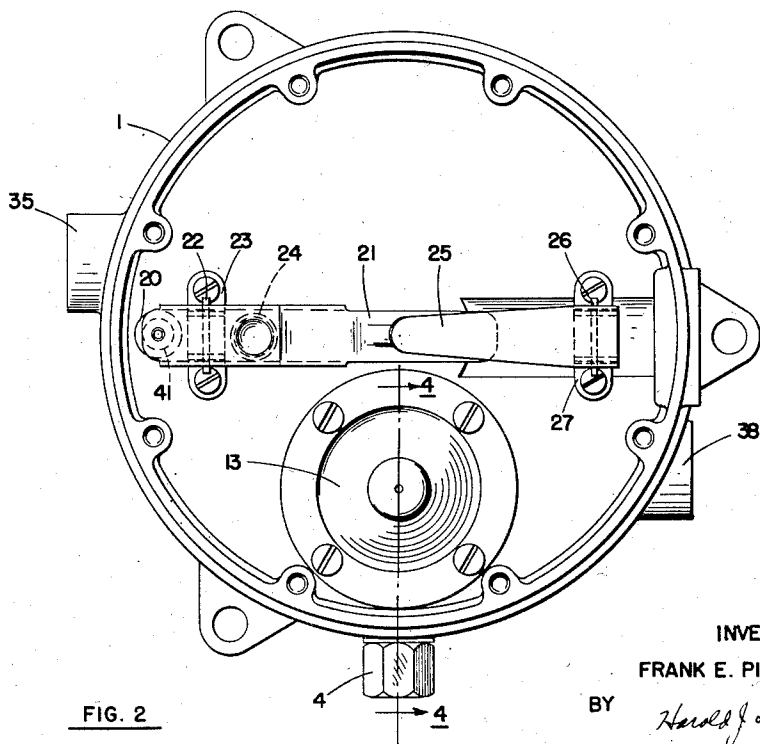


FIG. 2

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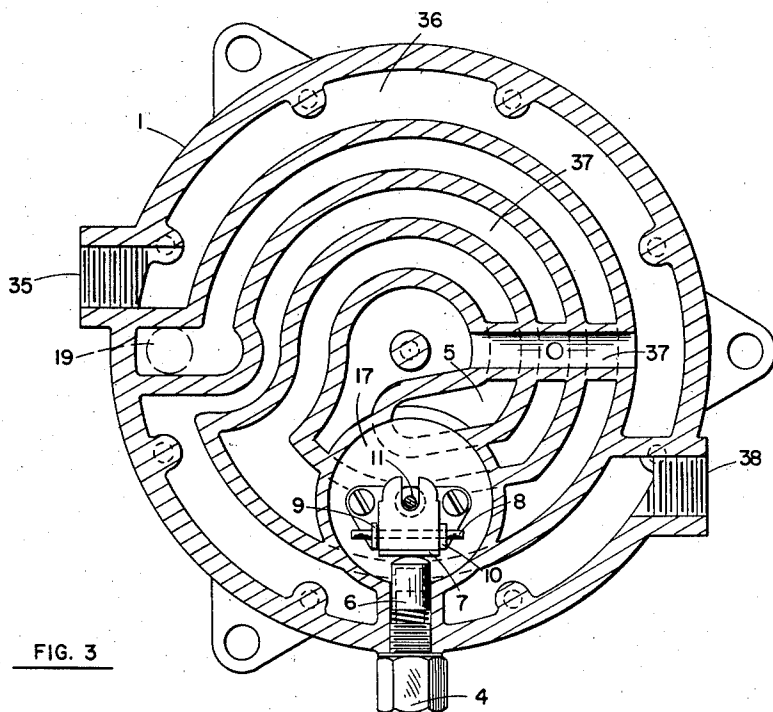


FIG. 3

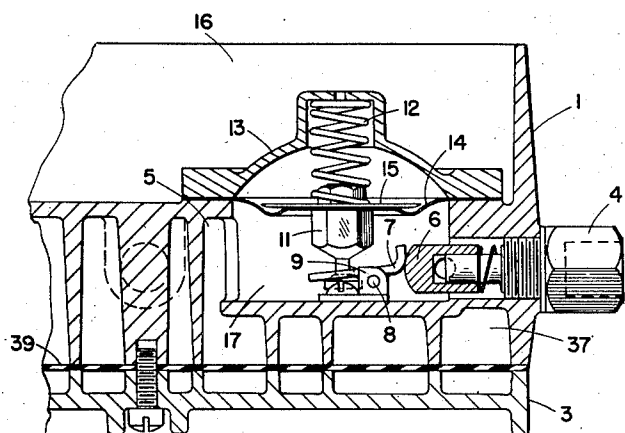


FIG. 4

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LIQUEFIED PETROLEUM GAS HEAT EXCHANGER AND PRESSURE REGULATOR

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4 Claims. (Cl. 62—1)

This invention relates to liquefied petroleum gas, internal combustion engines and particularly to a heat exchanger for use in connection with the carburetion of a liquefied petroleum gas.

Liquefied petroleum gas is normally carried in a closed tank on the vehicle, such as a bus or truck, which uses the liquefied petroleum gas as a fuel. Since the tank is closed and since the vapor pressure of the petroleum gas is normally higher than atmospheric at ordinary operating temperatures, the tank is pressurized and the liquid is fed through a conduit to a point near the engine where it is converted into a gas by vaporization and partial release of pressure. In order to convert the liquid into a vapor it is necessary to supply heat. This heat is normally obtained from the cooling system of the engine, by circulating the cooling water from the engine through a heat exchanger, one side of which is in the cooling water circuit. The temperature of the cooling water in an internal combustion engine, of course, may vary considerably due to changing load, speed and operating conditions. Similarly, the pressure in the liquefied petroleum gas storage tank may vary somewhat due to changes in temperature of the outside air. On the other hand the pressure at which the vaporized liquefied petroleum gas enters the carburetion system of the internal combustion engine, very greatly affects the operation of the engine.

It is therefore an object of this invention to provide an improved heat exchanger and pressure control system for converting liquefied petroleum gas into vaporized petroleum gas at an accurately controllable pressure.

It is another object of this invention to provide an improved liquefied petroleum gas heat exchanger.

It is another object of this invention to provide a liquefied petroleum gas heat exchanger which is not susceptible of damage due to freezing.

It is another object of this invention to provide a liquefied petroleum gas heat exchanger involving a two-stage step-down in operating pressure.

It is another object of this invention to provide a liquefied petroleum gas heat exchanger which is capable of operation over a wide range of tank pressures.

It is another object of this invention to provide a liquefied petroleum gas heat exchanger adapted to control the pressure of the vaporized liquefied petroleum gas in accordance with the requirements of the carburetor used in conjunction therewith.

It is another object of this invention to provide a liquefied petroleum gas heat exchanger which may be actuated remotely to supply additional quantities of liquefied petroleum gas in vaporized form to the carburetor with which it is associated at the time of starting the internal combustion engine.

It is another object of this invention to provide in a liquefied petroleum gas heat exchanger, means for preventing damage to the pressure regulator diaphragm associated therewith.

It is another object of this invention to provide a

combination heat exchanger and pressure regulator for the fuel system of a liquefied petroleum gas internal combustion engine.

It is another object of this invention to provide a two-stage pressure regulator in combination with a heat exchanger for use with liquefied petroleum gas.

Other objects of invention will become apparent from the following description taken in connection with the accompanying drawings in which:

Fig. 1 is a sectional view of the invention.

Fig. 2 is a sectional view of the invention taken at 2—2 in Fig. 1.

Fig. 3 is a sectional view of the device shown in Fig. 1 taken at 3—3 in Fig. 1, and

Fig. 4 is a sectional view of the invention taken at 4—4 in Fig. 2.

Referring to the drawings, the invention is comprised essentially of a cylindrical casing 1, having a cover portion 2, and a lower cover 3. Cylindrical casing 1, has incorporated integrally with it, a pair of spiral passages, one of which carries hot water and the other of which carries liquefied petroleum gas. Fuel flows into the device through inlet fitting 4 and is released into spiral passage 5, by means of valve 6, which in turn is actuated and restrained by lever 7, pivotable about shaft 8 in support members 9 and 10. Lever 7 is restrained by downward force applied by means of plunger 11 and spring 12, compressed in dome member 13. Diaphragm 14, supported by circular plate 15, also exerts a force upon plunger 11, which force is dependent upon the differential of pressure between chamber 16 and chamber 17.

From passage 5 fuel flows out orifice 19, if permitted to do so by valve 20, which is normally held in position to cover port 19 by lever 21 which in turn pivots about shaft 22 in bracket 23. Spring 24 normally urges lever 21 downward on its left end as viewed in Fig. 1 and upward on its right end as viewed in Fig. 1, to keep valve port 19 closed. Lever 21 is engaged in turn by lever 25, which in turn is pivoted about shaft 26 in bracket 27 secured to cylindrical member 1. The end of lever 25 is engaged by plunger 28, to which is attached circular plate 29 and diaphragm 30. Diaphragm 30 is of flexible material and circular plate 29, it will be noted, is somewhat larger in diameter than the central hole 31a in metallic plate 31 which serves as a stop for the plate should the plunger be forced downward an excessive amount by an unusual differential of pressure between chamber 32 and chamber 16. Plunger 28 extends through housing 34 which encases a conventional solenoid coil adapted to produce vertical forces upon the plunger to move plate 29 and the diaphragm in order to open valve port 19.

Hot water from the cooling system of the internal combustion engine with which this system is intended for use, enters the device through port 35 and thence travels through spiral passage 36, across conduit 37, and thence through spiral passage 37 to outlet port 38, where it is again returned to the internal combustion engines cooling system. It will be noted that the various spiral passages are arranged so that maximum heat flow occurs from the various passages containing water to the passages carrying the flow of liquefied petroleum gas. For example passage 36, which contains water, is outermost in the arrangement as shown. Passage 5 is surrounded both internally and externally at all points by passages containing and carrying a flow of water. It will be noted further that lower cover 3 is separated from cylindrical member 1, by a thin, flexible, water-tight diaphragm 39, which serves as a convenient means for sealing all the passages concerned and is effective in obviating damage to the device which might occur

due to exposure of the device to freezing temperatures while it contains water. If water freezes in passages 36 or 37 the only result is that flexible diaphragm 39 is stretched and no damage is done to the various walls of the passages containing water.

In equipment of this type, since the vaporization of the liquefied petroleum gas requires considerable heat, freezing of the water may occur even though the ambient temperature is above freezing, if there is a serious fuel leak in the system. In operation, water for causing vaporization of the liquefied petroleum gas is supplied through port 35 and as previously indicated this water circulates through passages 36 and 37 continuously and flows out through exit port 38. Meanwhile, fuel is admitted through valve 6, into chamber 17, which constitutes a high pressure, pressure regulator. In other words, the differential pressure between chamber 17 and chamber 16 controls the vertical movement of diaphragm 14 as biased by compression spring 12 and the force of gravity. Whenever the pressure in chamber 17 reaches a pressure which is a predetermined multiple of the pressure in chamber 16, valve 6 is closed until the pressure is again reduced. During normal flow conditions the liquefied petroleum gas flows out of chamber 17 into passage 5 and during its transit through chamber 5 it gradually vaporizes, absorbing heat from passages 36 and 37. From passage 5, the vaporized fraction of the liquefied petroleum gas passes upward through outlet valve port 19, if the valve is open. Flow of vaporized gas through port 19 is controlled by the difference of pressure between chamber 32 and chamber 33 and the action of spring 24, which normally holds the valve closed. Pressure for chamber 32 is supplied from the carburetor of the engine via port 40. Since this pressure comes from the air flow system of the carburetor, it is below atmospheric, especially when the opening of the throat of the carburetor is such that more fuel is required. In this case diaphragm 30 is drawn upward, as are levers 21 and 25, this would tend to close valve port 19 but for the fact that chamber 33 communicates with the intake manifold of the engine through outlet port 33a and the carburetor and hence is subject to actual manifold vacuum of the automobile. Accordingly, the vacuum in chamber 33 is always somewhat in excess of the vacuum in chamber 32 and valve port 19 is normally open. By the time the liquefied petroleum gas reaches chamber 33 it is entirely vaporized and is in condition to be fed to the engine carburetor.

The compound lever system comprised of levers 21 and 25 provides a very great mechanical advantage in a minimum of space to allow a slight differential pressure on the diaphragm to control effectively and efficiently the opening of the valve.

It will be noted that cover 20 is secured to lever 21 by the combination of a rounded cylindrical member 41 and a simple pin 42 in order that the cover will engage the end of valve port 19 squarely, despite the fact that lever 21 rotates about pin 22. The valve thus seats properly and functions satisfactorily despite an extremely simple construction.

Upon starting the internal combustion engine, it may be necessary or advisable to open port 19. Additionally, during starting, instead of the engine having to pump out

the air in the system, it may be flooded out by use of plunger 28. Plunger 28 is actuated to open the valve. This actuation may be accomplished manually by depressing the plunger or may be accomplished electrically by means of the solenoid contained in casing 34.

Although the invention has been described and illustrated in detail the same is to be understood to be by way of illustration and example only, the spirit and scope of the invention being limited only by the terms of the appended claims:

I claim:

1. A liquefied petroleum gas heat exchanger for converting liquefied petroleum gas into vaporized petroleum gas comprising a source of liquefied petroleum gas, a generally spiral shaped duct, a first inlet valve for permitting flow of said liquefied petroleum into said duct, a second generally spiral shaped duct shaped to match said first duct and arranged contiguous thereto, means for circulating heated water in said second duct, a closed chamber having an outlet port, means responsive to pressure in said chamber for actuating said first inlet valve, a second inlet valve communicating said first duct with said chamber and pressure responsive means for controlling said second inlet valve to thereby vaporize said liquefied petroleum gas and control the pressure of said gas as it leaves said chamber through said outlet port.

2. A device as recited in claim 1 in which said first inlet valve actuating means comprises a diaphragm communicating on one side with said chamber and on the other with said first duct a spring biasing said diaphragm against the pressure in said duct and mechanical linkage means connected to be actuated by said diaphragm for actuating said first inlet valve to thereby actuate said valve.

3. A liquefied petroleum gas heat exchanger for converting liquefied petroleum gas into vaporized petroleum gas comprising a source of liquefied petroleum gas, a closed chamber having an outlet port, a first generally spiral shaped duct, a pressure regulator for permitting flow of said liquefied petroleum gas into said duct at a predetermined differential in pressure existing between said duct and said chamber, a second spiral duct shaped to match said first duct and arranged contiguous thereto in the same plane, means for circulating heated water in said second duct, a second pressure regulator communicating said first duct with said chamber, said second pressure regulator being spring biased whereby the pressure in said chamber is less than the pressure in said first duct.

4. In a liquefied petroleum gas pressure regulator having adjacent co-planar heat exchange ducts providing counter-current flow of gas and hot water, a chamber having passages matching said ducts in a plane parallel and adjacent to said ducts and a flexible diaphragm separating said ducts from said chamber to prevent damage to said ducts in the event water freezes therein.

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