May 6, 1941. R. E. HANSON 2,240,846

FEEDER FOR PRESSURE-LIQUEFIED FUELS

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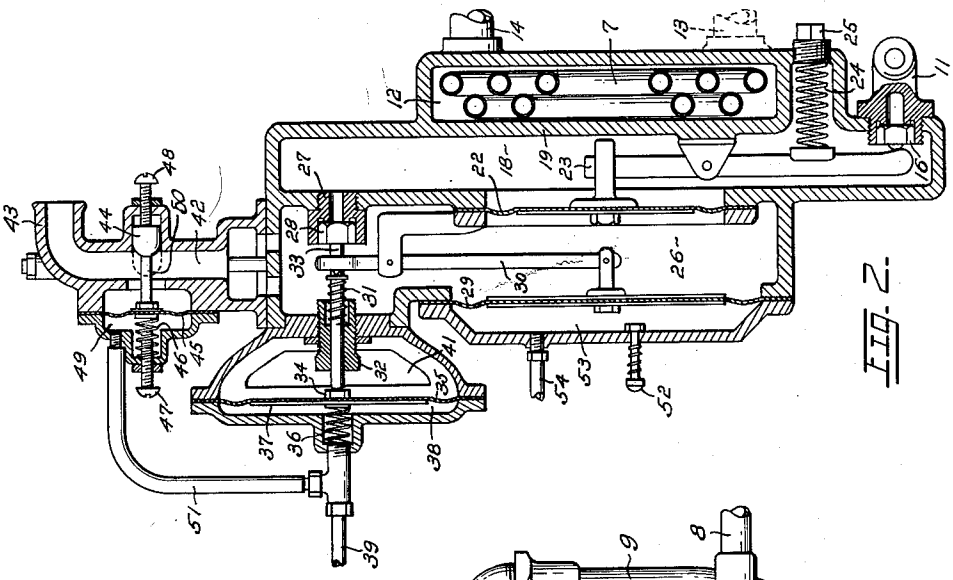


FIG. 2.

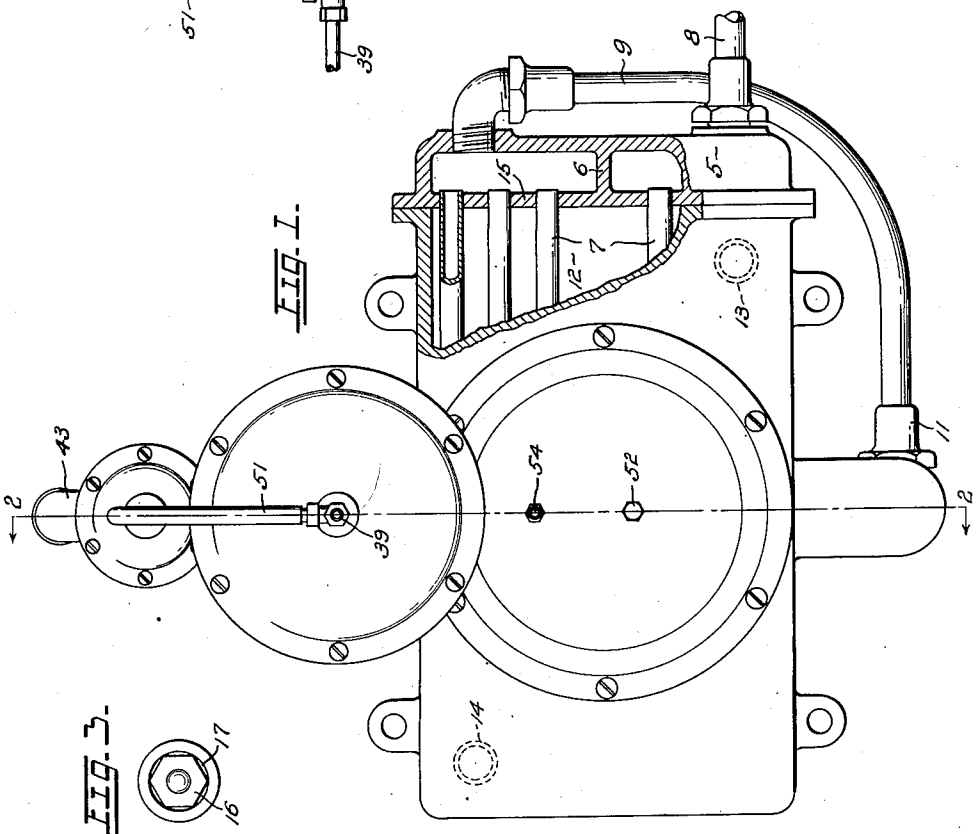


FIG. 1.



FIG. 3.

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## FEEDER FOR PRESSURE-LIQUEFIED FUELS

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3 Claims. (Cl. 137—153)

My invention relates generally to feeders for pressure-liquefied fuels, and particularly to those which are adapted for utilizing pressure-liquefied petroleum gases, such as butane. The principal objects of the invention include; first, provision of an improved device for treating and feeding pressure-liquefied fuels to consuming devices, which may be ordinary gasoline carburetors; second to supply a device of this kind which includes a positive fuel lock-off, adapted to function whenever the fuel demand ceases; third, to secure these results without loss of ability for immediately starting operation; and, fourth, to accomplish all of these things in a simple, efficient, and relatively inexpensive construction.

Petroleum gases of the kind for which my invention is particularly adapted, ordinarily are kept and dispensed in liquid form under considerable pressure. To make them available as fuels for internal combustion engines, it is necessary; to reduce their pressures to that of the atmosphere or less; and to vaporize them during this pressure reduction. These procedures necessarily produce strong refrigerating tendencies, and the chief difficulties have been; to adequately control the reduction of pressure; and to prevent "freezing" of various adjacent parts, as a result of the vaporization and expansion.

I have found that it is preferable to expand vaporized fuels of this kind in two stages; the initial pressure in the supply tank ordinarily being too great, and far too variable, for satisfactory single stage expansion. The two-stage method allows of starting the final expansion from a relatively constant and moderate intermediate pressure and temperature, and better regulation thus is attainable. During expansion by any method, it ordinarily is necessary to offset the refrigerating effects.

The objects of my invention have been attained by construction conforming to the principles just outlined. As illustrated in the accompanying drawing:

Figure 1 is a face view of my invention, with certain parts broken away to show the internal construction;

Figure 2 is a cross-section of said device, taken on the plane 2—2 of Fig. 1; and

Figure 3 is a face view of the inlet valve of the device, by itself, and drawn to a larger scale than the other figures.

Similar reference numerals refer to similar parts, throughout the several views.

My invention may be used with any device which is adapted for using gaseous fuel, and which is provided with means for creating a partial vacuum in accordance with its fuel demand. Hence it is feasible to employ it with the Venturi-tubes of ordinary gasoline carburetors. The embodiment illustrated, comprises; a primary heat exchanger, a high-pressure regulator, a secondary heat exchanger, a low-pressure regulator, fuel lock-off means, and a fuel metering device or "economizer." All of these are combined in a single self-contained unit, occupying little space and requiring no attention for long periods of time.

As here illustrated, the primary heat exchanger is of the removable multi-tube type. The part 5 (Fig. 1) is a two-compartment header; in which the compartments are separated by a partition 6, and are in communication with each other only through a plurality of U-tubes like that designated 7. The lower compartment of the header may be connected to a supply tank of pressure-liquefied fuel (not shown), through an inlet tube 8. The outlet tube 9 leads to fitting 11, and thence to the first stage expansion chamber of the device.

The nest of U-tubes is contained within a chamber 12, which normally is closed by header 5. This chamber may be filled with hot water, as from the radiator of a gas engine, constantly circulated therethrough, the water inlet being indicated at 13, and the water outlet at 14. Pressure-liquefied fuel, entering this thermal vaporizer through tube 8 is, at least partially, vaporized in the U-tubes into a high pressure gas, by absorption of heat from the surrounding hot water. The refrigerating effect of the transformation from liquid to gas is overcome by this absorption of heat, and the gas may be of the same temperature as, or even higher than, the temperature of the incoming liquid fuel. If, by reason of a too rapid flow of fuel, or because the water in chamber 12 is not hot enough, any of the incoming liquid fuel should fail to be vaporized in the U-tubes, it will be trapped in the upper compartment of header 5, and there become vaporized by further absorption of heat through wall 15 of the header. Thus the fuel leaving through outlet tube 9 ordinarily will be wholly gasified, and at a temperature that is well above the dew point.

The inlet valve of the first-stage expansion chamber comprises a floating unattached valve element 16 (Figs. 2 and 3). This may be formed out of a short length of hexagonal bar; and it is contained within, and is guided by, a cylindrical

bore 17 at the inner end of fitting 11 (Fig. 3). When the valve is open, the incoming fuel flows past the hexagonal sides of floating element 16.

The function of the first-stage regulating apparatus of my device, is to reduce the pressure of the incoming fuel to considerably less, and a substantially constant, pre-determined pressure. This reduction may be anything desired between, say, six to fifteen pounds per sq. in. guage. The reduction of pressure tends to cause a corresponding loss of temperature, and this would happen were it not for the fact that first-stage expansion chamber 18 is located directly behind hot water chamber 12, with a common wall therebetween. Thus the expanded gas will absorb heat through wall 19 as it passes upwardly alongside thereof, and the refrigerating effect at this point may be overcome. If any unvaporized fuel should enter chamber 18 through inlet valve 16, it will collect in the pocket at the bottom of this chamber, and later become vaporized as it passes up alongside of wall 19.

The pressure within chamber 18, acting upon first-stage pressure control diaphragm 22 in a wall thereof, which in turn controls the movement of an intermediately pivoted lever 23, tends to keep valve element 16 against its seat. Compression spring 24, however, tends to move lever 23 oppositely, to allow the valve element to open. The working strength of spring 24 is adjustable by means of the screw-plug 25, and it will be apparent that the described arrangement provides means for maintaining a substantially constant gas pressure within first-stage expansion chamber 18, determined in amount by the working strength of spring 24.

Gas from chamber 18 passes, as required, to the second-stage expansion chamber 26; through the bore of valve housing 27, and past the hexagonal faces of a second valve 28. The latter valve normally is operatively positioned; by a diaphragm 29 in the wall of the second-stage expansion chamber, by an intermediately pivoted lever 30, and by a compression spring 31, all of them functioning cooperatively. The working strength of this spring may be adjusted by means of screw plug 32.

Valve 28 is provided with a stem 33, which extends through plug 32. The left hand end of the stem bears against a central nut 34 on a lock-off diaphragm 35; and a compression spring 36 bears against a plate 37 on the opposite side of the last said diaphragm. This spring 36 keeps valve 28 closed when there is no fuel demand.

Chamber 38, at the left hand side of the lock-off diaphragm 35, may be connected to the intake of a fuel-gas consumer, as an associated gas engine, above the throttle, by means of a tube 39. When the engine is running, a partial vacuum will be created in its manifold, and diaphragm 35 will deflect to the left, against the compression of spring 36. This action, by relieving the opposing force, permits valve 28 to open, and allow gas to pass into chamber 26. The position of screw-plug 32 will determine the amount of gas that can be passed in this way, and thus provide a means for regulating the idling speed of a co-operating fuel consuming device. This adjustment may be made conveniently, through an opening 41 in the supporting housing.

Low-pressure gas chamber 26 may be connected to a fuel consuming device, as the throat of the Venturi tube of an associated carburetor, in advance of the engine throttle, through a passage 42 and nipple 43 (Fig. 2). It is desirable to have means for varying the flow resistance in passage 42, in order to additionally regulate the flow of fuel, according to the demand. For this purpose I have shown a movable plug at 44, adapted to variably obstruct passage 42. The position of this plug is controlled by a so-called economizer diaphragm 45 (to which the plug is connected by means of its integral stem 50), and its co-operating compression spring 46. The working strength of this spring is designed to change the position of plug 44 from a "lean mixture" setting to a "rich mixture" setting at a predetermined change of vacuum in chamber 49, the plug being positioned for these two settings by screw stops 47 and 48.

Chamber 49, back of economizer diaphragm 45 (Fig. 2), may be connected to the intake of a fuel consuming device, through tubes 51 and 39. When the fuel consumer is under load, the vacuum in its intake decreases. This permits spring 46 to move plug 44 to the right, to further open passage 42 and automatically allow more fuel to pass to the fuel consumer. Hence, by making proper adjustment of screws 47 and 48, it is possible to limit the richness of fuel mixtures going to the consumer. This is to say, a definite lean mixture for light loads and maximum economy, and a definite rich mixture for heavy loads and maximum power, is obtained.

I have illustrated a simple form of priming device at 52, whereby low-pressure diaphragm 29 may be moved to the right to open valve 28. This may be quite useful at times, for quick starting, particularly when associated heavy duty engines are employed.

The strength of spring 36 (Fig. 2) is quite sufficient to insure holding valve 28 against its seat, to thus completely shut off gas to low-pressure chamber 26 when there is no fuel demand. The arrangement therefore affords an effective automatic lock-off, and prevents "flooding" in case fuel might be admitted by valve 16 before there is a demand for it.

It will be noted that, when fuel is drawn through my device by the demand of associated fuel consuming apparatus, the movements of diaphragms 22 and 29, to open their respective valves, will occur almost simultaneously, and in the same direction. This is to say, a drop of pressure in chamber 26 will cause diaphragm 29 to deflect to the right, and valve 28 will be opened by such deflection. This will immediately result in a drop of pressure in chamber 18, and cause diaphragm 22 to deflect to the right to open valve 16. This functioning lends sensitivity to the device, and permits it to respond very rapidly to changes in the rate of fuel demand.

It is a well known fact that the pressure of the atmosphere under a motor hood is materially increased when the vehicle is traveling at high speed. If diaphragm chamber 53 of my device, at the side of low-pressure diaphragm 29, is placed in direct communication with the atmosphere under a motor hood, the diaphragm will deflect inwardly at high traveling speeds, and cause valve 28 to open wider than it should. This would make the fuel mixture too rich for the conditons. Another possible cause of too rich a mixture might be the use of an oil-bath on the air intake. Such devices may impart a variable flow resistance to air entering the Venturi tube of an associated carburetor. If the air flow resistance should be increased in this

way, the vacuum in the venturi would be correspondingly too high. Then, by reason of its action through tube **39** on diaphragm **35**, it would tend to further open valve **28**. The fuel mixture would be too rich under such conditions.

In order to offset these two possible causes of over-rich mixture, chamber **53** at the side of low-pressure diaphragm **29**, instead of being made open to the atmosphere surrounding it, may be connected to the air inlet of the venturi, through a connection **54**. Thus the effect of atmospheric pressure changes upon the diaphragm when caused in either of the ways just discussed, will be completely cancelled; for the reason that these changes of pressure act simultaneously on both sides of diaphragm **29**, through passage **42** and connection **54**.

In the use of my device upon vehicular motors, only three running adjustments ever are required. One of these, effected by means of screw plug **32**, regulates the idling speed of the associated engine. The other two adjustments, effected by means of screws **47** and **48**, adapt the device for service with engines of different sizes, and for various conditions of speed and load.

I desire to emphasize the fact that butane, and similar pressure-liquefied hydro-carbon gases, are very cheap and economical for the operation of internal combustion engines; and that they have higher anti-knock values than even ethyl, by reason of their relatively slow rates of combustion. Moreover such fuels may be burned completely and, even if they should not be, they do not deposit carbon. Still further, the use of such gases for fuel reduces the necessary frequency of changing lubricating oils in engine crank cases; since the oils do not become contaminated with carbon deposits. The use of my invention makes it easily possible to secure all of these advantages; and, consequently, it is especially adapted for use with vehicular motors.

I claim:

1. In a device of the character described, a fuel lock-off comprising; a fuel valve; a spring adapted for exerting a force tending to close the valve; a flexible diaphragm operable by a partial vacuum, whereby said force may be overcome sufficiently to permit the valve to open fully without opposition by the spring; and means, independent of said spring and said diaphragm, for controlling the valve after it has opened; the valve being unattached to either said spring or said diaphragm.

2. In a device of the character described, a fuel lock-off comprising; a fuel valve; a spring adapted for exerting a force tending to close the valve; a diaphragm adapted, by deflecting, to overcome said force sufficiently to permit the valve to open fully without opposition by the spring; means independent of said spring and which include a second diaphragm, for controlling the valve after it has opened; and means whereby the first said diaphragm may be subjected to differential deflecting pressure for the purpose stated; the valve being unattached to either said spring or the first said diaphragm.

3. In a device of the character described having a chamber for expanding gaseous fuel, a fuel lock-off comprising; a valve adapted for admitting such fuel into said chamber; a spring adapted for exerting a force tending to close the valve; differential pressure means whereby said force may be overcome sufficiently to permit the valve to open fully without opposition by the spring; and means for freely controlling the valve by gas pressure after it has opened; the valve being unattached to either said spring or said differential pressure means; and said spring being adapted to close the valve against opposing pressure of the incoming fuel and all opposing forces inherent in the structure.

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