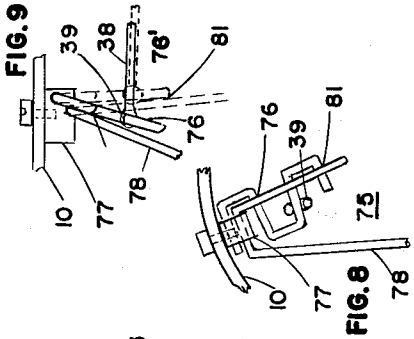
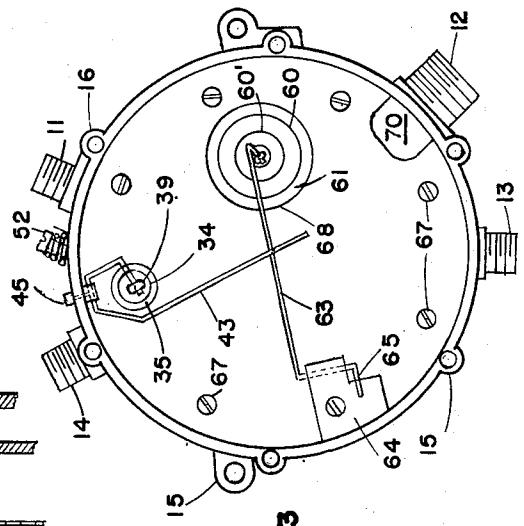
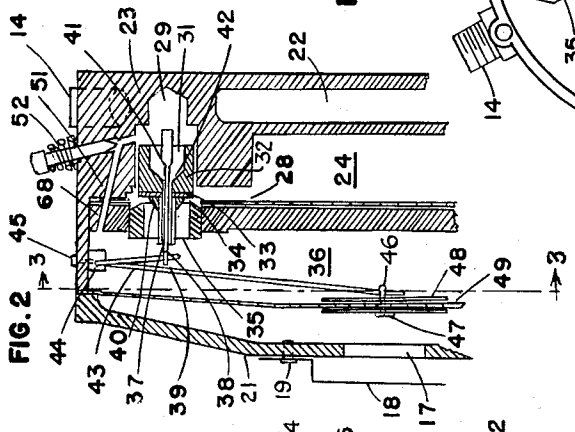
Dec. 8, 1953 C. W. HART 2,661,601

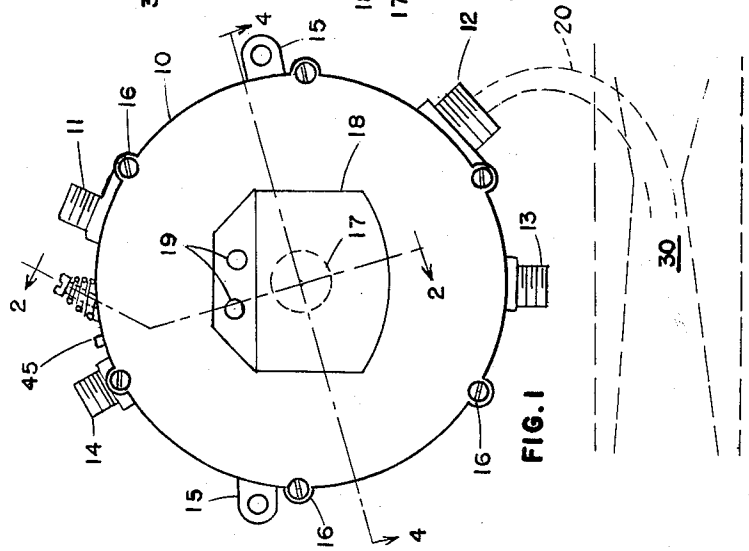
GAS REGULATOR

Filed Aug. 14, 1950 2 Sheets-Sheet 1









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GAS REGULATOR

Filed Aug. 14, 1950 2 Sheets-Sheet 2

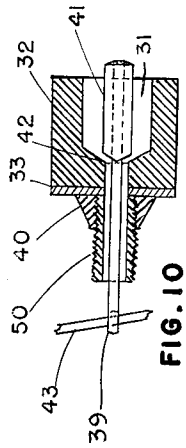


FIG. 10

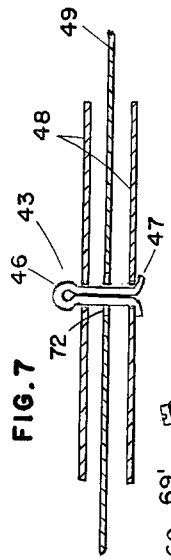


FIG. 7

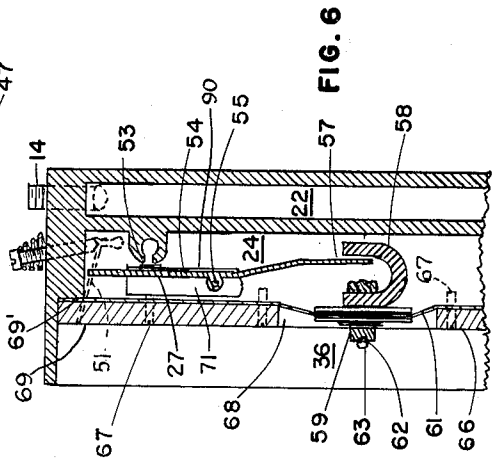


FIG. 6

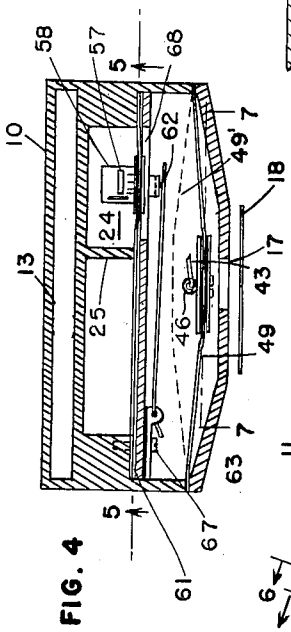


FIG. 4

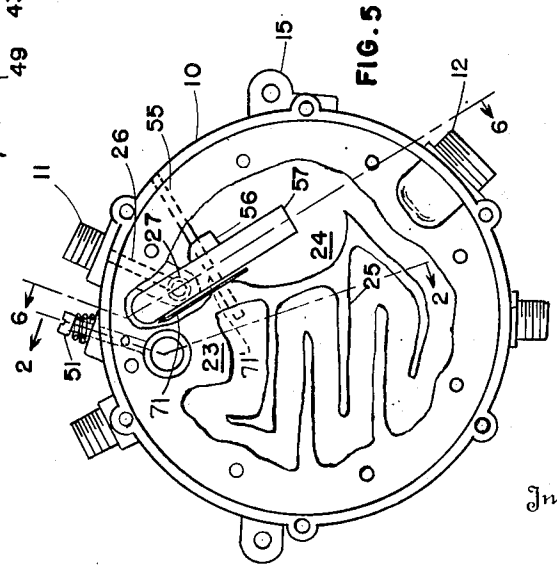


FIG. 5

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GAS REGULATOR

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Application August 14, 1950, Serial No. 179,215

5 Claims. (Cl. 62—1)

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The present invention relates generally to gas regulators and specifically to a regulator for use with compressed gaseous fuels for internal combustion engines.

In using gaseous fuels such as butane or propane in internal combustion engines, particularly vehicular engines, the fuel is contained under relatively high pressure in tanks and due to its low boiling point it is necessary to reduce the pressure of the fuel to a lower pressure consistent with the engine requirements. As the fuel expands from high pressure to low pressure, from a liquid to gas, it takes up quantities of heat, thus it is necessary to apply heat to the gas in order that it be expanded to the low pressure desired.

The principal object of this invention is to provide a regulator for expanding gaseous fuel from a high pressure to a low pressure for use in an internal combustion engine.

Another object of the invention is to provide a gas regulator which maintains the same ratio of gas to air at all altitudes.

A further object is to provide a gas regulator which heats the expanding gas to the desired temperature for optimum performance.

A still further object of the invention is to provide a regulator having a minimum of parts of non-varying characteristics.

Another object is to provide a gas regulator which is not dependent upon variable springs and weights.

A further object is to provide a regulator having linear sensitivity characteristics and having a range of sensitive operation for use with engines of widely varying horsepower.

A still further object is to provide a regulator of extreme sensitivity at low volume operation and one having the low pressure side at less than atmospheric pressure with a provision for stopping the total flow of gas when the engine is stopped, and one of a minimum number of parts, inexpensively constructed, easily assembled and capable of easy adjustment.

These and other objects of the invention will be readily discernable by reference to the accompanying drawings which illustrate preferred embodiments of the invention, and in which

Fig. 1 is a plan view in elevation of the invention with a schematic view of an associated carbureter venturi.

Fig. 2 is a partial view in section taken on line 2—2 of Fig. 1.

Fig. 3 is a view in section taken on line 3—3 of Fig. 2.

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Fig. 4 is a vertical view in section taken on line 4—4 of Fig. 1.

Fig. 5 is a view taken on line 5—5 of Fig. 4.

Fig. 6 is a partial side view in section slightly enlarged taken on line 6—6 of Fig. 5.

Fig. 7 is an enlarged and expanded view in section of the diaphragm and washers taken on line 7—7 of Fig. 4.

Fig. 8 is a detail view greatly enlarged of a second embodiment of the lever shown in Fig. 3.

Fig. 9 is a side view of the embodiment shown in Fig. 8, and

Fig. 10 is a view partly in section of the piston and pilot valve shown in Fig. 2.

Referring to the drawing in which like numerals indicate like parts throughout the several views, in Fig. 1, the regulator is seen to be a cylindrical case 10 having fuel inlet 11, fuel outlet 12, hot water inlet 13, cold water outlet 14. Mounting lugs 15 on the sides of case 10 permit securing the regulator to an engine in upright position and bolts 16 hold in gas tight condition the many sections and diaphragms of the regulator to be seen in the following views.

An atmospheric port 17, shown in dotted line in Fig. 1, is shielded from blown air from an engine's cooling fan or dirt and dust in impact air by port baffle 18 fixed by rivets 19 to cover 21.

Conduit 20 conducts fuel to the carbureter venturi 30 (here shown in schematic form) from fuel outlet 12.

In Fig. 2, the cold water outlet 14 is shown connecting with heat exchanger chamber 22 behind (in this view) block portion 23 of the case 10.

Referring momentarily to Figs. 5 and 6, it will be seen that case 10 has an intermediate pressure chamber 24 of a particular and serpentine shape formed by the convoluted walls 25, and is connected by passage 26 and valve 27 to fuel inlet 11.

Returning to Fig. 2, a passage 28 over a portion of block 23 connects chamber 24 with a low pressure valve cylindrical recess 29 and counterbore 31 cut in the rear portion of piston 32 which is movable within recess 29. Piston 32 has a valve face 33 of a resilient material such as a neoprene washer coacting with valve seat 34 to close a passage 35 which connects intermediate pressure chamber 24 with a low pressure chamber 36. Piston 32, also seen in Fig. 10, has a threaded stem 50 on which is threaded a conical valve head 40, holding the valve face 33 in proper position. Stem 50 and piston 32 have passage 37 therethrough in which is freely movable pilot valve connecting rod 38 having a loop 39 at one

end and at the other a conical pilot valve 41 seating on pilot valve seat 42 formed at the end of the counterbore 31. Pilot valve 41 is of cylindrical shape and is soldered to the connecting rod 38 as seen in Fig. 10 or may be fixed thereon in any suitable manner.

As is readily seen in Figs. 2 and 3, a spring steel wire rod 43 loosely traverses loop 39 and is fulcrumed in hole 44 in the stud 45 fixed in the side of case 10. The other end of rod 43 similarly traverses the swivel eye 46 in the diaphragm retaining pin 47 which holds washers 48 on either side of diaphragm 49 (Fig. 7) which forms one wall of the low pressure chamber 36. Cover 21 protects the diaphragm 49 from dirt and impairment of movement, and diaphragm 49 is movable between the washers 48 by reason of the slightly larger hole 72 (seen in Fig. 7) so that it is readily conformable to any stretching or wear. A bypass 51 controlled by needle valve adjusting screw 52 connects chamber 36 with recess 29 and port 70 connects chamber 36 with the fuel outlet 12.

In Figs. 4 to 6, valve 27 is seen to consist of a resilient wafer 53 of neoprene or other suitable material which controls passage 26, and is secured to the valve lever arm 54 which is fulcrumed on pin 55 traversing case 10, bracket 56 and wall 25. The end 57 of arm 54 (opposite the end having plug 53) is loosely movable within a U-shaped hook 58 secured by bolt 59 and washers 60 to a second diaphragm 61. Bolt 59 is grooved as at 62 to receive one end of a second spring steel rod 63 pinioned in block 64 (Fig. 3) and midway of its length is intersected by rod 43 approximatly adjacent the swivel eye 46 under one condition of movement of the diaphragm 49 as shown by dotted line 49' in Fig. 4. Rod 63 has a bent portion 65 to limit its motion in the direction of diaphragm 49, and a friction plate 71 which is a flat spring of brass or the like having a slight curve and shown in Figs. 5 and 6 in edge view and front view, respectively, and bears at one end upon the edge of valve lever arm 54 to reduce flutter of the valve 27 due to the characteristics of the wafer 53 and permitted by the lost motion connection of the valve lever arm end 57 in hook 58. The friction plate 71 is held in place bearing against the side of valve 27 with light pressure by having hole 71' through which pin 55 traverses, and as seen at 90 in Fig. 6, is slightly wider than the path of movement of valve 27 so that it exerts anti-flutter pressure in both open and closed positions.

Diaphragm 61 extends the full inside diameter of case 10 and is sealed by dividing wall 66 held in place in the frame of case 10 by screws 67. A port 68 in wall 66 permits limited movement of diaphragm 61 in the conventional manner. Wall 66 and diaphragm 61 have holes 69, 69a, respectively coinciding with the bypass 51.

Figs. 8 and 9 show the multiple leverage embodiment 75 to replace the leverage action of rod 43 acting with pilot valve connecting rod 38. In this embodiment, an intermediate lever arm 76 traverses loop 39 and contacts rod 78 at point 81, as shown in dotted lines in Fig. 9, gaining leverage to open the pilot valve 41, rod 78 being associated with diaphragm 49 in the same manner as rod 43. Pilot valve 41 moves from seat 42 only a few thousandths of an inch under most conditions and closes readily with any increase of pressure in recess 29 over the pressure in chamber 36.

In operation, pressurized fuel is admitted to fuel inlet 11, forces open valve 27 and fills chamber 24, slowly entering recess 29 by the close tolerance of piston 32 therein and moves piston 32 forward to seat valve face 33 on seat 34, conical pilot valve 41 also seating on pilot valve seat 42. Gaseous pressure builds up in chamber 24 until diaphragm 61 moves, tipping valve lever arm 54 by reason of hook 58 and closing valve 27. Now, with any dropping of pressure in chamber 36 or condition of partial vacuum such as due to suction of the carbureter venturi 30 as the engine is cranked, diaphragm 49 moves toward the wall 66 and rod 43 (or 78) moves the pilot valve connecting rod 38, lifting pilot valve 41 from seat 42, releasing pressure behind piston 32 and allowing the flow of gas to chamber 36. Piston valve face 33 being larger than valve face 34, when pressure in chamber 24 exceeds the pressure in recess 29 behind the piston 32, piston 32 will move into the recess farther and passage 35 will open, allowing gas to flow from chamber 24 to chamber 36 and thence to the engine. As pressure rises in chamber 36, diaphragm 49 moves away from wall 66, seating pilot valve 41 and, allowing pressure to build up again in recess 29, partially seating valve face 33 until pressure in chamber 36 reaches a balanced condition with the suction of the venturi 30. If pressure in chamber 36 exceeds the demand in the venturi, the diaphragm 49 will act to stop the fuel flow and if the demand is greater, the reverse will occur and more fuel will be allowed to flow from chamber 24 to chamber 36. Under conditions of heavy load or sudden acceleration, the drop in pressure in chamber 36 will move the diaphragm 49 until rod 43 contacts rod 63, moving diaphragm 61, hook 58, and valve lever arm 54 to open valve 27, thus supplying more fuel until pressure becomes constant in chamber 36.

Due to the construction of the pilot valve and piston as described, all of the lost motion of the connection is in one direction with the result that when valve face 33 starts to move off valve seat 34, the fuel flow impinging on the conical head 40 moves the piston 32 relatively fast and valve face 33 and valve seat 34 are momentarily over-opened until action of the diaphragm 49 reverses it. This causes the regulator to provide adequate acceleration action necessary for use with vehicular engines and is one of the distinct advantages of the invention over regulators commonly in use. Smooth acceleration and a rapid response to fuel flow result from construction of the regulator as here described and illustrated. The port 17 in the cover 21 permits the chamber 36 to be balanced by atmospheric pressure and therefore the regulator is self-compensating for changes in ambient pressure, and a normal fuel flow is maintained in the venturi at any altitude of operation.

The cross-sectional area of clearance between the piston 32 and the walls of recess 29 must be less than the cross-sectional area of passage 37 in the stem 50, taking into account, of course, the cross-sectional area of the connecting rod 38 in order that the pressure in recess 29 behind the piston 32 may be made less than the pressure in chamber 24, with the latter pressure then acting on the over-lap of valve face 33. The by-pass 51, adjustable by needle valve 52, permits a slight reduction in pressure in recess 29 if desired and as a result, less pressure in chamber 24 lifts the valve face 33 and a greater degree of sensitivity is obtained. For all normal operation and most engines, needle valve 52 is closed; fractional

horsepower engines having been found to require a greater sensitivity than larger engines.

As is readily understood, the regulator is supplied with hot water from the radiator of an internal combustion engine when used in a vehicle, and the regulator may be pre-heated before use in any conventional manner such as an electrical heating element or other means not here shown as not a part of the invention.

Further, the invention contemplates the use of a valve in the fuel line leading to fuel inlet 11, and may be of the solenoid type in circuit with the engine's ignition system, and the dimensions of diaphragm 61 and passage 26 relative to the gaseous fuel pressure at the inlet 11 are to be made such that valve 27 closes upon balancing of pressure in chamber 24 with the inlet pressure.

Among the advantages claimed for the invention are: the spring steel rod connection between the diaphragm 49 and the pilot valve 41 which absorbs shock on the diaphragm at any sudden opening of the throttle of the engine and assures long life for the diaphragm. Another advantage is the opening of valve 27 by the coaction of the spring steel rods 43 and 63 during conditions of acceleration, assuring the same long life to diaphragm 61, as well as providing smooth conditions of acceleration and operation under heavy loads.

A further advantage is that the fuel flow from chamber 24 to chamber 36 is governed by a valve which is changed from a pressure-closing valve to a pressure-opening valve in response to the operation of an associated pilot valve.

Finally, the regulator of the present invention has no weights or spring-loaded valves to inhibit the free action of the controlling diaphragm, and therefore there are no parts with variable or non-linear characteristics to affect the constant operation and optimum performance of the regulator.

It should be understood, of course, that the foregoing disclosure relates only to preferred embodiments of the invention and that numerous modifications and alterations may be made therein without departing from the spirit and scope of the invention as set forth in the appended claims.

What is claimed is:

1. In a gas regulator for use in the fuel induction system of an internal combustion engine, said regulator having a first chamber connected by conduit to a source of pressurized gaseous fuel and a second chamber adapted to be connected to a venturi in the engine's intake, the combination of a main valve in the inlet to said first chamber, a diaphragm between said first and second chambers, means connecting said diaphragm to said main valve operable to open said valve upon a decrease of pressure in said first chamber, a port between said first and second chambers, a recess in the wall of said first chamber opposite said port, a piston reciprocal in said recess having a valve face operable to close said port, restricted conduit means between said first chamber and said recess, a second diaphragm in said second chamber responsive to the difference between pressure therein and atmospheric pressure, a passage in said piston, a pilot valve in said recess having its stem extending through said passage and operably connected to said second diaphragm to open said passage upon a reduction of pressure in said second chamber, and means connecting said first diaphragm to said second diaphragm at positions of extreme movement of the latter whereby upon a sudden or extreme reduction of pressure in said second chamber said main valve is opened coincidentally with the movement of said pilot valve to open said passage and the movement of said piston to open said port as in normal operation on reduction of pressure in said second chamber, said piston and pilot valve closing said port and said passage respectively upon equalization of pressure in said recess and said first chamber.

2. The device as set forth in claim 1 together with a lost motion connection in the means connecting said first diaphragm to said main valve.

3. The device as set forth in claim 1 together with friction means associated with said main valve operable to prevent flutter of said valve.

4. The device as set forth in claim 1 in which the stem of the pilot valve is connected to the second diaphragm by a first lever pivoted at one end in the wall of the second chamber and in which the means connecting said first and second diaphragms at positions of extreme movement of the latter comprises a second lever similarly pivoted and engageable with said first lever substantially at their midlengths.

5. The device as set forth in claim 1 together with a metered by-pass between said recess and said second chamber.

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