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LIQUID FUEL PRESSURE REGULATOR

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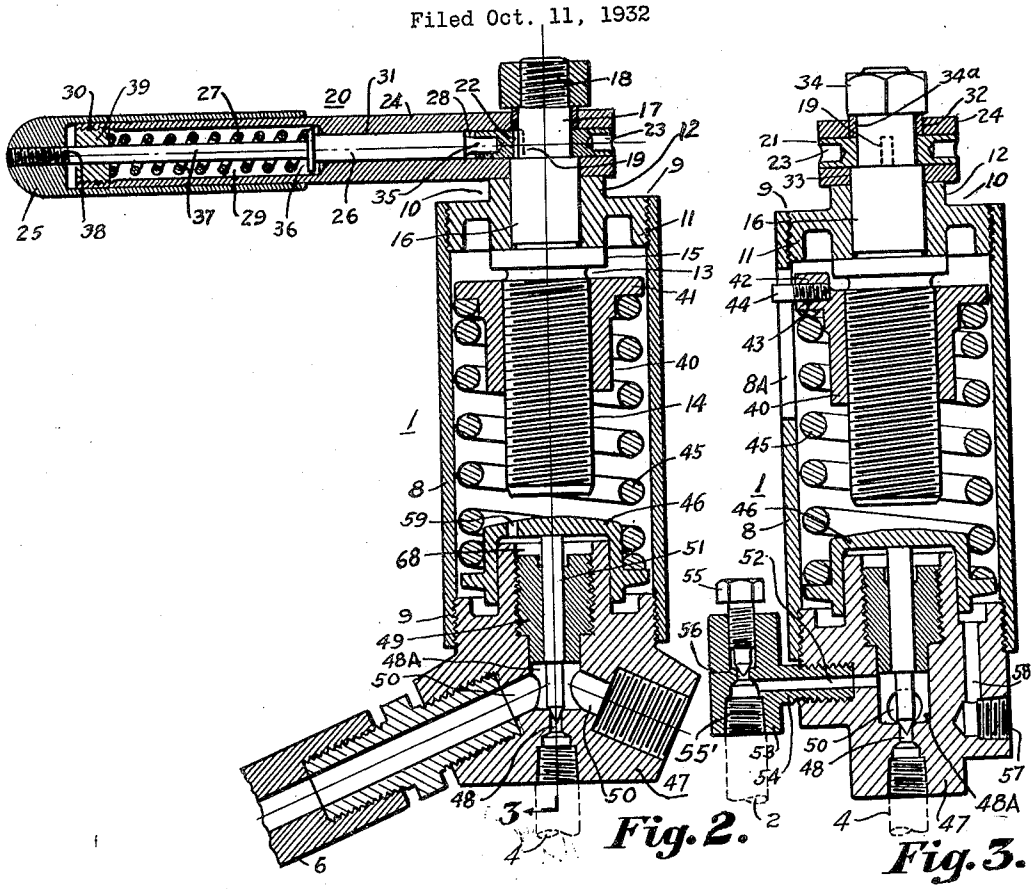


Fig. 2.

Fig. 3.

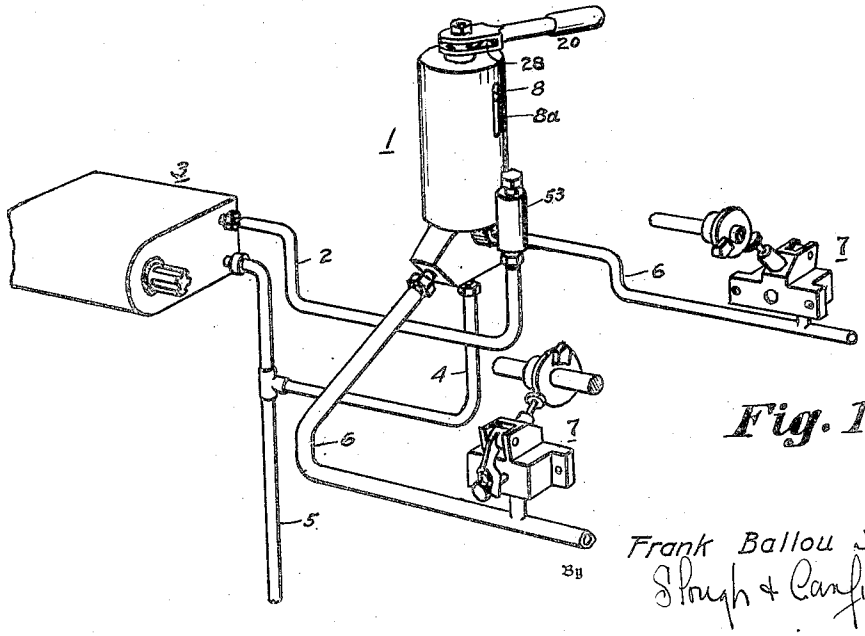


Fig. 1.

Inventor

Frank Ballou Stearns.

By Clough & Canfield

His Attorneys

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LIQUID FUEL PRESSURE REGULATOR

Frank Ballou Stearns, Shaker Heights, Ohio

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7 Claims. (Cl. 137—153)

This invention relates to fuel pressure regulators, and relates particularly to mechanisms for regulating the pressure of fuel supplied to fuel injection valves of internal combustion engines.

In internal combustion engines, and particularly of the solid injection type, the injection of the fuel is controlled by a fuel injection valve to which fuel is fed under relatively high pressure from a fuel pump. This pressure must be sufficiently high to overcome the pressure in the engine cylinders and to thoroughly atomize the fuel oil, and may vary from 3,000 lbs. to 20,000 lbs. per square inch. It is necessary to provide means of regulating the pressure against which the fuel pump will work and to provide means for varying this pressure. This is especially desirable in multi-cylinder engines wherein the same pressure must be maintained from the common supply line at each injection valve if the load per cylinder is to be substantially the same.

Further, since it is impracticable to regulate the exact and minute quantities of heavy and viscous fuel employed and which is needed for each combustion stroke of a cylinder, especially under varying load conditions, it is common practice to pump a quantity of oil in excess of that required, a part only of which goes to the fuel injection valve, the excess passing back to the pump.

It is an object of my invention therefore, to provide an improved fuel regulator for internal combustion engines whereby an excess of fuel may be drawn from a source by a fuel pump and a part distributed to the fuel injector valve and the remainder bypassed when a predetermined pressure is reached back to the fuel pump.

It is a further object of my invention to provide an improved fuel regulator for internal combustion engines whereby the pressure of the fuel supplied to the fuel injection valve may be varied.

Another object of my invention is to provide an improved fuel regulator which will limit the pressure at which fuel will be supplied to the fuel injection valves.

Another object of my invention is to provide a fuel regulator for internal combustion engines which is adapted to effect relatively large differences in pressures of fuel supplied to the fuel injection valve or relatively minute changes as desired.

Another object of my invention is to provide a fuel pressure regulator which will ensure that a substantially constant pressure is maintained at the fuel injection valves.

Another object of my invention is to provide a fuel regulator which is adapted to supply fuel to one or more fuel injection valves at the same pressure.

Another object of my invention is to provide a fuel regulator which employs the minimum of frictionally moving parts.

Another object of my invention is to provide a fuel regulator which may be easily assembled and disassembled.

Another object of my invention is to provide a fuel regulator the parts of which are generally susceptible of manufacture by relatively inexpensive screw machine operations.

Another object of my invention is to provide a fuel regulator which will be compact and occupy a relatively small amount of space.

These and other objects of the inventions will become more apparent from a consideration of the accompanying description and drawing and in which like reference characters will apply to like parts.

Referring to the drawing:—

Fig. 1 is a diagrammatic view showing a fuel pressure regulator embodying my invention connected to a fuel supply pump, to two fuel injection valves, and to a fuel pump supply line leading from a fuel supply reservoir.

Fig. 2 is a vertical, medial sectional view of a fuel pressure regulator embodying my invention.

Fig. 3 is a vertical sectional view taken on the line 3—3 of Fig. 2.

In the drawing, I show a fuel pressure regulator generally indicated at 1, connected by pipe 2 to the high pressure or outlet side of a fuel pump 3, and by pipe 4 to the low pressure or fuel supply line 5 of the pump 3 which leads from a fuel reservoir (not shown). Pipes 6 connect the fuel pressure regulator with the fuel injection valves 7, which are suitably mounted on the engine cylinders.

Referring now to the fuel pressure regulator 1 as illustrated in Figs. 1 and 2, a tubular housing member 8 internally threaded at the ends thereof as indicated at 9 is adapted to screw-threadedly engage a cap 10 at its upper end. The cap 10 comprises a downwardly extending annular flange 11 externally threaded, a central hub portion 12 and an intermediate horizontal portion integrally joining the flange 11 and hub 12.

A shaft 13 is rotatably disposed in hub portion 12 of cap 10 and comprises a threaded lower portion 14, an intermediate shoulder 15 which abuts the lower face of hub 12, and successively reduced portions 16 and 17, the end portion 17

being threaded as indicated at 18. A keyway 19 is provided in portion 17 as indicated in Fig. 2. A handle generally indicated at 20 is adapted to be secured to shaft 13 at various angular positions therewith and preferably at right angles to the shaft axis whereby the shaft may be rotated by the handle.

The handle comprises a preferably annular washer 21 keyed to shaft 13 by a key 22 therein and adapted to engage recess 19, and provided with a plurality of apertures 23 extending radially inward from the peripheral face thereof, a generally rectangular lever 24, a gripping member 25 disposed at one end of said lever, a pin 26 adapted to engage washer 21, and a spring 27 adapted to keep the pin 26 in spring-pressed relation with the said washer.

The lever 24 is preferably rectangular in cross-section and is provided with a transverse slot 28 at one end thereof, an elongated recess 29 at the other end thereof threaded as indicated at 30, a relatively reduced aperture 31 intermediate the slot 28 and recess 29, and aligned transverse apertures 32 and 33 in the top and bottom faces respectively.

The lever 24 encircles the upper end of portion 16 of shaft 13 and abuts the upper face of hub 12.

The washer 21 is disposed within the slot 28 and is co-axially aligned with shaft 13 and apertures 32 and 33. The lever 24 is rotatably secured to the shaft 13 by a nut 34 engaging the threaded portion 18 of the said shaft. A washer 34—A is preferably disposed within aperture 32 and encircling portion 17 of shaft 13 to ensure that relatively little play will exist therebetween. The pin 26 is slidingly disposed within aperture 31 of lever 24 and is provided with a tip 35 adapted to engage apertures 23 and a shoulder 36 against which the end convolutions of a normally compressed spring 27 abuts and a reduced portion 37 around which the said spring is disposed and threaded at the end thereof as indicated at 38. A threaded plug 39 engages the threaded portion 30 of lever 24 and thereby holds the spring in a compressed state. The gripping member 25 is slidingly disposed over one end of lever 24 and engages the threaded portion 38 of pin 26. It will therefore be observed that the gripping member 25 may be moved outwardly against the compression of spring 27 to disengage the pin 26 from washer 21 and angularly rotated relative to shaft 13 until the tip 35 of pin 26 is aligned with another aperture 23 of washer 21 whereupon release of the gripping member 25 will allow the pin 26 to again engage the washer 21. It will thus be seen that sufficient apertures 23 may be provided to rotate the washer 21 and thereby shaft 13 by a relatively limited movement of the handle 20.

The shaft 13 has threaded thereon at 14 a sleeve 40 provided with a radially extending flange 41 at the upper end and a lug 42 disposed preferably adjacent the outer edge of flange 41 and provided with a threaded aperture 43 extending in a direction generally at right angles to the sleeve axis. A pin 44 screw-threadedly engages lug 42 and is adapted to prevent rotative movement of sleeve 40 relative to casing 8 but may move in a vertical direction along slot 8—A provided in casing 8. A spring 45 abuts the under side of flange 41 and at its lower end seats upon a peripheral flange of a cap 46.

A generally circular ported casing 47 screw-threadedly engages tubular member 8 as indicated at 9. A central vertical chamber 48A therein is internally threaded to receive a valve guide 49 at its upper portion and threaded to receive a pipe 4 hereinbefore mentioned. A relatively small valve port 48 connects chamber 48A and pipe 4. Preferably downwardly divergent ports 50 lead to pipes 6 which connect with the fuel injection valves. A valve 51 is disposed within valve guide 49, the lower portion of which is provided with a conical tip adapted to sealingly close port 48 and the upper end of which abuts the inner face of cap 46.

A relatively small duct 52 as illustrated in casing 53 leads from chamber 48A to a preferably cylindrical casing 53 secured to casing 47 by a laterally extending externally threaded arm 54. The casing 53 is provided with an upper recessed internally threaded portion adapted to receive a valve bolt 55, a lower internally threaded recessed portion 55' adapted to receive pipe 2 leading from the fuel pump and a communicating port 56 therebetween which is adapted to be sealingly closed by a conical valve tip at the end of bolt 55. It will be observed that the duct 52 will always remain in open communication with port 56.

A chamber 68 is provided between valve guide 49 and the cap 46 wherein any leakage fuel oil due to the excessive pressure generated in chamber 48A and the reciprocating action of the valve stem 51 will be received. A port 59 is provided at the top of cap 46 whereby leakage oil in chamber 68 may escape to a recess in the top portion of casing 47 and thence through a vertical aperture 58 therein to a fuel return pipe (not shown) threadedly engaging recess 57.

It will be observed that no packing is required around valve stem 51 since it is relatively long and slender and the thin oil film therearound presents sufficient resistance relative to the outlet ports to limit leakage of fuel to a negligible amount.

The pressure regulator acts in the following manner to maintain a constant pressure on the fluid in the circuit with which it is connected as illustrated in Fig. 1.

On the compressive stroke of the fuel pump, fuel will be forced through pipe 2 thence through duct 52 to chamber 48A in the fuel regulator 1. The valve 51 is regulated to lift from its seat on port 48 and open the port 48 at a predetermined pressure value through regulation of the compressive force of spring 45 upon cap 46 against which the upper end of the valve 51 abuts.

By supplying an excess of fuel from the pump, so that the rate at which fuel is being utilized by the engine through the injection valves 7 will be less than the rate of supply, a substantially constant pressure in pipes 6 substantially the same as in chamber 48A is ensured. The valve 51 remains closed until a pressure beyond the desired predetermined amount is generated, and an excess supply of fuel is pumped to the chamber 48A, whereupon the valve 51 opens to by-pass the excess. A constant pressure is thus maintained in chamber 48A and consequently in the lines 6 supplying fuel to the injection valves.

The excess fuel is by-passed through port 48 to pipe 4 and thence back to the oil reservoir or pump or may be re-supplied directly to the fuel pump supply line as shown in Fig. 1.

The valve 51 is relatively large compared to the port 48 so that a surge of pressure will force the valve open to accommodate the surging effect of the oil.

It will be observed that the duct 52 through which fuel is supplied to chamber 48—A is relatively small as compared to the said chamber and also relative to the injection valve supply ports 50 thereby providing an additional check upon the impulse or pulsating effect of the pump in addition to the action of valve 51.

The predetermined maximum pressure at which it is desired to supply fuel may be altered through regulation of the compressive force exerted upon valve 51 by spring 45. As the shaft 13 is rotated the sleeve 41 will be moved vertically upwardly or downwardly since it is prevented from relative rotative movement through engagement of pin 44 in slot 8—A.

The threaded portion 14 of shaft 13 is of sufficient length to permit a wide range of working pressures to be controlled by the regulator. The method by which shaft 13 is rotated by handle 20 as previously described permits of a relatively close adjustment within the working range and also permits the regulator to be utilized in a space where only limited movement of the handle 20 is permitted.

The valve bolt 55 as shown in Fig. 2 is adapted to be removed to permit air to be expelled from the inlet line and regulator. It will be observed that port 52 leads from the upper portion of chamber 48—A to port 56 closed by bolt 55. This means that any air trapped in the upper portion of the chamber when priming will be thus expelled.

Although the fuel pressure regulator has been described as preferably used with a reciprocating plunger type of pump, it is understood that any type pump may be employed such as gear or rotary type. It is further understood that the regulator may be employed on any type engine requiring a constant fuel pressure supply, although it has been described as for a solid injection type engine.

Although I have shown and described a preferred embodiment of my invention, it is understood that various embodiments may be employed without departing from the spirit and scope of my invention and the claims thereof.

Having thus described this invention, what I claim is:—

1. A fuel pressure regulator comprising a casing provided with a fuel entry port, a plurality of fuel outlet ports, a vertical valve plunger provided with an end thereof adapted to sealingly close an aligned one of said outlet ports, a cap abutting the other end of said plunger, guide means associated with the casing and engaged by the cap, a normally compressed spring seated upon said cap, a closed tubular member enclosing said spring and disposed above and secured to said casing, a shaft rotatably mounted in the upper end of said tubular member, a sleeve screw-threadedly engaging said shaft abutting the upper end of said spring and adapted to move longitudinally of said tubular member, a handle rotatably mounted on said shaft and generally at right angles thereto adapted to be non-rotatably secured to the shaft in a plurality of relatively angular positions therewith whereby the force exerted by the spring may be altered by a limited movement of the handle.

2. In a fuel pressure regulator, a casing having a walled chamber therein, a fuel entry port through which liquid fuel under pressure may be supplied to the chamber, a fuel outlet port and a valve bore communicating with the chamber, a valve plunger substantially sealing the bore and having an end thereof adapted to close said outlet port and having a portion of reduced diameter providing a shoulder in the chamber and adapted to move axially to open said outlet port by predetermined pressure in the chamber, a thrust element of cup form abutting the other end of said plunger on the inner wall of the cup bottom, and shiftable laterally relative to the plunger, a spring associated with said thrust element and operable to hold said valve plunger normally in port closed position, said thrust element being reciprocably movable by said plunger in one direction and by said spring in the other direction, and guide means engaging the inner skirt wall of the cup-form thrust element to guide it during movements thereof.

3. In a fuel pressure regulator, a casing having a fuel entry port, a fuel outlet port, and an aperture therein, a valve plunger positioned in said aperture, said valve plunger being reciprocably movable in said aperture and having an end thereof formed to open and close said port, a cap abutting the other end of said plunger, a spring associated with said cap and operable to hold said valve plunger normally in the port closed position, said cap being movable with said plunger, said casing having a guide portion associated therewith and positioned adjacent said valve plunger, said cap being slidably mounted on said guide portion and being guided thereby.

4. In a fuel pressure regulator, a casing comprising a closed chamber, and having a fuel entry port through which liquid fuel under pressure may be supplied to the chamber, a fuel outlet port, and a bore communicating with the chamber, a valve plunger in the bore substantially sealing the said bore, being reciprocably movable in said bore and having an end thereof formed to open and close said port, a thrust element abutting the other end of said plunger and movable therewith, a spring associated with said thrust element and operable to hold said valve plunger normally in the closed position against pressure in the chamber, said casing having a substantially cylindrical portion surrounding said valve plunger receiving bore, said thrust element having a hollow cylindrical surface slidably engaging said cylindrical portion and being guided thereby.

5. In a fuel pressure regulator, a casing comprising a closed chamber, and having a fuel entry port through which liquid fuel under pressure may be supplied to the chamber, a fuel outlet port, and a bore communicating with the chamber, a valve plunger in the bore substantially sealing it, said valve plunger being reciprocably movable in said bore and having an end thereof formed to open and close said port, a cup-form element abutting, by the cup bottom, the other end of said plunger and movable therewith, a spring associated with said cup-form element and operable to hold said valve plunger normally in the closed position against pressure in the chamber, said casing having a substantially cylindrical portion surrounding said valve plunger receiving bore, the skirt of the cup-form element slidably engaging by the inner skirt wall of the cup said cylindrical portion and being guided thereby, the cup-form element and the casing cylindrical portion forming a closed walled chamber surrounding the outer end of the valve plunger, and a wall of said chamber having an aperture therethrough.

6. A fuel pressure regulator comprising a casing having a chamber therein, an inlet port adapted to admit fuel under pressure to the chamber, a fuel outlet port, a valve member in said casing normally closing the outlet port, spring means opposing the opening movement of said valve member, means for adjusting the force exerted by the said spring means comprising a threaded shaft rotatably mounted in said casing, a collar rigidly secured to said shaft having a circular series of recesses therein, a handle comprising a shank and a head thereon rotatably mounted on the collar, an elongated element reciprocable on the shank and having a portion adapted to selectively enter and engage the recesses, a spring on the shank tending to resiliently thrust the elongated element toward the recesses, a hand grip extending longitudinally of the shank and reciprocable thereon and connected at an outer portion to the elongated element whereby when the grip is reciprocated outwardly on the shank it may reciprocate the elongated element against the spring tension to withdraw the said portion of the elongated element from an engaged recess to permit the head to be turned on the collar to engage the said portion with another recess and whereby the grip may then be operated to turn the collar and shaft, a sleeve threadedly engaging said shaft and held in non-rotatable relationship with the casing adapted to contact with the spring means whereby, as the handle is operated by the grip, the said sleeve will be forced upwardly or downwardly thereby altering the force exerted by the spring means.

7. In a fuel pressure regulator, a casing comprising a chamber head having a cylindrical portion, a threaded recess in the head, a bored guide threadedly sealed in the recess to provide a chamber inwardly of the guide, an inlet port communicating with the chamber through which fuel under pressure may be supplied to the chamber, a reciprocable valve plunger in the bore of the guide, a chamber outlet port normally closed by the valve plunger, the valve plunger having a portion of enlarged diameter in the guide bore whereby pressure in the chamber tends to move the plunger to port-open position, the plunger projecting outwardly from the guide bore, a separate thrust element comprising an inner cylindrical bore reciprocably guided on the said cylindrical portion and abutting the outer free end of the plunger and shiftable laterally thereto, and a spring reacting on the thrust element to normally hold the plunger in outlet port closed position.

FRANK BALLOU STEARNS.