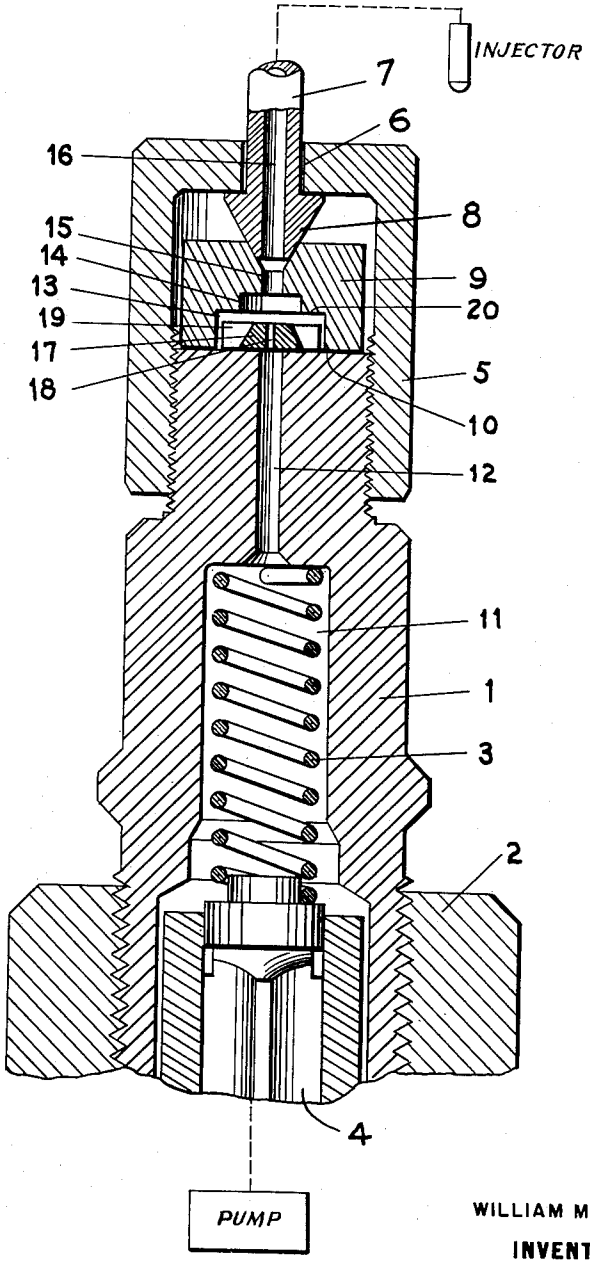
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FUEL PUMPING SYSTEM

Filed June 19, 1951 2 Sheets-Sheet 1

Fig. 1



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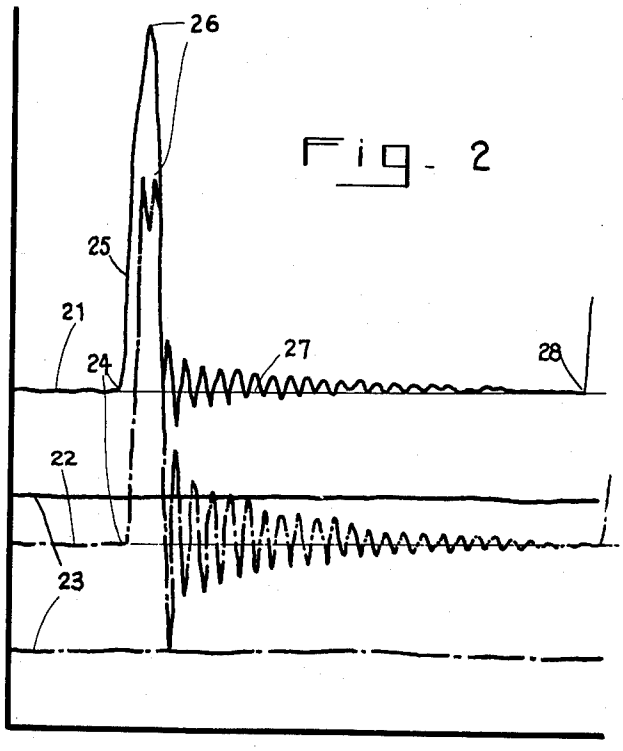


Fig. 2

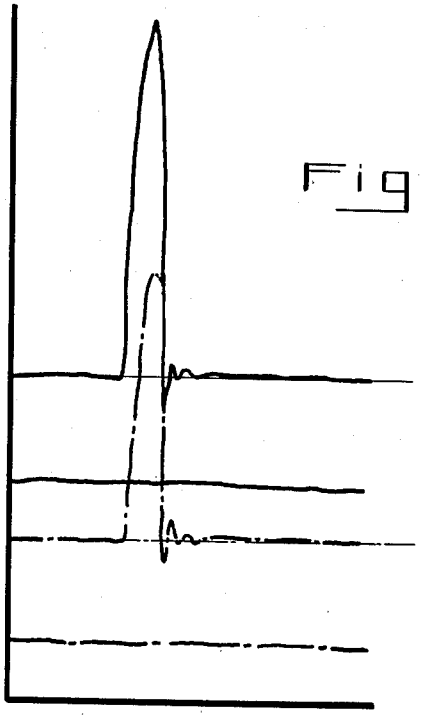


Fig. 3

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United States Patent Office 2,729,169 Patented Jan. 3, 1956

2,729,169

FUEL PUMPING SYSTEM

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Application June 19, 1951, Serial No. 232,283

2 Claims. (Cl. 103—41)

This invention relates to a fuel supply pumping system for compression-ignition engines.

In a common type of such a system, fuel is delivered to the injector through tubing which is fed by a pump having a plunger which overruns a supply port to entrap the charge. Pressures are abruptly generated in the fuel column when the port is suddenly closed and are transmitted along the column in the form of waves or surges which travel at the speed of sound in the fluid. These waves, which are reflected back through the column when they encounter the injector, create undesirable conditions in the system such, for example, as secondary injections and nozzle dribbling. It is also believed that these waves cause erosion in the metallic fuel tubing by dislodging metallic particles from the tubing wall which, when carried to the injector, cause faulty operation.

Several theories have been advanced as to the cause of such tube erosion, one being that vaporization of fuel due to sudden pressure changes in the tubing causes a series of small explosions that tear particles loose from the tubing walls. If this theory be true, it would be of importance that the pressure in the fuel line be prevented from dropping at any time below the vapor pressure of the fuel at operating temperature. The device of my invention achieves such a result.

The principal object of this invention is to provide means in the fuel pump of a compression-ignition engine to damp surging in the fuel column thereby to prevent secondary injection, nozzle drip, and fuel tubing erosion. Another object is to provide a device disposed in the fuel pump between the pump chamber and the tubing connection which will function to damp surging in the fuel column for the purpose previously stated. Other and further objects of the invention will appear from the following description, the acocmpanying drawings and the appended claims.

In the drawings:

Fig. 1 is a cross section of the upper portion of a fuel pump with the spill port open showing the application of my invention thereto the pump and injector and connections being shown diagrammatically.

Fig. 2 is a reproduction of a pressure trace for a conventional pump.

Fig. 3 is a similar trace, as in Fig. 2, but with the damping check valve of my invention arranged in the pump.

Reference is made to Fig. 1 wherein delivery valve holder **1** is threaded into pump housing **2** to encase spring **3** which serves to bias delivery valve **4** into seated position. Nut **5** is threaded to holder **1** and has an aperture **6** in its top wall for the reception of fuel tubing **7**. Tubing **7** is formed with a conical end **8** adapted to seat in spacer **9**. Nut **5** clamps tube end **8** and spacer **9** against the top face **10** of holder **1**.

Fuel supplied by a conventional solid injection type pump such as shown in U. S. Patent No. 2,384,011 to Bremser, after passing the delivery valve **4** in conventional manner, advances through chamber **11**, passage **12**, counterbore or recess **13**, bore **14**, and duct **15** into the fuel tube passageway **16**. Disposed in counterbore **13** and

normally resting upon face **10** of holder **1** is a fluted disc **17**, shown as a preferred form, the diameter of which is somewhat less than the diameter of the counterbore and the vertical thickness of which is somewhat less than the depth of the counterbore. These dimensions permit free movement of the disc in the counterbore. Disc **17** has an axial duct **18** therethrough and its upper portion is formed with a plurality of circumferentially arranged passageways **19** to permit the passage of fuel.

In operation, discs **17** will be lifted from the position shown in the drawing and forced against the annular shoulder **20** by the flow of fuel on the delivery stroke of the pump. Passages **19** and axial duct **18** will permit the fuel to pass freely by the disc into bore **14** and thence into the tubing system. When in the conventional system the pump plunger begins its spill, a negative pressure wave is created at the spill port and travels along the tubing to an injector (shown diagrammatically) reversing the fuel flow as it passes each increment of fuel. As this wave passes the delivery valve and reverses the fuel flow, the valve will snap shut, thereby increasing the available space above it. When the reversed fuel expands to fill such space, it will impinge upon the closed valve, double the amplitude of the wave, and start up the tube again toward the injector. As previously stated, this rapid surging of the negative wave is thought to cause erosion of the tubing walls. By the insertion of disc **17** in the system I have found that the fuel is fed slowly, or relatively slowly, through duct **18** into the space created above the delivery valve when it snaps shut. This prevents the heavy impingement of the fuel against the valve as the negative wave returns from the injector. By this arrangement I have considerably reduced the amplitude of any negative wave oscillating in the tube to cause erosion. That is to say, I have brought about a damping of the waves or surges. At this point I wish to emphasize that the location of the disc is important and that it should be disposed as close as practically possible to the outlet of the delivery valve which is the zone of wave creation.

The wave damping described causes the dissipation in the form of heat energy of the velocity energy in the conventional system.

Reference is now made to Fig. 2 which shows a pressure-time diagram of actual tests of a conventional pumping system. The diagram represents the pressure variations at two points in the fuel line. The solid line **21** indicates the pressure taken in spring chamber **11** just beyond delivery valve 4. The broken line **22** indicates the pressure variation taken in the fuel line at a point just before entering the injector (not shown). The supply pressure (about 50 p. s. i.) is indicated by lines **23**. Points **24** indicate the closing of the spill port after which the pressure is seen to rise rapidly to peaks **26**, the highest pressure developed in the system (approximately 10,000 p. s. i.). Injection takes place at approximately 3600 p. s. i. indicated at **25**. When the spill port opens, which will be at peak **26**, the pressure immediately drops and the delivery valve closes trapping the fuel above it at about 2000 p. s. i. Line **27** indicates the mean residual pressure. The amplitudes of the pressure of the successive waves or surges are apparent from the diagram. They are seen to oscillate in diminishing amounts until they substantially die out about the time the plunger closes the spill port for the start of the next cycle which is indicated at point **28**. The break at the peak of the broken line indicates an irregular pressure variation.

The difference in wave amplitudes between the broken and solid lines is due to the fact that the spring chamber contains a reservoir of fuel which will absorb more fluctuations than the fuel in the highly restricted fuel line. Of course, the points of greatest wave amplitude are the primary concern since it is at those points that the lower

pressure of the waves drops below the vaporization point of the fuel at its operating temperature to permit erosion. The solid and broken lines coincide for a short distance on the right side of the pressure peak because of the nature of the measuring instrument.

Reference is now made to Fig. 3 which shows the results of tests taken of a pumping system in which my novel damping check valve has been inserted, as shown in Fig. 1. A mere inspection of the diagram will show the results. It can be seen from the diagram of Fig. 3 that the pressure waves are almost immediately damped out by the use of my device and at the lowest pressure peak is only slightly below residual pressure and far above the line pressure and the vaporization pressure of the fuel.

While there has been hereinbefore described approved embodiments of this invention, it will be understood that many and various changes and modifications in form, arrangement of parts and details of construction thereof may be made without departing from the spirit of the invention, and that all such changes and modifications as fall within the scope of the appended claims are contemplated as a part of this invention.

What I claim is:

1. In a fuel pumping system for an internal combustion engine of the class in which fuel is supplied in metered amounts by a pump through a housing having a spring biased delivery valve into delivery means whence it passes into the injector, the pump completing its supply stroke upon a predetermined fuel spill, in combination, a valve in the delivery valve housing having duct means therethrough, and said housing having a closed chamber between and in communication with said valve in the delivery means and the delivery valve, said valve in the delivery means unseating in response to the flow of fuel upon the supply stroke of the pump and seating in response to the return flow of fuel upon the completion of the supply stroke of the pump, such seating of the valve serving to limit the return flow of fuel into the chamber thereby to damp surging in the fuel in the delivery means, said chamber trapping therein that portion of the return flow of fuel which passes through the duct means thereby to maintain accurate metering of fuel delivered by the pump.

2. In a fuel pumping system for an internal combustion engine of the class in which fuel is supplied in metered amounts by a pump through a spring biased delivery valve into delivery means whence it passes into the injector, the pump completing its supply stroke upon a predetermined fuel spill, in combination, a valve in the delivery means located proximate said delivery valve, a closed chamber between and in communication with said valve in the delivery means and the delivery valve, and duct means establishing communication between the closed chamber and the delivery means on the injector side of said valve in the delivery means, said valve in the delivery means unseating in response to the flow of fuel upon the supply stroke of the pump and seating in response to the return flow of fuel upon the completion of the supply stroke of the pump, such seating of the valve serving to limit the return flow of fuel into the chamber through said duct means thereby to damp surging in the fuel in the delivery means, said chamber trapping therein that portion of the return flow of fuel which passes through the duct means thereby to maintain accurate metering of fuel delivered by the pump.

References Cited in the file of this patent

UNITED STATES PATENTS

1,783,803	Lang	Dec. 2, 1930
2,090,350	Heinrich	Aug. 17, 1937
2,090,351	Heinrich et al.	Aug. 17, 1937
2,090,781	Camner	Aug. 24, 1937
2,126,985	Buckwalter	Aug. 16, 1938
2,348,282	Bremser	May 9, 1944
2,384,011	Bremser	Sept. 4, 1945
2,426,319	Meitzler	Aug. 26, 1947
2,555,334	Green	June 5, 1951
2,591,401	Camner	Apr. 1, 1952

FOREIGN PATENTS

144,671	Switzerland	Jan. 15, 1931