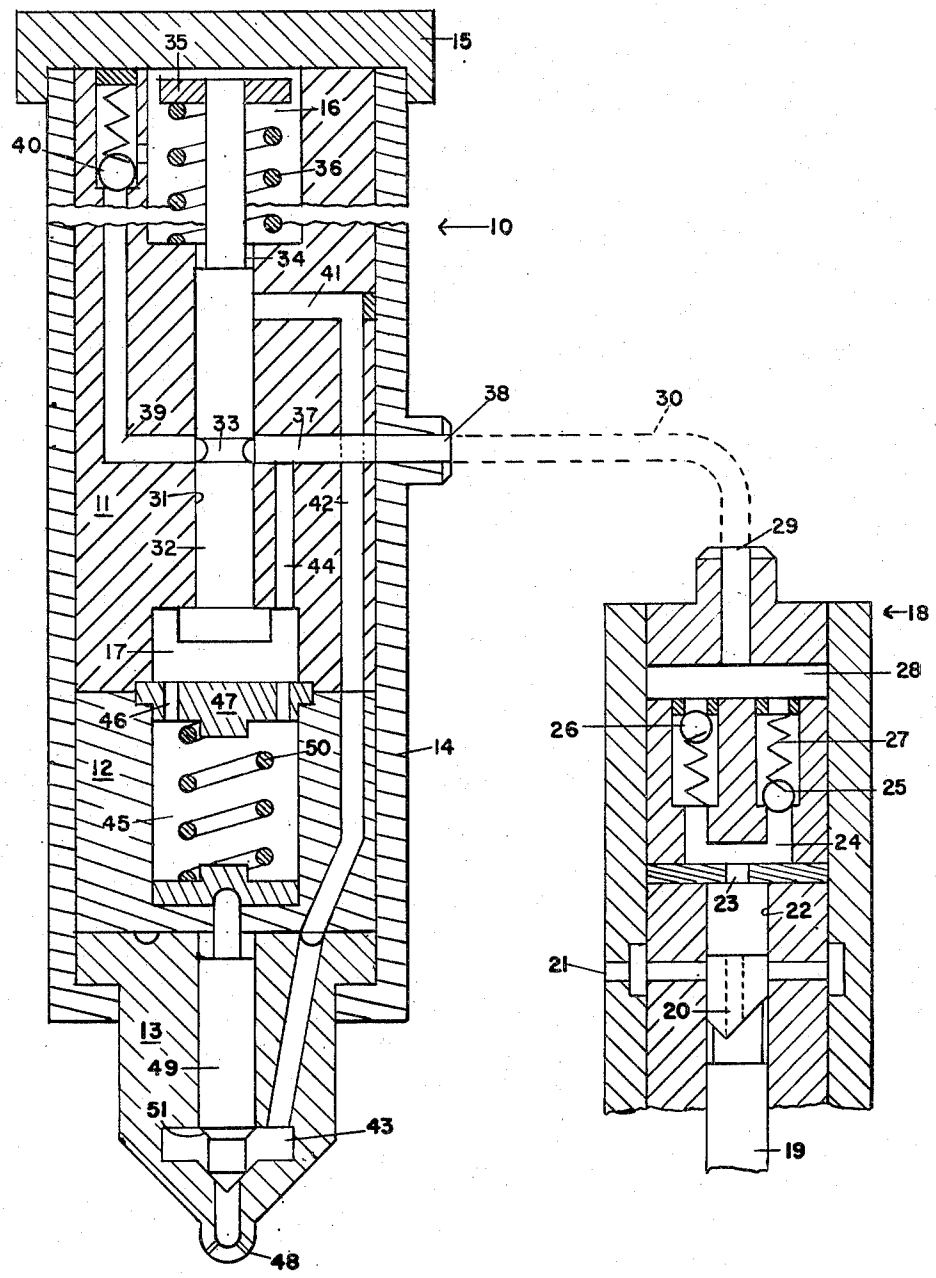
April 9, 1957 W. M. NICHOLS 2,788,246

FUEL INJECTORS

Filed June 27, 1956



WILLIAM M. NICHOLS
INVENTOR.

BY Maurice W. Grady

ATTORNEY

United States Patent Office

2,788,246

Patented Apr. 9, 1957

2,788,246

FUEL INJECTORS

William M. Nichols, Schenectady, N. Y., assignor to Alco Products, Incorporated, New York, N. Y., a corporation of New York

Application June 27, 1956, Serial No. 594,180

6 Claims. (Cl. 299—107.6)

This invention relates to fuel injectors and particularly to injectors of the accumulator type in which fuel is accumulated in a chamber on the supply stroke of the pump and is then discharged when pressure drops in the passage supplying the accumulator chamber.

A fuel injector of the accumulator type is known in which two separate valve devices are provided to control the flow of fuel into and out of the accumulator. The first of the valves is opened by fuel pressure in the supply means to permit fuel to enter the accumulator, and the second of the valves being contemporaneously closed by the same pressure to entrap the fuel in the accumulator. Upon the drop of line pressure following the spill action of the pump, the action of the valves is reversed. Return springs actuate the valves so that the first valve closes the inlet to the accumulator chamber and the second valve opens the outlet of the accumulator to permit fuel to be discharged to the injector.

Fuel injectors of the accumulator type are also known in which a single reciprocating valve, responding to fuel pressure alone, controls both the supply and discharge passages of the accumulator chamber. In this case, the pressure of the fuel on the supply stroke of the pump plunger moves the valve in one direction to a first seat. The valve is so constructed that it permits flow of fuel through itself into the accumulator but prevents it from entering the passage of the injector. When the pump spills and pressure in the supply line drops, the pressure of the fuel in the accumulator engages a working surface on the valve and forces the valve off its first seat to a second seat. Fuel from the accumulator thus flows into the injector. A valve of this type has a tendency to stick and hence is objectionable.

The principal object of the present invention is to provide a fuel injector of the accumulator type in which the flow of fuel into and out of the accumulator is controlled by a valve which is actuated solely by the pressure of fuel in the system, said valve permitting the accumulator to fill without discharging during the supply stroke of the pump but to discharge while out of communication with its supply line during the spill period of the pump.

Another object of the invention is to provide a fuel injector of the accumulator type having a valve therein reciprocable in response to fuel pressure in the system, such valve being so constructed and disposed that fuel cannot be discharged from the accumulator to the injector nozzle until the supply line from the pump is cut off from communication with the accumulator.

Another object is to provide such an accumulator type injector in which a valve controlling the flow of fuel into and out of the accumulator is maintained in balanced position by fuel pressure at its opposite ends during the supply stroke of the pump, the construction and arrangement of the valve being such that the pressure drop on the spilling of the pump affects only one end of the valve so that the valve permits discharge

from the accumulator to the injector nozzle while it contemporaneously cuts off connection between the accumulator and the supply passage from the pump.

Still another object is to provide a fuel injector of the accumulator chamber type which has a second chamber arranged therein in continuous communication with the supply line from the pump to the accumulator chamber, there being also disposed in the injector a reciprocating valve which is at all times in communication with the accumulator and the second chamber, the arrangement of the valve being such that during the pump supply stroke it is maintained in balanced position between the chambers to permit the accumulator to receive fuel from the pump without discharging to the nozzle, the valve having the further characteristic that on the spill of the pump the drop of pressure in the second chamber permits the valve to move to a position in which the accumulator will discharge but at the same time be cut-off from communication with its supply line.

Other and further objects of the present invention will be apparent from the following description, the accompanying drawing, and the appended claims.

In the drawing there is shown a sectional view of a portion of a fuel pump in connection with a fore-shortened sectional view of the fuel injector of the present invention.

The fuel injector, generally indicated by the numeral **10**, comprises a main body **11**, a spring housing **12**, and a nozzle **13**, all of which are held in assembled position by casing **14**. Cap **15** closes the upper end of casing **14**. An accumulator chamber **16** is formed in the upper portion of the main body **11** of the injector and a second chamber **17** is formed in the lower portion of the body **11** for purposes later to be described.

A fuel pump, generally indicated by numeral **18**, supplies fuel to the injector. The pump is conventional and is provided with a pumping plunger **19** having a spill duct **20** therein. Fuel, furnished through inlet passage **21**, is forced by plunger **19** through bore **22** and duct **23** into U-shaped passage **24**. A delivery valve **25** is disposed in one portion of passage **24** and a return valve **26** is disposed in the other portion. On the supply stroke of the plunger, delivery valve **25** is forced open against the action of return spring **27** to permit flow of fuel into chamber **28** whence it passes through outlet passage **29** to the tube **30** to supply the injector. During such supply stroke, return valve **26** is forced to closed position by the pressure of the fuel. Upon completion of the supply stroke, the pump spills in conventional manner and the valves are reversed so the fuel pressure in the system is permitted to drop.

The main body **11** of the injector has an axial bore **31** extending from chamber **16** to chamber **17** and within this bore is disposed a cylindrical reciprocable valve **32**. This valve has a central reduced portion **33** and an end reduced portion **34**. On the upper end of the valve there is formed a flange **35** adapted to support the valve upon a coil spring **36** disposed in the accumulator **16**. When the coil spring is in free or open position (as illustrated), the valve is in its elevated or fuel-receiving position. A fuel passage **37** establishes communication between fuel inlet duct **38** and bore **31**, and a second passage **39**, aligned with passage **37**, connects bore **31** with the accumulator chamber. Passages **37** and **39** thus serve as part of the supply line or means leading from the pump to the accumulator chamber. At the upper end of passage **39** adjacent the accumulator is a check valve **40** to permit flow of fuel into the accumulator on the pump supply stroke but to cut off its return flow when line pressure drops at pump spill.

An outlet passage **41** extends laterally from the axial bore **31** adjacent the accumulator chamber and connects

with axial passage 42 leading downwardly through the body of the injector, the spring housing, and the nozzle to the fuel chamber 43 of the injector. Fuel discharged from the accumulator passes through this line to the nozzle whenever valve 32 is lowered to the extent required to bring its end reduced portion into communication with passage 41.

Chamber 17 is connected to pasage 37 by axial passage 44 and is in communication with spring chamber 45 by means of ducts 46 through spring seat 47.

The injector nozzle is conventional. A fuel chamber 43 receives fuel from delivery passage 42 and as controlled by valve 49 supplies orifices 48. Valve 49 is normally maintained in seated position, as illustrated, by spring 50. A pressure responsive shoulder 51 on valve 49 causes the latter to be lifted off its seat against the bias of spring 50 when fuel pressure builds up sufficiently in chamber 43. When fuel pressure in chamber 43 drops, spring 50 returns the valve to its seat. In case valve 49 sticks open, fuel pressure in spring chamber 45 during the supply stroke of the pump acts to force valve 49 into seated position.

The operation of the system is as follows: Fuel supplied by pump 18 enters the injector through passage 37, passes around the reduced portion 33 of reciprocating valve 32 into passage 39 whence it lifts check valve 40 and flows into accumulator chamber 16. At the same time a part of the fuel passes through axial passage 44 downward into the second chamber 17. Fuel is also permitted to enter spring chamber 45 from chamber 17 to maintain valve 49 in seated position. Fuel pressure in chambers 16 and 17 maintain the accumulator valve 32 in balance since the pressure responsive surfaces on the opposite ends of the valve are equal. During the pump supply stroke, valve 32 assumes the position illustrated in the drawing. When the pump spills, pressure drops in the passages 37 and 39, and in the second chamber 17. Check valve 40 closes and fuel is entrapped in the accumulator chamber. The pressure on the valve 32 in chamber 17 is now less than the pressure on the valve in the accumulator chamber 16 so that valve 32 moves downwardly against the spring 36. End reduced portion 34 moves into communication with delivery passage 41 and the entrapped fuel accumulated in chamber 16 is delivered to the fuel injector nozzle through passages 41 and 42. The central reduced portion is so spaced from the end portion that it is moved out of communication with passages 37 and 39 before end reduced portion is brought into communication with passage 41. That is to say, the discharge from the accumulator 16 cannot begin until the supply passage 39 to the accumulator is cut-off from the pump supply line.

It should be noted and understood that the drawing presented herewith is purely diagrammatic and is intended solely to illustrate the principle of the invention so that those skilled in the art can understand its operation and it is not intended to be a working illustration either dimensionwise or in the particular arrangement of the components. For example, in an actual construction, pressure chamber 17 should be constructed to receive a minimum amount of fuel whereas accumulator chamber 16 should be dimensioned according to the requirements of the particular engine. The small capacity of chamber 17 is required because, when the pump spills, it is necessary that pressure be relieved under valve 32 before it is relieved at the top end of the valve. Such timing of the pressure drop permits the valve to move down to shut off the flow of fuel from the accumulator chamber 16 back to the pump. Also, in an actual construction, check valve 49 may be omitted since the earlier drop in pressure in the supply line, as just explained, will permit the valve 32 to drop almost instantaneously to shut off fuel flow from the accumulator chamber back to the pump.

It is further pointed out that fuel may be supplied from the pump to spring chamber 45 through a separate passage from inlet 37 rather than from pressure chamber 17 through ducts 46 as herein illustrated.

What I claim is:

1. In a fuel injector of the type in which fuel is supplied by a spill pump to an accumulator chamber, apparatus to control the flow of fuel into and out of the accumulator chamber comprising a supply passage to the accumulator chamber; a delivery passage from said chamber to the injector nozzle; a pressure chamber; means connecting the supply passage and the pressure chamber; a spring biased piston valve extending from the accumulator chamber to the pressure chamber and having balancing pressure responsive surfaces in each of said chambers, said valve extending through the supply and delivery passages to control the flow of fuel therethrough.

2. A fuel injector of the type in which fuel is supplied by a spill pump to an accumulator chamber, apparatus to control the flow of fuel into and out of the accumulator chamber comprising a supply passage to the accumulator chamber; a delivery passage from said chamber to the injector nozzle; a pressure chamber; means connecting the supply passage and the pressure chamber; a bore connecting the accumulator chamber and the pressure chamber; a valve in the bore extending through the supply and delivery passages to control the flow of fuel therethrough, said valve having a balancing pressure responsive surface in each of said chambers; a return spring normally holding the valve in a first position to permit fuel to flow through the supply passage into the accumulator chamber but to prevent the discharge of fuel from the accumulator chamber to the injector nozzle, said valve being adapted to be moved into a second position by the pressure of the fuel in the accumulator chamber upon pump spill thereby to permit fuel to flow from the accumulator chamber through the delivery passage but to prevent flow of fuel from the accumulator chamber back through the supply passage.

3. In a fuel injector of the type in which fuel is supplied by a spill pump to an accumulator chamber, apparatus to control the flow of fuel into and out of the accumulator chamber comprising a supply passage to the accumulator chamber; a delivery passage from said chamber to the injector nozzle; a pressure chamber; means connecting the supply passage and the pressure chamber; a piston valve extending from the accumulator chamber to the pressure chamber and having balancing pressure responsive surfaces in each of said chambers, said valve extending through the supply and delivery passages to control the flow of fuel therethrough; and a return spring which, when normally extended, locates the valve in a first position to permit the pump on its supply stroke to supply the accumulator chamber with fuel under pressure but to prevent fuel discharge therefrom, the arrangement of the parts being such that on the drop in fuel pressure following pump spill, pressure in the pressure chamber is relieved to permit the valve to move to a second position in response to pressure in the accumulator chamber thereby to open the delivery passage to the injector nozzle but to close the supply passage to prevent fuel flow from the accumulator chamber back through the supply passage.

4. A fuel injector of the type in which fuel is supplied by a spill pump to an accumulator chamber, apparatus to control the flow of fuel into and out of the accumulator chamber comprising a supply passage to the accumulator chamber; a delivery passage from said chamber to the injector nozzle; a pressure chamber; means connecting the supply passage and the pressure chamber; a bore connecting the accumulator chamber and the pressure chamber; a valve in the bore extending through the supply and delivery passages to control the flow of fuel therethrough, said valve having a balancing pressure responsive surface in each of said chambers; a re-

turn spring normally holding the valve in a first position establishing communication between the accumulator chamber and the supply passage but cutting off communication between the accumulator chamber and the discharge passage, said valve movable into a second position by the pressure of fuel in the accumulator chamber upon pump spill to establish communication between the accumulator chamber and the discharge passage but cutting off communication between the supply passage and the accumulator chamber.

5. In a fuel injector of the type in which fuel is supplied by a spill pump to an accumulator chamber, apparatus to control the flow of fuel into and out of the accumulator chamber comprising a supply passage to the accumulator chamber; a delivery passage from said chamber to the injector nozzle; a pressure chamber; means connecting the supply passage and the pressure chamber; a piston valve extending from the accumulator chamber to the pressure chamber and having balancing pressure responsive surfaces in each of said chambers, said valve extending through the supply and delivery passages to control the flow of fuel therethrough; and a

return spring normally holding the valve in a first position to establish communication between the accumulator chamber and the supply passage alone, said valve movable upon pump spill by the pressure of the fuel in the accumulator chamber to establish communication between the accumulator chamber and the discharge passage alone.

6. In a fuel injector of the type in which fuel is supplied by a spill pump to an accumulator chamber, apparatus to control the flow of fuel into and out of the accumulator chamber comprising a supply passage to the accumulator chamber; a delivery passage from said chamber to the injector nozzle; a pressure chamber; a passage in continuous communication between the supply passage and the pressure chamber; a valve extending through the supply and delivery passages; first control means on the valve adapted to communicate the accumulator chamber with the supply passage alone; and second control means on the valve adapted to communicate the accumulator chamber with the discharge passage.

No references cited.