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INJECTION SYSTEM

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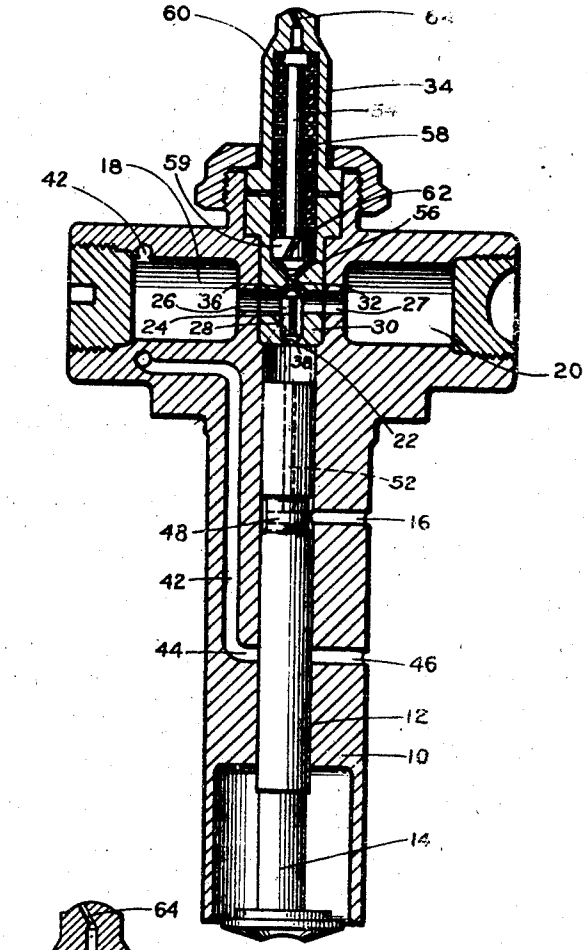


FIG. 1

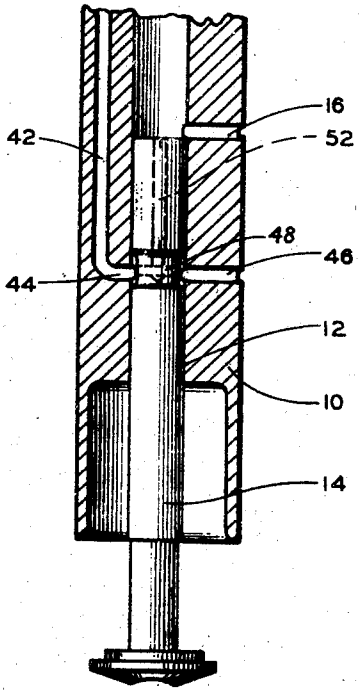


FIG. 2

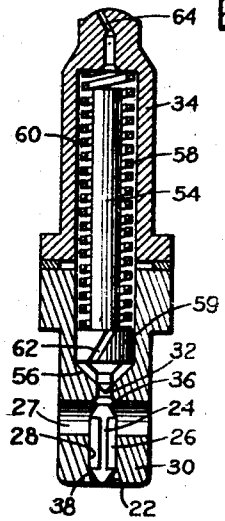


FIG. 3

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INJECTION SYSTEM

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6 Claims. (Cl. 103—41)

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This invention relates to fuel injection apparatus of the accumulator type.

In this type of apparatus, a single valve controls both inlet and discharge passages of the accumulator chamber. This valve is moved by the pressures in the inlet passage and in the chambers. In prior art devices the valve is held in position to close the discharge passage by a spring acting directly on the valve. This spring, which acts against the pressure in the chamber, has of necessity been large and has necessitated a large valve to compress the spring. A feature of this invention is an accumulator valve requiring no spring to control it.

The discharge of fuel from the accumulator chamber must be terminated positively at the end of each injection cycle. This is accomplished in the present invention by a check valve between the accumulator chamber and the nozzle, which requires only a light spring to move it against the pressure differential between the chamber and the nozzle.

Another feature is the automatic venting of the accumulator chamber at one part of the plunger stroke to remove any gas trapped in the chamber.

Another feature is an accumulator injection device of relatively small size and weight for use in aircraft power plants.

Other objects and advantages will be apparent from the specification and claims, and from the accompanying drawing which illustrates what is now considered to be a preferred embodiment of the invention.

Fig. 1 is a sectional view through the apparatus showing the plunger at the start of the injection stroke.

Fig. 2 is a detail view showing the plunger at the end of the injection stroke.

Fig. 3 is a fragmentary sectional view on a larger scale showing the accumulator valve.

The casing 10 has a bore 12 in which is a plunger 14. With the plunger in the position shown in Fig. 2, before it begins its injection stroke, an inlet port 16 admits fuel to the end of the bore 12. During the injection stroke, fuel is forced by the plunger 14 into accumulator chambers 18 and 20 through passage 22, groove 24 in a valve 26 and passage 27. This valve is slidable in a bore 28 in a ring 30 in the casing.

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While fuel is being forced into the accumulator chambers, valve 26 closes a passage 32 which connects passage 27 with the discharge nozzle 34. One end of valve 26 is in line with a seat 36 at the end of passage 32 and is held on this seat by pressure of fuel on the other end of the valve during the injection stroke of the plunger. Groove 24 extends longitudinally of valve 26 to permit a throttled flow of fuel past the valve into the accumulator chambers. The end of valve 26 remote from seat 36 is conical to engage a seat 38 at the end of bore 28 and to close the end of groove 24.

Air in the accumulator chambers 18 and 20 is vented through a passage 42 in casing 10 which connects with the upper end of chamber 18. The opposite end of the passage forms a port 44 in bore 12 opposite a relief port 46 which may be connected to a drain. Plunger 14 has a groove 48 which, during the plunger stroke, connects ports 44 and 46 so that any air in the accumulator chambers 18 and 20 is discharged through passage 42.

Discharge of fuel through passage 32 may be controlled by a check valve 54 held against a seat 56 by a spring 58. When accumulator valve 26 moves to open passage 32, fuel pressure opens the check valve 54 and fuel discharges past the check valve until the pressure of spring 58 is greater than the pressure differential holding the valve open. The check valve may have an integral plunger 59 slidable in a bore 60 in nozzle 34, and the plunger may have a longitudinal groove 62 for flow of fuel past the plunger. Nozzle 34 has one or more openings 64 for discharge of fuel.

During the pumping stroke of the plunger, the head of the plunger closes inlet port 16, and port 44 is closed by the edge of groove 48. As the plunger continues its pumping stroke with port 44 closed, the pressure of the fuel, which has accumulated in the chambers, is raised until port 16 in the casing is uncovered by groove 48. Fuel from the space at the head of the plunger is then discharged into port 16 through a passage 52 extending from the head of the plunger to groove 48. The resultant reduction of pressure in the plunger bore causes valve 26 to move endwise, thereby opening passage 32 for the discharge of fuel from the accumulator chambers through the

nozzle. The valve 26 is larger in diameter than the largest diameter of the valve seat, as shown in Fig. 3, to provide an end area on the valve exposed to the pressure in passage 27. As the conical valve surface now engages valve seat 38, flow of fuel through groove 24 is prevented. Accumulator valve 26 is again moved to engage seat 36 when the plunger begins its next pumping stroke.

During the return stroke of pump plunger 14, the groove 48 connects ports 44 and 46 and the pressure remaining in chambers 18 and 20 forces out through passage 42 any air that may be in chambers 18 and 20. Thus during each stroke of the pump plunger, the accumulator chambers are vented to prevent accumulation of air or gas bubbles.

It is to be understood that the invention is not limited to the specific embodiment herein illustrated and described, but may be used in other ways without departure from its spirit as defined by the following claims.

I claim:

1. Fuel injection apparatus including a casing having a bore, a reciprocating pump plunger in the bore, said casing having a filling port communicating with said bore by which fuel enters the bore, an accumulator chamber in the casing in which fuel is compressed by said plunger on its pumping stroke, a passage from the bore to said chamber through which the fuel is delivered to said chamber, a discharge passage from the chamber, each of said passages having a valve seat, and the valve seats in the passages being in alignment, and a single valve element independent of the plunger and having spaced seat engaging parts for engaging the seats in said passages for alternately closing the passage from the chamber to the plunger and the discharge passage, the valve element being shorter than the spacing between the seats so that only one passage is closed at one time.

2. Fuel injection apparatus including a casing having a bore, a reciprocating pump plunger in the bore, said casing having a filling port communicating with said bore by which fuel enters the bore, an accumulator chamber in the casing in which fuel is compressed by said plunger on its pumping stroke, a passage from the bore to said chamber through which the fuel is delivered to said chamber, a discharge passage from the chamber, each of said passages having a valve seat, and the valve seats in the passages being in alignment, and a single valve element independent of the plunger and having spaced seat engaging parts for engaging the seats in said passages for alternately closing the passage from the chamber to the plunger and the discharge passage, the valve element being shorter than the spacing between the seats so that only one passage is closed at one time, said valve fitting in and being slidable in part of the passage from the bore to the chamber and movable solely by pressure changes on the ends of the valve for alternately engaging the valve seats.

3. In injection apparatus, the combination with a casing having a bore and a filling port through which fuel may enter the bore, a pump plunger movable in said bore, an accumulator chamber in which fuel is compressed by said plunger on the pumping stroke, said chamber and bore being connected by an inlet passage through which fuel enters the chamber, a discharge passage from the chamber, each of said passages having a valve seat with the valve seats in the passages

arranged coaxially, of a small valve fitting in a part of one of the passages and having seat engaging means at opposite ends for engagement with the seats in said passages, said valve being slightly shorter than the spacing between the seats so that the valve may engage selectively with the seats, said valve being movable by pressure variations on said valve, said valve being otherwise free to move between the valve seats.

4. In injection apparatus, the combination with a casing having a bore and a filling port through which fuel may enter the bore, a pump plunger movable in said bore, an accumulator chamber in which fuel is compressed by said plunger on the pumping stroke, said chamber and bore being connected by a passage through which fuel enters the chamber, a discharge passage from the chamber, each of said passages having a valve seat with the valve seats in the passages arranged coaxially, of a small valve fitting in a part of one of the passages and having seat engaging means at opposite ends for engagement with the seats in said passages, said valve being slightly shorter than the spacing between the seats so that the valve may engage selectively with the seats, said valve being movable by pressure variations on said valve, said valve being otherwise free to move between the valve seats, said valve having an axial groove in its periphery to permit a throttled flow of fluid past said valve.

5. In injection apparatus, in combination, a casing having a bore and a filling port through which fuel enters the bore, a pump plunger in said cylinder, an accumulator chamber into which fuel is compressed by said plunger on its pumping stroke, said chamber and bore being connected by a passage through which fuel enters the chamber, a discharge passage from said chamber, said passage between the bore and chamber including a cylindrical portion having a valve seat at one end, and said discharge passage having a valve seat concentric with said first valve seat and spaced therefrom, and a valve slidable in said cylindrical portion and having a groove in its periphery to permit a flow of fluid from the bore to the chamber, said valve being shorter than the spacing between the valve seats and having seat engaging means at each end thereof by which said valve may alternately close the passage from the chamber to the bore and the discharge passage, the pressure acting on the end of the valve during the admission of fuel from the bore to the chamber acting to hold the valve in a position to close the discharge passage, said valve being otherwise free to move within the cylindrical portion of the passage.

6. In injection apparatus, in combination, a casing having a bore, a pump plunger in said bore, an accumulator chamber in which fuel is compressed by the plunger on its pumping stroke, said chamber being connected by a passage with the bore and having a discharge passage, a valve alternately closing said passages so that fuel will be delivered to the discharge passage only when fuel is not entering the chamber, and a check valve in the discharge passage, said discharge passage having a cylindrical portion in which the check valve is located, and a seat at the end of the cylindrical portion adjacent to the chamber, said check valve including a plunger fitting within the cylindrical portion of the passage and having a peripheral groove to permit a flow of fuel past said plunger, and a spring acting on said plunger to move it in a direction opposite to the

flow of fuel through said passage, said plunger having seat engaging means adapted to be held against the seat in said passage by said spring.

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