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FUEL FEEDING SYSTEM

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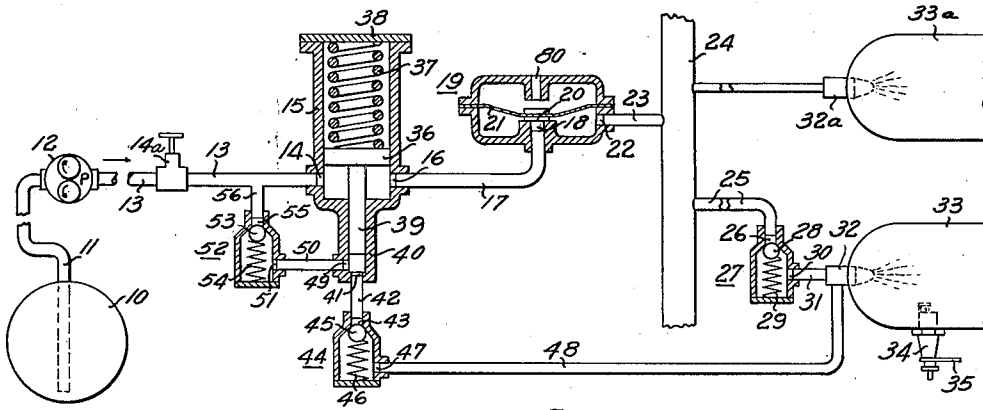


Fig. 1

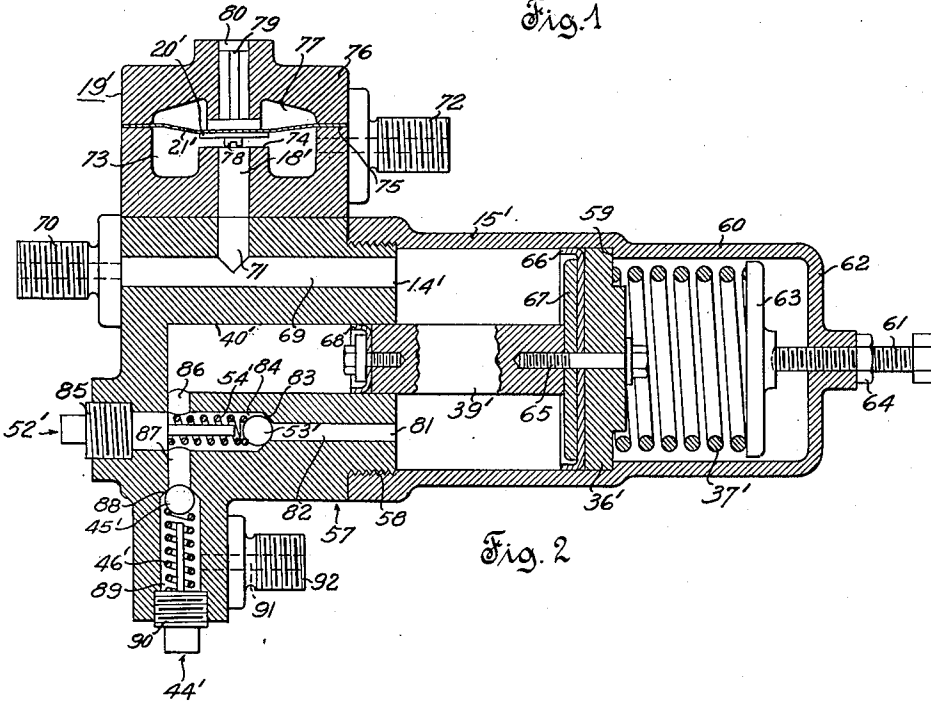


Fig. 2

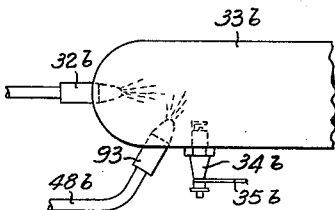


Fig. 3

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FUEL FEEDING SYSTEM

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This invention relates to fuel feeding systems, and more particularly to systems for feeding fuel to one or more combustion chambers, and the principal object of the invention is to provide new and improved systems of these types.

Another object of the invention is to provide a fuel feeding system in which fuel under high pressure is delivered to the combustion chamber for starting combustion, and, more specifically, a charge of fuel of predetermined quantity is so delivered.

Another object of the invention is to prevent delivery of fuel to the combustion chamber until the fuel pressure rises to a predetermined value.

Other objects will appear as the description of the invention proceeds.

The novel features of the invention and how the objects are attained will appear from this application and all of these novel features are intended to be pointed out in the claims.

Several embodiments of the invention are shown in the drawing accompanying this specification and forming a part of this application, and in this drawing:

Fig. 1 is a diagram of a system embodying the invention;

Fig. 2 is a longitudinal sectional detail view of apparatus which may be embodied in a system embodying the invention; and

Fig. 3 is a fragmentary diagrammatic view of an alternative detail.

Referring first to Fig. 1, the system there shown comprises a primary source of fuel here shown as a tank 10 for containing liquid fuel. A conduit 11 leads from the tank 10 to the suction side of a pump 12 of any suitable type. The pump 12 discharges into a conduit 13 in which a control or throttle valve 14a is desirably interposed, so that the rate of flow may be regulated.

The discharge end of the conduit 13 is here shown as connected to an inlet port 14 in a cylinder 15. The cylinder 15 is here shown as having an outlet port 16 to which a conduit 17 is connected, the conduit 17 being connected at its other end to the inlet 18 of a valve 19 having a movable valve body 20 pressed to its seat by a flexible diaphragm 21 of metal or any other suitable material. When a predetermined pressure is reached in the conduit 17 the diaphragm 21 is suddenly flexed upwardly and the valve body 20 is snapped to open position. The valve 19 has an outlet 22 which is here shown as connected by a conduit 23 to a fuel header 24.

Connected to the fuel header 24 is a conduit

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25 which is connected at its other end to the inlet 26 of a check valve 27. The check valve 27 may be of any suitable kind, it being here shown as comprising a ball 28 pressed to a seat by a spring 29. The check valve 27 has an outlet 30 connected by a conduit 31 to a burner nozzle 32 which is constructed and arranged to discharge fuel into a combustion chamber 33. The fuel discharged into the chamber 33 may be ignited by any suitable means here shown as a spark plug 34 from which a wire 35 leads to a source of high electric potential (not shown). Where a fuel header 24 is used, the header may have connected thereto any desired number of combustion chambers, one other chamber 33a fed by a nozzle 32a being indicated. If desired the chambers 33, 33a may be connected, so that ignition of fuel in all chambers may result from ignition of the fuel in one of the chambers.

A piston 36 is disposed in the cylinder 15, the piston being biased to the position shown by a spring 37 at one end engaging the piston 36 and at the other a cover 38 for the cylinder 15. The piston 36 has connected thereto a piston 39 of substantially smaller diameter fitting in a cylinder 40. Fuel in the cylinder 40 may be discharged from an outlet port 41 into a conduit 42 connected at its other end to the inlet 43 of a valve 44 of suitable form here shown as comprising a ball 45 pressed to a seat by a spring 46. The valve 44 has a discharge outlet 47 to which is connected one end of a conduit 48 the other end of the conduit being connected to the nozzle 32. The valve 44 will not open until the pressure in the cylinder 40, and hence the conduit 42, is a predetermined pressure which is substantially higher than the pressure sufficient to open the valve 19. For example, the valve 19 may be constructed and arranged to open when the pressure in the conduit 17 reaches 50 pounds per square millimeter, whereas the valve 44 may be constructed and arranged to open when the pressure in the conduit 42 reaches about 300 pounds per square millimeter. The values hereinbefore mentioned are given merely by way of illustration and not limitation, since other desired specific pressures may be used without departing from the spirit of the invention.

The smaller cylinder 40 is here shown as having a port 49 to which a conduit 50 is connected, the other end of the conduit being connected to the outlet 51 of a check valve 52 here shown as comprising a ball 53 pressed to a valve seat by a spring 54. The check valve 52 has an inlet

55 which is connected by a conduit 56 to the

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conduit 13, as here shown between the throttle valve 14a and the port 14.

Referring now to Fig. 2, this figure shows a structure in which certain of the parts of the system are combined in a unit. Parts in Fig. 2 which correspond to parts in Fig. 1 are designated by the same reference characters, primed. The larger cylinder 15' is separately formed and is assembled with a block 57 by cooperating screw threads 58. The piston 38' cooperating with the cylinder 15' is shown in the position it assumes when it has been moved, by fluid pressure in the cylinder, to the outward limit of its stroke, in which it abuts a shoulder 59 formed by a reduced cylindrical portion 60 forming a housing for the helical spring 37'. The pressure of the spring 37' against the piston 36' is adjustable by a screw 61 threaded through the end 62 of the spring housing and abutting a plate 63 which engages the spring 37'. A lock nut 64 is provided to hold the screw 61 in adjusted position.

A machine screw 65 extends through the piston 38' and is threaded into the piston 39', for fastening the piston 39' to the piston 36'. The piston 39' cooperates with the cylinder 40' formed in the block 57. The screw 65 may also serve to hold a pressure-retaining washer 66 which cooperates with the wall of the cylinder 15', and a plate 67 which serves to maintain all except outer peripheral portions of the washer 66 against the piston 36', the washer 66 and plate 67 being interposed between the face of the piston 36' and the right hand end of the piston 39. The free end of the piston 39' may also be provided with a suitably held pressure-retaining washer 68.

The inlet 14' to the cylinder 15' is provided by an end of a passage 69 formed in the block 57. The other end of the passage 69 communicates with a screw threaded connection 70 to which a conduit from the discharge outlet of the pump 12 is adapted to be connected.

The valve 19' (which is shown in open position in Fig. 2) is suitably seated on and fastened to the block 57, with its inlet 18' in communication with a passage 71 in the block 57, the passage 71 communicating with the passage 69. The passage 71 corresponds, functionally, to the conduit 17. The valve 19' is provided with a threaded connection 72 communicating with an annular recess 73, the connection 72 being adapted to be connected to the conduit 23. As here shown, the recess 73 leaves at its inner periphery an annular valve seat 74 around the inlet 18', the valve body 20 being in the form of a suitable disk cooperable with the valve seat 74 and biased toward the seat by the diaphragm 21'. The outer peripheral portion of the diaphragm 21' may be suitably held against an annular margin 75 surrounding the recess 73, by a member 76 having an upwardly directed recess 77. The valve body 20' is here shown as held to the diaphragm 21' by a screw 78 threaded into a guide member 79 fitting slidably in a hole 80 in the member 76. It will be evident that the diaphragm 21' forms a cover for the annular recess 73 whether or not the valve body 20' is in engagement with the seat 74.

The larger cylinder 15' has an outlet 81 provided by an end of a passage 82 formed in the block 57, the other end of the passage 82 communicating with the valve seat 83 formed at the end of the countersunk bore 84. The spring 54 is here shown as pressed against the ball 53 by a plug 85 threaded into an enlarged part of the bore 84.

A passage 86 is provided extending from the

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end of the smaller cylinder 40' into the bore 84. Another passage 87 is provided extending from the bore 84 to a valve seat 88 formed at the end of a countersunk bore 89. The spring 46' is here shown as pressed against the ball 45' by a plug 90 threaded into an enlarged part of the bore 89. A passage 91 extends from the bore 89 through a threaded connection 92 to which the conduit 48 is adapted to be connected.

It will be evident that conduit means is provided from the connection 70 to the smaller cylinder 40' by the passage 69, the larger cylinder 15', the passage 82, through the check valve 53'—83 into the bore 84, and through the passage 86 into the cylinder 40'. On the other hand, fluid cannot flow from the smaller cylinder 40' into the passage 82 such flow being prevented by the ball 53' acting against the seat 82. It will be noted that while, in Fig. 1, fluid flow from the conduit 13 to the conduit 23 takes place through the large cylinder 15, through the conduit 17 and valve 19, to the conduit 23, this is not the case in Fig. 2 in which flow from the connection 70 to the connection 72 takes place through the passage 69 and thence through the passage 71, through the valve 19' to the connection 72. However, the larger cylinder 15' is connected, through the passage 69 to the conduit means through which flow takes place from the connection 70 to the connection 72. In principle the instances of Fig. 1 and Fig. 2 are the same.

Referring first to Fig. 1, the operation of the system is as follows: Assuming that the pump 12 has been set into operation, fuel will flow through valve 14a through pipe 13 and port 14 into the larger cylinder 15. The valve 19 is closed, and hence pressure will be built up in the cylinder 15 by the fuel pumped into it, whereby the piston 36 is moved against the bias of the spring 37. Meanwhile fuel flows from the conduit 13 through the check valve 52 into the smaller cylinder 40. When the piston 36 has reached the limit of its outward stroke (upward as viewed in Fig. 1), and the spring 37 is fully compressed, or, in any event, when the fuel pressure in the cylinder 15, and hence in the conduit 17, reaches a predetermined value, higher than normal feed pressure, the valve body 20 of the valve 19 is moved, with a snap action, to its open position, thereby opening communication between conduits 17 and 23. The sudden reduction of pressure in the cylinder 15 caused by opening of the valve 19 permits the spring 37 to move the piston 36 rapidly to its initial position, thereby plunging the smaller piston 39 into the cylinder 40 to its initial position. Thereby a charge of fuel, corresponding to the stroke of the piston 39, is forced out of the smaller cylinder 40 at high pressure, this pressure being sufficient to open the valve 44. The charge of fuel under high pressure is fed through the conduit 48 into the burner nozzle 32 and thence into the combustion chamber where it may be ignited by the spark plug 34, or other suitable means. It will be noted that the check valve 52 prevents flow from the cylinder 40 into the conduit 13. The check valve 27 prevents flow from the conduit 48 through the conduit 31 into the conduit 25.

Meanwhile, the valve 19 having opened and the pump 12 continuing to operate, the valve 19 remains open and fuel is fed from the conduit 25, through the check valve 27 and the conduit 31 to the nozzle 32 as soon as the high pressure in conduit 48 disappears due to the piston 39 reaching the pressure end of its stroke with resultant

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reclosure of valve 44, whereupon the nozzle 32 is immediately fed with fuel at the normal desired feed pressure.

As long as fuel continues to be fed at normal desired pressure the valve 19 will stay open. If, for example, operation of the pump 12 is stopped, the valve 19 will close, and by restarting the pump, the cycle of operation hereinbefore described will be repeated.

As hereinbefore pointed out, the apparatus shown in Fig. 2 differs from that shown in Fig. 1 in that certain parts of the system are combined in a unit. When this unit is connected in a conduit system the connection 70 will be connected to the discharge outlet of a pump, such as pump 12, preferably downstream of valve 14a; the connection 72 will be connected to a discharge conduit, such as conduit 23; and the connection 92 will be connected to a discharge conduit, such as conduit 48. The parts in Fig. 2 are shown in the position which they assume after the pump 12 has been in operation a sufficient time to cause fuel pumped through port 14' into cylinder 15' to move the piston 36' to the outward limit of its stroke (to the right as viewed in Fig. 2); the cylinder 40' has been filled with fuel through valve 52' from cylinder 15'; the valve body 20' has just snapped to open position having been subjected to above normal fuel feed pressure through passage 71. The sudden release of fuel pressure through connection 72 will cause the spring 37' to force the piston 36' to the left, as viewed in Fig. 2, thereby plunging the piston 39' into the cylinder 40' forcing a charge of fuel from cylinder 40' through valve 44' out of the connection 92. In this operation the check valve 52 prevents fuel flow from cylinder 40' through valve 52, through passage 81 into cylinder 15'.

It will therefore be apparent that the mode of operation of the apparatus shown in Fig. 2 is exactly the same as that shown in Fig. 1.

It will be evident that the pressure produced by movement of the piston 39 (or 39') into the smaller cylinder 40 (or 40') may be substantially any desired amount higher than the pressure in the larger cylinder 15 (or 15') because the pressure in the cylinder 40 (or 40') depends upon the ratio of the effective area of the piston 36 (or 36') to that of the piston 39 (or 39').

If desired a high pressure fuel feed conduit 48b (Fig. 3) may be connected to a special nozzle 93 adapted to feed the high pressure starting fuel, adjacent a spark plug 34b, into a chamber 33b, instead of to a nozzle 32b. The nozzle 32b then serves only to feed fuel to the chamber 33b at normal operating pressure.

From the foregoing it will be apparent to those skilled in the art that the illustrated embodiments of the invention provide new and improved fuel feeding systems and accordingly each accomplishes the principal object of the invention. On the other hand, it will also be obvious to those skilled in the art that the illustrated embodiments of the invention may be variously changed and modified, or features thereof singly or collectively, embodied in other combinations than those illustrated with departing from the spirit of the invention, or sacrificing all of the advantages thereof, and that, accordingly, the disclosed embodiments are illustrative only, and the invention is not limited thereto.

It is claimed and desired to secure by Letters Patent:

1. Apparatus for feeding fuel to a combustion chamber, comprising: first conduit means for

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connection with the chamber for feeding fuel to the chamber at a predetermined pressure during normal operation; means responsive to fuel pressure in said first conduit means for preventing feed of fuel therethrough unless said fuel pressure rises to a predetermined value; second conduit means for connection with the chamber; connection means between said second conduit means and said first conduit means on the upstream side of said fuel pressure responsive means; and means for feeding fuel through said second conduit means to the chamber at a pressure substantially higher than said predetermined pressures, to provide fuel for combustion-starting in the chamber.

2. Apparatus for feeding fuel to a combustion chamber, comprising: first conduit means for connection with the chamber for feeding fuel to the chamber at a predetermined pressure during normal operation; valve means in said conduit means; means biasing said valve means to closed position constructed and arranged to prevent opening of said valve means until the fuel pressure in said conduit means rises to a predetermined value; second conduit means for connection with the chamber; and means, responsive to opening of said valve means, for feeding fuel through said second conduit means to the chamber at a pressure substantially higher than said predetermined pressure, to provide fuel for combustion-starting in the chamber.

3. Apparatus for feeding fuel to a combustion chamber, comprising: conduit means for connection with the chamber for feeding fuel to the chamber; means responsive to fuel pressure in said conduit means for preventing feed of fuel to the chamber unless said fuel pressure rises to a predetermined value; and separate means, controlled by the pressure in said conduit means, for feeding a predetermined quantity of fuel to the chamber at a pressure substantially higher than said predetermined pressure, to provide fuel for combustion-starting in the chamber.

4. Apparatus for feeding fuel to a combustion chamber, comprising: conduit means for connection with the chamber for feeding fuel to the chamber; control means for preventing feed of fuel to the chamber when said fuel pressure in said conduit means is below a predetermined value and operable by rise of said fuel pressure to a predetermined value to feed fuel to the chamber; and separate means, responsive to operation of said control means by rise in fuel pressure, for feeding a predetermined quantity of fuel to the chamber at a pressure substantially higher than said predetermined pressure, to provide fuel for combustion-starting in the chamber.

5. Apparatus for feeding fuel to a combustion chamber, comprising: conduit means for connection with the chamber for feeding fuel to the chamber at a predetermined pressure during normal operation; a first cylinder connected to said conduit means; a second cylinder of substantially smaller diameter than said first cylinder; connection means for delivering fuel to said second cylinder from said conduit means; discharge means for said second cylinder for connection with the combustion chamber; a first piston cooperating with said first cylinder, responsive to fuel pressure in said conduit means; and a second piston movable with said first piston and cooperating with said second cylinder for feeding fuel from said second cylinder to said discharge means at a pressure substantially higher than

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said predetermined pressure, to provide fuel for combustion-starting in the chamber.

6. Apparatus for feeding fuel to a combustion chamber, comprising: conduit means for connection with the chamber for feeding fuel to the chamber; valve means, interposed in said conduit means and operable in response to predetermined fuel pressure in said conduit means, to feed fuel to the chamber during normal operation; a first cylinder connected to said conduit means on the upstream side of said valve means; a second cylinder of substantially smaller diameter than said first cylinder; connection means for delivering fuel to said second cylinder from said conduit means on the upstream side of said valve means; discharge means for said second cylinder for connection with the combustion chamber; a first piston cooperating with said first cylinder responsive to the operation of said valve means by a rise in fuel pressure in said conduit means; and a second piston movable with said first piston and cooperating with said second cylinder for feeding fuel from said second cylinder to said discharge means at a pressure substantially higher than said predetermined pressure, to provide fuel for combustion-starting in the chamber.

7. Apparatus for feeding fuel to a combustion chamber, comprising: conduit means for connection with the chamber for feeding fuel to the chamber; valve means, interposed in said conduit means and operable with a snap action in response to predetermined fuel pressure in said conduit means, to feed fuel to the chamber during normal operation; a first cylinder connected to said conduit means on the upstream side of said valve means; a second cylinder of substantially smaller diameter than said first cylinder; connection means for delivering fuel to said second cylinder from said conduit means on the upstream side of said valve means; discharge means for said second cylinder for connection with the combustion chamber; a first piston cooperating with said first cylinder responsive to the operation of said valve means by a rise in fuel pressure in said conduit means; and a second piston movable with said first piston and cooperating with said second cylinder for feeding fuel from said second cylinder to said discharge means at a pressure substantially higher than said predetermined pressure, to provide fuel for combustion-starting in the chamber.

8. Apparatus for feeding fuel to a combustion

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chamber, comprising: conduit means for connection with the chamber for feeding fuel to the chamber; valve means, interposed in said conduit means and operable with a snap action in response to predetermined fuel pressure in said conduit means, to feed fuel to the chamber during normal operation; a first cylinder connected to said conduit means on the upstream side of said valve means; a second cylinder of substantially smaller diameter than said first cylinder; connection means for delivering fuel to said second cylinder from said conduit means on the upstream side of said valve means; a check valve in said connection means for preventing fuel flow from said second cylinder to said conduit means; discharge means for said second cylinder for connection with the combustion chamber; valve means interposed in said discharge means and operable to open in response to fuel pressure in said discharge means substantially higher than said predetermined pressure; a first piston cooperating with said first cylinder responsive to the operation of said valve means by a rise in fuel pressure in said conduit means; and a second piston movable with said first piston and cooperating with said second cylinder for feeding fuel from said second cylinder to said discharge means at a pressure substantially higher than said predetermined pressure, to provide fuel for combustion-starting in the chamber.

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