in an undesirable fuel spray formation. For this reason, in systems for which the combination of the rail control valve **62** and the non-return valve **362** is preferred (as in **FIG. 12**), it is desirable to include an additional high pressure shut off valve arrangement in the system.

[**0139**] In the embodiment shown in **FIG. 12**, the fuel injection system is therefore provided with control valve means in the form of a control valve **11** and a shut off valve arrangement **462** arranged within the high pressure fuel line **52**. The control valve **11** is arranged to control fuel pressure within a control chamber **157** associated with the shut off valve **462**, and thereby controls movement of the injector valve needle as described in further detail below. This configuration for controlling valve needle movement differs from the embodiments described previously, in that instead of providing a nozzle control valve **54** to control fuel pressure within an injector control chamber **57** at the back end of the valve needle, the control valve **11** acts to control fuel flow through the high pressure line **52** to the nozzle. In the embodiment of **FIG. 12**, the chamber **153** at the back end of the valve needle simply forms a chamber for housing the valve needle spring **53**, and whether or not the valve needle is lifted from its seating to inject fuel is determined by opening and closing the shut off valve **462**.

[**0140**] One practical embodiment of the high pressure shut off valve **462**, and its configuration in relation to the control valve **11** and the injector valve needle **55**, is shown in further detail in **FIG. 13**. The shut off valve **462** includes a shut off valve member **464** that is arranged within the high pressure supply line **52** to the delivery chamber **49** of the injector. The chamber **153** at the back end of the valve needle **55** houses a spring **53** which serves to urge the valve needle **55** into a closed position. It can be seen in **FIG. 13** that the valve needle **55**, the chamber **153** and the shut off valve member **464** are housed in adjacently mounted housing parts **106**, **108**, **110**.

[**0141**] The shut off valve member **464** is movable within a stepped bore **121** formed in the housing part **110** under the control of the control valve **11**. In the operating condition shown in **FIGS. 12 and 13**, the shut off valve member **464** is in a first position (a "closed" operating position) in which the shut off valve member **464** is engaged with a shut off valve seating **112** defined by a surface of the housing part **108** so that the flow of fuel through the high pressure supply line **52** to the injector delivery chamber **49** is prevented. The shut off valve member **464** is movable away from the shut off valve seating **112** into a second position (an "open" operating position) in which the flow of fuel through the high pressure supply line **52** to the injector delivery chamber **49** is permitted.

[**0142**] The control valve **11** has a control valve member **111** which is movable between a first position (herein referred to as a closed position), in which a branch passage **152** from the high pressure supply line **52** communicates with a control chamber **157** at a back end of the shut off valve member **464** and communication between the control chamber **157** and a low pressure reservoir is closed, and a second position (herein referred to as an "open" position) in which the chamber **157** communicates with the low pressure reservoir through a drain passage **116** and communication between the branch passage **152** and the chamber **157** is broken. It cannot be fully appreciated from the scale of the drawing in **FIG. 13**, but the control valve member **111** is engaged with a first seating **118** when in its closed position to break communication between the chamber **157** and the drain passage **116** and is engaged with a second seating **120** when in its open position to open communication between the control chamber **157** and the drain passage **116** and to break communication between the branch passage **152** and the control chamber **157**.

[**0143**] The shut off valve member **464** is movable between its open and closed positions in response to the hydraulic forces acting on surfaces of upper and lower end regions **466**, **468** respectively of the valve member **464**. The shut off valve member **464** is shaped to include upper and lower regions of different diameter. The upper end **466** has a first effective surface area exposed to fuel pressure within the control chamber **157**. The lower end region **468** defines a surface area of annular form that is exposed to fuel pressure within the high pressure line **52** when the shut off valve member **464** is in its closed position, and when the shut off valve member is in its open position a second effective surface area is exposed to fuel pressure in the high pressure line **52**. The first effective surface area of the upper end region **466** is greater than this second effective surface area of the lower end region **468**. A gallery **122** defined in the region of the step in the bore **121** communicates continuously with the drain passage **116** to low pressure so as to prevent the occurrence of a hydraulic lock.

[**0144**] In use, the function of the shut off valve **462** is essentially the same in both the common-rail type and the EUI-type modes of operation (i.e. at both the first and second injectable pressure levels). If the control valve member **111** is moved to its open position in which it is seated against the second seating **120**, the control chamber **157** communicates with the low pressure reservoir and hence the shut off valve member **464** will be urged away from the shut off valve seating **112** into its open position due to high fuel pressure within the supply line **52** (whether at pressure P1 or P2) acting on the exposed annular surface area of its lower end **468**. Additionally, as the shut of valve member **464** starts to open, the lowermost end surface will also experience building pressure in the downstream portion of the high pressure line **52** and so eventually the entire end surface of the shut off valve member **464** (i.e. the second effective surface area) is exposed to high fuel pressure in the line **52**. When the control valve member **111** is moved into this open state, fuel at either the first or second injectable pressure level is therefore able to flow through the open shut off valve **262**, into the supply line **52** to the injector delivery chamber **49**. As the pressure of fuel delivered to the delivery chamber **49**, and hence to the downstream parts of the injector, a force is applied to the valve needle **55** that is sufficient to overcome the closing force of the spring **53** and, hence, fuel is injected to the engine.

[**0145**] If the control valve member **111** is moved into its closed position in which the control valve member **111** is moved away from the second seating **120** and is caused to seat against the first seating **118**, high pressure fuel within the high pressure supply line **52** is able to flow through the branch passage **152** and into the control chamber **157** at the upper end **466** of the shut off valve member **464**. As the first effective surface area of the shut off valve member **464** at its upper end **466** is greater than the second effective surface area of the shut off valve member **464** at its lower end **468**