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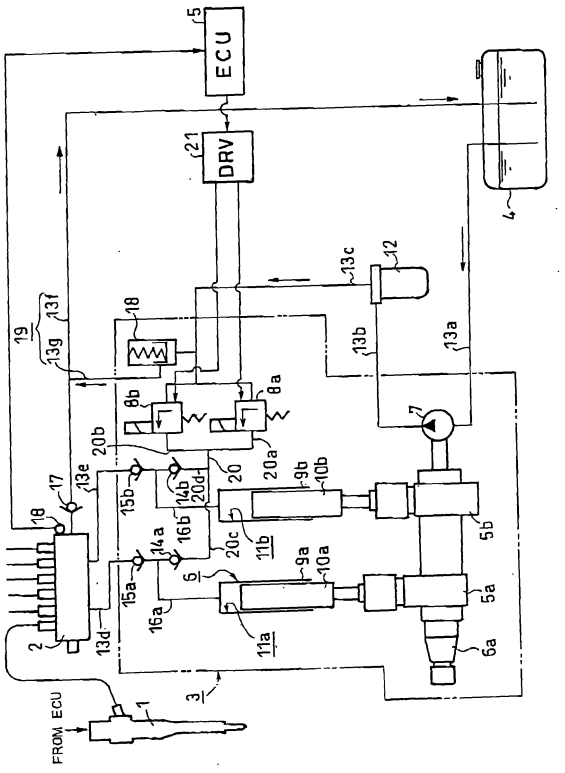
(54) DELIVERY FLOW RATE CONTROLLING METHOD IN ACCUMULATOR FUEL INJECTOR AND ACCUMULATOR FUEL INJECTOR

(57) Fuel in a fuel tank 4 is supplied to a supply pump 6 as a high pressure pump through first and second flow control valves 8a and 8b, high pressure fuel is supplied under pressure to a common rail 2 by the supply pump 6, and the high pressure fuel accumulated in the common rail 2 can be injected by fuel injection valves 1. The amount of fuel that can be passed are different between first and second flow control valves 8a and 8b, and only one of the valves can be operated by an electronic control portion 5 as required. In this way, various kinds of discharge amounts from the supply pump 6 can be addressed.

FIG. 1



EP 1 617 073 A1

Description

TECHNICAL FIELD

[0001] The present invention relates to a so-called accumulator fuel injection system, and more specifically, to such a system having improved controllability for the discharge amount and the like.

BACKGROUND ART

[0002] A conventional system of this kind has been publicly known or well known for example as the one disclosed by Japanese Patent Laid-Open No. H08-284722, according to which fuel pumped up from a fuel tank using a feed pump is supplied through a high pressure pump to a common rail to which a plurality of injection nozzles are connected, and the injection nozzles are opened by electronic control, so that the high-pressure fuel can be supplied to the combustion chamber of each of the cylinders in a diesel engine.

[0003] There have been various arrangements suggested for such an accumulator fuel injection system. Some controls the discharge amount by controlling the amount of fuel supplied to the plunger chamber of the high pressure pump on the inlet side, and more specifically, a proportional control valve whose valve travel changes in response to the magnitude of current passage or a flow control valve such as a simple on/off valve is provided (see for example Japanese Patent Laid-Open No. H08-284722 described above).

[0004] Meanwhile, in order to produce such a fuel injection system having a large discharge amount, it is a common practice to increase the capacity of the high pressure pump.

[0005] The increase in the capacity of the high pressure pump however naturally increases the amount of fuel passed through the flow control valve, so that the opening area of the flow control valve should be increased, which causes the size of the flow control valve to be increased. The increase in the size of the flow control valve makes it more difficult to secure an installment space in the system.

[0006] This not only causes difficulty in the arrangement of the system, but also pushes up the price of the system or prevents common elements from being used regardless of the discharge amount

[0007] It is an object of the invention to provide a method of controlling the discharge flow rate in an accumulator fuel injection system and an accumulator fuel injection system that can cope with various discharge amounts requested.

[0008] Another object of the invention is to provide an accumulator fuel injection system that can equally control the operation of a plurality of electromagnetic valves for flow control.

[0009] Yet another object of the invention is to provide a highly reliable accumulator fuel injection system that allows stable discharge amount control to be achieved.

DISCLOSURE OF THE INVENTION

[0010] According to a first aspect of this invention, there is provided a method of controlling a discharge amount in an accumulator fuel injection system, wherein fuel in a fuel tank is supplied to a high pressure pump through a flow control valve, high pressure fuel is supplied under pressure to a common rail by said high pressure pump, the high pressure fuel accumulated in said common rail can be injected by a fuel injection valve connected to said common rail,

a plurality of said flow control valves are connected in parallel, fuel can be supplied from said fuel tank to said high pressure pump through the plurality of flow control valves, and

among said plurality of flow control valves, flow control valves as many as necessary for a discharge amount from said high pressure pump attain an operation state.

[0011] In this structure, a necessary number of flow control valves among the plurality of flow control valves provided may be operated in response to the discharge amount from the high pressure pump, while the other flow control valves may be kept in a non-operation state. Therefore, if the high pressure pump is replaced by a pump having a different discharge amount, the difference can be addressed without changing the other elements of the accumulator fuel injection system. This allows a common system arrangement to be achieved.

[0012] According to a first aspect of this invention, there is provided an accumulator fuel injection system, wherein fuel in a fuel tank is supplied to a high pressure pump through a flow control valve, high pressure fuel is supplied under pressure to a common rail by said high pressure pump, the high pressure fuel accumulated in said common rail can be injected by a fuel injection valve connected to said common rail,

said high pressure pump comprises a plurality of plunger chambers, and

a plurality of flow control valves are provided in fuel passages connecting said plurality of plunger chambers and said fuel tank.

[0013] Said high pressure pump comprises a plurality of plunger chambers, and a plurality of flow control valves are provided in fuel passages connecting said plurality of plunger chambers and said fuel tank.

[0014] In this structure, a necessary number of flow control valves among the plurality of flow control valves provided may be operated in response to the discharge amount from the high pressure pump, and if the high pressure pump is replaced by a pump having a different discharge amount, the difference can be addressed without changing the other elements of the accumulator fuel injection system. This allows a common system arrangement to be achieved.

BRIEF DESCRIPTION OF THE DRAWINGS

[0015]

Fig, 1 is a diagram of a first example of an accumulator fuel injection system according to an embodiment of the invention;

Fig. 2 includes graphs for use in illustration of the operation of flow control valves according to the embodiment of the invention, among which Fig. 2A is a graph showing the state of how two flow control valves are operated at the same time, and Fig. 2B is a graph showing the state of how only one of the flow control valves is controlled;

Fig. 3 is a diagram of a second example of an accumulator fuel injection system according to the embodiment of the invention; and

Fig. 4 is a circuit diagram showing how the electromagnetic coils of the first and second flow control valves and the conduction driving circuit in the example shown in Fig. 3 are connected.

BEST MODE FOR CARRYING OUT THE INVENTION

[0016] The present invention will be described in detail in conjunction with the accompanying drawings.

[0017] Note that the elements, arrangements, and the like in the following description should not be construed as limiting the invention but they can be modified in various ways within the scope of the invention.

[0018] To start with, the structure of an accumulator fuel injection system (hereinafter as "the present system") according to an embodiment of the invention will be described with reference to Fig. 1.

[0019] The present system is largely divided into fuel injection valves (injectors) 1 provided corresponding to the cylinders of a diesel engine (not shown) to inject fuel for supplying the cylinders, a common rail 2 for accumulating high pressure fuel to be supplied to the fuel injection valves 1, a high pressure pump portion 3 that feeds high pressure fuel under pressure to the common rail 2, a fuel tank 4, and an electronic control portion (denoted as "ECU" in Fig. 1) 5.

[0020] The high pressure pump portion 3 includes, as main elements, a supply pump 6 serving as a high pressure pump, a feed pump 7 composed of a so-called gear pump co-axially attached to the cam shaft 6a of the supply pump 6, first and second flow control valves 8a and 8b that control the amount of fuel to be supplied to the supply pump 6, and a pressure control valve 18.

[0021] The supply pump 6 is a so-called plunger type pump that is publicly known/well known, and now the general structure of the pump will be described. The supply pump 6 according to the embodiment of the invention has first and second cylinders 9a and 9b, and first and second plungers 10a and 10b for which first and second plunger chambers 11a and 11b are formed, respectively. The first and second plungers 10a and 10b abutted against first and second cams 5a and 5b, respectively attached to the cam shaft 6a having its end (not shown) connected to the clank shaft (not shown) of the engine, and these plungers are reciprocated in the first and second cylinders 9a and 9b according to the movement of the cams moved with the rotation of the cam shaft 6a. The movement increases the pressure of the fuel in the first and second plunger chambers 11 a and 11b.

[0022] The feed pump 7 composed of a so-called gear pump is attached to the cam shaft 6a and the rotation causes fuel in the fuel tank 4 to be sucked up and supplied through the flow control valves 8 to the first and second plunger chambers 11a and 11b ahead of the supply pump 6.

[0023] According to the embodiment of the invention, the intake side of the feed pump 7 is connected to the fuel tank 4 through a first fuel passage 13a, and the discharge side of the feed pump 7 is connected to the inlet side of a fuel filter 12 through a second fuel passage 13b. The outlet side of the fuel filter 12 and the inlet side of the first and second flow control valves 8a and 8b are connected through a third fuel passage 13c. More specifically, one end of the third fuel passage 13c is connected to the outlet side of the fuel filter 12, while the other end is divided into two branches, one of which is connected to the inlet side of the first flow control valve 8a and the other is connected to the second flow control valve 8b. Therefore, fuel removed of dust and the like by the fuel filter 12 is let into the first and second flow control valves 8a and 8b.

[0024] The third fuel passage 13c is connected with one end of a seventh fuel passage 13g having the pressure control valve 18 provided therein in an appropriate location between the branch location on one end and the fuel filter 12, and the other end of the seventh connection passage 13g is connected to a sixth fuel passage 13f that will be described, The sixth and seventh fuel passages 13f and 13g form a fuel return passage 19.

[0025] The pressure control valve 18 is for example a so-called mechanical valve that opens at a prescribed pressure level or higher. According to the embodiment, when the pressure at the inlet side of the first and second flow control valves 8a and 8b reaches a prescribed pressure level or more, the pressure control valve 18 is opened, so that fuel from the feed pump 7 is returned to the fuel tank 4 through the pressure control valve 18, and the seventh and sixth fuel passages 13g and 13f. In this way, the amount of fuel discharged by the first and second flow control valves 8a and 8b can be controlled more precisely.

[0026] The first and second flow control valves 8a and 8b are both made of a current-driven proportional electromagnetic valve, the amount of current passage therethrough is controlled to control the opening state, and the amount of current passage and the opening state are

substantially in proportion. According to the embodiment of the invention, as the amount of current passage increases, the distribution amount of fuel increases. Based on the amount of fuel supplied to the first and second plunger chambers 11a and 11b through the first and second flow control valves 8a and 8b, the amount of high pressure fuel fed under pressure to the common rail 2 is determined. Therefore, the first and second flow control valves 8a and 8b serve as electromagnetic valves for controlling the pressure of the common rail 2.

[0027] Meanwhile, a common fuel passage 20 is provided on the outlet side of the first and second flow control valves 8a and 8b. More specifically, the common fuel passage 20 have both ends divided into two, two branch paths 20a and 20b on one side are connected to the outlet side of the first and second flow control valves 8a and 8b, respectively. Meanwhile, among the two branch passages 20c and 20d on the other side of the common fuel passage 20, the branch passage 20c is connected with one end of a fourth fuel 13 d through a first intake valve 14a, while the branch passage 20d is connected with one end of a fifth fuel passage 13e through a second intake valve 14b. The other ends of the fourth and fifth fuel passages 13d and 13e are both connected to the common rail 2.

[0028] Therefore, according to the embodiment of the invention, the first and second flow control valves 8a and 8b are connected in parallel between the fuel tank 4 and the first and second plunger chambers 11a and 11b.

[0029] A first discharge valve 15a is provided in an appropriate location in the fourth fuel passage 13d between the first intake valve 14a and the comumon rail 2. A second discharge valve 15b is provided in an appropriate location in the fifth fuel passage 13e between the second intake valve 14b and the common rail 2.

[0030] A first plunger chamber connection fuel passage 16a in communication with the first plunger chamber 11a is connected to the fourth fuel passage 13d in an appropriate location between the first intake valve 14a and the first discharge valve 15a. A second plunger chamber connection fuel passage 16b in communication with the second plunger chamber 11b is connected to the fifth fuel passage 13e in an appropriate location between the second intake valve 14b and the second discharge valve 15b.

[0031] The first and second intake valves 14a and 14b have a check valve structure that prevents the flow of fuel from the side of the first and second plunger chambers 11a and 11b to the side of the first and second flow control valves 8a and 8b. When the first and second plungers 10a and 10b are in locations in a suction stroke state, and the first and second flow control valves 8a and 8b are opened, fuel sucked up from the fuel tank 4 by the feed pump 7 is let to flow into the first and second plunger chambers 11a and 11b through the first and second intake valves 14a and 14b, respectively.

[0032] The first and second discharge valves 15a and 15b have a check valve structure that prevents the flow of fuel from the side of the common rail 2 to the side to which first and second intake valves 14a and 14b are connected. In this way, when the first and second plungers 10a and 10b are in locations in a compression stroke state, and the fuel in the first and second plunger chambers 11a and 11b attains a prescribed high pressure state, the high pressure fuel is let to flow from the first and second plunger chambers 11a and 11b to the common rail 2 through the first and second discharge valves 15a and 15b.

[0033] Note that the sixth fuel passage 13f and a relief valve 17 are provided between the common rail 2 and the fuel tank 4 in order to return excess fuel in the common rail 2 to the fuel tank 4. When the pressure of fuel in the common rail 2 reaches a prescribed level or higher, the fuel is returned to the fuel tank 4 through the relief valve 17.

[0034] The electronic control portion 5 for example includes for example a microcomputer as a main element and is provided with detection signals for the pressure sensor 18 provided for detecting the pressure inside the common rail 2 and various other signals necessary for controlling the engine such as a signal for the revolutions of the engine and a accelerator opening signal (not shown). The electronic control portion 5 controls the operation of the first and second flow control valves 8a and 8b based on these input signals through a conduction driving circuit (denoted as "DRV" in Fig. 1) 21, in other words, the portion controls the current passed therethrough, the operation of the fuel injection valves 1 and the like so that the fuel pressure in the common rail 2 reaches a target common rail pressure.

[0035] Now, how this structure operates will be described.

[0036] The electronic control portion 5 calculates a target fuel injection amount and a target common rail pressure based on various signal inputs such as a signal for the engine revolutions and the accelerator opening signal, and the calculated pressure is compared to an actual pressure in the common rail 2 detected by the pressure sensor 18 in order to calculate the amount of current to be passed through the first and second flow control valves 8a and 8b. The DRV 21 is controlled to be at the calculated current value and the first and second flow control valves 8a and 8b attain a prescribed opening state accordingly. The opening state of the first and second flow control valves 8a and 8b allows fuel sucked up from the fuel tank 4 by the feed pump 7 to be supplied to the first and second plunger chambers 11a and 11b through the first and second flow control valves 8a and 8b.

[0037] The compression function of the first and second plungers 10a and 10b causes the fuel in the first and second plunger chambers 11a and 11b to attain a high pressure state, and once the pressure reaches a prescribed level or higher, an amount of high pressure fuel controlled based on the opening state of the flow control valves 8a and 8b is supplied to the common rail 2 through the first and second discharge valves 15a and 15b.

[0038] Then, the fuel injection valves 1 are driven by the electronic control portion 5 in appropriate timings, so that the high pressure fuel is injected by the fuel injection valves 1 into the internal combustion engine that is not shown.

[0039] In this accumulator fuel injection system, the feed pump 7 is designed to have discharge ability to allow sufficient fuel as much as that in a high speed state to be secured even in a low speed state such as at the start of the engine, and therefore when the revolution speed of the engine (not shown) is higher, and the discharge amount from the high pressure pump portion 3 is desired to be zero such as during deceleration, most of the fuel from the feed pump 7 is returned to the fuel tank 4 through the pressure control valve 18 and the fuel return passage 19.

[0040] In the above described operation, the first and second flow control valves 8a and 8b are both used, but if the necessary discharge amount is relatively small or small enough not to use both the first and second flow control valves 8a and 8b, only one of the first and second flow control valves 8a and 8b may be operated while the other is kept in a non-operation state.

[0041] Fig. 2 illustrates the concept of how the flow control valves operate in such a case.

[0042] Fig. 2A shows how two flow control valves are simultaneously operated, in which case the opening areas of the two valves are added to provide an opening area corresponding to the maximum discharge amount of the high pressure pump. Note that in Fig. 2A, the bold characteristic line attached with letter a represents the opening area characteristic when the two flow control valves are operated at the same time, and the dotted characteristic line attached with letter b represents the opening area characteristic per flow control valve. The position of the thin line attached with Sl represents the necessary opening area for the maximum discharge amount. The inclination of the characteristic line a represented by indicates the opening area sensitivity in response to current change,

[0043] When for example a diesel engine is operated in an idle state, the necessary discharge amount from the high pressure pump is very small. Therefore, if the opening area changes greatly in response to the current change amount, it is difficult to stably control the pressure in the common rail in some cases.

[0044] Fig. 2B shows an example of how such a problem is solved by carrying out control using one flow control valve while closing the other flow control valve when the requested discharge amount is small.

[0045] More specifically, if the discharge amount from the supply pump 6 is smaller than K, the flow control valve 8b is closed and the flow rate is controlled using only the flow control valve 8a. If the discharge amount from the supply pump 6 is greater than K, the flow control valve 8a is fixed at the level of current value k (A) corresponding to the discharge amount K, and the excess amount above K is taken care of by the flow control valve 8b, so that the flow rate change in response to the current change is not increased while the opening area corresponding to the maximum discharge amount can be secured.

[0046] Note that in Fig. 2B, the bold characteristic line attached with letter c represents the opening area characteristic of the flow contrvl valves 8a and 8b altogether, and at the time the flow control valve 8a is kept at the current level K immediately before the fully open state, while the flow control valve 8b is in a closed state. In Fig. 2B, the dotted characteristic line attached with letter d represents the opening area characteristic of the flow control valve 8b. More specifically, the position of the thin line attached with S2 represents the necessary opening area for the maximum discharge amount. The part of the dotted line attached with letter e corresponds to the discharge amount K. The inclination of the characteristic line c represented by _2 indicates the opening area sensitivity in response to current change.

[0047] In the above example, the first and second flow control valves 8a and 8b have the same electrical and mechanical characteristics, but one of the valves may have a different flow rate sensitivity from the other. (In other words, the area of the part through which the fluid passes may be different).

[0048] In this way, if the requested discharge amount sensitivity differs depending on the discharge amount, the same structure may be employed. When for example the discharge amount is relatively large and the requested discharge amount sensitivity is also large, the first and second flow control valves 8a and 8b may both be operated, while when the discharge amount of the supply pump 6 is relatively small and the requested discharge amount sensitivity is also small, only the one of the first and second flow control valves 8a and 8b that has a smaller flow rate sensitivity may be operated.

[0049] Now, a second example will be described with reference to Figs. 3 and 4. Note that the same elements as those of the example shown in Fig. 1 will be referred to as the same elements, a detailed description of them will not be provided, and the different points will mainly be described.

[0050] To start with, the characteristic of the second example will briefly be described. In the foregoing first example, the first and second flow control valves 8a and 8b are connected to the first and second plunger chambers 11a and 11b of the supply pump 6 through the common fuel passage 20, while in the second example, fuel from the fuel tank 4 is supplied to the first and second plunger chambers 11a and 11b of the supply pump 6 through the first and second flow control valves 8a and 8b provided in separate fuel passages, and the electromagnetic coils 23 a and 23b of the first and second flow control valves 8a and 8b are connected in series.

[0051] More specifically, the outlet side of the first flow control valve 8a and the first intake valve 14a are connected by a first control valve outlet side-fuel passage 22a, and the outlet side of the second flow control valve 8b and the second intake valve 14b are connected by a

second control valve outlet side-fuel passage 22b.

[0052] The pipes are arranged on the outlet side of the first and second intake valves 14a and 14b in the same manner as the first example described above (see Fig. I).

[0053] Therefore, fuel passed through the first flow control valve 8a is made to flow into the first plunger chamber 11a through the first control valve outlet side-fuel passage 22a, the first intake valve 14a, and a first plunger chamber connection fuel passage 16a. Meanwhile, fuel passed through the second flow control valve 8b is made to flow into the second plunger chamber 11b through the second control valve outlet side-fuel passage 22b, the second intake valve 14b, and a second plunger chamber connection fuel passage 16b.

[0054] As shown in Fig. 4, the electromagnetic coils 23a and 23b of the first and second flow control valves 8a and 8b are connected in series and turned on by a conduction driving circuit 21.

[0055] Now, the operation of this example will be described.

[0056] The basic operation of the second example is the same as that of the first example, and therefore the different points between them will mainly be described.

[0057] The first and second flow control valves 8a and 8b are driven to turn on at the same time by the electronic control portion 5 through the conduction driving circuit 21. Unlike conventional arrangements, these first and second flow control valves 8a and 8b have their electronic coils 23a and 23b connected in series, and therefore current passed through the two electronic coils 23a and 23b is surely the same, so that the electrical and mechanical characteristics and the like of the first and second flow control valves 8a and 8b are the same. In this way, the valves are controlled in the same state. Stated differently, the amounts of fuel passed through the first and second flow control valves 8a and 8b are surely controlled to be equal.

[0058] The fuel passed through the first flow control valve 8a is made to flow into the first plunger chamber 11a through the first control valve outlet side-fuel passage 22a, the first intake valve 14a, and the first plunger chamber connection fuel passage 16a. Meanwhile, the fuel passed through the second flow control valve 8b is made to flow into the second plunger chamber 11b through the second control valve outlet side-fuel passage 22b, the second intake valve 14b, and the second plunger chamber connection fuel passage 16b. The fuel is then compressed in the first and second plunger chambers 11a and 11b and supplied to the common rail 2 as high pressure fuel in the same manner as the first example.

[0059] In this way, if there are variations in the electrical resistance of the electromagnetic coils caused during the manufacture or imbalance in the electrical resistance caused by temperature differences during driving, the current values can surely be kept equal. Therefore, when for example the winding numbers of the coils may surely be controlled, the characteristics of the two electromagnetic coils may be controlled to be equal. Only a single driving circuit and a single current detection circuit are necessary, which is advantageous as well.

[0060] It is understood that in any of the examples described above, the two flow control valves 8a and 8b are provided, but three or more such valves rather than two may be provided

[0061] As in the foregoing, an accumulator fuel injection system provided according to the present invention has a plurality of flow control valves that can selectively be operated as required, so that the elements of the system do not have to be changed if the discharge amount from the high pressure pump changes. Therefore, high flexibility in response to specification changes in the system results, and stable control can be achieved.

[0062] In the arrangement in which the electromagnetic coils of the plurality of flow control valves are connected in series, current passed through the flow control valves can surely be equal, so that the operation of the flow control valves can stably be controlled. Therefore, a highly reliable accumulator fuel injection system having stable controllability can be provided

INDUSTRIAL APPLICABILITY

[0063] As in the foregoing, the accumulator fuel injection system according to the invention can selectively operate a plurality of flow control valves as required and cope with different discharge amounts from the high pressure pump and is suitably applied to a system that can be subjected to specification changes.

Claims

1. A method of controlling a discharge amount in an accumulator fuel injection system, wherein fuel in a fuel tank is supplied to a high pressure pump through a flow control valve, high pressure fuel is supplied under pressure to a common rail by said high pressure pump, the high pressure fuel accumulated in said common rail can be injected by a fuel injection valve connected to said common rail,
   a plurality of said flow control valves are connected in parallel, fuel can be supplied from said fuel tank to said high pressure pump through the plurality of flow control valves, and
   among said plurality of flow control valves, flow control valves as many as necessary for a discharge amount from said high pressure pump attain an operation state.

2. The method of controlling a discharge amount in an accumulator fuel injection system according to claim 1, wherein at least one of the plurality of flow control valves has a flow rate sensitivity smaller than those of the other flow control valves.

3. An accumulator fuel injection system, wherein fuel

in a fuel tank is supplied to a high pressure pump through a flow control valve, high pressure fuel is supplied under pressure to a common rail by said high pressure pump, the high pressure fuel accumulated in said common rail can be injected by a fuel injection valve connected to said common rail,
said high pressure pump comprises a plurality of plunger chambers, and
a plurality of flow control valves are provided in fuel passages connecting said plurality of plunger chambers and said fuel tank.

4. The accumulator fuel injection system according to claim 3, wherein the plurality of flow control valves are provided as they are connected in parallel.

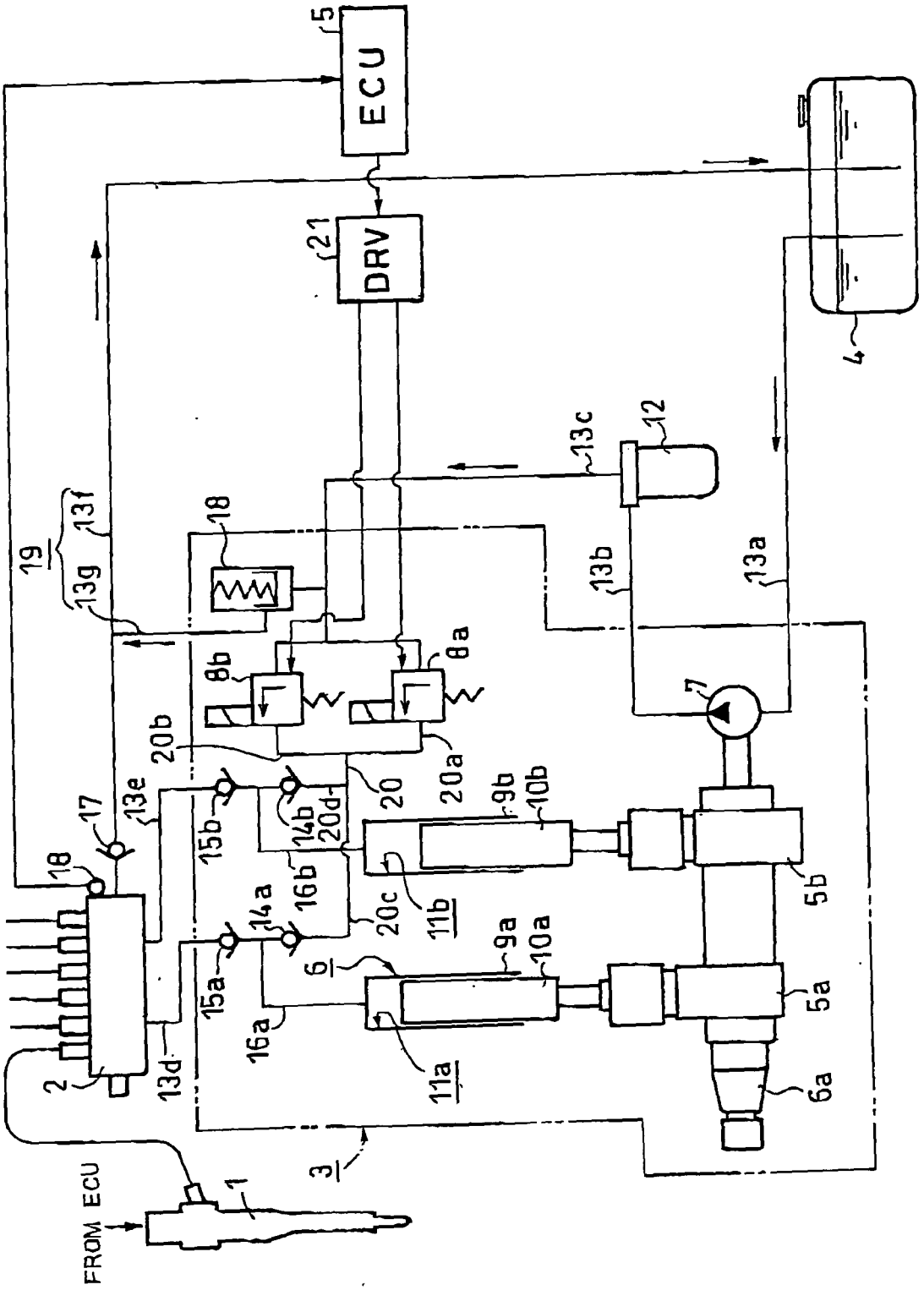
5. The accumulator fuel injection system according to claim 4, wherein the plurality of flow control valves are provided so that the operation of said valves can be controlled independently from one another.

6. The accumulator fuel injection system according to claim 5, wherein the plurality of flow control valves can pass different quantities of flow from one another.

7. The accumulator fuel injection system according to claim 3, wherein the high pressure pump comprises a plurality of plunger chambers, flow control valves are provided corresponding to the number of said plunger chambers, and said plurality of plunger chambers are each supplied with fuel from said fuel tank through a corresponding one of the flow control valves.

8. The accumulator fuel injection system according to claim 7, wherein the flow control valves provided corresponding to the number of plunger chambers are made of electromagnetic valves that have their electromagnetic coils connected in series.

FIG. 1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DRV
21
4
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13c
13a
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13g
18
8a
8b
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13e
17
15b
14b
20d
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16b
20c
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13d
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FROM ECU

FIG. 2

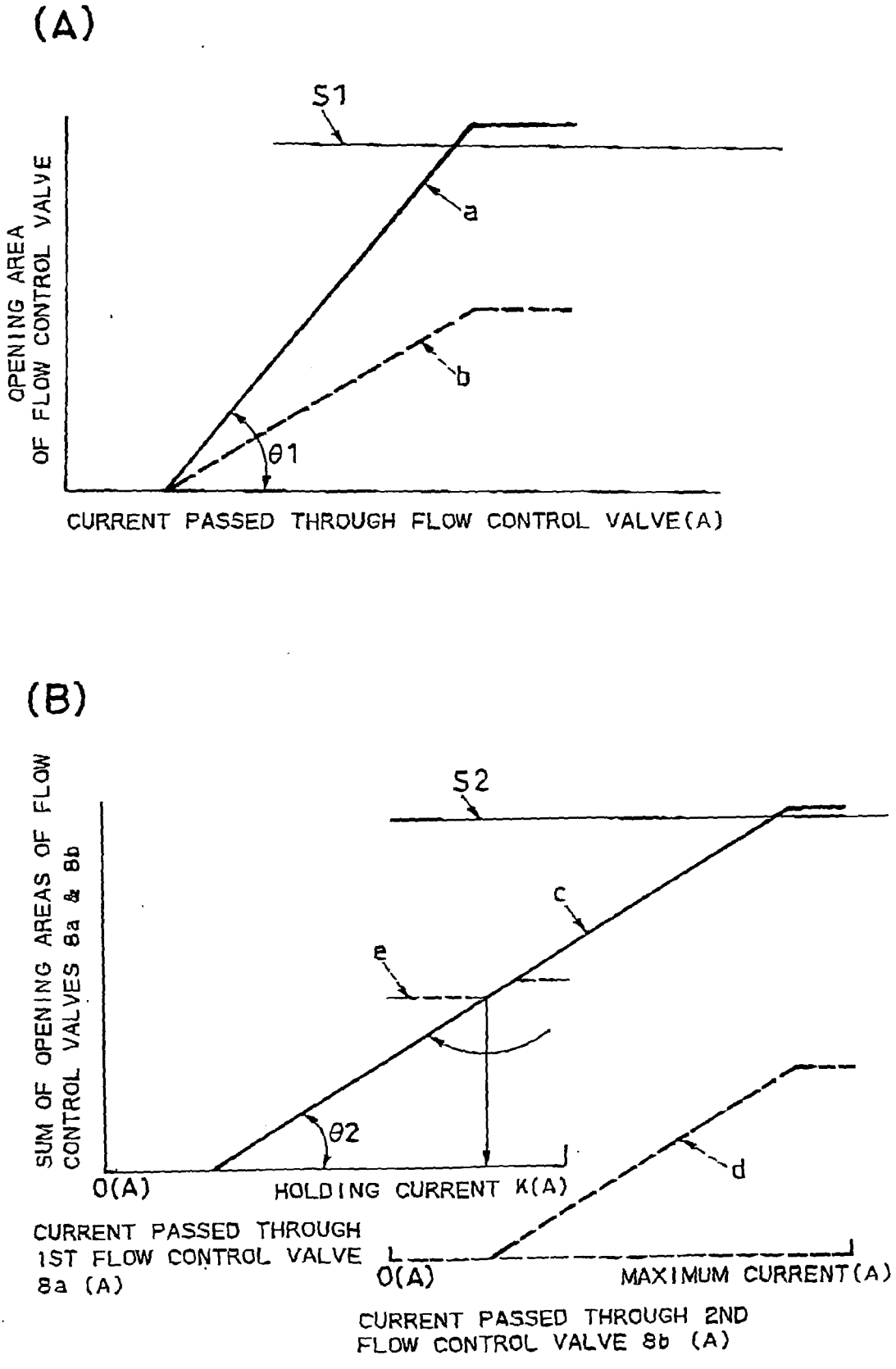
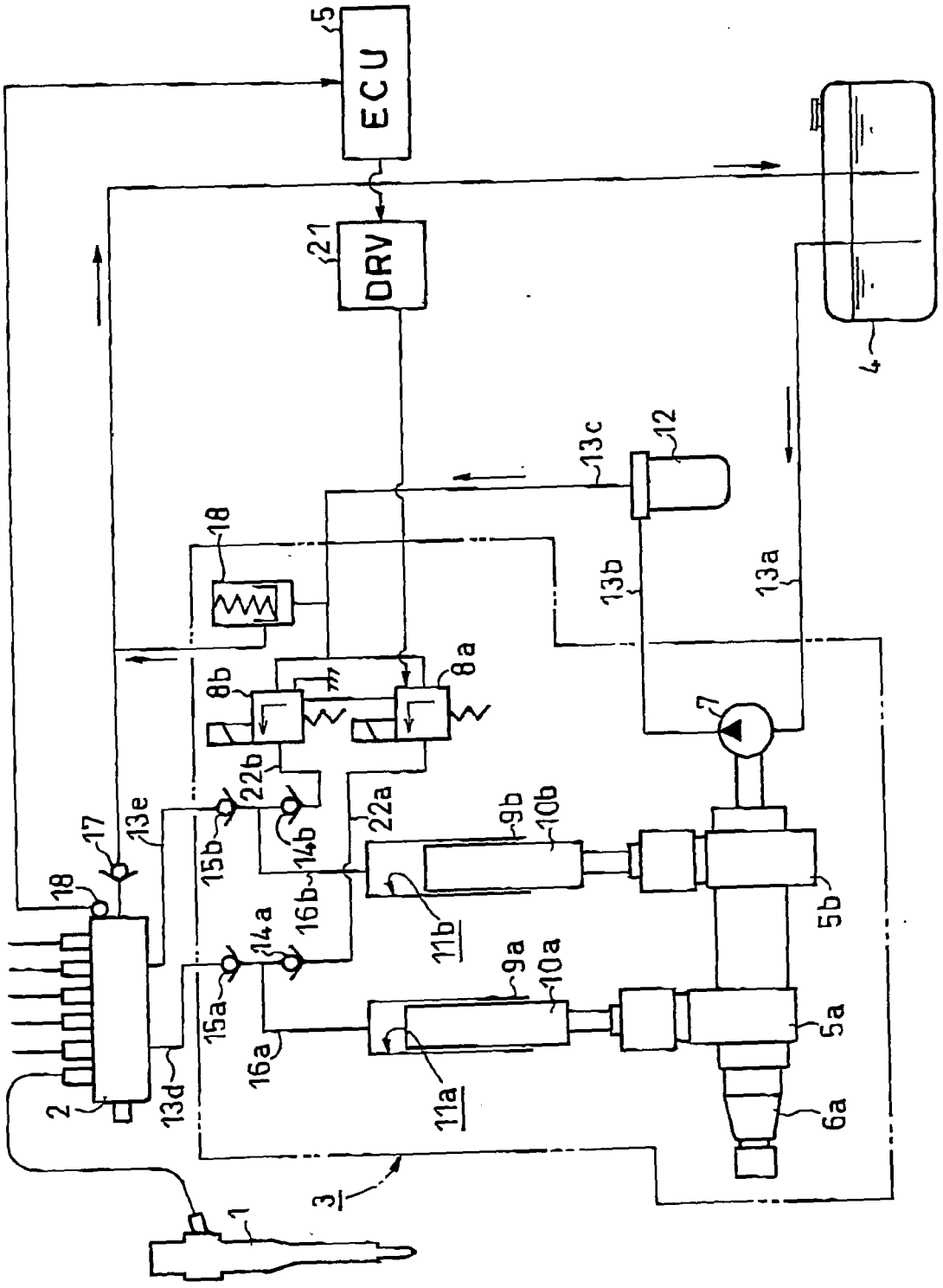

(A)
S1
a
b
θ1
OPENING AREA OF FLOW CONTROL VALVE
CURRENT PASSED THROUGH FLOW CONTROL VALVE(A)
(B)
S2
c
e
θ2
d
SUM OF OPENING AREAS OF FLOW CONTROL VALVES 8a & 8b
0(A)
HOLDING CURRENT K(A)
CURRENT PASSED THROUGH 1ST FLOW CONTROL VALVE 8a (A)
L
0(A)
MAXIMUM CURRENT(A)
CURRENT PASSED THROUGH 2ND FLOW CONTROL VALVE 8b (A)

FIG. 3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DRV
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8a
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13e
17
18
15b
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16a
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6a
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13d
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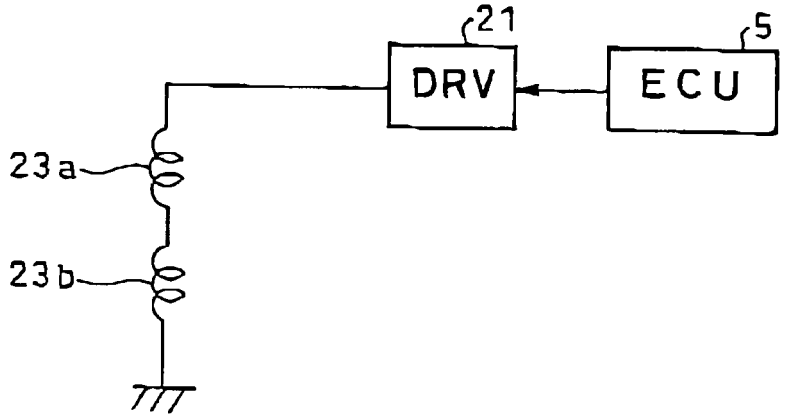
1

FIG. 4



INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP03/05232

A. CLASSIFICATION OF SUBJECT MATTER
Int.Cl[7] F02M59/34, F02M51/00, F02M47/00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
Int.Cl[7] F02M59/34, F02M51/00, F02M47/00

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Jitsuyo Shinan Koho	1922-1996	Toroku Jitsuyo Shinan Koho	1994-2003
Kokai Jitsuyo Shinan Koho	1971-2003	Jitsuyo Shinan Toroku Koho	1996-2003

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	JP 2003-42025 A (Bosch Automotive Systems Corp.), 13 February, 2003 (13.02.03), Full text; all drawings (Family: none)	1-6
Y	US 4763560 A (Tokyo Precision Instruments Co., Ltd.), 16 August, 1988 (16.08.88), Full text; all drawings & JP 60-249777 A	1-6
Y	JP 49-20719 A (Tokyo Keiki Co., Ltd.), 23 February, 1974 (23.02.74), Full text; all drawings (Family: none)	1-6

[x] Further documents are listed in the continuation of Box C. [ ] See patent family annex.

* Special categories of cited documents:
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"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
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"&" document member of the same patent family

Date of the actual completion of the international search 15 July, 2003 (15.07.03)	Date of mailing of the international search report 29 July, 2003 (29.07.03)
Name and mailing address of the ISA/ Japanese Patent Office Facsimile No.	Authorized officer Telephone No.

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP03/05232

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	Microfilm of the specification and drawings annexed to the request of Japanese Utility Model Application No. 192439/1986(Laid-open No. 97778/1988) (Ranco Japan Ltd.), 24 June, 1988 (24.06.88), Full text; all drawings (Family: none)	1-6
X A	JP 11-257141 A (Nippon Soken, Inc.), 21 September, 1999 (21.09.99), Full text; all drawings (Family: none)	3-5,7 8
X A	US 5701873 A (Wolfgang Schneider), 30 December, 1997 (30.12.97), Full text; all drawings & JP 8-505680 A & EP 678166 A & WO 95/13474 A & CN 1116441 A & DE 59406680 C & CA 2151518 A	3-5,7 8

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