(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 0 728 935 A1

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
28.08.1996 Bulletin 1996/35

(51) Int. Cl.[6]: F02M 9/06, F02M 7/22

(21) Application number: 96102351.2

(22) Date of filing: 16.02.1996

(84) Designated Contracting States:
DE FR GB IE IT

(30) Priority: 21.02.1995 JP 58168/95

(71) Applicant: TK CARBURETOR CO., LTD.
Toyota-shi, Aichi-ken (JP)

(72) Inventors:
- Takeuchi, Yuzo
Toyota-shi, Aichi-ken (JP)
- Minoura, Mikio
Toyota-shi, Aichi-ken (JP)
- Suzuki, Satoshi
Toyota-shi, Aichi-ken (JP)

(74) Representative: Blumbach, Kramer & Partner
Patentanwälte
Radeckestrasse 43
81245 München (DE)

(54) Carburetor having metering valve with improved air-fuel ratio adjusting performance

(57) A carburetor (1) having a single fuel supply system of a simple construction and capable of stable fuel supply to an engine in an appropriate air-fuel ratio is provided. Air and fuel is mixed to obtain a constant air-fuel ratio in a negative pressure moderating chamber (13) so controlled under negative pressure that adverse effect of air compressibility can be practically negligible. Then, air-fuel mixture and main intake air metered through a main intake air restriction (8) are mixed at the restriction or in a main intake passage (3) downstream thereof. Both the air-fuel mixture and the main intake air are compressible fluids, so that there is a direct proportion between the intake air flow rate and the air-fuel mixture amount injected from the negative pressure moderating chamber (13). Thus, the air-fuel ratio of the mixture composed in said main intake passage (3) is kept constant in all the running operations of the engine. This permits fuel supply with a single supply system.

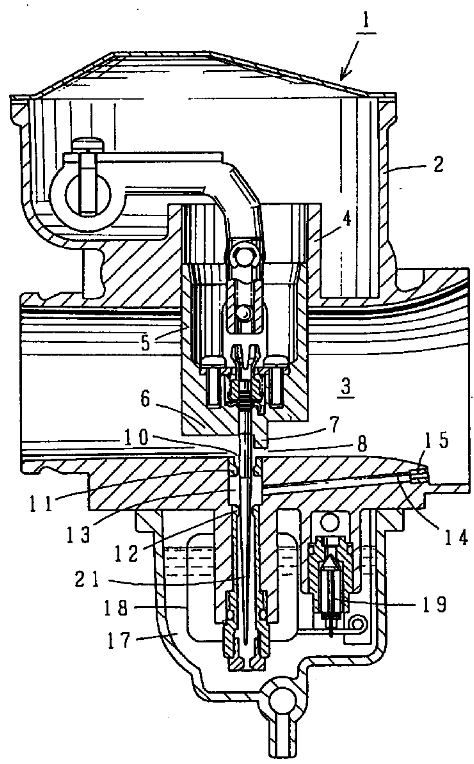

FIG.1

EP 0 728 935 A1

Description

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to a carburetor having a metering valve adapted to accurately adjust an air-fuel ratio of air-fuel mixture supplied to an internal combustion engine.

2. Description of the Prior Art

Generally, in a carburetor, when a negative pressure of an intake passage is large as during idling operation of an engine, the compressibility of air causes intake air amount (weight) to be reduced, thus providing a rich air-fuel ratio. In contrast, when the negative pressure of the intake passage is small as in normal- or high-speed engine operation, a lean air-fuel ratio is provided, causing shortage of fuel. Therefore, individual fuel supply systems have been required both for low speed operation and for high speed operation. Here, by large negative pressure of an intake passage is meant low pressure therein, namely, large pressure difference from the atmospheric pressure. Accordingly, the smaller the negative pressure will be, the nearer it will approach the atmospheric pressure.

However, such a multi-systematization of the fuel supply systems complicates air-fuel ratio control, and prohibits smooth shift between the fuel supply systems when a vehicle starts and rapidly accelerates. This causes a discontinuous combustion, thus preventing smooth control of the running conditions of the engine.

In some carburetors, a jet needle interlocked with a metering valve is inserted in a needle jet so as to change the area of a clearance defined between the jet and the needle, thereby controlling the air-fuel ratio to be substantially constant from idling operation to full-open running operation. Still, adverse effect of the air compressibility to the air-fuel ratio cannot be avoided, because compressible air is controlled by the metering valve and incompressible fuel is controlled by the jet needle in this system. Thus, it is difficult to accurately stabilize the air-fuel ratio for all the running conditions of the engine.

SUMMARY OF THE INVENTION

It is, accordingly, an object of the present invention to provide a carburetor having a metering valve and a single fuel supply system of a simple construction and capable of supplying fuel to an engine stably in a proper air-fuel ratio.

According to the present invention, an air-fuel mixture metering jet and a fuel metering jet are provided for cooperating with a jet needle movable in association with an opening and closing of a metering valve. Specifically, the jet needle is inserted both through the air-fuel mixture metering jet and through the fuel metering jet provided between a fuel chamber and a negative pressure moderating chamber. The negative pressure moderating chamber communicates with the main intake passage upstream of the metering valve through an air metering jet and downstream of the metering valve through the air-fuel mixture metering jet.

With this construction, not only the main intake air flows in the main intake passage, but also sub-intake air flows therein through the air metering jet, the negative pressure moderating chamber, and the air-fuel mixture metering jet. In this case, negative pressure in the negative pressure moderating chamber varies with the negative pressure of the main intake passage downstream of the metering valve. It should be noted that the negative pressure in the negative pressure moderating chamber is moderated compared with that in the main intake passage downstream of the metering valve. The fuel is introduced through the fuel metering jet into the negative pressure moderating chamber and is transformed into an air-fuel mixture which is then introduced into the main intake passage through the air-fuel mixture metering jet.

The fuel metering jet is provided between the fuel chamber and the negative pressure moderating chamber, and the negative pressure in the negative pressure moderating chamber is smaller than that in the main intake passage. Thus, the air-fuel ratio of the air-fuel mixture produced in the negative pressure moderating chamber is accurately controlled independently of the variation of the negative pressure in the main intake passage. Such an accurately adjusted air-fuel mixture is introduced into the main intake passage through the air-fuel mixture metering jet, so that the mixture supplied to the engine is accurately adjusted in the air-fuel ratio.

The present invention will be more fully understood from the following detailed description and appended claims when taken with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a vertical cross-sectional view of a carburetor with a slidable metering valve according to an embodiment of the present invention;

FIG. 2 is a cross-sectional view of the essential parts of a modification according to the present invention to the embodiment of FIG. 1;

FIG. 3 is an explanatory view of another modification according to the present invention wherein a manual adjusting valve is provided in an air introduction passage;

FIG. 4 is an explanatory view of still another modification according to the present invention wherein a solenoid valve driven by an O_2 sensor is provided in the air introduction passage;

FIG. 5 is an explanatory view of a further modification according to the present invention where in a temperature-responsive valve is provided in the air introduction passage;

FIG. 6 is an explanatory view of a still further modification according to the present invention wherein a high-altitude compensation valve is provided in the air introduction passage; and

FIG. 7 is a vertical cross-sectional view of a carburetor with a butterfly valve according to another embodiment of the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now to FIG. 1, shown therein in section is a carburetor 1 with a slidable metering valve 5 embodying the present invention. The carburetor 1 includes a carburetor body 2 defining a main intake passage 3 formed therethrough. The main intake passage 3 is provided with a valve guide cylinder 4 into which the slidable metering valve 5 is retractably inserted to directly control engine output. The slidable metering valve 5 has a bottom 6 from which a projection wall 7 is downwardly projected. The projection wall 7 and an opposing inside wall of the main intake passage 3 form a main intake air restriction 8 therebetween to control an effective aperture of the main intake passage 3.

The carburetor body 2 further defines a negative pressure moderating chamber 13 and a fuel chamber 17. The negative pressure moderating chamber 13 is communicated with the main intake passage 3 downstream of the metering valve 5, the main intake passage 3 upstream of the metering valve 5 and the fuel chamber 17. An air-fuel mixture supply hole 10 is opened to the main intake passage 3 and is located downstream of the metering valve 5. To be more exact, the air fuel mixture supply hole 10 is located downstream of the main intake air restriction 8. An air-fuel mixture metering jet 11 is provided between the negative pressure moderating chamber 13 and the main intake passage 3. A fuel metering jet 12 is provided between the negative pressure moderating chamber 13 and the fuel chamber 17. An air introduction passage 14 is provided between the negative pressure moderating chamber 13 and the main intake passage 3 upstream of the metering valve 5. An air metering jet 15 is provided between the air introduction passage 14 and the main intake passage 3. The air-fuel mixture metering jet 11 and the fuel metering jet 12 are located on a line along which the metering valve 5 slides.

The downward side of the fuel metering jet 12 is communicated with the fuel chamber 17 at a position under the fuel level in the fuel chamber 17. The fuel level of the fuel chamber 17 is kept constant by a floating mechanism including a float 18 and a needle valve 19. This floating mechanism is well known in the art, and its description will be omitted.

A jet needle 21 is attached to the bottom 6 of the slidable metering valve 5. The jet needle 21 has an end inserted into the air-fuel mixture metering jet 11 and the fuel metering jet 12 with clearances therearound. Fuel flow from the fuel chamber 17 to the negative pressure moderating chamber 13 is metered through the clearance defined between the jet needle 21 and the fuel metering jet 12. An air-fuel mixture is produced in the negative pressure moderating chamber 13 by the fuel flow from the fuel chamber 17 through the fuel metering jet 12 and an air flow from the main intake passage 3 through the air metering jet 15. The air-fuel mixture is metered through the clearance defined between the jet needle 21 and the air-fuel mixture metering jet 11, and is then injected into the main intake passage 3.

As should be apparent from the above description, the jet needle 21 is advanced and retracted in association with the opening and closing of the metering valve 5. The air-fuel mixture metering jet 11, through which the jet needle 21 is inserted with a clearance, is formed downstream of the metering valve 5 and between the main intake passage 3 and the negative pressure moderating chamber 13. The fuel metering jet 12, through which the jet needle 21 is inserted with a clearance, is formed between the negative pressure moderating chamber 13 and the fuel chamber 17. The negative pressure moderating chamber 13 is communicated through the air introduction passage 14 and the air metering jet 15 with the main intake passage 3 upstream of the metering valve 5.

The negative pressure in the negative pressure moderating chamber 13 is controlled both by the air metering jet 15 and the clearance defined between the air-fuel mixture metering jet 11 and the jet needle 21. The area of the air metering jet 15 is determined to be larger than that of the clearance between the air-fuel mixture metering jet 11 and the jet needle 21, so that the negative pressure of the negative pressure moderating chamber 13 is suppressed, even when the negative pressure at the main intake passage 3 downstream of the metering valve 5 becomes highest such as in idling and decelerating operations of the engine, to be 60 mmHg or lower under which the effect of the air compressibility to the air-fuel ratio A/F is practically negligible. With this construction, air and fuel are mixed always in the same proportion In weight volume in the negative pressure moderating chamber 13, thus assuring a constant air-fuel ratio A/F.

Further, the air-fuel mixture produced in the negative pressure moderating chamber 13 is metered through the clearance between the air-fuel mixture metering jet 11 and the jet needle 21 to be injected into the downstream of the main intake air passage 3 and mixed with the air metered by the main intake air restriction 8. The air-fuel mixture produced in the negative pressure moderating chamber 13 and the air flowing in the main intake passage 3 are both compressible fluids. Accordingly, the air-fuel mixture and the air are directly proportional to each other in volume, and therefore, the air-fuel ratio A/F of a mixture supplied to the engine is kept constant in all the running operations.

The operation of the above embodiment will now be described. The negative pressure in the negative pressure moderating chamber 13 is determined by the area ratio of the clearance defined between the jet needle 21 and the air-fuel mixture metering jet 11 to the air metering jet 15, so that it may be controlled to be 60 mmHg or lower under which adverse effect of the air compressibility to the air-fuel ratio is practically negligible. Therefore, the flow rate of the sub-intake air sucked from the air metering jet 15 through the air introduction passage 14 into the negative pressure moderating chamber 13 is constantly proportional to the amount of the fuel sucked from the fuel metering jet 12, and accordingly, the air-fuel ratio A/F of the air-fuel mixture produced in the negative pressure moderating chamber 13 is always kept constant. On the other hand, the main intake air flowing through the main intake passage 3 is metered through the main intake air restriction 8, and is mixed with the air-fuel mixture injected from the negative pressure moderating chamber 13 through the clearance defined between the mixture metering jet 11 and the jet needle 21. The air-fuel mixture in the negative pressure moderating chamber 13 is a compressible fluid because of its large ratio of the air-volume to the fuel-volume. Therefore, the main intake air flow rate metered through the main intake air restriction 8 and the amount of air-fuel mixture injected from the air-fuel mixture supply hole 10 are constantly proportional to each other. Thus, the air-fuel ratio A/F of the mixture supplied to the engine is kept constant in its all running operations.

FIG. 2 shows a modification according to the invention in which an idle passage 25 is provided such that one end thereof is connected to the negative pressure moderating chamber 13 and the other end thereof is connected to the main intake passage 3 downstream of the main intake air restriction 8. With this construction, fuel supply during idling operation is effected from the idle passage 25, so that the idling operation can be stabilized.

FIGS. 3 to 6 show further modifications according to the invention in which compensation valves 27a to 27d capable of adjusting air amount are provided in the air introduction passage 14, so that the air-fuel ratio A/F can be compensated by adjusting the negative pressure of the negative pressure moderating chamber 13.

The compensation valve 27a shown in FIG. 3 is in the form of an adjusting valve 31 which manually adjusts the area of an air metering jet 30. Preferably, the adjusting valve 31 is so coupled to the air metering jet 15 of a fixed diameter that the negative pressure of the negative pressure moderating chamber 13 can be controlled not to exceed 60 mmHg even when the adjusting valve 31 is fully opened. However, the adjusting valve 31 may serve only for opening and closing operation.

The compensation valve 27b shown in FIG. 4 is in the form of a solenoid valve 38 which is driven by an output signal from an electronic control circuit 37 into which a signal from an O_2 sensor 36 mounted on a discharge pipe 35 is inputted. In the compensation valve 27b, the air-fuel ratio is feedback controlled according to O_2 density in the discharge air.

The compensation valve 27c shown in FIG. 5 is in the form of a temperature-responsive valve 40 which is driven by bimetal and waxes responsive to an engine temperature. The temperature-responsive valve 40 is opened when the engine temperature is high, and is closed when it is low. Thus, when the engine is at low temperature, the negative pressure of the negative pressure moderating chamber 13 is increased to have a richer air-fuel ratio.

The compensation valve 27d shown in FIG. 6 is in the form of a high-altitude compensation valve 43 which is driven by a high-altitude compensator 42. In a high place, the compensation valve 43 serves to increase air flow rate from the air introduction passage 14 into the negative pressure moderating chamber 13.

It will be noted that the above described compensation valves 27a to 27d can be used alone or in combination.

FIG. 7 shows a butterfly valve carburetor 45 embodying the present invention. The butterfly valve carburetor 45 includes a butterfly valve 47 mounted on a valve shaft 46 across the main intake passage 3. The butterfly valve 47 is rotated to open and close the main intake passage 3 so that the engine output is directly controlled. The butterfly valve 47 and the jet needle 21 are connected by a link or cam 48. The peripheral edge 49 of the butterfly valve 47 and the inside wall of the main intake passage 3 form the main intake air restriction 8 therebetween.

As described above, according to the present invention, air and fuel are mixed in the negative pressure moderating chamber in which the negative pressure is controlled within the range that the effect of the air compressibility to the air fuel ratio is practically negligible, so that an air-fuel mixture of the constant air-fuel ratio can be obtained. Further, the air-fuel mixture and the main intake air metered through the main intake air restriction are mixed in the main intake passage downstream of the main intake air restriction, so that the air-fuel ratio supplied to the engine is kept constant in all the running conditions of the engine. Accordingly, the fuel amount can be controlled by a single system, thus reducing the cost and preventing combustion discontinuation in starting, rapid accelerating and in other operations.

While the invention has been described with reference to preferred embodiments thereof, it is to be understood that modifications or variations may be easily made without departing from the scope of the present invention which is defined by the appended claims.

Claims

1. A carburetor comprising:

   a body defining a main intake passage, a negative pressure moderating chamber and a fuel chamber;

   a metering valve for opening and closing said main intake passage;

said negative pressure moderating chamber being communicated with said main intake passage downstream of said metering valve through an air-fuel mixture metering jet, said main intake passage upstream of said metering valve through an air metering jet and said fuel chamber through a fuel metering jet; and

a jet needle movable in association with the opening and closing of said metering valve and inserted through said air-fuel mixture metering jet and said fuel metering jet with a clearance thereabound, respectively.

2. The carburetor as defined in claim 1, wherein said air metering jet has an area larger than the area of the clearance defined between said air-fuel metering jet and said jet needle.

3. The carburetor as defined in claim 1, wherein a negative pressure of said negative pressure moderating chamber is adjusted to be 60 mmHg or lower even when a negative pressure in said main intake passage downstream of said metering valve is highest such as in idling or decelerating operation of an engine.

4. The carburetor as defined in claim 1, wherein said metering valve is a slidable metering valve having a valve guide cylinder disposed across said main intake passage and into which said slidable metering valve is slidably inserted to be advanced and retracted in said main intake passage, thereby controlling the opening and closing of said main intake passage.

5. The carburetor as defined in claim 4 further comprising a projection wall projected downwardly from a bottom of said slidable metering valve, said projection wall and an opposing inside wall of said main intake passage forming an intake air restriction therebetween.

6. The carburetor as defined in claim 1, wherein said metering valve is a butterfly valve mounted on a valve shaft disposed across said main intake passage such that the rotation of said butterfly valve controls the opening and closing of said main intake passage.

7. The carburetor as defined in claim 1, wherein said air metering jet includes a compensation valve capable of adjusting air flow rate.

8. The carburetor as defined in claim 7, wherein said compensation valve is manually adjusted or manually opened and closed.

9. The carburetor as defined in claim 7, wherein said compensation valve is driven by signals from an O_2 sensor mounted on a discharge pipe.

10. The carburetor as defined in claim 7, wherein said compensation valve is driven by a temperature-responsive member responsive to an engine temperature.

11. The carburetor as defined in claim 7, wherein said compensation valve is connected to a high-altitude compensator.

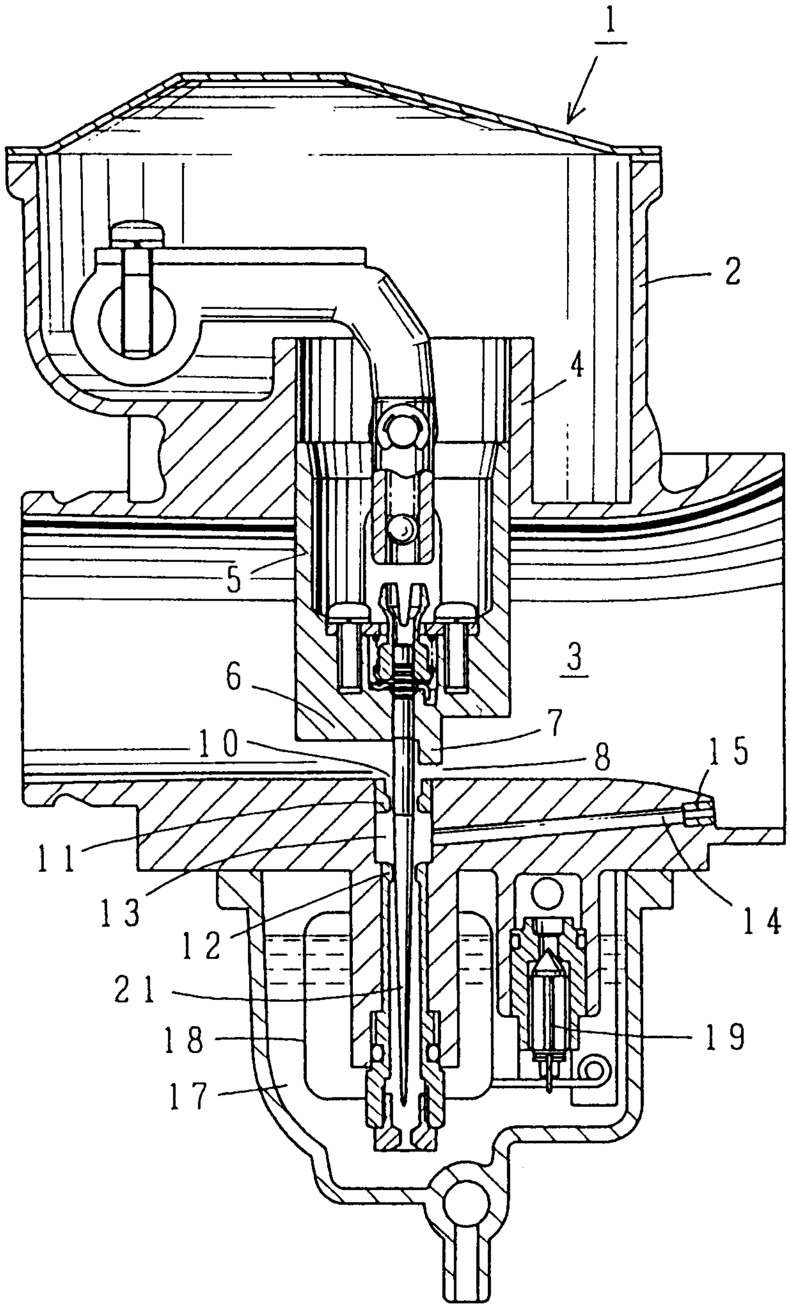

FIG. 1

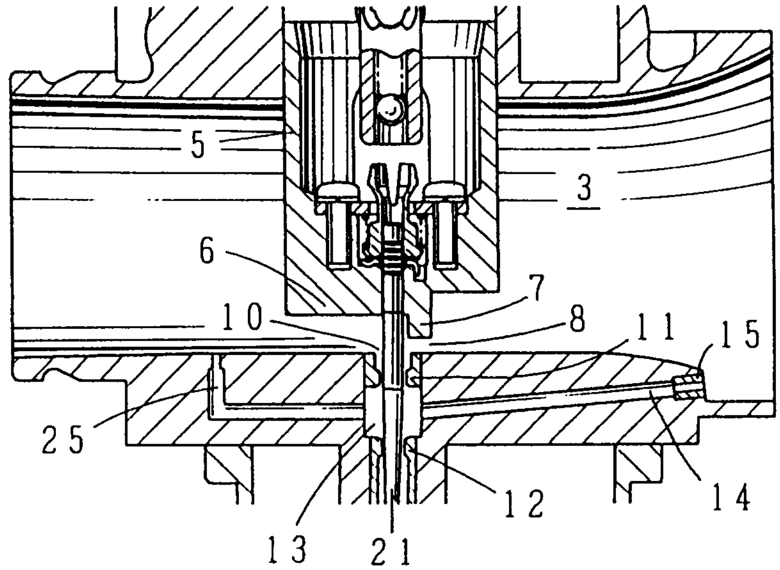

FIG.2

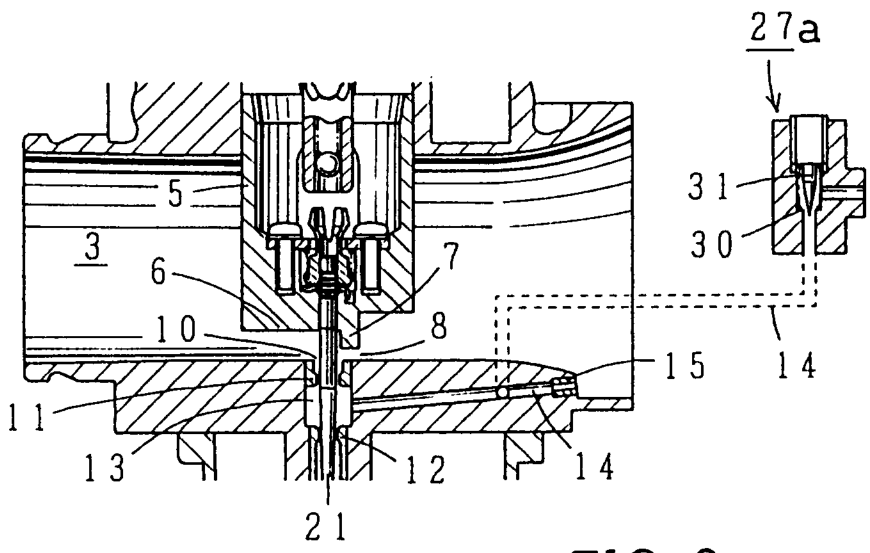

FIG.3

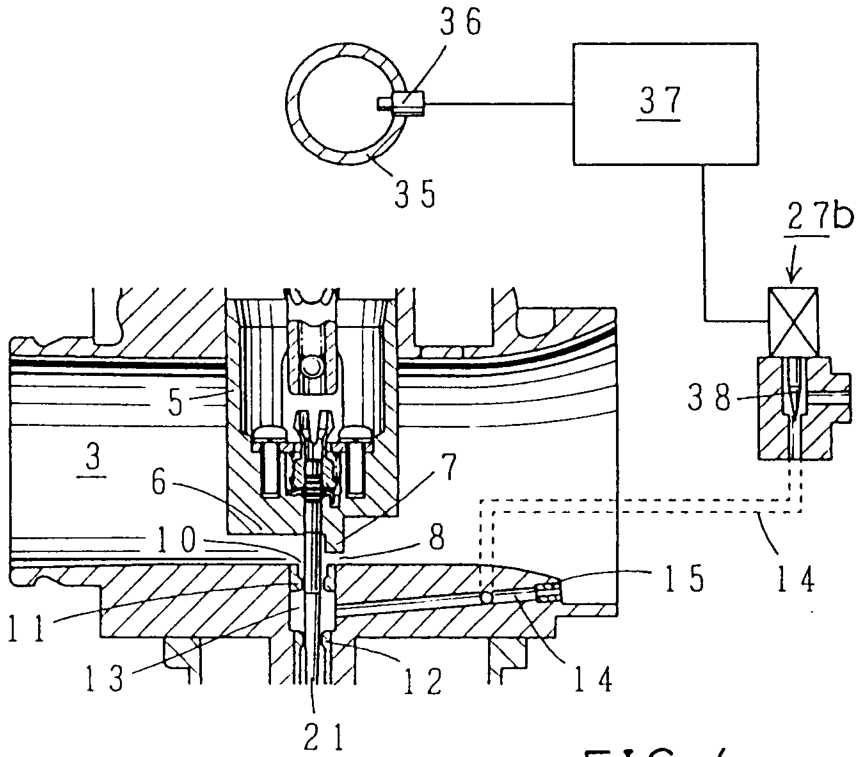
36
37
35
27b
38
5
3
6
7
10
8
15
14
11
13
12
14
21

FIG.4

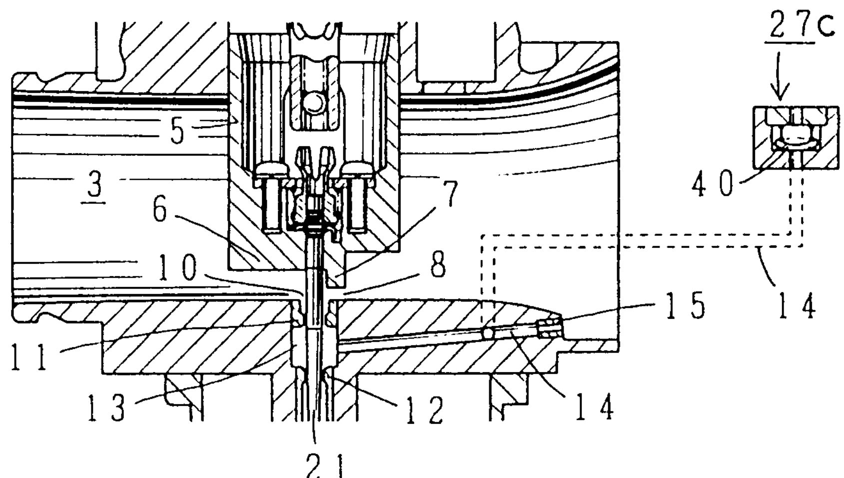
27c
5
3
6
7
40
10
8
15
14
11
13
12
14
21

FIG.5

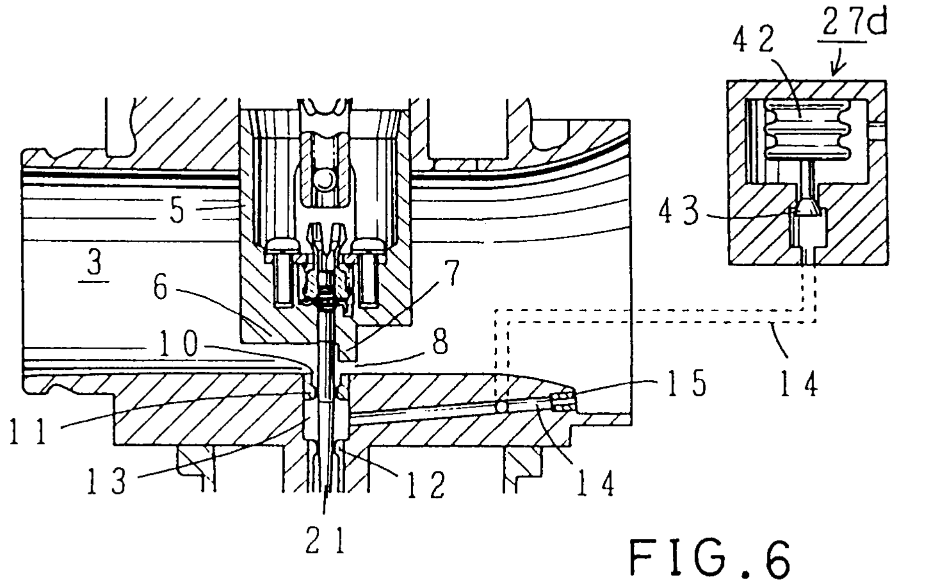
27d
42
43
5
3
6
7
10
8
15
14
11
13
12
14
21

FIG.6

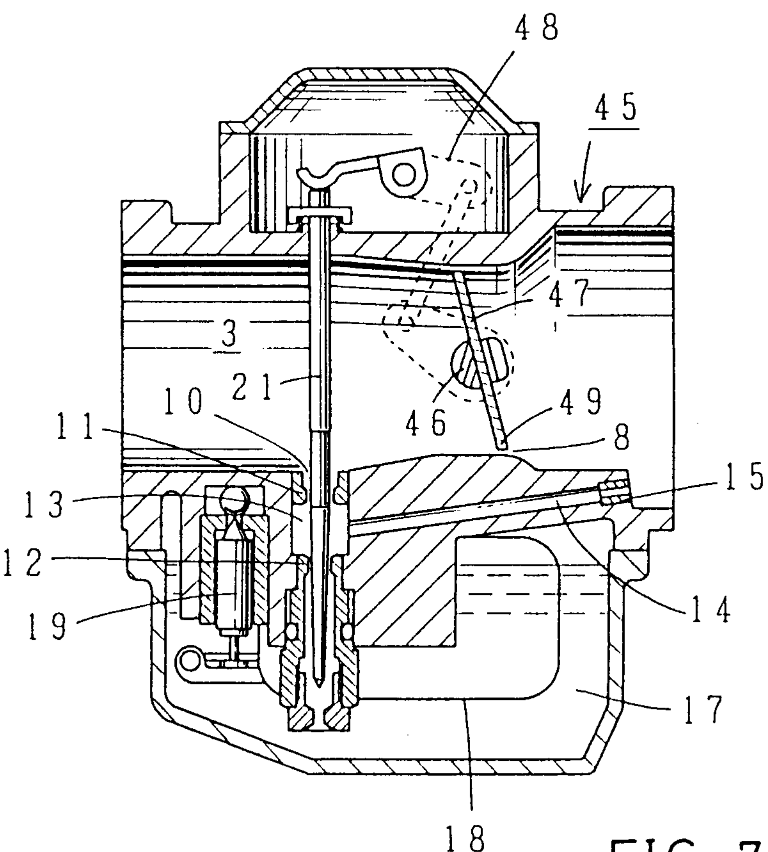
48
45
47
3
21
10
11
49
46
8
15
13
12
19
14
17
18

FIG.7

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 96 10 2351

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
X Y	GB-A-1 375 419 (MORGENROTH) * page 2, line 34 - line 53 * * page 3, line 25 - line 39 * * page 3, line 54 - line 94 * * page 4, line 72 - line 77; figure 1 *	1,2,6-8 9-11	F02M9/06 F02M7/22
X	GB-A-2 033 482 (NISSAN) * page 1, line 127 - page 2, line 3 * * page 2, line 25 - line 37 * * page 2, line 81 - line 83 * * page 2, line 91 - line 99; figure 4 *	1,6-8	
X	GB-A-2 112 072 (TOYOTA) * page 1, line 115 - page 2, line 24 * * page 2, line 104 - line 105; claim 1; figure 1 *	1,4,5,7,10	
X	DE-C-673 510 (BAILEY POLLARD DAWES) * page 1, line 33 - page 2, line 40; figures 1,3 *	1,4	
			TECHNICAL FIELDS SEARCHED (Int.Cl.6)
X	DE-A-29 41 705 (TOYOTA) * page 10, paragraph 3; figures 1,2,4 * * page 11, paragraph 1-2 *	1,4	F02M
X	GB-A-2 034 823 (NISSAN) * page 1, line 97 - line 114; figure 1 *	1,6,7	
Y A	US-A-4 091 781 (MITUYASU) * column 2, line 17 - line 51; figure 2 *	9 1,7	
Y	GB-A-2 086 988 (TOYOTA) * page 2, line 40 - line 56; figure 8 *	10	
Y	US-A-3 925 521 (OTANI) * column 2, line 40 - line 63 *	11	
	-/--		

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	20 May 1996	Joris, J

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 96 10 2351

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
A	FR-A-1 499 111 (DE PONTAC) * page 2, line R, paragraph 3; figure 1 *	10,11	
A	GB-A-2 042 088 (AMAL LTD) * figures 1-3 *	5	
A	DE-C-476 520 (BROWN & BARLOW) * figures 2,5 *	7,8	
A	US-A-5 054 449 (STARK) * column 4, line 42 - line 49; figure 3 * * column 4, line 59 - line 62 * * column 5, line 12 - line 19 *	9	
			TECHNICAL FIELDS SEARCHED (Int.Cl.6)

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	20 May 1996	Joris, J

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

EPO FORM 1503 03.82 (P04C01)