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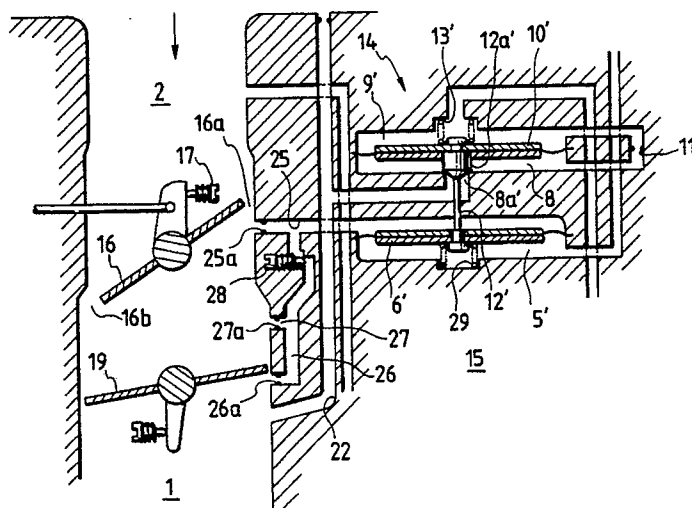
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(54) Air-fuel ratio control device for injection carburetors.

(57) The air-fuel ratio control device for injection carburetors is equipped with a slow fuel control unit (14) and a main fuel control unit (15) each of which comprises a negative pressure diaphragm (10') forming a depression chamber for receiving negative pressures produced dependently on flow rates of air to be sucked, and a fuel injection valve (12') for opening and closing a fuel injection port (8a') dependently on displacement of the negative pressure diaphragm. Communicated with the depression chamber of the slow fuel control unit (25) is a bypass passage (26) for introducing negative pres-

ures into said depression chamber, and provided in the bypass passage is an adjusting screw (28) capable of adjusting effective cross sectional area thereof. This air-fuel ratio control device is capable of maintaining air-fuel ratio of the mixture at an adequate constant level from the idling condition to the slow zone, prevents fuel leakage at rest time of engine and enables to provide carburetors having very excellent responsibility over the entire operating range of engine.

FIG. 6



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AIR-FUEL RATIO CONTROL DEVICE FOR INJECTION CARBURETORS

The present invention relates to an air-fuel ratio control device for injection carburetors which is equipped with a slow fuel control unit and a main fuel control unit, and serves for adjusting fuel injection rate adequately on the basis of negative pressure produced dependently on flow rate of air to be sucked.

This type of injection carburetors have already been proposed, for example, by European Patent Application No. 89 109 196.9 submitted by the applicant. Fig. 1 is a sectional view illustrating the fundamental structure of the air-fuel ratio control device of the injection carburetor. In this drawing, the reference numeral 1 represents a suction bore of the carburetor comprising a venturi 2, the reference numeral 3 designates a fuel control unit arranged at a location neighboring the venturi 2, and the reference numeral 4 denotes an air section of regulator arranged at a location also neighboring the venturi 2 but on the side opposite to the fuel control unit 3 with regard to the suction bore 1. The air section of regulator 4 has an air chamber and a depression chamber 5 which are separated from each other by a negative pressure diaphragm 6, and formed in the depression chamber 5 is an opening 5a for communication with the venturi 2. Further, a fuel section of regulator 7 has a fuel injection chamber 8 and a fuel pressure chamber 9 which are separated from each other by a fuel diaphragm 10, and formed in the fuel injection chamber 8 is a fuel injection port 8a which is opposed to the opening 5a of the depression chamber 5. The fuel injection chamber 8 is communicated with the fuel pressure chamber 9 through a main jet 11. The reference numeral 12 represents a connecting member inserted through the opening 5a of the depression chamber 5 and the fuel injection port 8a of the fuel injection chamber 8, one end of the connecting member 12 being fixed to the negative pressure diaphragm 6 and the other end of the connecting member being fixed to the fuel diaphragm 10. Formed on the connecting member 12 is a conical valve 12a capable of opening and closing the fuel injection port 8a, and controlling opening degree of said injection port. The reference numeral 13 represents a spring which is arranged in the depression chamber 5 and functions to urge the negative pressure diaphragm 6 upward, i.e., to move the valve 12a in the direction to close the fuel injection port 8a. When a negative pressure corresponding to the flow rate of the air flowing through the venturi 2 is introduced into the depression chamber 5 and negative pressure diaphragm 6 is displaced toward the depression chamber 5 against the resilience of the spring

13 in the air-fuel ratio control device having the structure described above, also the fuel diaphragm 10 is displaced in the same direction (downward) to allow the valve 12a to open the fuel injection port 8a, whereby the fuel is ejected into the suction bore 1 and pressure drops in the fuel injection chamber 8. When the pressure differential between the negative pressure in the depression chamber 5 and atmospheric pressure is balanced with the fuel pressure differential between both the sides of the main jet 11, the pressure applied to the negative pressure diaphragm 6 is balanced with the pressure applied to the fuel diaphragm 10 and air-fuel ratio is maintained constant in this condition. When resilience of the spring 13 is so selected as to be equal to the total weight of the assembly consisting of both the diaphragms 6 and 10 plus the connecting member 12 in order to obtain high responsibility in the carburetor of this type, however, no substantial negative pressure is produced at the starting time of the engine as shown in Fig. 2A since air flows through the venturi 2 at a low rate at that time. Accordingly, variation of fuel flow rate is slower than variation of air flow rate, thereby producing a deviation of x from a target value as illustrated in Fig. 2B. Therefore, the injection carburetor of this type has a defect that, when actually measured values of air-fuel ratios are so adjusted as to be matched with adequate values (target values) in the region of the medium opening degrees of the throttle valve, actual air-fuel ratio is too high during idling of the engine, thereby making the mixture fuel-lean.

Fig. 3 illustrates a carburetor so adapted as to control air-fuel ratios of the mixture in a broad range by combining two air-fuel ratio control devices having the fundamental structure shown in Fig. 1 as a slow fuel control unit 14 mainly for controlling the slow zone and a main fuel control unit 15 chiefly for controlling the main zone. In Fig. 3, the members and parts of the slow fuel control unit 14 which are similar to those illustrated in Fig. 1 are represented by the same reference numerals but with a prime, and the members and parts of the main fuel control unit 15 which are similar to those illustrated in Fig. 1 are designated with the same reference numerals but with double primes. The reference numeral 16 represents an air valve arranged openably and closably downstream the venturi 2 in the suction bore 1, the reference numeral 17 designates a stopper for holding the air valve 16 at the minimum opening degree thereof, the reference numeral 18 denotes a negative pressure actuator which is connected to the air valve 16 for serving to open and close the air valve 16 in

conjunction with variation of negative pressure produced downstream the air valve 16, the reference numeral 19 represents a throttle valve arranged downstream the air valve 16, the reference numeral 20 designates a fuel tank, and the reference numeral 21 denotes a fuel pump. The discharge side of the fuel pump 21 is communicated with the fuel pressure chamber 9" of the main fuel control unit 15 and the fuel injection chamber 8" thereof is communicated with the fuel pressure chamber 9' of the slow fuel control unit 14. The depression chamber of the slow fuel control unit 14 is communicated with the suction bore 1 at a location downstream the air valve 16, whereas the depression chamber of the main fuel control unit 15 is communicated with the venturi 2. The fuel injection port 8a' of the slow fuel control unit 14 and the fuel injection port 8a" of the main fuel control unit 15 are communicated with a fuel passage 22 which is open to the suction bore 1 at a location downstream the throttle valve 19.

The carburetor described above has already been proposed by the applicant and functions as follows. In the slow zone of the engine where the throttle valve 19 is opened at a small degree, a low negative pressure is produced downstream the air valve 16 and the negative pressure actuator does not operate. Accordingly, the air valve 16 is held at the position shown in Fig. 3 and only the slow fuel control unit 14 is set in the operating condition. The slow fuel control unit 14 functions in the same manner as the fuel control unit described with reference to Fig. 1, and the fuel ejected through the fuel injection port 8a' is discharged into the suction bore 1 through the fuel passage 22. When the opening of the throttle valve attains to a predetermined degree from the condition described above, the negative pressure actuator operates to displace the air valve 16 to the fully open position thereof. During this process, the negative pressure acting on the depression chamber of the slow fuel control unit 14 is gradually reduced and the negative pressure acting on the depression chamber of the main fuel control unit 15 is gradually increased, whereby the fuel injection port 8a" of the main fuel control unit begins to eject the fuel. The fuel ejected from the fuel injection port 8a" is discharged into the suction bore 1 through the fuel passage 22 and operating condition of the engine shifts to the main zone. However, both the slow fuel control unit 14 and the main fuel control unit 15 have the defects described with reference to the carburetor illustrated in Fig. 1.

In order to correct these defects, i.e., to match actual air-fuel ratios with target values from the idling stage, there has been proposed a carburetor wherein the negative pressure diaphragms 6 and 6' are so designed as to operate with higher respon-

sibility to air flow rates by selecting resilience of the spring 13 so as to be smaller than the total weight of the diaphragm assembly 6, 10, 12 in Fig. 1 and resilience of the spring 13' so as to be smaller than the total weight of the diaphragm assembly 6', 10', 12' in Fig. 3, or arranging, in the air chamber of the air section of regulator 4, a compensating spring 23 urging the negative pressure diaphragm 6 toward the depression chamber 5, and providing an adjusting screw 24 permitting adjustment of resilience of the compensating screw 23 as illustrated in Fig. 4. This proposal makes it possible to match fuel flow rates to be controlled dependently on air flow rates nearly with target value from the beginning of the slow zone as illustrated in Fig. 5A and to control air-fuel ratios of the mixture nearly at target values from the idling stage as illustrated in Fig. 5B. When the fuel control units are composed as described above, however, the forces for urging the negative pressure diaphragms 6 and 6' toward the depression chamber 5 and 5' respectively are too strong, and the fuel injection ports 8a and 8a' are kept open conditions thereof even while the engine is rested, thereby producing defects that the fuel is leaked and that the fuel is discharged through the fuel injection ports 8a and 8a' before the engine starts rotating at the restart time by the fuel pump 21 which starts operating upon the ON operation by the engine key.

A primary object of the present invention is to provide an air-fuel ratio control device for injection carburetors which is capable of maintaining air-fuel ratio of the mixture at a constant level in both the idling condition and the slow zone.

Another object of the present invention is to provide an air-fuel ratio control device for injection carburetors which is capable of securely preventing unnecessary fuel from being discharged into the suction bore at the rest time or restart time of an engine.

A further object of the present invention is to provide an air-fuel ratio control device for injection carburetors which has a relatively simple structure and very excellent responsibility over the entire operating range of an engine.

According to the present invention, the objects mentioned above are attained by equipping with a slow negative pressure passage for introducing the negative pressure produced just downstream the air valve into the depression chamber of the slow fuel control unit, a main negative pressure passage for introducing the negative pressure from the venturi into the depression chamber of the main fuel control unit, a bypass passage which is communicated with the slow negative pressure passage and capable of introducing a negative pressure in a manifold into the slow negative pressure passage,

and an adjusting means which is provided in the bypass passage and capable of adjusting a ratio of the negative pressure in the manifold to be added into the slow negative pressure passage.

The air-fuel ratio control device according to the present invention allows the negative pressure produced in the manifold downstream the throttle valve to be added at a predetermined ratio into the slow negative pressure passage through the bypass passage so that a total of the negative pressure downstream the air valve and the added manifold pressure is introduced into the depression chamber of the slow fuel control unit in the slow zone after the engine is started, and is therefore capable of controlling the negative pressure in the depression chamber in proportion to air flow rate whereby the air-fuel ratio control device is capable of maintaining air-fuel ratio of the mixture at a constant level from the beginning stage of the engine start.

In a preferred formation of the present invention, provided in the slow fuel control unit is a resilient means functioning to make a force acting to close the fuel injection valve stronger or equal than or to the force acting to open the fuel injection valve until the manifold negative pressure is produced. This means serves for closing the valve without fail at the rest time of the engine and enhancing responsibility of the valve after the manifold pressure is produced.

These and other objects as well as the features and advantages of the present invention will become apparent from the following detailed description of the preferred embodiment when taken in conjunction with the accompanying drawings.

In the drawings:

Fig. 1 is a sectional view illustrating the fundamental structure of the conventional air-fuel ratio control device for injection carburetors;

Fig. 2A, Fig. 2B and Fig. 2C are graphs illustrating various characteristics of the air-fuel ratio control device shown in Fig. 1;

Fig. 3 is a sectional view illustrating overall structure of the injection carburetor;

Fig. 4 is a sectional view illustrating another conventional example obtained by improving the air-fuel ratio control device shown in Fig. 1;

Fig. 5A and Fig. 5B are graphs illustrating characteristics of the air-fuel ratio control device shown in Fig. 4;

Fig. 6 is a sectional view illustrating the main members and parts of an embodiment of the air-fuel ratio control device according to the present invention;

Fig. 7 is a characteristic curve illustrating variation of negative pressures corresponding to air flow rates at two locations different from each other in the suction bore as well as variations of

the total of these negative pressures;

Fig. 8A is a characteristic curve illustrating variation of a second total negative pressure corresponding to air flow rates in the embodiment of the present invention; and

Fig. 8B is a characteristic curve illustrating variation of air-fuel ratio of the mixture corresponding to opening degrees of the throttle valve.

Now, the embodiment of the present invention will be described with reference to Fig. 6. In this drawing wherein the main fuel control unit is omitted, the members and parts which are substantially the same as those illustrated in Fig. 3 are represented by the same reference numerals. The reference numeral 25 represents a slow negative pressure passage which is open to the suction bore 1 at a location downstream the air valve 16, contains a jet 25a and serves for introducing a negative pressure P_1 produced downstream the air valve into the depression chamber of the slow fuel control unit, the reference numeral 26 designates a bypass passage which has an end containing a jet 26a and open to the suction bore 1 at a location downstream the throttle valve 19, and the other end open to the slow negative pressure passage 25 at a location downstream the jet 25a, the reference numeral 27 denotes a sub-bypass passage which is branched from the bypass passage 26, and has an end containing a jet 27a and open to the suction bore 1 at a location between the air valve 16 and the throttle valve 19, the reference numeral 28 represents an adjusting screw which is arranged in the sub-bypass passage 27 at a location between the junction of the slow negative pressure passage 25 and the bypass passage 26 and the junction of the sub-bypass passage 27 and the bypass passage 26, and permits adjusting a ratio of the negative pressure downstream the throttle valve 19, i. e., the manifold pressure P_2 to be added into the slow negative pressure passage 21, and the reference numeral 29 designates a spring which is arranged in the air chamber 5' of the slow fuel control unit 14 and functions to urge the negative pressure diaphragm 6' toward the depression chamber. The sub-bypass passage 27 serves for enhancing displacing responsibility of the negative pressure diaphragm 6'. The jets 25a, 26a and 27a are used for moderating variation of the negative pressure P_1 downstream the air valve 16 and variation of the manifold negative pressure P_2 , thereby relatively stabilizing the total pressure P_a thereof over the entire range including both the slow zone and the main zone. (See Fig. 7) Let us now assume that a reference symbol w_1 represents weight of the diaphragm assembly of the slow fuel control unit, a reference symbol w_2 designates resilience of the spring 13', a reference symbol w_3 denotes resilience of the spring 29 and a reference

symbol w_4 represents a force which acts to lift said diaphragm assembly to close the fuel injection valve 12a'. The resilience w_2 of the spring 13' and the resilience w_3 of the spring 29 are so selected as to satisfy the following relation (1) in the rest condition of the engine and the following relation (2) in the operating condition of the engine:

$$w_3 < w_1 + w_2 \quad (1)$$

$$w_3 + w_4 > w_1 + w_2 \quad (2)$$

This embodiment uses the air-fuel ratio control device illustrated in Fig. 3 as the main fuel control unit 15.

Now, functions of the air-fuel ratio control device preferred as the embodiment of the present invention will be described below.

In the rest condition of the engine where no negative pressure is produced, the slow fuel control unit is set in the condition (1) and the valve 12a is kept closed, thereby preventing leakage of the fuel. When the engine is started, the manifold negative pressure is introduced into the bypass negative pressure passage 26 through the jet 26a. At the initial stage, however, the negative pressure P_1 is not produced since the throttle valve 19 is set at the minimum opening degree thereof, and air flows at a very low rate through the openings 16a and 16b of the air valve 16. (See Fig. 8A) Accordingly, a first total negative pressure P_a (Fig. 7) determined by the manifold negative pressure P_2 only is introduced at the predetermined ratio into the slow negative pressure passage 25 at this stage and a second total negative pressure P_b nearly proportional to the air flow rate is introduced into the depression chamber from the initial state. (See Fig. 8A) Therefore, the condition (2) is established from the idling stage to enhance responsibility of the negative pressure diaphragm 6' and the air-fuel ratio control device is capable of controlling air-fuel ratio of the mixture nearly to a target value from the initial stage as illustrated in Fig. 8B. Even after opening degree of the throttle valve 19 is increased, the air-fuel ratio control device can maintain air-fuel ratios at target values. Further, also at restart time of the engine, no negative pressure is produced and the valve 12a' is kept in the closed condition before the engine starts rotating even in the condition where the fuel pump 21 is operating with the engine key set at the ON position.

As is understood from the foregoing description, the embodiment of the air-fuel ratio control device according to the present invention is capable of maintaining air-fuel ratio of the mixture nearly at a target value from the initial stage of the slow zone and securely preventing leakage of the fuel. Further, the embodiment has a relatively simple structure and prevents slow response since it uses no means for adjusting the resilience of the springs. Though the embodiment uses a leaf valve

as the air valve, it is needless to say that a piston valve is usable as the air valve. In addition, though the embodiment is so constructed as to strengthen the force acting to close the valve 12a' by using the spring 13', it is possible to strengthen the force acting to close the valve 12a' by reducing the resilience of the spring 29.

Claims

1. An air-fuel ratio control device equipped with a slow fuel control unit (14) and a main fuel control unit (15) each comprising a negative pressure diaphragm (10', 10'') forming a depression chamber for receiving negative pressures dependently on flow rates of air to be sucked into a suction bore and a fuel injection valve (12', 12'') for closing a fuel injection port (8a', 8a'') dependently on displacement of said negative pressure diaphragm, characterized in that said air-fuel control device comprises a slow negative pressure passage (26) serving for introducing a negative pressure produced downstream an air valve arranged downstream a venturi in a suction bore into the depression chamber of the slow fuel control unit, a bypass passage communicated with said slow negative pressure passage and capable of introducing an internal negative pressure of a manifold into said slow negative pressure passage, and an adjusting means (28) capable of adjusting ratio of the internal negative pressure of the manifold to be introduced into said slow negative pressure passage.

2. An air-fuel ratio control device according to Claim 1 wherein a jet is provided in the entrance of each of said slow negative pressure passage and said bypass passage.

3. An air-fuel ratio control device according to Claim 1 wherein said adjusting means is screwed in said bypass passage and designed as an adjusting screw capable of varying effective cross sectional area of said bypass passage.

4. An air-fuel ratio control device according to Claim 1 wherein said air valve is designed as a leaf valve.

5. An air-fuel ratio control device according to Claim 1 wherein said air valve is designed as a piston valve.

6. An air-fuel ratio control device according to any one of Claims 1 through 5 further comprising a resilient means functioning so as to make the force acting to close the fuel injection valve of said slow fuel control unit stronger than the force acting to open the fuel injection valve of said slow fuel control unit until the manifold pressure is produced.

FIG. 1 PRIOR ART

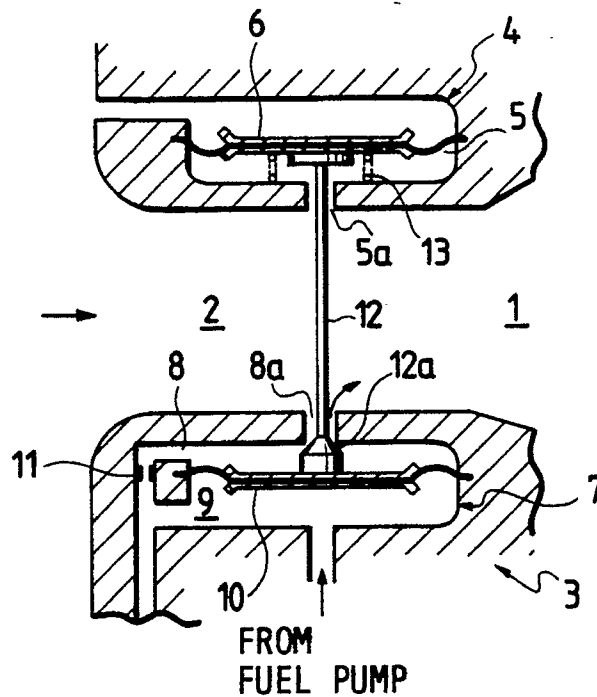


FIG. 2A
PRIOR ART

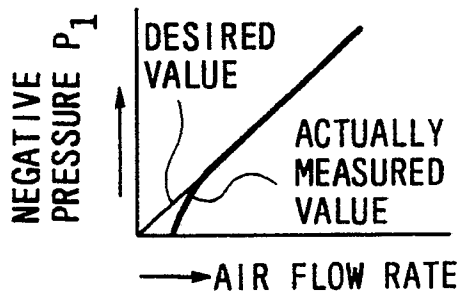


FIG. 2B
PRIOR ART

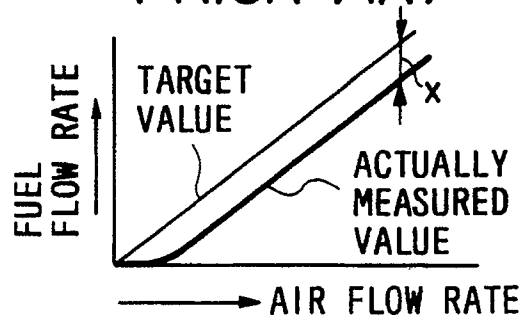


FIG. 2C
PRIOR ART

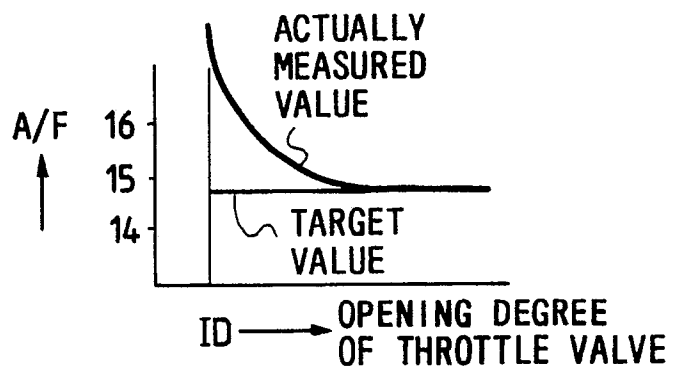


FIG. 3 PRIOR ART

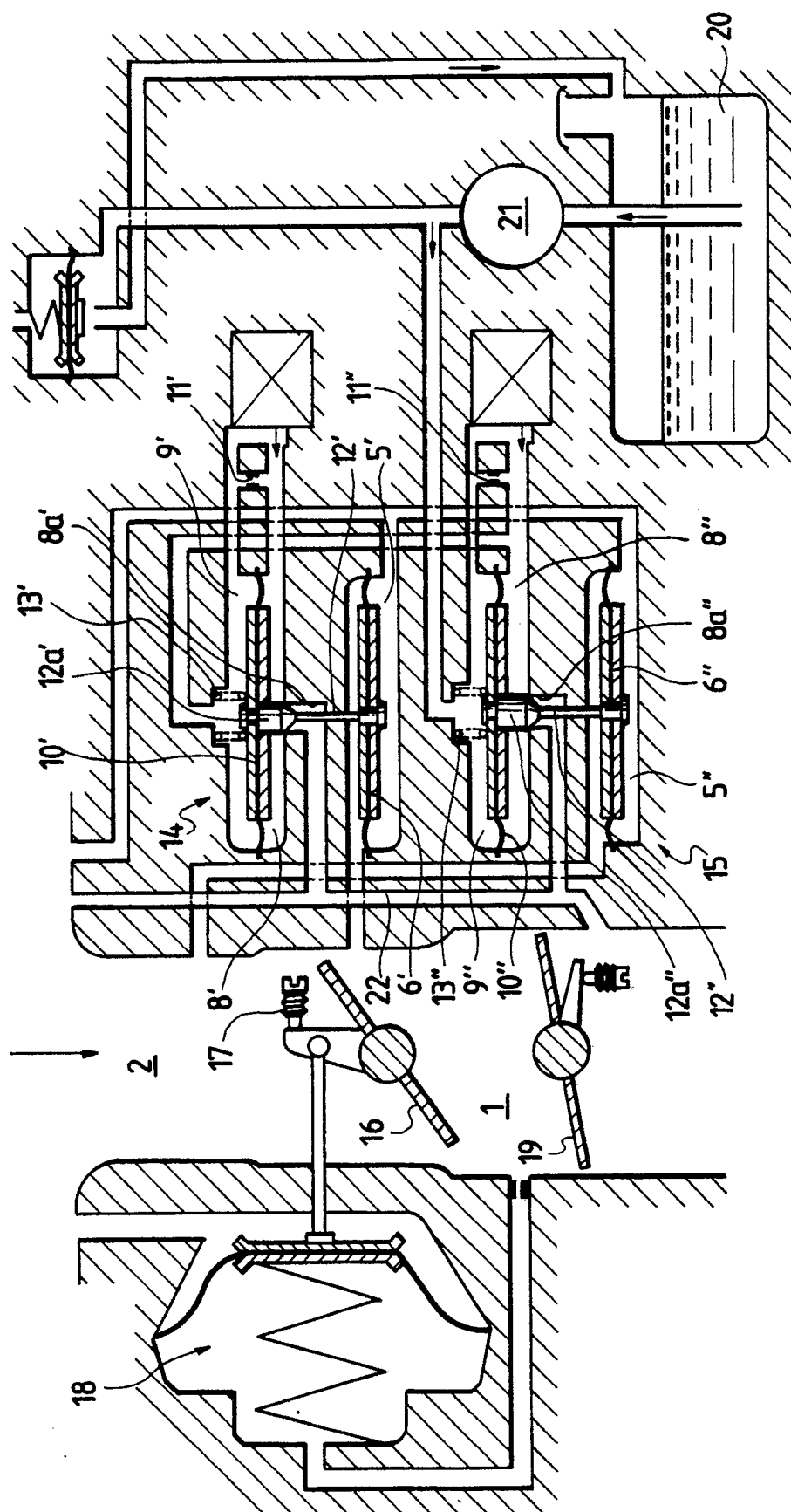


FIG. 4 PRIOR ART

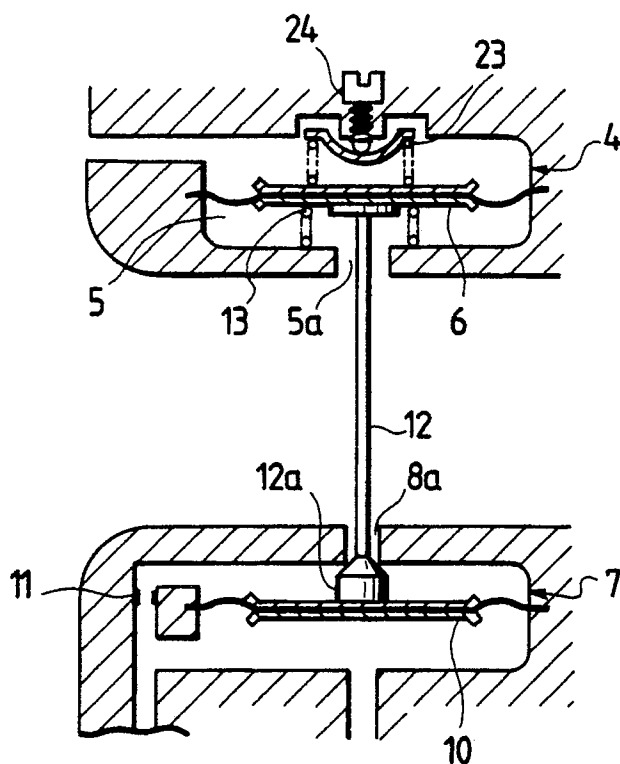


FIG. 5A
PRIOR ART

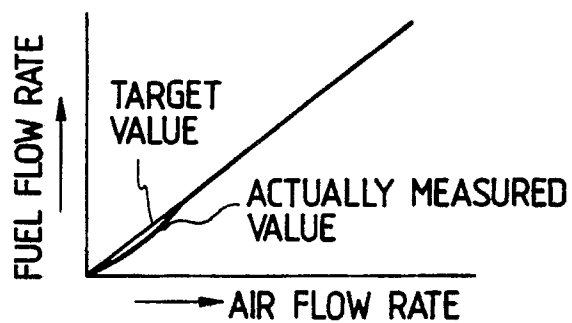


FIG. 5B
PRIOR ART

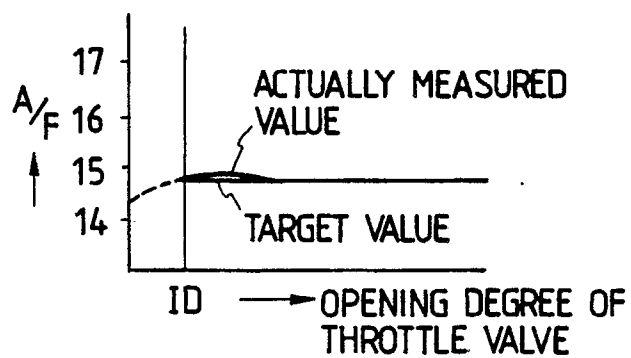


FIG. 6

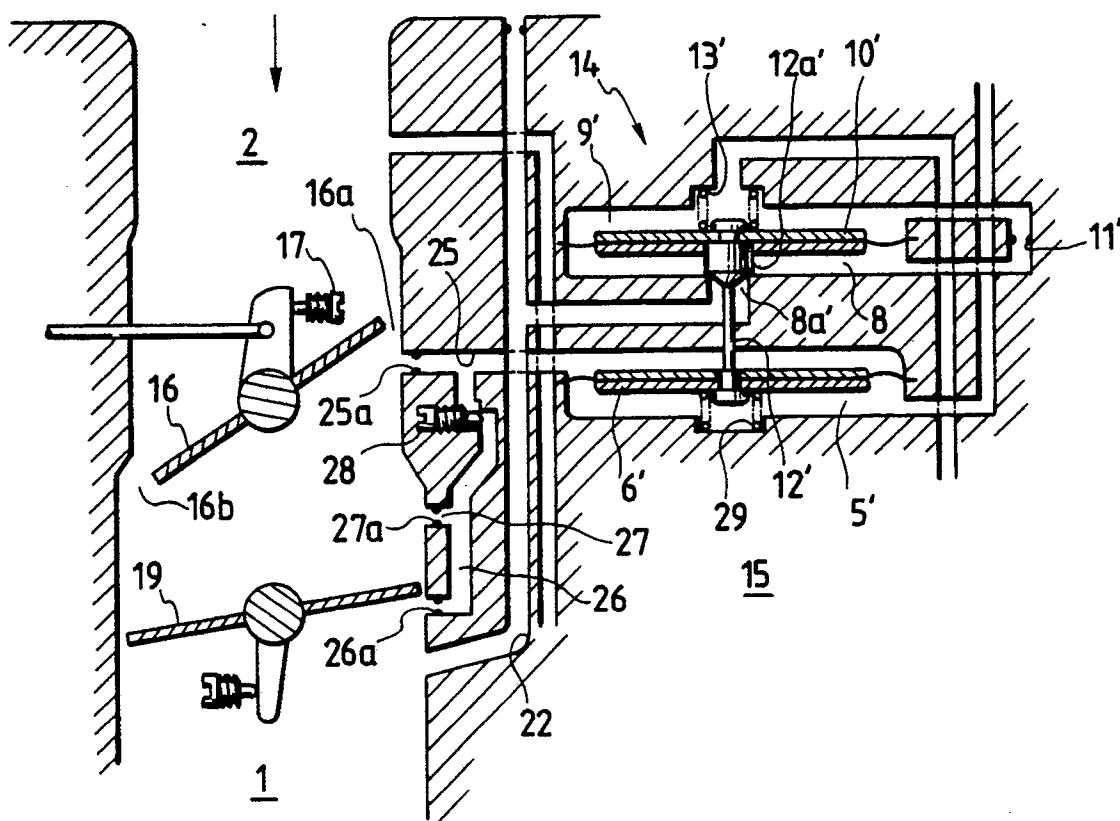


FIG. 7

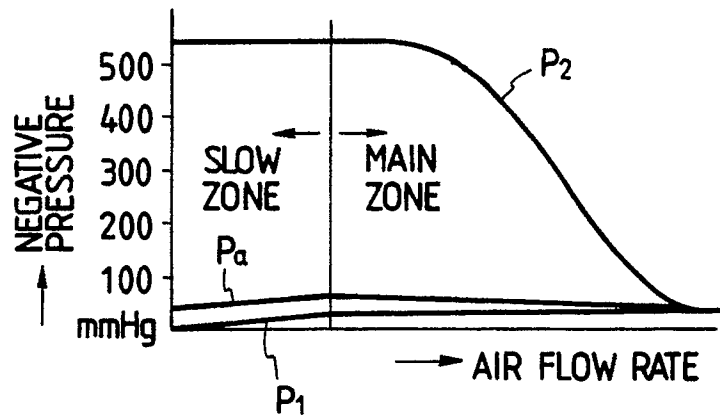


FIG. 8A

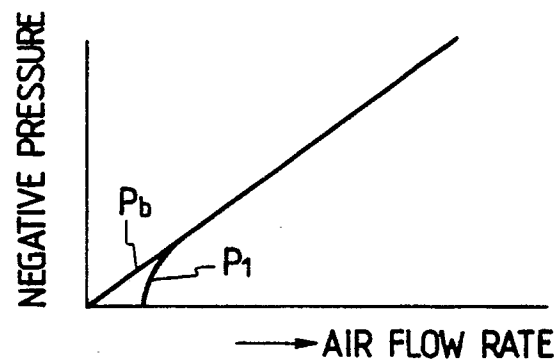
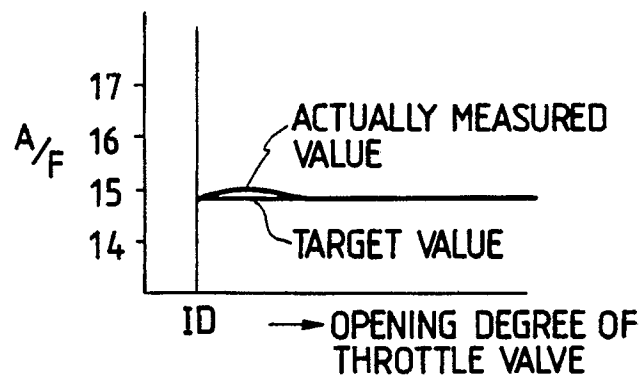


FIG. 8B





European Patent
Office

EUROPEAN SEARCH REPORT

Application Number

EP 89 11 9829

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.5)
X	JP-A-01262331 (MIKUNI) * the whole document *	1-5	F02M69/00 F02M69/04
A	JP-A-01257761 (MIKUNI) * the whole document *	1-5	
A	GB-A-1021509 (HEINRICH KLEIN WUCHERER) * the whole document *	1	
A	FR-A-2093219 (PETROL INJECTION LIMITED)		
A	FR-A-2311190 (TECALEMIT)		
The present search report has been drawn up for all claims			TECHNICAL FIELDS SEARCHED (Int. Cl.5)
			F02M
Place of search THE HAGUE		Date of completion of the search 07 JUNE 1990	Examiner ERNST J. L.
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