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(54) FUEL SUPPLY SYSTEM FOR FOUR-STROKE ENGINES

(57) Especially applicable to motorcycle engines, it consists of establishing in the main conduct through which the air from the filter (FA) arrives, whose flow is controlled by a butterfly valve of gases or main valve (1), a secondary butterfly valve (2) that keeps each operation in functioning, be it in stationary or transitory regime, the opening being appropriate for producing the loss of load that, added to the Venturi effect generated in the conduct section downstream from the aforementioned secondary butterfly valve (2) and the loss the load of the air filter (FA), giving rise to the appropriate suction at the emulsioned fuel outlet (3), the fuel from a cell (4) of constant level being mixed with the air flow, joined to the atmosphere, such that the suction at the outlet (3) produces a flow through and controlled by the main distributor (5), which emulsioned with the air from the tube (9), equipped with transverse holes, discharges in the central conduct of the system (11) through the outlet (3).

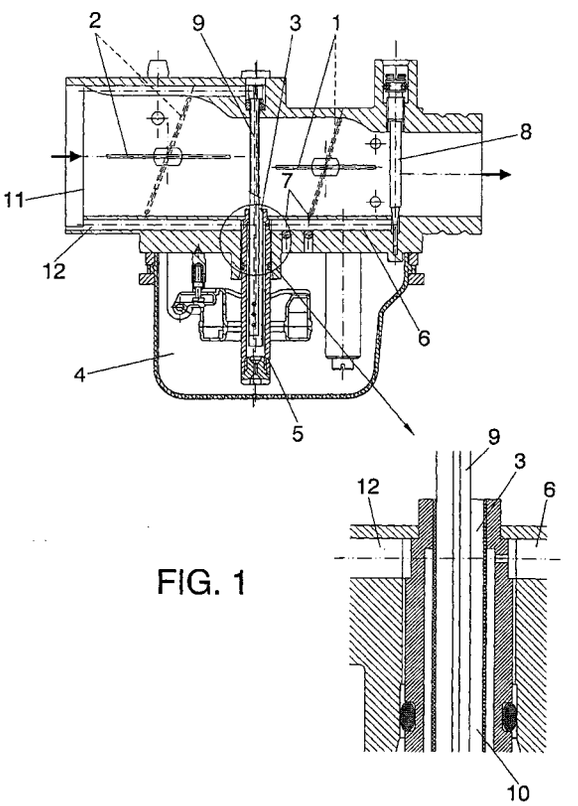

FIG. 1

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Description

OBJECT OF THE INVENTION

[0001] The present invention relates to a fuel feed system for four-stroke engines, in particular, to engines used in motorcycles, which has been conceived and structured in order to optimise the performance of the engine, with rapid responses in more or less sharp accelerations, with a lower emission of contaminants and with a structural simplification that allows a notable reduction in the costs of the process for manufacturing the carburettor.

BACKGROUND OF THE INVENTION

[0002] The carburettors for four-stroke engines used in motorcycles consist of a valve piston system as a fuel dosing element, the degree of sealing of which depends on the flow of air that passes through it, generating a depression in the minimum clearance section that acts on a membrane, with its spring in opposition, attached to said piston and a conic needle that seals the output of the main conduct of the carburettor, of a mixture rich in petrol through a distributor. In this fashion, petrol is supplied to the engine as a function only of the sucked air.

[0003] This system requires high precision engineering and special surface treatments to ensure the perfect movement of the piston within its housing, which has to be similar to the minimum variations of the pressure function that is negatively affected by the rigidity and hysteresis of the membrane. All these phenomena reduce the precision and repeatability of the dosing function of the carburettor, with the added difficulty of the necessary precision and repeatability of positioning of the conic needle that partially seals the petrol outlet or rich air-petrol mixture in its distributor.

[0004] In addition, this type of carburettor normally needs to be equipped with an acceleration pump, which basically consists of a positive displacement pump, with inlet and outlet valves, which injects a certain amount of liquid gasoline into the carburettor conduct to prevent the mixture from becoming leaner as a result of the time lags of petrol flow increase in the carburettor circuits during more or less quick acceleration. The petrol so supplied is difficult to be homogenised with the admission air and this notably increases the emission of contaminants, in particular, carbon monoxide and hydrocarbons that have not been burnt.

[0005] This type of carburettor is generally made of a permanent moulded aluminium structure and subsequently profusely machined in channels of housing circuits of valves as piston and butterfly, threads, and housings for other devices. This machining operation with the minimum quality control guarantees requires expensive investments and work times to which the possibility of failure and errors has to be added, with the obvious loss of functionality in the carburettor.

[0006] Other types of carburettor use a fixed Venturi dosing device as a main element, which discharges the rich mixture emulsioned by means of a distributor. For low flow rates of air, it generates a very low depression, producing a poor quality mixture and long delays in accelerations, which require the installation of an acceleration pump with the problems of high emission of contaminants, which has already been mentioned.

DESCRIPTION OF THE INVENTION

[0007] The system conceived in this patent efficiently resolves the problems and limitations considered in the aforementioned cases. From the anti-polluting point of view and from that of low fuel consumption, a secondary butterfly valve generates sufficient depression at any air flow to ensure the air-fuel mixture can be highly homogeneous and precise both in stationary operation and when accelerating, controlled by a cam joined to the main butterfly valve and a membrane bellows with its antagonist spring pushed by the depression produced by the secondary butterfly valve. This means that during the accelerations, fuel is supplied through the same holes as in Stationary operation, and so the acceleration pump is not necessary notably improving the emission of contaminants (CO and HC) and the fuel efficiency with respect to the conventional feed systems already mentioned, in addition to the economic results of its running.

[0008] The construction of the system contemplated by this patent is preferably made of plastic highly resistant to hydrocarbons at all temperatures of use, without discarding the possibility of using conventional materials such as Zamac and aluminium. The use of this plastic as structure material of this system allows two objectives to be accomplished that represent large advantages:

- It is possible to obtained the inner profile of the conduct of the system by moulding such that at low flow rates of air, much of the flow passes near to the distributor of mixture of emulsion providing a very homogeneous air-fuel mixture suitable for a perfect combustion, due to the appropriate curvature of the aforementioned conduct in the upper zone of the main butterfly valve and secondary butterfly valve.

- The circuit communication channels are simplified to the maximum such that no significant machining operation is required and so great economic benefit is obtained and also the geometric dispersion of form and heights produced by machining processes is eliminated, thus reducing the probability of error and machinery failure that negatively affect its functionality, in other words, the amount of product.

DESCRIPTION OF THE DRAWINGS

[0009] To complement the description being given and with the aim of aiding a better understanding of the characteristics of the invention, in accordance with an example of a preferred embodiment thereof, the current specification is accompanied as an integral part thereof by a set of drawings in which, with an illustrative and non-limiting character, the following has been represented:

Figure 1.- Shows a longitudinal and central section of a carburettor equipped with a fuel feed system that constitutes the object of the present invention.

Figure 2.- Shows, according to a view similar to that of the previous figure, the outer appearance of the same set, at a generic point in the operation of the system.

Figure 3.- Shows, a similar representation to that of the previous figure, corresponding to another point of operation, specifically, when there is an acceleration.

Figure 4.- Shows, finally, once again a section profile of the set represented in the previous figures.

PREFERRED EMBODIMENT OF THE INVENTION

[0010] In figure 1 we see a central longitudinal section, where the main conduct is found through which the air from the air filter (FA) arrives, the flow of which is controlled by the butterfly valve of gases or the main valve (1). The secondary butterfly valve (2) maintains in each functioning operation, be it in stationary regime or transitory one, the aperture appropriate to produce the loss of load that, added to the Venturi effect generated in the conduct section downstream from the secondary butterfly valve and the loss of load of the air filter (FA), gives rise to the appropriate suction at the outlet (3) of the emulsioned fuel that is mixed with the air flow.

[0011] This feed system also consists of a constant level fuel cell (4) in contact with the atmosphere through a vertical conduct, such that the suction at the outlet (3) produces a flow through and controlled by the main distributor (5) which, emulsioned with the air from the tube (9) equipped with some transverse holes, discharges the central conduct of the system (1) through the outlet (3).

[0012] The present patent of invention also contemplates the possibility that the fuel cell is not in contact with the atmosphere, but rather downstream from the secondary butterfly valve, in which case the suction at outlet (3) would not be originated partially with loss of load from the air filter.

[0013] In order to improve the quality of the air-fuel mixture supplied to the motor at low loads and motor regimes near to neutral (6), a neutral circuit supplies fuel in parallel with the previously mentioned and main one, and in the aforementioned conditions. This neutral circuit takes fuel already controlled by the main distributor (5) and subsequently measured by the neutral distributor (6) located in series with the previous one and which discharges in the air channel (12) so producing an emulsion, such that in neutral position it takes air from the by-pass holes and discharges into the main conduct (11) through the hole controlled by the mixing screw (8) downstream of the main butterfly valve and in small apertures of this butterfly valve. The fuel discharge is effected through said hole controlled by the screw (8) and totally or partially by the by-pass holes or grooves (7).

[0014] It remains to be described how the aperture of the secondary butterfly valve is positioned to produce the appropriate suction at the outlet (3). Said suction is also produced in the by-pass holes and it is taken into account when obtaining the profile (18) of the dosing cam (13) joined to the axis of the main butterfly valve (1). (Figures 2 and 3)

[0015] For each of the apertures of the main butterfly valve, which is controlled by the cable from the accelerator of the engine, there is a point located on the inner profile (18) of the dosing cam (13) which in contact with the bolt (14) of the lever (15) joined to the axis of the secondary butterfly valve (2), determines the aperture of said butterfly valve, which generates the loss of additional load to suction the emulsioned fuel that with the admission air constitutes the mixture of air-fuel in a suitable proportion to produce an optimum combustion in the engine, following the classical criteria of proportion of mixture of maximum power at this aperture and proportion of mixture of maximum consumption efficiency for partial apertures of said butterfly valve. The need to overcome the norms for emission of contaminants can be slightly modified by these criteria without them constituting a significant exception. If the aperture of the main butterfly valve is maintained and the regimen of the motor is changed, the flow of air should be changed, except that said butterfly valve determines a section of clearance in sonic conditions in which case the air flow remains constant. The change of air flow mentioned earlier should modify the suction in circuits of emulsioned fuel so that there is no significant change in the air-fuel ratio of the mixture that arrives at the engine. This is obtained by adapting the dimensions of the geometry of the circuit lying between the main distributor (5) and the outlet (3) so that a turbulent flow is obtained both in said zone and at the edges of the secondary butterfly valve (2), a phenomenon controlled by the Reynolds Number.

[0016] If, from the generic point of operation determined by figure 2 there is a rapid or slow acceleration, which means an opening at said speed of the main butterfly valve (1) we can distinguish two phases as a response of the system to this operation:

- In a first phase, and for a brief instant, the secondary

butterfly valve (3) remains with the initial aperture that to all intents and purposes represents a Venturi effect of smaller section than that corresponding to the end point of the acceleration determined by another greater aperture of the secondary butterfly valve, as can be appreciated in figure 3. In these conditions, the response of the fuel circuits is practically instantaneous, given the high levels of suction in the aforementioned circuits, mainly keeping the same ratio of air to fuel in the mixture or with small enrichments. Thus, the vehicle equipped with an engine with the proposed feed system would not present any failure in conduction.

- In a second phase, longer than the first one depending on the power available and that necessary to overcome the resistance to advance, the bellows (17), equipped with a membrane and antagonist spring opens the secondary butterfly valve more (2) by means of a strip (16), as said bellows acts under the depression of the point (19) located downstream from the secondary butterfly valve. In this fashion, the rate of opening of said butterfly valve is a function of the increase in flow rate of air that circulates through the main conduct of the system (11) keeping a ratio of mixture of air to fuel mainly constant or with small enrichments.

The automatism described operating in accelerations, in addition to allowing the vehicle to be driven without failure, does not generate high emissions of CO and OH contaminants that a conventional carburettor of the type mentioned earlier equipped with an accelerated pump would produce.

[0017] The present patent of invention contemplates the alternative of establishing a control over the functionality of this feed system piloted by an electronic control to which signals of engine temperature, speed of rotation and opening of the butterfly valve arrive so that it can act on:

- An electric motor that controls the opening of the secondary butterfly valve.
- A valve that controls the air behind the butterfly valve (1) making an initially rich mixture leaner at will.

Claims

1. A fuel feed system for four-stroke engines, in which a central conduct is established through which air and the admission mixture circulate, equipped with a butterfly valve connected to the accelerator control, **characterised in that** the it also has a secondary butterfly valve that produces the necessary suction in the fuel circuits, having foreseen that the main butterfly valve is of smaller diameter than the secondary one and the profile of the conduct such that it obstructs the passage of gases at the outlet greater than the butterfly valves obliging a reduction in flow rates of gases, to which a large fraction of these pass near to the outlets of the fuel circuits producing a mixture of air-fuel in a suitable ratio for combustion in the engine.

2. A fuel feed system for four-stroke engines, according to claim 1, **characterised in that** the secondary butterfly valve has its opening limited by a cam system, such that said aperture depends only, in stationary operations, on the aperture of the main butterfly valve.

3. A fuel feed system for four-stroke engines, according to claims 1 and 2, **characterised in that** during the accelerations, some bellows equipped with a membrane and antagonist spring or without said spring, moved by the depression between the two butterfly valves, sets the secondary butterfly valve at the aperture that corresponds to it determined by the aperture of the main butterfly valve by means of the aforementioned system of cams.

4. A fuel feed system for four-stroke engines, according to claims 1 and 3, **characterised in that** the secondary butterfly valve is positioned by means of an electric motor which in turn receives the opportune signal from an electronic control that decides the type of intervention processing different parameters of the engine received as signals from sensors such as speed of rotation of the engine, temperature of the engine and admission and aperture of the main butterfly valve.

5. A fuel feed system for four-stroke engines, according to claims 1, 2, 3 and 4, **characterised in that**, downstream of the main butterfly valve, an electric valve controls an air flow that makes the mixture of the fuel feed system leaner such that the final mixture is appropriate for a perfect combustion with said electric valve being piloted by an electronic control that in turn receives information of the engine parameters from sensors of speed of rotation of the engine, temperature of the engine and admission and aperture of the main butterfly valve.

6. A fuel feed system for four-stroke engines, according to previous claims, **characterised in that** its structure, especially the inner part of the main conduct, is preferably obtained by means of injection based on a plastic material resistant to fuels at any operating temperature, that makes it dimensionally stable in the environment near to the engine.

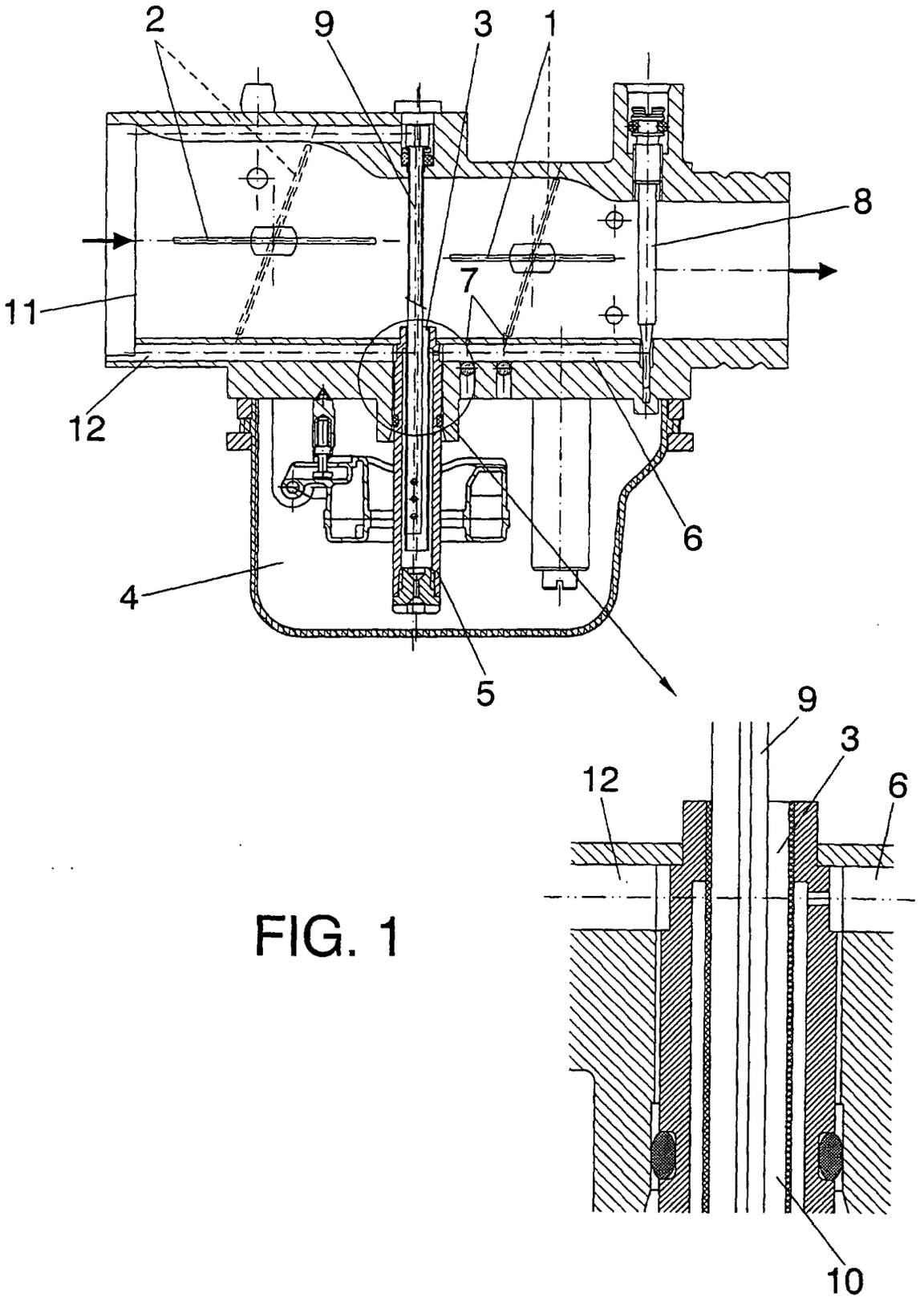

FIG. 1

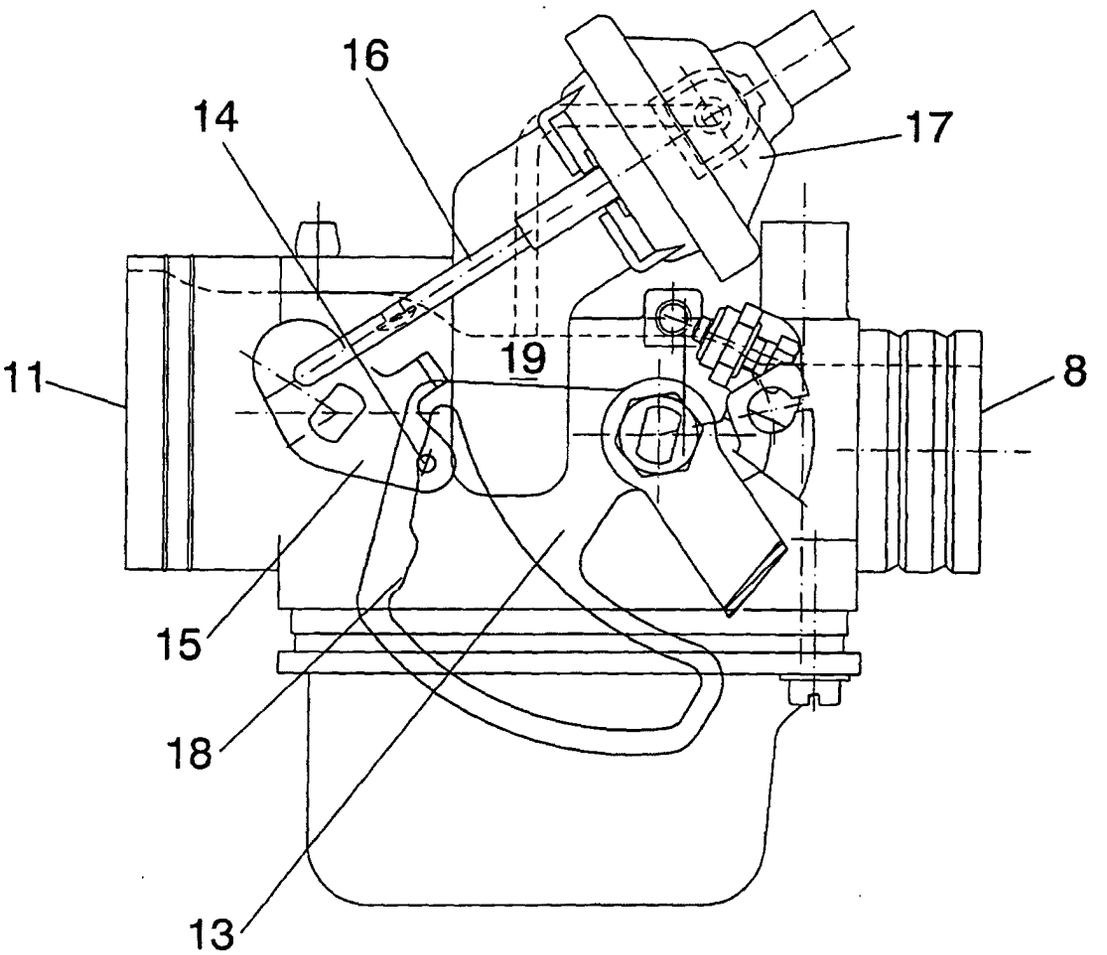

FIG. 2

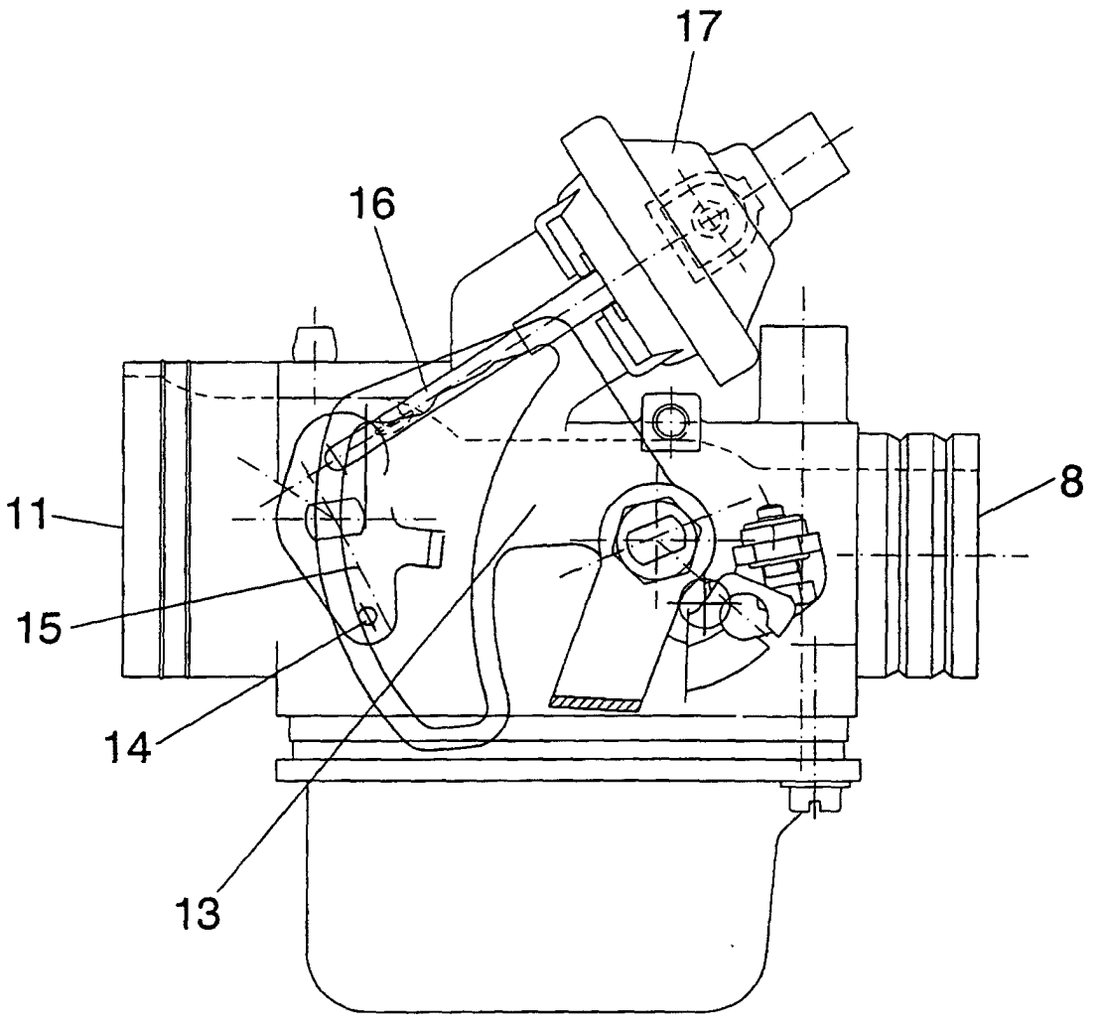

FIG. 3

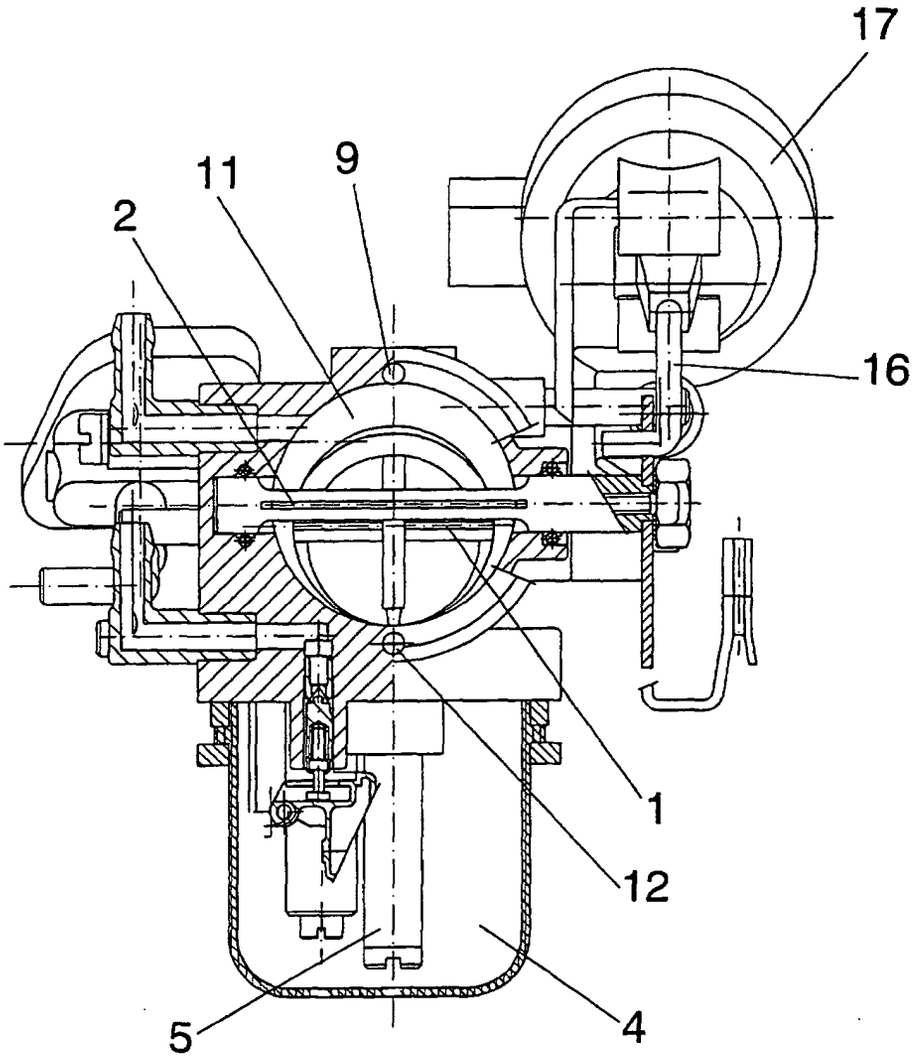

FIG. 4

INTERNATIONAL SEARCH REPORT

International application No.
PCT/ ES 01 / 00291

A. CLASSIFICATION OF SUBJECT MATTER

IPC[7] F02M 7/06

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)

IPC[7] F02M

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

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

CIBEPAT, EPODOC, WPI, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X Y	US 3 680 846 A (BICKHAUS et al) 1st August 1972 (01.08.1972), column 2, line 25 - column 5, line 50; figures.	1, 2 3 - 6

Y A	US 3 284 063 A (BICKHAUS et al) 8th November 1966 (08.11.1966), column 2, line 52 - column 3, line 38; column 5, lines 35 - 48; figures.	3 1

Y A	WO 91 16 536 A1 (KÖRÖSZTÖS et al) 31st October 1991 (31.10.1991), page 7, line 8 - page 8, line 14; figures 1-3.	4 1

☒ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
10 December 2001 (10.12.2001)	13 December 2001 (13.12.2001)
Name and mailing address of the ISA/ O.E.P.M. Facsimile No. Panamá,1 28071 Madrid,España	Authorized officer J. GALÁN MAS Telephone No.

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/ ES 01 / 00291

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 4 119 074 A (MASAKI et al) 10th October 1978 (10.10.1978), column 3, line 19-51; column 5, line 23 - column 6, line 19; figures 1, 8.	5
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INTERNATIONAL SEARCH REPORT

Information on patent family members

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PCT/ ES 01 / 00291

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