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(71) Applicant: **MORINI FRANCO MOTORI S.p.A.**
Via Porrettana 377
Casalecchio di Reno Bologna(IT)

(72) Inventor: **Trivelli, Aroldo**
Via Stresa 29
Milano(IT)

(74) Representative: **Raimondi, Alfredo, Dott. Ing. Prof. et al**
Studio Tecnico Consulenza Brevetti Piazzale Cadorna 15
I-20123 Milano(IT)

(54) Controlled feed and ignition apparatus for internal combustion engines.

(57) The controlled feed and ignition device for internal combustion engines comprises a carburettor having an air feed duct equipped with a controllable regulator valve and having a reduced section, into which leads a flooded fuel feed duct from a constant level chamber, in which there is present a device for varying the flow cross-section of the fuel feed duct, an electronically controllable ignition device and an electronic control unit, adapted for governing the device for varying the flow cross-section of the fuel feed duct as a function of instantaneous operating data about the engine supplied to it from relative sensors, the electronic control unit being moreover adapted for acting upon the ignition device for regulating the spark advance value for the engine ignition, as a function of said instantaneous data supplied from the sensors, for setting optimum operating conditions for said engine.

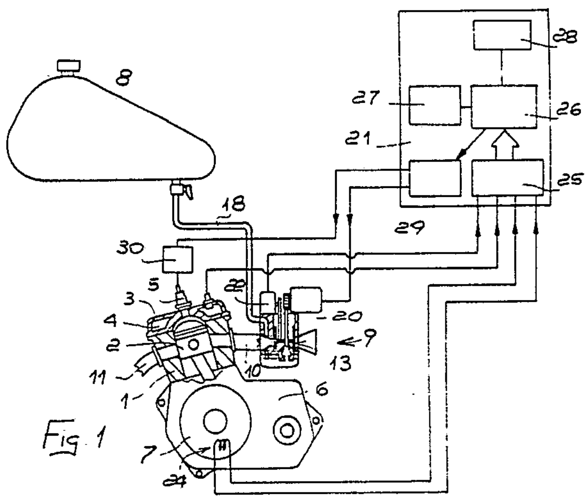

Fig. 1

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Controlled feed and ignition device for internal combustion engines

The subject of the present invention is a controlled feed and ignition device for internal combustion engines.

Internal combustion engines are usually equipped with a device for feeding fuel and combustion supporter, usually air, mixed in the required proportions for achieving optimum combustion in the cylinder or cylinders of said engine.

Said device is often composed of a carburettor, in which there is present, basically, a duct equipped with a zone of restricted cross-section, where the passage of the air, drawn in by the vacuum generated in the cylinder or cylinders, determines a suction of fuel through an associated duct, which fuel thus becomes mixed and finely dispersed in the combustion air.

The air flow rate passing through the carburettor is determined by a valve for regulating the section of the air duct, and the variation in this air flow rate determines, for reasons of fluid dynamics well known in the art, a corresponding variation in the quantity of fuel drawn in; the actuation of said regulating valve, normally termed a "butterfly" valve although frequently of varying constructional types, therefore determines the total quantity of air-fuel mixture supplied to the engine, and the associated operating regime.

The use of fuel feed ducts of fixed cross-section does not, however, prove to be optimum from the point of view of forming a correct air-fuel ratio at every engine speed, thus giving rise to the creation of toxic emissions at the exhaust, high fuel consumption, and unsatisfactory engine output and so on.

For the purpose therefore of achieving, in all conditions, a correct ratio of feed, it is therefore necessary to vary the flow aperture for the fuel in the air duct, in order to influence the flow rate of fuel emitted; carburettors have been constructed, in which a device for regulating such flow aperture is movable integrally with the butterfly valve, but this kind of regulation is fairly difficult, especially for the small values of flow rate involved, and moreover does not prove satisfactory in all operating conditions, which depend upon other parameters in addition to the position of the butterfly valve.

The running of the engine is influenced also by its ignition, and in particular by the spark advance value of same, which can give rise, if it is inadequate, to operating irregularities and emission of high quantities of pollutant, in particular nitrogen oxides and unburnt hydrocarbons.

A regulation of the feed and ignition conditions may be achieved with electronic ignition and injection apparatuses, but such devices prove to be especially complex and delicate and also expensive, and therefore do not lend themselves to use in engines of small sizes, and in particular for the engines used for motor cycles. Engines intended for motor cycles, moreover, are frequently two-stroke and often run at high rotational speeds, and the known electronic injection devices are not capable of operating in optimum manner under such conditions.

The problem therefore arises of providing an ignition and feed device for an internal combustion engine, which shall realize, in all operating conditions, the ideal values for achieving the intended results, that is to say low fuel consumption, reduction of pollutants and so on.

Said results are achieved by the present invention, which provides a device for controlled feed and ignition for internal combustion engines, which comprises a carburettor having an air feed duct, equipped with a controllable regulator valve and having a reduced cross-section, into which there leads a flooded fuel feed duct from a constant level chamber, in which there is present a member for varying the flow cross-section of the fuel feed duct, an electronically controllable ignition member and an electronic control unit, adapted for governing the device for varying the flow cross-section of the fuel feed duct as a function of instantaneous operating data of the engine, the data being supplied to it from relative sensors, the electronic control unit being, moreover, adapted for acting upon the ignition member for regulating the spark advance value for the engine as a function of said instantaneous data supplied by the sensors, for the purpose of setting optimum operating conditions for said engine.

With advantage, in one preferred form of embodiment of this invention, the member for varying the flow cross-section of the fuel feed duct is constituted of a stem having a tapered end, capable of being inserted to a variable depth into the fuel feed duct coaxially with same, thereby determining, in cooperation with said duct, an annular flow aperture having a variable section according to the depth of insertion of said end into the duct, the stem being equipped with a controllable actuator adapted for determining its depth of insertion into the duct.

The controllable regulator valve for the air feed duct of the carburettor is equipped with a position transducer, generating a signal corresponding at each instant to the position of the valve, the signal being adapted to be despatched to the electronic control unit for regulating, on the basis of it and possibly also other values, the value of the flow cross-section of the fuel feed duct of the carburettor and the ignition advance value.

In the device according to the present invention, there is present at least one sensor for the rotational speed of the engine, generating a signal corresponding at each instant to said speed, the signal being adapted to the despatched to the electronic control unit for regulating, on the basis of it and possibly other values, the value of the flow cross-section of the fuel feed duct of the carburettor and the ignition advance value; furthermore, there is advantageously present a sensor for the temperature of the engine or of an important part of the engine, generating a signal corresponding at each instant to said temperature, this signal being adapted to be despatched to the electronic control unit for regulating, on the basis of it and possibly other values, the value of the flow cross-section of the fuel feed duct of the carburettor and the ignition advance value.

The electronic control unit comprises a memory unit, having recorded, in a plurality of important operating conditions of the engine, the values of the quantities detected by the sensors and of the regulated quantities, that is to say the ignition advance and flow cross-section for the fuel, in the optimum operating conditions, and a microprocessor adapted for governing, in the varying operating conditions, the setting of the values for the optimum regulated quantities memorized in correspondence with the instant-by-instant values detected by the sensors.

Further details will become apparent from the following description, given with reference to the attached drawings, of an example of embodiment of the invention, in which there are shown:

in figure 1, an arrangement of use for the feed device according to this invention;

in figure 2, a basic diagram of a carburettor for the device according to this invention;

in figure 3, the carburettor for the device according to this invention, in one particular form of embodiment thereof, in section on the plane III-III of figure 4;

in figure 4, the carburettor of figure 3, in section on the plane IV-IV;

in figure 5, the carburettor of figure 4, in section on the plane V-V.

As figure 1 shows, an engine for motor cycles comprises a cylinder 1, in which a piston 2 is slidable, the cylinder having a head 3 equipped with cooling and ignition devices 4, 5 respectively, mounted on an engine block 6, in which there is a flywheel 7, locked in rotation on the engine shaft.

The cylinder 1 is supplied from a tank 8 via a carburettor 9, is equipped with an associated intake duct 10, and possesses an exhaust duct 11.

As shown in the basic diagram of figure 2, the carburettor 9 is equipped with an air flow duct 12, in which there is present a regulating valve 13 for the flow rate of air sucked in, commonly known as "butterfly" valve, although it may be of a different type; said valve, as is known, is operated manually for varying the speed of the engine during its use.

The carburettor possesses also, along the duct 12, a reduced portion of "venturi tube" type 41, into which, in the zone of maximum vacuum, there leads a fuel intake duct 15, through which said fuel is sucked for mixing with the air, the fuel being supplied from a constant level chamber 16, equipped with a float valve 17, adapted for occluding, at the predetermined level, the outlet aperture,leading into the chamber,of the fuel feed duct 18, coming from the tank 8.

As figure 2 shows, for the purpose of keeping optimum under all conditions the air flow rate, determined by the aperture of the valve 13, the flow rate of fuel and the passage cross-section of the relevant duct, the duct 15 is equipped with a conical needle 19, which, with its greater or lesser penetration into the duct 15, regulates the cross-section of the duct.

The needle 19 is associated with an actuator 20, adapted for controlling the greater or lesser insertion of the needle into the duct 15, thereby varying the pressure drop in the fuel which passes through it and therefore regulating its outflow rate under the effect of the vacuum produced in the venturi tube.

The position of the needle 19 is regulated on the basis of the operating conditions of the engine; in particular, the actuator 20 is controlled by an electronic control unit 21, shown in figure 1, which determines the movement of the actuator to bring the needle, in every operating condition of the engine, into the position which corresponds to the optimum flow cross-section out of the duct 15.

For this purpose, there is associated with the valve 13 a position transducer 22, which at every instant detects the position of the valve, which corresponds to the load applied to the engine.

The control unit 21 receives, from the position transducer 22, a signal relating to the position occupied from one instant to the next by the valve 13, and also other signals, corresponding to important operating parameters of the engine, advantageously constituted of the engine temperature, detected by a sensor 23, and the rotational speed of the engine itself, detected by a sensor 24.

These quantities, converted by an analogue-digital converter 25, are supplied to a microprocessor 26, to which there are connected a timer unit 27 and a memory unit 28, which microprocessor, on the basis of these supplies via a gate 29 the control signal to the actuator 20.

With advantage, the microprocessor 26 also controls the electronic ignition device 30, actuating the ignition member 5, and regulating its advance as a function of the operating conditions of the engine detected by the sensors.

The microprocessor 26 determines the position conditions of the needle 19, and therefore the air-fuel ratio, and the ignition advance on the basis of values stored in the memory 28, advantageously of the EPROM type, obtained in bench tests at various operating speeds of the engine, reproducing in every real condition those adjustments that, on the test bench, have led to reduced fuel consumption, reduced pollution emission at the exhaust and so on.

In fact, the variation in the air-fuel ratio requires an adjustment of the ignition advance values, in order that the thermal loadings on the components of the engine shall not be excessive; in particular, if the mixture is made leaner, that is to say the air-fuel ratio is increased, this requires a reduction in the ignition advance value, in order to avoid dangerous knocking or pinking. A suitable value of the air-fuel ratio as a function of the engine load, in conjunction with an appropriate ignition advance value, enables a net improvement in the specific fuel consumption and in the overall efficiency of the engine to be achieved, and also an improvement for the purposes of atmospheric pollution.

In fact, an accurate choice of the most appropriate air-fuel ratio under all conditions enables the engine to be run on a leaner mixture, thereby reducing the percentage of CO and unburned hydrocarbons in the exhaust, and in combination with the most appropriate choice of the ignition advance value, enables the formation of nitrogen oxides to be reduced.

It is therefore possible to achieve a complete control of the operating conditions of the engine with an apparatus that is simple and of moderate cost, without having recourse to complex and expensive electronic injection or ignition devices, which furthermore do not prove to be suitable for the typical operating conditions for two-stroke engines for use in motor cycles.

In the form of embodiment of figures 3 to 5, shown by way of example, the carburettor comprises a body 31, in which there is present the principal duct 12, with a portion 14 of "venturi tube" type, traversed in the direction of the arrow F by the air sucked in by the cylinder, and equipped with a valve 13 in the narrow zone of the venturi tube 14.

The position of the valve 13 is determined by the action of a cable 32, operated manually by the driver, in opposition to the action of a spring 33. The fuel present in the chamber 16, is sucked through a calibrated nozzle 34 and arrives, through the duct 15, at the reduced section of the duct 12.

Inside the duct15 there is present the conical needle 19, equipped with a conically tapered end portion 35, adapted for varying, by its greater or lesser insertion into the duct 15, the flow aperture of the duct.

The conical needle 19 is associated, at its upper end, with the actuator 20, which causes its axial displacement between a raised position, with the lower tapered end 35 entirely extracted from the duct 15, and a lowered position, in which the tapered end 35 entirely occludes the aperture of the duct 15.

The actuator 20 may be composed, as shown in the example in the figure, of a motor of the type known as "stepping", having on its own shaft 36 a pinion 37, engaging into a rack 38 integral with the needle 19, or connected to the needle 19 by an analogous device for converting the rotational movement into a linear movement.

In an alternative, the stepping motor may be replaced by an actuator of a different class, for example a linear actuator, adapted for producing the axial movement required by the needle 19 with the desired stopping precision.

With the valve 13 there is also associated a stem 39, connected to the rotatable arm 40 of the position transducer,22 supported, like the motor 20, on the body 31 of the carburettor.

The chamber 16 of the carburettor is equipped with a float valve 17, having the relevant float 41 comprising two elements, and the obturator 42 situated at the opening into the chamber 16 of the duct 18.

The microprocessor 26 can operate, not only on the basis of the data stored in the EPROM unit 28 as a result of bench tests, but also on the basis of a suitable algorithm, in the case where it is possible to determine, for a specific engine, a correlation between the operating quantities that can be detected and the regulating operations to be carried out on the carburettor and the ignition.

Although the invention has been described with reference to its application to a two-stroke engine intended for motor cycles, it is applicable in an analogous manner also to internal combustion engines of other types, for example to four-stroke engines intended for automobiles.

Numerous variants may be introduced, without thereby departing from the scope of the invention in its general characteristics.

Claims

1. Controlled feed and ignition device for internal combustion engines, characterized by the fact that it comprises a carburettor having an air feed duct equipped with a controllable regulator valve

and having a zone of reduced cross-section, into which there leads a flooded fuel feed duct from a constant level chamber, in which there is present a member for varying the flow cross-section of the fuel feed duct, an electronically controllable ignition member and an electronic control unit, adapted for governing the member for varying the flow cross-section of the fuel feed duct as a function of instantaneous operating data of the engine supplied to it from associated sensors, the electronic control unit being, moreover, adapted for acting upon the ignition member for regulating the ignition advance value of the engine as a function of said instantaneous data supplied by the sensors, for setting optimum operating conditions for said engine.

2. Controlled feed and ignition device for internal combustion engines according to claim 1, characterized by the fact that the member for varying the flow cross-section of the fuel feed duct is constituted of a stem having a tapered end, capable of being inserted to a variable depth into the fuel feed duct, coaxially with it, determining, in cooperation with said duct, an annular flow aperture of variable cross-section in correspondence with the amount of insertion of said end into the duct, the stem being equipped with a controllable actuator adapted for determining its depth of insertion into the duct.

3. Controlled feed and ignition device for internal combustion engines, according to claim 1, characterized by the fact that the controllable regulating valve for the air feed duct of the carburettor is equipped with a position transducer, generating a signal corresponding, at each instant, to the position of the valve, this signal being adapted to be despatched to the electronic control unit for regulating, on the basis of this signal and possibly other values, the value of the flow cross-section of the fuel feed duct of the carburettor and the value of the ignition advance.

4. Controlled feed and ignition device for internal combustion engines according to claim 1, characterized by the fact that there is present a sensor of the rotational speed of the engine, generating a signal corresponding, at each instant, to said speed, the signal being adapted to be despatched to the electronic control unit for regulating, on the basis of this signal and possibly other values, the value of the flow cross-section of the fuel feed duct of the carburettor and the value of the ignition advance.

5. Controlled feed and ignition device for internal combustion engines according to claim 1, characterized by the fact that there is present at least one sensor for the temperature of the engine or of an important element of the engine, this sensor generating a signal corresponding, at each instant, to said temperature, this signal being adapted to be despatched to the electronic control unit for regulating, on the basis of the signal and possibly of other values, the value of the flow cross-section of the fuel feed duct of the carburettor and the value of the ignition advance.

6. Controlled feed and ignition device for internal combustion engines according to one or more of the preceding claims, characterized by the fact that the electronic control unit comprises a memory unit having recorded, in a plurality of important operating conditions of the engine, the values of the quantities detected by the sensors and of the regulated quantities, that is to say ignition advance and flow cross-section for the fuel, in the optimum operating conditions, and a microprocessor adapted for governing, in the different operating conditions, the setting of the values of the optimum regulated quantities stored in the memory in correspondence with the instant-by-instant values detected by the sensors.

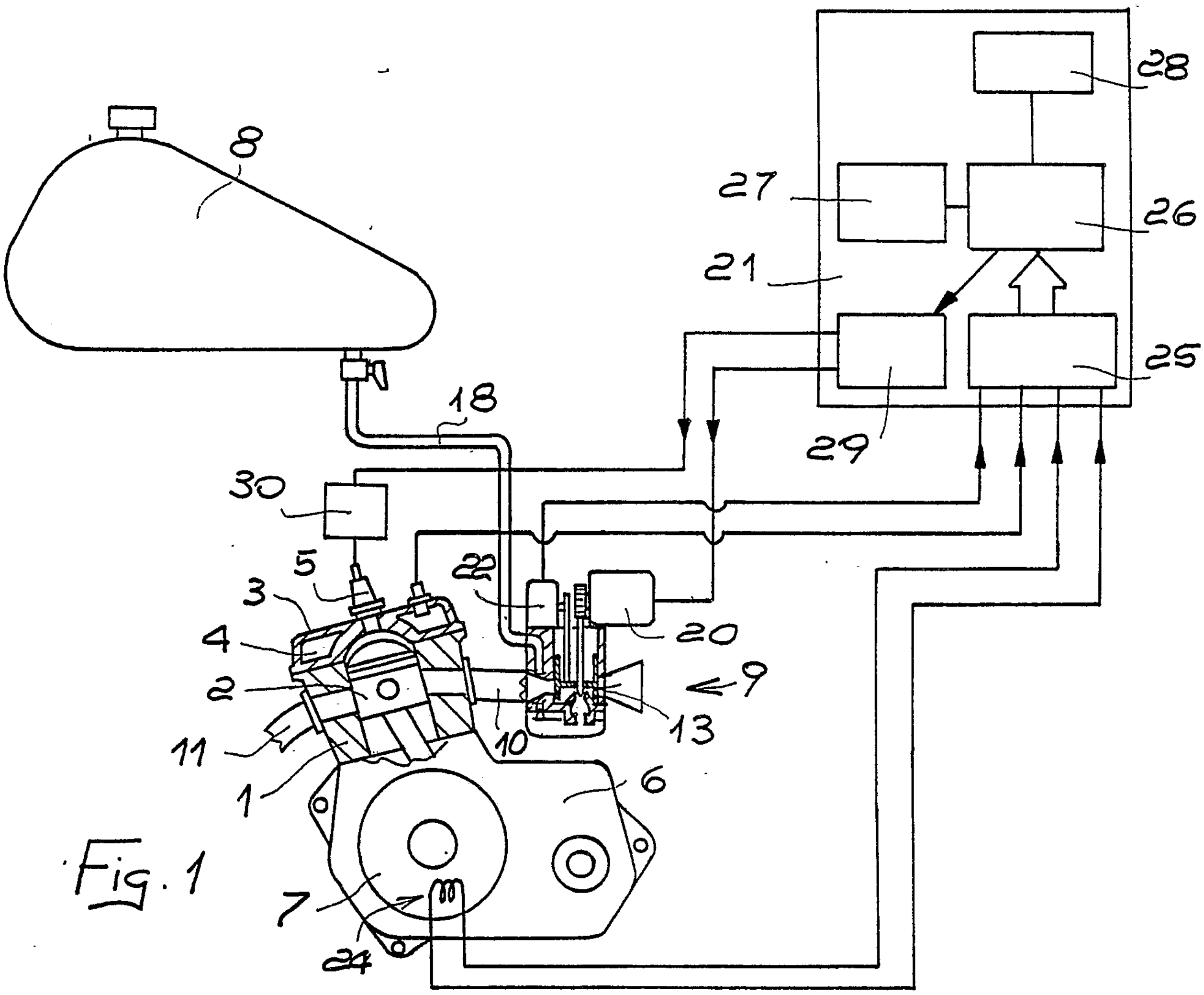

Fig. 1

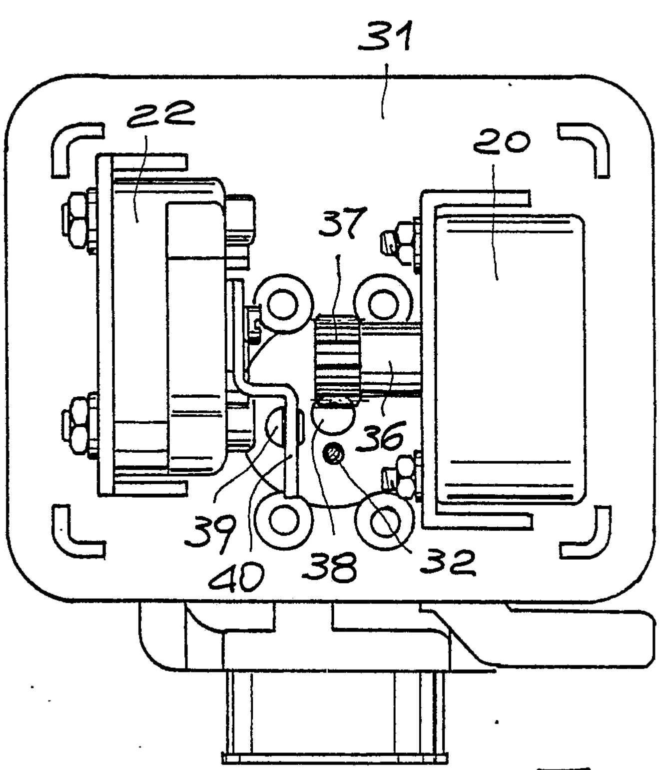

Fig. 5

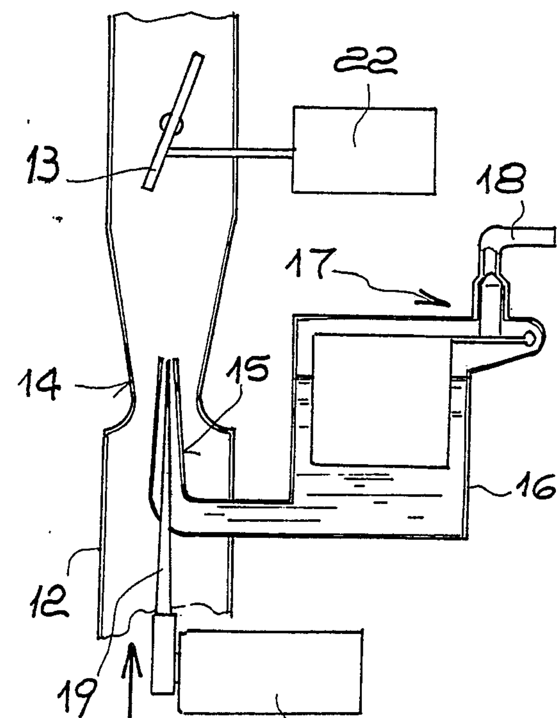

Fig. 2

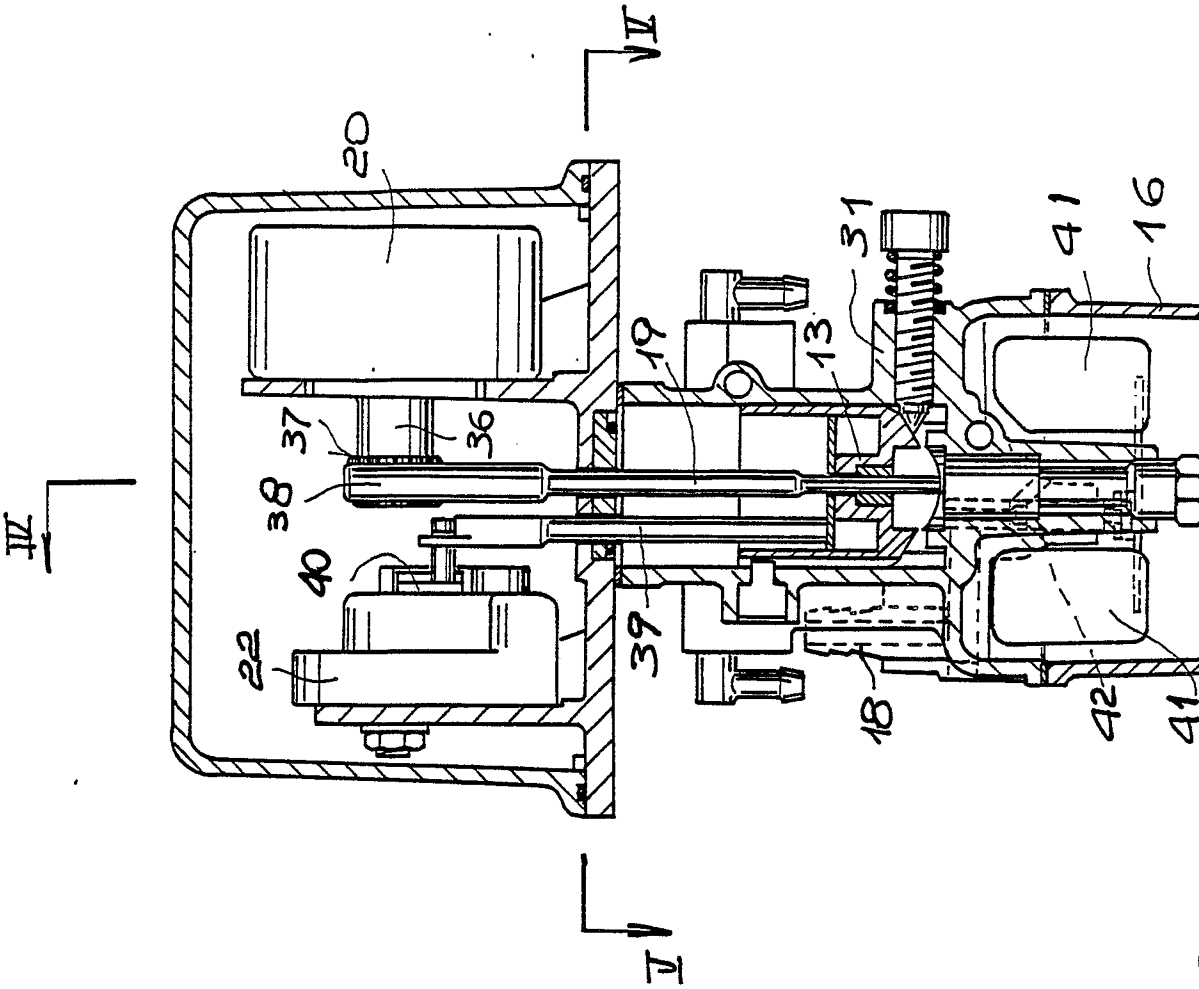
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Fig. 4

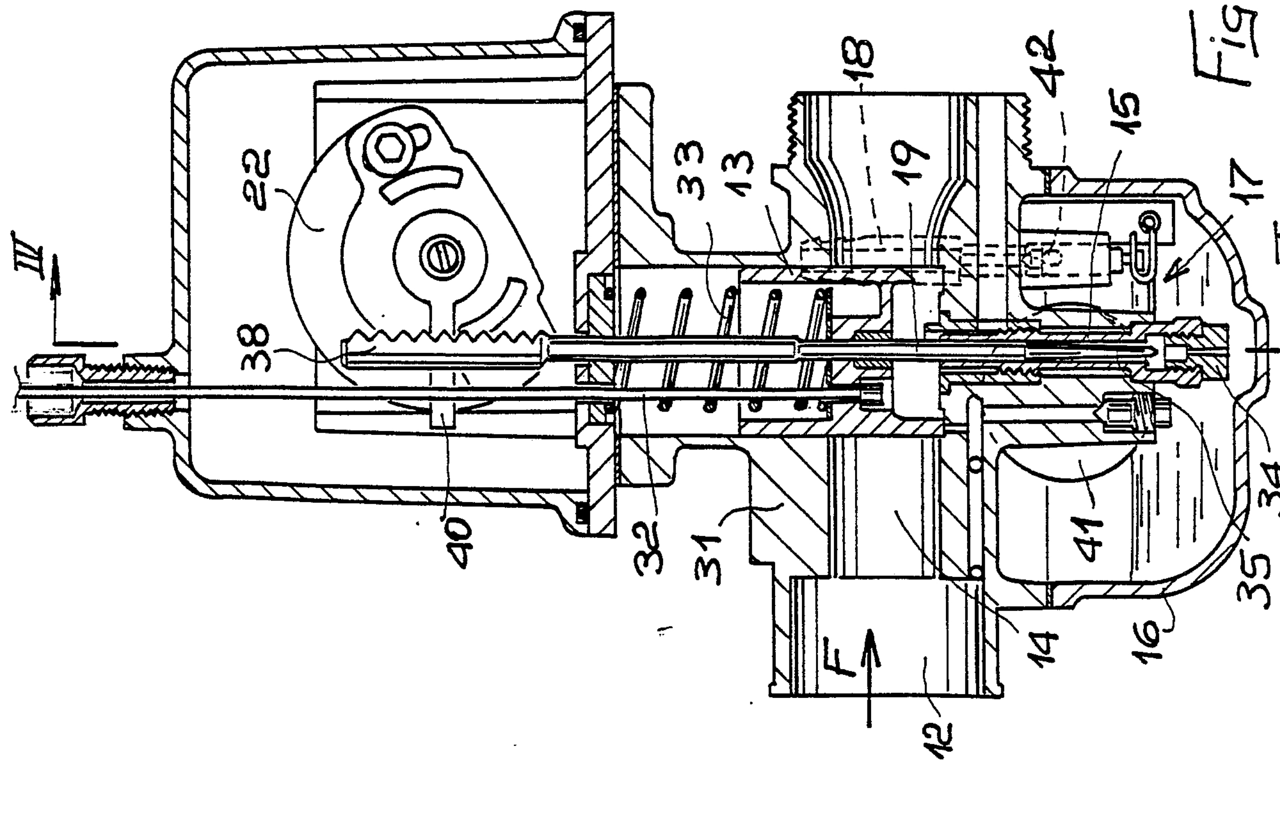
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Fig. 3