

June 6, 1972

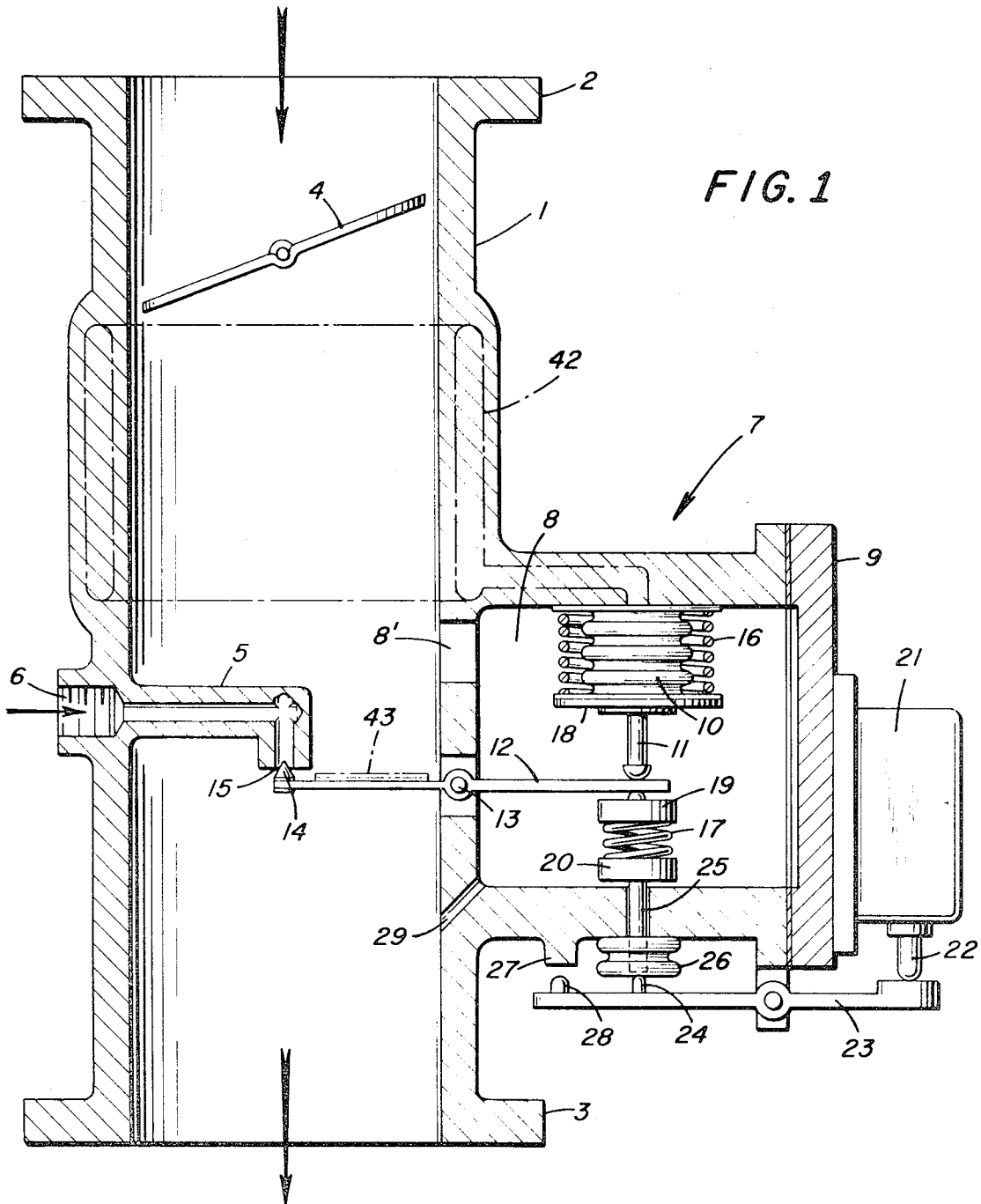
STEN-ERIK MORTSTEDT

3,667,740

CARBURETOR

Filed Aug. 1, 1969

6 Sheets-Sheet 1



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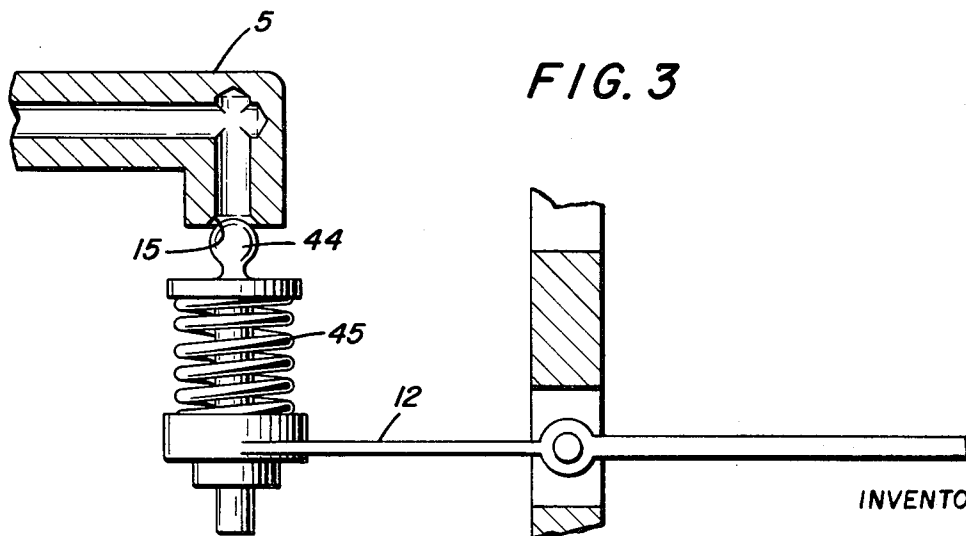
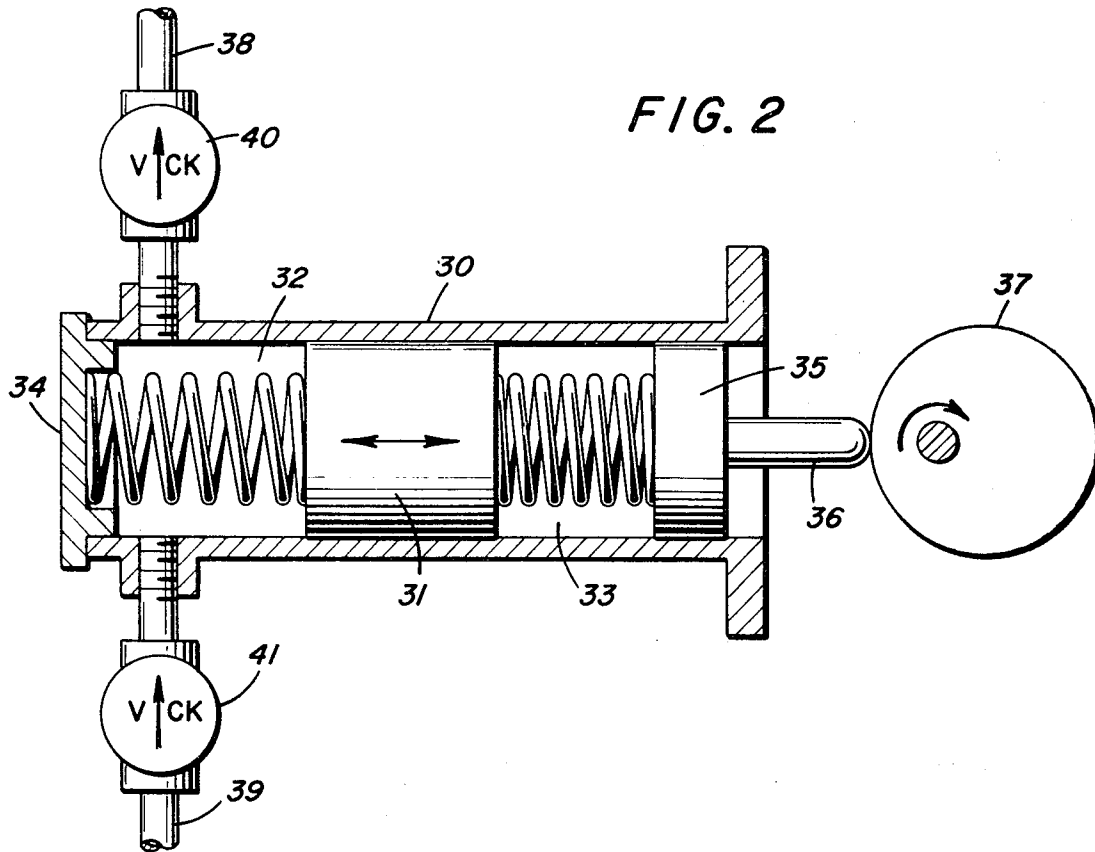
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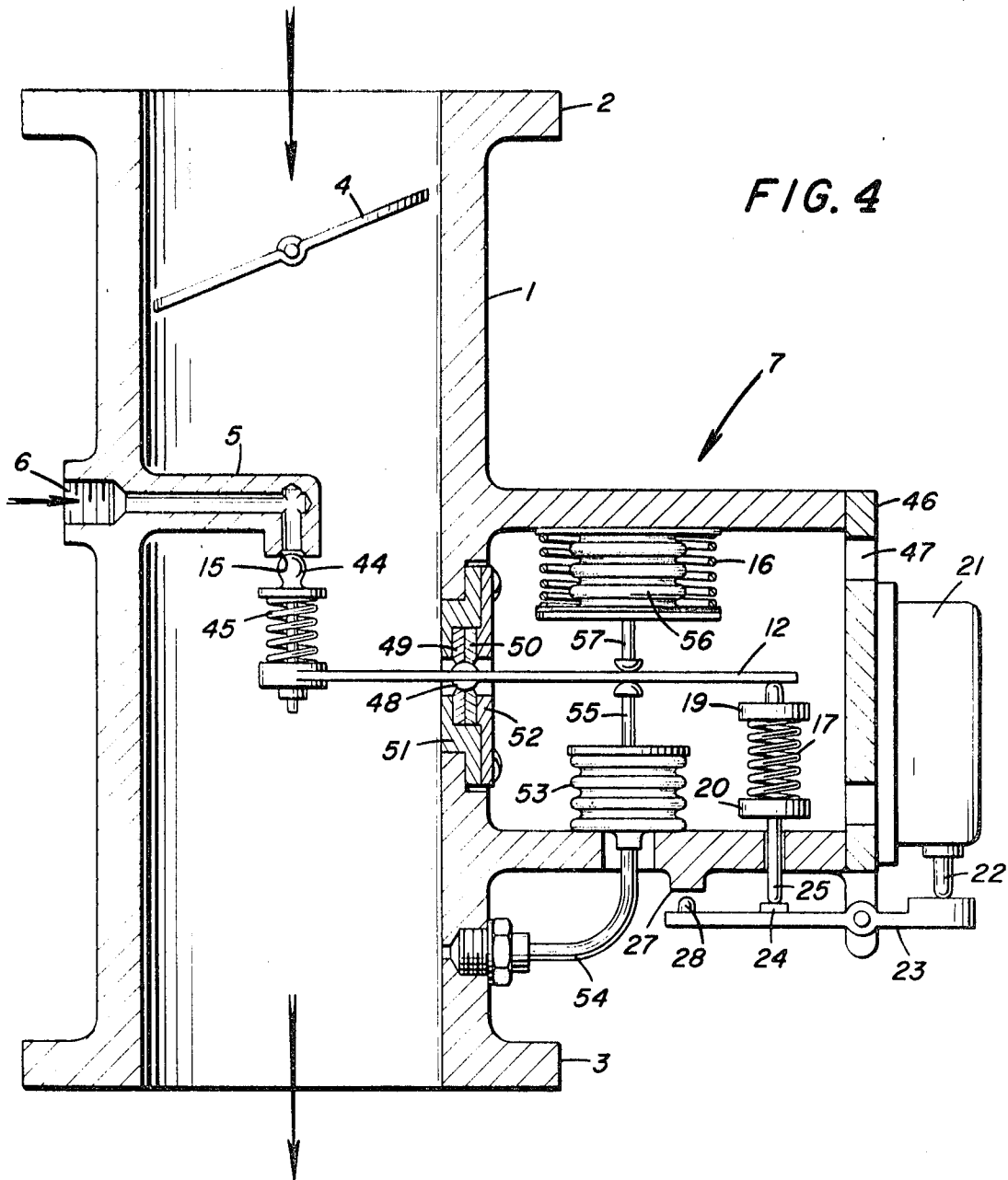
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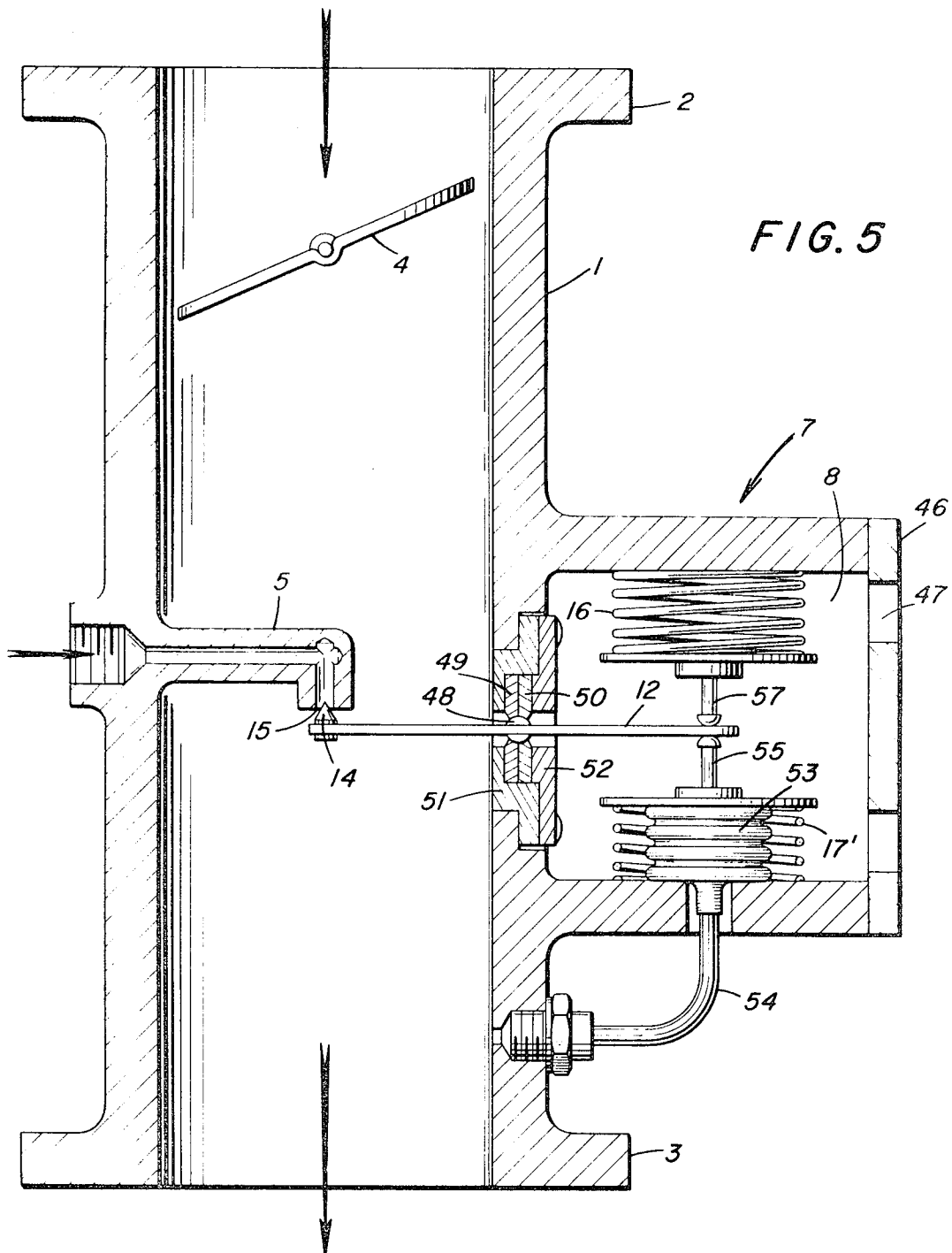
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6 Sheets-Sheet 4



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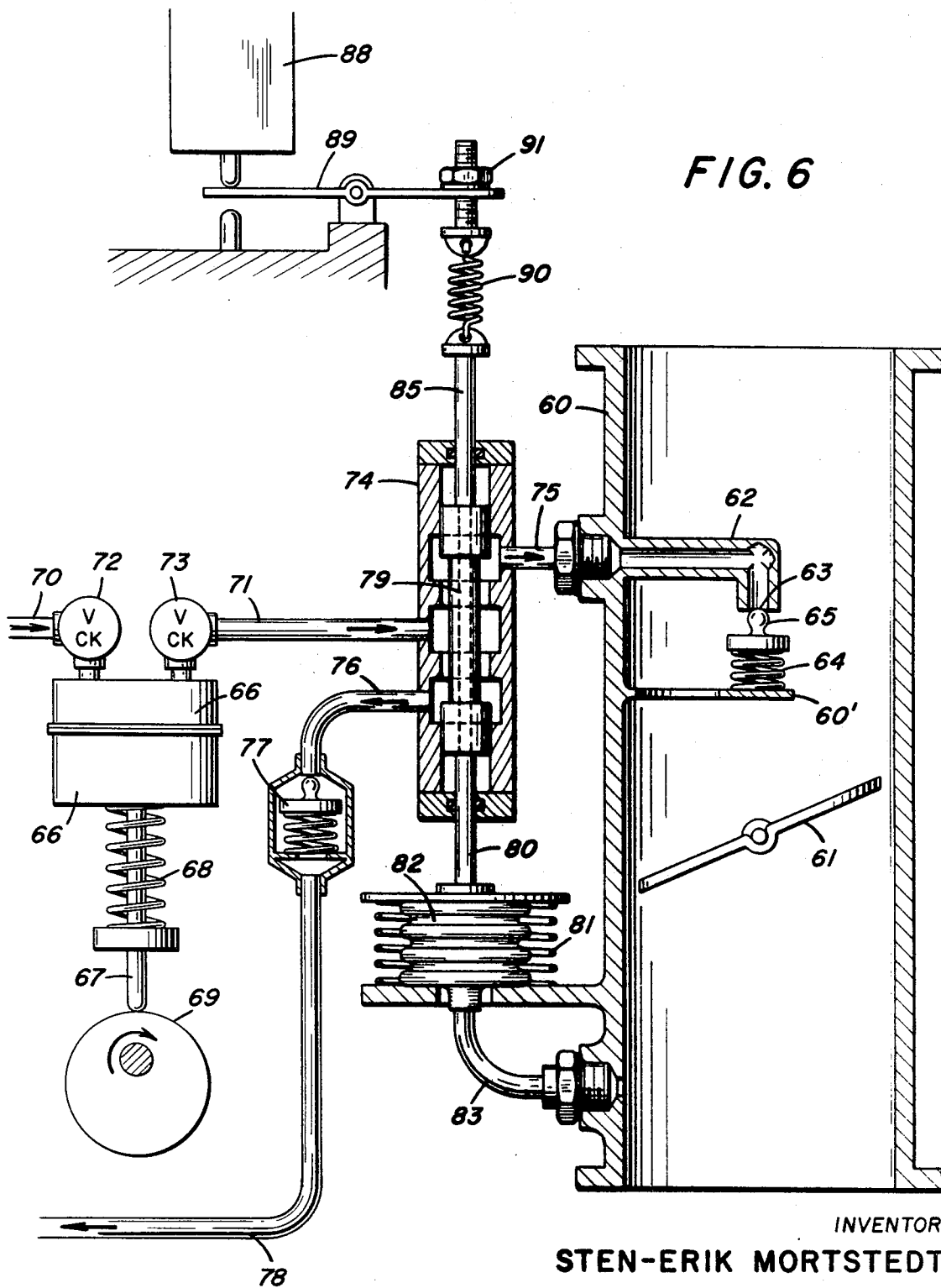
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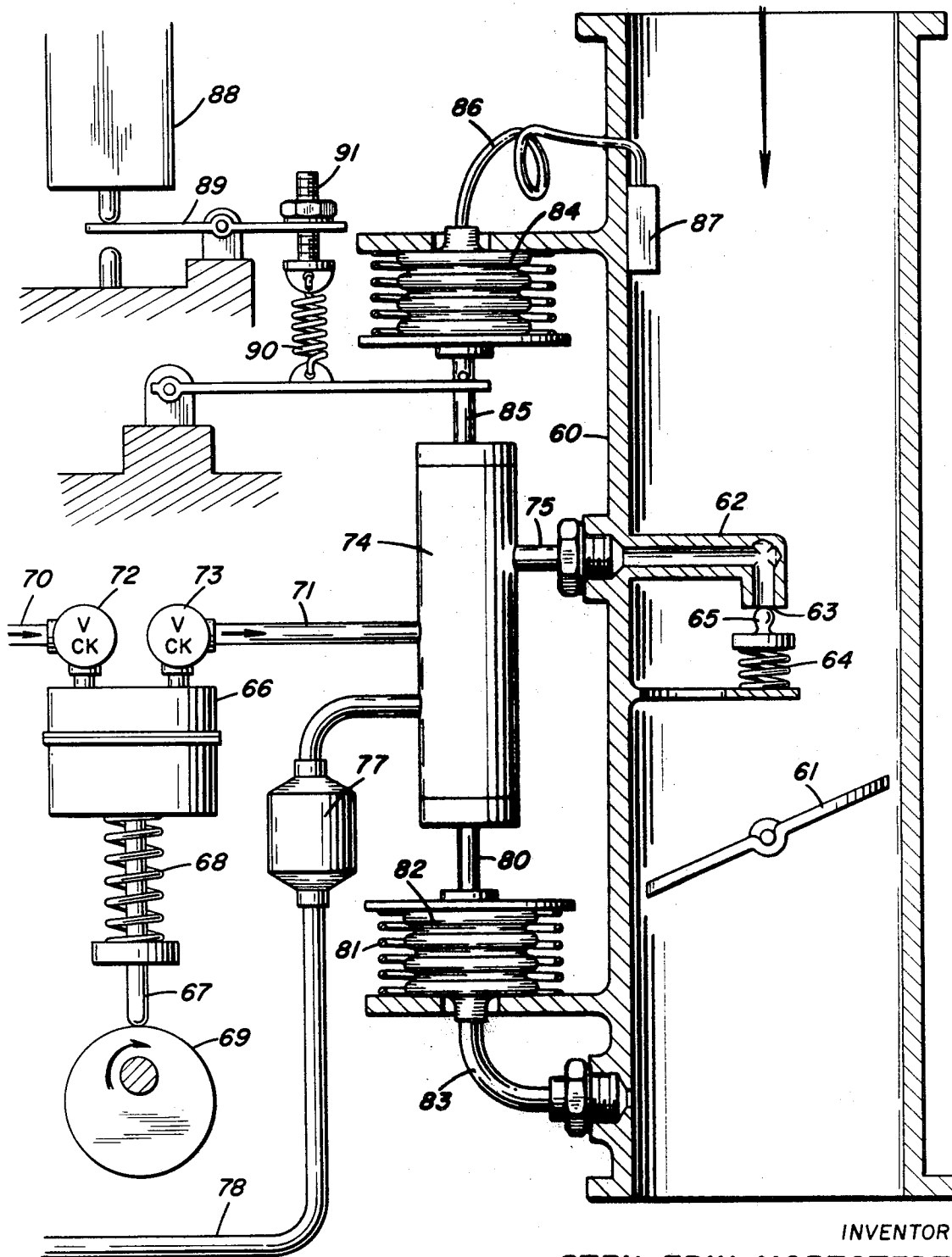
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CARBURETOR

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6 Sheets-Sheet 6



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FIG. 7

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6 Claims

ABSTRACT OF THE DISCLOSURE

A fuel-injection type carburetor for internal combustion engines, including means for automatically varying the rate of fuel flow into the air pipe in relation to the air pressure within said pipe and including the possibility for temperature and atmospheric pressure compensation.

The present invention relates to a carburetor for internal combustion engines, the carburetor being of the fuel-injection type wherein fuel under pressure is fed through a nozzle into the intake side of the engine cylinders. Specifically, the invention relates to an arrangement for automatically varying the amount of fuel fed into the carburetor air pipe in relation to various control factors, such as atmospheric pressure, temperature conditions, and engine speed.

It is known to vary the fuel input in proportion to engine speed, in fuel-injection type engines, by means of a fuel pump which is driven by the engine at a speed proportional to said engine speed. This known expedient, however, is inadequate to provide the best fuel to air ratios at the various engine speeds, which ratios depend on load conditions as well as on pressure and temperature conditions of the engine intake air.

Proper fuel to air ratios are, of course, important to the attainment of optimum engine efficiencies and low fuel costs, but they are especially of current importance relative to the reduction of air pollution which presently constitutes an area of major concern especially because of high levels of carbon monoxide and unburnt hydrocarbons in the exhaust of internal combustion engines.

It is an object of this invention to provide an improved fuel-injection type carburetor for automatically controlling the fuel to air ratio in response to various control factors.

It is a further object of the invention to provide such a carburetor whereby the fuel to air ratio may be reliably controlled in dependence upon either one or a combination of various control factors.

Other objects of this invention are those which are inherently derived from the inventive concept disclosed herein, a detailed description of various specific embodiments of realization following with reference to the accompanying drawings; wherein:

FIG. 1 is a sectional view through a carburetor according to a first embodiment of the invention wherein the fuel rate is controlled in dependence upon the air pressure in the intake pipes regardless of atmospheric pressure;

FIG. 2 is a schematic sectional view of a fuel pump which is employed in conjunction with the carburetor of FIG. 1;

FIG. 3 is a schematic illustration of an alternative nozzle valve assembly for use in the embodiment of FIG. 1;

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FIGS. 4 and 5 are sectional views through respective carburetors according to two further embodiments of the invention wherein the fuel rate is controlled in dependence upon the air pressure in the air inlet pipe and compensated by the atmospheric air pressure;

FIG. 6 is a sectional view through a carburetor according to a further embodiment of the invention; and

FIG. 7 is a sectional view through a modified form of the carburetor of FIG. 6.

The aforementioned objects are derived generally from an arrangement wherein the fuel rate is controlled in response to pressure conditions in the inlet pipe on the downstream side of the carburetor throttle valve. A further general aspect of the invention entails either a regulation of the fuel pump stroke in the case of a variable stroke pump or the regulation of the amount of fuel admitted to the carburetor in the case of a constant stroke pump.

The carburetor shown in FIG. 1 comprises a housing consisting of a generally circular cylindrical casing 1 forming the intake air pipe of the engine and at both ends provided with radially extending mounting flanges 2 and 3, respectively. In the upper portion of intake pipe 1 there is provided in well known manner a throttle valve 4 mounted for limited rotation around an axis extending substantially perpendicular to the longitudinal axis of the pipe 1. Reference numeral 5 designates a fuel nozzle opening in the central portion of the carburetor housing 1 and at its outer end provided with a threaded bore forming a connection 6 for a fuel conduit.

At its right-hand side in FIG. 1 the carburetor housing 1 is provided with a projecting portion 7 defining a chamber 8 which through openings 8' in the wall of pipe 1 communicates with the passage in pipe 1. Said chamber 8 which is delimited by a cover 9 contains an internally sealed hollow aneroid 10 having its one end surface resting against the upper wall of chamber 8, while its lower end surface is connected to the one end of a link or rod 11, the opposite end of which is adapted to actuate the one arm of a double-armed lever 12 pivotally mounted on a pin 13 in an opening in the wall of pipe 1 and at its free end, which extends into intake pipe 1, carries a valve body 14 cooperating with a valve seat formed by the mouth 15 of nozzle 5.

Lever 12 is spring biased by means of two counteracting springs 16 and 17 disposed in chamber 8 and stressed in such a way that when no fuel is supplied into nozzle 5, valve body 14 will bear against valve seat 15 with a predetermined pressure. Said springs are both formed as helical pressure springs and one spring 16 is provided around the aneroid 10 to act between the upper wall of chamber 8 and a circular disc 18 disposed between link 11 and the lower end surface of aneroid 10. Thus said spring 16 tends to pivot lever 12 in a direction so as to increase the contact pressure of valve body 14 against valve seat 15. The other spring 17 is arranged between two spring carriers 19 and 20, the upper spring carrier 19 resting against the arm of lever 12 extending into chamber 8 immediately opposite to link 11, while the lower spring carrier 20 normally rests on the bottom wall of chamber 8. Thus, spring 17 tends to counteract spring 16, i.e. to reduce the contact pressure between valve body 14 and valve seat 15.

In FIG. 1 reference numeral 21 designates a choke device which may be either of automatic or manually operated type. This device has a reciprocable operating rod 22 acting on one arm of a double-armed lever 23 pivotally

mounted on housing 1, the opposite arm of said lever being arranged to operate, by means of a projecting pin 24, on a rod 25 extending from spring carrier 20 through the bottom wall of chamber 8. In order to prevent any leakage from chamber 8 and along rod 25 any suitable sealing means may be provided. In the embodiment illustrated in the drawings said means consists of an aneroid 26. The movability of lever 23 in one direction is limited by two cooperating stop members 27 and 28. Reference numeral 29 designates a bore provided in the wall of pipe 1 to serve as a drain from chamber 8 in order to prevent any accumulation of fuel in said chamber.

The fuel pump shown in FIG. 2 is a piston pump and consists of cylindrical housing 30 and a piston 31 disposed in said housing and operated by two counteracting springs 32 and 33 of which the first mentioned is arranged between a fixed end wall 34 of housing 30 and one end surface of piston 31, while the other spring 33 acts between the opposite end surface of piston 31 and a disc 35 mounted axially displaceable in housing 30 and forming the opposite end wall of the pump. Disc 35 carries an axially extending rod end of which bears against an eccentrically journaled circular cam disc 37. Reference numerals 38 and 39 designate the discharge and inlet pipes of the pump each containing a non-return valve 40 and 41, respectively.

The function of the above described carburetor and pump will now be explained in detail. Cam disc 37 is driven in a known manner at a speed proportional to the rotary speed of the engine whereby piston 31 is caused to carry out a number of reciprocating working strokes per unit of time in proportion to said rotary speed. The length of the stroke of piston 31 will, due to the resilient mounting of said piston, vary in response to the back-pressure existing in discharge pipe 38 which is connected to the carburetor nozzle 5. This back-pressure is proportional to the force with which valve body 14 is pressed against valve seat 15 and since the magnitude of this force is inversely proportional to the pressure in chamber 8 acting on aneroid 10, which pressure is equal to the pressure in intake pipe 1, the stroke length of piston 31 will vary in direct proportion to the last-mentioned pressure. This means that the quantity of fuel delivered per unit of time by the fuel pump can be controlled so that for various engine loads as well as for various atmospheric pressures it will be possible to maintain the desired fuel-air ratios.

Upon actuation of the choke device 21 whereby rod 22 descends the distance, between valve body 14 and valve seat 15 will further be reduced whereby a rich fuel-air mixture will be obtained for any particular pressure in pipe 8.

The carburetor can also be provided with means to compensate for variations in the temperature of the intake air. This compensation can be obtained in many different ways. Only three methods will be mentioned here. Firstly, as illustrated with dash-dotted lines in FIG. 1, an annular chamber 42 may be provided in the wall of pipe 1 in communication with the interior of gas filled aneroid 10. Such an arrangement will cause the gas pressure in aneroid 10 to increase with a rising temperature of the intake air in pipe 1, whereby the back-pressure in fuel discharge pipe 38 from the fuel pump will increase and less fuel will be pumped through nozzle 15. The second alternative is to provide a known bimetallic means 43 in the arm of lever 12 projecting into tube 1 so that said arm, which is sufficiently resilient, is bent upwards with increasing temperature of the intake air and downwards with decreasing air temperature in correspondence with the expansion-contraction characteristics of means 43. The third method of providing a temperature compensation is to produce rod 11 from a material having a high coefficient of expansion so that the length of said rod is substantially changed at varying temperature. Naturally, if desired, two or more of the above-mentioned or other

methods for temperature compensation may be combined together.

FIG. 3 illustrates an alternative arrangement of the valve body carried by lever 12. Thus, in FIG. 3 the valve body 14 of FIG. 1 has been replaced by a valve body 44 which is resiliently supported relative to lever 12 by means of a spring 45 tending to force valve body 44 against valve seat 15.

In the carburetor shown in FIG. 1 the aneroid 10 serving as a pressure sensing means is provided in chamber 8 in which the existing pressure is equal to the pressure in intake pipe 1 downstream of throttle 4; however, the pressure sensing means 10, can, instead, be placed in a space under atmospheric pressure. Two different carburetors of this type are shown in FIGS. 4 and 5. In said figures those elements which have their correspondence in FIG. 1 have been identified by the same reference numerals as in FIG. 1. The main novel characteristic of the embodiments according to FIGS. 4 and 5 is that chamber 8 does not communicate with the central passage in intake pipe 1; instead, said chamber 8 communicates with the surrounding atmosphere through openings 47 in cover 46. In order to prevent any communication between chamber 8 and the passage in intake pipe 1 along lever 12 said lever has been provided with a cylindrical or spherical bearing member 48 received in a correspondingly shaped bearing shell formed by members 49 and 50 which are mounted in the wall of pipe 1 by means of members 51 and 52.

The aneroid 10 of FIG. 1 has in FIG. 4 been replaced by a hollow axially expansible aneroid 53 located below the arm of lever 12 extending into chamber 8, and having its inner space connected to the passage in intake pipe 1 through a conduit 54. The aneroid 53 is thereby actuated internally by the pressure in intake pipe 1 downstream of throttle 4 and externally by atmospheric pressure. Aneroid 53 acts through a rod 55 on lever 12 with a force corresponding to the pressure difference between the outer and inner end surfaces of the aneroid. Compensation for variations in the pressure of the surrounding atmosphere is provided by means of a further internally sealed hollow aneroid 56 placed in chamber 8. Since said aneroid 56 is closed it is actuated only by the atmospheric pressure. Said aneroid 56 is by means of a rod 57 connected to lever 12.

For the rest, the carburetor shown in FIG. 4 is built up in the same way as the carburetor of FIG. 1 with the exception that valve body 44 is resiliently supported in the manner shown in FIG. 3.

The main difference between the carburetor according to FIG. 5 and the carburetor shown in FIG. 4 is that aneroid 56 has been omitted in FIG. 5. This means that the carburetor of FIG. 5 does not provide any compensation for variations in the atmospheric pressure. In FIG. 5 no choke device has been shown; however, the carburetor may of course be provided with such a device which may be arranged in the manner shown in FIG. 1 and 4, respectively. Furthermore, although the aneroid 56 has been omitted from FIG. 5, the spring means 16 has been retained which acts in opposition to the biasing action of spring 17' which in turn coaxially surrounds the aneroid 53.

FIGS. 4 and 5 do not illustrate any means for temperature compensation. Such compensating means may, however, be provided also in the carburetors shown in said figures and they may be designed according to any of the alternatives illustrated in FIG. 1.

FIGS. 6 and 7 illustrate two further carburetors made in accordance with the invention. Reference numeral 60 designates a cylindrical carburetor housing forming an intake pipe of an engine and containing a throttle 61 mounted for limited rotation around an axis perpendicular to the longitudinal axis of pipe 60. Reference numeral 62 designates a fuel nozzle terminating in the central portion of pipe 60. The mouth 63 of said nozzle forms a valve seat for a valve body 65 carried by a spring 64 which is

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compressed between said body and a fixed ledge 60'. Reference numeral 66 designates a fuel pump of diaphragm type having its diaphragm actuated by a rod 67 which by a spring 68 is maintained in contact with the envelop surface of a cam disc 69 eccentrically journaled and driven at a speed proportional to the rotary speed of the engine. The inlet and discharge pipes 70 and 71, respectively, of pump 66 are in usual manner provided with non-return valves 72 and 73, respectively. The discharge pipe 71 is connected to the inlet of a fuel distributor means 74 formed as a by-pass valve and having two outlets, namely: one outlet connected to fuel nozzle 62 through a conduit 75 and one outlet connected by a conduit 76 to a non-return valve 77 of the same type as valve 63, 64, 65 in carburetor housing 60. Valve 77 has its outlet connected to the suction end of the fuel pump, for instance to the fuel reservoir through a conduit 78.

Distributor means 74 contain, as appears in FIG. 6, an axially displaceable distributor slide valve 79 and is designed so that the total flow area to the two outlets of the valve is maintained constant, irrespective of the axial position of slide 79. By means of an axially projecting rod 80 valve slide 79 is coupled to a spring actuated hollow aneroid 82 surrounded by air at atmospheric pressure and having its inner space communicating through a conduit 83 with the passage in pipe 60 downstream of throttle 61. Thus, aneroid 82 will give slide 79 a position determined by the difference between the atmospheric pressure and the pressure within said passage in pipe 60. The carburetor shown in FIG. 7 has a further internally sealed hollow aneroid 84 which by means of a rod 85 is connected to the opposite end of slide 79. Aneroid 84 has the same effective area as aneroid 82 and will thereby additionally compensate for variations in the pressure of the surrounding atmosphere. Aneroid 84 does also serve to permit compensation for temperature variations in the intake air. For this purpose it is through a conduit 86 connected to a closed bulb 87 located in pipe 60 and containing a small amount of liquid having a low vapour pressure. The amount of liquid may preferably be chosen so that all liquid will be vaporized at a temperature of about 20° C. Naturally, temperature compensation by means of such liquid bulbs can be used also in the carburetors shown in FIGS. 1, 4 and 5.

In FIGS. 6 and 7 there is also shown a choke device 88 coupled to valve slide 79 by means of lever 89 and a spring 90. Reference numeral 91 designates an adjusting screw serving to facilitate any desired adjustment of valve 74.

The embodiments of the invention above described are only intended to be illustrative of different applications of the inventive concept. Thus, many further modifications within the same inventive concept are feasible. Moreover, it should be noted that all figures contained in the drawings are only of schematic nature so that the different disclosed carburetors may include a number of known elements or means. In this connection it is noted that, especially in the carburetors of FIGS. 6 and 7, it is possible to completely omit valve means 64, 65 and 77 whereby the nozzle 62 and conduit 76 are continuously open, the fuel flow therethrough being regulated solely by the axial position of slide 79.

An analysis of the foregoing disclosed embodiments reveals that they are all based upon the general principle of varying the fuel flow through the fuel injection nozzle in dependence upon variation in the air pressure in the carburetor air pipe. In addition, said pressure may be compensated relative to varying temperature of the air in said pipe and also relative to varying atmospheric pressure. In any event, the fuel flow is either regulated as in FIGS. 1, 4 and 5, by varying the fuel nozzle opening through use of the movable valve body 14 or 44 which in turn results in a corresponding variation of the output from a variable stroke, variable flow rate pump means 30, or the fuel flow is regulated as in FIGS. 6 and 7, by varying the distribu-

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tion of flow between the fuel nozzle and the fuel reservoir in the case of a constant output pump means 66.

The respective aneroids mentioned hereinbefore may be conventional collapsible, hollow, metallic bellows of cylindrical shape.

During normal operation, the absolute pressure in the casing 1 will vary between 0.5 to 1.0 bar and this same pressure variation will be transmitted into chamber 8 in FIG. 1 and into aneroid 53 in FIGS. 4 and 5, and into aneroid 82 in FIGS. 6 and 7. In FIG. 1, aneroid 10 and in FIG. 4, aneroid 56 are preferably under an internal vacuum of zero absolute pressure if it is desired that they not be responsive to temperature fluctuations. On the other hand, if aneroid 10 in FIG. 1 were internally connected with chamber 42 so as to provide temperature compensation, said chamber 42 and the aneroid 10 must be filled with a gas such as air and the absolute pressure thereof would be in the vicinity of 0.5 bar.

The bulb 87 in FIG. 7 may be filled with a liquid such as C₂H₅OH.

Various of the herein given details relating to practical embodiments of the invention are illustrative and not limitative of the scope of applicability of the inventive concepts disclosed herein, it being understood that such details may be changed without departing from the spirit of said inventive concepts.

I claim:

1. A fuel-injection type carburetor, comprising: an air intake, a throttle valve disposed in said air intake; a fuel nozzle extending into and having an opening in communication with said air intake; a valve body removably seated in said fuel nozzle opening in said air intake; means supplying fuel to said air intake through said fuel nozzle under a pulsating pressure; means sensing the pressure in said air intake; means connecting said pressure sensing means to said valve body, wherein said valve body is movable by said pressure sensing means to adjust the seating of said valve body in said fuel nozzle opening; means, distinct from said pressure sensing means, sensing the temperature in said air intake; and means connecting said temperature sensing means to said valve body, wherein said valve body is movable by said temperature sensing means to adjust the seating of said valve body in said fuel nozzle opening, wherein said valve body further comprises a valve body support member mounted on one wall of said air intake and said temperature sensing means comprises a bi-metallic element mounted on said support member such that said support member is bent in relation to a bending of said bi-metallic element due to temperature variations acting on said bi-metallic element, thereby resulting in a corresponding movement of said valve body into and out of engagement with said fuel nozzle opening.

2. A fuel-injection type carburetor as defined in claim 1, wherein said valve body further comprises means resiliently mounting said valve body at one end portion of said support.

3. A fuel-injection type carburetor as defined in claim 1, wherein said pressure sensing means comprises a chamber in open communication with said air intake, an aneroid disposed in said chamber and means connecting said aneroid with said valve body.

4. A fuel-injection type carburetor as defined in claim 3, wherein said temperature sensing means comprises a closed receptacle in said air intake, a fluid having a low vapor pressure contained in said receptacle and means connecting said fluid with said aneroid.

5. A fuel-injection type carburetor, comprising: an air intake; a throttle valve disposed in said air intake; a fuel nozzle extending into and having an opening in communication with said air intake; a valve body removably seated in said fuel nozzle opening in said air intake; means supplying fuel to said air intake through said fuel nozzle under a pulsating pressure; means sensing the pressure in said intake; means connecting said pressure sensing means to said valve body, wherein said valve body is movable

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by said pressure sensing means to adjust the seating of said valve body in said fuel nozzle opening; means, distinct from said pressure sensing means, sensing the temperature in said air intake; and means connecting said temperature sensing means to said valve body, wherein said valve body is movable by said temperature sensing means to adjust the seating of said valve body in said fuel nozzle opening, wherein said pressure sensing means comprises a chamber in open communication with said air intake, an aneroid disposed in said chamber and means connecting said aneroid with said valve body, wherein said valve body further comprises a valve body support member pivotally mounted on one wall of said air intake; and one portion of said support member extends into said chamber, further comprising: means connecting said aneroid with said one portion of said support member for pivotal movement of said support member in a first direction; and means resiliently biasing said one portion of said support member for pivotal movement in a direction substantially opposite to said first direction.

6. A fuel-injection type carburetor as defined in claim 5, wherein said resilient biasing means comprises spring means disposed on the opposite side of said one portion of said support member as said aneroid and means adjusting the biasing force exerted by said biasing means,

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including a choke and means adjustably connecting said choke with said spring means.

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TIM R. MILES, Primary Examiner

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