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CARBURETOR OF COMBUSTION ENGINES WITH AUTOMATIC FUEL REGULATION

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Fig. 1

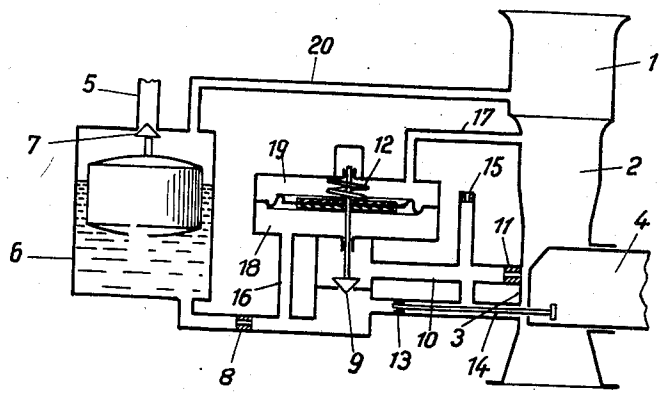
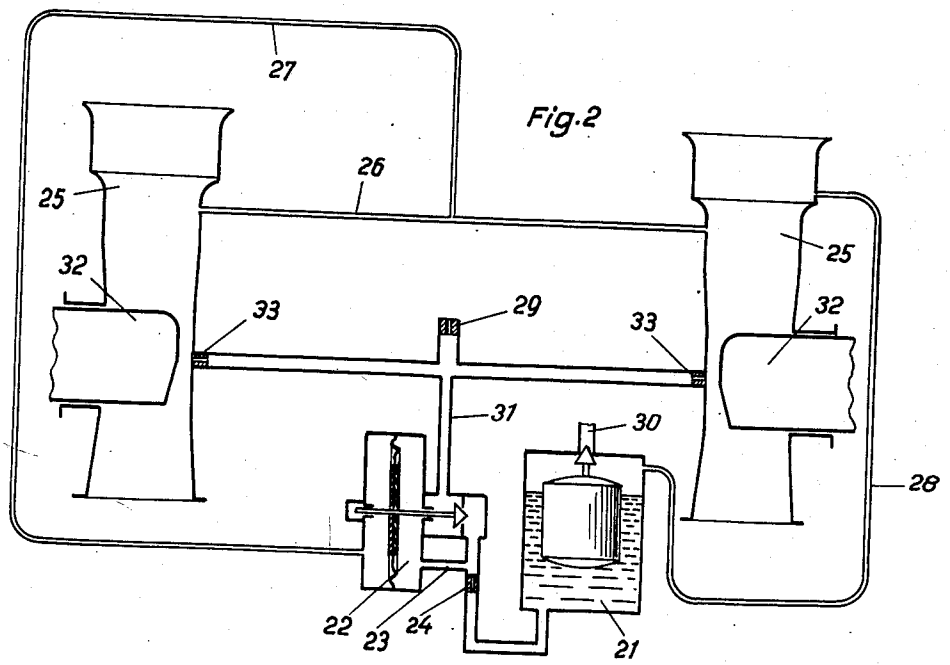


Fig. 2



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CARBURETOR OF COMBUSTION ENGINES WITH AUTOMATIC FUEL REGULATION

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Carburetors are used for the regulation and formation of the combustible mixture in so-called "Otto-engines" in which the proportion of mixture of air and fuel is determined thereby that the effective pressure produced in an air nozzle, air funnel or the like is transmitted to a calibrated fuel nozzle in such a way that the two effective pressures are equal and therewith the proportion of mixture equals to the proportion of the cross-section of the air and fuel nozzle. If the mentioned two cross-sections remain constant also a substantially constant proportion of mixture would result independent of the load of the engine and of the number of revolutions. This supposition essentially also prevails if, as in the so-called foam nozzle carburetors, additional or correcting air is added to the fuel before its exit into the air funnel where in the most cases the mixing of air and fuel happens, provided that the dimensioning of the spraying tubes and the forming of the nozzles correctly considers the rules of the mechanics of flow. Then approximately the following conditions exist:

$$G_L = c.f_L.\sqrt{\gamma_L \Delta p_L}$$

$$G_{Be} = c.f_{Be}.\sqrt{\gamma_{Be} \Delta p_L}$$

and

$$G_L : G_{Be} = f_L : f_{Be}\sqrt{\gamma_L : \gamma_{Be}} = \text{const.}$$

Herein means:

G_L=weight of the air sucked in per time unit,
G_{Be}=weight of the fuel sucked in per time unit,
f_L=narrowest cross-section of the air funnel,
f_{Be}=narrowest cross-section of the fuel nozzle,
γ_L=specific gravity of the air sucked in,
γ_{Be}=specific gravity of the fuel.

In connection with carburetor of vehicles the variability of γ_L may be neglected, while the variability of γ_L requires special regulating devices in connection with carburetors of aeroplanes.

For the purpose to balance alterations of the load of the engine mostly a throttle valve or a sliding valve is provided behind the place where the combustible mixture is formed; or, if the throttle valve is arranged in the direction of the air flow before the air funnel, mechanical devices are known regulating the feeding of the fuel according to an empirically found law or said devices act in a similar way as the depth rudder of carburetors of aeroplanes.

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For small engines, especially engines of motor cycles, carburetors are usual in which the place where the combustible mixture is formed coincides with the throttling place. The controlling of such carburetors is made fully empirically by considering the variable air cross-section on the mixture forming place by simultaneously changing the cross-section of the fuel nozzle. In consequence, however, of the very small fuel cross-sections the desired regularity cannot be reached. The described methods of regulating and forming the combustible mixture have great disadvantages.

If the carburetors are provided with a constant air measuring and fuel measuring cross-section a quadratic decrease of the effective pressure results from a decreasing load, so that the suction effect of the carburetor and therewith the atomizing of the fuel rapidly decreases. By this regularity for example also the arrangement of a device for running without load became necessary, ending on the edge of the throttling valve and constituting a second mixing place of air and fuel. Thereby the fuel supply depends upon the depression on that mixing place following very complicated rules. Thus it happens that the simple relation between the quantity of fuel and air is very considerably disturbed by the added device for running without load. The regulation of fuel and air will therefore not have approximately equal results for all loads but essentially depends also upon the position of the throttling valve. Further especially within the region of transition from running without load to running with partial load very undesired discontinuities of the proportion of mixture result.

A further considerable disadvantage of these mostly used carburetors arises during the forming of the combustible mixture. The forming of the combustible mixture should suitably take place on the place of the greatest air speed because there the mixture is the most intimate and perfect. Instead of that, here the mixture is again deposited in these carburetors behind the place of forming the mixture, the throttling valve being partially closed, and the mixture must be formed anew when passing through the throttling place. As further in consequence of the different circumstances of flow the passage through the throttling valve is quite different on the two halves related to the axis also the mixture behind the throttle valve is very differently concentrated. The mixture is "stripped." The quality of the atomizing further depends

upon the rate of decrease in pressure on the nozzle at a given cross-section. Now, as the rate of decrease in pressure becomes smaller in the square of the load also for this reason the fuel preparing on the exit of the nozzle becomes bad if there is a partial load.

These circumstances are an essential reason for the bad consumption of partially loaded engines working with the usual carburetors. In this respect the conditions on the usual carburetors of motor cycles are more favorable as here the forming of the combustible mixture takes place in fact on the place of the greater speed of flow.

There is however the difficulty to correctly dimension the jet needle destined to change the cross-section of the fuel nozzle proportionally to the alteration of the cross-section on the mixture forming place. In consequence of the high speed of flow at the throttling place the coefficients of flow resulting in a deviation from the quadratic rule of flowing are of considerable importance so that it is impossible to shape the jet needle so much approximate that the desired constant proportion of mixture or the required dependency of the proportion of mixture on the air quantity results with every load.

Further it is clear that the air slide which mostly is cylindrically shaped in combination with the air suction pipe socket of the carburetor arranged rectangularly thereto on the narrowest place does not form a cross-section formation adapted to be inserted into the equation of flow as measuring cross-section f_L, so that the effective pressure happening on the fuel nozzle is not at all a measure for the flowing air volume. The proportion of mixture, therefore, is very fluctuating with the load and the number of rotations even if the jet needle is accurately shaped. Also in that case a high consumption results with partial load.

The improved device according to the invention removes the above described disadvantages of the mentioned two systems of carburetors by the fact that the forming of the mixture takes place at the place of the highest speed of flow, i. e. on the throttling place itself. Further according to the invention the metering of the fuel is automatically made by a simple controller in dependency on the effective pressure measured in an air funnel having on unvariable cross-section.

The air measuring place may be arranged in that case before the throttling place of the air, a fact which is to be preferred in consequence of the so reached greater measuring exactness, or behind the throttling place in a sufficient distance if the variable air density is correspondingly considered. In the improved carburetor the construction of the throttling place is of no influence at all to the measuring exactness of the device as the fuel measuring nozzle is arranged between the float chamber and the controller in such a way that it remains free of all disturbance factors of the air flow. It is further without any importance whether there are arranged for example twisting devices behind the controller in the flowing direction of the fuel for the purpose for ameliorating the atomizing. The proportion of mixture is determined in every case only by the cross-section of the main nozzle and the cross-section of the air funnel. This assumption naturally is only correct if the decrease of pressure on the throttling valve is sufficiently high to overcome the flowing resistances of the mixture of fuel and atomizer air between the regulating valve and the spraying nozzle.

As with decreasing load until a smallest partial load (10–20% of the full load) the action of the regulator intermits in consequence of the quadratically decreasing effective pressure a no-load device of the usual form is necessary. But also this device does not influence the proportion of mixture if the regulator starts with increasing partial load as the quantity of fuel escaping from the slow running jet is also measured by the main nozzle and the regulator only allows so much fuel to pass as required on both nozzles altogether.

So it is also possible to arrange only one regulator and one main measuring nozzle in multicylinder motors and to provide any number of throttling places or mixture forming places on different places of the suction tube. In this case only one air measuring place may be provided or the measuring tube lines of a plurality of air measuring places may be conducted to one sole regulator.

The new regulator becomes very simple especially by the fact that the effective pressures Δp_L and Δp_{Be} are divided. The negative pressures are conducted to the two sides of a membrance connected with the controlling valve, while the positive pressures are short circuited in a float chamber arranged before the regulator.

When shaping the Venturi portion of the carburetor it is of importance that the open cross-section of the fully opened throttling valve be smaller than the narrowest cross-section of the air measuring place. If the throttling valve is fully opened the narrowest cross-section of the carburetor must be of such size that the decrease of pressure from the air funnel until the throttling place is greater than the loss of pressure of the fuel from the place behind the fuel measuring nozzle until the exit of the spraying nozzle, including the exit losses.

The drawing shows by way of example two embodiments of the invention, Fig. 1 being a diagrammatical illustration of the one and Fig. 2 of the other embodiment.

According to Fig. 1 the air enters through the air suction pipe socket 1 and flows through the air funnel 2 to the throttling and mixture forming place 3. For limiting the output or power a throttling valve or throttling slide 4 of any desirable construction is provided. The valve or slide is operated by any suitable leverage not shown and described.

The fuel is delivered from the fuel container not shown in the drawing through the opening 5 and over the throttling needle 7 into the float chamber 6 of known construction, and from there to the main fuel nozzle 8 and over the throttling needle 9 of the regulator to the spraying nozzle 11. When partially loaded with a small load or when idly running the regulator closes automatically, in a given case under the action of the small additional spring 12, said spring being simultaneously a valuable means for influencing the characteristic of the regulator. In this event the fuel escapes through the slow running jet 13 which, if desired, may be controlled by a needle 14. The atomizing in the spraying pipe may be effectively ameliorated by additional air entering through the nozzle 15 or by twisting devices on the exit of the fuel without the regulation being influenced thereby.

The negative pressure in the air funnel 2 results from the difference in air velocity of that funnel as compared to that of the socket 1 of the air intake pipe. This velocity difference is brought

about by the shape of the socket and funnel. The air intake pipe is so constructed that the pressure drop between the intersection of the socket 1 with the pipe 20 and of the funnel 2 with the pipe 17 can be measured yielding an exact measurement for the calculation of the air volume taken in. Downstream of the intersection of the pipe 17 with the funnel 2, the latter still further converges or is reduced, in order to yield a further pressure drop at the point of fuel ejection by the nozzle 11, even when the throttle 4 is fully opened. The pressure drop must be large enough so that air may also be taken in through the auxiliary air nozzle 15.

The negative pressure on the fuel nozzle is conducted through the pipe line 16 into the chamber 18 and the negative pressure on the air nozzle through the pipe line 17 into the chamber 19, the two chambers being separated from each other by a membrane. The positive pressures are short circuited by the pipe line 20. The regulator operates as follows:

During idling, the throttle 4, as best shown in Fig. 1, is closed so that only a small amount of air will pass through the funnel 2. During this idling the pressure drop between the points of intersection with the socket and funnel with the pipes 20 and 17 is correspondingly small. For this reason, the spring 12 will be made sufficiently strong to close the throttling needle 9 of the regulator. The fuel needed for idling is being calibrated accordingly by the nozzle 13 and, where there is provided a regulation for said nozzle 13, for instance the needle 14, the calibration is also aided thereby. Where there is provided no needle 14, the idling fuel feed will be regulated by the size of the nozzle 13 and the size of the auxiliary air nozzle 15.

When the throttle 4 is opened wider and therefore the flow of air through the funnel 2 is increased, the regulator will be opened. The throttling needle 9 of the regulator will admit an amount of fuel necessary to cover the fuel required in addition to that fed through the nozzle 13, for ejection through the nozzle 11. The calibration of the amount of that fuel is made by the nozzle 8. Thereby the quantity of fuel increases until the pressure behind the fuel nozzle 8 is exactly as great as the pressure in the air funnel 2 so that the regulator is again balanced.

Another embodiment of invention in which a plurality of mixture forming places are combined with one sole regulator is shown in Fig. 2. In this figure 21 designates the float chamber and 22 the fuel regulator connected with the negative pressure of the fuel nozzle 24 by the pipe line 23, while the negative pressure of the air measuring nozzle 25 is connected with the regulator by the connecting pipe 26 and the assembling pipe line 27. In the pipe line 27 therefore the average pressure of the measurements in the air funnels 25 prevails so that also an average pressure is adjusted on the common fuel measuring nozzle. By the pipe line 28 the positive pressure of the air measuring nozzle 25 is connected with the float chamber. Exactly as described with respect to the negative pressures of the air measuring nozzles also here the two pressures may be combined to an average value. In the pipe line of the fuel also the common atomizing nozzle 29 is provided. The fuel flows through the admitting socket 30 into the float chamber 21 and over the main measuring nozzle 24 to the regulator 22. After passing the regulating valve the fuel flows into the assembling pipe 31 and from there to the spraying nozzles of which any desirable number may be provided and which are combined with mixture forming places 32 and throttling places. The throttle valves 32 are connected with each other by a leverage not shown in the drawing and are actuated by a common lever.

This arrangement allows to supply any number of suction sockets in the suction pipe line of a motor with an equal quality of mixture and is especially simple by using only one regulator and only one float chamber.

Having thus particularly described the nature of my invention and the manner in which the same is to be performed what I wish to have covered by Letters Patent is:

1. In a carburetor, for use in connection with a combustion engine, in combination, an air pipe having a wide section, a converging section adjacent thereto abruptly narrowing the width of said pipe as compared to said wide section, a narrow section spaced from said converging section and constituting the smallest width throughout said pipe, and a funnel section extending between said converging and narrow sections and continuously converging between the widths thereof, whereby air flowing through said pipe from said wide section to said narrow section will undergo a first pressure drop between said wide and said converging sections and will undergo a second pressure drop between said converging and said narrow sections, throttle means disposed in said narrow section and operable for reducing the width thereof, a fuel conduit comprising a float chamber structure including a regulatable inlet pipe, means operable in response to the amount of fuel prevailing at any moment in said chamber for regulating the amount of fluid delivered by said inlet pipe and comprising a valve, a float for opening and closing said valve, and an interconnection between said wide section of said air pipe and the upper portion of said chamber structure, a fuel pipe connected to the lower portion of said chamber structure and interconnected to said narrow section of said air pipe and operable for delivering controlled amounts of fuel sidewise thereto, and means connected to said fuel pipe for controlling the amount of fuel passing therethrough comprising a valve and a regulator interconnected to said converging section and being operable to actuate said valve in response to predetermined values of differentials between the pressure of the fuel flowing in said fuel pipe and the pressure prevailing in said converging section.

2. In a carburetor, for use in connection with a combustion engine, in combination, an air pipe having a wide section, a converging section adjacent thereto abruptly narrowing the width of said pipe as compared to said wide section, a narrow section spaced from said converging section and constituting the smallest width throughout said pipe, and a funnel section extending between said converging and narrow sections and continuously converging between the widths thereof, whereby air flowing through said pipe from said wide section to said narrow section will undergo a first pressure drop between said wide and said converging sections and will undergo a second pressure drop between said converging and said narrow sections, throttle means disposed in said narrow section and operable for reducing the width thereof, a fuel conduit comprising a float chamber structure including an inlet pipe and a float having a valve needle, said float floating in the fuel within said structure and being operable for clos-

ing with said needle said inlet when the level of said fuel surpasses a predetermined height inside of the structure, an air chamber formed in said structure above the level of the fluid thereof and intercommunicating with said wide section of said air pipe, a fuel pipe connected to the underside of said structure and operable for conveying said fuel and including a first fuel nozzle, a second fuel nozzle adjacent said narrow section of said air pipe and being operable for delivering sidewise fuel into said narrow section, and a valve intermediate said nozzles operable for interrupting the flow of fuel between said nozzles, means actuable for operating said valve in response to said pressure drops comprising a housing, a diaphragm partitioning said housing into two compartments and being in driving connection with said valve, the compartment nearest said valve being interconnected to said fuel pipe to receive fuel that passed said first nozzle and the other compartment intercommunicating with said converging section of said air pipe, and an air intake nozzle adjacent said second nozzle.

3. In a carburetor, for use in connection with a combustion engine, in combination, an air pipe having a wide section, a converging section adjacent thereto abruptly narrowing the width of said pipe as compared to said wide section, a narrow section spaced from said converging section and constituting the smallest width throughout said pipe, and a funnel section extending between said converging and narrow sections and continuously converging between the widths thereof, whereby air flowing through said pipe from said wide section to said narrow section will undergo a first pressure drop between said wide and said converging sections and will undergo a second pressure drop between said converging and said narrow sections, throttle means disposed in said narrow section and operable for reducing the width thereof, a fuel conduit comprising a float chamber structure including an inlet pipe and a float having a valve needle, said float floating in the fuel within said structure and being operable for closing with said needle said inlet when the level of said fuel surpasses a predetermined height inside of the structure, an air chamber formed in said structure above the level of the fuel thereof and intercommunicating with said wide section of said air pipe, a fuel pipe connected to the underside of said structure and operable for conveying said fuel and including a first fuel nozzle, a second fuel nozzle adjacent said narrow section of said air pipe and being operable for delivering sidewise fuel into said narrow section, and a valve intermediate said nozzles operable for interrupting the flow of fuel between said nozzles, means actuable for operating said valve in response to said pressure drops comprising a housing, a diaphragm partitioning said housing into two compartments and being in driving connection with said valve, the compartment nearest said valve being interconnected to said fuel pipe to receive fuel that passed said first nozzle and the other compartment intercommunicating with said converging section of said air pipe, and a regulatable third fuel nozzle connected to said fuel pipe and operable to receive fuel from said first nozzle and intercommunicating with said narrow section of said air pipe for delivering sidewise a regulatable amount of fuel thereto, and an air intake nozzle adjacent said second nozzle.

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