March 18, 1952 M. C. CARBONARO 2,589,536

FEEDING OF INTERNAL-COMBUSTION ENGINES

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Fig. 1

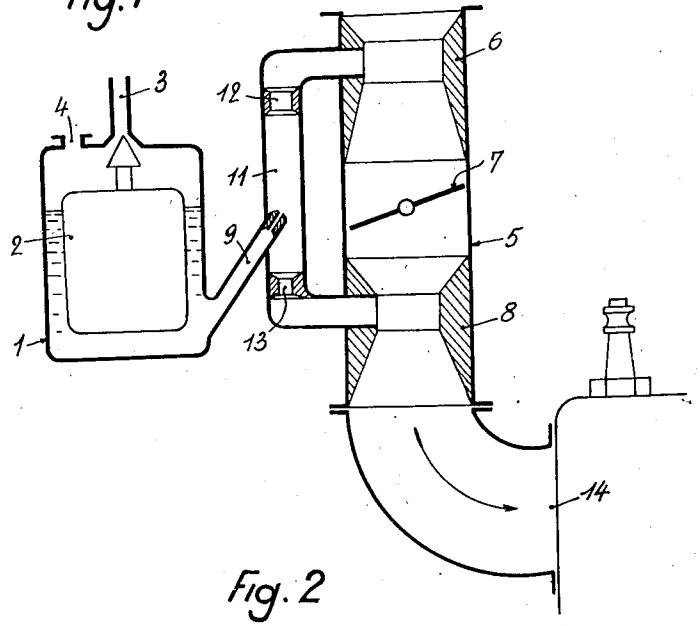
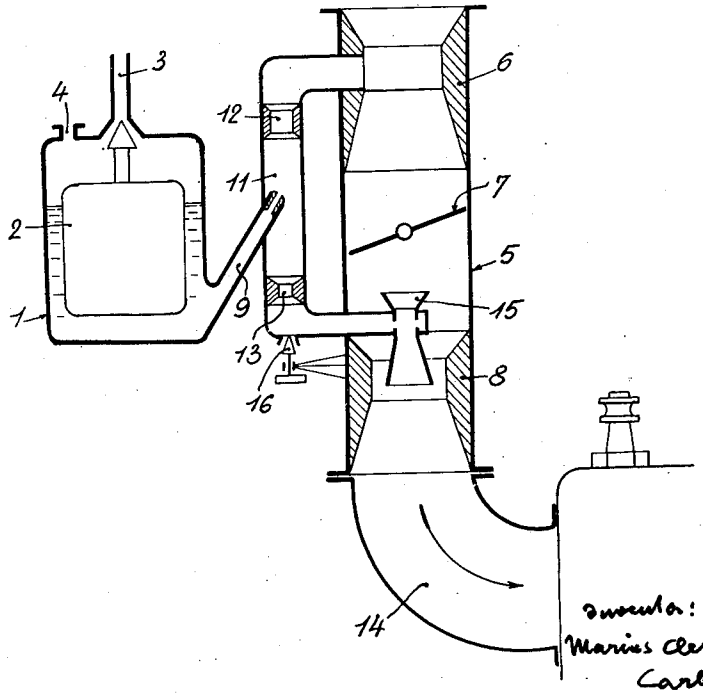


Fig. 2



Inventor:
Marius Clement
Carbonaro

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Fig. 3

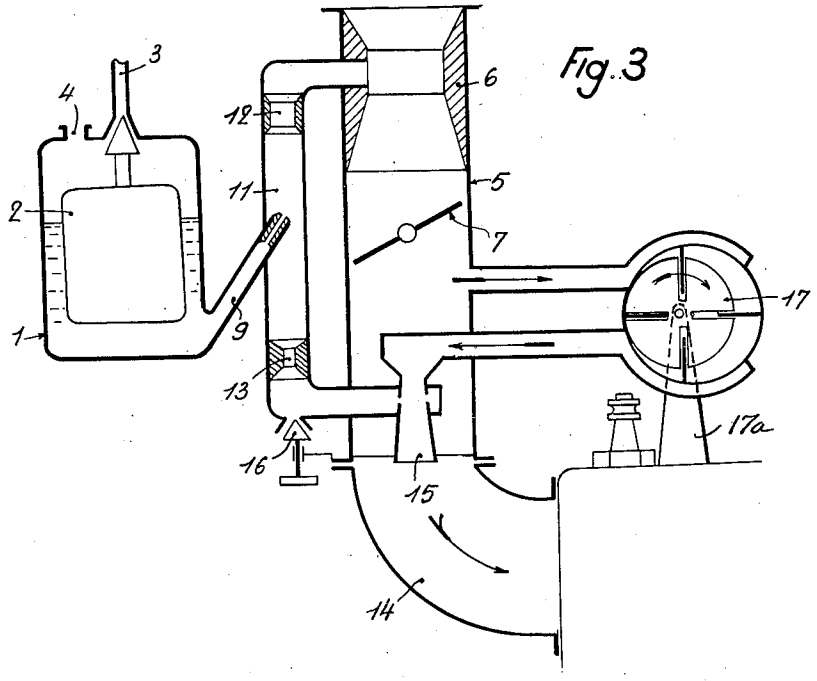
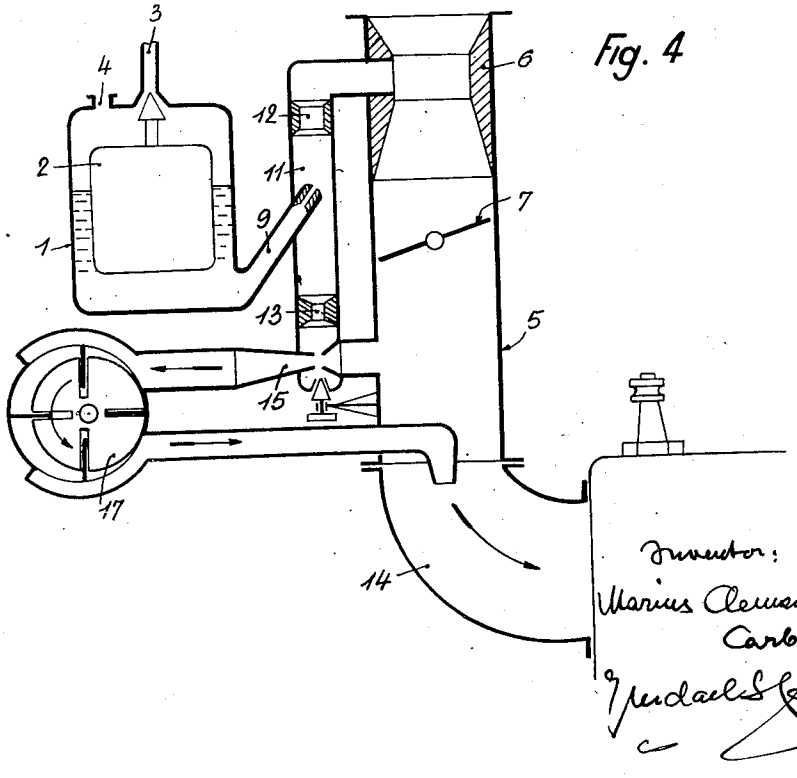


Fig. 4



Inventor:
Marius Clement
Carbonaro

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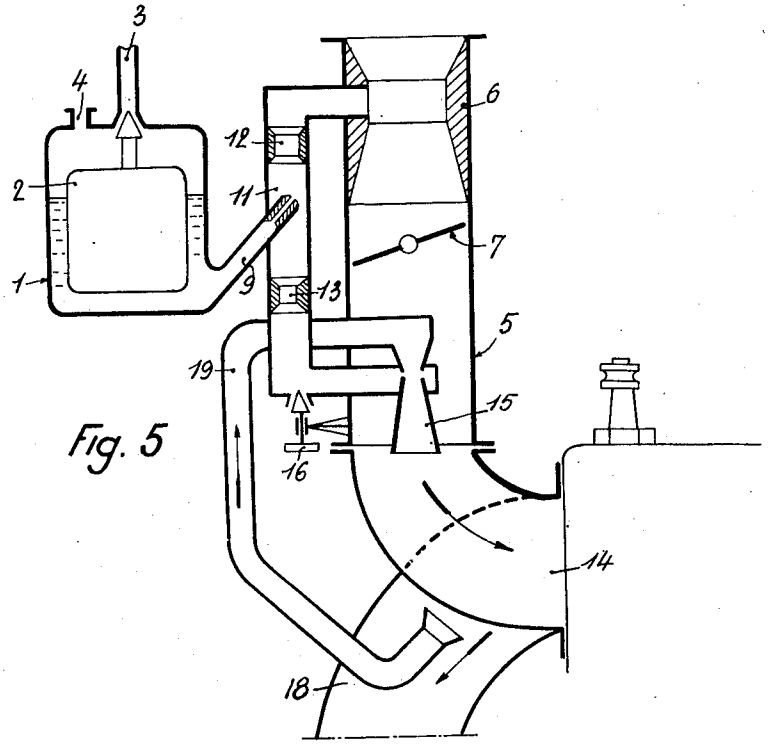


Fig. 5

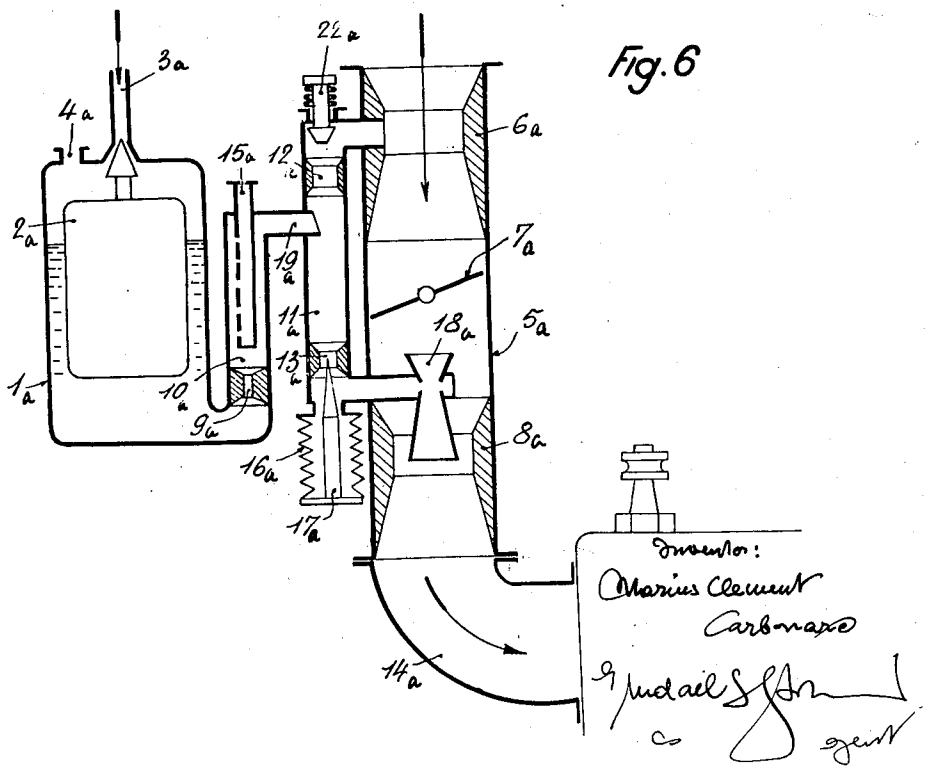


Fig. 6

Inventor:
Marius Clement
Carbonaro

March 18, 1952 M. C. CARBONARO 2,589,536

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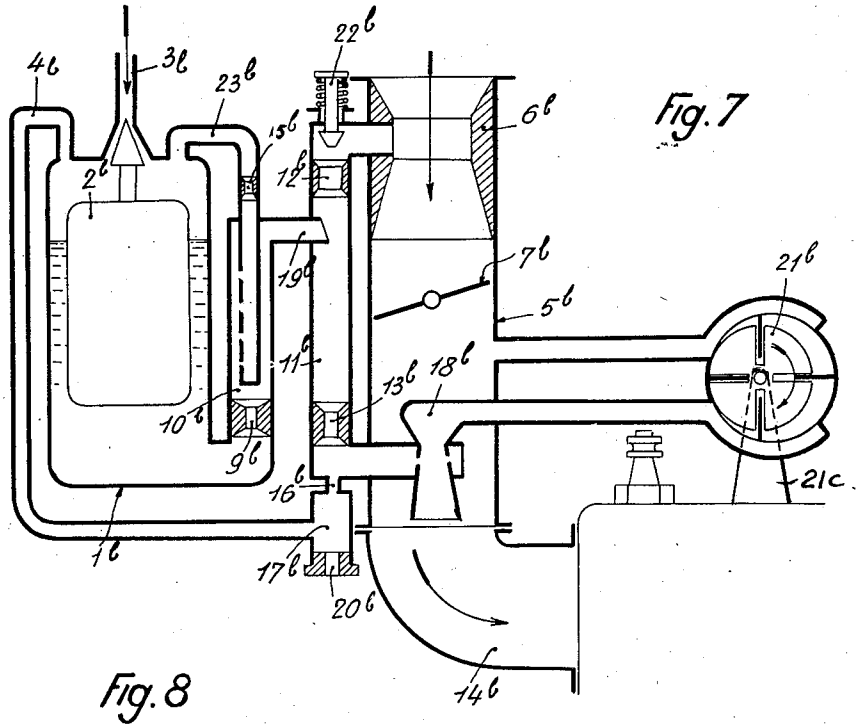
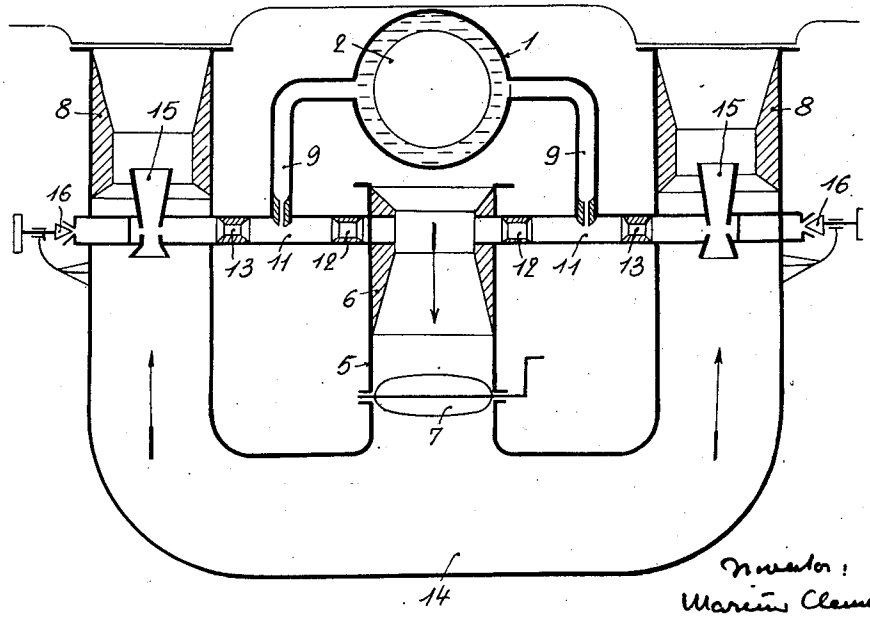


Fig. 7

Fig. 8



Inventor:
Marcus Clement
Carbonaro
by Mudael & Hoffman
Agent

Patented Mar. 18, 1952

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UNITED STATES PATENT OFFICE

2,589,536

FEEDING OF INTERNAL-COMBUSTION ENGINES

Marius Clément Carbonaro, Paris, France

Application June 14, 1947, Serial No. 754,695
In France December 14, 1944

Section 1, Public Law 690, August 8, 1946
Patent expires December 14, 1964

9 Claims. (Cl. 123—119)

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In the usual carbureters:

(a) The mixture is generally too rich when running at reduced load in consequence of the addition of the delivery of the power jet and that of the idle-jet.

(b) The atomization is uneffective as the air-speed in the venturi preceding the throttle is too low.

(c) The mixture of air and fuel is imperfect on account of the condensations taking place on the throttle arranged across the carburetted air stream.

These faults produce a defective distribution of the mixture between the cylinders in consequence of the separation of the liquid from the air, produced by the bends in the intake manifold.

In the process which is the subject of the present invention these disadvantages are avoided by utilizing one or more of the following essential arrangements.

(1) The intake air stream runs across two successive and distinct constructions, the first of which is hereinafter termed the upper or up-stream venturi, and is arranged before the throttle, and the second, termed hereinafter the lower or downstream venturi, is arranged after the throttle.

(2) The diameter of the lower venturi is smaller than that of the upper venturi, so that the depression or partial vacuum prevailing there is always greater than that produced in the first.

(3) An auxiliary conduit designated hereinafter by the term "primary by-pass" communicates through its two extremities with the constricted sections of the two venturis mentioned above by means of two calibrated orifices designated hereinafter by the names upper or up-stream orifice and lower or downstream orifice respectively.

(4) These two orifices are of unequal cross-sections the upper orifice being always much larger than the lower orifice, so that the depression prevailing inside the primary by-pass is always approximately equal to that prevailing in the upper venturi.

(5) The fuel is fed, at all speeds of the engine, through a nozzle or jet discharging into the primary by-pass and supplied by a constant-level float tank of the usual type. The delivery of this jet may be corrected by known means, such as flooding or air injection.

(6) The mixture or emulsion obtained in the primary by-pass through the mixing of the liquid fed through the jet with the air circulating in this by-pass receives a new addition of air to improve the atomization by linking the lower orifice not to the lower venturi but to a secondary by-pass shaped also to the form of a venturi, connecting the non-constricted part of the intake manifold below the throttle with the constricted section of the lower venturi.

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(7) The effectiveness of the atomisation occasioned by the secondary by-pass may be considerably increased by substituting for the said by-pass an atomisation air compressor of the dry type or of the wet type, the suction of which branches out of the intake manifold of the engine beyond the throttle, and the discharge of which likewise delivers beyond the throttle. The primary by-pass then communicates through its down-stream orifice with a constriction in the form of a venturi provided on the outlet or on the inlet of the said compressor.

(8) The above mentioned compressor may be replaced by a supply of exhaust gas picked from the exhaust manifold and brought to expand into a tube shaped into the form of a venturi the said tube discharging into the intake manifold beyond the throttle, the primary by-pass leading to the constricted section of this said venturi.

(9) In view of correcting at low speeds the excessive flow from the main jet due to an excessive vacuum in the secondary by-pass, the four following means may be employed, separately or in combination.

(a) An adjustable calibrated orifice opening in the atmosphere is arranged between the down-stream orifice of the primary by-pass and the secondary by-pass providing so a means of moderating the effect of this secondary by-pass at low engine speeds.

(b) The cross-section of the down-stream orifice is made variable, by means for instance of a suitably profiled movable needle, this needle being operated for example either mechanically by rod-and-lever mechanism bound to the position of the throttle, or pneumatically by means of a member sensitive to the vacuum prevailing in the atomizing venturi;

(c) The cross-section of the nozzle or jet is controlled for instance by means of a suitably profiled movable needle this needle being operated, as indicated in the above paragraph (b), either mechanically by means of rod-and-lever mechanism bound to the position of the throttle or pneumatically by means of a mem-

ber sensitive to the vacuum prevailing in the atomizing venturi.

(*d*) The difference of pressure under which the nozzle or jet delivers is reduced, for instance by utilizing the partial vacuum that prevails in the down-stream venturi.

In particular, it is possible to obtain this reduction by bringing into action upon the level of the liquid in the float chamber an opposing vacuum, which, for low speeds, is substantially equal or bears a substantially constant ratio to the vacuum induced in the primary by-pass by the atomizing venturi or the like.

This opposing vacuum may be obtained by connecting the float chamber to an auxiliary chamber provided with an inlet orifice and with an outlet orifice, the cross-sections of which are in the same or approximately the same ratio as those of the up-stream and down-stream orifices of the primary by-pass, the smaller of these orifices being subjected to the vacuum created by the atomizing venturi. In this case the braking air of the nozzle or jet mentioned in the above paragraph (5) will have to be taken from the float chamber, in order that the amount of the said braking air may be independent of the above mentioned opposing vacuum.

(10) In view of temporarily enriching the mixture in order to facilitate starting, the vacuum prevailing in the primary by-pass may be increased by partially obstructing the up-stream orifice of the primary by-pass, when starting by means of a movable needle operated by hand or automatically, for instance by means of a member sensitive to the temperature of the engine or of the circulating water jacket, this needle and its control thus playing the part devolved to startters in usual carbureters.

(11) In view to enrich the mixture for take off conditions a mechanical connection may be established between the movable needle mentioned in the preceding paragraph and the throttle so as to reduce automatically the cross-section of the up-stream orifice when the throttle reaches its fully open position.

(12) By way of modification of the general arrangements indicated above, in a multi-cylinder engine, there is only one up-stream venturi to serve for measuring the quantities, whereas there may be a plurality of down-stream venturis, at the rate of one per cylinder, or one per intake port common to two cylinders. The primary by-passes the number of which is equal to the number of down-stream venturis, each provided with its own jet fed by a common float chamber, communicate by their up-stream orifices with the constricted cross-section of the up-stream venturi and by their down-stream orifices with the various down-stream venturis, each provided with its own secondary by-pass.

Various embodiments of carbureters according to the present invention are illustrated by way of example in the accompanying drawings, in which:

Figure 1 is a fundamental diagram of the new method of carburation proposed, comprising only a single primary by-pass.

Figure 2 is a diagram of the method of feed proposed, including a primary by-pass, a secondary by-pass and an orifice for moderating the effect of this second by-pass at low engine speeds.

Figure 3 and 4 show two methods of forced atomization in which an air compressor of the dry type or of the wet type is substituted for the

secondary by-pass, the intake of said compressor being branched to the intake manifold beyond the throttle and the outlet delivering likewise beyond the throttle.

Figure 5 shows a form of forced atomisation, in which a certain amount of exhaust gases, taken from the exhaust manifold of the engine, expands into a pipe in the form of a venturi taking the part of a secondary by-pass, the restricted section of which communicates with the lower orifice of the primary by-pass.

Figure 6 is a diagram of a carbureter comprising an upstream venturi, a down-stream venturi, an atomizing venturi and a primary by-pass, the up-stream orifice of the latter being provided with a temporary throttling system acting as a starter, and the down-stream orifice being provided with a movable needle operated by a metallic bellows subject to the down-stream depression.

Figure 7 is a diagram of a carbureter comprising an up-stream venturi, an air-compressor of the dry type feeding the atomizing venturi, a primary by-pass, the up-stream orifice of the latter being provided with a temporary throttling system acting as a starter, the float chamber being subjected to the effect of an opposing depression obtained from an auxiliary chamber in permanent communication with the atomizing venturi and provided with an inlet orifice and an outlet orifice suitably selected, the braking air of the main nozzle or jet being obtained from the float chamber.

Figure 8 is a diagram of the method of carburation proposed applied to a four-cylinder engine and embodying a single upper diffuser with two lower diffusers and two separate primary and secondary by-passes.

In Figures 1, 2, 3, 4, 5 and 8 the same elements are denoted by the same reference numerals.

Referring to Figure 1, the carbureter which is the subject of the invention comprises essentially a float chamber **1**, in which a float **2** controls the petrol inlet **3**. This chamber is opened to the atmosphere through an orifice **4**, and supplies a jet or nozzle **9**. The body of the carbureter comprises an intake pipe **5** containing a first venturi **6** arranged above or on the up-stream side of the throttle **7** and a second venturi **8** arranged below or on the down-stream side of the said throttle. The constricted section of the lower venturi **8** is markedly smaller than the constricted section of the upper venturi **6**, to such an extent that for any given air delivery, the vacuum prevailing at **8** is always higher than that prevailing at **6**.

The constricted sections of the upper and of the lower venturis are connected to each other by a primary by-pass **11** communicating with the said constricted sections through an upper orifice **12** and through a lower orifice **13**, the orifice **13** being much smaller than the orifice **12**.

The working of the arrangement is as follows: For any opening of the throttle **7**, the vacuum prevailing in the primary by-pass **11** is approximately equal, at all speeds, to that prevailing in the venturi **6**, because the orifice **12** is much larger than the orifice **13**.

It follows that the delivery of the jet **9** is approximately equal to that which it would have if it opened into the upper venturi. However the vacuum acting at **13** being stronger than that acting at **12**, the circulation in the conduit **11** takes place in the direction from **12** towards **13**. The liquid supplied by the jet **9**, supplemented

with a certain quantity of air, arrives in the state of a mixture or emulsion in the body of the carbureter at the constricted section of the lower venturi 8. It is mixed there with the main amount of air sucked by the engine and then proceeds to the intake valves of the engine.

The mixing of the intake air with the emulsified fuel has thus been effected below the throttle, the metering being ensured, as in an ordinary carbureter, by the combined action of a constant-level tank and a jet with the upper venturi.

It should be observed that for the same engine speed the depression acting on the lower orifice 13 continues to increase as the throttle closes, while it decreases on the upper orifice 12. For atomizing the fuel supplied by the jet 9, there is then available an increasing difference of pressure between 12 and 13, which increases the quantity of atomizing air at low speeds, contrary to the usual working of the customary carbureters, in which the atomization is not carried so far at low speeds.

Figure 2 shows an alternative form of the arrangement represented in Figure 1, in which the primary by-pass 11 does not end at the constricted section of the lower venturi 8 but at the constricted section of a secondary by-pass 15, connecting the body of the carbureter below the throttle with the constricted section of the venturi 8. This secondary branch has the profile of a venturi and the confluence of the primary by-pass and the secondary by-pass coincides exactly with the constricted section of the said venturi.

The liquid supplied by the jet 9 therefore receives a first addition of air in the primary by-pass and then a second addition of air in the venturi. It is atomized a third time through mixture with the main amount of air in passing into the lower venturi.

In the arrangements described above, the differences of pressure available for atomization range from a few centimeters of water head when running at full load to half an atmosphere when running idle, thereby enabling much better atomization than in standard carburetors, the latter having available pressure differences ranging merely from zero to a few centimeters of water head. With the foregoing arrangements, however, it is not possible to equal the atomization obtained through direct injection systems by means of injection pressures reaching values from 10 to 200 kilograms per square centimeter.

The fact that in the device described above the functions of metering the liquid and of atomizing are effected by the primary by-pass and by the secondary by-pass respectively, however, enables this result to be obtained.

The fuel metered into the primary by-pass may undergo a pneumatic atomisation under strong pressure in the secondary by-pass by interposing in this latter an air-compressor driven by the engine. The presence of this air-compressor, which may be of the rotary type or of the piston type, does not introduce any disturbance into the feeding of the engine or into the quantity of air that passes through the upper venturi, provided the intake and the delivery of the said compressor are both below the throttle. The amount of air that traverses the compressor is always a constant fraction of the total amount of intake air drawn in by the engine, as they rotate at proportionate speeds and are supplied at the same pressure.

Figures 3 and 4 are two alternative forms of this arrangement. In Fig. 3 the compressor 17 of the dry type, is only traversed by pure air, the atomization taking place after the compressor. This solution is applicable to all fuels. The compressor 17 is driven from the engine by means of a belt 17a.

In Figure 4, the compressor 17 is of the wet type, and is traversed by a mixture or emulsion of air and fuel. The compressor is driven from the engine by means of a belt (not shown in Fig. 4). The atomization takes place partially before the compressor and partially after it, through the medium of an injector of suitable profile. This solution is applicable to fuels which act to a slight extent as lubricants, such as gas oil the flow of which through the body of the compressor does not involve any danger of affecting the latter.

Practically, the capacity of the atomizing compressor is of the order of one twentieth of the capacity of the engine; the outlet pressure is of the order of from 0.5 to 1 kilogram per square centimeter, according to the degree of constriction of the outlet orifice.

The essential advantage of the pneumatic atomization thus obtained as compared with the mechanical atomization of direct injection is that a low-pressure air-compressor without any metering function is substituted for a high-precision injection pump, which is a great deal more costly and difficult to manufacture.

Instead of producing the compressed air for atomization by a mechanical compressor, it is possible to use exhaust gases under pressure taken from the conduit 19 in the exhaust pipe 18 common to all the cylinders. These gases at a high pressure and a high temperature supply a venturi 15 constituting the secondary by-pass. This arrangement is shown diagrammatically in Figure 5.

It has been admitted above that by suitably selecting the relative cross-sections of the up-stream and down-stream orifices of the primary by-pass the depression or partial vacuum in the latter is substantially equal at all speeds to that prevailing in the up-stream venturi. In matter of fact this equality is only approximate, particularly when the engine runs idle. It may therefore be advantageous to adopt corrective arrangements.

Thus in the arrangements illustrated in Figures 2, 3, 4 and 5 the excessive delivery of the main jet as low loads occasioned by the excessive vacuum then prevailing in the secondary by-pass (on account of the utilization of the venturi 15, which has the effect of increasing the depression at the orifice 13) is corrected by menas of a needle screw 16, which, permitting an admission of air from the exterior, provides the possibility of reducing at will the vacuum acting upon the orifice 13. The screw 16 thus enables the richness to be regulated at idling speed.

Figures 6 and 7 illustrate two other solutions of the problem of idling, consisting in acting directly upon the supplementary depression induced when idling in the primary by-pass by the atomizing venturi.

In Figure 6, the float chamber 1a feeds a submerged jet 9a corrected by an injection of air in stages, coming from a corrector 15a. The emulsion duct 19a opens into the primary by-pass 11a, which communicates on the one hand with the up-stream venturi 6a and on the other hand with

the atomizing venturi 18a, co-operating with the down-stream venturi 8a. The up-stream orifice 12a and the down-stream orifice 13a control the circulation of air in the by-pass 11a. The down-stream orifice 13a is controlled by a movable needle 17a actuated by metallic bellows 16a, subjected internally to the action of the vacuum created at low speeds by the venturi 18a.

This device operates in the following manner: When starting, the vacuum created by the venturi 18a is considerable on account of the closure of the throttle 7a. The needle 17a penetrates into the orifice 13a and diminishes the cross-section thereof, thereby moderating the vacuum induced in the by-pass.

As the throttle 7a is opened more and more, the needle 17a returns to its initial position, thus opening the orifice 13a wider and wider, and thereby leaving a larger and larger passage for the emulsion delivered by the duct 19a.

The control of the down-stream orifice might be effected in various other ways, in particular by a mechanical control of the throttle 7a transmitted to the needle by any convenient means. A method of control analogous to that of the down-stream orifice is applicable to the orifice of the jet 9a.

It is often useful to be able to enrich the carburetted mixture temporarily at the time of starting. This result can be obtained, according to the invention by temporarily reducing the cross-section of the up-stream orifice. To this end the orifice 12a may be partially obstructed at the time of starting by a movable needle 22a, returned to its starting position by a return spring, and operated by a starting pull member, not shown, or else by a member sensitive to the temperature of the engine or of the water jacket. As soon as the starting has been effected the pull member controlling the needle 22a is released and the depression at 11a falls back to its original value, corresponding to the value selected for idling.

The movable needle 22a may likewise be utilized to occasion the supercharging of the engine at full power by means of any suitable connection between the throttle and the needle, enabling a reduction to be effected in the cross-section of the up-stream orifice when the needle reaches substantially the fully open position.

In Figure 7 the carbureter comprises a float chamber 1b in which a float 2b controls the petrol inlet 3b. This chamber communicates by a duct 4b with the auxiliary chamber 17b, which is in communication by an orifice 20b with the open air and by an orifice 16b with the atomizing venturi. The jet 9b delivers petrol into the emulsion chamber 10b, which is supplied with braking air through an orifice 15b, which is connected by a duct 23b with the float chamber. This figure also includes the up-stream venturi 6b, the primary by-pass 11b, controlled by the up-stream orifice 12b and the down-stream orifice 13b, the atomizing venturi 18b, fed by the compressor 21b driven from the engine by means of a belt 21c, the inlet side of which is connected with the intake pipe 5b of the up-stream carbureter of the throttle 7b, and finally the starter 22b.

With the arrangement adopted, the braking effect produced by the air passing through the orifice 15b upon the out-flow from the jet 9b is independent from the opposing depression induced upon the float chamber, because this opposing depression acts at the same time upon the braking orifice 15b on the one hand and upon the jet 9b on the other hand.

It will be quite understood that the method of correction of the flow of braking air described above is applicable to all the modifications of the carbureter according to the present invention in which an opposing correctional depression is caused to act upon the float chamber, whether a down-stream venturi combined with a vacuum booster, or a compressor of the dry or wet type is employed for feeding the atomization venturi, or finally whether a part of the exhaust gases is used for feeding this same venturi.

Figure 8 is a diagram of the application of the arrangements illustrated in Figures 1 and 2 to a four cylinders engine. In this diagram, each of the two intake ports is provided with its lower venturi 8. To each of these two venturis there leads a secondary by-pass such as 15, constituted by a venturi acting through its constricted section on one of the two primary by-passes such as 11. The two jets 9 are supplied by a common float chamber tank 1. The single upper venturi 6 acts on the two upper orifices 12 of the two primary by-passes. The throttle 7 controls the intake manifold 14 interposed between this throttle and the two intake ports of the engine.

This arrangement makes possible to control the richness of the mixture separately on each group of two cylinders. It can be extended to the case in which the four intake valves are installed in four different ports. There is then the possibility of separately adjusting the richness in each cylinder by acting on each of the four corresponding jets.

If in the application of the invention to a multi-cylinder engine the atomization is of the air-compressor forced type, the following procedure may be adopted: if the compressor is of the dry type, and with a single body, delivery may be effected in parallel to a plurality of jets, if on the other hand recourse is had to a compressor of the wet type, a compressor with a plurality of bodies will be utilized, each of the latter delivering its emulsion to a different injector located at the entrance of an intake port.

What I claim is:

1. Means for feeding internal combustion engines comprising in combination an intake pipe; a throttle arranged in said pipe; a Venturi tube disposed in said pipe before said throttle; means for creating a vacuum of a higher degree than prevailing in said Venturi tube, the latter means being disposed beyond the said throttle; a bypass communicating at one end with the restricted part of said Venturi tube and at the other end with said means for creating a vacuum; and a device for supplying and atomizing fuel, delivering into the said bypass.

2. Means for feeding internal combustion engines, having a plurality of cylinders, comprising one device for feeding fuel as claimed in claim 1 per group of at least one cylinder, all said devices being fed by a common float chamber.

3. Means for feeding internal combustion engines having a plurality of cylinders, comprising one device as claimed in claim 1 per group of at least one cylinder in which the various primary by-passes of said devices, are respectively connected to the intake manifold before and beyond the throttle, the up-stream venturis communicating with a single Venturi, all said devices being fed by a common float chamber.

4. Means for feeding internal combustion engines comprising in combination an intake pipe;

a throttle arranged in said pipe; a Venturi tube disposed in said pipe before said throttle; means for creating a vacuum of a higher degree than prevailing in said Venturi tube, the latter means being disposed beyond the said throttle; a by-pass communicating at one end with the restricted part of said Venturi tube and at the other end with said means for creating a vacuum; two orifices of unequal cross-section disposed one after the other in said bypass, the upstream orifice being larger than the downstream orifice so that the vacuum prevailing in said bypass will at all times be substantially equal to that prevailing in said Venturi tube; and a device for supplying and atomizing fuel, delivering into the said bypass.

5. A device constructed in accordance with claim 4 wherein the said means for creating a vacuum consisting of a Venturi passage formed coaxially in said air intake and beyond said throttle.

6. Means for feeding internal combustion engines comprising in combination an intake pipe; a throttle arranged in said pipe; a Venturi tube disposed in said pipe before said throttle; a by-pass communicating at one end with a restricted part of said Venturi tube and at the other end with said pipe at a point beyond said throttle; two orifices of unequal cross-section, the said orifices being spaced apart and having a relative cross-section so that the vacuum prevailing in said bypass is substantially equal to the vacuum prevailing in said Venturi tube; a device for supplying and atomizing fuel, delivering into said bypass; and a device for forced atomization constituted by an air compressor driven by the internal combustion engine and drawing air from and returning it to said pipe beyond the throttle.

7. Means for feeding internal combustion engines comprising in combination an intake pipe; a throttle arranged in said pipe; a Venturi tube disposed in said pipe before said throttle; a by-pass communicating at one end with a restricted part of said Venturi tube and at the other end with said pipe at a point beyond said throttle; two orifices of unequal cross-section, the said orifices being spaced apart and having a relative cross-section so that the vacuum prevailing in said bypass is substantially equal to the vacuum prevailing in said Venturi tube; a device for supplying and atomizing fuel, delivering into said bypass; and a device for forced atomization constituted by an air compressor driven by the internal combustion engine and drawing air from and returning it to said pipe beyond the throttle, the atomization being affected beyond said compressor.

8. Means for feeding internal combustion engines comprising in combination an intake pipe; a throttle arranged in said pipe; a Venturi tube disposed in said pipe before said throttle; a by-pass communicating at one end with a restricted part of said Venturi tube and at the other end with said pipe at a point beyond said throttle; two orifices of unequal cross-section, the said orifices being spaced apart and having a relative cross-section so that the vacuum prevailing in said bypass is substantially equal to the vacuum prevailing in said Venturi tube; a device for supplying and atomizing fuel, delivering into said bypass; and a device for forced atomization constituted by an air compressor driven by the internal combustion engine and drawing air from and returning it to said manifold beyond the throttle, the said compressor being traversed by an emulsion of air and fuel, the mixing of which is effected at a position preceding the compressor.

9. Means for feeding internal combustion engines comprising in combination an intake pipe; a throttle arranged in said pipe; a Venturi tube disposed in said pipe before said throttle; a by-pass communicating at one end with a restricted part of said Venturi tube and at the other end with said pipe at a point beyond said throttle; two orifices of unequal cross-section, the said orifices being spaced apart and having a relative cross-section so that the vacuum prevailing in said bypass is substantially equal to the vacuum prevailing in said Venturi tube; a device for supplying and atomizing fuel, delivering into said bypass; and a device for forced atomization of the fuel including an exhaust pipe and a conduit connecting said exhaust pipe to the end of said by-pass communicating with said intake pipe at the point beyond said throttle.

MARIUS CLÉMENT CARBONARO.

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