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JULY 13, 1943.

BY A. P. C.

M. L. MENNESSON

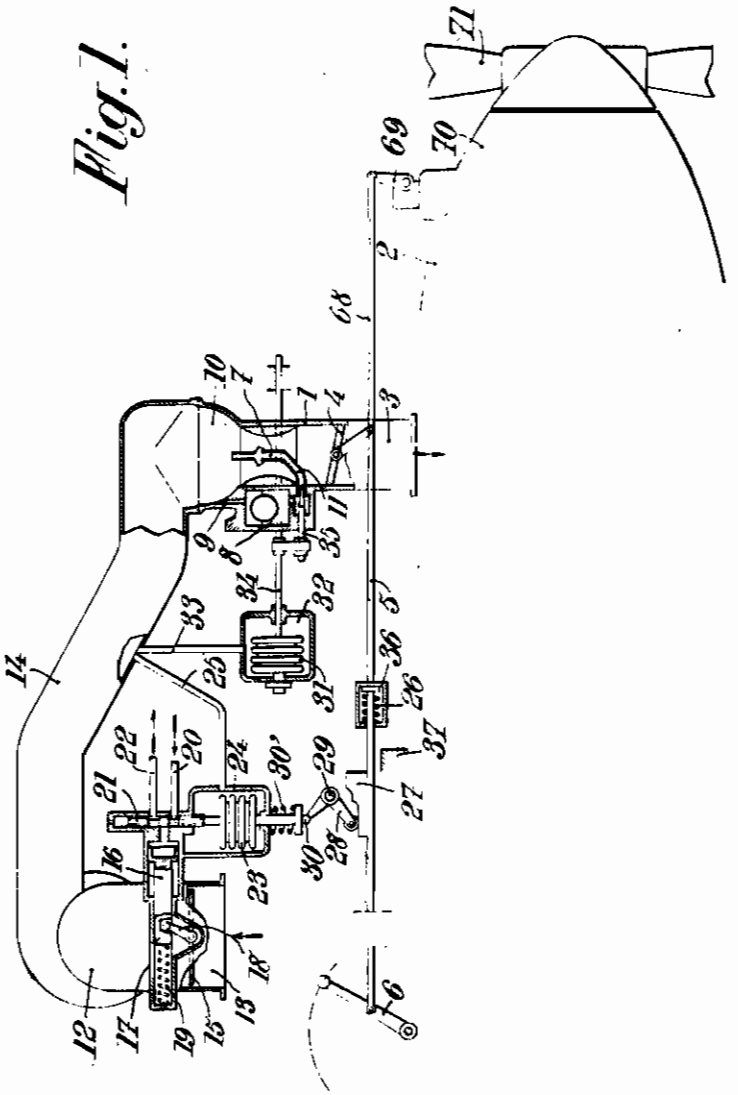
COMPRESSOR-SUPERCHARGED CARBURATION DEVICES FOR INTERNAL COMBUSTION ENGINES

Filed April 5, 1940

Serial No. 328,115

4 Sheets-Sheet 1

Fig. 1.



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4 Sheets-Sheet 2

Fig. 2.

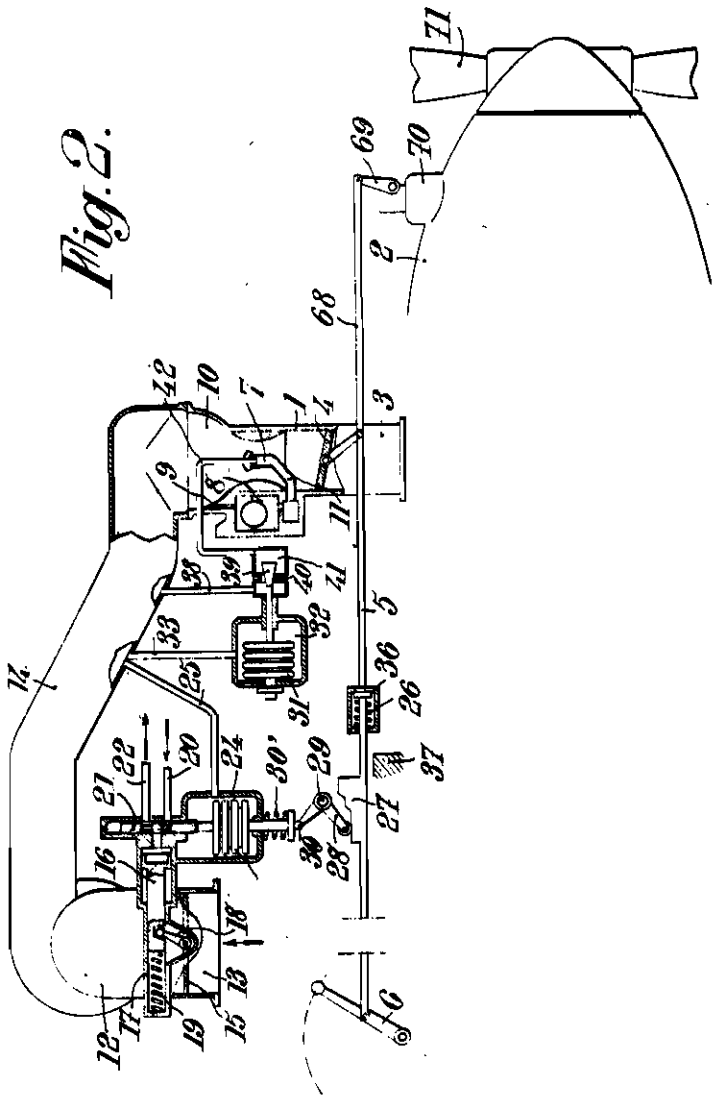

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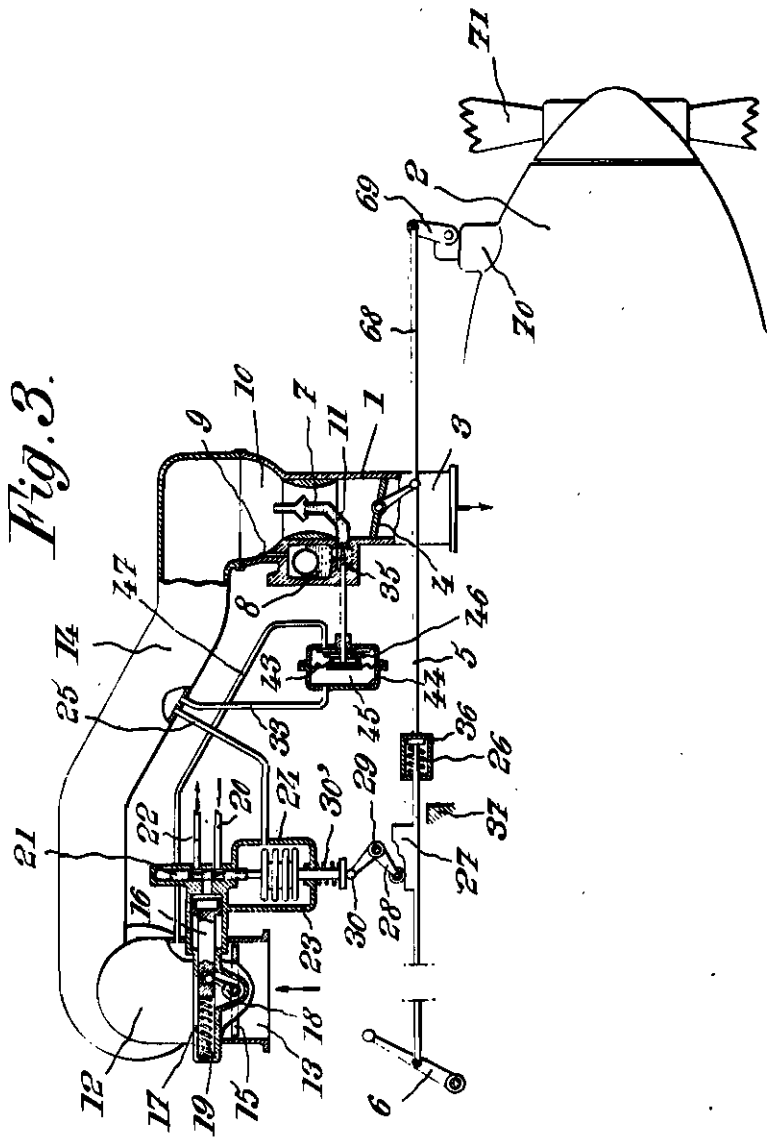
Fig. 3.



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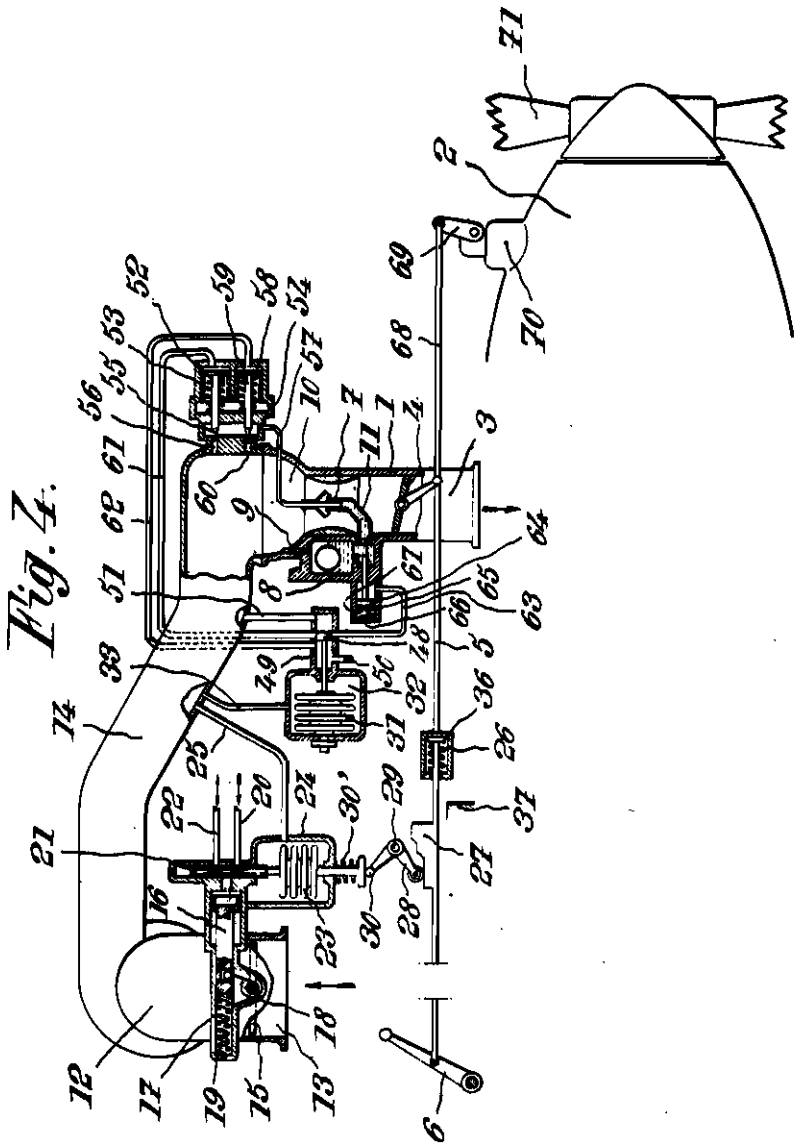
4 Sheets-Sheet 4

Fig. 4.



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ALIEN PROPERTY CUSTODIAN

COMPRESSOR-SUPERCHARGED CARBURATION DEVICES FOR INTERNAL COMBUSTION ENGINES

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Application filed April 5, 1940

This invention relates to compressor-supercharged carburation devices for internal combustion engines, of the kind wherein the compressor is located upstream of the carburettor for the general purpose of maintaining a constant pressure at the inlet of the carburettor by an automatic device which modifies the inlet or outlet section of the compressor, and has for its main object to utilise the properties of the compressor, thus located, to modify, in a simple manner, the adjustments of the carburation device and which are necessitated by the working conditions of the engine.

According to the main feature of the invention carburation devices of the above kind are so arranged that the value of the pressure at the inlet of the carburettor can be made to vary as a function of the working conditions of the engine, supplied by the carburation device.

In addition to this main feature the invention comprises further features, including the following:

A second feature consisting in arranging such carburation devices that the value of the pressure at the inlet of the carburettor can be reduced when only a fraction of the maximum power of the engine is utilised, in order to reduce the power absorbed by the compressor.

A third feature consisting in establishing a positive connection between the member by means of which the delivery of gases from the carburettor is regulated and the device which automatically determines the value of the pressure at the inlet of the carburettor, with a view to varying this value.

A fourth feature consisting in providing such a carburation device with a single automatic apparatus on which the delivery pressure of the compressor acts. This, for example, could be a single manometric capsule subjected to the pressure reigning at the outlet from the compressor or a deformable member (diaphragm) or movable member (piston) subjected to the difference of the pressures reigning respectively at the inlet and at the outlet of the compressor. This single automatic apparatus acts on regulating means adapted to effect the enrichment of the mixture when in the neighbourhood of the maximum power and also the automatic correction of the mixture as a function of the density of the air at the inlet of the carburettor.

A fifth feature consisting in making the single automatic apparatus, with which such carburation devices are provided, act on a distributor which, in turn, is adapted to control the above-mentioned regulating means through a relay, for example of the piston or diaphragm type, so that the single automatic apparatus simultaneously can serve several carburettors at the same time.

And a sixth feature—more especially relative to the case where the engine drives a propeller with automatically variable pitch—consisting in establishing a positive connection between the member which regulates the flow of the gases from the carburettor and the mechanism by which the variation of the pitch of the propeller is effected.

In order that the invention may be better understood, it will now be described with reference to the accompanying drawings, which are given by way of example only and in which:

Figs. 1 to 4 show, in diagrammatic vertical section, respectively four carburation devices constructed according to as many different embodiments of the invention.

With regard to the complete carburation device, it is provided, as known, with:

(1) A carburettor proper 1 which supplies the cylinders of the engine 2 with an air-fuel mixture through a conduit 3 and which comprises a butterfly-valve 4, operated by a remote control constituted for example by a rod 5 and a hand lever 6 or the like, a nozzle system 7 fed by a constant level chamber 8 which always communicates by the passage 9 with the inlet 10 of the carburettor and which is connected by a conduit 11 to the nozzle system 7,

(2) A compressor 12 with an inlet 13 and which is located upstream of the carburettor and connected, by a pipe 14, to the inlet 10 of this latter,

(3) And automatic means adapted to maintain constant the pressure at the inlet 10 of the carburettor, these means being for example constituted by a shutter 15, which is located by means of an automatic servo-control subjected to the action of the pressure reigning in the pipe 14 which connects the compressor 12 to the inlet 10 of the carburettor.

This servo-control is constituted, for example, by a piston 16 housed in a cylinder 17 and adapted to act on an arm 18 integral with the shutter 15, the said piston being constantly acted upon by a spring 19 and being able to be subjected to the action of a fluid under pressure (for example oil under pressure) from an appropriate source connected by a supply conduit 20 to the inlet of a slide-valve distributor 21 or the like, the return conduit being designated by 22. The distributor is controlled by a manometric capsule 23 which

is located in a chamber 24, permanently connected by a conduit 25 to the pipe 14, the free extremity of the capsule taking support on the base of the said chamber 24.

When the air shutter 15 occupies a determined angular position, the slide valve 21 closed the inlet of the cylinder 17 having the piston 16. If the pressure in the pipe 14 diminishes, the capsule 23 expands and moves the slide valve, to bring the cylinder 17 into communication with the oil-inlet conduit 20. This forces the piston 16 towards the left (Figs. 1 to 4) and further opens the shutter 15. The delivery of air drawn in by the compressor 12 increases and the pressure in the pipe 14 increases in consequence. This pressure, transmitted through the conduit 25 into the chamber 24, causes the contraction of the capsule 23 which moves the slide valve 21 in the opposite direction.

If the pressure at the outlet of the compressor or at the inlet 10 of the carburettor is that which is suitable, the slide valve returns to its closing position, shown on the drawings, and the air shutter 15 remains at its new position. If the pressure is or becomes too great, the slide valve 21 is moved until the cylinder 17 communicates with the return conduit 22 and the spring 19, in becoming preponderant, forces back the piston 16 which closed the shutter 15 further.

The pressure regulator, described above and which is known per se, can of course be replaced by any other similar device, with or without servo-control, so long as its operating member always acts to fix the value of the pressure reigning at the outlet of the compressor 12 or at the inlet 10 of the carburettor.

According to the invention the carburation device, such as that described above, is so arranged that the pressure reigning at the outlet of the compressor 12 or at the inlet 10 of the carburettor can be varied as a function of the working conditions of the engine 2 fed by this carburation device.

For this purpose there is inserted in the rod 5, which connects the butterfly-valve 4 of the carburettor to the control handle 6, an elastically deformable device such as a spring 26 and there is mounted on the said rod 5, at a suitable point, a cam 27 adapted to act on a bent lever 28, pivoted at a fixed point 29 and the free extremity of which acts on the point of support of the capsule 23 and against the action of a spring 30^1. By operating the hand lever 6 not only is the position of the butterfly-valve 4 of the carburettor modified but also the position of the cam 17 and in consequence that of the capsule 23 and slide valve 21 independently of the pressure which reigns in the pipe 14. The effect of this is to modify the constant value of the delivery pressure of the compressor, that is to say that which resigns at the inlet of the carburettor.

In addition, the carburation device is provided with means adapted to correct the richness of the mixture supplied to the engine by the conduit 3. For example and as shown in Fig. 1, the said means are constituted by a manometric capsule 31 which is housed in a chamber 32 which communicates by a conduit 33 with the pipe 14 which connects the compressor 12 to the inlet 10 of the carburettor. There is mounted on this capsule a rod 34, suitably guided in the axial direction and which is made integral with a needle valve 35 adapted to regulate the output of the fuel passing through the conduit 11 connecting the constant level chamber 6 to the nozzle system 7.

This device according to Fig. 1 functions in the following manner.

When the butterfly-valve 4 of the curburettor is wide open, the maximum power must be obtained from the engine 2. This maximum power is determined by the pressure which reigns in the conduit 3, which supplies the cylinders, this pressure being substantially equal to that reigning in the pipe 14 terminating in the inlet of the carburettor. This maximum pressure is determined by the designer according to the type of engine utilised. In order to obtain high powers, it is the general practice to utilise relatively high pressures and the maximum pressure is determined by the regulation of the inlet limiter, that is to say by the position of the manometric capsule 23.

If it is not desired to utilise the engine to the maximum of its power, it is necessary to move the butterfly-valve 4 of the carburettor towards its closing position, for example to its half-open position. The pressure in the supply conduit 3 then becomes very weak for the reason that the suction from the cylinders creates a certain depression between the engine and the butterfly-valve 4. But, on the other hand, the inlet limiter of the compressor always restores the same pressure in the pipe 14 as that which is required when the butterfly-valve is wide open. Now, this excess pressure may have several disadvantages; first of all the increase of pressure raises the temperature of the air rather considerably, which has an advantage in that freezing-up is avoided, but, on the other hand, if this temperature is too high, there is a risk of its causing an undue heating of the fuel in the carburettor.

On the other hand, the power absorbed by the compressor remains somewhat considerable since the degree of compression is itself rather high.

It is therefore of advantage, when only a fraction of the maximum power of the engine is utilised, to reduce the constant pressure which reigns at the inlet of the carburettor and in the pipe 14. For this purpose and when the pilot moves the hand lever towards the right (Fig. 1), that is in the closing direction of the butterfly-valve 4, the cam 27 causes the point of support 30 of the capsule 23 to descend towards the bottom (Fig. 1) and in consequence the pressure reigning in the pipe 14 stabilises itself at a lower value than when the butterfly-valve 4 is wide open.

In the case where it is desired to be able to effect an extreme-pressure for some minutes, especially and as usual for taking off, the spring 26 inserted in the control rod 5 is accommodated in a casing 36 which is mounted on the part of the rod 5 which is connected to the butterfly-valve 4. In this way the two parts of the said rod remain integral so long as the said casing has not come into contact with a fixed abutment 37 during the displacement of the hand lever 6 towards the left (Fig. 1). When the casing 36 reaches the abutment 37, the butterfly-valve 4 is wide open.

In order to obtain this extreme-pressure it is sufficient to change the value of the pressure in the pipe 14. To this end a supplementary stroke is provided for the hand lever 6 during which the position of the point of support 30 of the capsule 23 is modified through the intermediary of the cam 27. This supplementary stroke is made possible, without a displacement of the but-

terfly-valve 4 resulting therefrom, owing to the compression of the spring 26. It is possible to give the cam 27 a suitable profile for the most efficient utilisation of the engine 2 and the compressor 12.

At the same time as these variations of the conditions of use of the engine, it is necessary to change the composition of the mixture introduced into the engine. More especially, when in the neighbourhood of the maximum power of the engine, it is of advantage to increase the richness of the mixture and, when the extreme-pressure at the time of "taking-off" is brought into action, to subject this richness to a fresh augmentation.

As this variation of richness is a function of the charging, it was logical, hitherto, to have recourse to an automatic control by a capsule subjected to the pressure of the portion of the conduit 3 included between the butterfly-valve 4 and the cylinders. But when, according to the invention, the pressure at the inlet 10 of the carburettor is caused to vary, it is possible to connect the casing 32 containing the capsule 31 to the pipe 14 in which reigns the same pressure as at the inlet of the carburettor.

In effect, for running at low powers, a certain value of the pressure reigning in the pipe 14 is utilised, for running at maximum power a higher value of this pressure is utilised and for super-power running, a still higher value of this pressure is utilised.

In consequence, these three different values give three different lengths to this capsule 31 and the needle valve 35, coupled to this latter corrects, for example, the output of fuel passing in the conduit 11, so as to vary the richness of the air-fuel mixture in concordance with the desired condition of operation. The outline of the needle valve 35 is, naturally, fixed according to the variation of the richness it is desired to obtain.

Moreover, a time arrives, in consequence of the fall of pressure at the air inlet 13 of the compressor 12, when this compressor no longer can maintain the desired pressure in the pipe 14 although the shutter 15 remains open. From this moment, the pressure progressively diminishes in the pipe 14 in proportion as the density of the air diminishes. The above conditions exist for example in the case of an aeroplane rising to high altitude. Then the pressure which acts on the capsule 31 progressively diminishes and it is possible to utilise the same needle valve 35 to diminish the output of fuel to effect the automatic correction of the air-fuel mixture as a function of the density of the air at the inlet 10 of the carburettor.

In consequence, by establishing a positive control between the hand lever or the like and the butterfly-valve 4 of the carburettor 1 and by acting through the intermediary of this positive control on the value of the pressure at the inlet 10 of the carburettor, there is therefore the possibility of effecting the corrections of the mixture necessary to the efficient operation of the carburettor under all conditions, and this by means of a single manometric capsule 31 subjected to the pressure reigning at the inlet of the carburettor.

For the example shown in Fig. 2, recourse is had to the carburation device similar to that described above but for which the power-enrichment and correction apparatus acts, not by means of a needle valve 35 on the output of the fuel, but on the delivery of ventilation air. For this purpose the ventilation air is taken by a piping 38 from the air inlet of the carburettor, or—what comes to the same thing—from the delivery pipe 14 of the compressor. The delivery of this air is regulated by a valve 38 of suitable profile, connected to the capsule 31 and located in a calibrated orifice 40 provided in a chamber 41 into which opens the piping 38 and which is connected to the nozzle system 7 by a conduit 42 a desired length of which is engaged in the said system.

It is known, when the delivery of this ventilation air is reduced, that the effective suction on the fuel-calibrator increases and, in consequence, that the mixture is enriched. If the delivery of this air is increased, the mixture on the contrary becomes impoverished. The result sought for is obtained by actuating the needle valve 39 by the capsule 31 since this latter is always subjected to the action of the pressure reigning in the delivery pipe 14 of the compressor.

For the example shown in Fig 3, recourse is had to a carburation device analogous to that of Fig. 1 but for which there is utilised not a manometric capsule 31 for actuating the needle valve 35 but a diaphragm 53 loaded by a spring and dividing a chamber 44 into two compartments 45 and 46. The compartment 45 is made to communicate, through the conduit 33, with the delivery pipe 14 of the compressor and the compartment 46, by the conduit 47, with the air inlet 13 of the compressor 12 at a point which is located between the shutter 15 and the rotor of the compressor.

It is obvious that the diaphragm 43 acts exactly like the capsule. In effect, the pressure in the chamber 45 is always the same. It is determined by the admission-limiter of the compressor. The pressure in the chamber 46 depends, for a given working condition, upon the opening of the shutter 15. This opening is all the greater as the necessary flow of air is greater and, in consequence, the butterfly-valve 4 is more fully open. In consequence the movement of the diaphragm 42 and, consequently, of the needle valve 35, varies in a manner similar to the opening of the butterfly-valve 4. It is therefore possible to effect, with the aid of this diaphragm 42, the operations of enrichment at full powers and of correction when the pressure in the delivery pipe 14 becomes too feeble.

For the example shown in Fig. 4 recourse is had to a modification of the carburation device of Fig. 1, in that the manometric capsule 31, still subjected to the pressure reigning in the delivery pipe 14, no longer directly actuates the enrichment and correction devices but actuates a distributor 48, for example of the slide valve type, adapted to slide in a chamber 49 one extremity of which opens to the atmosphere by an orifice 50 and the other extremity of which is connected by a conduit 51 to a source of pressure, for example to the delivery pipe 14 of the compressor.

A two-stage power-enrichment system has been shown; this system comprises a piston 52 loaded by a spring 53 and of which the surface situated towards the spring communicates with the atmosphere by an orifice 54. This piston acts on a needle valve 55 adapted more or less to obturate a passage 56 which opens into the delivery pipe 14 and which permits of assuring, by a conduit 57, the ventilation of the main nozzle system 7 in the same fashion as the conduit 42 of Fig. 2. When the needle valve 55 obturates the passage 56, a certain enrichment of the mixture is obtained. When a second piston 58, identical

with the first 52, actuates, in its turn, a needle valve 59 in order to obturate a corresponding passage 60, another enrichment is effected.

The face of the piston 52 opposed to that where the spring 53 is located, communicates by a piping 61 with the chamber 49 of the distributor 48 and the apparatus acts in the following manner.

When the engine is utilised at a fraction of its maximum power, the pressure in the delivery pipe 14 is not at its maximum value as has been explained above, and the slide valve 49 occupies such a position that the pipe 61 communicates with the air through the orifice 50.

If the opening of the butterfly-valve 4 is increased, the cam 27 is displaced at the same time by the hand lever 6, which causes the rise of the pressure in the delivery pipe 14. The capsule 31 contracts and the slide valve 46 first of all obturates the piping 61 so as subsequently to put it into communication with the pipe 14 by the conduit 51. At this moment the pressure in the pipe 14 is transmitted behind the piston 52 and the force created compresses the spring 53. The needle valve 55 then obturates the passage 56 and a certain enrichment takes place.

If the pressure in the pipe 14 is further augmented, for the taking-off of the aeroplane for example, the slide valve 40 operates in the same way with the piping 62 which opens into the chamber of the second piston 58 and the needle valve 59, integral with this needle valve, obturates the other passage 60 for the ventilation air, thus producing a second enrichment stage.

Finally, if the pressure in the pipe 14 falls below the minimum value provided for, in consequence of the fall of the density of the air at the inlet 13 of the compressor, the slide valve 48 acts in the same way, by a conduit 63, on a piston 64 united with the needle valve 35 and accommodated in a chamber 65 the base of which is pierced by an orifice 66 to the atmosphere. The two faces of the piston 64 are thus put into communication with the atmosphere. As one of the faces is loaded by a spring 67, the piston 64 and the needle valve 35 move towards the right of Fig. 4, to reduce the flow of fuel.

The advantage is thus obtained that a piping (61 or 62) can intervene in the operation of a piston, such as 52, for several carburettors at the same time and, when the engine is equipped with two, or a greater number of carburettors, a single capsule, such as 31, permits of effecting the enrichment or the correction for all the carburettors at the same time, a condition necessary for preserving an efficient operation of the engine.

In all the cases considered above, the pressure in the pipe 14 has, for the circumstances considered, a fixed value. It is therefore obvious that the supply to the engine for a given condition depends solely upon the position of the butterfly-valve 4, that is to say upon the position of the hand lever 6 and, in the case where the engine 2 comprises a propeller with automatic variable pitch, for which the operation of the blades 71 depends upon a regulating device 70 of any appropriate type (the details of which have not been shown in Figs. 1 to 4), it is possible, according to the invention, to control the operating member 69 of this regulator through the intermediary of a positive connection, such as a rod 68, located between the said member 69 and the rod 5 which acts on the butterfly-valve 4 of the carburettor. The effect of this connection between the respective operations of the control members 4 and 69 therefore is that for the same condition of operation of the engine 2 there always corresponds the same power and reciprocally.

The invention is not limited to the precise forms or details of construction described, as these may be varied to suit particular cases.

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