Feb. 3, 1970

J. D. FARLEY

3,493,217

CARBURETTORS

Filed May 16, 1968

3 Sheets-Sheet 1

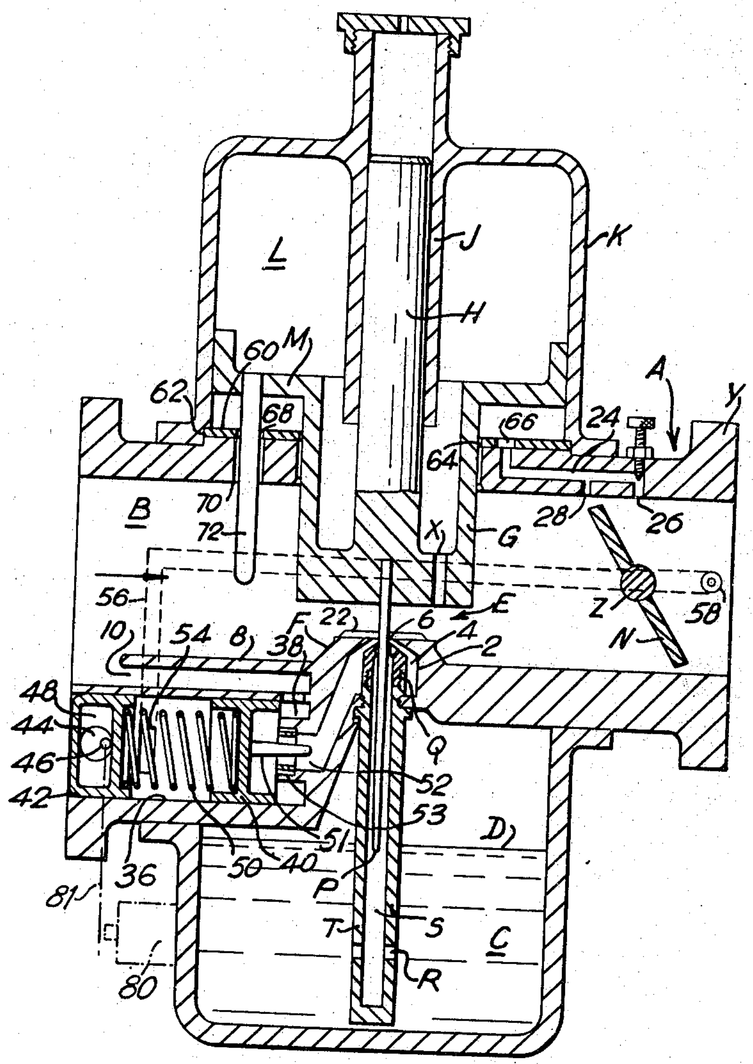

Fig. 1.

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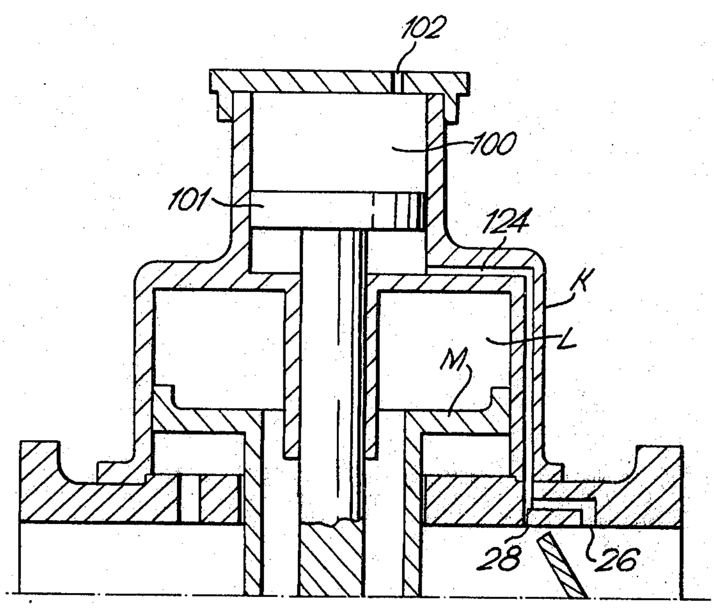

Fig.2

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CARBURETTORS

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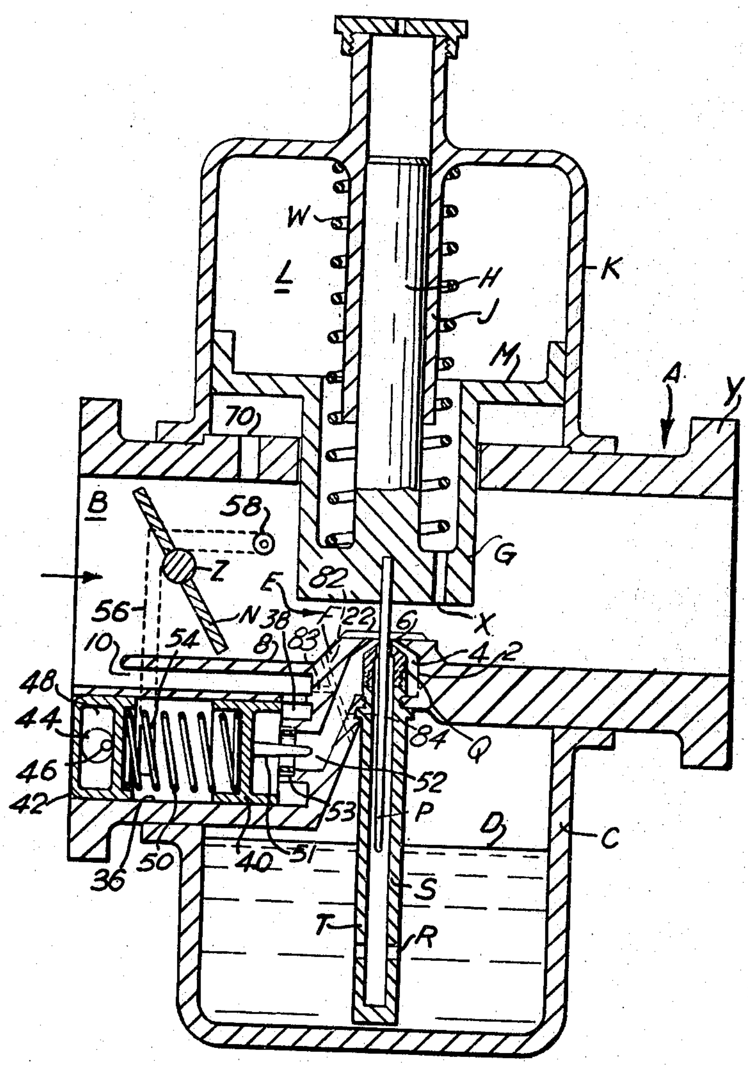

Fig.3.

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3,493,217
Patented Feb. 3, 1970

3,493,217

CARBURETTORS

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Filed May 16, 1968, Ser. No. 729,581
Claims priority, application Great Britain, Mar. 18, 1968, 54,202/66
Int. Cl. F02m 9/06
U.S. Cl. 261—39 19 Claims

ABSTRACT OF THE DISCLOSURE

In a carburettor of the variable choke type, means are provided responsive to the depression downstream of the carburettor throttle valve to apply a force to the choke member in opposition to the normally applied force derived from the local depression at the choke, whilst further means are provided to preatomise the fuel before it enters the carburettor choke. The air supply to the preatomiser may be controlled by a valve responsive to depression downstream of the throttle and a degree of depression may be applied to a fuel reservoir in the carburettor body; in one form of the invention, the throttle valve is placed downstream of the choke, and in another form the throttle valve is placed upstream of the choke.

This invention relates to carburettors of the variable choke type in which the cross sectional area of the choke of the carburettor is controlled by a member movable into and out of the bore of the carburettor under the influence of a depression set up at or adjacent the choke, the movement of this member being related to the operation of a metering device via which fuel is discharged into the choke.

The ideal carburettor should be capable at all times of supplying to an engine a mixture of air and perfectly atomised fuel in the correct quantity and proportion to meet the needs of the engine at any particular moment but in fact no carburettor reaches this ideal. Common defects in carburettor performance are the supply of an excessively rich mixture under cruising and idle conditions, and imperfect atomisation of the fuel particularly at small and part throttle openings. The supply of excess fuel or imperfectly atomised fuel to the engine results in bad distribution between the cylinders of a multicylinder engine and incomplete combustion with consequent additional contamination of exhaust gases from the engine, and in waste of fuel thus increasing fuel consumption. In addition, imperfect atomisation results in rough and uneven running of the engine.

It is the object of the invention to reduce these defects in carburettors of the variable choke type.

I have sought to improve the atomisation of fuel in a variable choke carburettor by utilising the relatively high depressions existing downstream of the carburettor throttle valve under certain conditions in the inlet tract of an internal combustion engine to provide an improved atomising action in the carburettor, since it happens that such depressions are at their highest under just those conditions in which it is most difficult to obtain proper atomisation in a conventional carburettor, i.e., under idling and part throttle conditions.

According to the invention, in a carburettor of the variable choke type having a bore, a throttle valve in the bore, and a choke member forming a choke in the bore and movable under the influence of a depression set up at or adjacent the choke by the passage of air therethrough, the choke member being operatively associated with a metering device via which fuel is discharged into the choke, said carburettor comprises a preatomising device between the metering device and the point of discharge of the fuel into the choke of the carburettor, a passage of controlled capacity from a source of air at substantially atmospheric pressure to the preatomising device whereby a mixture of air and already at least partially atomised fuel is discharged into the choke of the carburettor, and means to apply to the choke member an additional force in opposition to that applied by the influence of the depression adjacent the choke and approximately proportional to the pressure drop across the throttle valve.

The invention will be more fully described with reference to the accompanying diagrammatic drawings in which:

FIGURE 1 shows in vertical cross section one embodiment of a carburettor constructed in accordance with the invention,

FIGURE 2 shows in part vertical cross section a variant of the embodiment of FIGURE 1, and

FIGURE 3 shows in vertical cross section an alternative embodiment of a carburettor in accordance with the invention.

Referring to the drawings, the carburettor in both FIGURES 1 and 3 broadly comprises a body A defining a carburettor bore B and a chamber C in which fuel is maintained at a constant level D in a conventional manner by means of a float (not shown) controlling a needle valve (not shown). A choke orifice E is defined by means of a bridge F and a movable choke member G each projecting into the bore B. The member G is guided by a rod H received in a guide J integral with a casting K defining a chamber L which forms a cylinder for a piston M integral with member G. It should be understood that piston M could be replaced by a diaphragm or other arrangement such as would permit member G to move in response to differential pressures in the chamber L on the two sides of the member M or its equivalent.

Downstream (FIGURE 1) or upstream (FIGURE 3) of the member G is a throttle valve N, preferably of the conventional butterfly type mounted on a spindle Z. The member G carries a calibrated needle P which projects through a jet orifice Q to which fuel is supplied from the chamber C via passages R, S, in a jet carrier member T. That part of chamber L on the upper side of piston M is placed in communication with the bore B of the carburettor downstream or (or beneath) the choke member G by means of a calibrated passage X in member G. In use, the carburettor is attached to the manifold of an engine by means of a flange Y, air passing through the instrument from left to right as seen in the drawings. All parts of the carburettor described so far, or their direct equivalents, are found in currently available conventional variable choke carburettors, except that the throttle valve N would normally always be placed downstream of the choke.

However, whereas in a conventional carburettor of this type, the jet Q is immediately adjacent the surface of the bridge F, in the present construction it discharges in a chamber **4** defined by a bore **2** in the body A immediately behind the bridge F. the chamber **4** communicating with the choke passage E through an annular orifice **6** surrounding the needle P, and opening into a groove **22** along the top of the bridge F. An air intake **8** projecting into the bore B upstream of the bridge F (and in FIGURE 3, upstream of the throttle valve N) defines a passage **10** supplying air at substantially atmospheric pressure to one end of a cylinder **36** through a port **38**. In the cylinder **36** slides a piston **40** which at one end of its travel occludes the port **38**. The other end of the cylinder **36** is closed by a movable plug **42** located by an eccentric **44** fast on a shaft **46** journalled in the body of the carburettor, the eccentric acting on the walls of a window

48 in the plug to locate the latter axially within the cylinder.

The plug 42 and the piston 40 are connected by a spring 50 whose free length is such that with the eccentric positioned so as to withdraw the plug from the cylinder substantially as far as possible, the port 38 is unoccluded by the piston. Mounted on the piston is a tapered needle 51 passing through a calibrated jet passage 53 in the end wall of the cylinder 36, the jet communicating with a passage 52 to the chamber 4.

In the wall of the cylinder adjacent the plug is a further orifice 54 which communicates via a passage 56 with an orifice 58 downstream of the throttle valve N. The orifice 54 is located so that it is closed by the plug 42 when the eccentric is turned so as to project the plug as far as possible. The orifice 58 is sufficiently restricted to damp out pulsation effects occuring downstream of the throttle before they are passed to the piston 40.

Referring now to FIGURE 1, that part of chamber L beneath the piston M is placed in communication with bore B via a passage 24 and a calibrated or, as shown, preset orifice 26, the latter being downstream of the throttle valve N.

This part of the chamber is also provided with a leak path to regulate, in conjunction with the orifice 26, the proportion of the depression existing downstream of the throttle valve which is applied to the piston M. Whilst leakage between the piston M and the body A from the bore B of the body A may be relied upon, manufacturing tolerances may make the leakage rate too large or too erratic if sticking of the piston is to be avoided, and other methods of controlling leakage are preferred.

As shown in FIGURE 1, cylinder K is provided with a rigid circular diaphragm 60 retained by a groove 62 in the base of the cylinder. This groove is machined accurately concentric with the bore of the cylinder, and the diaphragm is provided with a concentric circular aperture 64 just large enough to permit free movement of member G therethrough. This makes unimportant precise concentricity of the aperture in the body A of the carburettor, which concentrically is difficult to achieve and maintain. The diaphragm is provided with an aperture 66 coincident with the opening to passage 24 and an orifice 68 coincident with an aperture 70 in the body A of the carburettor upstream of the choke. A pin 72 extends from the piston M through the orifice 68 and the aperture 70, and serves the dual purpose of locating the piston M against rotating about its axis and of controlling the amount of leakage to beneath the piston M through orifice 68. The pin may if desired be profiled so as to vary the leakage as the piston rises, thus modifying the relative influence of the perssure drop across the throttle as the piston M rises.

In an alternative construction (shown in FIGURE 2) the piston housing K defines a second chamber above and coaxial with chamber L, and the rod H carries two pistons M and 101, one in each chamber. The part above the piston of the additional chamber is open to the atmosphere via vent 102, whilst the lower part of that chamber is placed in communication with the bore of the carburettor via a passage 124 and the orifices 26, 28. Using this arrangement it is possible to dispense with the application of dispression beneath piston M. Furthermore by choosing an appropriate diameter for the second piston 101 such downward biasing of member G as is desired at part throttle can be attained without leakage path problems.

The working of the embodiment shown in FIGURE 1 is best described by comparison with a conventional variable choke instrument which may be considered to comprise only those parts of the carburettor described designated by letters, together with a calibrated vent orifice in casting K beneath the level of piston M and communicating with the atmosphere, and a light spring acting to urge the member G towards the bridge F. A stop member is

provided to prevent member G contacting the bridge F and completely closing the choke passage E.

With the engine to which the carburettor is applied stationary, the member G is held just apart from the bridge F by the stop member mentioned leaving only a narrow passage over the bridge. On starting the engine, a depression is set up in the intake manifold of the engine and downstream of the member G thus drawing air through this narrow passage, the resultant venturi effect drawing fuel through jet Q into the choke passage E where it mingles with the air and is thence delivered to the engine. In order to produce the richer mixture required for cold starting, provision is made for the member T carrying the jet to be withdrawn relative to the needle P thus permitting more fuel to pass through the jet Q. When the engine is running, the depression existing at the choke or in that part of the bore B between the choke member G and the throttle valve N is communicated to that part of the chamber L above the piston M causing it to be lifted against the pressure of the spring previously referred to, the weight of the piston and choke member, and the downward force exerted on the choke member G due to the depression in the choke passage E, thus controlling the size of the choke passage and the position of the calibrated needle P relative to the jet Q. This action controls both the effective cross section of the jet Q and the effective cross section of the choke passage E. The depression in that portion of the bore between the throttle valve N and the choke member G depends on the degree of depression downstream of the throttle valve, the degree of opening of the throttle valve and the position of the member G and the interaction of these factors is adjusted so that in conjunction with a suitably calibrated needle P the engine is fed as far as possible at all times with approximately the correct fuel and air mixture. However, the characteristics of the spring biasing the member G and of any gravity bias towards the bridge F must remain constant and hence the spring and gravitational bias applied to the choke member G has to be compromise in conventional instruments in order to avoid excessive withdrawal of the choke member at part throttle opening without unduly restricting its opening at full throttle, since at full throttle the pressure drop across the instrument as a whole should be a minimum in order for the engine to produce the highest possible brake means effective pressure whereas from the point of view of engine performance at small throttle openings this pressure drop is immaterial. This in practice entails that under most part throttle conditions the cross section of the choke passage E is relatively large compared to the amount of air passing through it, with the result that the depression at this point is comparatively low requiring a comparatively large effective cross section of the jet orifice Q with correspondingly low discharge rates of fuel and resultant imperfect atomisation at the point of discharge.

I have approached this problem in two directions, firstly by delivering fuel from the jet Q to the passage E in a manner which is conducive to improved atomisation of the fuel under all conditions, and secondly by arranging that under those circumstances most conducive to poor atomisation, the depression at the point at which fuel is discharged into the choke passage B is increased.

Considering first the jet and bridge construction embodying the invention described above, the supply of metered quantities of air via passage 10, orifice 38 and jet 53 to chamber 4 pulverises the fuel discharged from jet Q before it emerges into passage E through orifice 6. The pulverised fuel/air mixture produced in chamber 4 is drawn through orifice 6 at high velocity whereupon the already partially atomised fuel is subjected additionally to essentially the same atomisation process as would in a conventional instrument be applied to the liquid fuel, although in many circumstances the efficiency of this process will be yet further increased as described below.

Additionally, the groove 22 concentrates the air flow over the orifice 6 when the choke member G is very close to the bridge F.

Secondly, the spring conventionally provided in the prior art for urging the choke member G towards the bridge F is replaced or augmented by applying via passage 24 and orifice 26 a proportion of the depression existing downstream of the throttle valve N to the lower surface of the piston M, this proportion being controlled by the leak path or bleed to this area: if desired virtually the full depression may be used. Thus under part throttle conditions, a force corresponding to any desired proportion of the high depression and generated by the pressure drop across the throttle valve is applied to the lower face of the piston M to act in opposition to the depression applied to the upper face of the piston via the passage X, thus increasing the biasing force on the choke member G and bringing it closer than would otherwise be the case to the bridge F. This results in the cross section of the choke passage E being reduced and the air velocity through the passage consequently being increased, thus improving atomisation. As the throttle opening is increased, the depression downstream of the throttle valve N is progressively decreased, and the biasing force on the piston also decreases, the characteristics of the biasing force applied to the member G then approximating to those resulting from conventional biasing. It may be desirable to provide one or more progression jets or orifices such as is shown at 28 adjacent the edge of the throttle valve N at various points during its opening in order to provide suitable biasing characteristics at all throttle openings.

Since this arrangement creates a increased depression in the choke passage E under certain circumstances, i.e., when the depression downstream of the throttle valve N is high, the flow through the jet Q would be increased under these conditions, and it is necessary to provide some compensation for this tendency.

This is done by means of the piston 40 and cylinder 36 and their associated parts which control the amount of air admitted to chamber 4 for admixture with the fuel before the latter reaches the choke. It will be seen that with the plug 42 in the position shown, the depression existing downstream of the throttle valve is applied to one side (left as shown) of the piston, thus causing it to move to the left withdrawing the needle relative to the jet and increasing effective orifice through which air is admitted to chamber 4: the amount of air admitted is thus regulated relative to the pressure downstream of the throttle to compensate for the corresponding greater depression in the vicinity of the choke tending to increase fuel flow through the jet Q and decrease air flow through passage B. I find that the size of the opening 6 is also an important factor in controlling mixture strength under idling and part throttle conditions since it isolates the jet Q from the choke depression to some extent, and experimentation may be required to find a satisfactory dimension. A further degree of control over mixture strength may be acheived by arranging for a proportion of the depression downstream of the throttle valve to be applied to chamber C by a suitable arrangement of bleeds, as will be seen by reference to passages 82, 83, 84 in FIGURE 3, to which such an arrangement may also be applied. Indeed, it is possible to dispense with the depression control of the air admission to chamber 4 and substitute a fixed calibrated orifice between the chamber 4 and orifice 10 if this is done, although it will then be necessary to provide other means for enabling enrichment on starting and control mixture strength. Problems may arise however due to fuel vaporisation.

The eccentric 44 serves several puruposes, the shaft 46 being movable between one position bringing the eccentric to a position in which it causes maximum insertion of the plug 42 into the cylinder 36 and a second adjustable position substantially as shown in the drawing. By adjustment of the second position, mixture strength under normal running conditions is controlled, since such adjustment will cause, via spring 50, corresponding adjustment of the relative position of the piston 40 and thus of the amount of air admitted to chamber 4 throughout the range of throttle openings. Moreover, automatic adjustment of mixture strength to compensate for variations in ambient temperature or pressure can be achieved by the provision of a thermostatic or pressure responsive actuator schematically shown at 80 acting on the shaft 46 through the schematically shown lever 81.

Such an arrangement permits automatic correction of mixture strength to compensate for variations in atmospheric pressure and temperature, or for engine temperature during the warm-up period. As a further refinement, a mechanical linkage between the shaft 46 and the throttle spindle could be introduced to provide a further means of mixture strength control.

Movement of the shaft towards its first position enriches the mixture as is required during starting and warming up by moving piston 40 further towards the right thus reducing the air admitted to chamber 4, and at said first position, port 38 is wholly occluded, thus providing maximum enrichment. In this position, port 54 is also occluded, preventing piston 40 from being moved from its furthest right position under the influence of the depression downstream of the throttle valve N.

Considering the operation of a carburettor in accordance with the invention, at small and part throttle opening the high depression and high air velocity created in the choke passage by increased downward displacement of the choke member G provides in conjunction with the improved jet and bridge structure exceptional atomisation of the mixture, with resultant smoother running of the engine and reduced fuel consumption and atmospheric pollution, since the improved atomisation allows a leaner mixture to be used. This improved carburettor performance is particularly valuable under idling and part throttle conditions, since research appears to show that atmospheric pollution by petrol engines is to a large extent caused by carburation defects under these conditions. Moreover, the maximum amount of air will be being admitted to chamber 4, so as to cause a high degree of preatomisation of the fuel before it reaches the choke.

At larger throttle openings, the biasing on the piston M due to depression in that part of the chamber L beneath the piston falls due to reduced depression downstream of the throttle valve N and the behaviour of the choke member G. approximates to that in a conventional variable choke instrument. At full throttle, performance may be enhanced since the elimination or reduction of strength of the biasing spring provided in conventional instruments prevents excess bias being applied to the choke member G.

Sufficient enrichment of the mixture during acceleration is obtained from the inertia of the piston and the work done in dispacing the air above and below the piston, both factors contributing to a temporary rise in choke depression. However, conventional dash pot damping of the rod H can be employed, or alternatively a non return valve could be incorporated in passage 24 to maintain temporarily the depression beneath the piston M after sudden opening of the throttle valve N.

If the jet Q is situated well back behind orifice 6, a two part needle P may be used, the lower half being profiled to control the effective area of jet Q, and the upper half profiled to control the effective area of orifice 6, thus providing yet further control of carburettor performance, since the relationship of the dimensions of the orifice 6 and the jet 53 as partially occluded by needle 51 has a marked effect on the variation of fuel flow with choke depression.

Referring now to the embodiment of FIGURE 3, this closely resembles the embodiment of FIGURE 1 in most constructional respects, the same reference numerals being sparsely used to refer to corresponding parts, and only the differences will be further described.

Firstly, the throttle valve N is located upstream of the choke, and the passage **24** and the orifice **26** of FIGURE 1 are replaced by a simple opening **70** located upstream of the choke, though still downstream of the valve N. Secondly, for reasons that will become apparent, strict control of the leakage between member G and body A is no longer necessary so that diaphragm **64** is dispensed with.

In operation, since the entire choke region of the carburettor is situated downstream of the throttle valve, the local depression at the choke will be supplemented by the depression due to the pressure drop across the throttle valve N, whilst this latter depression will be applied to the underside of the piston M. This piston therefore moves in response to the local depression in the vicinity of the choke, as in a conventional variable choke instrument, although there will be an additional downward pressure proportional to the pressure drop across the throttle valve acting on the choke member G as a result of the unbalanced application of atmospheric pressure to the top of the piston rod H. This has a similar effect as to the application of manifold depression to the underside of piston M in the embodiment of FIGURE 1.

The increased depression in the vicinity of the choke if uncompensated would cause additional fuel to be drawn through the jet Q, and this is compensated for by the action of piston **40** and its associated parts in supplying metered quantities of air to the chamber **4**. The operation of these parts is the same as in the case of FIGURE 1, except that the pressure drop between air intake **8** and orifice **6** will be further increased by the amount of the pressure drop across the throttle valve, thus increasing the velocity of the air passing through this system and still further improving atomisation of the fuel before its emergence into the choke passage E.

A further advantage of this layout is that the throttle valve being placed upstream of the point at which fuel is introduced, does not result in the deposition of liquid fuel and its subsequent re-evaporation which is known sometimes to cause carburetion faults in the normal form of carburettor in which the throttle valve is placed downstream of the choke.

The embodiment of FIGURE 3 may be modified in the same ways as FIGURE 1 by providing a second piston on the rod H and associated chamber in housing K, and/or by supplementing or replacing the depression operated control of the air supply to chamber **4** by the application of depression to the chamber C.

It will be understood that no dimensions have been given for the various orifices and bleeds introduced by the novel features of the invention, but these, which in any event will tend to vary in different installations, can readily be ascertained by normal experimental methods once the principles of the invention have been understood.

What I claim is:

1. A carburettor of the variable choke type having a body defining a bore, a throttle valve located in the bore, and a choke member movable relative to said body projecting into saiad bore to form a choke, first means responsive to the depression set up at or adjacent the choke by the passage of air therethrough to apply a force to said choke member tending to withdraw it from said bore, the choke member being operatively associated with a metering device in the body through which fuel is discharged from a reservoir in the body to the choke, said carburettor further comprising a preatomising device between the metering device and a fuel discharge orifice communicating with the bore at the choke, a passage of controlled capacity from a source of air at substantially atmospheric pressure to the preatomising device whereby a mixture of air and already at least partially atomised fuel is discharged into the choke of the carburettor, and second means to apply to the choke member an additional force generated by the pressure drop across the throttle valve and acting in opposition to the force applied to said choke by said first means responsive to the depression adjacent the choke.

2. A carburettor according to claim **1**, wherein the choke member is carried for movement into and out of the bore by a double acting pneumatic actuator comprising an actuator member attached to the choke member and presenting opposed surfaces one of which lies in a chamber communicating with the bore at or adjacent the choke and the other of which lies in a chamber communicating with the bore downstream of the throttle valve.

3. A carburettor according to claim **2**, wherein the actuator member comprises a piston or flexible diaphragm connected to the choke member and dividing a chamber within the body in which it can move to withdraw the choke member from the carburettor bore, that part of the chamber nearest the bore being placed in communication with the latter downstream of the throttle valve, and that part furthest from the bore being placed in communication with the bore at the choke.

4. A carburettor according to claim **2**, wherein the actuator member comprises two pistons or flexible diaphragms connected in series to the choke member, that piston or diaphragm nearest the carburettor bore moving in a chamber of which that part furthest from the bore is in communication with the choke, and that piston or diaphragm furthest from the bore moves in a chamber of which that part nearest the bore is in communication with the bore downstream of the throttle valve.

5. A carburettor according to claim **1**, wherein there is provided within the passage between the source of air at substantially atmospheric pressure and the preatomising device a vacuum operated valve having a vacuum chamber in communication with the bore downstream of the throttle valve, the sense of operation of the valve being such that the degree of opening of the valve increases with increase of the applied vacuum.

6. A carburettor according to claim **5**, wherein the valve comprises a valve member carried by a piston within a cylinder communicating via a passage with the bore downstream of the throttle valve, the piston moving against the pressure of a compression spring supported at its remote end by a member movable axially in relation to the cylinder, whereby movement of the member alters the response of the valve to the depression downstream of the throttle valve.

7. A carburettor according to claim **6**, wherein the movable member is movable between a first position determining the operation of the valve during normal operation of the carburettor, and a second position movement towards which causes the spring to load the piston so as to close the valve in the absence of any substantial depression downstream of the throttle valve.

8. A carburettor according to claim **7**, wherein the movable member in its second position cuts off the passage through which the depression downstream of the throttle valve is applied to the cylinder.

9. A carburettor according to claim **7**, wherein the first position of the movable member is determined by means of an actuator responsive to ambient atmospheric conditions and engine temperature.

10. A carburettor according to claim **1**, wherein a chamber from which fuel is supplied to the metering device is placed in communication with the bore downstream of the throttle valve and with the atmosphere by bleed passages, whereby to apply a proportion of the depression existing downstream of the throttle valve to said chamber.

11. A carburettor according to claim **1**, wherein the fuel metering device comprises a calibrated jet within which moves a profiled needle carried by the choke member, and the pre-atomising device comprises a chamber situated between the jet and an orifice surrounding the needle and communicating with the choke, the orifice being situated in a bridge member extending into the bore of the carburettor opposite the choke member.

12. A carburettor according to claim **11**, wherein the orifice between the chamber and the choke opens into a groove across the top of the bridge member and extending longitudinally relative to the carburettor bore.

13. An orifice according to claim **11**, wherein the jet projects into the chamber toward the orifice into the choke so as to form therewith an internal mix atomising nozzle.

14. A carburettor according to claim **3**, wherein the throttle valve is situated downstream of the choke member.

15. A carburettor according to claim **14**, wherein that part of the chamber nearest the bore is placed in communication with said bore downstream of the throttle valve via a calibrated orifice, and is also placed in communication with the atmosphere or the bore upstream of the throttle valve via a controlled leak path, whereby a controlled proportion of the depression downstream of the throttle valve is applied to that part of the chamber.

16. A carburettor according to claim **15**, wherein the leak path comprises an orifice between the chamber and the bore of the carburettor, and the capacity of the leak path is controlled by a profiled needle carried by the piston.

17. A carburettor according to claim **15**, wherein the chamber is defined by a separate housing secured to a body defining the bore of the carburettor, that side of the housing facing the body being closed by a rigid diaphragm having an orifice just large enough to permit free passage of the choke member without substantial leakage, this orifice coinciding with a slightly larger orifice in the body.

18. A carburettor according to claim **2**, wherein the throttle valve is situated upstream of the choke member.

19. A carburettor according to claim **18**, wherein the actuator member includes an additional surface opposed to that exposed to the depression existing downstream of the throttle valve which surface is exposed to atmospheric pressure.

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