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INTERNAL COMBUSTION MOTOR SYSTEM

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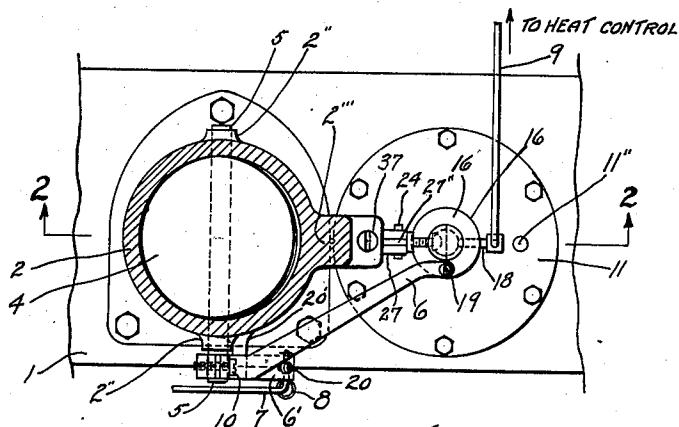


Fig. 1

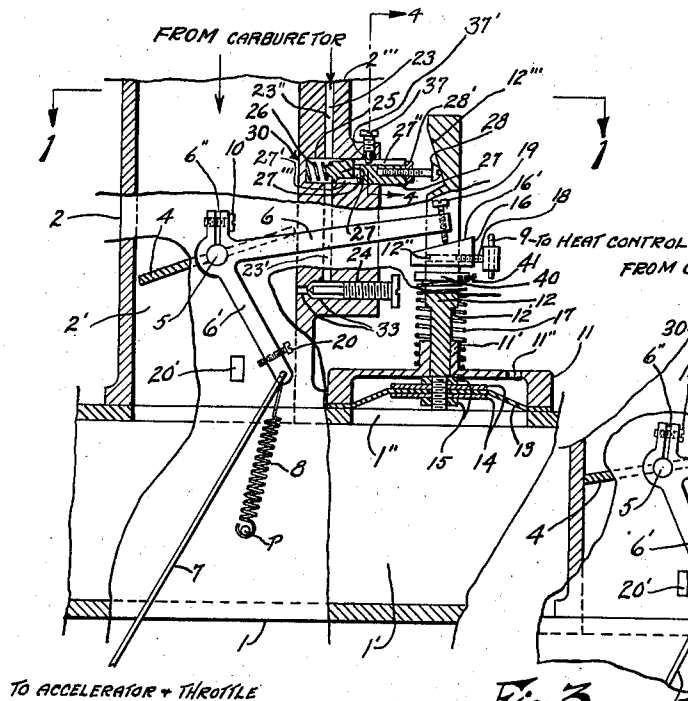


Fig. 2

Fig. 4

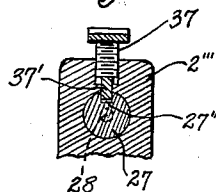
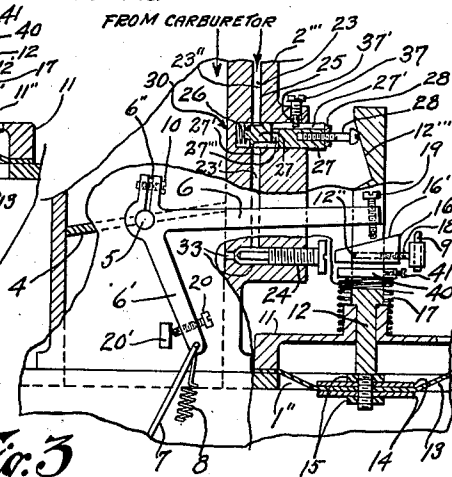


Fig. 3



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INTERNAL COMBUSTION MOTOR SYSTEM

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20 Claims. (Cl. 123—103)

This invention relates to internal combustion motor systems, and more particularly to the control of combustible mixture inflow in such systems, with special reference to mixture inflow occurring during motor de-celeration. While not limited thereto, the invention may have a special utility in connection with the motor systems of automobiles or other vehicles, wherein motor de-celeration is opposed by the momentum not only of the motor but also from time to time of the thereto connected vehicle. In these latter cases motor de-celeration is frequently relied on for a braking effect upon the vehicle.

It is an object of my invention to provide methods and automatically operative means for aiding the de-celeration of internal combustion motors.

It is another object to provide methods and automatically operative means for reducing fuel consumption by such motors during de-celeration.

It is a further object to provide automatically operative means for reducing the combustible mixture inflow to an abnormally low or negligible value during de-celeration and for restoring it to a normal minimum in time to prevent motor stalling.

It is a still further object to provide improved mixture inflow control means for such motor systems; and it is an allied object to provide improved mixture intake arrangements for such systems.

Other and allied objects will more fully appear from the following description and the appended claims.

In the description reference is had to the accompanying drawing, of which:

Figure 1 is in general a top view of a portion of the intake system of an internal combustion motor, looking downwardly from a plane intersecting the carburetor connection;

Figure 2 is a cross-sectional view taken along the line 2—2 of Figure 1, certain portions of Figure 2 appearing however in elevation, Figure 2 illustrating one set of positions of various components of my invention;

Figure 3 is a view similar to Figure 2, but illustrating a second set of positions of the same components, and

Figure 4 is an enlarged cross-sectional view along line 4—4 of Figure 2.

The most pertinent portions of an internal combustion motor (for example an automobile or other vehicle motor) in connection with which my invention has been illustrated may first be briefly described, with reference to Figures 1 and

2. The numeral 1 designates the intake manifold of the motor and 2 a cylindrical extension thereof connecting with the carburetor (not shown), it being understood that the main path of combustible mixture from the carburetor to the intake manifold (from which the fuel passes into the motor cylinders) is the space 2' within the manifold extension 2. Transversely of the extension 2, as in bosses 2'' formed therein, is journaled the butterfly valve 4 with shaft 5, the function of the valve 4 being of course the regulation of mixture flow through the main path. The valve shaft 5 is rotated to effect this regulation by a crank 6', clamped to the shaft 5 as by screw 10 in crank bifurcation 6'', the extremity of crank 6' being connected with the rod 7 responsive to the accelerator and throttle motor controls (not shown). The rod 7 may itself be considered the speed control member for manipulation by the operator of the motor; as illustrated, this member is pivotally connected with the crank 6' and therethrough with the valve, so that the connection is a substantially unyielding one. The valve 4 is biased to a closed position as by a tension spring 8, connected between the extremity of the crank 6' and some fixed point P and biasing the crank to clockwise rotation as illustrated in Figure 2, so that in the absence of appropriate manipulation of the accelerator and throttle controls the valve 4 tends to close. There may also be provided a small, adjustable auxiliary path for combustible mixture, leading from the carburetor into the intake manifold on the motor side of the valve and thus by-passing the latter. Such an auxiliary path has been illustrated in the drawing as comprising the horizontal, inwardly tapered hole 33 leading into the space 2' just below the valve 4, the vertical hole 23 leading from the carburetor to the hole 33 within the rib 2''' comprised in extension 2, and the adjusting screw 24 passing inwardly into hole 33 and having a tapered end forming an adjustable passage with the taper of that hole.

When the motor is to idle (the accelerator and throttle controls being accordingly released) the auxiliary path may be relied on to supply a significant or even the principal portion of the mixture inflow, and the valve 4 permitted almost fully to close. For precisely regulating the normal minimum opening of the valve 4, the clockwise rotation of crank 6' is limited in any convenient manner—as by an adjustable screw 19, in a crank 6 integral with crank 6', impinging on a stop member such as 16 hereinafter de-

scribed. The auxiliary path is sometimes arranged to pass combustible mixture of greater richness than the main path, so that as the valve 4 approaches its minimum opening in normal operation not only is the total combustible mixture inflow reduced but also the mixture is increased in richness.

It will be understood that combustible mixture is drawn from the carburetor through the main and auxiliary paths into the intake manifold and thence into the motor by the suction produced by the motor in the intake manifold. This intake suction varies jointly with motor speed and motor load—it varies, in a qualitative sense, in accordance with that speed and inversely in accordance with that load. The first of these two variations is quite obvious; the second may be appreciated by considering that, at any given speed, the greater the load the greater must be the mixture inflow into the intake manifold, and the greater this flow the less will be the intake suction. Low loads may of course comprise negative loads, as occur when the momentum of the motor or of the motor plus a vehicle connected therewith is temporarily providing a driving force for the motor. In alternative and more direct terms, the intake suction varies in accordance with motor speed and in inverse accordance with fluid inflows into the intake manifold—e. g., the combustible mixture inflow through auxiliary and main paths, the latter of which is regulable by the valve 4. Generally speaking, the variation with fluid inflow (or with load) is the wider, or more steep. Thus, the mixture inflow being low as a result of establishment of a minimum or near-minimum opening of valve 4, a moderately high intake suction is produced even at low motor speeds; but at such low mixture inflow and higher motor speeds e. g., substantial motor speeds the intake suction reaches still higher values.

In accordance with my invention I provide means automatically operative only under the joint conditions of substantial motor speed and low combustion mixture inflow (or substantial motor speed and very low motor load) for reducing or substantially eliminating the minimum combustible mixture inflow otherwise occurring. These joint conditions will be recognized as those obtaining immediately upon release of accelerator and throttle controls at substantial motor speeds—a release conventionally effected for the purpose of an intended de-acceleration of the motor; the action of my invention both aids this de-acceleration and reduces or eliminates an ordinarily occurring waste of fuel. When the motor speed has reduced toward a normal idling speed a normal minimum mixture inflow is automatically re-established, preventing stalling.

In carrying out my invention I take advantage of the fact that the intake suction is at its highest under the joint conditions which I have specified for operation of my automatic means; I therefore may make the means responsive to intake suction. More specifically, I may make the means differentially responsive to higher intake suction—i. e., inoperative at the moderately high suction obtaining with low motor speeds and low combustible mixture inflows, while operative at the still higher suction obtaining with substantial motor speeds and low mixture inflows. One element of my automatic means may therefore be a member movably responsive in the manner outlined; and without intending any limitation of form and arrangement of such a

member, I have illustrated it as a plunger 12 secured to a diaphragm 13 so responsive in limited movement.

Thus an aperture 1' may be provided in the top of the intake manifold, for example adjacent the extension 2, and over this aperture there may be secured to the manifold an inverted cup-member 11, leather or other diaphragm 13 being clamped between cup-member and manifold. The cup-member is provided with a central, outwardly- or upwardly-extending boss 11', and in this boss is slidably arranged the plunger 12. The threaded lower end portion of the plunger may be passed through the diaphragm 13 and secured thereto as by clamping washers 14 above and below the diaphragm and nuts 15 above and below the washers. Upward or outward movement of the plunger is limited by impingement of the upper nut 15 against the inner surface of cup-member 11, while downward or inward movement of the plunger is limited as by impingement of a shoulder 12' in the plunger against the top of boss 11'. In order to avoid the formation of an air pocket in the space between cup-member 11 and the diaphragm 13, the cup-member may be provided with one or more apertures 11'' placing this space in communication with the atmosphere. Above the shoulder 12' there may be secured to the plunger 12, as by screw 41, a collar 40, and between this collar and the top or outer surface of cup-member 11 an expansion spring 17 may surround the plunger 12 and boss 11'. This spring biases the plunger to upward movement, and its normal position is the upward one illustrated in Figure 2. This position obtains for low intake suction (including all obtaining with higher mixture inflows) up to and including that moderately high suction obtaining with low motor speeds and low mixture inflows. The expanding force of spring 17 is so adjusted, however, (as by choice of position of collar 40 longitudinally of the plunger 12) that it is overpowered at still higher intake suction, at which the diaphragm and plunger will accordingly be attracted inwardly to the position illustrated in Figure 3.

In response to inward movement of the plunger 12 there is cut off the mixture inflow normally occurring through the auxiliary path above mentioned. I have illustrated this cut-off action as effected by an auxiliary valve associated with the vertical hole 23. By way of example, this valve is formed by a valve rod 27 operating in a horizontal hole 25 which intercepts the smaller hole 23, dividing the latter into lower and upper portions 23' and 23'' respectively. The rod 27 is normally kept from intercepting the hole 23 by an expansion spring 26 between the inner rod end and the base of the hole 25, which biases the rod outwardly. At the outer end of the rod 27 may be provided an adjustable screw 28 (locked by nut 28') which, when plunger 12 is in its normal upward position (as in Figure 2) impinges against the lower and most indented portion of a cut-out cam surface 12''' in the plunger, then just permitting the rod 27 to clear the hole 23. As the plunger 12 is lowered, however, in response to high intake suction, the cam surface 12''' forces the rod 27 inwardly to intercept the hole 23 and thus to intercept the auxiliary mixture path, as illustrated in Figure 3. Raising of the plunger 12 in response to reducing intake suction will of course cause spring 26 to restore the valve rod 27 to its Figure 2 position, re-opening the auxiliary mixture path.

It will of course be appreciated that the reduction of suction with reducing motor speed is predicated on the inflow of air, combustible mixture, or other fluid into the intake manifold and cylinders in response to the suction. It will be obvious that when the auxiliary valve 30 intercepts the auxiliary path the combustible mixture inflow is reduced to an abnormally low value. This mixture inflow reduction, unless sufficiently compensated for in some inherent or specially provided manner, may sufficiently increase the intake suction to cause the system to "block" i. e., to maintain the mixture inflow abnormally low (by inward plunger position) until after the reducing motor speed has reached normal idling value, so that stalling would occur. I have therefore illustrated a path for admission of non-combustible fluid—e. g., an air-admission, or suction-leakage, path—arranged to open automatically as the combustible mixture path is intercepted. While such an arrangement may obviously be provided in any of a variety of ways, I have illustrated by way of non-limitative example an arrangement whereby the valve 30 opens such a path as it intercepts the auxiliary mixture path, and vice versa. Thus I may provide in the bottom of valve rod 27 a key-way-like slot 27' extending outwardly from very near the inner rod extremity, a similar slot 27'' in the top of the rod extending inwardly from the outer rod extremity, and vertical hole 27''' joining the slots. As the valve rod 27 is moved inwardly, the slots place the hole portion 23' (and therethrough the hole 33) in communication with the atmosphere, this communication preferably beginning before the hole 23 is fully intercepted (discharge of combustible mixture from the upper hole portion 23'' through slot 27'' in the short interim during which they may mutually communicate being obviated by the suction of lower hole portion 23'). A key to maintain the slot 27'' upwardly may be provided by a screw 37 having smooth cylindrical end 37' substantially fitting slot 27'', and adjustably retained in the rib 2''.

It is desirable that the relationship of total fluid admission rate (i. e., total fluid inflow) to intake suction be substantially equalized for the different positions of plunger 12 and valve rod 27. Air, through a given orifice or aperture, will of course flow more rapidly than combustible mixture, and accordingly the use of a flow-limiting means in the suction leakage path is indicated. Such a means may be conveniently provided, in the system as I have illustrated it, by the key screw 37 of which the end 37' forms an adjustable aperture with the bottom of slot 27''.

While the operation of my invention, as thus far described, has been made apparent in the structural description, I may review its action as follows: Under all higher combustible mixture inflow (or load) conditions, and under conditions of low mixture inflow and low motor speed, the plunger 12 remains upwardly, the valve rod 27 outwardly, and the normal mixture inflow undisturbed. When, however, the joint conditions arise of low combustible mixture inflow and substantial motor speed (as in response to accelerator and throttle control release at substantial motor speeds), the plunger 12 moves downwardly, the valve rod 27 moves inwardly, mixture inflow through the auxiliary path is intercepted, and a preferably corresponding air inflow through the suction leakage path is established. As the motor speed reduces the intake suction reduces; and as the speed becomes quite low the attendant suc-

tion becomes insufficient to maintain the plunger 12 downwardly, so that the plunger moves upwardly, the valve rod 27 moves outwardly, and a normal minimum inflow of combustible mixture is established. Preferably the spring 17 is adjusted to the weakest expanding force which will insure completion of upward plunger movement in time to prevent the motor from stalling. It may be noted that in an arrangement, such as illustrated, in which the upward plunger biasing means (spring 17) has a force which increases somewhat as the plunger moves downwardly (and vice versa), the plunger movements may not be altogether abrupt, but rather at least slightly gradual; preferably, however, the biasing means are so selected and arranged as to maintain reasonably small this change of their force.

In the operation of my invention as so described no movement of the stop member 16 has been specially contemplated, and a fixed minimum combustible mixture inflow through the main path 2' (in the absence of accelerator or throttle manipulation) has been assumed. Additionally to cutting off the mixture inflow through the auxiliary path, however, I may under similar conditions reduce or substantially eliminate mixture inflow through the main path. This may be accomplished by effecting movement of the stop member 16 in accordance with plunger 12 movement. Accordingly the stop member 16 may be carried by the plunger 12, for example above collar 40, in secure relation to the plunger as to movement longitudinally thereof—screw 19 in crank 6 impinging on the top surface 16' of member 16 to reduce the valve 4 opening as the plunger 12 is lowered. Preferably the parts are so apportioned that complete downward movement of the plunger will be at most but slightly more than enough fully to close the valve 4 from a normal minimum adjustment. To prevent possible jamming of the valve 4 in a closed position, and to afford a means of maintaining it a trifle open if desired even when the plunger 12 has moved downwardly, a second adjustable screw 20 may be provided in the crank system, (for example in crank 6') adapted to impinge against a fixed stop device (for example a lug 20' formed on the extension 2). When such screw 20 impinges on such stop device, screw 19 is of course relieved of impingement against surface 16'. When the main valve 4 minimum opening is reduced in response to plunger movement, as so described, the total reduction of mixture inflow in response to plunger movement is of course greater than otherwise, and a correspondingly wider-open adjustment of the aperture between screw 37 and slot 27'' is therefore necessary to maintain the desirable equalization, for different plunger positions, of the relationships of total fluid inflow to intake suction, above discussed (and now applicable on the basis that its minimum opening is assumed by valve 4).

Frequently a stop member for limiting the minimum opening of the main valve—such as stop member 16—is arranged to move in response to the temperature of the motor, so as to provide higher than normal minimum valve openings before the motor attains normal operating temperature. To provide this arrangement in the system which I have illustrated, for operation under the normal plunger-up conditions, I may make the surface 16' a bevelled or cam surface, and arrange the member 16 for circumferential movement with respect to the plunger in response to motor temperature. I accordingly have illus-

trated a circumferential groove 12" in the plunger 12 and a screw 18 passing through the member 16 and engaging the groove 12" for movement therein. I further show a rod 9 which will be understood to be responsive in its longitudinal position to the motor temperature. The end of this rod is connected with the head of screw 18 to move the stop member 16 circumferentially in limited degree, thereby slightly readjusting the valve 4 in accordance with the motor temperature. It may be mentioned that with such an arrangement the normal minimum mixture inflow through valve 4, for purposes of determining a desirable adjustment of the screw 37, should be considered that obtaining at full normal motor operating temperature.

It will of course be understood that control of combustible mixture flow according to my invention may if desired comprise simply the reduction of minimum openings of the valve 4—the suction leakage path preferably still being opened in inverse accordance with the minimum valve 4 openings, and the screw 37 adjusted to provide the desirable substantial equalization of fluid inflow-suction relationships already discussed. In such a case the illustrated auxiliary mixture path will be omitted by omission of connection of upper hole portion 23" to the carburetor. I prefer, however, to control the auxiliary mixture path, as in the manner illustrated and described, whenever such a path is provided.

It will be understood that the terms "in accordance with" and "in inverse accordance with" are employed herein in a qualitative sense, to denote respectively similar or opposite direction of two coincident variations or the like.

It may be noted that in particular cases it may be possible to employ, without danger of blocking of the system, a somewhat smaller aperture between screw 37 and slot 27" (or in any equivalent adjusting means for the suction leakage path) than actually equalizes the relationships of total fluid inflow to intake suction as above described; the extent to which this aperture reduction, or departure from substantial equalization, may be carried, when desired, must be determined by test in any particular case.

It will be understood that while I have described my invention as employed in a particular embodiment, I do not intend to be limited by the details of that embodiment, it being obvious that wide variations may be made therein without departing from the spirit or scope of the invention. In the appended claims I intend to claim my invention as broadly as the state of the art will permit.

I claim:

1. In combination in an internal combustion motor system including an intake manifold adapted to admit combustible mixture: closely biased valve means having a normal minimum opening and openable therefrom at will to regulate said mixture inflow; and means, automatically responsive only to conditions including substantial motor speed and unresponsive at low motor speeds, for reducing said minimum valve means opening.

2. In combination in an internal combustion motor system including an intake manifold adapted to admit combustible mixture: valve means of variable opening, biased toward closed condition, for regulating the inflow of said mixture; stop means for establishing a normal minimum opening of said valve means; and means, automatically responsive only to conditions in-

cluding substantial motor speed and unresponsive at low motor speeds, for moving said stop means to reduce said minimum valve means opening.

3. In combination in an internal combustion system including a motor and an intake manifold therefor: means providing a path for combustible mixture to said manifold; means operative at substantial motor speeds together with low mixture inflow through said path, for reducing said mixture inflow; and means, operative with said reducing means, for maintaining the relationship between total fluid inflow to and suction within said manifold substantially independent of the operation of said reducing means.

4. In combination in an internal combustion motor system including an intake manifold: means providing a path for combustible mixture thereto; means operative only at substantial motor speeds together with low mixture inflow through said path, for reducing said mixture inflow; and means for maintaining the relationship between total fluid inflow to and suction within said manifold substantially independent of said reducing means, including means, connected and operative with said reducing means, for admitting into said manifold a non-combustible fluid.

5. In combination in an internal combustion system including a motor and an intake manifold adapted to admit combustible mixture thereto: valve means of variable opening for regulating the inflow of said mixture; means for establishing a variable minimum opening of said valve means; means for admitting into said manifold a non-combustible fluid; and means regulating said fluid admission in inverse accordance with said minimum valve means opening.

6. In combination in an internal combustion motor system including an intake manifold adapted to admit combustible mixture: valve means of variable opening for regulating the inflow of said mixture, said valve means having a normal minimum opening; means operative only at substantial motor speeds for reducing said minimum valve means opening; and means for maintaining the relationship between total fluid inflow to and suction within said manifold substantially independent, at minimum openings of said valve means, of said minimum opening reduction.

7. In combination in an internal combustion motor system including an intake manifold adapted to admit combustible mixture: valve means of variable opening for regulating the inflow of said mixture, said valve means having a normal minimum opening; means operative only at substantial motor speeds for reducing said minimum valve means opening; means providing a suction leakage path; and means, connected and operative with said reducing means, for connecting said leakage path with said manifold.

8. In combination in an internal combustion motor system including an intake manifold adapted to admit combustible mixture: valve means for regulating the inflow of said mixture, said valve means being biased toward closed condition and having an opening regulable independently of suction within said manifold; and means, differentially responsive to mutually different higher intake suction within said manifold, for establishing a minimum opening of said valve means in inverse accordance with said suction.

9. In combination in an internal combustion motor system including an intake manifold

adapted to admit combustible mixture: valve means of variable opening, biased toward closed condition, for regulating the inflow of said mixture; stop means for establishing a minimum opening of said valve means; and means, differentially responsive to mutually different higher intake suction within said manifold, for moving said stop means to alter the minimum valve means opening in inverse accordance with said suction.

10. In combination in an internal combustion motor system including an intake manifold adapted to admit combustible mixture: valve means of variable opening, biased toward closed condition, for regulating the inflow of said mixture; stop means for establishing a normal minimum opening of said valve means; and means, responsive to higher intake suction within said manifold and operative only at substantial motor speeds, for moving said stop means to reduce said minimum valve means opening.

11. In combination in an internal combustion motor system including an intake manifold adapted to admit combustible mixture: a movable motor speed control member; valve means of variable opening, substantially unyieldingly connected with and responsive to said control member and biased toward closed condition, for regulating the inflow of said mixture; and means, differentially responsive to higher intake suction within said manifold, for establishing a minimum opening of said valve means of size in inverse accordance with said suction.

12. In combination in an internal combustion motor system including an intake manifold adapted to admit combustible mixture: valve means of variable opening for regulating the inflow of said mixture; means, differentially responsive to higher intake suction within said manifold, for varying the minimum opening of said valve means in inverse accordance with said suction; means providing a suction leakage path communicating with said manifold; and means for opening said path in inverse accordance with said minimum valve means opening.

13. In combination in an internal combustion motor system including an intake manifold: means providing a main path for combustible mixture thereto, and a main valve of variable opening in said path; means providing an auxiliary path for combustible mixture in parallel with said main path, and auxiliary valve means in said auxiliary path; and means, differentially responsive to higher suction within said manifold, for varying the minimum opening of said main valve in inverse accordance with said suction and operating said auxiliary valve means.

14. In combination in an internal combustion motor system including an intake manifold: means providing a main path for combustible mixture thereto, and a main valve of variable opening in said path; means providing an auxiliary path for combustible mixture in parallel with said main path, and auxiliary valve means in said auxiliary path; means providing a suction leakage path communicating with said manifold, and leakage valve means therein; and means, differentially responsive to higher suction within said manifold, for varying the minimum opening of said main valve and operating said auxiliary and leakage valve means.

15. In combination in an internal combustion motor system including an intake manifold and

means providing a regulable main path for combustible mixture thereto: means providing an auxiliary path for combustible mixture; means providing a suction leakage path; a two-way valve selectively connected with said auxiliary path and said leakage path, and operable to connect either of the same with said manifold; and means, differentially responsive to higher suction within said manifold, for operating said two-way valve.

16. In combination in an internal combustion motor system including an intake manifold adapted to admit combustible mixture: a valve of variable opening for regulating an inflow of said mixture; means providing a normally open auxiliary path for combustible mixture by-passing said valve; and means for reducing the minimum opening of said valve and means for closing said auxiliary path, said two last-mentioned means being interconnected for simultaneous operation.

17. In combination in an internal combustion motor system including an intake manifold adapted to admit combustible mixture: a main valve of variable opening for regulating an inflow of said mixture; means providing a normally open auxiliary path for combustible mixture by-passing said valve; means providing a normally closed suction leakage path communicating with said manifold; and means for reducing the minimum opening of said valve and means for closing said auxiliary path and means for opening said leakage path, said three last mentioned means being interconnected for simultaneous operation.

18. In combination in an internal combustion motor system including an intake manifold adapted to admit combustible mixture: a main valve of variable opening for regulating an inflow of said mixture; means providing an auxiliary path for combustible mixture; means providing a suction leakage path; a two-way valve operable to connect said manifold selectively with said auxiliary path and said leakage path; and means for varying the minimum opening of said main valve and means for operating said two-way valve, said two last mentioned means being interconnected for simultaneous operation.

19. In an internal combustion motor system including an intake manifold adapted to admit combustible mixture: a valve for regulating the inflow of said mixture; means biasing said valve to movement in one direction; and limiting means for said movement responsive to motor temperature conditions and intake suction conditions, comprising a stop member, a support therefor, means responsive to one of said conditions for moving said support, and means responsive to the other of said conditions for moving said member with relation to said support.

20. In an internal combustion motor system including an intake manifold adapted to admit combustible mixture: a valve for regulating the inflow of said mixture; a plunger associated with said manifold for inward and outward movement relative thereto and responsive to suction therein; a member secured to said plunger as to movement longitudinally thereof and provided with a cam surface; means responsive to motor temperature for moving said member circumferentially of said plunger; a crank system for said valve; and means biasing said crank system to impingement against said surface.

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