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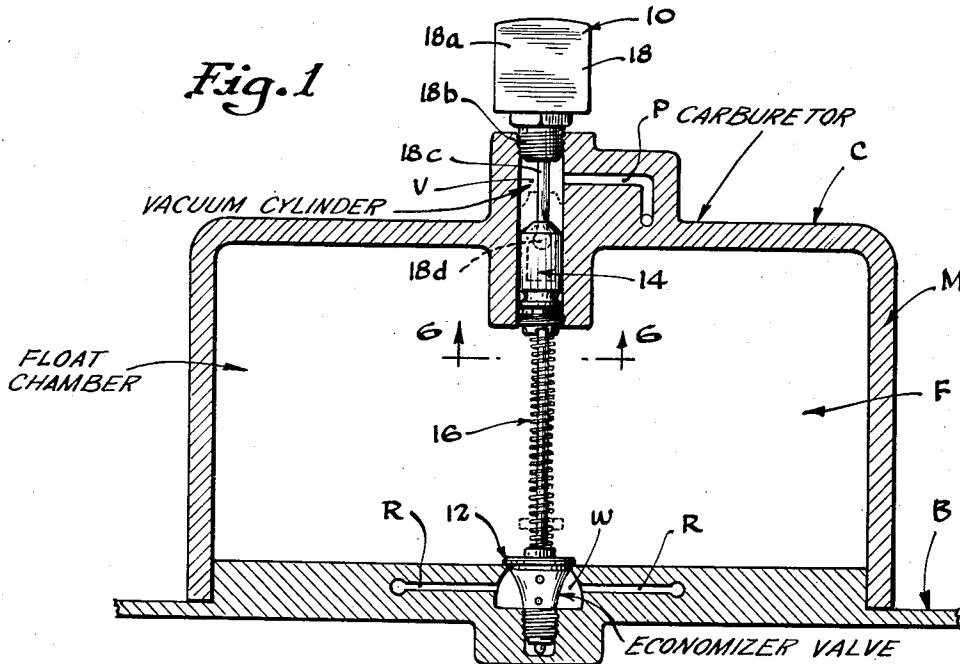
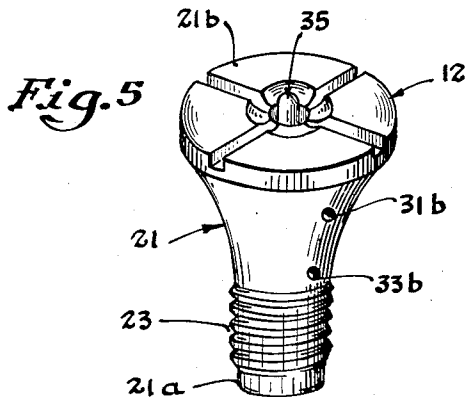
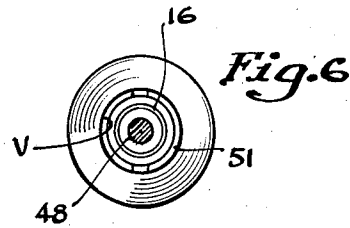
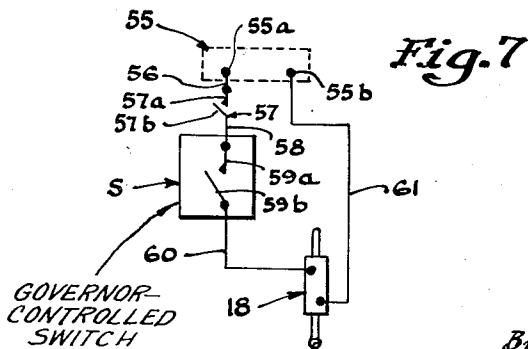
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2,831,471

VALVES

Filed July 15, 1955

2 Sheets-Sheet 1

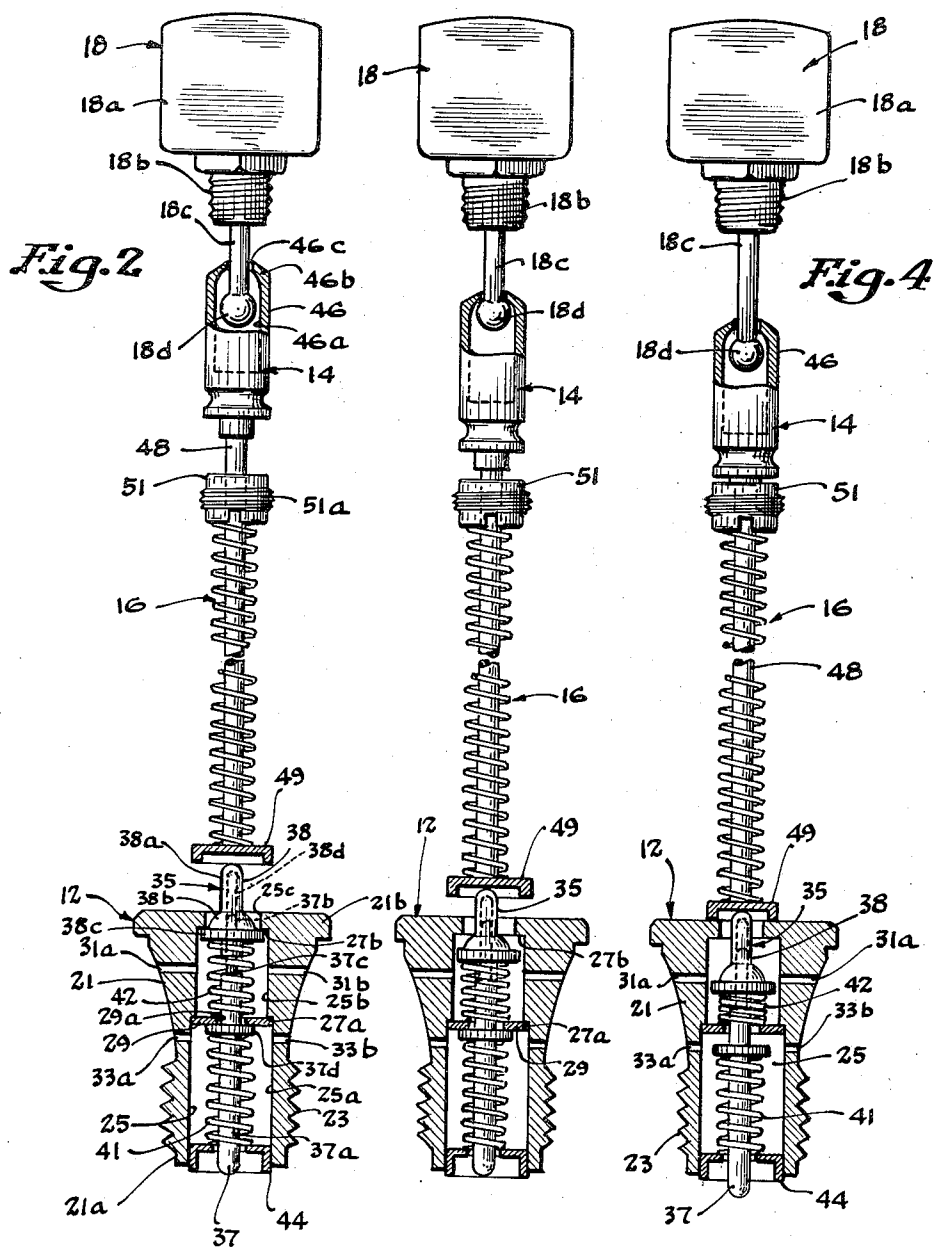


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2 Sheets-Sheet 2

Fig. 3



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2,831,471

VALVES

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18 Claims. (Cl. 123—119)

This invention relates to valves and more specifically, to economizer valves for carburetors.

Economizer valves for carburetors have been heretofore known in the art. However, such economizer valves as have been heretofore known have had several inherent disadvantages such as, for example, being complicated in construction or operation; being wasteful of fuel; affording too rich, or too lean, a mixture under certain engine operating conditions; being inefficient or unreliable in operation, and the like. It is a primary object of my invention to overcome such disadvantages.

In general economizer valves are embodied in carburetors for internal combustion engines to afford supplemental feeding of fuel to an engine in the higher-speed operations thereof, and which supplemental feed is cut off when the engine is idling or cruising under normal road load conditions so as to conserve fuel.

Economizer valves have been heretofore known, and are in use today, which operate in accordance with the degree of vacuum in the intake manifold of the engine, with the strong manifold vacuum, when the engine is idling or cruising under normal road load conditions, or the like, being effective to maintain such valves closed, and with the relatively weak manifold vacuum, when the engine is accelerating or operating at other load conditions greater than normal road load conditions, being ineffective to maintain such valves closed and, therefore, permitting the latter to open and feed supplemental fuel through the carburetor into the engine.

One common disadvantage of such previously known economizer valves is that their operation does not adequately take into consideration the conditions under which the engine, with which they are associated, is operating. Thus, for example, it is common in economizer valves heretofore used to have only two settings of the valve, namely, a fully closed setting and a fully open setting, the fully closed setting being the "idle" setting, and the fully open setting being the "power" setting. With such valves, no effective, if any, metering of fuel between those two settings is afforded. With such an arrangement it is common to find that engines using such valves are being fed too rich a mixture at low-speed, high power, conditions. This is true, for one reason, because with only two settings available namely, an idle setting and a power setting, a choice must be made as to which range of speed of operation of the engine optimum performance is desired. If the single power setting is arranged to afford the ideal amount of fuel flow to the engine at lower speeds of operation, the mixture fed to the engine at higher speeds will be too lean for optimum performance. On the other hand, if the single power setting is arranged to afford the ideal amount of fuel flow to the engine at higher speeds of operation, the mixture fed to the engine at lower speeds will be too rich for optimum performance. Inasmuch as too rich a mixture is, generally, less damaging to an engine and is less disadvantageous than too lean a mixture, the latter operating condition, namely, optimum performance at higher speeds, has

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been heretofore commonly chosen for economizer valves as being the lesser of two evils.

Obviously, with an engine getting too rich a mixture at the lower engine speeds under the aforementioned abnormal load conditions, the engine does not give optimum performance under such conditions so that the accelerating characteristics of the engine under low-speed, abnormal-load conditions such as, for example, when the vehicle is laboring up a steep hill, are less than desirable. This is especially noticeable in heavy trucks, heavy busses, and the like, which, because of their relatively great weight are slow to accelerate.

It is a primary object of my invention to enable the accelerating and power operating characteristics of such internal combustion engines at lower operating speeds thereof to be improved in a novel and expeditious manner.

Another object of my invention is to enable optimum performance of an internal combustion engine to be realized in a novel and expeditious manner at both lower speeds and higher speeds of operation thereof.

It is a common fault of many drivers whether they be driving relatively light vehicles such as automobiles, or relatively heavy vehicles such as large trucks, busses, and the like, to depress the accelerator all the way down, or at least, an excessive amount when desiring to accelerate rapidly, or the like. In most instances, such excessive depression of the accelerator, even without an economizer valve, would cause the carburetor to feed too rich a mixture to the engine for best performance under such low-speed accelerating conditions. In other words, such drivers are often merely defeating their own purpose. Commonly, under such conditions economizer valves of the aforementioned type heretofore known in the art have merely added additional fuel to an already too rich mixture, because the valves, being disposed in the full open position fed considerable quantities of supplemental fuel into the engine. It is an important object of my invention to assist in alleviating, in a novel and expeditious manner, such "too rich" mixture conditions under the aforementioned accelerating operations, and the like.

An ancillary object is to afford a novel economizer valve which may be fully opened under high speed-high power engine operation, but which will automatically be prevented from moving into full open position at low speed engine operation even when the engine is operating under above normal loads.

It is another object of my invention to enable an economizer valve to be controlled in a novel and expeditious manner so as to spread optimum operation of an engine over a relatively large power range.

Another object of my invention is to afford a novel economizer valve the operation of which, between fully closed, partially open and fully open position, may be controlled in a novel and expeditious manner in accordance with a combination of the power load on, and the speed of operation of, the engine with which the valve is associated.

Yet another object of my invention is to afford a novel economizer valve which may be maintained closed by vacuum in the carburetor during idling operation and which is automatically urged toward fully open position under power operation at the higher ranges of engine speed but which is electrically controlled in a novel and expeditious manner from moving to full open position in the lower ranges of speed of operation of the engine.

A further object of my invention is to afford a novel economizer valve which controls the flow of fuel into the cylinders of an engine in accordance with the amount of fuel needed to meet power demands on the engine in a novel and expeditious manner.

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Another object is to afford a novel economizer valve embodying a power valve and electromagnetic controls therefor associated with each other in a novel and expeditious manner.

Another object is to afford a novel vacuum controlled economizer valve embodying a novel power valve having a closed position and a plurality of open positions wherein the power valve is maintained closed by vacuum in the carburetor during idling conditions and is electrically controlled for successive opening under power conditions as the engine speed increases.

Yet another object of my invention is to afford a novel economizer valve which embodies a power valve, actuating mechanism for actuating the power valve, and a solenoid for controlling operation of the actuating mechanism, constituted and arranged in a novel and expeditious manner.

A further object of my invention is to enable an economizer valve, which is responsive to the load conditions under which an engine is operating, to also be controlled in a novel and expeditious manner in accordance with the speed of operation of the engine.

Another object of my invention is to enable an economizer valve to be controlled in a novel and expeditious manner in accordance with the operating speed of the engine with which it is associated, without interfering with any desired closing of the valve under decelerating operations of the engine.

Other and further objects of the present invention will be apparent from the following description and claims and are illustrated in the accompanying drawings which, by way of illustration, show a preferred embodiment of the present invention and the principles thereof and what I now consider to be the best mode in which I have contemplated applying these principles. Other embodiments of the invention embodying the same or equivalent principles may be used and structural changes may be made as desired by those skilled in the art without departing from the present invention.

In the drawings:

Fig. 1 is a side elevational view of an economizer valve embodying the principles of my invention, showing the valve mounted in operative position in a carburetor, with parts of the carburetor shown more or less diagrammatically;

Fig. 2 is a view of the economizer valve shown in Fig. 1, partly in side elevation and partly in section, with the parts of the economizer valve disposed in a position different from that shown in Fig. 1;

Fig. 3 is a view similar to Fig. 2 with the parts of the economizer valve disposed in a still different position;

Fig. 4 is a view similar to Figs. 2 and 3 but with the parts of the economizer valve disposed in the same position as shown in Fig. 1;

Fig. 5 is a detail perspective view of a portion of the economizer valve shown in Fig. 1;

Fig. 6 is a detail sectional view taken substantially along the line 6—6 in Fig. 1; and

Fig. 7 is a wiring diagram.

An economizer valve 10, embodying the principles of my invention, is shown in the drawings mounted in operative position in a carburetor C, Fig. 1, to illustrate the preferred embodiment of my invention. The carburetor C, is shown in the drawings somewhat diagrammatically and embodies a main body member B on which is mounted a cover member M, the cover member M and the body member B defining the fuel chamber or float chamber F of the carburetor C.

A vacuum cylinder V of the carburetor C is formed in the top wall of the cover member M, and may be connected to the manifold of an engine, not shown, with which the carburetor C is to be used, by a suitable manifold vacuum passage P. An economizer well W is formed in the body portion B of the carburetor C below the cylinder V, in axial alignment therewith, and opens

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upwardly into the float chamber F. The well W may be connected to the main well, not shown, of the carburetor C by economizer restriction passages R formed in the main body portion B and extending from the economizer well W, Fig. 1.

It will be appreciated by those skilled in the art that the carburetor C is merely shown by way of illustration and not by way of limitation; that it forms no part of my invention except insofar as it may form a part of my novel combination; and that various carburetors of specifically different construction heretofore known in the art may be used with my novel economizer valve.

In general, the novel economizer valve 10 embodies a power valve 12, a reciprocally mounted actuating piston 14, disposed in position to actuate the power valve 12, a compression coil spring 16 mounted on the actuating piston 14 in position to urge the piston 14 towards actuating engagement with the power valve 12, and a solenoid 18 connected to the piston 14 and operable to control the actuation of the power valve 12 by the piston 14 in accordance with the speed of the engine on which the carburetor C is mounted, all of which will be discussed in greater detail presently.

The power valve 12 embodies a substantially inverted frusto-conically shaped body member 21 having a reduced lower end portion 21a and an enlarged upper head portion 21b. The lower end portion 21a of the body member 21 has external threads 23 formed thereon which are normally engaged in the body portion B of the carburetor C in position to hold the body portion 21 of the power valve 12 in the economizer well W in such position that the enlarged head portion 21b is disposed in engagement with the adjacent portion of the body portion B defining the passageway between float chamber F and the economizer well W, Fig. 1. An elongated passageway 25 extends longitudinally through the body portion 21 of the power valve 12 and has a substantially cylindrical shaped lower end portion 25a, a substantially cylindrical shaped intermediate portion 25b, which is of smaller cross sectional area than the lower end portion 25a, and a substantially cylindrical shaped upper end portion 25c, which is of smaller cross sectional area than the intermediate portion 25b. The progressively reduced cross sectional size of the passageway 25 affords an inwardly projecting shoulder 27a between the lower end portion 25a and the intermediate portion 25b, and another inwardly projecting shoulder 27b between the intermediate portion 25b and the upper end portion 25c of the passageway 25, Fig. 2.

A valve seat 29, in the form of a metal disc having an opening 29a therein, is mounted in the lower end portion 25a of the passageway 25 in abutting relation to the shoulder 27a. The disc 29 is preferably disposed in the passageway 25 with a press fit.

The shoulder 27b, likewise, affords an inwardly projecting valve seat at the lower edge of the upper end portion 25c of the passageway 25 for a purpose which will be discussed in greater detail presently.

Two orifices 31a and 31b extend radially outwardly through the side walls of the body member 21 of the power valve 12 from the intermediate portion 25b of the passageway 25 between the shoulders 27a and 27b, Fig. 2. Similarly, two orifices 33a and 33b extend radially outwardly through the body member 21 of the power valve 12 from the lower end portion 25a of the passageway 25 below the shoulder 27a. The orifices 31a, 31b, 33a, and 33b are so disposed in the main body portion 21 that they open into the economizer well W in the carburetor C when the economizer valve 10 is mounted in operative position in the carburetor.

An elongated valve piston 35, having a lower end portion or stem 37 and an upper end portion or cap 38, is reciprocally mounted in the passageway 25 in the main body member 21 of the power valve 12. The stem 37 has an elongated main body portion 37a from the up-

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per end portion of which a reduced head portion 37b projects upwardly in longitudinal alignment therewith to thereby afford an outwardly facing shoulder 37c at the upper end of the main body portion 37a. A flange 37d projects outwardly from the main body portion 37a and is disposed in the lower end portion 25a of the passageway 25 below the valve seat 29.

The cap member 38 has a reduced upper end portion 38a and an outwardly flaring lower end portion 38b terminating in a substantially annular shaped lower rim 38c. The cap member 38 is hollow, having an elongated recess 38d therein opening downwardly through the annular rim 38c. The recess 38d is of such size and length that the cap member 38 may be slidably mounted on the upper end portion 37b of the stem 37 and is movable downwardly thereon into position wherein the annular rim 38c rests on the shoulder 37c at the upper end of the main body portion 37a of the stem 37. The cap member 38 is mounted in the passageway 25 with the upper end portion 38a thereof projecting outwardly through the upper end portion 25c of the passageway 25, and with the annular rim 38c disposed in the intermediate portion 25b of the passageway 25 below the valve seat 27b.

Two compression coil springs 41 and 42 are mounted on the valve stem 37 in position to yieldingly urge the flange 37d on the valve stem 37 and the annular rim 38c on the cap 38 toward engagement with the valve seats 29 and 27b, respectively. The spring 41 is disposed in the lower end portion 25a of the passageway 25 with the lower end portion of the spring 41 disposed in abutting relation to a retainer plate 44 mounted in the lower end of the lower end portion 25a of the passageway 25, and the upper end portion of the spring 41 disposed in abutting relation to the lower face of the flange 37d. The spring 42 is mounted in the intermediate portion 25b of the passageway 25 with the lower end of the spring 42 disposed in abutting relation to the upper face of the valve seat 29, and the upper end of the spring 42 disposed in abutting relation to the lower face of the cap 38. In normal position of the valve piston 35, that is, when the valve piston 35 is not depressed by external forces, the springs 41 and 42 are effective to yieldingly maintain the flange 37d and the annular rim 38c in sealing engagement with the valve seats 29 and 27b, respectively, to thereby close the passageway 25 between the upper end portion 25c thereof and the orifices 33a and 33b, and between the upper end portion 25c and the orifices 31a and 31b, respectively. When the valve piston 35 is disposed in this position, Fig. 2, the cap 38 is disposed on the upper end portion 37b of the stem 37 in upwardly spaced relation to the shoulder 37c.

With this construction it will be seen that if it is desired to open the passageway 25 between the upper end portion 25c thereof and the orifices 31a and 31b without opening the passageway 25 between the upper end portion 25c and the orifices 33a and 33b, this may be accomplished by moving the cap 38 downwardly on the head 37b of the stem 37 to any position between the position shown in Fig. 2, wherein the annular rim 38c is disposed in engagement with the valve seat 27b, and the position shown in Fig. 3, wherein the annular rim 38c is disposed in engagement with the shoulder 37c on the stem 37. If it is desired to open the passageway 25 between the upper end portion 25c and both of the pairs of orifices 31a and 31b, and 33a and 33b, this may be accomplished by first moving the cap 38a downwardly from the position shown in Fig. 2 to the position shown in Fig. 3, as previously mentioned, and then continue to depress the cap 38 downwardly to thereby press the stem 37 downwardly toward the position shown in Fig. 4 wherein the flange 37d is disposed in downwardly spaced relation to the valve seat 29.

The strength of the two springs 41 and 42 and the relative movement of the cap 38 and the stem 37, dur-

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ing movement of the valve piston 35 from fully closed position as shown in Fig. 2 to fully open position as shown in Fig. 4, is such that during reverse movement of the valve piston 35, that is, during movement from fully open position to fully closed position, the flange 37d moves into sealing engagement with the seat 29 during such upward movement of the valve piston 35, while the cap 38 is still disposed in "open" position as shown in Fig. 3 to thereby afford an intermediate open position for the power valve 12, and the cap 38 then moves from the intermediate open position shown in Fig. 3 to the fully closed position shown in Fig. 2 wherein the annular rim 38c is disposed in sealing engagement with the valve seat 27b.

The power valve 12 is so mounted in the body portion B of the carburetor C that the upper end portion of the cap 38 projects above the body member 21 of the valve 12 and above the economizer well W, Figs. 1-4, in all operative positions of the valve piston 35.

The actuating piston 14 embodies an elongated substantially cylindrical shaped head 46 having an elongated recess 46a disposed longitudinally therein, the recess 46a terminating in spaced relation to the lower end of the head 46 and opening outwardly through the top wall 46b of the head 46 through a reduced opening 46c. An elongated stem 48 projects downwardly from the head 46, and a radially outwardly projecting retainer plate 49 is mounted on the lower end thereof. The stem 48 is slidably mounted in a collar 51 which has external threads 51a formed thereon.

The compression coil spring 16 is mounted on the stem 48 with the lower end portion thereof disposed in abutting engagement with the retainer plate 49 and the upper end portion thereof disposed in abutting engagement with the collar 51. The spring 16 is of such length as to be effective, at all times, to urge the piston 14 downwardly relative to the collar 51, or, in other words, to urge the piston 14 to move longitudinally through the collar 51 in a direction whereby the head 46 of the piston 14 is urged toward engagement with the collar 51.

When the economizer valve 10 is mounted in operative position in the carburetor C, the collar 51 is threadedly engaged in the lower end portion of the vacuum chamber V, Fig. 1, in position to retain the head 46 of the piston 14 within the vacuum chamber V. The head 46 of the actuating piston 14 is disposed in the valve cylinder V with a snug, but freely slidable, fit and is reciprocable longitudinally thereof.

A solenoid 18 having a body portion 18a, a threaded nipple 18b projecting from the body portion, and a plunger 18c projecting outwardly from the body portion 18a through the nipple 18b, is mounted on the cover member M with the nipple 18b threadedly engaged in the upper end portion of the vacuum cylinder V of the carburetor C, Fig. 1. The plunger 18c projects downwardly through the opening 46c into the recess 46a of the actuating piston 14, and has an enlarged outer end portion 18d which is of sufficient size that it may not be withdrawn through the reduced opening 46c in the top wall 46b of the piston 14.

The plunger 18c of the solenoid 18 is reciprocally mounted in the body member 18a for movement between a fully retracted position such as shown in Figs. 2 and 3, and a fully extended position such as shown in Fig. 4. The plunger 18c is spring loaded in the body member 18a for movement into fully extended position when the solenoid 18 is not energized, and is moved into fully retracted position upon energization of the solenoid 18.

A centrifugal switch S, Fig. 7, of any one of several suitable types readily available on the market, is preferably used to control the energization and deenergization of the solenoid 18. The switch S is preferably of the type which is closed at all speeds below a predetermined speed, and is open at such predetermined speed and all speeds thereabove. The switch S may be connected to and op-

erated by any suitable shaft which rotates at all times during operation of the engine such as, for example, the distributor shaft, not shown.

The solenoid 18 may be connected through the switch S to the electrical system of the engine, with which it is associated, in any suitable manner such as, for example, by a circuit, Fig. 7, extending from one terminal 55a of a battery 55, through a line 56, one contact 57a of an ignition switch 57, a line 58, one contact 59a of the switch S, the other contact 59b of the switch S, a line 60, the winding of the solenoid 18, and a line 61 back to the other terminal 55b of the battery 55. With this circuitry for the solenoid 18 it will be seen that the latter is not energized when either the centrifugal switch S, or the ignition switch 57 is open.

The present day internal combustion engines for automotive vehicles, and the like, operate at a relatively wide range of speeds. Thus, for example, when idling, such an engine may operate at a speed wherein the crankshaft thereof is turning at 500 R. P. M. and, when the engine is operating at full speed the crankshaft may be turning at 2700 R. P. M. Normal cruising speed for such an engine might be 2200 R. P. M. It will be appreciated by those skilled in the art that many engines for automotive vehicles, and the like, operate at idling, full speed, cruising speeds, and the like, far different from those set forth above, and that such speeds are set forth herein merely by way of illustration and not by way of limitation.

When such an engine is operating at idling speed the manifold vacuum is relatively high. However, when power is applied to the engine for such purposes as, for example, normal acceleration during starting, pulling up long steep hill, and the like, the manifold vacuum drops considerably. With economizer valves of the previously mentioned type known in the art, wherein control of the economizer valve was entirely through the amount of vacuum in the intake manifold, such operation of the engines often resulted in too rich a mixture being fed to the engine especially at lower engine speeds, with this condition being aggravated, at least, by the opening of the economizer valve. The degree of manifold vacuum varies so greatly under various engine load and engine speed conditions, that attempts to afford effective control over any wide range of engine operating conditions, solely by the changes in manifold vacuum, have been notably unsuccessful.

By my novel invention, I have afforded a novel economizer valve which is controlled by a combination of engine operating characteristics including the load on the engine and the speed of the engine. With my novel invention, control of the opening and closing of the economizer valve may be responsive to variations in manifold vacuum under certain conditions, but the valve is prevented from opening more than a partial amount during lower speed operation of the engine.

The governor switch S may be set to move from closed to open position at any desired speed of crankshaft revolution. Thus, for example, with an engine having the previously mentioned speeds of operation, it may be assumed that it is desirable to have the economizer valve set in such a manner that, with the valve wide open, optimum engine performance will normally be obtained at an engine crankshaft speed somewhere between 2100 R. P. M. and 2700 R. P. M. The governor switch S may then be chosen and set to open at a speed somewhat less than this high speed range, such as, for example, at 2000 R. P. M.

Under these conditions, when the carburetor C is installed on an engine, and the engine is running at the assumed 500 R. P. M. idling speed, the vacuum afforded in the vacuum cylinder V above the head 46 of the actuating piston 14 by the connection of the vacuum cylinder V to the manifold of the engine through the manifold vacuum passage P, Fig. 1, is sufficient to hold the actuating piston 14 in the upwardly disposed position in the vacuum cylinder V, shown in broken lines in Fig. 1,

against the urging of the spring 16. In this position, the retainer plate 49 mounted on the lower end of the stem 48 of the piston 14 is disposed in upwardly spaced relation to the valve piston 35, as shown in Fig. 2, so that the springs 41 and 42 are effective to maintain the valve piston 35 in closed relation to both of the valve seats 29 and 27b. In this position, the enlargement 18d on the lower end portion of the plunger 18c of the solenoid 18 is disposed in downwardly spaced relation to the top wall 46b of the head 46 of the actuating piston 14, Fig. 2.

When power is then applied to the engine on which the carburetor C is mounted so that the engine is accelerated above idling speed, the centrifugal switch S remains closed during the acceleration of the engine between idling speed and 2000 R. P. M. so that the solenoid 18 remains energized. However, during this initial acceleration, the vacuum in the manifold passage P, and, therefore, in the vacuum cylinder V is reduced to a level wherein the vacuum in the cylinder V is no longer effective to hold the actuating piston 14 in raised position against the urging of the spring 16. When this occurs, the spring 16 is effective to move the actuating piston 14 downwardly toward the power valve 12 into position wherein the top wall 46b of the head 46 engages the enlargement 18d on the plunger 18c.

During this movement of the actuating piston 14 the retainer plate 49 thereon moves into engagement with the upper end of the valve piston 35 and presses the valve piston 35 downwardly into intermediate open position shown in Fig. 3 wherein the annular flange 38c is disposed out of engagement with the valve seat 27c, but the flange 37d remains in engagement with the valve seat 29, as previously described. Such movement of the valve piston 35 is effective to open the passageway 25 from the upper end portion 25c thereof to the orifices 31a and 31b so that fuel is fed from the fuel chamber F through the upper end portion 25c of the passage 25, and through the upper end portion of the intermediate portion 25b of the passage 25, outwardly through the orifices 31a and 31b and the economizer restriction passages R, Fig. 1, into the main well of the carburetor C to afford a supplemental flow of fuel to be utilized by the engine during such acceleration. During this initial acceleration of the engine on which the carburetor C is mounted, the solenoid 18 remains energized so that the enlarged portion 18d on the plunger 18c is effective to prevent the actuating piston 14 from moving downwardly beyond this just described intermediate actuating position.

As the engine on which the carburetor C is mounted continues to accelerate, with power being applied thereto, the engine passes through the aforementioned low speed range below 2000 R. P. M. into the aforementioned high speed range. It will be remembered that the governor switch S is so set that when the speed of the engine reaches 2000 R. P. M. the contacts 59a and 59b are opened to thereby de-energize the solenoid 18. Upon de-energization of the solenoid 18 the plunger 18c moves outwardly into fully extended position as shown in Fig. 4.

Such movement of the plunger 18c moves the enlarged free end portion 18d thereon downwardly toward the power valve 18 to thereby permit the spring 16 to further move the actuating piston 14 toward the power valve 12. During this movement of the actuating piston 14, the retainer plate 49 is moved downwardly into engagement with the upper face of the body member 21 of the power valve 12, and such movement of the retainer plate 49 is effective to move the piston 35 downwardly into the aforementioned fully open position wherein the passageway 25 is open between the upper end portion 25c thereof and both pairs of orifices 31a and 31b and 33a and 33b. Such actuation of the power valve 12 is effective to feed an additional supply of fuel from the fuel chamber F through the lower orifices 33a and 33b into the economizer restriction passages R and thus into the main well of the carburetor C to be fed into the engine.

The recess 46a in the head 46 of the piston 14 is of such length that, when the plunger 18c of the solenoid 18 is disposed in fully extended position as shown in Fig. 4, the actuating piston 14 may be moved upwardly into the position shown in Fig. 2 without interference by the plunger 18c. Hence, it will be seen that after the engine on which the carburetor C is mounted has been accelerated into the aforementioned upper speed range and the engine assumes normal road load conditions at which the vehicle is cruising at normal cruising speed under normal cruising conditions, so that the power load on the engine is again reduced to a point wherein the vacuum in the vacuum cylinder V is sufficient to raise the actuating piston 14 upwardly against the urging of the spring 16 from the full actuating position shown in Fig. 4 into either the intermediate actuating position shown in Fig. 3, or the idling position shown in Fig. 2, the piston 14 is free to move upwardly into either of the last two mentioned positions even though the speed of the engine is maintained at a sufficiently high level to maintain the solenoid 18 de-energized.

If, on the other hand, while cruising at the aforementioned normal cruising speed, wherein the engine is operating in the aforementioned high speed range, the vehicle such as an automobile, truck, or the like, in which the engine on which the carburetor C is mounted, encounters abnormal load conditions, such as, for example, a steep hill so that, although the engine is operating in the high power range, it is slowed down below the high speed range, the centrifugal switch S is automatically again closed to thereby energize the solenoid 18 and retract the plunger 18c. Such retraction of the plunger 18c is effective to move the actuating piston 14 upwardly against the urging of the spring 16 from the full actuating position shown in Fig. 4 to the intermediate actuating position shown in Fig. 3 to thereby permit the springs 41 and 42 in the power valve 12 to move the valve piston 35 into intermediate position wherein the supplemental flow of fuel through the orifices 33a and 33b is cut off and the only supplemental flow of fuel through the power valve 12 is through the orifices 31a and 31b.

From the foregoing it will be seen that I have afforded a novel economizer valve which is not solely dependent upon the vacuum pressure effected in the vacuum cylinder V, nor is it solely dependent upon the power load on the engine. I have afforded a novel economizer valve which is responsive to a combination of the vacuum pressure in the vacuum cylinder V, the power load on the engine on which the carburetor is mounted, and the speed of the engine. In this manner, I have afforded a novel economizer valve which effectively meters the supplemental fuel fed to the engine in a manner wherein the amount of such supplemental fuel is reduced at the lower speeds of the engine, and is increased at the higher speeds of the engine, so as to thereby tend to eliminate the feeding of a large amount of fuel to an engine at lower idling speeds, when a larger amount of fuel affords too rich a mixture, and to feed a greater amount of fuel at the higher speeds wherein the engine is operating at a sufficient speed to handle the greater amount of fuel without overly enriching the mixture fed to the engine. With my invention this may be done without endangering the engine being so operated by affording too lean a mixture at the higher operating speeds thereof.

Also it will be seen that I have afforded a novel economizer valve which, although it is electrically controlled in accordance with the speed of the engine, such control does not interfere in any way with reducing the amount of fuel fed to the carburetor, and thus to the engine, by "letting up" on the accelerator, no matter what the speed of the engine.

Also, it will be seen that I have afforded an economizer valve which meters the amount of supplemental fuel fed through the carburetor in a novel and expeditious manner so that the range of engine speed at which optimum per-

formance of the engine is realized is considerably extended over that of engines having carburetors embodying the aforementioned economizer valves heretofore known in the art.

Also it will be seen that I have afforded a novel economizer valve which may be readily and economically produced commercially and may be relatively easily embodied in carburetors of a type in common use today with a minimum of modification.

Thus, while I have illustrated and described the preferred embodiment of my invention, it is to be understood that this is capable of variation and modification.

I claim:

1. An economizer valve for carburetors comprising a power valve having a fuel passage including an inlet, two orifices in communication with said fuel passage in spaced relation to each other, and a valve member movable in said passage to open and close said passage between said inlet and said orifices, and means for controlling movement of said valve member in said passageway, said means comprising a second member movable into two positions relative to said power valve, said second member, when disposed in one of said positions, being disposed in position relative to said power valve to disposed said valve member in such position in said passage to open said passage between said inlet and one of said orifices, said second member, when disposed in the other one of said positions being disposed in position relative to said power valve to dispose said valve member in such position in said passage to open said passage between said inlet and both of said orifices, and electromagnetic means connected to said second member in position to hold the latter out of said second position when said electromagnetic means are energized and to free said second member for movement into said second position when said electromagnetic means are de-energized.

2. In a carburetor of the type embodying a main fuel passage, an auxiliary fuel passage for feeding supplemental fuel into said main fuel passage, and a vacuum cylinder, valve means mounted in position to feed fuel into said auxiliary fuel passage, and means for selectively controlling said valve means for thereby selectively controlling the flow of fuel therethrough into said auxiliary fuel passage, said second mentioned means comprising an elongated piston projecting outwardly from said valve means and movable longitudinally into and out of a position to fully open said valve means, a spring connected to said piston and urging said piston toward said position, said piston being reciprocally mounted in said cylinder outwardly of said valve means in position to be so subjected to vacuum in said cylinder as to hold said piston, against said urging of said spring, out of position to open said valve means when a predetermined degree of evacuation is effected in said cylinder, and a solenoid connected to said piston in position to hold said piston out of said first mentioned position when said solenoid is energized and to free said piston for movement into said first mentioned position when said solenoid is not energized.

3. In a carburetor of the type embodying a main fuel passage, an auxiliary fuel passage for feeding supplemental fuel into said main fuel passage, and a vacuum cylinder, valve means mounted in position to feed fuel into said auxiliary fuel passage, and means for selectively controlling said valve means for thereby selectively controlling the flow of fuel therethrough into said auxiliary fuel passage, said second mentioned means comprising an elongated piston reciprocally mounted in said cylinder for longitudinal reciprocation between a position wherein said piston is ineffective to open said valve means and a second position wherein said piston is effective to fully open said valve means, a spring urging said piston toward said second position, said piston being disposed in said cylinder in position to be so subjected to vacuum in said cylinder as to hold said piston in said one position when said cylinder is evacuated to a predetermined extent, and

means for releasably holding said piston in a position intermediate to said two positions, said last named means comprising an electrically operable plunger movably connected to said piston.

4. An economizer valve for carburetors comprising a valve for feeding fuel, means in said valve urging said valve toward closed position, and means for opening said valve, said last named means comprising actuating means movable into position relative to said valve to open the latter, means yieldingly urging said actuating means toward said position, and a solenoid connected to said actuating means in position to control movement of said actuating means toward said position.

5. An economizer valve for carburetors comprising a valve for feeding fuel, means in said valve urging said valve toward closed position, and means for opening said valve, said last named means comprising actuating means movable along a path of travel from one position wherein said actuating means is ineffective to open said valve to a second position wherein said actuating means is effective to open said valve, and means, including a solenoid, for controlling said movement of said actuating means, said solenoid being connected to said actuating means in position to limit movement of said actuating means to an intermediate position along said path between said first two mentioned positions when said solenoid is energized and to free said actuating means for movement to said second position when said solenoid is de-energized.

6. An economizer valve for carburetors comprising a valve for controlling the flow of fuel, said valve being movable from a closed position through one open position into another open position, and means for moving said valve from said closed position into said open positions, said means comprising actuating means movable from a first position, wherein said actuating means is ineffective to open said valve, through a second position, wherein said actuating means is effective to dispose said valve in said one open position, to a third position, wherein said actuating means is effective to dispose said valve in said other open position, and means, including a solenoid, for controlling said movement of said actuating means, said solenoid being connected to said actuating means in position to limit movement of the latter to movement between said first position and said second position when said solenoid is energized and to permit said actuating means to move between said second position and said third position when said solenoid is de-energized.

7. An economizer valve for carburetors comprising a valve for controlling the flow of fuel, said valve being movable from a closed position through an intermediate open position into a fully open position, means yieldingly urging said valve toward said closed position, and means for moving said valve between said closed position and said open positions, said last named means comprising actuating means movable from a first position, wherein said actuating means is ineffective to dispose said valve in either of said open positions, through a second position, wherein said actuating means is effective to dispose said valve in said intermediate open position, to a third position, wherein said actuating means is effective to dispose said valve in said fully open position, and means, including a solenoid, for controlling said movement of said actuating means, said solenoid including a plunger movable between an actuated position and an unactuated position, said plunger being disposed in said unactuated position when said solenoid is de-energized, and being disposed in said actuated position when said solenoid is energized, said plunger being connected to said actuating means in position to limit movement of the latter to movement between said one position and said second position when said plunger is disposed in said actuated position, and to free said actuating means to move between said second position and said third position when said plunger is disposed in said unactuated position.

8. An economizer valve for carburetors comprising a

valve for controlling the flow of fuel, said valve being movable from a closed position through an intermediate open position into a fully open position, means yieldingly urging said valve toward said closed position, an elongated plunger, supporting means disposed on said plunger in position to support the latter for reciprocation along a path of travel toward and away from said valve, said plunger being movable through said supporting means along said path of travel from a first position, wherein said plunger is ineffective to dispose said valve in either of said open positions, through a second position, wherein said plunger is effective to dispose said valve in said intermediate position, to a third position wherein said plunger is effective to dispose said valve in said full open position, and means including a solenoid, for controlling said movement of said plunger, said solenoid being connected to said plunger in position to selectively limit movement of the latter from said first position to said second position and said third position.

9. An economizer valve for carburetors comprising valve means having an inlet connected to two spaced orifices by a passageway, a valve mounted in said passageway and movable therein between a position to close said passageway between said inlet and said orifices and two other positions, said valve, when disposed in one of said two other positions, being effective to open said passageway between said inlet and one of said orifices and, when disposed in the other of said two other positions, being effective to open said passageway between said inlet and the other of said orifices, an elongated plunger having a piston on one end and an abutment on the other end, means mounted on said plunger in position to support the latter for reciprocation along a path of travel toward and away from said valve, said plunger being movable along said path of travel from a first position, wherein said abutment is engaged with said valve in position to hold said valve in said other of said two positions, through a second position, wherein said abutment is engaged with said valve in position to hold said valve in said one of said two positions, to a third position, wherein said plunger is disposed in such position as to permit said valve to occupy said closed position, and means, including said piston and a solenoid, for controlling said movement of said plunger, said solenoid having a plunger normally disposed in one position when said solenoid is de-energized and disposed in another position when said solenoid is energized, said last mentioned plunger being connected to said first mentioned plunger in position to hold said first mentioned plunger from moving from said second to said first position when said plunger of said solenoid is disposed in said other position, and to free said first mentioned plunger for movement between said first and third position when said plunger of said solenoid is disposed in said one position.

10. An economizer valve for carburetors comprising valve means having an inlet connected to two spaced orifices by a passageway, a valve mounted in said passageway and movable therein between a position to close said passageway between said inlet and said orifices and two other positions, said valve, when disposed in one of said two positions, being effective to open said passageway between said inlet and one of said orifices and, when disposed in the other of said two positions, being effective to open said passageway between said inlet and the other of said orifices, an elongated plunger having a piston on one end and an abutment on the other end, means mounted on said plunger in position to support the latter for reciprocation along a path of travel toward and away from said valve, said plunger being movable along said path of travel from a first position, wherein said abutment is engaged with said valve in position to hold said valve in said other of said two positions, through a second position, wherein said abutment is engaged with said valve in posi-

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tion to hold said valve in said one of said two positions, to a third position, wherein said plunger is disposed in such position as to permit said valve to occupy said closed position, a spring mounted between said supporting means and said abutment and urging said plunger to move in a direction from said third position toward said first position, and means, including said piston and a solenoid, for controlling movement of said plunger, said solenoid being connected to said plunger to selectively limit movement of the latter to movement between said third position and said second position when said solenoid is energized, and to permit movement of said plunger between said second position and said first position when said solenoid is de-energized.

11. An economizer valve for carburetors comprising valve means having an inlet connected to two spaced orifices by a passageway, a valve mounted in said passageway and movable therein between a position to close said passageway between said inlet and said orifices and two other positions, said valve, when disposed in one of said two positions, being effective to open said passageway between said inlet and one of said orifices and to close said passageway between said inlet and the other of said orifices and, when disposed in the other of said two positions, being effective to open said passageway between said inlet and both of said orifices, an elongated plunger, means mounted on said plunger in position to support the latter for reciprocation along a path of travel toward and away from said valve, said plunger being movable along said path of travel from a first position, wherein said plunger is engaged with said valve in position to hold said valve in said one of said two positions, to a third position, wherein said plunger is disposed in such position relative to said valve as to permit said valve to occupy said closed position, and means for controlling said movement of said plunger, said last named means including a solenoid connected to said plunger in position to limit movement of the latter to movement between said third position and said second position when said solenoid is energized and to permit said plunger to move to said one position when said solenoid is deenergized.

12. An economizer valve for carburetors comprising valve means for feeding fuel therethrough, said valve means having a fully closed position, a partially open position, and a fully open position, an elongated plunger having a piston on one end and an abutment on the other end, means mounted on said plunger in position to support the latter for reciprocation along a path of travel toward and away from said valve means, said plunger being movable along said path of travel from a first position, wherein said plunger is engaged with said valve means in position to hold said valve means in said fully open position, through a second position, wherein said plunger is engaged with said valve means in position to hold said valve means in said partially open position, to a third position, wherein said plunger is disposed in position relative to said valve means to permit said valve means to occupy said closed position, and means, including said piston and a solenoid, for controlling said movement of said plunger, said solenoid having a movable member reciprocable upon energization and de-energization of said solenoid and slidably connected to said plunger in position to selectively limit movement of said plunger between said third position and said second and first positions.

13. In a carburetor having a vacuum cylinder subjected to greater vacuum under idling conditions than under loaded power conditions, a piston mounted in said cylinder for reciprocation into and out of said cylinder, a spring connected to said piston and urging said piston out of said cylinder, said spring being ineffective to move

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said piston out of said cylinder under said idling conditions and being effective to move said piston out of said cylinder along a path of travel under said loaded power conditions, valve means for feeding fuel in said carburetor, said valve means being movable between fully closed position, a partially open position, and a fully open position, said valve means being mounted in said path of travel of said piston and being movable therewith between said closed position and said fully open position during movement of said piston through said path of travel, and a solenoid mounted on said piston in position to selectively limit said movement of said piston along said path of travel independently of the vacuum in said cylinder.

14. In a carburetor having a vacuum cylinder subjected to greater vacuum under idling conditions than under predetermined power conditions, a piston mounted in said cylinder for reciprocation into and out of said cylinder, a spring connected to said piston and urging said piston out of said cylinder, said spring being ineffective to move said piston out of said cylinder under said idling conditions and being effective to move said piston out of said cylinder along a path of travel under said power conditions, valve means for feeding fuel in said carburetor, said valve means being movable from a fully closed position through a partially open position to a fully open position, said valve means being mounted in said path of travel of said piston and being movable therewith between said closed position and said fully open position during movement of said piston through said path of travel, and means including a solenoid, for controlling movement of said piston along said path of travel to thereby control movement of said valve means between said closed position and said open positions, said solenoid including a plunger having an actuated and unactuated position, said plunger being connected to said piston in position to limit movement of the latter to movement between one end of said path of travel and an intermediate portion of said path of travel when said plunger is disposed in said actuated position, and to free said piston for movement between the other end of said path of travel and an intermediate portion of said path of travel when said plunger is disposed in said unactuated position.

15. In a carburetor having a vacuum cylinder subjected to greater vacuum under idling conditions than under power conditions, a piston mounted in said cylinder for reciprocation into and out of said cylinder, a spring connected to said piston and urging said piston out of said cylinder, said spring being ineffective to move said piston out of said cylinder under said idling conditions and being effective to move said piston out of said cylinder along a path of travel under power conditions, valve means for feeding fuel in said carburetor, said valve means being movable from fully closed position through a partially open position to a fully open position, said valve means being mounted in said path of travel of said piston and being movable thereby between said closed position and said fully open position during movement of said piston through said path of travel away from said cylinder, and means, including a solenoid, for controlling movement of said piston, said solenoid including a plunger having an actuated and an unactuated position, said plunger having an abutment member thereon slidably mounted in said piston in position to holdingly engage said piston when the latter moves from fully retracted position in said cylinder to the partially extended position effective to move said valve to said partially open position when said plunger is in said actuated position, said abutment being positioned in said piston to permit the latter to move between said partially extended position and fully extended position when said plunger is disposed in said unactuated position.

16. In an engine operable at idling speeds, and two power speeds, one of said power speeds being between said idling speed and the other of said power speeds, and

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said engine having a carburetor having a vacuum cylinder subjected to greater vacuum at said idling speed of said engine than at said power speeds, an elongated piston slidably mounted in said cylinder for longitudinal reciprocation into and out of said cylinder along a predetermined path of travel, a spring mounted on said piston and urging said piston out of said cylinder along said path of travel, said spring being ineffective to move said piston out of said cylinder, when said piston is subjected to said vacuum in said cylinder at said idling speed of said engine, and being effective to move said piston out of said cylinder along said path of travel at said power speeds of said engine, a solenoid including an elongated plunger having a free end portion, said solenoid being mounted in position wherein said plunger is disposed in said cylinder in axial alignment with said piston with said free end portion slidably mounted in said piston, said plunger having an actuated position and an unactuated position, said free end portion being disposed in position to limit movement of said plunger along said path of travel to movement between fully retracted position in said cylinder and a partially extended position, when said plunger is in said actuated position, and to permit movement of said piston along said path of travel between said fully retracted position and fully extended position when said plunger is in said unactuated position, means connected to said motor and said solenoid for actuating the latter, said means being effective to energize said solenoid when said motor is operating at a speed between said idling speed and said one power speed, and being ineffective to energize said solenoid when said engine is operating at a speed between said power speeds, and a valve for metering fuel in said carburetor, said valve being closed when said piston is in fully retracted position, said valve being mounted in said path of travel of said piston in position to be partially opened by said piston when said piston is disposed in said partially extended position, and to be fully opened when said piston is in said fully extended position.

17. An economizer valve for a carburetor comprising a power valve having an inlet connected to two orifices by an elongated passageway, said orifices being spaced from

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each other longitudinally of said passageway, two valve seats spaced from each other longitudinally of said passageway, one of said valve seats being disposed between one of said orifices and said inlet, the other of said valve seats being disposed between said two orifices and between the other of said two orifices and said inlet, a valve piston reciprocally mounted in said passageway and movable into and out of closing relation to said valve seats, spring means engaged with said piston normally holding said piston in said closed position, and means for successively moving said piston into open position relative to said one valve seat and then into open position relative to both of said valve seats, said last named means comprising actuating means engageable with said piston for moving the latter from said closed position to said open positions in accordance with the amount of vacuum in the carburetor, and a solenoid connected to said actuating means for selectively controlling movement of the latter and thereby controlling movement of said piston.

18. An economizer valve as defined in claim 17 and in which said actuating means comprises an elongated piston slidably mounted for reciprocation along a predetermined path of travel and engageable with said valve piston for moving said valve piston between said closed position and said open position relative to both said valve seats during said movement in one direction along said path of travel, and a spring connected to said elongated piston and urging said elongated piston to move in said one direction, and in which said solenoid includes a plunger connected to said elongated piston with a lost-motion connection, said plunger having an actuated and an unactuated position.

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