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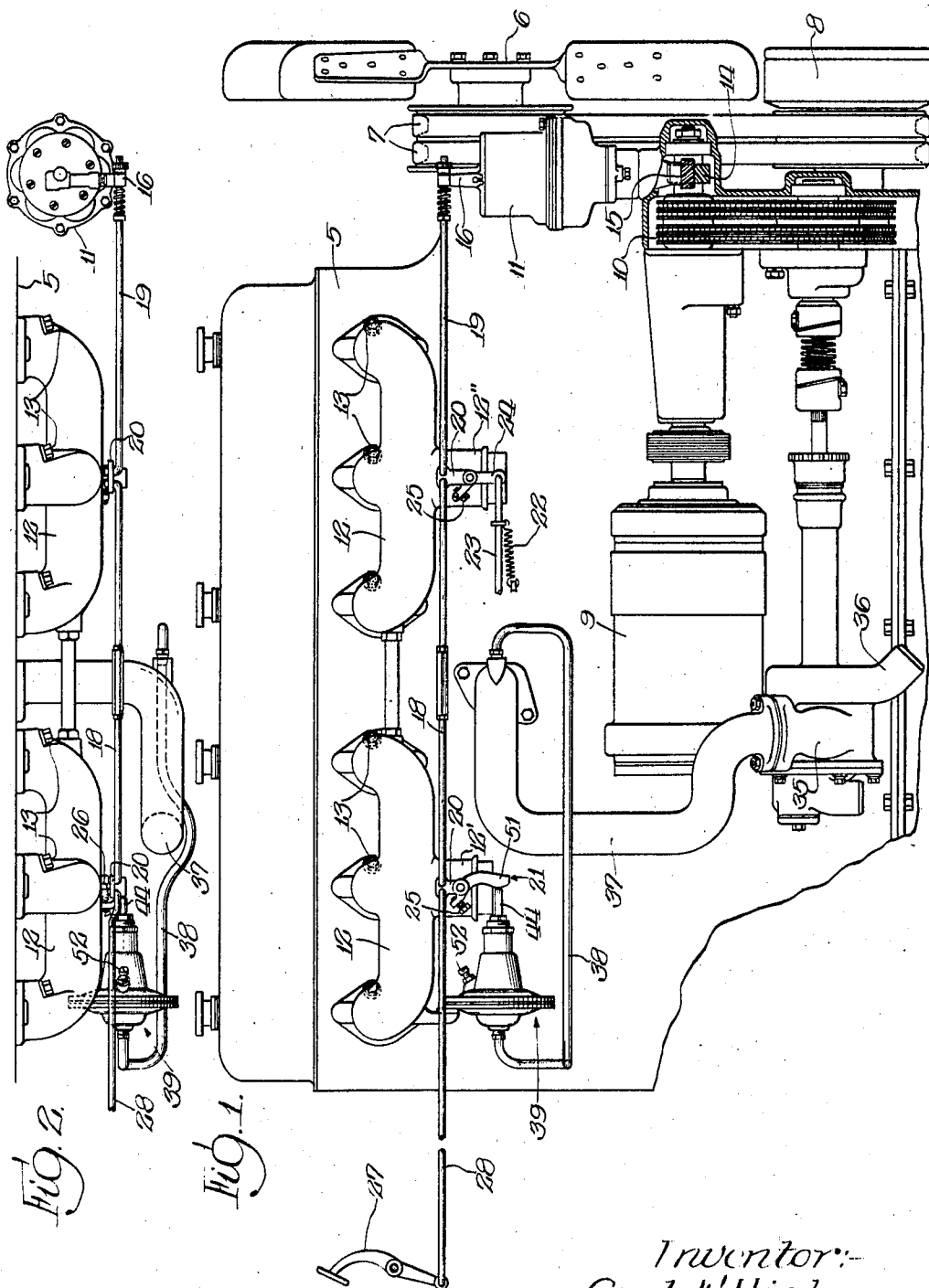
C. F. HIGH

2,131,950

FUEL FEEDING SYSTEM FOR INTERNAL COMBUSTION ENGINES

Filed Nov. 11, 1936

3 Sheets-Sheet 1



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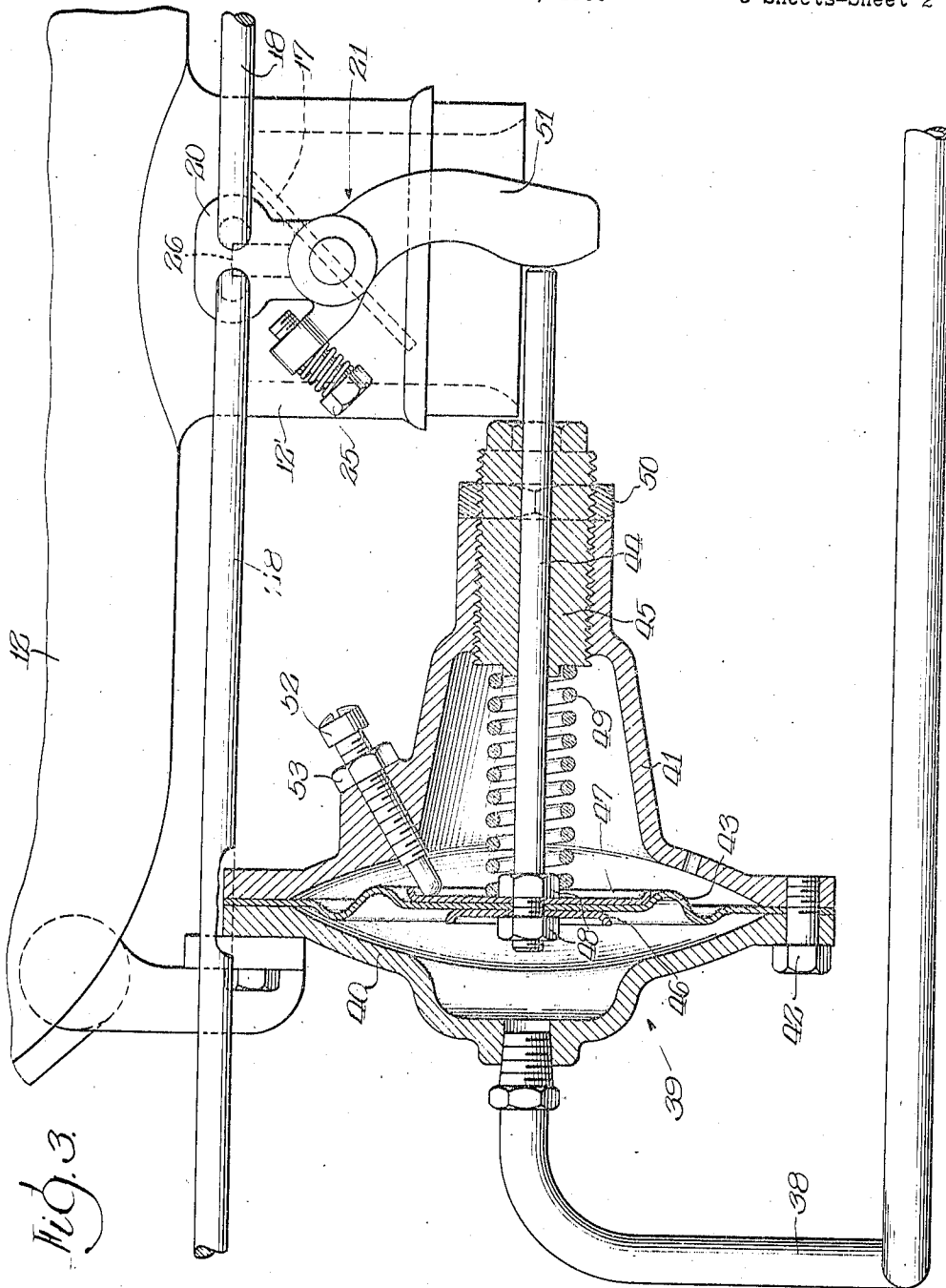
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FUEL FEEDING SYSTEM FOR INTERNAL COMBUSTION ENGINES

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3 Sheets-Sheet 2



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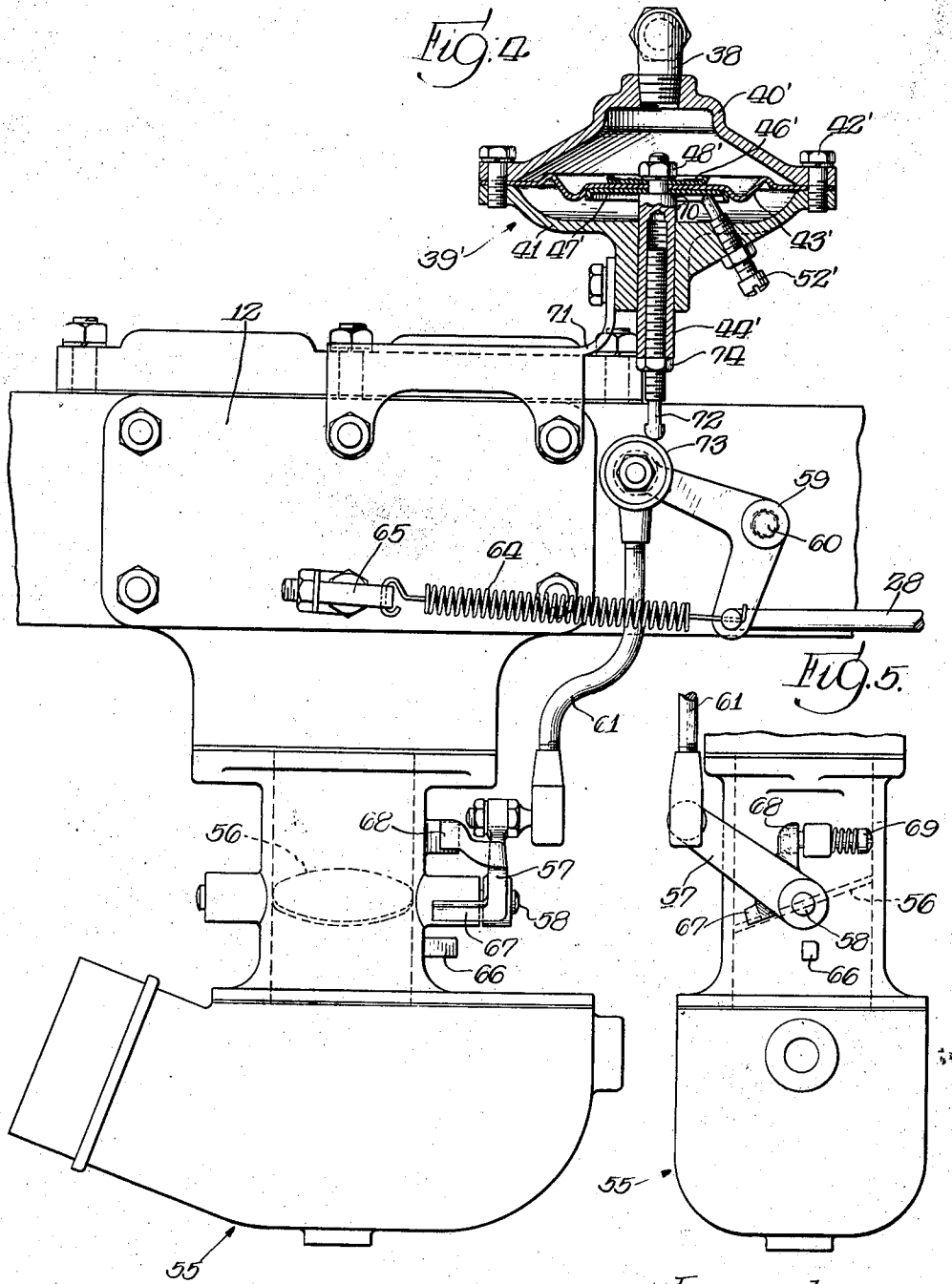
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FUEL FEEDING SYSTEM FOR INTERNAL COMBUSTION ENGINES

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3 Sheets-Sheet 3



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UNITED STATES PATENT OFFICE

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FUEL FEEDING SYSTEM FOR INTERNAL COMBUSTION ENGINES

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24 Claims. (Cl. 123—103)

The invention relates generally to internal combustion engines and more particularly to a new and improved fuel feeding system therefor.

Fuel is generally supplied to internal combustion engines (particularly those of the spark ignition type as used in present day automotive vehicles) by means including either a carburetor or a fuel injector. When a system including a carburetor is employed, a throttle valve is customary which controls the mixture of fuel and air in its passage to the engine cylinders. When a system including a fuel injector is employed, the throttle valve of the carburetor is generally replaced by an air throttle valve and a liquid fuel control or metering device, the air throttle valve and the liquid fuel metering device preferably being operated in unison by a single control element so that the fuel-air ratio is properly maintained.

Whether an internal combustion engine is supplied with fuel through a carburetor or by means of a fuel injection system, it has been found that under certain circumstances a considerable quantity of smoke and obnoxious gases and odors are discharged from the exhaust manifold and create an obnoxious and unhealthful condition around the vehicle in which the engine is mounted. This condition exists particularly when, with the vehicle in motion, the throttle valve is suddenly closed either for the purpose of shifting gears or for slowing down. The condition is created under those circumstances because the throttle valve closes immediately, cutting off the supply of air, and the high speed of the engine then creates a high vacuum in the engine cylinders and the passages leading thereto with the result that lubricant is drawn into the cylinders past the piston rings and the valves and the wet fuel film along the intake manifold walls is flashed while insufficient air is admitted to produce a combustible mixture. As a result the fuel and lubricant are only partially burned, if at all, and then discharged as smoke and nauseating odors and gases. It is to the solution of this smoke and odor problem that the invention herein is particularly directed.

It is the general object of the invention to provide a new and improved fuel feeding system wherein the smoke and attendant odorous gases are eliminated.

It is another object of the invention to provide means for retarding the closing of the throttle valve of a fuel feeding system for an internal combustion engine so that the decrease in air supplied to the engine cylinders is in

proportion to the decrease in speed in the engine, thus providing sufficient air for proper combustion during deceleration.

Yet another object of the invention is to provide means for controlling the last portion of the closing movement of the throttle of a fuel feeding system for an internal combustion engine so that the rate of closing movement is proportional to the rate of deceleration of the engine but in advance thereof.

A more particular object of the invention is to provide a governor mechanism operated by the engine and incorporating a control element effective to retard the closing of the throttle when released by an operator.

A still further object of the invention is to provide a control mechanism for retarding the closing of the throttle governed by a diaphragm subjected to the pressure of the cooling water circulating pump of the engine, the water pump generally provided with such an engine producing a pressure which varies with the engine speed.

Other objects and advantages will become apparent from the following detailed description taken in connection with the accompanying drawings, in which:

Fig. 1 is a fragmentary side elevational view partially in section of an internal combustion engine having a fuel feeding system embodying the features of the invention.

Fig. 2 is a top plan view of the fuel feeding system shown in Fig. 1.

Fig. 3 is an enlarged, fragmentary view of a portion of the fuel feeding system, with the pressure responsive device in section.

Fig. 4 is a view showing a modified form of pressure responsive device employed with a fuel feeding system of the carburetion type.

Fig. 5 is a fragmentary side elevational view taken from the right in Fig. 4.

While the invention may be embodied in a variety of fuel feeding systems for an internal combustion engine, one form is for purposes of disclosure herein shown and will hereinafter be described as embodied in a fuel feeding system of the injection type. Herein such a system is shown supplying fuel to an internal combustion engine 5 (for driving a vehicle not shown) having the usual fan 6 driven by means of belts 7 from the crank shaft 8 and a generator 9 driven from the crank shaft by means of a chain drive 10. In a fuel feeding system of the injection type, fuel is supplied to the internal combustion engine in metered quantities and under pressure by

means of a fuel injector 11 and air is supplied to form a combustible mixture with the fuel through an intake manifold 12 which herein is shown divided into two sections each having an air intake, 12' and 12'', respectively. The fuel injector 11, as more particularly described and claimed in my Patent No. 1,931,543, issued October 24, 1933, usually comprises a plurality of individual pumps connected by suitable conduits (not shown) to fuel injection valves 13 discharging directly to the intake passage of each cylinder of the engine. The injector 11 is driven in proper timed relation with the reciprocations of the engine pistons through the chain drive 10 and gears 14 and 15 to insure injection of the fuel at the proper point in the engine cycle.

The quantity of fuel supplied to the engine is controlled by metering means, constituting a part of the injector, actuated by an arm 16, while the quantity of air supplied is controlled by a throttle valve 17 located in each of the air intakes 12' and 12''. To insure a proper ratio of fuel to air with all quantities of fuel injected, the throttle valve 17 and the fuel metering means are connected to operate in unison by means of rods 18 and 19. Rod 18 coordinates the valves 17 and to that end is pivotally connected at its ends in upward extensions 20 of a control arm generally designated 21 rigidly fixed on the projecting end of the shaft of each throttle valve. Rod 19 coordinates the movements of the valves and the metering means and at one end is pivotally connected to the extension 20 of the control arm of the valve in the intake 12'' and at the other end has a suitable yieldable connection with the arm 16. Both throttle valves, as well as the fuel metering means, are urged to closed position by means of a spring 22 having one end anchored on a stationary portion of the engine and the other end adjustably connected to a rod 23 secured to a downward extension 24 of the control arm for the throttle valve in the intake 12''. Such closing movement is limited to an idle position by engagement of an idle adjusting screw 25 carried by the arm 21 with a fixed idle stop 26. Manual means is provided for opening the throttle valves and the fuel metering means which herein is shown as a foot actuated accelerator pedal 27 connected to the valves and the fuel metering means by a rod 28.

Means is provided for eliminating the condition, previously described, resulting in the discharge of smoke and obnoxious and nauseating gases upon deceleration of the engine. This means functions to eliminate that condition by retarding the closing movement of the throttle or throttles when the manual means for opening the same is released. In order that the retardation may not, for one rate of deceleration, be so great as to prevent proper deceleration of the engine and, for another rate, be so little as to be practically ineffective, the means controls the closing movement of the throttle in accordance with the deceleration of the engine but in advance thereof. By that is meant, the throttle is always permitted to close to a position such that the flow of combustible mixture would only maintain an engine speed less than the then speed of the engine. This differential may be approximately 10 miles per hour. Under such conditions, if the vehicle driven by the engine is travelling at 40 miles per hour and the manual throttle opening means released, the means immediately permits the throttle to close to a position normally producing a speed of 30 miles per

hour, then as the engine speed is reduced further the throttle is closed so that when the engine speed reaches 30 miles per hour the throttle is at a 20 mile per hour position. This progressive closing of the throttle with the rate of deceleration of the engine continues until the fixed idle position of the throttle is reached.

To obtain such progressive closing movement at a rate proportional to the rate of deceleration of the engine but in advance thereof, the means is in the nature of a governor responsive to the speed of the engine. Herein a device which is a normal accessory of most engines, namely, the cooling water circulating pump 35 is utilized. As shown in the drawings, the pump 35 is driven in direct timed relation with the engine through the chain drive 10 and draws water from the water jackets of the engine block through an intake conduit 36 and discharges the water to the jackets through a conduit 37. The speed of the pump therefor varies directly with the speed of the engine and, as a result, the pressure in the discharge conduit 37 also varies directly with the speed of the engine and substantially independently of the temperature.

Tapped into the conduit 37, at a point near the attachment of the conduit to the engine block, is a tube 38 which, at its other end, communicates with a pressure responsive device generally designated 39. This device has a casing composed of separable and complementary sections 40 and 41 (see Fig. 3) secured together by bolts 42. Clamped between the sections is a flexible diaphragm 43 which has secured thereto a rod 44 projecting outwardly slidably through a bearing and spring seat member 45 threaded into the section 41. Preferably the attachment of the rod 44 to the diaphragm 43 is made more secure by means of disks 46 and 47 which are placed on opposite sides of the diaphragm and which are securely clamped to the diaphragm by nuts 48 threaded onto the end of the rod extending through the diaphragm. Movement of the rod outwardly of the device 39 under the influence of water pump pressure diaphragm 43 of fixed diameter, designed for any specific case, is opposed by a compression spring 49 seated at one end on the member 45 and at the other end on the disk 47. The tension of the spring may be adjusted to a proper value by rotation of the member 45 and the member then locked in adjusted position by means of a nut 50.

The device 39 is mounted on the engine block in a position such that the projecting end of the rod 44 is disposed in the path of an extension 51 of the arm 21 of the throttle valve in the intake 12' to be abutted thereby in the closing movement of the throttle. Thus, when the accelerator pedal 27 is released and the throttles freed to the control of the spring 22, tending to close the same immediately, the extension 51 strikes the rod 44 and thereby temporarily arrests the closing movement of the throttles. Thereafter the rate of closing movement of the throttles is determined by the rate of deceleration of the engine which is reflected in a drop in pressure in the conduit 37, with a corresponding movement of the rod 44 as the pressure is overcome by the spring 49.

It was found that only the last portion of the closing movement of the throttle need be retarded in order to eliminate the discharge of smoke and obnoxious gases and odors, and that the total closing time could be reduced by permitting unrestricted closing during the first por-

tion of the closing movement. To that end, means is provided to limit the control of the governing means to the last portion only of the closing movement of the throttle. Herein that means takes the form of an adjusting screw 52 threaded into the section 41 in a position to abut the disk 47 and thereby determine the extent of outward movement of the rod 44. By adjusting the screw 52 into or out of the casing, the point in the closing movement of the throttle at which the rod 44 becomes effective may be varied and the extent of the controlled portion of the closing movement determined. The screw 52 may be locked in adjusted position by means of a nut 53.

The operation of this new and improved fuel feeding system may be briefly summarized in the following manner: Assume that the engine is rotating at a vehicle speed of approximately 45 miles per hour with the accelerator 27 held to open the throttles to an extent sufficient to maintain that speed. The accelerator is then suddenly released by the operator of the vehicle with which the engine is associated. Upon such release of the accelerator, the throttles are permitted to close unretarded and uncontrolled for the first portion of the closing movement. The exact position to which they may close will vary with the adjustment made on each system by the screw 52, but may, for example, be assumed to be a position which would maintain a vehicle speed of 25 miles per hour. At that position of the throttles, the extension 51 abuts the end of the rod 44 and thereafter the closing movement is controlled by the pressure responsive device 39. The device 39, as previously explained, is adjusted to permit closing of the throttle in advance of the deceleration of the engine but at a rate comparable therewith. Thus as the engine slows down, the throttles close progressively and at a rate comparable with the rate of deceleration of the engine. Such delayed and controlled closing movement of the throttles continues until the throttles are arrested by the fixed idle stop 26. By such control of the last portion of the closing movement of the throttles combustible mixture is always supplied to the engine resulting in a clean burning and an absence of smoke and obnoxious fumes and odors.

In Figs. 4 and 5 there is shown a pressure responsive device 39' of modified construction incorporated as part of a fuel feeding system of the carburetor type. Such a system herein comprises a carburetor, generally designated 55, functioning in well-known manner to supply a combustible mixture of fuel and air to the intake manifold 12. The flow of combustible mixture from the carburetor to the intake manifold is controlled by a throttle valve 56 having a control arm 57 fixed on the projecting end of the throttle valve shaft 58. The throttle valve 56 is opened manually by actuation of the accelerator pedal 27 (see Fig. 1) operatively connected with the throttle through the rod 28, a bell crank lever 59, pivotally mounted at 60, and a link 61. Upon release of the accelerator pedal 27, the throttle valve is urged to closed position by a tension spring 64, one end of which is attached to the bell crank lever 59 at the point of connection of the rod 28, and the other end of which is anchored in a screw 65 adjustably mounted on the intake manifold. Opening movement of the throttle is limited by a lug 66 disposed in the path of a lateral extension 67 on the arm 57 and the idling position of the throttle 56 is deter-

mined by the abutment of a second lateral extension 68 with an adjusting screw 69.

The pressure responsive device 39' has a casing composed of separable and complementary sections 40' and 41' secured together by bolts 42'. Clamped between the sections is a flexible diaphragm 43' which has secured thereto a rod 44' projecting outwardly slidably through the section 41'. Preferably the attachment of the rod 44' to the diaphragm 43' is made more secure by means of disks 46' and 47' which are placed on opposite sides of the diaphragm and which are securely clamped to the diaphragm between a shoulder 70 on the rod 44' and a nut 48' threaded onto the reduced end of the rod 44' extending through the diaphragm. The chamber defined by the section 40' and the diaphragm 43' still communicates through the tube 38 with the conduit 37 (see Fig. 1) leading from the water pump 35 to the engine block. Outward movement of rod 44' as a result of pressure on the diaphragm 43' is limited by an adjustable screw 52'.

A bracket 71 bolted to the intake manifold 12 supports the device 39' with the rod 44' in the path of movement of the arm of the bell crank 59 to which the link 61 is attached. To make the connection between the bell crank and the device 39' adjustable, the rod 44 is hollow and has threaded thereinto a stem 72 adapted to abut the edge of a washer 73 carried on the end of the bell crank. The stem 72 is secured in adjusted position by a nut 74.

It will be apparent from the foregoing that the device 39' is without spring means opposing the movement of the diaphragm 43' by pressure. The diaphragm 43' is, of course, urged in a direction counter to the pressure by the spring 64 during the last portion of the closing movement of the throttle valve 56. The spring 64, however, is overcome manually by the actuation of the accelerator pedal 27 to open the throttle, thereby leaving the device 39' free and unrestrained to respond immediately to any rise in pressure. This unrestrained movement of the diaphragm 43' is very desirable and assures that the device 39' will be effective to control the closing movement of the throttle even under an extreme condition of rapid acceleration and then immediate deceleration. The operation of the device in other respects is the same as that of the device disclosed in Figs. 1 to 3, namely, it controls the last portion of the closing movement of the throttle in a manner to assure a combustible mixture during deceleration and thereby avoid the obnoxious odors and gases commonly present at such times.

I claim as my invention:

1. In a fuel feeding system for an internal combustion engine, a throttle biased to closed position, manual means for opening the throttle, and governor means for controlling the last portion of the closing movement of said throttle upon release of said manual means, said governor means being responsive to the speed of the engine with which the system is associated and causing said throttle to close progressively with but in advance of deceleration of the engine.

2. In a fuel feeding system for an internal combustion engine, a throttle biased to closed position, manual means for opening the throttle, and means controlling the last portion of the closing movement of said throttle to maintain the same parallel with but in advance of the deceleration of the engine with which the system is associated.

3. In a fuel feeding system for an internal combustion engine, a throttle biased to closed posi-

tion, manual means for opening the throttle against its bias to closed position, and means responsive to the speed of the engine with which the system is associated for controlling the last portion of the closing movement of said throttle upon release of said manual means.

4. In combination with an internal combustion engine and a water circulating pump therefor driven thereby, a fuel feeding system comprising a throttle biased to closed position, manual means for opening the throttle, and a device responsive to pump pressure limiting the rate of the last portion of the closing movement of said throttle to the rate of deceleration of the engine.

5. In combination with an internal combustion engine and a water circulating pump therefor driven thereby, a fuel feeding system comprising a throttle biased to closed position, a control arm fixed with said throttle, manual means for opening the throttle and a device responsive to pump pressure limiting the rate of the last portion of the closing movement of said throttle to the rate of deceleration of the engine comprising a casing, a diaphragm within the casing, a rod attached to the diaphragm and projecting from the casing into the path of movement of said control arm, said rod being urged outwardly by the fluid pressure, a spring urging said rod inwardly, and an adjustable screw determining the limit of outward movement of said rod.

6. In a fuel feeding system for an internal combustion engine, a throttle biased to closed position, means for opening the throttle against its bias to closed position, and means responsive to the speed of the engine with which the system is associated for regulating the last portion only of the closing movement of said throttle when said throttle is released, the first portion of the closing movement of said throttle being uncontrolled.

7. In a fuel feeding system for an internal combustion engine, a throttle biased to closed position, speed responsive means for regulating the last portion only of the closing movement of said throttle, and adjustable means for varying the portion of movement controlled.

8. In a fuel feeding system for an internal combustion engine, a throttle biased to closed position, means for opening said throttle against its bias, and speed responsive means for retarding the natural movement of the last portion of the closing movement of said throttle when said throttle is released.

9. In a fuel feeding system for an internal combustion engine, a throttle biased to closed position, and governor means for opposing the last portion of the closing movement of said throttle.

10. In a fuel injection system for an internal combustion engine, a fuel pump driven by the engine having metering means for controlling the quantity of fuel supplied to the engine, an air intake manifold, a throttle controlling the air flowing through the manifold, said throttle and said metering means being connected to operate in unison and being biased to closed position, manual means for opening the same, pressure generating means driven by the engine, and means responsive to the pressure of said pressure generating means for retarding the normal rate of the last portion of the closing movement of said throttle and metering means upon release of said manual means to decelerate the engine.

11. In a fuel injection system for an internal combustion engine, a fuel pump driven by the engine having metering means for controlling

the quantity of fuel supplied to the engine, an air intake manifold, a throttle controlling the air flowing through the manifold, said throttle and said metering means being connected to operate in unison and being biased to closed position, manual means for opening the same, and means responsive to the speed of the engine controlling said throttle and said metering means to close during the last portion of the movement progressively with but in advance of the deceleration of the engine.

12. In a fuel injection system for an internal combustion engine, a fuel pump driven by the engine having metering means for controlling the quantity of fuel supplied to the engine, an air intake manifold, a throttle controlling the air flowing through the manifold, said throttle and said metering means being biased to closed position, manual means for opening the same, and means responsive to the speed of the engine controlling said throttle to produce a lag in the last portion of the closing movement inversely proportional to the rate of deceleration of the engine to maintain a combustible mixture during deceleration.

13. A throttle for the fuel feeding system of an internal combustion engine, and means for controlling the last portion of the closing movement of the throttle so that the rate of closing movement is proportional to the rate of deceleration of the engine but in advance thereof.

14. A pressure responsive device comprising a casing having two sections, a flexible diaphragm secured between the sections, a rod secured to the diaphragm and projecting outwardly of the casing, a spring urging the rod inwardly against the action of the pressure on the diaphragm, and an adjustable screw threaded into the casing determining the positive limit of extension of said rod.

15. A pressure responsive device comprising a casing having two sections, a flexible diaphragm secured between the sections, a rod secured to the diaphragm and projecting outwardly of the casing, said rod being urged outwardly by the pressure within the casing, and an adjustable screw threaded into the casing against the diaphragm determining the limit of extension of said rod.

16. In a fuel feeding system for an internal combustion engine, a carburetor, a throttle valve controlling the flow of combustible mixture from the carburetor to the engine, manual means for opening the throttle, and means responsive to the speed of the engine with which the system is associated inoperative during the first portion of the closing movement and operative during the last portion of the closing movement for retarding the normal rate of closing said throttle.

17. In a fuel feeding system for an internal combustion engine, means for supplying combustible mixture to the engine including a throttle valve, manual means for moving said throttle valve to open position to increase the quantity of combustible mixture supplied to the engine, a spring urging said throttle valve to closed position, and means responsive to the speed of the engine with which the system is associated for controlling the last portion of the closing movement of said throttle valve, said means having an extended and a withdrawn position and being urged to said withdrawn position only by the spring tending to close the throttle valve.

18. In combination with an internal combustion engine and a water circulating pump driven thereby, a fuel feeding system for the engine compris-

ing means for supplying combustible mixture to the engine including a throttle valve, manual means for moving said throttle valve to open position to increase the quantity of combustible mixture supplied to the engine, means responsive to the pressure created by the water circulating pump for controlling the last portion of the closing movement of said throttle valve, said means having a member projected outwardly by pressure to oppose closing movement of said throttle valve, and a single spring only for urging said throttle valve to closed position and for moving said projecting means against the pressure whereby said means is unrestrained when the throttle valve is moved to open position to respond freely to changes in pressure.

19. A throttle for the fuel feeding system of an internal combustion engine, and means for controlling the last portion of the closing movement of the throttle so that the rate of closing movement is proportional to the rate of deceleration of the engine.

20. In a fuel feeding system for an internal combustion engine having a water circulating pump driven thereby, in combination, a throttle biased to closed position, means for opening the throttle against its bias, and a device responsive to the pressure of the pump driven by the engine operative to control the closing movement of said throttle when the throttle is released to its bias toward closed position.

21. In a fuel feeding system for an internal combustion engine, a throttle biased to closed position, means for opening the throttle against its bias, and means responsive to the speed of the engine with which the system is associated controlling the last portion of the closing movement of said throttle to maintain the rate of closing

movement proportional to the rate of deceleration of the engine.

22. In a fuel feeding system for an internal combustion engine having a fluid pressure generating means driven in timed relation therewith so as to generate pressure proportional to the speed of the engine, in combination, a throttle biased to closed position, means for opening the throttle against its bias, and a device responsive to the pressure created by said pressure generating means adapted and adjusted to control the last portion of the closing movement of said throttle to limit the rate of closing movement to the rate of deceleration of the engine but slightly in advance thereof.

23. In a fuel feeding system for an internal combustion engine, a carbureter, a throttle valve controlling the flow of combustible mixture from the carbureter to the engine, said throttle valve being biased to closed position, means for opening the throttle valve against its bias, and means for controlling the last portion of the closing movement of the throttle when released to its bias so that the rate of closing movement is proportional to the rate of deceleration of the engine with which the system is associated.

24. In a fuel injection system for an internal combustion engine, a fuel pump driven by the engine having metering means for controlling the quantity of fuel supplied to the engine, an air intake manifold, a throttle valve controlling the air flowing through the manifold, said throttle valve and said metering means being biased to closed position, means for opening the throttle valve, and means for controlling the last portion of the closing movement of said throttle valve so that the rate of closing movement is proportional to the rate of deceleration of the engine.

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