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CHARGE FORMING DEVICE

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This invention relates to means controlling the fuel mixture ratio supplied by a charge forming device to an internal combustion engine automatically so as to provide a fuel mixture having the correct ratio of fuel and air for all operating conditions.

It is well known that when starting an internal combustion engine when cold, it is necessary to have a fuel mixture which is rich in fuel content and it is equally well known that when the engine is hot, it can be started on leaner mixtures. It is further well known that in order to operate satisfactorily when cold, a fuel mixture richer in fuel content must be provided than that which is necessary to enable the engine to operate properly after it has warmed up. It is further well known that if a rich fuel mixture is supplied to the engine for starting purposes and the engine fails to fire when the engine is cranked for a considerable period, so much fuel would be drawn into the cylinders of the engine without any combustion taking place that the engine would become flooded with raw fuel. Under such circumstances, this excess of raw fuel must be cleaned out before the engine can be started, this being generally accomplished by admission of excess air. It is, therefore, highly desirable to facilitate easy starting to provide some means to prevent the above described flooding from taking place.

In an earlier joint application of the present applicant and Peter J. Jorgensen, Serial No. 585,510, a device was disclosed in which automatically operated mechanism was provided for so controlling the operation of an air inlet or choke valve as to produce the desired mixture ratio for all operating conditions, a rich mixture being provided for cold starting which is gradually reduced in fuel content as the engine warms up and means being also provided for causing the admission of air in progressively increasing quantities in the event of prolonged cranking without starting so as to prevent flooding, and means is also disclosed in said earlier application which is operative to increase the fuel content in the mixture upon opening of the throttle valve so as to take care of the well known demand for a richer mixture during acceleration. In the earlier application referred to, these results were accomplished by proper manipulation of a valve in the air inlet, said valve being held closed by a thermostat when cold, the effect of the thermostat being gradually reduced during the warm up period, and means being also provided operable by engine suction for moving the valve toward open posi-

tion through the medium of the thermostat in the event of prolonged cranking and also upon the sudden increase of suction when the engine begins to run. Still further means, operable upon reduction of suction, were provided to move the valve toward closed position to enrich the mixture for acceleration purposes.

It is the principal object of the present invention to provide means for accomplishing the desired variations in the fuel mixture ratio above referred to by automatic manipulation of the fuel valve. In carrying out this object of the invention, the fuel valve, in the embodiment of the invention shown herein, is held open by a thermostat when the engine is cold and is gradually moved toward its closed position by the thermostat as the engine temperature increases. This valve is also controlled by the effect of engine suction, the latter being effective to move the valve toward its closed position through the medium of the thermostat in the event that the engine fails to start immediately so as to prevent flooding and also when the engine first starts to run, while the fuel valve is adapted to be moved toward open position by another suction controlled means when the suction falls following an opening movement of the throttle to provide a somewhat richer mixture for acceleration. Of course, on sudden increase in load with the throttle valve in fixed position, there would also be a decrease in engine suction which would effect the same movement of the fuel valve and cause an enrichment of the mixture which would be desirable under such operating conditions.

The means for controlling the fuel valve of the present application are very similar to the means for controlling the air valve of the earlier application but operate upon the fuel valve in the reverse manner. By controlling the fuel valve certain advantages are produced over the control of the air valve.

The device disclosed and claimed specifically herein is an improvement on the device disclosed and broadly claimed in the earlier joint application previously referred to, Serial No. 585,510.

Further objects and advantages of the present invention will be apparent from the following description, reference being had to the accompanying drawing wherein a preferred embodiment of the present invention is clearly shown.

In the drawing:

Fig. 1 is a diagrammatic view of a charge forming device in which the present invention is embodied.

Figs. 2 and 3 are vertical, sectional views

through the control unit showing the devices for operating the fuel valve which are illustrated diagrammatically in Fig. 1.

Referring to Fig. 1, the reference character 10 indicates a carburetor of the conventional air valve type which is secured to the riser of an intake manifold 12 having a heating chamber or "hot spot" 14 formed therein through which exhaust gas is adapted to pass in the conventional manner. The carburetor unit is provided with an attaching flange 16 by which it is secured to the manifold in the conventional way.

As stated above, the carburetor is of the air valve type and is provided with an air inlet 18 which is controlled by an air valve 20 normally held in its closed position by a spring 22. The valve is slidable on the stem 24 and, of course, is adapted to be opened by the effect of engine suction thereon, the valve being progressively opened as the engine suction is increased. This valve has the effect not only of controlling the admission of air, but by placing some restriction upon the admission of air to the carburetor, increases the necessary air velocity for transporting the fuel from the fuel inlet to the engine cylinders. Obviously, the liquid fuel will precipitate out of an air column if the latter is moving too slowly.

The air inlet 18 is an auxiliary inlet while a primary inlet 26 is also provided to supply a relatively small quantity of air at all times, this inlet being of fixed area if desired, or it may be provided with a valve for regulating the admission of air. Fuel is supplied through the connection 28 to a float chamber 30 and is maintained at a constant level therein by a valve 32 carried by a float 34 in the usual conventional manner. Fuel flows from the float chamber through the passage 36 to a fuel nozzle 38, which terminates at substantially the point of greatest suction within a Venturi tube 40, which is employed to increase the suction effect at the nozzle outlet as is customary in carburetors of this type. The flow of fuel from the nozzle is controlled by the fuel valve 42 which is operable by the mechanism to be described in detail hereinafter and the quantity of mixture supplied by the carburetor is controlled by a throttle valve 44 of the usual type.

The fuel valve 42 is pivotally supported on a lever 46 secured to a shaft 48 which is journaled for rotation in the carburetor housing. The lever 46 is within the carburetor housing and the opposite end of the lever is provided with a stop lug 50 which is adapted to engage a stop screw 52 threaded in the housing and which may be adjusted to limit the closing movement of the fuel valve. The pivotal mounting of the valve 42 is such as to provide a slight degree of lost motion so that the valve may seat accurately.

Secured to the shaft 48 outside the carburetor housing is a lever arm 54 which is pivotally connected to a link 56, the latter being pivotally connected to an arm 58, which is secured to a shaft 60 journaled for rotation in the housing 62 of a control unit in which are positioned the thermostat and other devices for operating the fuel valve 42. This housing 62 is flanged at 64 and is adapted to be secured to that portion of the manifold in which the passage 14 for exhaust gas is formed. Obviously, the construction is such that any rotation of the shaft 60 is communicated to the shaft 48 and will result in movement of the fuel valve 42. Connected at one end to the shaft 60 is a bi-metallic thermostat

66 of the coil type, the free end of which is pivotally connected to a link 68, which is pivotally connected at its upper end to a plate 70 forming one end of a bellows 72 normally held in its expanded position by a compression spring 74, received within the bellows. The interior of the bellows 72 communicates with a valve controlled suction passage 76 through which the suction of the intake manifold may be communicated to the interior of the bellows, the effective area of this passage being controlled by the manually adjustable valve 78, which is screwed into the housing 62.

Normally, when the device is cold, the parts are in the position shown in Fig. 1. The spring 74, which is stronger than the force exerted by the thermostat, holds the bellows in its expanded position so as to definitely determine the position of one end of the coil thermostat 66. The thermostat tends to coil up when cold so that the shaft 60 is positioned as shown in the drawing, in which position the arm 58 is depressed to move the arm 54 to the position shown in the drawing with the fuel valve wide open. As the engine warms up, the thermostat would, of course, expand and as long as the bellows remains in its expanded position, the increase in temperature would cause a clockwise movement of the arm 58, so that any normal position of the thermostat with the engine at a higher temperature would be such as to position the valve 42 in a partially closed position. When the engine has fully warmed up, the effect of the thermostat would be to move the valve downwardly to the position which is determined by the stop screw 52.

The action of the engine suction upon the bellows 72 is utilized to move the valve 42 toward its closed position in the event that the engine does not start to run within a relatively short time after the cranking of the engine begins. The engine suction is communicated through the passage 76 and the valve controlled passage 76 to the interior of the bellows as set forth previously and the air within the bellows is slowly drawn out by this suction. However, the flow of air in exhausting the bellows is necessarily very slow, as the valve 78 should be so set as to provide a passage of very small size. With this construction, the bellows does not contract enough to move the valve to closed position until sufficient time has elapsed for the engine to start normally, but does contract if the cranking operation is prolonged, so as to pull the link 68 upwardly and through the medium of the thermostat, the bellows is effective to rotate the shaft 60 in a clockwise direction so as to move the valve 42 toward its closed position. This mechanism is provided for the purpose of preventing flooding in the event that the engine does not start within a very brief period after cranking begins. The bellows eventually will become effective to completely close the fuel valve, that is, to move it to the position determined by stop screw 52, if the engine fails to start until the air within the bellows is sufficiently exhausted to effect so great a movement of the parts.

It will be understood, also, that when the engine starts to run, the increase in manifold vacuum is very considerable by comparison to the vacuum during cranking. This increased suction is communicated to the bellows, which results in a movement of the fuel valve toward closed position and a leaner mixture is in this way provided, it being desirable to have a leaner

mixture after the engine starts to run than during the cranking period.

Means are also provided, as previously indicated, to operate the needle valve to enrich the mixture during the acceleration period. In order to accomplish this purpose, the shaft 60 has secured thereto, inside the control unit housing, an arm 80, one end of which is pivotally connected to a link 82, which is pivotally connected to a piston 84, slidable in the cylinder 86 formed in the housing of the control unit. The top of the cylinder 86 is connected by a passage 88 with a cylinder 90, also in the housing of the control unit and adjacent the cylinder 86, the cylinder 90 being connected at its lower end to a vertical passage 92 which, at its upper end, connects with the suction passage 75. A piston 94 is slidable within the cylinder 90 and is normally held in its upper position, as shown in the drawing, by a spring 96 received between the piston and a closure plate 98 at the lower end of cylinder 90. A valve 100 normally closes a port 102 in the piston 84 and is normally held closed by the spring 104. This valve permits the piston to have a dash pot action, but is no part of the present invention.

Obviously, the piston 84 will be moved downward if the pressure above the piston is increased and on such movement of the piston the fuel valve will be moved toward open position to increase the fuel content of the mixture. The pressure above the piston 84 is increased upon any drop in the vacuum above the throttle such as occurs when the throttle is opened. The high vacuum existing in the intake when the throttle is closed or partially closed is communicated through passages 75 and 92 to the cylinder 90 and pulls the piston 94 down against the pressure of spring 96. Any reduction in this vacuum will cause the piston 94 to move upwardly, and force air from the cylinder 90 through the passage 88 increasing the pressure above the piston 84 and forcing it downwardly as previously described.

A copper gasket 110 is shown as secured between the housing 62 and the manifold. This gasket is so formed as to extend partially around the thermostat so as to facilitate the heating effect thereon, the gasket being heated by direct conductivity and serving to radiate heat to the thermostat. This, however, is a feature which is not covered in the claims of the present application.

In view of the fact that the invention has been completely described with respect to the diagrammatic view in which the whole device is shown in diagrammatic form and in view of the further fact that the details of construction of the control unit form no part of the present invention and are not covered in the claims specifically, it is deemed unnecessary to describe specifically the two Figures 2 and 3 which merely show the actual mechanical construction of what is shown diagrammatically in Fig. 1. Therefore, the specific details of construction of this control unit are not set forth herein.

I claim:

1. In a charge forming device for an internal combustion engine, a fuel valve adapted to be variably adjusted to control the proportions of fuel and air in the mixture, the combination of means responsive to the temperature of the engine for setting said fuel valve and means responsive to the suction of the engine and movable independently of the valve for varying

the setting of said valve as determined by said temperature responsive means.

2. In a charge forming device for an internal combustion engine having an air valve controlling admission of air thereto, a fuel valve adapted to be variably adjusted to control the proportions of fuel and air in the mixture, the combination of means responsive to the temperature of the engine for setting said fuel valve, and means responsive to the acceleration of the engine for varying the setting of said fuel valve as determined by said temperature responsive means.

3. In a charge forming device for an internal combustion engine, a fuel valve adapted to be variably adjusted to control the proportions of fuel and air in the mixture, the combination of means jointly responsive to the intake pressure and engine temperature for setting said fuel valve, and means responsive to acceleration of the engine for varying the setting of said fuel valve as determined by the first named means.

4. In a charge forming device for an internal combustion engine, a fuel valve adapted to be variably adjusted to control the proportions of fuel and air in the mixture, thermally responsive means operable in accordance with engine temperature for determining the position of the fuel valve, means responsive to an increase in engine suction for moving the said fuel valve toward closed position and independent means responsive to a decrease in engine suction for moving said fuel valve toward open position.

5. In a charge forming device for an internal combustion engine, a fuel valve adapted to be variably adjusted to control the proportions of fuel and air in the mixture, the combination of means operable upon an increase in the normal intake suction to urge the said fuel valve toward closed position, and independent means responsive to a decrease in the normal intake suction to move said fuel valve toward open position.

6. In a charge forming device for an internal combustion engine, a fuel valve adapted to be variably adjusted to control the proportions of fuel and air in the mixture, the combination of means responsive to normal intake suction and operable upon any increase in suction to move said fuel valve toward closed position, and a thermostat operable in accordance with engine temperatures and interposed between said fuel valve and said suction responsive means, whereby the latter is operable upon the fuel valve through the medium of the thermostat.

7. In a charge forming device for an internal combustion engine, a fuel valve adapted to be variably adjusted to control the proportions of fuel and air in the mixture, the combination of means responsive to normal intake suction and operable upon any increase in suction to move said fuel valve toward closed position, and a thermostat operable in accordance with engine temperatures, said thermostat being interposed between the fuel valve and said suction responsive means and normally tending to hold the fuel valve in open position, whereby the suction responsive means is operable upon said fuel valve through the medium of the thermostat and the latter normally opposes the action of said suction operated means.

8. In a charge forming device for an internal combustion engine, a fuel valve adapted to be variably adjusted to control the proportions of fuel and air in the mixture, the combination of means responsive to an increase in normal intake

suction for moving the said fuel valve toward closed position, means responsive to the temperature of the engine for retarding the movement of said valve when operated by said suction responsive means, and independent means responsive to a decrease in the normal intake suction for moving the fuel valve toward open position.

9. In a charge forming device for an internal combustion engine, a fuel valve operable to control the fuel mixture ratio, means for shifting said fuel valve to a given position dependent on certain running conditions of the engine, separate means operable upon acceleration of the engine for moving said fuel valve from said given position to increase the fuel content of the mixture, and means for restoring said fuel valve to said given position after an interval of time.

10. Means for controlling the fuel to air ratio of the fuel mixture supplied to an internal combustion engine during starting, warming up and normal operating conditions comprising a charge forming device having in combination, a fuel valve movable to different positions to vary the fuel mixture ratio, a throttle valve for controlling the quantity of mixture supplied to the engine, and means for changing the position of said fuel valve in accordance with changes in the temperature under which the engine operates, in accordance with changes in the intake suction of the engine brought about by changes in the engine speed and by changes in the position of the throttle valve.

11. Means for controlling the fuel to air ratio of the fuel mixture supplied to an internal combustion engine during starting, warming up and normal operating conditions comprising a charge forming device having in combination, a fuel valve movable to different positions to vary the fuel mixture ratio, a throttle valve for controlling the quantity of mixture supplied to the engine, means for moving the fuel valve to decrease the fuel content of the mixture upon increase of engine suction or upon increase in engine temperature, and means to move the fuel valve to increase the fuel content of the mixture upon increase of load and upon movement of the throttle toward open position.

12. In a charge forming device for an internal combustion engine, a fuel valve adapted to be variably adjusted to control the proportions of fuel and air in the mixture, a throttle for regulating the engine speed, means for operating said fuel valve comprising a thermostat responsive to engine temperature and a suction motor responsive to the suction of the intake passage anterior to said throttle, said thermostat and said suction motor being connected to said fuel valve in series.

13. In a charge forming device for an internal combustion engine, a fuel valve adapted to be variably adjusted to control the proportions of fuel and air in the mixture, means for operating said valve comprising a thermostat responsive to engine temperature, a suction motor responsive to the suction of the intake passage, said thermostat and said suction motor being con-

nected to said fuel valve in series, and a separate suction motor connected directly to the fuel valve.

14. In a charge forming device for an internal combustion engine, a fuel valve adapted to be variably adjusted to control the proportions of fuel and air in the mixture, means for holding the fuel valve fully open to provide a rich mixture for starting the engine, and means for progressively moving the fuel valve toward closed position during the cranking of the engine to gradually lean the mixture at a rate dependent on the temperature of the engine and on the suction produced by cranking said engine.

15. In a charge forming device for an internal combustion engine, a fuel valve adapted to be variably adjusted to control the proportions of fuel and air in the mixture, thermostatic means normally holding the fuel valve open when the engine is cold and tending to move said fuel valve toward closed position as the engine temperature increases, and a suction operated member connected to the thermostat and operable to move said fuel valve toward closed position through the medium of the thermostat upon increase in engine suction.

16. In a charge forming device for an internal combustion engine, a fuel valve adapted to be variably adjusted to control the proportions of fuel and air in the mixture, thermostatic means normally holding the fuel valve open when the engine is cold and tending to move said fuel valve toward closed position as the engine temperature increases, a suction operated member connected to the thermostat and operable to move said fuel valve toward closed position through the medium of the thermostat upon increase in engine suction, and a second member responsive to engine suction and connected directly to said fuel valve so as to move said fuel valve toward open position upon decrease in engine suction.

17. In a charge forming device for an internal combustion engine, a fuel valve adapted to be variably adjusted to control the proportions of fuel and air in the mixture, thermostatic means normally holding the fuel valve open when the engine is cold and tending to move said fuel valve toward closed position as the engine temperature increases, a suction operated member connected to the thermostat and operable to move said fuel valve toward closed position through the medium of the thermostat upon increase in engine suction, and means for adjustably determining the rate at which said valve is moved by engine suction.

18. In an internal combustion engine having an intake and a manifold having a fuel valve, the combination of means jointly responsive to the intake pressure and the engine temperature for setting said fuel valve, and means responsive to the acceleration of the engine for varying the setting of said fuel valve as produced by the first mentioned means.

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