

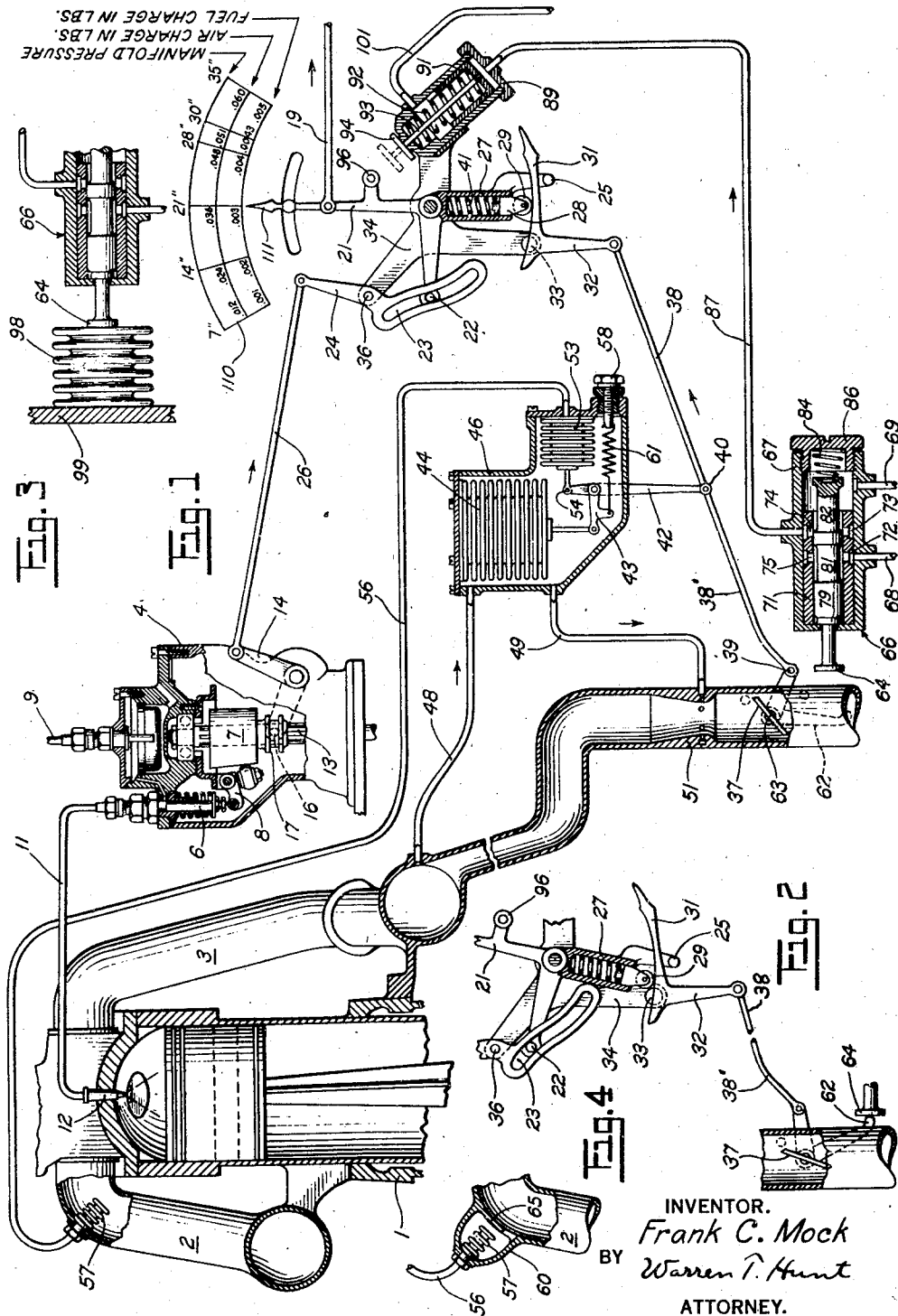
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ENGINE CONTROL

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ENGINE CONTROL

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1

This invention relates to internal combustion engines and more particularly to fuel mixture controls for internal combustion engines.

An object of the invention is to provide a fuel mixture control for an internal combustion engine which will automatically deliver a correct fuel and air mixture throughout a wide range in atmospheric pressure.

Another object of the invention is to provide a device for a fuel injection engine that will prevent the delivery of an over-rich fuel and air mixture at high altitude.

Another object of the invention is to provide a fuel mixture control which will vary the mixture in accordance with the density of the air charge in the engine.

Another object of the invention is to provide a fuel mixture control which will vary the fuel mixture in accordance with a number of variables, including the temperature and pressure in the intake conduit and the temperature and pressure in the exhaust conduit.

Another object of the invention is to provide a control for a fuel injection engine having a manual fuel control that will tend to reduce the fuel supply when the air pressure controlled throttle reaches substantially its wide open position.

Another object of the invention is to provide a control for a fuel injection engine that will forcibly move the manual control toward a decreased fuel position when the air throttle reaches substantially its wide open position.

Another object of the invention is to provide a control for a fuel injection engine having an air pressure controlled throttle in which the throttle valve may be manually moved from its extreme open and closed position.

Another object of the invention is to provide an automatic mixture control that will deliver a constant fuel charge regardless of the external air pressure.

Another object of the invention is to provide an automatic mixture control that will enable an airplane pilot to set his engine for a predetermined power output which will be maintained constant irrespective of the temperature and pressure of the atmosphere.

Other objects and features of the invention will be apparent from the following description taken in connection with the accompanying drawings, in which:

Fig. 1 is a somewhat diagrammatic showing of the improved fuel mixture control as applied to an internal combustion engine.

2

Fig. 2 is a fragmental view showing the manual fuel control in the increased fuel position.

Fig. 3 is a showing of a modified form of control mechanism.

Fig. 4 is a showing of a modified form of installing the bellows in the exhaust manifold.

Referring to the drawing, and particularly to Figs. 1 and 2, the engine is represented at 1 which is provided with an exhaust manifold 2, an air inlet manifold 3 and a fuel injection pump 4 which is manually controlled by apparatus hereinafter described. The fuel pump comprises plungers 5, one for each engine cylinder, which are reciprocated by cam 7 acting through the bell-crank 8, fuel being drawn in through pipe 9 and injected into the engine cylinder through pipe 11 and nozzle 12. The cam 7 is axially slidable upon the splined shaft 13 by bell-crank 14 having projections 16 extending into the groove collar 17. The pump is shown in an intermediate fuel position and the quantity of fuel injected at each stroke of the plunger is increased when the cam 7 is moved downwardly and decreased when it is moved upwardly. Movement of the cam is obtained through the manually operated control rod 19 pivotally secured to bell-crank 21, one arm of which is provided with a roller 22 which is movable within the cam groove 23 of lever 24 which is connected with bell-crank 14 by rod 26. The above described linkage is so arranged that movement of rod 19 toward the left, as viewed in Fig. 1, moves the cam 7 downwardly to increase the fuel and movement of the rod 19 toward the right moves the linkage in a manner to decrease the fuel. Bell-crank 21 is provided with a hollow extension 27 in which is mounted a spring pressed plunger 28 having a roller 29 which is adapted to move over the surface of arm 31 of the bell-crank lever 32 which is pivotally mounted at 33 on the fixed bracket 34, it being noted that lever 24 is also pivotally mounted on the fixed bracket at 36. Lever 32 is operatively connected with throttle valve 37 by rods 38 and 38', both of which are pivotally connected at 40 with lever 42 and rod 38' having a pivotal connection with the throttle operating lever at 39, the connecting linkage between throttle 37 and bell-crank 32 being so arranged that opening movement of the throttle causes the bell-crank to rock in a counter-clockwise direction against the force of spring 41. In order to provide against closure of throttle 37 and too great an enrichment of the mixture, in the event of a failure of bellows 44 or 53, it is desirable to incorporate a safety feature. To this end casing

3

27 is provided with an arm 25 projecting beneath the lever 31 and adapted to limit its downward movement. The outer end of lever 31 has its under side of such a contour that in the event of failure of either or both bellows, spring 41 will force the lever against arm 25. Although the mixture will be enriched by failure of the bellows, it will not be enriched beyond the point at which the engine will not operate. The quantity of fuel injected into the engine at each stroke of the pump is positively controlled by manual operation of rod 19, but the operation of throttle 37 is dependent on the pressure within the air inlet manifold 3. Movement of the throttle valve in accordance with the manifold pressure is accomplished by connecting the rod 38 with arm 42 of a bell-crank lever, the arm 43 of which is connected to an evacuated bellows 44 secured to the inner side of air tight casing 46. The bellows 44 may be evacuated to any desired degree and is preferably formed of some inherently elastic material whereby the bellows will expand when the pressure within the casing 46 is reduced. The engine intake manifold pressure is transferred to casing 46 by conduits 48 and 49 which are connected to points spaced in the direction of flow within the manifold. Conduit 48 is preferably of a larger capacity than conduit 49 in order that the pressure within casing 46 shall be substantially the same as the pressure within manifold 3.

In the construction shown in Fig. 1, pipe 48 is connected to the inlet manifold 3 some little distance on the down-stream side of the connection leading to pipe 49. Therefore, at all times there will be a circulation through casing 46 and the bellows 44 will be subjected to the temperature of the inlet manifold as well as the pressure. If the bellows 44 is not completely evacuated, or if it contains a fluid, it will expand both in accordance with the temperature and static pressure of the manifold. The differential in pressure between the two spaced points may be increased somewhat by the use of Venturi tube 51, the use of which is recommended, as it will enable the apparatus to function properly when used in connection with a supercharger, not shown, which may be connected to the lower end of the inlet manifold. The throttle valve 37 is also controlled in accordance with the pressure and temperature of the exhaust gases within conduit 2 by means of an expansible bellows 53 which is secured to the housing 46 and has its movable end secured to the upper extension of lever 42 at 54. The interior of bellows 53 is connected through pipe 56 to an expansible bellows 57 located in the interior of the exhaust conduit 2. In some cases it may be desirable to control bellows 53 only by the pressure of the exhaust gases and in such cases the bellows 57 may be shielded from the hot gases by locating the bellows in a recess as shown at 60 in Fig. 4, or by the use of a suitable baffle 65. Bellows 57 and 53, as well as conduit 56, are preferably filled with a fluid which will expand with temperature and also cause bellows 53 to expand when the bellows 57 is compressed by the pressure of the exhaust gases within exhaust conduit 2. A manual adjustment of the bellows is effected by means of a headed screw 58 which is connected to the lever 43 by a tension spring 61. It will be noticed that by a proper selection of spring 61 and the angularity of lever arm 43 the balancing force of spring 61 upon the bellows may be made substantially constant for various positions of the

4

bellows. For example, upon expansion of bellows 44 arm 43 will be moved counter-clockwise and tension of spring 61 will be reduced, but at the same time the effective length of the lever arm acted upon by the spring 61 will be increased, therefore by a proper selection of levers the bellows may be substantially balanced in all of its positions. Throttle valve 37 is provided with an arm 62 which is mounted on the throttle shaft 63 and in substantially the wide open position of the throttle valve is adapted to contact the operating member 64 of the control valve generally designated at 66. The control valve 66 comprises a housing 67, the interior of which is connected to a source of oil pressure by pipe 68 and is drained by pipe 69 through a bushing 71 having grooves 72 and 73 which are connected to the interior of the bushing by radial holes 74 and 75. Within bushing 71 is slidably mounted a piston valve 79 having relieved portions 81 and 82. Piston 79 is normally urged toward the left by spring 84 which abuts against the removable plug 86. In the normal position of the valve, conduit 87 is aligned with relief portion 82 whereby any fluid in 87 may be drained out through pipe 69 and there is no connection between pressure pipe 68 and conduit 87. Conduit 87 is connected to the interior of casing 89 in which is slidably mounted a piston 91 normally urged to its inner position by spring 92. Piston 91 is provided with a rod 93 having an enlarged head 94 located in the path of movement of roller 96 which is secured to lever 21.

In the form of the invention shown in Fig. 3, the operating member 64 is actuated by an evacuated bellows 98 which is secured to a fixed member 99, the bellows 98 being evacuated to any desired degree and preferably formed of an elastic material whereby a decrease of pressure causes the bellows to expand and move the controlling member 64 toward the right.

In the operation of the form shown in Figs. 1 and 2, when the manually operated rod 19 is moved to its extreme position toward the right, corresponding to the maximum fuel position, the roller 96 is adjacent the plunger head 94 and the roller 29 is positioned as shown in Fig. 2, it being noted that the mechanical advantage of the lever 32 to compress the spring 41 is increased and the throttle valve 37 can open further for any given intake manifold suction.

The operation of the above described mechanism up to this point is quite similar to my copending application, Serial No. 618,380, filed June 20, 1932.

If the above described fuel control be installed on an airplane, the throttle 37 will follow the operation of the manual fuel control and deliver the correct proportion of fuel for all ordinary altitudes, but it will be understood that under certain conditions of extreme high altitude or decreased atmospheric pressure, the throttle valve may be wide open and still not permit enough air to enter the engine to give a correct mixture for the quantity of fuel injected. This point may be designated as the critical position of the apparatus, and in order to secure a correct mixture the operator must either manually reduce the fuel or descend to a region of higher pressure.

In the present invention a means has been provided whereby the fuel control will be automatically moved to a decreased fuel position when the throttle valve is wide open. For effecting this purpose, the valve actuating member 64

5

is so located with respect to lever arm 62 that in substantially the wide open throttle position the plunger 79 will be pushed toward the right and groove 73 will be brought into communication with groove 72 by means of the relieved portion 81. The pressure within groove 73 is transferred to the casing 89 by means of conduit 87 and piston 91 is moved upwardly to contact roller 96 and positively move the manual control to reduce the fuel. The change in the fuel control position changes the position of roller 29 with respect to 31 and the spring 41 is effective to partially close the throttle 37 and permit plunger 79 to return to the position shown in Fig. 1 wherein the pressure within the casing 89 is relieved and the spring 92 acts to return the plunger to the position shown in full lines in Fig. 1. The upper side of the piston 91 is connected to atmosphere through pipe 101 which also acts as a drain for any fluid which may have leaked past the piston.

An increase in temperature or a decrease in pressure within intake manifold 3 will cause bellows 44 to expand and open the throttle to compensate for the decreased weight of air passing through the manifold. The weight of air taken into the engine under a constant intake manifold pressure increases somewhat at high altitudes because of the decreased back pressure in the exhaust manifold, therefore means has been incorporated to compensate for this action.

It has been discovered that the weight of air charge taken into the cylinder will vary with the temperature and pressure of the exhaust gases, because of the space occupied and the heat transferred from the residual exhaust gases remaining in the cylinder at the top of the exhaust stroke. It is, therefore, necessary to take into account the pressure and possibly the temperature of the exhaust in obtaining a throttle action which will accurately measure the amount of the intake charge per cylinder. Where the exhaust manifold stacks are short and individual for each cylinder, a satisfactory approximation may be obtained by assuming that the exhaust pressure is that of the external atmosphere, but when the exhaust is confined or restricted, a direct transfer of pressure and temperature is preferable. The pressure and temperature of the exhaust gases have therefore been utilized to further modify the throttle action, and an increase in either exhaust gas pressure or temperature will increase the pressure of the fluid within bellows 57 and partially close throttle 37.

It may now be seen that by reason of the control of the throttle in accordance with exhaust gas pressure, that the air charge is varied with changes in exhaust gas pressure in a manner to keep the charge constant for any given intake manifold pressure. This is very desirable because heretofore there has been danger of overloading the engine at high altitudes with a constant inlet manifold pressure, because of the inherent increase in horsepower due to reduced back pressure of the exhaust gases.

In the present invention the charge per cylinder and the horsepower of the engine remain constant at all altitudes and the quadrant 110 may be directly calibrated in manifold vacuum, air charge, and fuel charge. For example, if the pointer 111 be set on the line corresponding to 28 inches mercury, the engine will deliver a constant fuel and air charge, and therefore constant power at all altitudes, provided some device, such as a supercharger, be used to maintain the intake

6

manifold pressure at the desired point after the throttle has attained its wide open position. It will be apparent that indicator 111 will show a correct reading of the unit mixture charges entering the engine and there will be no danger of the operator unwittingly operating the engine with a greater horsepower than is desirable.

In the form of the invention shown in Fig. 3, the operating member 64 is actuated by means of the evacuated bellows 98 whenever the external pressure reaches a predetermined minimum and the manual fuel control is moved to a decreased position in the same manner as that described for the form shown in Figs. 1 and 2. It will be noted that in the improved control, herein before described, the throttle valve position is determined by the conjoint action of intake temperature and pressure, exhaust temperature and pressure, and the position of the manual fuel control, and that the position of the throttle in turn acts to reduce the fuel at substantially its wide open position.

While certain embodiments of the invention have been illustrated and described, it is understood that the showing and description are illustrative only and the invention is not regarded as limited to the forms shown and described, or otherwise, except by the terms of the following claims:

What is claimed is:

1. In a fuel mixture control for an engine, a fuel pump, an air conduit and a throttle therefor, means for controlling the fuel pump, means for controlling the throttle to increase the air flow as the fuel is increased, and means controlled by the throttle at substantially its wide open position for limiting the movement of the fuel pump control in the direction to increase the fuel.

2. In a fuel mixture control for an engine, a fuel pump, an air conduit and a throttle therefor, means for controlling the fuel pump, means for controlling the throttle to increase the air flow as the fuel is increased, and means controlled by throttle position for positively moving the pump control to a reduced fuel position at the wide open position of the throttle.

3. In a fuel mixture control for an internal combustion engine, means for supplying fuel to the engine, an air conduit and a throttle therefor, means for controlling the fuel supply means, means for controlling the throttle to increase the air supply as the pressure in the air conduit is decreased, and means operated at substantially wide open position of the throttle to limit movement of the fuel control and to keep the fuel supply less than a predetermined amount.

4. In a fuel and air mixture control for an engine, manual means for controlling the fuel, automatic means for controlling the air, said automatic means including a plurality of mutually coacting pressure responsive members that are operatively connected to the throttle and to the fuel control whereby the throttle is conjointly controlled in its operation by variations in fuel control position, exhaust gas pressure resulting from variations in atmospheric pressure, exhaust gas temperature, air conduit pressure and air conduit temperature.

5. In a fuel mixture control for an engine, a fuel feed, an air conduit and a throttle therefor, a manually actuated element controlling the fuel feed, means responsive to conduit pressure for controlling the throttle, power controlled means for moving the element toward a decreased

7

fuel position, and means operable at substantially wide open throttle position for supplying power to the power controlled means.

6. In a control for fuel and air feeds to an engine, a control of the fuel feed, a control of the air feed in accordance with engine intake manifold air pressure for controlling the fuel-air ratio, and means for modifying one of said feeds in response to variations in the temperature of the engine exhaust gas and to variations in the exhaust back pressure resulting from variations in altitude.

7. In a fuel mixture control for an internal combustion engine, a fuel pump, an air conduit and a throttle therefor, a manual control for the fuel pump, means responsive to conduit pressure for controlling the throttle, fluid pressure actuated means for moving the manual control toward a decreased fuel position, and means actuated by the throttle at substantially the open position thereof for supplying fluid pressure to said fluid pressure actuated means.

8. In a fuel mixture control for an engine, a fuel feed, an air conduit and a throttle therefor, means for controlling the fuel feed, means controlled by the temperature and pressure of the air in the conduit for controlling the throttle position, means movable with the fuel feed control to cause the throttle to admit an increased air supply when the fuel is increased, means controlled by the temperature and pressure of the exhaust gas for controlling the throttle position and throttle operated means arranged to positively control the fuel feed and reduce the fuel supply at substantially wide open throttle position.

9. In a control for fuel and air feeds to an engine, a manual control for one of said feeds, an automatic control of the other of said feeds in accordance with engine intake manifold air pressure for controlling the fuel-air ratio, and means for modifying one of said feeds in response to variations in the temperature of the engine exhaust gas and to variations in the exhaust back pressure resulting from variations in altitude.

10. In a fuel mixture control for an engine, a fuel feed, an air conduit and a throttle therefor, manual means for controlling the fuel feed, means actuated by air pressure tending to open the throttle as the pressure is reduced, means movable with the feed control resiliently opposing the opening movement of the throttle and arranged to progressively decrease the opposition as the fuel feed control is moved toward an increased fuel position, and power actuated means for positively moving the manual fuel control means toward a decreased fuel position, said power actuated means being actuated by the throttle at substantially its wide open position.

11. In a fuel mixture control for an internal combustion engine, a fuel pump, an air conduit and a throttle therefor, manual means for controlling the fuel pump, means actuated by air pressure tending to open the throttle as the pressure is reduced, means movable with the pump control resiliently opposing the opening movement of the throttle and arranged to progressively decrease the opposition as the fuel pump control is moved toward an increased fuel position, a normally inactive servo motor adjacent the manual fuel control arranged to force the control a predetermined amount toward a decreased fuel position, and a control member for the servo motor arranged to be operated at substantially wide

8

open throttle position to cause the servo motor to reduce the fuel supply.

12. Engine fuel-air ratio control means, and means actuating said control means to regulate said fuel-air ratio with changes of engine speed, manifold pressure and exhaust pressure.

13. In a fuel mixture control for an internal combustion engine, a fuel pump, an air conduit and a throttle therefor, a manual control for the fuel pump, a pressure operated member operatively connected with the throttle to control the same, means for subjecting said pressure operated member to air conduit pressure, said pressure operated member being arranged to open the throttle as the pressure in the conduit is reduced, a lever connected with the throttle and movable thereby, a resilient device movable with the fuel control, said device contacting said lever in a manner to oppose opening of the throttle, and said device being movable with respect to said lever in a manner to decrease the effective lever length and the opposition to throttle opening when the fuel control is moved toward increased fuel position, a pressure operated device adjacent the fuel control arranged to force the same toward a decreased fuel position when pressure is applied to the device, and a valve operated by the throttle and arranged to supply pressure to the pressure operated device only when the throttle is in substantially the wide open position.

14. In a fuel mixture control for an internal combustion engine, a fuel pump, an air conduit and a throttle therefor, a manual control for the fuel pump, a pressure operated member operatively connected with the throttle to control the same, means for subjecting said pressure operated member to air conduit pressure, said pressure operated member being arranged to open the throttle as the pressure in the conduit is reduced, a lever connected with the throttle and movable thereby, a resilient device movable with the fuel control, said device contacting said lever in a manner to oppose opening of the throttle, and said device being movable with respect to said lever in a manner to decrease the effective lever length and the opposition to throttle opening when the fuel control is moved toward increased fuel position, a pressure operated device adjacent the fuel control arranged to force the same toward a decreased fuel position when pressure is applied to the device, and a valve operated by the throttle and arranged to supply pressure to the pressure operated device only when the throttle is in substantially the wide open position, said valve having a relief opening associated therewith which is uncovered by the valve to relieve the pressure on the device when the throttle is moved toward the closed position.

15. In a fuel mixture control for an engine, a fuel feed, an air manifold and a throttle therefor, a manual control for the fuel feed, means for controlling the throttle in accordance with the fuel control position, means responsive to engine exhaust gas temperature, means responsive to air conduit temperature, both of said heat responsive means being differentially operative to control the throttle in a manner to open the throttle upon an increase in either conduit temperature or exhaust gas temperature.

16. In a fuel mixture control for an internal combustion engine, a fuel feed, an air manifold and a throttle therefor, a manual control for the fuel feed, means for controlling the throttle in accordance with the fuel control position, means

responsive to engine exhaust gas temperature, means responsive to air conduit temperature, both of said heat responsive means being differentially operative to control the throttle in a manner to open the throttle upon an increase in either conduit temperature or exhaust gas temperature, both of said heat responsive means being exposed to air conduit pressure and responsive thereto in a manner to open the throttle when the pressure is decreased.

17. In a fuel mixture control for an internal combustion engine, a fuel pump, an air conduit and a throttle therefor, a manual fuel pump control, a linkage for controlling the throttle in accordance with the position of the pump control, conduit pressure operated means connected with said linkage tending to open the throttle as the conduit pressure is reduced, means for exposing said conduit pressure operated means to air conduit temperature in a manner to increase the throttle opening when the air conduit temperature is increased, and expansible means exposed to the engine exhaust gas and connected with said linkage in a manner to increase the throttle opening when the exhaust temperature is increased.

18. In a fuel mixture control for an engine, a fuel feed, an air conduit and a throttle therefor, a manual fuel feed control, a linkage for controlling the throttle in accordance with the position of the feed control, conduit pressure operated means connected with said linkage tending to open the throttle as the conduit pressure is reduced, means for exposing said conduit pressure operated means to air conduit temperature in a manner to increase the throttle opening when the air conduit temperature is increased, expansible means exposed to the engine exhaust gas and connected with said linkage in a manner to increase the throttle opening when the exhaust temperature is increased and means actuated by the throttle only at substantially its wide open position for forcing the fuel feed control toward a decreased fuel position.

19. In a fuel and air mixture control for an engine, manual means for controlling the fuel, automatic means for controlling the air, said automatic means including a plurality of mutually coacting pressure responsive members that are operatively connected to the throttle and to the fuel control whereby the throttle is conjointly controlled in its operation by variations in fuel control position, exhaust gas pressure, exhaust gas temperature, air conduit pressure and air conduit temperature.

20. In a fuel and air mixture control for an engine, manual means for controlling the fuel, automatic means for controlling the air, said automatic means being subjected to and conjointly controlled in its operation by variations in fuel control position, exhaust gas pressure, exhaust gas temperature, air conduit pressure and air conduit temperature and means controlled by the throttle arranged to reduce the fuel supply only at substantially wide open throttle position.

21. In a fuel mixture control for an internal combustion engine, a fuel pump, an air conduit and a throttle therefor, a fuel pump control, means for moving the throttle including a pivoted lever, resilient means movable with the pump control, said resilient means being arranged to contact the lever and to move relatively thereto in a manner to vary the mechanical advantage of the resilient means, said resilient means being

arranged to have increased mechanical advantage when the fuel control is in the decreased fuel position, a bellows sealed under a predetermined pressure, said bellows being operatively connected with the throttle in a manner to open the same when the bellows is expanded, means for subjecting the bellows to the pressure of the air conduit at two points in the conduit having a pressure differential between them, a second bellows containing an expansible fluid, a pipe in communication with the interior of the second bellows, said pipe having its other end closed and exposed to the engine exhaust gases, and said bellows being operatively connected with the throttle in a manner to open the same when the bellows is expanded.

22. Engine fuel-air ratio control means, and means actuating said control means to regulate said fuel-air ratio with changes of engine speed, manifold pressure, exhaust pressure and an operative temperature.

23. In a fuel and air mixture control device for an internal combustion engine, a fuel pump, an air conduit connecting the engine with the atmosphere and an air-pressure actuated throttle therefor, a manual control for the fuel pump including a lever, movable stop means arranged in the path of said lever, and atmospheric pressure operated means arranged to move said stop means to limit the movement of the manual control toward the increased fuel position when the atmospheric pressure is reduced below a predetermined value.

24. In a fuel and air mixture control device for an internal combustion engine, a fuel pump, an air conduit connecting the engine with the atmosphere and an air-pressure actuated throttle therefor, a manual control for the fuel pump including a lever, movable stop means arranged in the path of said lever, and means including a sealed bellows exposed to atmospheric pressure arranged to move said stop and limit the movement of the lever toward the increased fuel position when the atmospheric pressure is reduced below a predetermined value.

25. In a fuel mixture control for an engine, the combination of a fuel pump, an air conduit and a throttle control therefor, means for controlling the fuel pump, fluid pressure actuated means for controlling the throttle in accordance with engine air conduit pressure, and a stop associated with the pump control and so located as to limit throttle movement in the event of failure of the fluid pressure control.

26. In a fuel mixture control for an engine, the combination of a fuel pump, an air conduit and a throttle control therefor, means for controlling the fuel pump, air conduit pressure actuated means for controlling the throttle in accordance with engine air conduit pressure, and a stop associated with the pump control and so located as to limit throttle closing movement in the event of failure of the air conduit pressure control.

27. In a fuel mixture control for an internal combustion engine, having a fuel pump, an air conduit and a throttle therefor, a manual control for the pump, air conduit pressure actuated means for controlling the throttle, and exhaust gas pressure actuated means for modifying the action of the air conduit pressure actuated means.

28. In a fuel mixture control for an engine, means for supplying fuel to the engine, an air conduit and a throttle therefor, a manual control for the fuel supply, air conduit pressure

actuated means for controlling the throttle, exhaust gas pressure actuated means for modifying the action of the air conduit pressure actuated means, and means for modifying the action of the air conduit pressure actuated means in accordance with air conduit temperature.

29. In a fuel mixture control for an engine having a fuel feeding device, an air conduit and a throttle therefor, a manual control for the device, means movable by the manual control for controlling the throttle in accordance with the fuel charge, means operated by air conduit temperature for controlling the throttle, and means actuated by exhaust gas pressure for controlling the throttle.

30. In a fuel mixture control for an engine having a fuel feeding device, an air conduit and a throttle therefor, a manual control for the device, means movable by the manual control for controlling the throttle in accordance with the fuel charge, means operated by air conduit pressure for controlling the throttle, and means actuated by exhaust gas temperature for controlling the throttle.

31. In a fuel mixture control for an engine having a fuel feeding device, an air intake conduit and a throttle therefor, a manual control for the device, means movable by the manual control for controlling the throttle in accordance with the fuel charge, means for controlling the throttle in accordance with exhaust gas pressure, and an indicator movable by the manual control for indicating the quantity of the air charge passing through the conduit.

32. In a fuel mixture control for an internal combustion engine, having a fuel and air feeding device including an air conduit and a throttle therefor, a manual control for the device, means movable by the manual control for obtaining a desired quantity of air and fuel charge, and means responsive to air conduit temperature to maintain said quantity of air charge while the manual control remains set in a fixed position under changes of entering air pressure and temperature.

33. In a fuel mixture control for an internal combustion engine, having a fuel and air feeding device including an air conduit and a throttle therefor, a manual control for the device, means movable by the manual control for obtaining a desired quantity of air and fuel charge, and means responsive to air conduit temperature and the pressure of the engine exhaust gas to maintain said quantity of air charge while the manual control remains set in a fixed position under changes of entering air pressure and temperature.

34. In a fuel mixture control for an internal combustion engine, having a fuel and air feeding device including an air conduit and a throttle therefor, a manual control for the device, means movable by the manual control for obtaining a desired quantity of air and fuel charge, and means responsive to air conduit pressure and to exhaust gas pressure and temperature to maintain said quantity of air charge while the manual control remains set in a fixed position under changes of entering air pressure and temperature.

35. In a fuel mixture control for an internal combustion engine, having a fuel and air feeding device including an air conduit and a throttle therefor, a manual control for the device, means movable by the manual control for obtaining a desired quantity of air and fuel charge, and means responsive to air conduit temperature and

pressure modified by the exhaust gas temperature and pressure to maintain said quantity of air charge while the manual control remains set in a fixed position under changes of entering air pressure and temperature.

36. In a fuel mixture control for an internal combustion engine, a fuel feed, an air conduit and a throttle therefor, a means for controlling the fuel feed, a manual means for controlling the throttle to regulate the air flow as the fuel is increased, and means for positively moving the fuel feed control to a reduced fuel position at a predetermined position of the throttle.

37. In a fuel mixture control for an internal combustion engine, means for supplying fuel to the engine, an air conduit and a throttle therefor, means for controlling the fuel supply, means for controlling the throttle to regulate the air flow as the fuel is increased, and means responsive to exhaust gas pressure for controlling the throttle.

38. A method of mixing fuel and air for an internal combustion engine having a fuel pump including manually controlling the flow of fuel through the pump and controlling the air flow by the exhaust gas pressure.

39. In a fuel and air feeding system for an internal combustion engine, means for feeding fuel to the engine, an air conduit and a throttle therefor, means controlling the fuel feed, means for controlling the throttle to increase the air flow as the fuel is increased, and means becoming operative at substantially wide open position of the throttle for moving the fuel feed control toward a reduced fuel position.

40. In a control for fuel-air feeds to an engine, a control of the fuel feed, a control of the engine intake manifold air pressure for controlling the fuel-air ratio, and means for modifying the fuel-air ratio according to engine exhaust gas pressure.

41. In a control for fuel-air feeds to an engine, a control of the fuel feed, a control of the air feed in accordance with the engine intake manifold air pressure and temperature to thereby control the fuel-air ratio, and means for modifying one of said feeds in response to variations in engine exhaust gas pressure.

42. In a control for fuel and air feeds to an engine, a control of the fuel feed, a control of the air feed in accordance with engine intake manifold air pressure for controlling the fuel-air ratio, and means for modifying one of said feeds in response to variations in the pressure and temperature of the engine exhaust gas.

43. In a charge forming device for an internal combustion engine, means for supplying fuel to the engine in accordance with engine speed, manual means for controlling the fuel supply and for controlling the engine intake manifold air pressure to thereby control the fuel-air ratio, and means responsive to the pressure of the engine exhaust gases and operative in a direction to decrease the fuel-air ratio upon increase in the pressure of the exhaust gas.

44. In a fuel and air feeding system for an internal combustion engine, means controlling the fuel feed to the engine in accordance with engine speed, a manually actuated element for controlling the fuel feed, means including an air conduit and a throttle for controlling the air feed to the engine, a manually actuated element for controlling the throttle, and automatic means responsive to variations in the temperature and pressure of the air in the engine intake manifold and in the

pressure of the exhaust gas for controlling the relative amounts of fuel and air to control the fuel-air ratio.

45. The invention defined in claim 44 comprising in addition fluid pressure responsive means becoming operative when the throttle reaches substantially wide open position for moving the fuel feed controlling element in a direction to reduce the fuel feed.

46. In a control for an internal combustion engine having an air supply conduit and a throttle therefor, a manual control operatively related to the throttle for obtaining a desired engine charging pressure, and means responsive to variations in the pressure and temperature of the engine exhaust gas for modifying the throttle position while the manual control remains set in a fixed position.

47. In a control for an internal combustion engine having an air supply conduit and a throttle therefor, a manual control operatively related to the throttle for obtaining a desired engine charging pressure, and means responsive to the pressure and to the velocity of the air in the conduit posterior to the throttle for modifying the throttle position.

48. An engine fuel and air control device including means for controlling the engine fuel and air feeds, and means operatively connected with said first mentioned means for varying at least one of said feeds with changes of engine manifold air pressure and temperature, surrounding atmospheric pressure and engine speed.

49. Engine fuel injection and air supply system including first means for modifying the supply of one of said fluids, namely fuel and air, operative in a direction tending to increase the fuel to air ratio with increase of the engine manifold air pressure and with decrease of the engine manifold air temperature and atmospheric pressure, and additional engine operative condition responsive means for altering said supply independently of said first means.

50. A hydraulically controlled fuel injection system having valve means for regulating the engine fuel supply, means responsive to changes of manifold air pressure, of manifold air temperature, of atmospheric pressure, and of an additional engine operative temperature, and an operative interconnection between said means.

51. Engine fuel-air ratio control means, and means responsive to changes of manifold pressure and temperature and exhaust pressure actuating said control means to regulate said fuel-air ratio automatically.

52. Engine fuel-air ratio control means, and means responsive to changes of exhaust pressure and temperature actuating said control means to regulate said fuel-air ratio.

53. Supercharged engine fuel-air ratio control means; and manual regulating means and means responsive to changes of induction pressure and temperature between supercharger and engine

and exhaust pressure actuating said control means to regulate said fuel-air ratio.

54. Engine fuel-air ratio control means, and manual regulating means and means responsive to changes of exhaust pressure and temperature actuating said control means to regulate said ratio.

55. Charge forming device including Venturi means to keep the engine fuel supply substantially proportional to the engine air supply; mixture control means regulating the ratio of proportionality between said fuel and air supplies; and means responsive to changes of exhaust pressure and temperature operatively connected with said mixture control means to regulate said mixture ratio automatically.

56. In a control for an internal combustion engine having an air supply conduit, an engine throttle in the passage for variably controlling the power developed by the engine, a manual control operatively connected to the throttle, and means responsive to variations in the pressure of the engine exhaust gas and operative throughout the major portion of the throttle operating range for modifying the throttle position.

57. In a control for an internal combustion engine having an air supply passage means, a manual control operatively connected to an engine speed-controlling throttle in the air supply passage means, and means responsive to variations in the pressure of the engine exhaust gas connected to an engine speed-controlling throttle in the air passage means and operative during periods of normal temperature operation to modify the throttle position.

58. In a control for fuel-air feeds to an engine, a control for one of said feeds, a control for the other of said feeds in accordance with the engine intake manifold air pressure and temperature to thereby control the fuel-air ratio, and means for modifying one of said feeds in response to variations in engine exhaust gas pressure.

59. Supercharged engine fuel-air ratio control means, and manual control means and means responsive to changes of engine speed, induction pressure between supercharger and engine, and exhaust pressure operatively connected with said ratio control means to control said ratio.

FRANK C. MOCK.

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The following references are of record in the file of this patent:

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Certificate of Correction

Patent No. 2,426,740.

September 2, 1947.

FRANK C. MOCK

It is hereby certified that errors appear in the printed specification of the above numbered patent requiring correction as follows:

Column 10, line 26, claim 23, for the word "therefore" read *therefor*; line 55, beginning with "26. In a fuel" strike out all to and including "control." in line 63, comprising claim 26; column 11, line 25, before "engine" insert *internal combustion*; for the claims now numbered "27" through "59" read *26 to 58* respectively; in the heading to the printed specification, line 8, for "59 Claims" read *58 Claims*;

and that the said Letters Patent should be read with these corrections therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 7th day of December, A. D. 1948.

[SEAL]

THOMAS F. MURPHY,
Assistant Commissioner of Patents.