Nov. 24, 1959 J. DOLZA ET AL 2,914,051

SIGNAL MODIFIER FOR FUEL INJECTION SYSTEM

Filed May 9, 1957 3 Sheets-Sheet 1

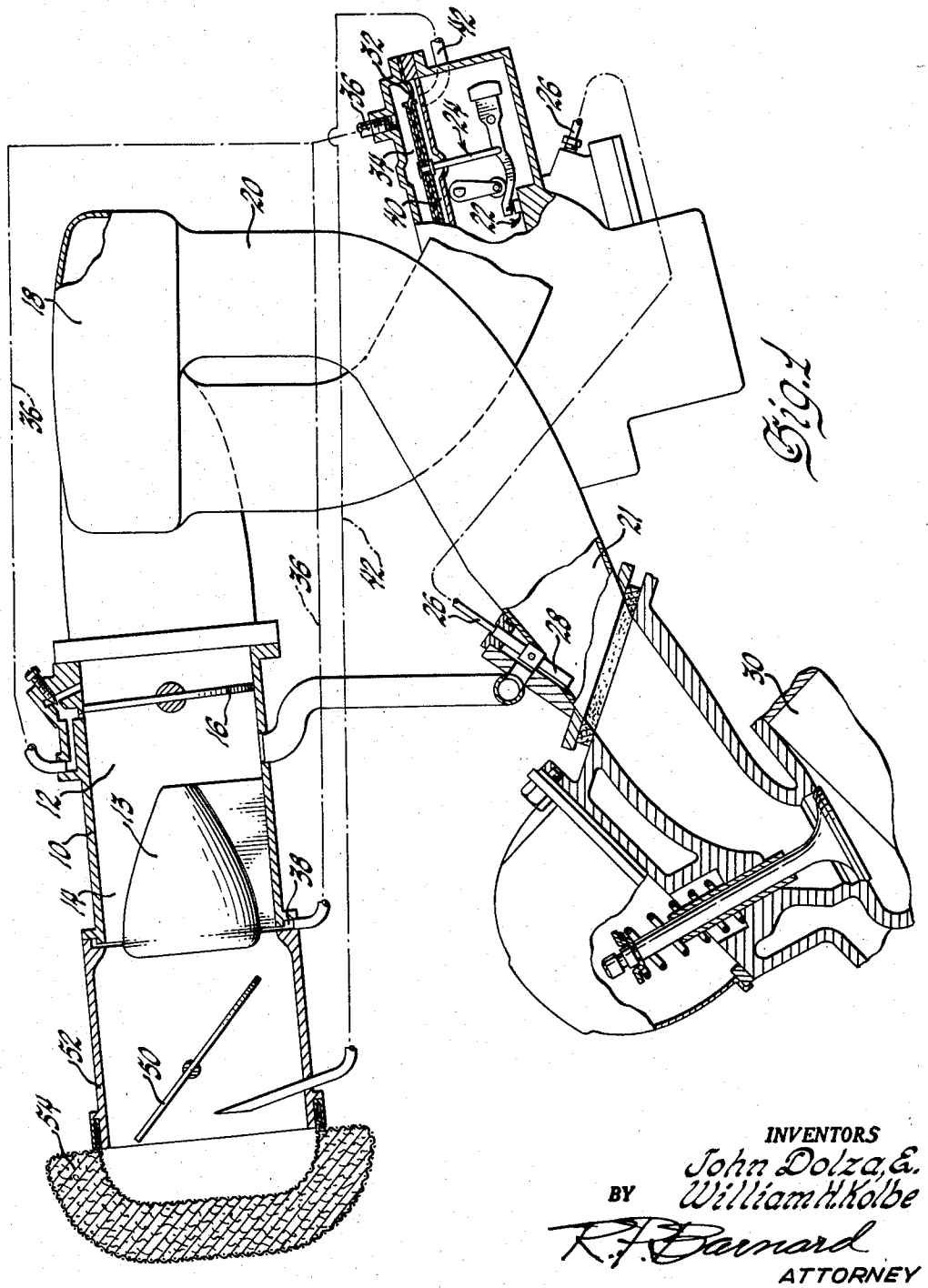


Fig. 1

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Filed May 9, 1957 3 Sheets-Sheet 2

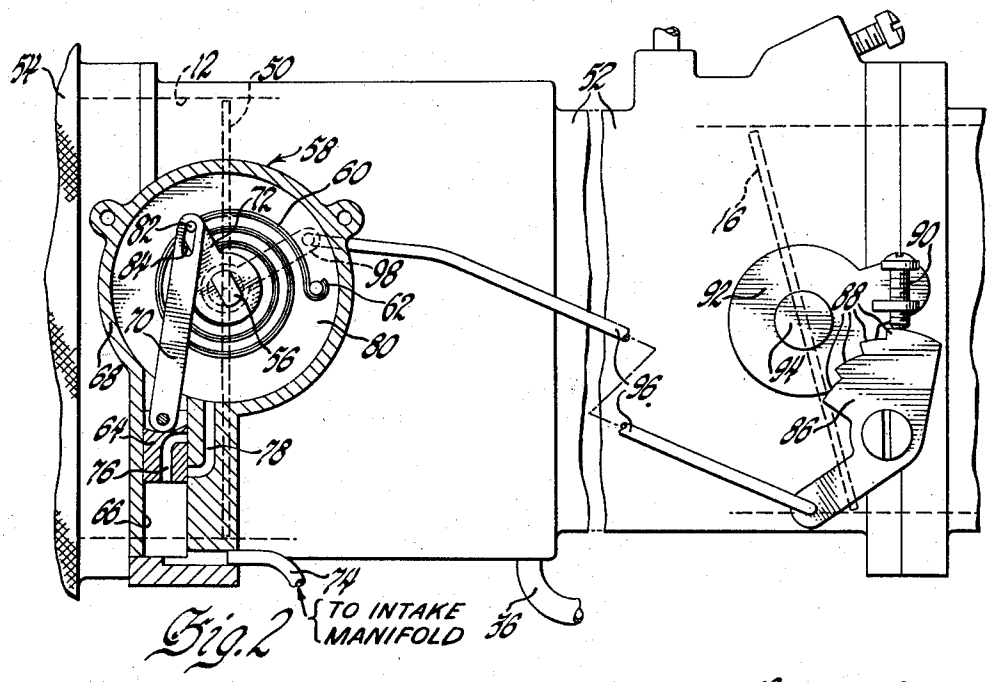


Fig. 2

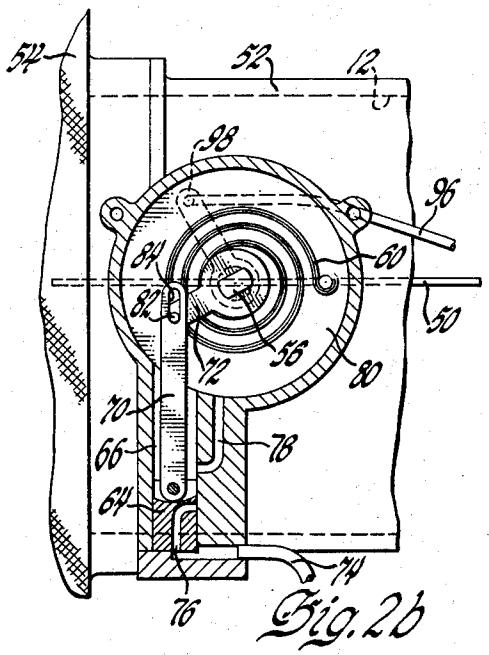


Fig. 2b

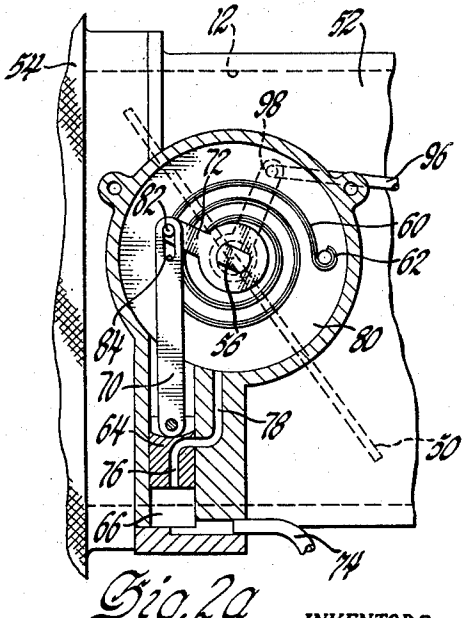


Fig. 2a

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Nov. 24, 1959 J. DOLZA ET AL 2,914,051

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Filed May 9, 1957 3 Sheets-Sheet 3

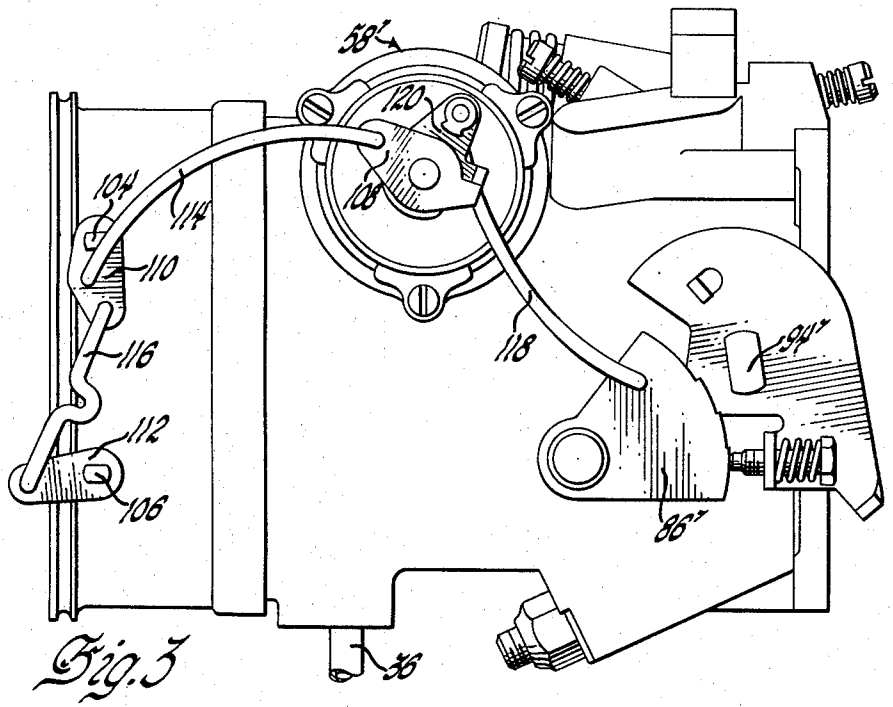


Fig. 3

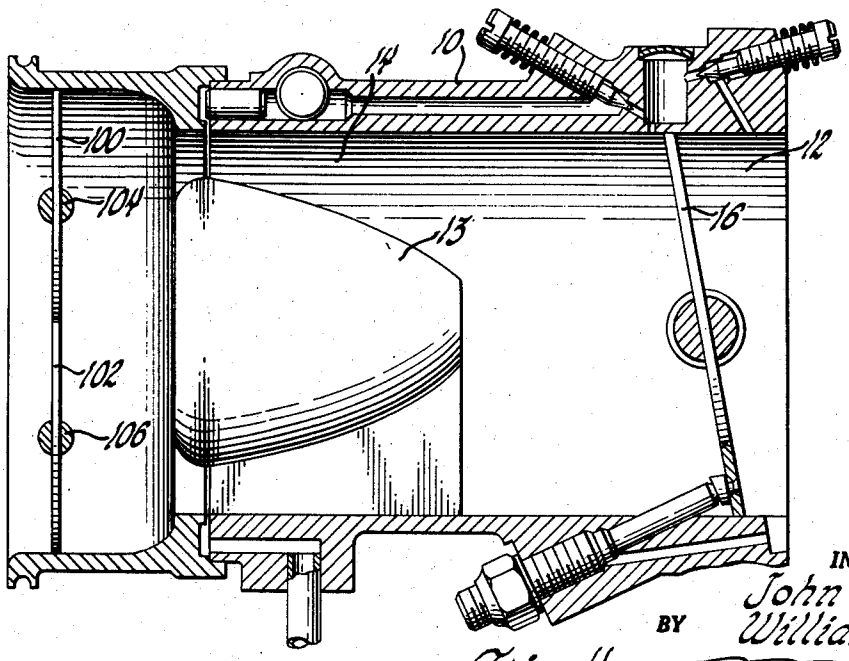


Fig. 4

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SIGNAL MODIFIER FOR FUEL INJECTION SYSTEM

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Application May 9, 1957, Serial No. 658,091

6 Claims. (Cl. 123—119)

The present invention relates to a fuel injection system of the mass air flow type as generally shown in copending application Serial No. 608,853 Dolza, filed September 10, 1956, now Patent No. 2,843,098. In particular, the present device represents an improvement over the earlier Dolza system in providing a novel cold enrichment mechanism. In the earlier Dolza system a solenoid mechanism was provided which retained the fuel metering valve in a maximum flow position for a timed interval to obtain an enriched starting mixture. Such control results in a step type enrichment which approximates but does not reflect the actual needs of the engine.

In the present system a device is provided whereby a modulated enrichment of the system is achieved and which enrichment is accurately determined by the needs of the engine during warm up. In the present device the modulated enrichment is achieved by providing a metering signal modifying valve which is controlled by temperature and air flow in such a way as to vary the metering vacuum signal in inverse proportion to such temperature and air flow.

In the present invention the signal modifier valve is mounted in the air intake or induction passage anteriorly of the venturi and is offset with respect to the induction passage so as to be responsive to the air flow therethrough and is further connected with a thermostatic element which tends to close said valve with a force inversely proportional to temperature. The present signal modifier valve is adapted to coact with the venturi so as to provide a fuel metering control force which is proportional to the quantity of air flowing through the venturi and the degree to which said valve is closed.

The details as well as other objects and advantages of the present invention are set forth in the description which follows.

In the drawings:

Figure 1 is a partially sectioned view of a fuel injection system embodying the subject invention;

Figures 2, 2*a* and 2*b* are enlarged views showing the subject invention in greater detail; and

Figures 3 and 4 represent a modified form of the subject invention.

Except as will hereinafter be specifically pointed out, the present fuel injection system functions in the same manner as in the aforenoted copending Dolza application. Briefly, the fuel injection system includes an intake casing **10** having an air induction passage **12** formed therethrough. The induction passage **12** includes a tapered plug **13** disposed therein which coacts with the casing **10** to define an annular venturi **14**. A throttle valve **16** is also disposed in the induction passage **12** posteriorly to venturi **14**. The induction passage communicates with an air manifold or plenum chamber **18** from which the air is supplied to the individual cylinders of the engine through intake passages **20**. Fuel under pressure is supplied from a source **21** to a valve member indicated generally at **22** where the fuel is metered through the action of a diaphragm controlled linkage mechanism **24**. The

metered fuel from valve **22** is supplied to conduits **26** which communicate with the individual cylinder intake passages **20** and each of which conduits terminates in a nozzle member **28**. In this way the fuel and air are adapted to be mixed just prior to their induction into the engine cylinders **30**.

Metering valve control mechanism **24** includes a diaphragm **32** having a vacuum chamber **34** which communicates with venturi **14** through a conduit **36** and an annular open venturi chamber **38**. The diaphragm **32** also includes another chamber **40** which is vented to the atmosphere through a conduit **42** within the induction passage **12** anteriorly of the venturi **14**.

As already noted, in the earlier Dolza application a solenoid was provided for retaining the metering valve **22** in a maximum fuel output position to provide cold starting enrichment. The solenoid type enrichment control represents an approximation of engine needs and which cold starting and running enrichment control is considerably refined by the mechanism now to be described.

The theory of the present device has been to provide a mechanism whereby the metering control force acting on diaphragm **32** is reinforced or supplemented in inverse proportion to engine air flow and temperature. In this way when the engine is coldest a maximum metering signal will be generated and will retain the metering valve **22** in its maximum fuel output position. The reinforcing of the metering signal will progressively diminish or be modulated as the engine warms and becomes capable of running on a leaner fuel-air mixture.

To this end, and as shown in Figures 1 and 2, a signal modifying valve **50** is disposed in an extended intake casing portion **52** upon which an air cleaner **54** is adapted to be mounted. As better seen in Figures 2*a* and 2*b*, the modifying valve **50** is mounted on a shaft **56** which is offset with respect to the intake passage so that the valve is unbalanced and hence responsive to air flow tending to open as such flow increases. In order, under cold starting conditions particularly, to supplement the metering control signal which is normally generated in venturi chamber **38** by air flow therepast, it is necessary to maintain the valve **50** in a closed position. In this way manifold depression will create a high vacuum force posteriorly of the modifier valve **50** and in so doing increase the vacuum force in vacuum chamber **38**.

To maintain the modifier valve in a closed position and to open the same as the engine warms, a temperature responsive mechanism indicated generally at **58** is provided. The temperature responsive mechanism includes a bimetallic coil element **60** adapted to be anchored at one end **62** to the induction casing and fixed at its other end to the modifier valve shaft **56**. Thermostatic coil **60** is so arranged that the force with which it retains the valve **50** in a closed position varies inversely with temperature.

It is also desirable to make the modifier valve **50** responsive to engine load which is manifested by the magnitude manifold vacuum. To this end, a vacuum piston **64** is mounted in a bore **66** formed in the casing **68** of the thermostatic mechanism **58**. Piston **64** is suitably articulated to the modifier valve shaft **56** through a link **70** and a lever **72** fixed to the shaft. A conduit **74** is adapted to communicate manifold vacuum to the end of the vacuum piston **64** so as to urge the latter in a valve opening direction as manifold vacuum increases to indicate a decrease in engine load.

As thus far described the signal modifier valve is made responsive to three engine operating conditions, namely, engine temperature through bimetallic member **60**, engine demand through the offset or unbalance construction of valve **50** and engine load through vacuum piston **64**.

If it should be desired to tailor the operation of the signal modifier valve for a particular type of stepped operation, it is possible to provide a passage **76** in the vacuum piston **64** which is adapted to bleed down to reduce the effectiveness of manifold vacuum on the piston during certain phases of engine operation. A conduit **78** is formed in casing **68** and communicates with piston bore **66** and the thermostatic chamber **80**, the latter which may be maintained at atmospheric pressure or, as will subsequently be considered, may be in communication with a stove or heating mechanism. Under certain operating conditions conduit **78** is adapted to be communicated with conduit **76** in vacuum piston **64** as will be seen from a description of the operation of the device which follows.

With the engine cold and hence requiring an enriched fuel-air mixture thermostatic element **60** will retain the modifier valve **50** in its closed position as shown in Figure 2. In such position a maximum metering signal will be transmitted through venturi chamber **38** and conduit **36** to diaphragm chamber **34** which will position the metering valve **22** in a maximum fuel flow condition. After the engine begins to fire manifold vacuum will shift the vacuum piston **64** to the position shown in Figure 2*a* in which the signal modifier valve is partially opened and also in which position piston conduit **76** communicates with conduit **78** to bleed down the manifold vacuum force acting on the piston. This will cause the modifier valve **50** to be retained in the partially opened position until such time as the engine warms sufficiently to permit the thermostatic coil member **60** to relax and open the valve sufficiently more to move the vacuum piston **64** to interrupt the registry between conduits **76** and **78** permitting manifold vacuum to again urge the valve to a still further open position.

In order that the final amount of opening of the modifier valve **50** be under the control of the thermostatic coil member **60** a lost motion pin and slot connection **82** and **84** is formed between lever **72** and link **70** so that after manifold vacuum causes the piston **64** to bottom within the casing bore **66** as shown in Figure 2*b*, the bimetallic coil will complete the final opening of the valve.

If it is desired to make the coil **60** more accurately responsive to engine temperature, it is possible, as suggested above, to communicate the thermostatic chamber **80** with a source of engine heat such as the exhaust manifold. In this event the manifold vacuum acting on vacuum piston **64** will draw such heated air across the thermostatic member when conduits **76** and **78** are in registry. It is apparent that, if such is desired, the device may be modified to continuously draw heated air through chamber **80**.

If it is preferable to eliminate the stepped type control of the air valve which is achieved by providing the conduits **76** and **78**, it is possible to eliminate the latter conduits whereby manifold vacuum will continuously act on the piston **64** to provide an even engine load modulation of the action of the thermostatic element **60**.

During cold starting and cold running operation engine friction is higher than during warm engine operation. For this reason it is normal practice to provide means for supplying a greater charge to the engine when the latter is cold than when it is warm. For this purpose a fast idle cam member **86** is mounted on the induction casing **52**. Cam **86** includes a stepped cam surface **88** with which an adjustable screw member **90** mounted on a lever **92** fixed to the throttle shaft **94** can coact to regulate the quantity of air which flows past the throttle **16** under idling conditions. Thus as engine temperature increases, the fast idle cam is adapted to be rotated in a clockwise direction, as viewed in Figure 2, causing the screw **90** to progressively engage lower steps of the cam and reduce the engine idling speed. The rotation of the fast idle cam **86** is adapted to be controlled by the thermostatic element **60** to which it is articulated through a suitable link **96** and lever **98**.

If it is desired to reduce the longitudinal displacement

or length of the induction passage casing, it is possible to utilize a pair of signal modifying valves **100** and **102** as shown in the modification of Figures 3 and 4. In this event, the individual valves **100** and **102** are mounted on separate shafts **104** and **106** and have unbalanced areas in order to be air flow responsive as in the modification of Figures 1 and 2.

Further, if it is desired for better heat response or other reasons to mount the thermostatic controlling mechanism other than on the modulating valve shaft **56**, as shown in Figures 1 and 2, it is possible to position this mechanism **58'** elsewhere, as shown in Figure 3. In this case the mechanism **58'** is connected through suitable levers and links **108**, **110**, **112**, **114** and **116** to the signal modifying valve shafts **104** and **106**. In the case of the modification of Figure 3, a link **118** articulated between the thermostat lever **120** and fast idle cam **86'** determines the idle position of throttle shaft **94'**.

It is apparent that various modifications may be made in the present device within the scope of the invention as set forth in the appended claims.

We claim:

1. A fuel injection system for an internal combustion engine comprising an air induction passage, an annular venturi means disposed in said induction passage, a throttle valve in said induction passage posteriorly of said venturi means, a plurality of intake passages communicating the induction passage with the individual cylinders of said engine, a source of fuel under pressure, conduit means for communicating said fuel source with the intake passages, a metering valve intermediate said fuel source and said conduit means, diaphragm means for actuating said metering valve, an annular chamber formed in said induction passage and communicating with said venturi means, a conduit communicating said chamber with said diaphragm means for increasing the flow through said metering valve with an increase in air flow through said venturi, air flow responsive valve means disposed in said induction passage anteriorly of said venturi means, a temperature responsive member operatively connected to said air flow responsive valve means for resiliently holding said valve means in a closed position to increase the vacuum force in said induction passage chamber whereby said metering valve will insure an enriched fuel-air mixture when the engine is cold, said temperature responsive member being adapted to open said air flow valve as the engine warms, and engine load responsive means for modifying the operation of the temperature responsive member.

2. A fuel injection system for an internal combustion engine comprising an air induction passage, an annular venturi means disposed in said induction passage, a throttle valve in said induction passage posteriorly of said venturi means, a plurality of intake passages communicating the induction passage with the individual cylinders of said engine, a source of fuel under pressure, conduit means for communicating said fuel source with the intake passages, a metering valve intermediate said fuel source and said conduit means, diaphragm means for actuating said metering valve, an annular chamber formed in said induction passage and communicating with said venturi means, a conduit communicating said chamber with said diaphragm means for increasing the flow through said metering valve with an increase in air flow through said venturi, air flow responsive valve means disposed in said induction passage anteriorly of said venturi means, a temperature responsive member operatively connected to said air flow responsive valve means for resiliently holding said valve means in a closed position to increase the vacuum force in said induction passage chamber whereby said metering valve will insure an enriched fuel-air mixture when the engine is cold, said temperature responsive member being adapted to open said air flow valve as the engine warms, and manifold vacuum responsive means operatively connected to said air flow

valve for urging said valve in an open direction as manifold vacuum increases.

3. A fuel injection system for an internal combustion engine comprising an air induction passage, an annular venturi means disposed in said induction passage, a throttle valve in said induction passage posteriorly of said venturi means, a plurality of intake passages communicating the induction passage with the individual cylinders of said engine, a source of fuel under pressure, conduit means for communicating said fuel source with the intake passages, a metering valve intermediate said fuel source and said conduit means, diaphragm means for actuating said metering valve, an annular chamber formed in said induction passage and communicating with said venturi means, a conduit communicating said chamber with said diaphragm means for increasing the flow through said metering valve with an increase in air flow through said venturi, air flow responsive valve means fixed for rotation on a shaft in said induction passage anteriorly of said venturi means, a bimetallic temperature responsive coil concentrically disposed about and fixed at one end to said shaft, said coil fixed against movement at its other end for resiliently holding said valve means in a closed position against the force of air flow to increase the vacuum force in said induction passage chamber whereby said metering valve will insure an enriched fuel-air mixture when the engine is cold, said coil being adapted to open said air flow valve as the engine warms, a piston mounted on the induction passage and articulably connected to the air flow valve shaft, and conduit means communicating manifold vacuum with said piston to urge the air flow valve in an open direction as engine load decreases.

4. A fuel injection system as set forth in claim 3 in which said vacuum piston is connected through a lost motion mechanism to the air flow valve shaft whereby under certain operating conditions manifold vacuum is inoperative to effect the position of said valve.

5. A fuel injection system for an internal combustion engine comprising an air induction passage, intake passages communicating the induction passage with the individual cylinders of the engine, a source of fluid under pressure, conduit means communicating said fuel source with the individual intake passages, valve means for metering the quantity of fuel flow through said conduit means, diaphragm means for controlling the actuation of said valve, a venturi in said induction passage, a conduit communicating with said venturi and said diaphragm means whereby said latter means is actuated to increase the output of said metering valve in proportion to the mass of air flow through said venturi, a throttle valve disposed in said induction passage posteriorly of said venturi, and valve means disposed in said induction passage anteriorly of said venturi for modifying the diaphragm metering control force in accordance with certain engine operating conditions.

6. A fuel injection system for an internal combustion engine comprising an air induction passage, intake passages communicating the induction passage with the individual cylinders of the engine, a source of fluid under pressure, conduit means communicating said fuel source with the individual intake passages, valve means for metering the quantity of fuel flow through said conduit means, diaphragm means for controlling the actuation of said valve, a venturi in said induction passage, a conduit communicating with said venturi and said diaphragm means whereby said latter means is actuated to increase the output of said metering valve in proportion to the mass of air flow through said venturi, a throttle valve disposed in said induction passage posteriorly of said venturi, and valve means disposed in said induction passage anteriorly of said venturi for modifying the diaphragm metering control force in accordance with certain engine operating conditions, a cam for limiting the idle position of the throttle valve and means connecting said valve means and cam whereby the position of said cam is determined by the position of said valve means.

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