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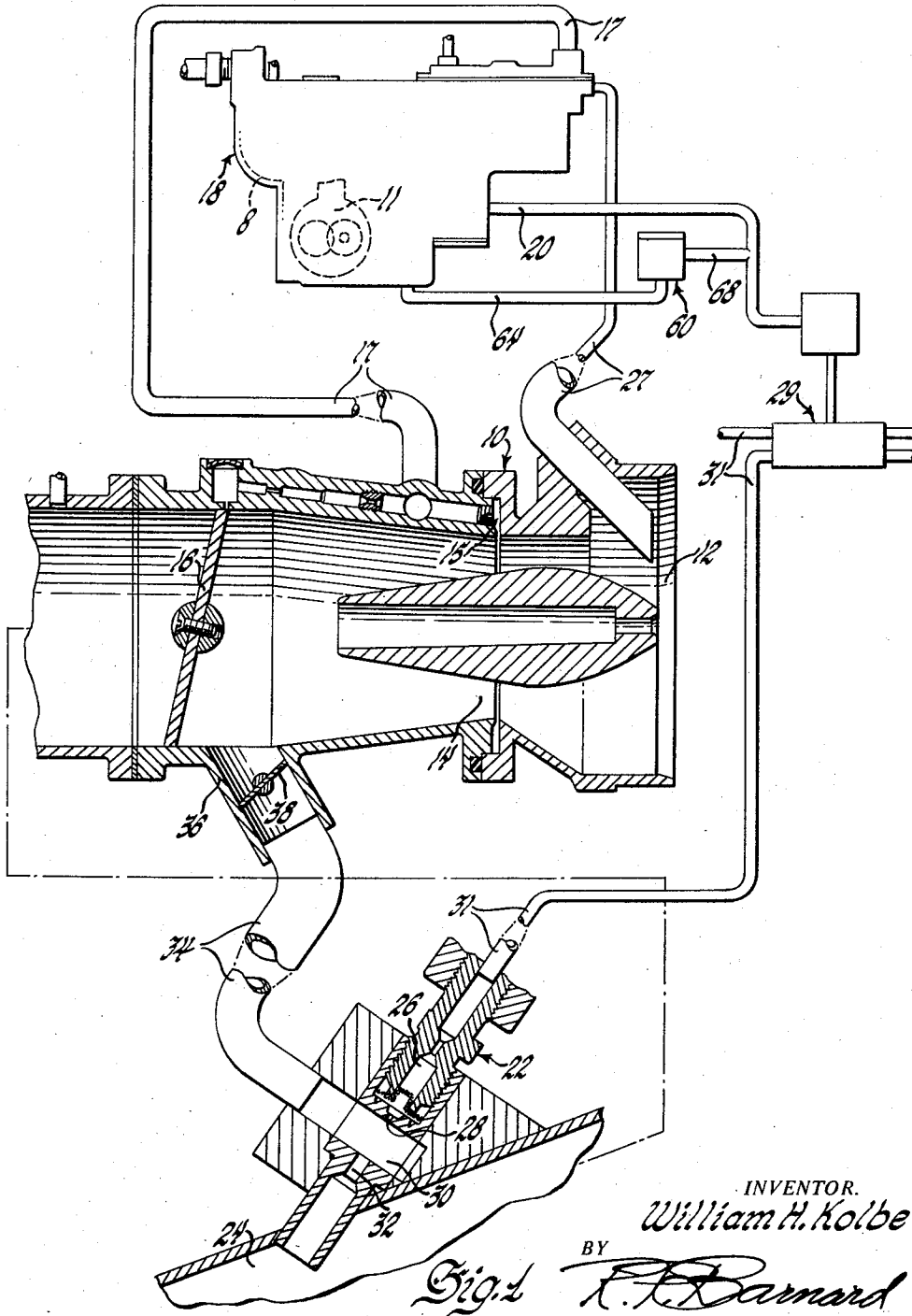
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FUEL INJECTION ENRICHMENT DEVICE

Filed March 5, 1958

2 Sheets-Sheet 1



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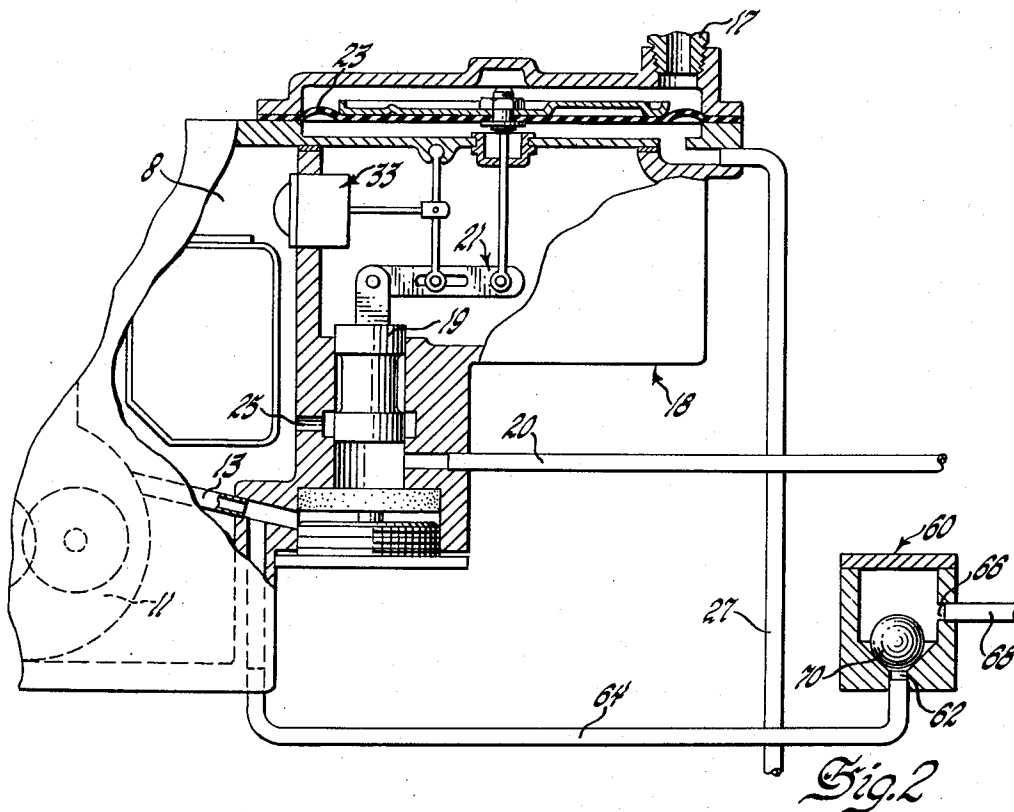
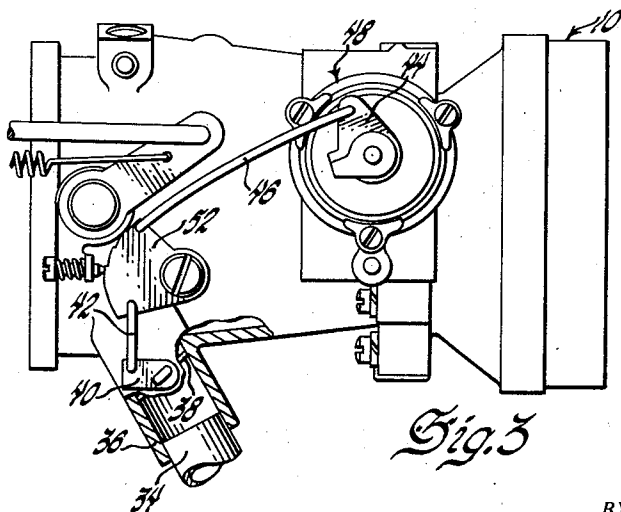
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FUEL INJECTION ENRICHMENT DEVICE

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5 Claims. (Cl. 261—37)

The present device relates to an improved fuel injection system of the mass air flow type and more particularly such system employing an atmospheric type nozzle.

The present fuel injection system is of the type shown in copending application Serial No. 608,893 Dolza, filed September 10, 1956, now Patent No. 2,860,859 granted Nov. 18, 1958. In the noted Dolza system a fuel nozzle is utilized in which atmospheric reference air is introduced into the nozzle fuel stream in order that the fuel flow through the nozzle is not affected by the variations in manifold depression to which the nozzle is subjected.

While under normal operating conditions it is desirable that the fuel flow through the nozzle be unaffected by manifold vacuum, it has been found that this force may be utilized under certain operating conditions to provide fuel enrichment. With the engine cold it has been found necessary to provide means for enriching the normal fuel-air mixture of a fuel injection system. In the Dolza system noted this is achieved by a temperature responsive mechanism which causes the mechanical advantage of a fuel control linkage to be changed to insure fuel enrichment for a given time interval.

In the present device a simple means has been provided whereby manifold vacuum may act directly on the nozzle fuel stream to thereby facilitate starting and cold running enrichment. More specifically, the present device is an improvement upon Serial No. 662,928 Dermond, filed May 31, 1957, now Patent No. 2,860,616 granted Nov. 18, 1958, in which fuel enrichment is realized by providing an engine temperature responsive valve adapted to cut off the flow or bleed of atmospheric reference air to the fuel nozzle as long as the engine is cold, and further to gradually restore the flow of such air as the engine temperature increases. The present improvement consists of providing a manifold vacuum operated bypass valve in parallel with the normal fuel metering valve intermediate the nozzle and fuel reservoir. When atmospheric air is restricted or cut off from the nozzle for enrichment purposes, manifold vacuum creates a pressure drop across the bypass valve which unseats the latter to supply fuel directly from the fuel reservoir to the nozzle.

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 shows a fuel injection system embodying the present invention;

Figure 2 is a detail enlarged view of a portion of Figure 1; and

Figure 3 is a partially sectioned view of the air intake passage.

The fuel injection system functions in the same manner as in the aforementioned copending application except as will be specifically described herein. In general, the fuel injection system comprises an air intake casing 10 having air induction passage 12 formed therein. A venturi 14 is formed in said induction passage which also includes

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a throttle valve 16 disposed posteriorly of said venturi. A fuel metering mechanism is shown generally at 18. In brief, mechanism 18 comprises a metering valve 19 to which fuel under pressure is supplied through conduit 13 by a pump 11 in fuel reservoir 8. Valve 19 is operatively connected through a linkage system 21 to a diaphragm 23. As air flow increases through venturi 14 a vacuum force proportional to air flow is created in annular chamber 15 and is transmitted through a conduit 17 to the upper side of the diaphragm. This causes valve 19 to progressively block off a spill or bypass passage 25 which increases the fuel flow to fuel conduits 20. A conduit 27 vents the lower side of diaphragm 23 to the atmosphere.

As described in the aforementioned Dolza application, an engine load responsive device 33 is provided for changing the mechanical advantage of lever system 21 to achieve economy fuel flow when the engine load is normal. Fuel conduit 20 supplies a distributor 29 from which conduits 31 supply the individual cylinder intake passages 24. Each conduit 31 terminates in a nozzle 22 supported upon and partially projecting within the individual cylinder intake passages 24. Each fuel nozzle 22 includes a fuel inlet passage 26 which terminates in a fuel metering orifice 28. The fuel from metering orifice 28 is projected in a stream across the enlarged chamber 30 where it is targeted through a larger air metering orifice 32. Chamber 30 communicates with a conduit 34 which communicates at its other end with the air intake casing 10 to provide reference air to the nozzle 22. The orifice 32 in the nozzle 22 has no metering effect on the fuel flow through the nozzle but does meter the quantity of air which is mixed with the fuel stream prior to its injection into the intake passage 24. As already noted, under normal operating conditions the reference air in chamber 30 neutralizes the manifold vacuum force acting on the end of the nozzle 22 and thereby stabilizes the metered fuel flow.

It is to be noted that air conduit 34 communicates with the air induction passage 12 intermediate the throttle valve 16 and the venturi 14. In this way all air flowing to the cylinders of the engine passes through the venturi 14 and insures a maximum metering signal for the fuel metering control device 18. While it is preferable to communicate the air conduit 34 with the induction passage 12 intermediate the throttle valve 16 and the venturi 14, it is possible to communicate the conduit with the passage at any point anterior to the throttle valve. In other words, it is possible to communicate the air conduit 34 with the air induction passage 12 anteriorly of the venturi 14 if desired.

As best seen in Figure 1, a boss 36 is formed on the intake casing 10 to which the air conduit 34 is suitably connected. A rotatable valve member 38 is disposed in boss 36 and is adapted to control the quantity of air flow through conduit 34. As seen in Figure 3, a lever 40 is fixed to the valve 38 and is articulated through link 42, lever 44 and link 46 to an engine temperature responsive device 48. A fast idle cam 52 is pivotally mounted on the induction casing 10 and suitably articulated to the temperature responsive element 48 by a link 46 in order to control the idle position of the throttle valve 16 in accordance with engine temperature in the well known manner. The temperature responsive element 48 may be disposed within the manifold exhaust cross-over passage or may be disposed on the air intake casing 10 as shown in Figure 3.

Under normal operating conditions, valve 38 will be opened whereby the pressure differential existing between the air induction passage 12 anteriorly of throttle 16 and the cylinder intake passage 24 proximate nozzle 22 will cause air to flow or be bled through conduit 34 and

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nozzle chamber 30. In this way the manifold vacuum acting on the nozzle 22 will be neutralized and have no effect on the quantity of metered fuel flowing through the nozzle. However, with the engine cold the valve 38 will be closed, as shown in Figure 1, cutting off the supply of reference air to the metering nozzle as a result of which the manifold depression acting on the nozzle 22 will cause the flow of fuel through the nozzle to be increased thereby tending to enrich the fuel-air ratio while the engine is cold.

As the engine temperature increases valve 38 will progressively open under the influence of the temperature responsive element 48 permitting the gradual flow or bleed of air through conduit 34. When the engine has reached its normal operating temperature valve 38 will be completely opened under which condition manifold vacuum will no longer have any enrichment effect on the fuel flowing through the nozzle 22.

While the fuel enrichment is obtained, as already described, it is found that metering valve 19 tends to be a limiting factor in the amount of additional or enriching fuel which may flow due to the action of manifold vacuum acting on nozzle 22. Accordingly, the earlier Dermond system has been improved by providing a bypass valve 60 in parallel with metering valve 19. Valve 60 includes an inlet port 62 communicating through a conduit 64 with pump supply passage 13 and an outlet port 66 communicating through a branch passage 68 with nozzle fuel conduit 20. A ball check element 70 is normally biased by nozzle fuel pressure in conduits 20 and 68 against port 62 to block any flow through inlet port 62. Under these conditions all nozzle fuel flow will be through metering valve 19.

When the nozzle air control valve 38 is restricted or closed, manifold vacuum acting on nozzle 22, and hence the fuel in conduit 20, reduces the nozzle fuel back pressure below that of the fuel in passage 64. Under this condition the pressure of the fuel in conduit 64 will unseat ball element 70. Some fuel is, therefore, bypassed around the metering valve 19 and flows directly from reservoir 8 to nozzle 22. The additional or bypassed fuel will continue to be supplied so long as valve 38 restricts air flow to the nozzle 22. In this way additional fuel enrichment is insured whenever valve 38 is positioned to permit manifold vacuum to act on nozzle 22 and influence fuel flow therethrough.

I claim:

1. A charge forming device for an internal combustion engine comprising an intake passage for each cylinder of the engine, nozzle means disposed in said intake passage proximate the associated cylinder, a source of fuel, a valve for supplying metered quantities of fuel to each of said nozzles in accordance with the mass of air flow through said intake passages, temperature responsive valve means for admitting substantially atmospheric air to each of said nozzles, said temperature responsive valve means being open under normal operating conditions whereby manifold vacuum will have no effect on the quantity of fuel being supplied to said nozzles, passage means adapted to bypass fuel around the metering valve to said nozzle, and a valve device in said passage means to control flow therethrough, said valve device blocking flow when said temperature responsive valve means is open and permitting flow when the latter valve means is closed.

2. A charge forming device for an internal combustion engine comprising an intake passage for each cylinder of the engine, nozzle means disposed in said intake passage proximate the associated cylinder, a source of fuel, a valve for supplying metered quantities of fuel to each of said nozzles, temperature responsive valve means for admitting substantially atmospheric air to each of said nozzles, said temperature responsive valve means being open under normal operating conditions whereby manifold vacuum will have no effect on the quantity of fuel

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being supplied to said nozzles, passage means adapted to bypass fuel around the metering valve to said nozzle, and a valve device in said passage means to control flow therethrough, said valve device blocking flow when said temperature responsive valve means is open and permitting flow when the latter valve means is closed.

3. A charge forming device for an internal combustion engine comprising an intake passage for each cylinder of the engine, nozzle means disposed in said intake passage proximate the associated cylinder, a source of fuel, a valve for supplying metered quantities of fuel to each of said nozzles in accordance with the mass of air flow through said intake passages, temperature controlled valve means for admitting substantially atmospheric air to each of said nozzles, said temperature responsive valve means being open under normal operating conditions whereby manifold vacuum will have no effect on the quantity of fuel being supplied to said nozzles, passage means adapted to bypass fuel around the metering valve to said nozzle, and a valve device in said passage means to control flow therethrough, said valve device blocking flow when said temperature responsive valve means is closed, said bypass valve means including a casing having inlet and outlet ports, a ball element adapted to coact with one of said ports, fuel pressure downstream of said bypass valve means normally seating said element to block bypass fuel flow when the temperature responsive valve means is open.

4. A fuel injection system for an internal combustion engine comprising an air intake passage for supplying air to the individual cylinders of the engine, a throttle valve in said passage for controlling the quantity of air flow therethrough, means for supplying a metered quantity of fuel to the passage posteriorly of said throttle, said means including a fuel metering valve, a fuel reservoir, a pump in said reservoir for supplying fuel under pressure to the metering valve, a nozzle disposed in said passage proximate the individual cylinders of the engine, a first fuel conduit communicating said metering valve and said nozzle, a conduit communicating said nozzle with said intake passage anteriorly of said throttle, the pressure differential across the throttle normally causing air to flow through said conduit whereby manifold vacuum acting on said nozzle has no effect on the quantity of fuel flowing therethrough when the air flow through said conduit is unrestricted, a valve disposed in said air conduit, engine temperature responsive means connected to said valve for restricting the quantity of air flow through said conduit in inverse proportion to the temperature of said engine, a second fuel conduit communicating said reservoir and said first fuel conduit, a valve member in the second fuel conduit adapted to supply fuel to said first fuel conduit when air flow is restricted through said nozzle air conduit.

5. A fuel injection system for an internal combustion engine comprising an air intake passage for supplying air to the individual cylinders of the engine, a throttle valve in said passage for controlling the quantity of air flow therethrough, means for supplying a metered quantity of fuel to the passage posteriorly of said throttle, said means including a fuel metering valve, a fuel reservoir, a pump in said reservoir for supplying fuel under pressure to the metering valve, a nozzle disposed in said passage proximate the individual cylinders of the engine, a first fuel conduit communicating said metering valve and said nozzle, a conduit communicating said nozzle with said intake passage anteriorly of said throttle, the pressure differential across the throttle normally causing air to flow through said conduit whereby manifold vacuum acting on said nozzle normally has no effect on the quantity of fuel flowing therethrough when the air flow through said conduit is unrestricted, a valve disposed in said air conduit, engine temperature responsive means connected to said valve for restricting the quantity of air flow through said conduit in inverse proportion to

the temperature of said engine, a second fuel conduit communicating said reservoir and said first fuel conduit, a valve member in the second fuel conduit, fuel pressure downstream of said member tending to move the latter to block fuel flow through the second conduit, reservoir 5 fuel pressure adapted to unseat said valve member when said air valve is closed permitting manifold vacuum to

reduce the fuel pressure downstream of said valve member.

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