Dec. 28, 1943. D. S. HERSEY ET AL 2,337,996

FUEL DISTRIBUTING DEVICE

Filed April 25, 1940 2 Sheets-Sheet 1

Fig. 1

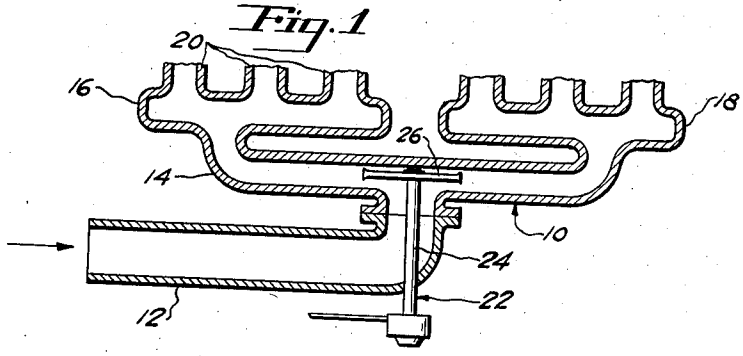
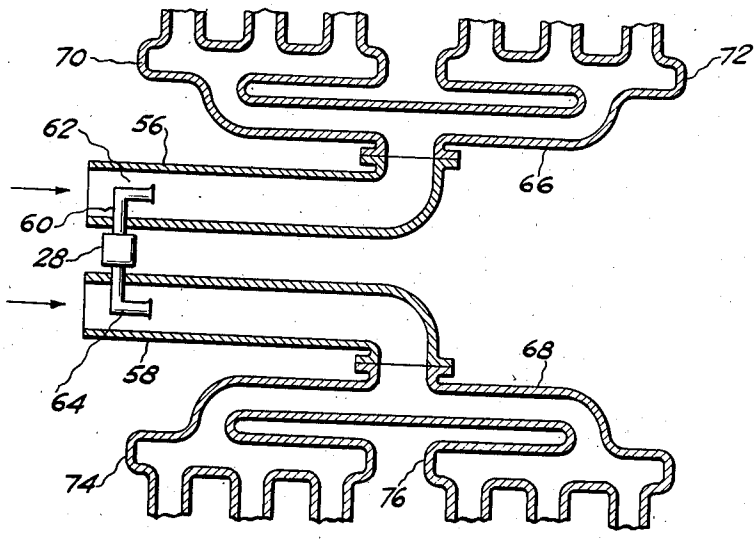


Fig. 2



INVENTOR
Donald S. Hersey
Paul J. Campbell
BY Harris & Luther
ATTORNEY

Dec. 28, 1943. D. S. HERSEY ET AL 2,337,996

FUEL DISTRIBUTING DEVICE

Filed April 25, 1940 2 Sheets-Sheet 2

Fig. 3

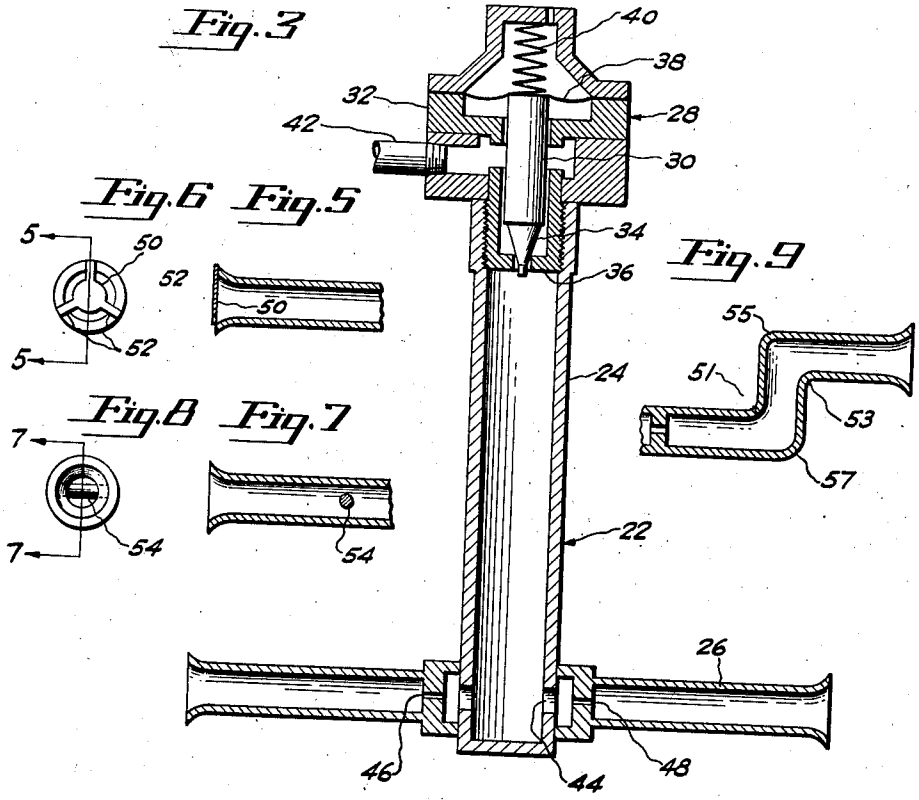
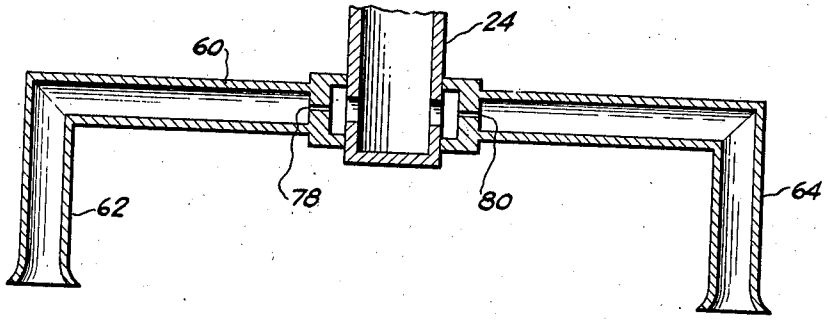


Fig. 6 Fig. 5

Fig. 9

Fig. 8 Fig. 7

Fig. 4



INVENTOR
Donald S. Hersey
Paul J. Campbell
BY Harris G. Luther
ATTORNEY

Patented Dec. 28, 1943

2,337,996

UNITED STATES PATENT OFFICE

2,337,996

FUEL DISTRIBUTING DEVICE

Donald S. Hersey, West Hartford, and Paul J. Campbell, Manchester, Conn., assignors to United Aircraft Corporation, East Hartford, Conn., a corporation of Delaware

Application April 25, 1940, Serial No. 331,560

9 Claims. (Cl. 261—23)

This invention relates to improvements in fuel distributing devices for internal combustion engines and has particular reference to an improved fuel distributing device for an engine of the type in which fuel is mixed with air to form an explosive charge before entering the engine cylinders.

An object of the invention resides in the provision of an improved fuel supply means for a multi-cylinder internal combustion engine arranged to provide a uniform distribution of fuel to all of the cylinders of the engine.

A further object resides in the provision of engine fuel vaporizing and distributing means of the character indicated having an independent nozzle for each of various selected groups of engine cylinders.

A still further object resides in the provision of engine fuel distributing and vaporizing means of the character indicated in which each nozzle is disposed in the air stream flowing directly to the respective group of engine cylinders.

An additional object resides in the provision of fuel vaporizing and distributing means of the character indicated including means for facilitating the vaporization of the fuel and the intermixture of the vaporized fuel and engine intake air.

Other objects and advantages will be more particularly pointed out hereinafter or will become apparent as the description proceeds.

In the accompanying drawings, in which like reference numerals are used to designate similar parts throughout, there is illustrated a suitable mechanical embodiment of the improved fuel vaporizing and distributing device for the purpose of disclosing the invention, one arrangement being illustrated for distributing fuel to a single bank engine and another arrangement being illustrated for distributing fuel to a multiple bank engine. The drawings, however, are for the purpose of illustration only and are not to be taken as limiting the invention since it will be apparent to those skilled in the art that various changes in the illustrated construction may be resorted to without in any way exceeding the scope of the invention.

In the drawings,

Fig. 1 is a somewhat diagrammatic sectional view of the intake manifold system for a single bank engine showing a fuel vaporizing and distributing device constructed according to the invention applied thereto.

Fig. 2 is a somewhat diagrammatic sectional view of the manifold system for a two-bank engine showing a fuel vaporizing and distributing device constructed according to the invention applied thereto.

Fig. 3 is a sectional view on an enlarged scale of the fuel vaporizing and distributing device shown in Fig. 1.

Fig. 4 is a sectional view on an enlarged scale of a fragmentary portion of the fuel vaporizing and distributing device shown in Fig. 2.

Fig. 5 is a sectional view of a fragmentary portion of the fuel vaporizing and distributing device showing the application thereto of one form of means for facilitating the vaporization of the fuel and the distribution of the fuel into the engine intake air stream flowing past the device.

Fig. 6 is an end elevational view of the portion of the device shown in Fig. 5.

Fig. 7 is a sectional view similar to Fig. 5 showing a different form of means for facilitating the vaporization of the engine fuel and the distribution of the fuel into the engine intake air stream.

Fig. 8 is an end elevational view of the portion of the device illustrated in Fig. 7, and

Fig. 9 is a sectional view of a fragmentary portion of the fuel vaporizing and distributing device showing the portion modified to facilitate the vaporization of fuel, and mixture of the vaporized fuel into the engine intake air stream.

Referring to the drawings in detail, and particularly to Figs. 1, and 3, the numeral **10** generally indicates an engine intake system including an intake air duct **12**, a main header **14**, branch headers **16** and **18** connected respectively with the ends of the main header, and risers **20** leading from the respective branch headers to the intake valve ports of the various engine cylinders, not illustrated. The fuel vaporizing and distributing device, generally indicated at **22**, has a stem portion **24** which extends through a portion of the intake manifold system to a point located near the center of the main header **14**. At its end within the header **14** the stem **24** carries a distributing member **26** connected intermediate its length to the stem and provided at each end with a fuel injecting nozzle. The member **26** is disposed substantially at the middle of the main header **14** and substantially parallel to the center line thereof so that its opposite ends are directed respectively towards the opposite ends of this main header. As each end of the main header is connected with a branch header and as each branch header is connected with a selected group of engine cyl-

inders, each end of the member 26 will direct a supply of fuel to a respective cylinder group and, as the ends are exactly similar and are similarly connected with the fuel supply through the stem 24, an equal amount or proportion of fuel will be directed to each small group of engine cylinders.

The construction of the member 22 is more particularly illustrated in Fig. 3. At the end of the header opposite the member 26 there is a fuel supply valve, generally indicated at 28, which receives the engine fuel at a metered rate and acts to prevent leakage or drip of fuel into the intake system when the fuel supply pressure is below a predetermined value. This valve may conveniently include a plunger 30 slidably mounted in a casing 32 and having a tapered end 34 cooperating with a valve seat 36, the opposite end of the plunger being in contact with the center of a flexible diaphragm 38 the edges of which are clamped in the casing 32 and the plunger being urged towards its value-closing position by a compression spring 40. A fuel line 42 leads from a fuel-metering device, not illustrated, into the casing at the side of the diaphragm 38 opposite the spring 40 so that, when the fuel pressure in the line 42 is below the value necessary to compress the spring 40 the valve will be closed but will open when sufficient fuel pressure acts on the diaphragm 38 to compress the spring. When this valve is open fuel flows from the line 42 into the interior of the hollow stem 24 and passes through an aperture 44 in the end of the stem opposite the end connected with the valve member 28 and from this aperture passes through restricted orifices indicated at 46 and 48, into the opposite ends of the nozzle member 26. The orifices 46 and 48 are of the same degree of restriction and insure an equal distribution or proportioning of fuel between the groups of equal numbers of cylinders through the opposite portions of the nozzle member 26. Although the particular construction illustrated has but two orifices 46, 48 and associated nozzles 26 it is to be understood that any desired number of orifices and associated nozzles may be provided.

The ends of the member 26 are flared to create disturbance in the flow of intake air through the manifold system past these flared end portions and to provide a flow surface for the fuel directed somewhat transversely of the airstream in order to obtain a more thorough mixture of the fuel ejected from the member 26 with the intake air and to overcome any tendency toward stratification of the air and fuel.

Further means may be provided, if desired, to atomize the fuel leaving the ends of the member 26 and obtain a more complete and uniform distribution of the fuel through the intake air stream, two examples of such additional means being shown in Figs. 6 to 8, inclusive. In Figs. 5 and 6 the additional means comprises small plates or targets 50, disposed one at each end of the tubular member 26 and held in concentric relation with the tubular member by suitable supporting arms as indicated at 52. The fuel from the orifices 46 and 48 upon impinging against these targets 50 will have its velocity reduced to such an extent that the end portions of the nozzle member will be completely filled with the fuel which will flow at relatively low velocity to the edge of each flared end portion where it will be picked up by the intake air stream and evenly distributed therethrough to carburet the entire mass of intake air. The same effect may be accomplished in a substantial degree by inserting a pin 54 through the fuel nozzle somewhat back from the end thereof, as is particularly shown in Figs. 7 and 8, to reduce the velocity of fuel flow through the nozzle and prevent the formation of a small-diameter, high-speed jet directed into the intake air stream, and the same effect may also be produced to a substantial degree by modifying the form of the nozzle by putting a bend therein as illustrated in Fig. 9, and indicated at 51, 53, 55 and 57.

With an arrangement such as has been described, the fuel flows through and from the nozzle at a comparatively slow rate while the intake air flows through the intake header and past the nozzle at a comparatively rapid rate. This difference in speed of flow enables the intake air stream to be carbureted or pick up the fuel at a substantially uniform rate so that each unit volume of air receives substantially the same quantity of fuel. This results in a more even distribution of air and fuel and a more homogeneous mixture and avoids such distribution defects as stratification, condensation and concentration of the fuel. The three arrangements illustrated for keeping the nozzles filled with fuel and producing a more complete mixture of fuel with the intake air, are shown merely by way of example and various other arrangements accomplishing the same general purpose may be utilized without in any way exceeding the scope of the invention.

While the arrangement shown in Figs. 1 and 3 has been stated to be specially adaptable for a single bank engine, it is obvious that this arrangement could be applied with equal facility to a multiple bank engine by disposing a unit 22 in the manifold system of each bank in the manner described above.

A fuel supply and distributing device particularly adapted for use in a multiple bank engine is particularly illustrated in Figs. 2 and 4. The construction of the device for use with two manifold systems is the same as that described above except that the tube member 24 and valve 28 may be conveniently disposed between the two intake air ducts 56 and 58 and the nozzle member 60 may be extended through the wall of each duct so that an end of the member is located in each duct substantially concentrically thereof. Within each intake air duct the member 60 is provided with a right angle bend so that the end portions as indicated at 62 and 64 thereof are disposed in the direction of the intake air flow through the ducts. In the manifold system illustrated the intake ducts lead to the center portions of main headers 66 and 68 respectively and each main header is connected at each end to a branch header, as indicated at 70 and 72 for the main header 66 and 74 and 76 for the main header 68. Each branch header is connected with a group of engine cylinders in the manner indicated above. This arrangement, by providing a substantially equal distance and substantially equal frictional resistance between the cylinder groups and the respective nozzle from which they receive their fuel supply, tends to provide a substantially uniform distribution of fuel and air to all of the engine cylinders. The fuel is supplied through the valve 28 and tube 24 to the member 60 in the manner described above and enters the opposite end of the member 60 through the metering orifices 78 and 80 which orifices would be

somewhat larger than the orifices 46 and 48 since each nozzle in the arrangement of Figs. 2 and 4 supplies fuel to a greater number of cylinders than do the nozzles in the engine arrangement illustrated in Figs. 1 and 3.

The fuel supplying and distributing device illustrated in Figs. 2 and 4 will supply or proportion equal amounts of fuel to the intake manifolds of the two engine banks and the construction of the nozzle portions of the device will insure a complete intermixture of the fuel and intake air flowing through the manifold system to the respective engine banks.

While a particular constructional arrangement of fuel supplying and distributing device has been hereinabove described and illustrated in the accompanying drawings for the purpose of disclosing the invention, it is to be understood that the invention is not limited to the particular constructional arrangement so described and illustrated but that such changes in the size, shape and arrangement of the various parts may be resorted to as come within the scope of the subjoined claims.

Having now described the invention so that others skilled in the art may clearly understand the same, what it is desired to secure by Letters Patent is as follows:

1. In a device for introducing fuel into each of a plurality of intake air passages for an internal combustion engine, means forming a plurality of air passages, a fuel nozzle in each passage, a fuel supply conduit, means for introducing fuel under pressure into said supply conduit, a plurality of branch conduits connecting each of said nozzles with said supply conduit, and a metering orifice in each said branch conduit, the flow resistance of said metering orifices being each sufficiently large relative to the fuel pressures in said branch conduits that the amount of fuel flow in each branch conduit is substantially determined only by the capacity of the respective orifice and the pressure of the fuel in said supply conduit, each branch conduit and nozzle being materially larger in cross-sectional area than the respective metering orifice yet so proportioned relative to the quantity of fuel passed by said orifice as to maintain said branch conduit and nozzle substantially full of fuel flowing at a low velocity relative to the velocity of the fuel in said metering orifice.

2. In a fuel proportioning and air carbureting apparatus for a multi-cylinder internal combustion engine, means forming a plurality of individual carbureting passages, an air inlet for each of said passages, a plurality of branch fuel conduits discharging respectively into each passage, means for mixing fuel delivered through each of said conduits with the air passing through the respective passage, comprising an enlarged bell-mouth nozzle portion on the end of each branch fuel conduit, and means for proportioning fuel in a predetermined relationship between said nozzles, comprising a single source of fuel under pressure connected to each of said branch conduits and a metering restriction in each branch conduit between each nozzle and said single fuel source.

3. In a fuel proportioning and carbureting means for a multi-cylinder internal combustion engine, a plurality of air conduits, a plurality of fuel conduits each provided with an externally enlarged diameter end portion, said end portions forming nozzles associated one with each of said air conduits and discharging thereinto for mixing fuel with air passing through said air conduits, a metering restriction in each of said fuel conduits, and means forming a source of fuel under pressure common to all of said fuel conduits, the fuel pressure in said source and the fuel pressure drop across each said metering restriction being sufficiently large relative to variations in the pressure of the air in each said air conduit, that the amount of fuel flow through each fuel conduit is substantially independent of variations in the said air pressure.

4. A fuel and air mixing apparatus for an internal combustion engine comprising a plurality of air conduits, independent branch fuel conduits having end portions positioned one in each of said air conduits and including fuel nozzles for discharging fuel into the airstreams passing through said air conduits, means forming a source of fuel under pressure common to all of said branch fuel conduits, fuel proportioning means comprising metering restrictions in each of said branch fuel conduits between said source and each of said nozzles, and an obstruction to the flow of fuel in each said branch conduit between the metering orifice and the nozzle outlet, each said obstruction being positioned in the path of the jet leaving a respective orifice for receiving the impact thereof and thus reducing the velocity of the jet to insure an initial filling of the branch conduits with fuel.

5. A fuel and air mixing apparatus for an internal combustion engine comprising a plurality of air conduits, independent branch fuel conduits having end portions positioned one in each of said air conduits and including fuel nozzles for discharging fuel into the airstreams passing through said air conduits, means forming a source of fuel under pressure common to all of said branch fuel conduits, fuel proportioning means comprising metering restrictions in each of said branch fuel conduits between said source and each of said nozzles, and an obstruction to the flow of fuel in each said branch conduit between the metering orifice and the nozzle outlet, said obstruction comprising a flat disc target disposed transversely of said conduit at its exit end.

6. A fuel and air mixing apparatus for an internal combustion engine comprising a plurality of air conduits, independent branch fuel conduits having end portions positioned one in each of said air conduits and including fuel nozzles for discharging fuel into the airstreams passing through said air conduits, means forming a source of fuel under pressure common to all of said branch fuel conduits, fuel proportioning means comprising metering restrictions in each of said branch fuel conduits between said source and each of said nozzles, and an obstruction to the flow of fuel in each said branch conduit between the metering orifice and the nozzle outlet, said obstruction comprising a pin extended transversely across said branch conduit.

7. A fuel and air mixing apparatus for an internal combustion engine comprising a plurality of air conduits, independent branch fuel conduits having end portions positioned one in each of said air conduits and including fuel nozzles for discharging fuel into the airstreams passing through said air conduits, means forming a source of fuel under pressure common to all of said branch fuel conduits, fuel proportioning means comprising metering restrictions in each of said branch fuel conduits between said source and each of said nozzles, and an obstruction to the flow of fuel in each said branch conduit between the

metering orifice and the nozzle outlet, said obstruction comprising a sharp bend in said branch conduit.

8. In a carbureting device, an air carbureting passage having an outlet at each end and an inlet connected intermediate its ends, a fuel conduit extending into said passage adjacent said inlet, fuel nozzles connected to said conduit and directed toward the ends of said passage, and a restricted orifice between each nozzle outlet and said conduit, the fuel flow capacity of said orifices being substantially the same, said fuel nozzles comprising elongated tubes surrounding said orifices, there being one nozzle for each carbureting passage outlet.

9. A fuel carbureting and proportioning device comprising, at least two air carbureting passages, a fuel chamber, a single fuel supply line introducing fuel under pressure into said chamber, independent fuel conduits leading from said chamber and including nozzles disposed one in each of said carbureting passages, and a metering orifice in each conduit between each nozzle and said chamber, each conduit comprising a tube connecting a respective orifice with a respective nozzle, each tube having a cross sectional area greater than the cross sectional area of its respective orifice, and a valve in said supply line responsive to fuel pressure and closing upon a reduction in fuel pressure below a predetermined minimum.

DONALD S. HERSEY.
PAUL J. CAMPBELL.