Aug. 8, 1961 R. J. POWELL ET AL 2,995,125

FUEL METERING SYSTEMS

Filed Dec. 28, 1959

FIG. 1.

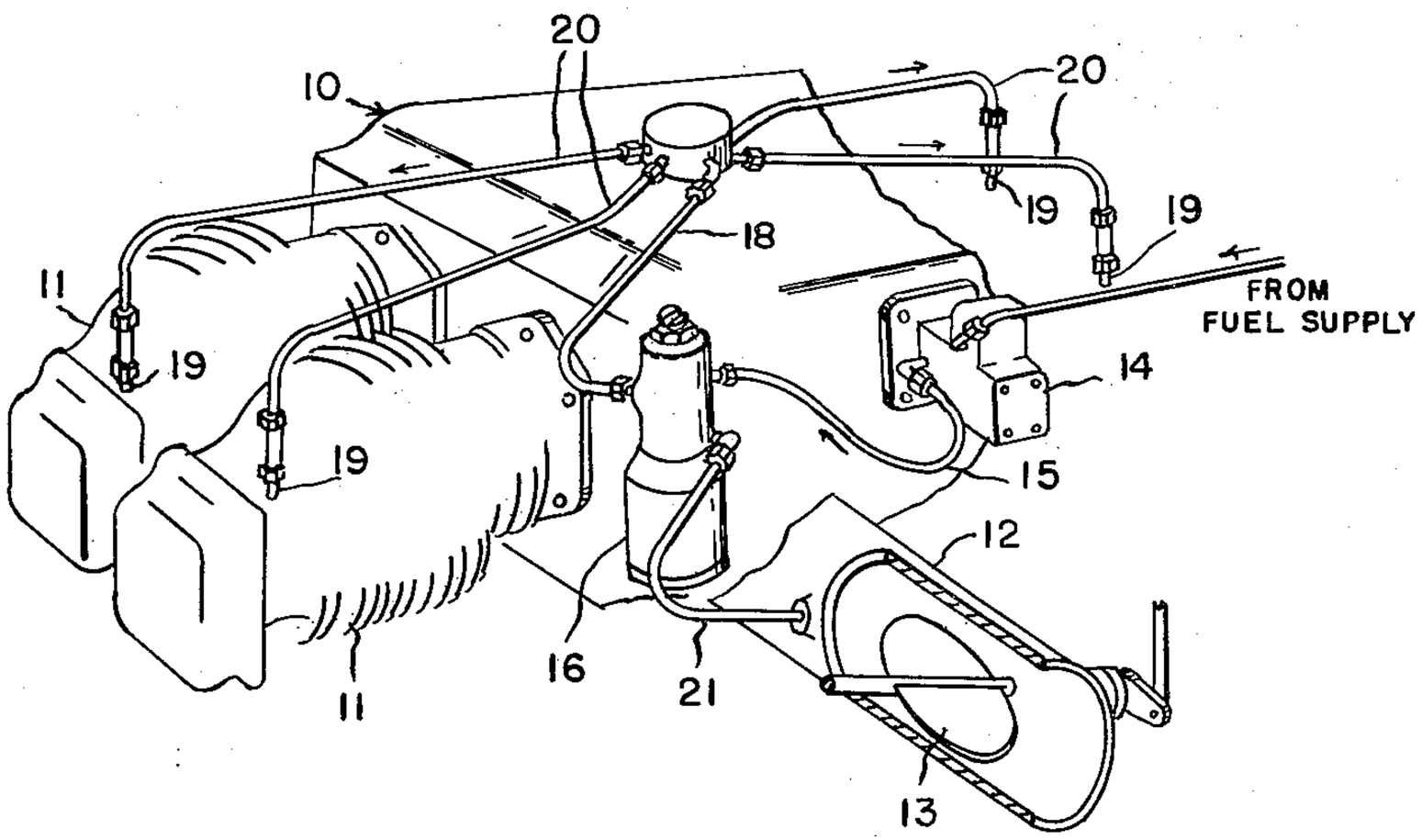
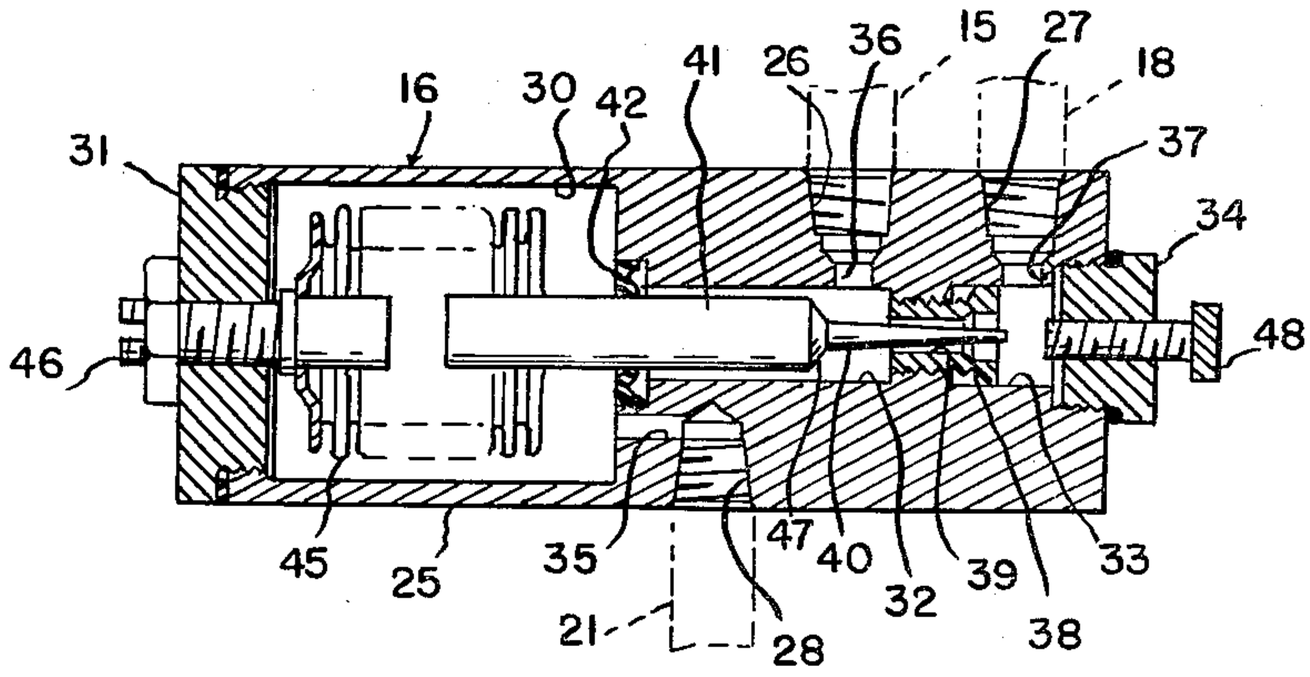


FIG. 2.



INVENTORS
ROBERT J. POWELL
JAMES E. CHAMPION
BY Hauke & Hardesty
ATTORNEYS

United States Patent Office

2,995,125

Patented Aug. 8, 1961

2,995,125

FUEL METERING SYSTEMS

Robert J. Powell and James E. Champion, Muskegon, Mich., assignors to Continental Motors Corporation, Muskegon, Mich., a corporation of Virginia

Filed Dec. 28, 1959, Ser. No. 862,328

6 Claims. (Cl. 123—119)

This invention relates to fuel metering systems for internal combustion engines and more particularly to fuel flow regulating means operable to variably meter fuel to the engine in response to engine speed and air intake manifold pressure variations.

An object of the present invention is to simplify fuel metering systems for small engines by providing a means of regulating fuel flow dependent on variations of air intake manifold pressure and engine speed as it is reflected by fuel pump delivery pressure.

Another object of the invention is to facilitate fuel metering control for internal combustion engines by providing a simplified pressure responsive fuel flow regulator.

A further object of the invention is to improve fuel metering characteristics for an engine in which fuel delivery pressure varies in response to engine speed changes by providing a fuel flow regulator actuated to vary fuel metering in response to variations of fuel delivery pressure and air intake manifold pressure.

For a more complete understanding of the invention, reference may be had to the accompanying drawing illustrating a preferred embodiment of the invention in which like reference characters refer to like parts throughout the several views and in which

FIG. 1 is a diagrammatic perspective view of a preferred fuel metering system incorporating the present invention, and

FIG. 2 is a cross-sectional view of a preferred fuel flow regulator embodied in the invention.

The preferred system is illustrated diagrammatically in FIG. 1 as adapted to an internal combustion engine **10** having cylinders **11**, an air intake manifold **12** having a throttle valve **13**, and an engine driven fuel pump **14** which delivers fuel through a conduit **15** under a pressure which is variable with respect to variations in engine speed.

The fuel injection system comprises, in addition to the fuel pump **14**, a fuel flow regulator **16** to which the conduit **15** delivers fuel, a fuel manifold **17** which receives metered fuel from the regulator **16** through a conduit **18**, and an individual fuel discharge nozzle **19** at each cylinder supplied with metered fuel through conduits **20** connected with the fuel manifold **17**. A pressure sensing conduit **21** connects the regulator **16** with the air intake manifold **12** downstream of the throttle valve **13**.

FIG. 2 illustrates a preferred construction of the regulator **16** as comprising a housing **25** having a fuel inlet port **26** connected to the conduit **15**, a fuel outlet port **27** connected to the conduit **18**, and a port **28** connected to the manifold sensing conduit **21**. The housing **16** is provided with axially aligned chambers, namely a manifold pressure chamber **30** closed by an end cap **31**, a fuel inlet chamber **32**, and a fuel discharge chamber **33** closed by a second end cap **34**, the chambers **30**, **32** and **33** respectively being openly connected with the ports **28**, **26**, and **27** by means of passages **35**, **36** and **37**.

A preferred metering valve element **38** is disposed intermediate the fuel inlet and discharge chambers **32** and **33**, and is provided with a metering orifice **39** openly connecting the chambers **32** and **33**, the open cross-sectional area of the orifice **39** being variably controlled by means of an axially movable tapered pin **40** which is carried on

the end of a plunger or piston **41** extending axially from the fuel inlet chamber **32** into the manifold pressure chamber **30**. The chambers **30** and **32** are separated by means of an annular seal **42** disposed around the piston **41**.

The manifold pressure chamber end of the piston **41** is connected to one end of a pressure sensitive bellows **45** disposed in the manifold pressure chamber **30** and mounted at its other end on an adjustable supporting element **46** carried by the cap **31**. It will be apparent that the axial position of the tapered pin **40**, which determines the fuel flow through the orifice **39** is variable with respect to variations of manifold pressure in the manifold pressure chamber **30** causing the bellows **45** to contract and expand.

The end of the piston **41** disposed in the fuel inlet chamber **32** has a pressure sensitive area **47** which acts also to effect axial adjustment of the piston in response to variations of fuel pressure in the fuel inlet chamber **32**, so that the fuel flow through the orifice **39** as regulated by the pin **40** varies as engine speed increases and decreases.

An idle stop element **48** is preferably adjustably carried by the end cap **34** and limits the valve closing movement of the tapered pin **41**. The stop element as shown is preferably manually set in the present instance, where the engine **10** is used in such aircraft as drones or the like, but it will be apparent that any means can be utilized for adjustment to act as an idle mixture control. Opening movement of the piston **41** is limited preferably by the supporting element **46** to impose a maximum fuel flow through the metering orifice **39**.

In operation, as the throttle valve **13** is opened to a desired position, air intake manifold pressure increases and effects a contraction of the bellows **45**, adjusting the tapered pin towards a more open position, metering an increased fuel flow through the orifice **39**. Engine speed will then increase, assuming that there is a constant load on the engine **10**, and the increase in speed causing an increase in fuel delivery pressure further acts on the piston **41** to effect a further opening adjustment of the pin **40** until that engine speed is reached at which a further increase would cause a reduction of manifold pressure tending to expand the bellows **45** and prevent any further opening adjustment of the pin **40**.

Thus it will be seen that for any position of the throttle valve **13**, the fuel metering of the regulator will provide an optimum fuel flow to the engine by virtue of the balance, on the forces adjusting the piston **41**, of fuel delivery pressure, as determined by engine speed, and air intake manifold pressure, as determined by throttle position and engine speed, assuming other factors to be constant.

The present device eliminates mechanical connections between throttle and fuel metering device, has only one movable element and is readily manufactured, assembled and adjusted, while ensuring efficient metering of fuel to the engine.

Although only one embodiment of the invention is described herein, it will be apparent to one skilled in the art to which the intervention pertains that various changes and modifications may be made therein without departing from the spirit of the invention or the scope of the appended claims.

We claim:

1. A fuel metering system for an internal combustion engine having an air intake manifold and a fuel supply means delivering fuel to said engine at a pressure variable in response to engine speed variations, said fuel metering system comprising a fuel flow regulating means operable to meter the fuel being delivered to said engine, and means actuating said fuel flow regulating means to increase and decrease fuel flow respectively in response to increase and decrease of air intake manifold pressure

and to increase and decrease of fuel delivery pressure, said fuel flow regulating means comprises a regulator housing having a fuel inlet connected with said fuel supply means, a fuel outlet connected with said engine, and a valve means intermediate said inlet and said outlet, and in which said actuating means comprises a pressure responsive means operably connected with said valve means for opening and closing same, means connecting said pressure responsive means with the engine air intake manifold to operate said pressure responsive means directly proportionately to manifold pressure variations, and means connecting said pressure responsive means with said fuel inlet means to operate said pressure responsive means directly proportionately to fuel pressure at said inlet means, said pressure responsive means being operable to open and close said valve means respectively as air intake manifold pressure increases and decreases and respectively as fuel pressure increases and decreases.

2. The fuel metering system as defined in claim 1 and in which said housing has an orifice openly connecting said inlet and said outlet, and in which said valve means comprises a tapered pin element axially movably disposed in said orifice.

3. The fuel metering system as defined in claim 2 and including adjustable means limiting axial movement of said pin element.

4. A fuel metering system for an internal combustion engine having an air intake manifold and a fuel supply means delivering fuel to said engine at a pressure variable in response to engine speed variations, said fuel metering system comprising a fuel flow regulating means operable to meter the fuel being delivered to said engine, and means actuating said fuel flow regulating means to increase and decrease fuel flow respectively in response to increase and decrease of air intake manifold pressure and to increase and decrease of fuel delivery pressure, said fuel flow regulating means comprises a regulator housing having a fuel inlet pressure chamber, means connecting said fuel inlet pressure chamber with said fuel supply means to conduct fuel supply pressure directly to said fuel inlet pressure chamber, a fuel outlet connected with said fuel inlet pressure chamber, a manifold pressure chamber, means connecting said manifold pressure chamber with said air intake manifold to conduct manifold pressure directly to said manifold pressure chamber, and a valve means intermediate said fuel inlet pressure chamber and said outlet, and in which said actuating means comprises a pressure responsive element in each of the aforesaid pressure chambers and means operably connecting said pressure responsive elements with said valve means, said pressure responsive elements being operable to open and close said valve means respectively as air intake manifold pressure increases and decreases and respectively as fuel pressure increases and decreases.

5. The fuel metering system as defined in claim 4 and including adjustable means operable to limit opening and closing movement of said valve means.

6. The fuel metering system as defined in claim 4 and in which said housing has an orifice openly connecting said fuel inlet pressure chamber and said outlet, and in which said valve means comprises a tapered pin element axially movably disposed in said orifice, said orifice and said chambers being axially aligned, one of said pressure responsive elements comprising a piston disposed in said fuel inlet pressure chamber and extending into said manifold pressure chamber, said piston carrying said tapered pin element and having a fuel pressure sensitive area exposed to fuel pressure in said fuel pressure chamber whereby to move said tapered pin to positions increasing and decreasing the open cross-sectional area of said orifice respectively as fuel pressure increases and decreases, the other of said pressure responsive elements comprising a pressure actuated means supported by said housing in said manifold pressure chamber and connected to said piston therein, said pressure actuated means being operable to move said piston and the tapered pin carried thereby to positions increasing and decreasing the open cross-sectional area of said orifice respectively as air intake manifold pressure increases and decreases and respectively as fuel supply pressure increases and decreases.

References Cited in the file of this patent

UNITED STATES PATENTS

2,341,257	Wunsch	Feb. 8, 1944
2,891,532	Turlay	June 23, 1959
2,898,899	Karpiej	Aug. 11, 1959