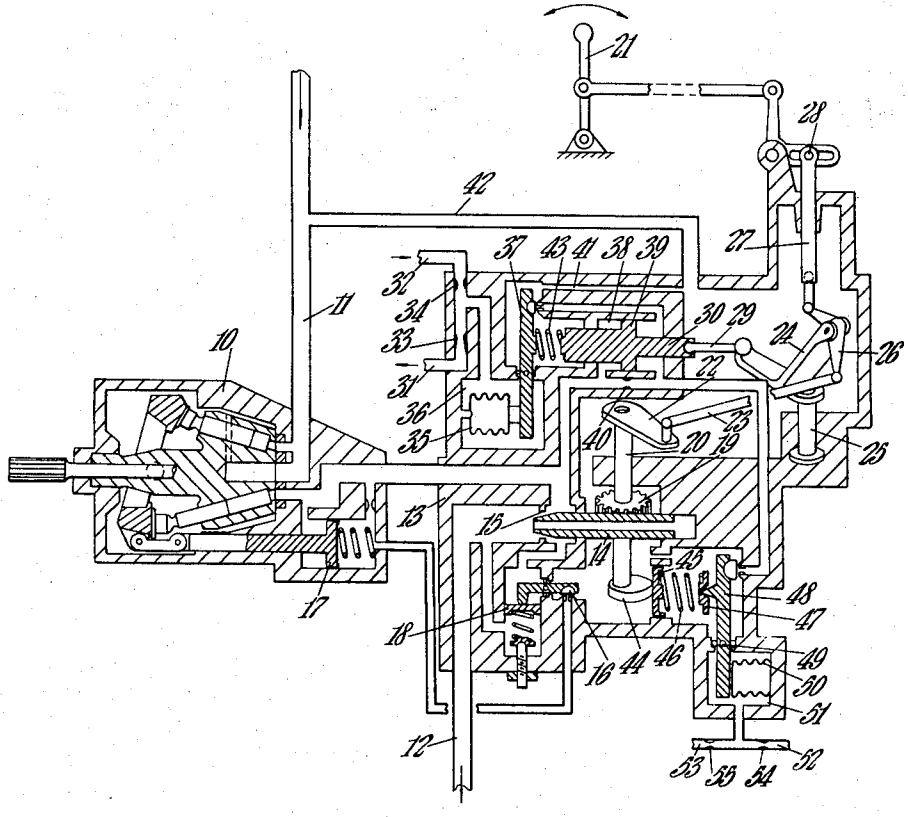
March 5, 1968 E. H. WARNE 3,371,481

FUEL SYSTEMS FOR GAS TURBINE ENGINES

Filed Nov. 8, 1966



United States Patent Office 3,371,481
Patented Mar. 5, 1968

3,371,481

FUEL SYSTEMS FOR GAS TURBINE ENGINES

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Filed Nov. 8, 1966, Ser. No. 592,901
4 Claims. (Cl. 60—39.28)

This invention relates to fuel systems for gas turbine engines, and of the kind having a throttle controllable manually, and also controllable in accordance with changes in a pressure which varies with that in the engine air intake.

The object of this invention is to provide an acceleration control for use with a fuel system as referred to.

In accordance with a primary aspect of the present invention an acceleration control for a gas turbine engine fuel system comprises a throttle, a manual control for the throttle, a further device also for controlling the throttle, said further device being responsive to changes in pressure conditions within the engine with which the system is associated, a cam connected to the throttle so as to be movable therewith, a spring acting between the cam and a valve member, means responsive to changes in the speed of the engine and acting upon the valve member in opposition to the spring, the valve member being arranged to modify the response of said pressure upon the further device for controlling the throttle, the arrangement being such that manual opening of the throttle will increase the load exerted by the spring to actuate the valve to modify the further device in a manner to tend to close the throttle, the resultant force upon the throttle causing its opening rate to be controlled until the engine speed increases to an extent to again actuate the valve member, whereupon equilibrium conditions will be obtained to maintain the engine speed at a new value.

In accordance with a further aspect the invention resides in the provision of a fuel system comprising a pump having a delivery passage to burners in an associated engine, and a throttle and acceleration control as set forth in the preceding paragraph.

The invention will now be described by way of example with reference to the accompanying drawing which is a diagrammatic representation of a fuel system for a gas turbine engine.

The fuel system includes an engine driven pump **10** of the swash-plate type arranged to obtain a supply of fuel from a reservoir (not shown) through an inlet passage **11** and connected to a passage **12** leading to burners (not shown) in the engine. The passage **12** passes through a body **13** containing a throttle **14** in the passage **12**, the throttle being in the form of a hollow plunger having a tapered end and movable lengthwise with respect to an annular seating **15**. Also within the body **13** and associated with the throttle **14** is a device for maintaining constant pressure drop across the throttle. This device is a valve **16** controlling escape of fuel from a servo mechanism **17** associated with the pump for controlling its stroke, the opening of the valve **16** being determined by the pressures existing at the upstream and downstream sides of the throttle **14** acting upon a piston **18** which in turn exerts a force on the valve **16**.

The throttle **14** is movable through a pinion **19** on a shaft **20** by a linkage which can either be actuated by a manual lever **21** or in response to changes in air pressure conditions in the engine, in a manner to be described. The linkage which is connected in the shaft **20** through an arm **22** and a universally jointed rod **23** has a two armed lever **24** mounted on a shaft **25**, one of the arms of the lever **24** carrying a bell crank **26**, one limb of which is connected through a universally jointed rod **27** and lost motion pin and slot connection **28**, to the manual

lever **21**, and the other limb of the bell crank **26** is connected to the rod **23** to the throttle **14**. The other arm of the lever **24** is connected, through a further universally jointed rod **29** to a member **30** which is controlled in a manner to be described.

The linkage is preferably however so constructed that it is capable of occupying a position in which the manual lever **21** can be moved without moving the throttle **14**, or a further position in which movement of the member **30** has no effect upon the throttle.

The member **30** moves in response to changes in the ratio of two pressures exerted respectively in the passages **31**, **32**. In this example the pressures are atmospheric pressure and that obtaining in the engine intake respectively. The passages **31**, **32** have respective restrictors **33**, **34** and the intermediate pressure is exerted upon an evacuated bellows **35** mounted in a chamber **36** in the body **13**. The bellows **35** is connected to a valve member **37** controlling the pressure in a cylinder **38** containing a piston **39** to which the member **30** is connected. Pressure conditions in the cylinder **38** are derived from the pump outlet passage **12**, at a position upstream of the throttle **14**, one end of the cylinder being supplied therefrom through a restrictor **40**. Escape of fuel takes place past the valve **37** through a passage **41** communicating through a further passage **42** with the pump inlet passage **11**. A spring **43** acts between the piston **39** and the valve member **37**.

The arrangement of this portion of the apparatus is such that a signal which varies with the engine air intake pressure is applied through the valve member **37** and thence through the spring **43** to the piston **39**. Movement of the valve member **37** opens the cylinder **38** to the passage **41**. This causes movement of the piston **39** to compress the spring **43** so that it exerts a pressure to close the valve. Movement of the piston **39** causes the linkage to take up a new position which in turn alters the setting of the throttle **14**. As described, such movement of the piston **39** causes a feed back which arrests the piston in its new position.

When accelerating a gas turbine engine, it is necessary to supply an additional quantity of fuel, and to provide for this, the system shown in the drawing includes a cam **44** which is attached to the lever spindle **20** carrying the throttle operating pinion **19**, this cam **44** bearing against an abutment plate **45** for a compression spring **46**, the opposite end of which bears upon a further abutment plate **47** carried by a valve member **48**. The valve member **48** is arranged to control flow of fuel through a passage **49** which communicates with the end of the cylinder **38** remote from the spring **43**. The valve member **48** is pivotally mounted on a fixed support in the body **13** in its mid-region indicated by numeral **49** and acting against the spring **46** is a bellows **50** which is evacuated and which is disposed in a chamber **51** to the interior of which is supplied, in use, a pressure which is responsive to engine speed, and which is substantially higher than the pressure on the bellows **35**. This pressure is an intermediate pressure corresponding to the ratio of the pressure, exerted in two passages **52**, **53** having restrictors **54**, **55** respectively. The pressure in the passage **52** is the pressure at the upstream side of the engine compressor and that in the passage **53** is the pressure at the downstream side of the compressor, or of a first compressor thereof as the case may be.

In use under steady running conditions, the valve member **48** provides limited flow from the cylinder **38** and the position of the linkage is determined by a setting of the manual lever **21** and also by the pressure on the bellows **35**, the latter determining the position of the valve member **37** and thus the position of the piston **39**

in the cylinder **38**, as modified by the flow past the valve member **48**.

If it is desired to accelerate the engine, the manual lever **21** is moved to a new setting, thus moving the throttle **14** to the right as seen in the drawing. The cam **44** is also moved and this increases the preload of the spring **46**, thus overcoming the force resulting from the pressure on the bellows **50** and closing the valve and preventing escape of fuel from the end of the cylinder **38** to the pump inlet **11**, through the body **13**, thus creating a build up of pressure to cause the piston to move in a direction to move the linkage to tend to close the throttle **14**. The resultant force upon the throttle tends to move it relatively slowly and provides an additional quantity of fuel for acceleration purposes. The increasing speed of the engine causes the value of the pressure in the passage **53** to rise, this causing the bellows **50** to collapse thus creating a force for reopening the valve to permit escape of fuel from the cylinder **38** past the valve member **48** and through the body **13** to the pump inlet passage **11**. This then permits the piston **39** to return to a position in which equilibrium conditions are obtained, the throttle **14** arriving at a position to maintain the required fuel flow to the engine to run it at the desired new higher speed.

It will be apparent that under deceleration conditions, there will be no tendency for the valve member **48** to move to close the valve since the pressure on the bellows **50** will always, during deceleration, provide a force less than the rating of the spring **46**.

Having thus described my invention what I claim as new and desire to secure by Letters Patent is:

1. An acceleration control for a gas turbine engine fuel system comprising a throttle, a manual control for the throttle, a further device also for controlling the throttle, said further device being responsive to changes in pressure conditions within the engine with which the system is associated, a cam connected to the throttle so as to be movable therewith, a spring acting between the cam and a valve member, means responsive to changes in the speed of the engine and acting upon the valve member in opposition to the spring, the valve member being arranged to modify the response of said pressure conditions upon the further device for controlling the throttle.

2. An acceleration control as claimed in claim **1** in which the further device is a piston and cylinder device, passage means being provided for supplying fuel under pressure thereto, and said pressure conditions in the engine controlling a further valve member arranged to control the escape of fuel from one end of the cylinder, the first mentioned valve member also controlling escape of fuel from the same end of the cylinder of the device.

3. A fuel system for a gas turbine engine comprising a pump having a delivery passage, to burners in an associated engine, and an acceleration control comprising a throttle in said delivery passage, a manual control for the throttle, a further device also for controlling the throttle, said further device being responsive to changes in pressure conditions within the engine with which the system is associated, a cam connected to the throttle so as to be movable therewith, a spring acting between the cam and a valve member, means responsive to changes in the speed of the engine and acting upon the valve member in opposition to the spring, the valve member being arranged to modify the response of said pressure conditions upon the further device for controlling the throttle.

4. A fuel system as claimed in claim **3** in which there is a device for maintaining substantially constant pressure drop across the throttle, said device being arranged to control the output of the pump through an associated servo mechanism.

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