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ENGINES REHEAT EQUIPMENT

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2 Sheets-Sheet 1

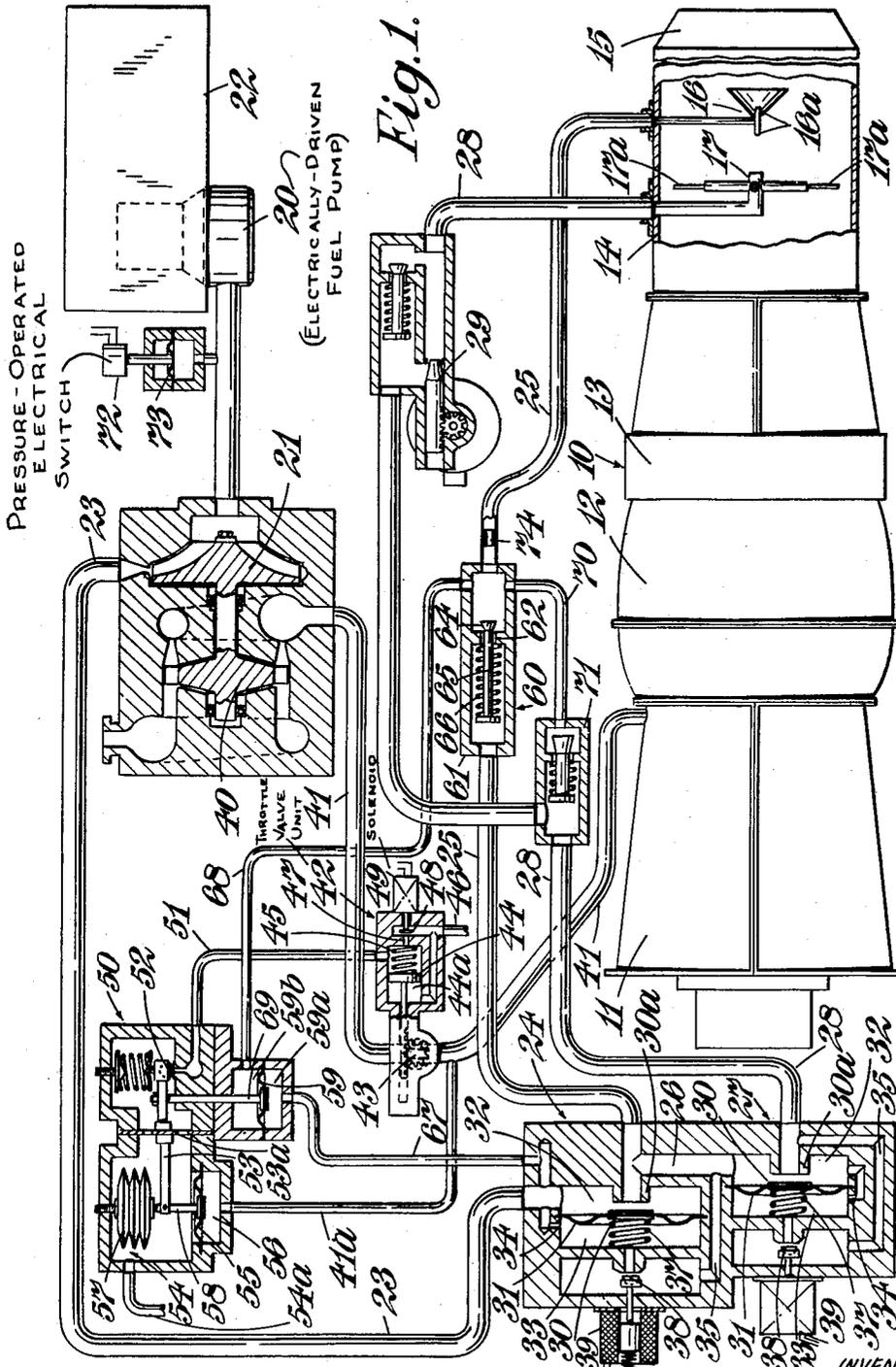


Fig. 1.

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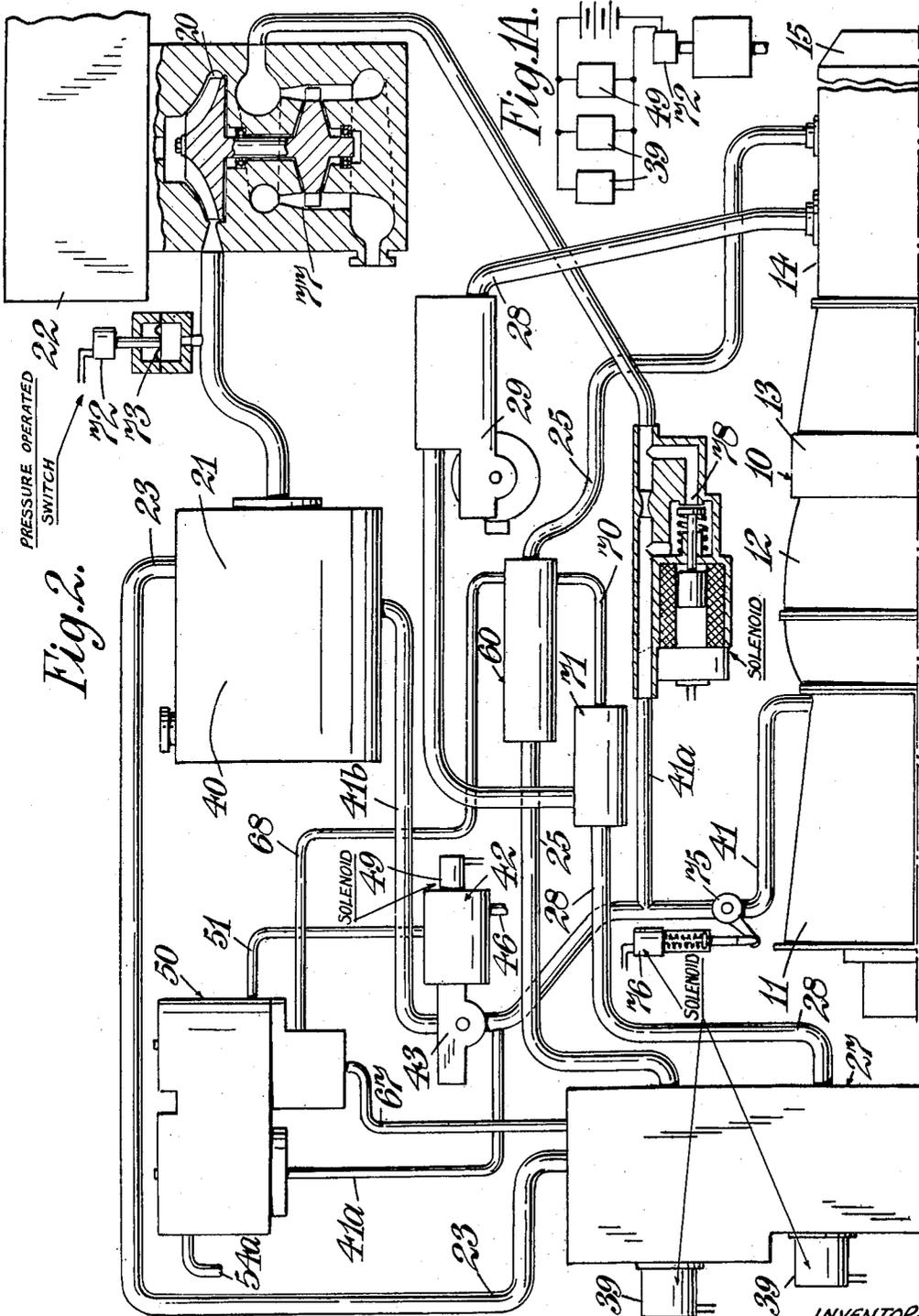


Fig. 2.

Fig. 1A.

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FUEL SYSTEM FOR PILOT BURNERS OF GAS-TURBINE ENGINES REHEAT EQUIPMENT

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18 Claims. (Cl. 60—35.6)

This invention relates to fuel systems for gas-turbine engines.

In some gas-turbine engines provision is made for burning fuel in the working fluid after it has passed through one or more of the turbine stages in order to increase the power of the engine, and additional combustion equipment supplied by a fuel system (hereinafter referred to as a "re-heat fuel system"), is provided for this purpose. Such additional combustion equipment is sometimes employed in jet propulsion engines for aircraft, the working fluid exhaust from a gas-turbine engine being re-heated in the jet pipe before being discharged through the jet nozzle. It is not usual to employ the re-heat fuel system all the time that the power plant is operating, but only when an abnormally large power requirement is to be met. It has been proposed in re-heat fuel systems to provide a pilot burner through which a comparatively small proportion of the re-heat fuel flow is passed. This pilot burner maintains a flame which stabilizes the combustion of the fuel delivered by the main burners of the system, a suitable arrangement being, for example, as described in co-pending application Serial No. 157,732, filed April 24, 1950, now Patent No. 2,708,339.

It is usual for the pilot flame to be ignited before fuel is supplied through the main burners so as to ensure that when this main fuel supply is injected, it is readily ignited and continues to burn.

It will be appreciated that the flame of the pilot burner should be maintained stable despite variations of the conditions in the jet pipe. In an aircraft jet propulsion engine, conditions in the jet pipe may vary due, for example, to changes in the altitude and forward speed of the aircraft. An important object of the invention is to provide a reheat fuel system supplying such a pilot burner in a manner which results in a stable pilot flame being maintained despite such variations in conditions in the jet pipe.

According to one aspect of this invention, a re-heat fuel system for a gas-turbine engine, of the kind having a pilot burner and a plurality of main burners, comprises means for maintaining substantially constant the fuel/air ratio at the pilot burner.

According to a preferred feature of this invention, a re-heat fuel system for a gas-turbine engine, of the kind having a pilot burner and a plurality of main burners, may comprise means for maintaining the fuel flow to the pilot burner proportional to the absolute delivery pressure of the compressor.

It is known that when a sonic velocity occurs in the turbine nozzles of a gas-turbine engine, the mass flow of air which passes through the engine is proportional to the absolute delivery pressure of the compressor of the engine if the turbine inlet temperature is constant with present designs of gas-turbine engines, a sonic velocity at this point is obtained under all normal load running conditions, and since the re-heat system is only employed when an abnormally large power requirement is to be

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met, and since the turbine inlet temperature is substantially constant, the re-heat fuel system will only be in use when the mass flow of air is substantially proportional to the absolute delivery pressure of the engine compressor.

Since in preferred arrangements according to the invention, the fuel delivery to the pilot burner is proportional to the absolute delivery pressure of the compressor, it is also proportional to the mass flow of air flowing through the engine, and therefore the fuel/air ratio of the flame of the pilot burner is maintained substantially constant despite variations in ambient conditions producing variations in the actual air mass flow. This results in the flame of the pilot burner being maintained stable.

It has been found that when the main burners of the re-heat system are being fed with fuel in operation of the re-heat system, the pilot burner requires a greater proportion of fuel, and according to an important feature of this invention there may be provided means whereby on initiation of the supply of fuel to the main fuel burners of the re-heat system, the fuel/air ratio which is maintained constant is increased from one value to another or, in other words, when the main burners are inoperative the fuel flow to the pilot fuel injector is maintained in one fixed proportion to the absolute delivery pressure of the compressor and when the main burners are operative, the fuel supply to the pilot burner is maintained in a greater proportion to the absolute delivery pressure of the engine compressor.

A re-heat fuel system which is suitable for a gas-turbine jet propulsion engine and which embodies the invention will now be described by way of example, reference being made in the description to the accompanying drawings, in which

Figure 1 shows diagrammatically a gas-turbine engine and the reheat fuel system therefor,

Figure 1A shows diagrammatically a method of electrical connection of parts illustrated in Figure 1, and

Figure 2 is an arrangement similar to Figure 1 but with some parts modified.

Referring to Figure 1 of the drawings, there is diagrammatically shown one form 10 of jet-propulsion gas-turbine engine with which a re-heat fuel system of this invention may be employed. The engine comprises a compressor 11, main combustion equipment 12 connected to the delivery of the compressor 11, a turbine 13 connected to the delivery of the combustion equipment 12, and an exhaust arrangement comprising a jet pipe 14 and propelling nozzle 15 through which exhaust gases from the turbine pass to atmosphere. The turbine 13 drives the compressor 11.

When the load to be met is abnormal, it is usual to burn fuel in the jet pipe 14, and the re-heat fuel is normally supplied through a pilot injector device 16 comprising a pair of burners or nozzles 16a and a main fuel injector device 17 comprising a plurality of burners or nozzles 17a. The flame from the pilot injector device 16 is employed to ignite and ensure continued burning of the flame from the main injector device 17.

In order that the pilot injector may fulfil its purpose it is desirable to ensure a stable pilot flame.

The re-heat fuel system for supplying fuel to the pilot and main injection devices 16, 17, is arranged in accordance with the present invention to maintain a stable pilot flame both when the main injector device 17 is not operating and when it is operating.

The re-heat fuel system comprises two fuel pumps 20, 21 in series, whereof the low-pressure pump 20 is electrically driven and is located in a fuel tank 22, and whereof the high-pressure pump 21 is a centrifugal pump. The discharge conduit 23 of the high-pressure pump 21 contains a shut-off cock 24 and downstream of this cock is divided

into two branches 25, 26, whereof the branch 25 leads to the pilot injector device 16 and whereof the branch 26 leads to a main burner fuel cock 27 and a main delivery pipe 28 leading past a throttle valve 29 to the main fuel injector device 17 of the re-heat system.

The shut-off cocks 24, 27 may be of any convenient construction and are illustrative as electrically-controlled servo-operated valves. Each comprises a disc 30 carried by a flexible diaphragm 31 separating the inlet chamber 32 of the valve from a chamber 33 which is connected with the chamber 32 by a restriction 34 and with the outlet from the valve by a duct 35. The disc 30 engages a seat 30a around the outlet and is loaded by a spring 37 on to the seat. The outflow from chamber 33 is controlled by a lift valve 38 which is operated by a solenoid 39. When the solenoid 39 is de-energized, an outflow from chamber 33 is prevented and the disc 30 is held against its seat 30a by the spring 37; when, however, the solenoid is energized, and outflow occurs from chamber 33 through duct 35 and the fluid pressure on the spring-loaded side of the diaphragm 31 falls so that the spring 37 is overcome by the pressure in the chamber 32 and the disc 30 lifted from its seat 30a.

The pump 21 is driven by an air-turbine 40 which is supplied through conduit 41 with air compressed by the compressor 11 of the gas-turbine engine. The air supply conduit 41 to the turbine 40 is connected to the delivery of the compressor and contains a combined control cock and throttle valve unit 42 which operates in a manner more fully described hereinafter.

The invention is applied to the above described system in order to maintain the amount of fuel supplied to the pilot fuel injector device 16 in a fixed proportion to the absolute value of the delivery pressure of the compressor 11 of the gas-turbine engine 10.

The throttle valve 43 of the unit 42 is located in the air supply conduit 41 and is connected for operation to a piston 44 which is loaded by spring 45 to bias the throttle valve 43 to the open position. A conduit 46 leads from the discharge of the main engine fuel pump, that is the main pump of the fuel system (not shown) supplying the main combustion equipment 12, directly to the cylinder 44a of this piston 44 on one side of the piston and through a restriction 47 to the cylinder on the other side of this piston 44. The unit 42 also comprises a lift valve 48 controlling the flow through restriction 47, the valve 48 being operated by a solenoid 49. When the solenoid is de-energized the valve 48 closes off the restriction 47 so that pressure fuel from conduit 46 cannot reach the spring-loaded side of piston 44 and the latter moves to the right (as viewed in the drawing) to close throttle valve 43. When solenoid 49 is energized, pressure fluid can reach the spring-loaded side of the piston 44 through the restriction 47 so that the piston can act to control the extent of opening of throttle valve 43. The lift valve 48 and solenoid 49 thus act to control the throttle valve 43, as a shut-off cock.

When the lift-valve 48 is open, the pressure-drop across the restriction 47, and therefore across the piston 44, is controlled by a bleed valve mechanism 50 which controls a bleed flow through conduit 51 from the spring-loaded side of piston 44. The valve element 52 of the mechanism 50 is mounted on the end of a lever 53 contained in a chamber 54 which has a flexible diaphragm 55 for part of its wall. To the other side of the flexible diaphragm 55 there is a chamber 56 connected to the turbine air supply conduit 41 through a branch 41a, so that the diaphragm 55 is subjected to the delivery pressure of the engine compressor 11. The chamber 54 containing the lever 53 also contains an evacuated capsule 57 of the same effective area as the flexible diaphragm 55, and the capsule is connected to the flexible diaphragm 55 by a rod 58 which is also connected to the lever 53, so that the lever 53 is loaded through the rod 58 with a load pro-

portional to the absolute delivery pressure of the engine compressor 11.

The lever 53 is carried on a perforated flexible diaphragm 53a as its fulcrum, and the chamber 54 is connected by conduit 54a to a fuel tank or the suction side of the main engine fuel pump (not shown).

The supply conduit 25 to the pilot fuel injector device 16 contains a linear flow valve mechanism 60, that is a valve mechanism across which the pressure-drop is proportional to the flow of liquid through the valve. The valve mechanism 60 comprises a body 61 having formed therein a seat 62 around an orifice the effective area of which is controlled by the head 64 of a valve element 65. The valve element 65 is loaded by a spring 66 in the sense to reduce the effective area of the orifice and the spring is so rated and the head 64 so shaped that the valve element stabilizes in a position in which the pressure drop across the orifice is proportional to the flow therethrough.

The pressure-drop across this valve mechanism 60 is arranged to load a flexible diaphragm 59 forming part of the mechanism 50. The diaphragm 59 separates two chambers 59a, 59b whereof the chamber 59a is connected by a conduit 67 to the conduit 23 and the chamber 59b is connected by conduit 68 with the valve body 61 downstream of the orifice therein. The diaphragm 59 is in turn connected by a rod 69 to the lever 53 to load it in opposition to the load from the flexible diaphragm 55. Conveniently this is done by arranging (as shown) the flexible diaphragm 59 with its axis parallel to the axis of the flexible diaphragm 55, by arranging that the higher pressure acts on the underside of each diaphragm, and locating the fulcrum of the lever 53 between the connections to it from the two flexible diaphragms 55, 59.

The arrangement is such that an increase in the delivery pressure of compressor 11 tends to close the bleed valve 52 on to the outlet from conduit 51, which results in a reduction in pressure drop across the piston 44 operating the throttle valve 43, so that the throttle valve is opened by its spring 45 to increase the air supply to the turbine 40 of the high-pressure pump 21 and thus to increase the output of this pump so that the fuel flow to the pilot fuel injection device 16 is increased. Increase of such fuel flow results in a higher pressure drop across the linear flow valve mechanism 60 and this results in the second flexible diaphragm 59 tending to open the bleed valve 52 and thus tending to reduce the air flow to turbine 40 and thus the speed of the high-pressure pump 21.

It will be appreciated that since the areas of the flexible diaphragms 55, 59 are fixed and since the distances of their connections to the lever 53 from the fulcrum-forming diaphragm 53a are also fixed, the arrangement will operate to maintain the flow of fuel to the pilot fuel injector device 16 proportional to the absolute delivery pressure of the compressor 11. The flow of air through the gas-turbine engine is also proportional to the absolute delivery pressure under those conditions in which re-heating is employed, and therefore the fuel/air ratio of the pilot burner flame will be maintained constant giving a stable pilot flame.

The re-heat fuel system also comprises a branch conduit 70 from the supply conduit 28 of the main fuel injector device 17, downstream of the main burner fuel cock 27, and the branch conduit 70 leads to the pilot supply conduit 25 on the downstream side of the orifice of the linear flow valve mechanism 60. This branch conduit 70 contains a second linear flow valve mechanism 71. When the main burner fuel cock 27 is opened by energising the solenoid 39 thereof, a second supply of fuel is led to the pilot fuel injector device through the second linear flow valve 71.

Since the first and second flexible diaphragms 55, 59 will continue to operate to maintain the flow through the linear flow valve mechanism 60, and therefore the pressure drop across it, proportional to the absolute

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compressor delivery pressure, and since this pressure drop is the same as that across the second linear flow valve 71, the flow through the second linear flow valve 71 will be proportional to the absolute compressor delivery pressure.

The supply to the pilot fuel injector device 16 will therefore still be in a fixed proportion to the absolute compressor delivery pressure although this fixed proportion will be greater than that in which fuel is supplied when the main fuel injector device 17 is not operative, i. e. when the main burner cock 27 is closed.

The fuel system also contains a pressure-operated electric switch 72 which is connected for operation to a flexible diaphragm 73 subjected to the pressure between the low-pressure fuel pump 20 and the high-pressure fuel pump 21. This switch is arranged to control in any convenient manner the energisation of the solenoid 49 of the combined throttle and shut-off cock unit 42 in the air supply conduit 41 to the air turbine 40 and of the solenoids 39 of the shut-off cocks 24, 27 in the delivery conduit from the high-pressure pump 21, so that on failure of the supply of fuel, the shut-off cocks are closed and the system is put out of operation. For instance as shown in Figure 1A, the solenoids 39, 49 may be connected to a current source through switch 72.

The system also comprises a fixed flow restrictor 74 in the pilot fuel delivery conduit 25 downstream of the linear flow valve mechanism 60 and of the points of the connections of conduits 68, 70 to the delivery conduit 25. The restrictor 74 is solely for the purpose of facilitating adjustment of the pressure/flow characteristics of the pilot burner 16.

Instead of only the high-pressure fuel pump 21 being driven by an air turbine, both the low-pressure pump 20 and the high-pressure pump 21 may be air turbine driven. Such an arrangement is shown in Figure 2 in which those parts which are the same as in Figure 1 are shown in outside view and are given the same references. In such an arrangement the air supply pipe 41 from the engine compressor will contain a shut-off cock 75 which is conveniently electrically operated, as by solenoid 76, and downstream of the cock the air supply pipe will branch, one branch 41a leading to the turbine 77 which drives the low-pressure pump 20 and the other branch 41b leading to the turbine 40 driving the high-pressure pump 21. The supply branch 41a to the turbine driving the low-pressure pump may have provided in it an electrically controlled throttle 78 and the supply branch 41b to the air turbine driving the high-pressure pump may have provided in it a throttle 43 controlled in substantially the same manner as above described.

We claim:

1. In a gas turbine engine of the kind comprising an engine compressor, a jet pipe, and a burner in said jet pipe; means to supply fuel to the burner comprising a fuel pump, a fuel supply conduit connecting the outlet of the fuel pump with the burner, restrictor means connected in said conduit and comprising an orifice with a valve member to vary the restriction of the orifice which valve member is movable by the fuel flow through the orifice in a manner to decrease the restriction and which is loaded to increase the restriction by a spring having a strength selected in relation to the effective area of the valve member to give a pressure drop in said conduit across the restrictor means proportional to the fuel flow through the restrictor means, a first pressure-sensitive device connected to be subjected to the absolute delivery pressure of the engine compressor, a second pressure-sensitive device connected to be subjected to the pressure drop across said restrictor means, and delivery-varying means for controlling the delivery to said burner connected to be loaded in opposition by said first and second pressure-sensitive devices.

2. In a gas turbine engine of the kind comprising an engine compressor, a jet pipe, and a burner in said jet

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pipe; means to supply fuel to the burner comprising a variable-output fuel pump, a fuel supply conduit connecting the outlet of the fuel pump with the burner, restrictor means connected in said conduit and comprising an orifice with a valve member to vary the restriction of the orifice which valve member is movable by the fuel flow through the orifice in a manner to decrease the restriction and which is loaded to increase the restriction by a spring having a strength selected in relation to the effective area of the valve member to give a pressure drop in said conduit across the restrictor means, said restrictor means proportional to the fuel flow through it, a first pressure-sensitive device connected to be subjected to the absolute delivery pressure of the engine compressor, a second pressure-sensitive device connected to be subjected to the pressure drop across said restrictor means, and output-varying means for said fuel pump connected to be loaded in operation by said first and second pressure-sensitive devices.

3. In a gas turbine engine of the kind comprising an engine compressor, a jet pipe, a pilot burner in said jet pipe, and a main burner in said jet pipe; means to deliver fuel to the burners comprising a fuel pump, a fuel supply conduit connected with the outlet of the fuel pump and having first and second branches connected respectively with the main burner and the pilot burner, restrictor means connected in said second branch and comprising an orifice with a valve member to vary the restriction of the orifice which valve member is movable by the fuel flow through the orifice in a manner to decrease the restriction and which is loaded to increase the restriction by a spring having a strength selected in relation to the effective area of the valve member to give a pressure drop across said restrictor means proportional to the fuel flow through said restrictor means, a first pressure-sensitive device connected to be subjected to the absolute delivery pressure of the engine compressor, a second pressure-sensitive device connected to be subjected to the pressure drop across said restrictor means, and delivery-varying means for controlling the delivery to said pilot burner which delivery-varying means loaded in opposition by said first and second pressure-sensitive devices.

4. In a gas turbine engine of the kind comprising an engine compressor, a jet pipe, a pilot burner in said jet pipe, and a main burner in said jet pipe; and means to deliver fuel to said main burner and said pilot burner comprising a variable-output fuel pump, a fuel supply conduit connecting the outlet of the fuel pump with the pilot burner restrictor means connected in said conduit and comprising an orifice with a valve member to vary the restriction of the orifice which valve member is movable by the fuel flow through the orifice in a manner to decrease the restriction and which is loaded to increase the restriction by a spring having a strength selected in relation to the effective area of the valve member to give a pressure drop across said restrictor means proportional to the fuel flow through said restrictor means, a first pressure-sensitive device connected to be subjected to the absolute delivery pressure of the engine compressor, a second pressure-sensitive device connected to be subjected to the pressure drop across said restrictor means, and output-varying means for said fuel pump loaded in opposition by said first and second pressure-sensitive devices.

5. In a gas turbine engine of the kind comprising an engine compressor, a jet pipe, a pilot burner in said jet pipe, and a main burner in said jet pipe; means to deliver fuel to the burners comprising a variable-output fuel pump, a fuel discharge conduit connected to the outlet of said fuel pump, a first fuel supply conduit connecting said fuel discharge conduit with the pilot burner, restrictor means connected, in said first fuel supply conduit and comprising an orifice with a valve member to vary the restriction of the orifice, which valve member is movable by the fuel flow through the orifice in a manner to decrease the restriction

and which is loaded to increase the restriction by a spring having a strength selected in relation to the effective area of the valve member to give a pressure drop across said restrictor means proportional to the fuel flow through said restrictor means, a second fuel supply conduit connecting said fuel discharge conduit with said main burner, a branch conduit connecting said second supply conduit with first said supply conduit downstream of said restrictor means, and second restrictor means connected in said branch conduit and comprising an orifice with a valve member to vary the restriction of the orifice which valve member is movable by the fuel flow through the orifice in a manner to decrease the restriction and which is loaded to increase the restriction by a spring having a strength selected in relation to the effective area of the valve member to give a pressure drop across said second restriction means proportional to the fuel flow through it, the pressure upstream of said second restrictor means being substantially equal to the pressure upstream of first said restrictor means when said main burner is operative, a first pressure-sensitive device connected to be subjected to the absolute delivery pressure of the engine compressor, a second pressure-sensitive device connected to be subjected to the pressure drop across first said restrictor means, which is equal to the pressure drop across said second restrictor means when the main burner is operative, and delivery-varying means for controlling the delivery of fuel through said fuel discharge conduit which delivery-varying means is loaded in opposition by said first and second pressure-sensitive devices.

6. In a gas turbine engine of the kind comprising an engine compressor, a jet pipe, and a pilot burner in said jet pipe; means to deliver fuel to the pilot burner comprising a variable-output fuel pump, an air turbine connected to drive said fuel pump, an air supply conduit to conduct air compressed by said compressor to said air turbine, a fuel supply conduit connecting the delivery of the fuel pump with the pilot burner, restrictor means connected in said conduit and comprising an orifice with a valve member to vary the restriction of the orifice which valve member is movable by the fuel flow through the orifice in a manner to decrease the restriction and which is loaded to increase the restriction by a spring having a strength selected in relation to the effective area of the valve member to give a pressure drop across said restrictor means proportional to the fuel flow through said restrictor means, a first pressure-sensitive device subjected to the absolute delivery pressure of the engine compressor, a second pressure-sensitive device subjected to the pressure drop across said restrictor means, and a throttle device in said air supply conduit controlled by said first and second pressure-sensitive devices acting in opposition.

7. A combination as claimed in claim 6, comprising also a source of pressure fluid, third pressure-sensitive means acted upon by said pressure fluid and operative to control said throttle device, and pressure-relieving means to relieve the pressure to which said third pressure-sensitive means is subjected and controlled by said first and second pressure-sensitive devices acting in opposition.

8. A re-heat fuel system for a gas-turbine engine, which re-heat fuel system comprises a pilot burner, a plurality of main burners, a variable-output fuel pump, a supply conduit connected to the delivery of the fuel pump and having first and second branches connected with the main burners and with the pilot burner, restrictor means connected in said second branch, which restrictor means comprises an orifice with a valve member to vary the restriction of the orifice which valve member is movable by the fuel flow through the orifice in a manner to decrease the restriction and which is loaded to increase the restriction by a spring having a strength selected in relation to the effective area of the valve member to give a pressure drop across said restrictor means proportional to the fuel flow through it, a first pressure-sensitive device connected to be sensitive to the absolute delivery

pressure of the engine compressor, a second pressure-sensitive device connected to be sensitive to the pressure drop in said second branch across said restrictor means, said two pressure-sensitive devices being arranged to co-operate to control the output of the fuel pump to maintain the fuel/air ratio at the pilot burner substantially constant.

9. A re-heat fuel system as claimed in claim 8, comprising a third pressure-sensitive device arranged to control the output of said variable-output fuel pump and having said first and second pressure-sensitive devices arranged together to control the pressure to which said third pressure-sensitive device is sensitive.

10. A re-heat fuel system as claimed in claim 8, wherein said variable-output fuel pump is of the kind whereof the output is varied by varying its rotational speed and wherein said first and second pressure-sensitive devices are arranged to control the rotational speed of the pump.

11. A re-heat fuel system as claimed in claim 10, comprising a turbine to drive said variable-output fuel pump, means to supply working fluid to said turbine, and a throttle to control the supply of working fluid to said turbine, said throttle being connected for adjustment to said first and second pressure-sensitive devices.

12. A re-heat fuel system for a gas-turbine engine, which re-heat fuel system comprises a variable-output fuel pump, a first fuel supply conduit connected to the delivery of said fuel pump, a pilot burner connected to said first supply conduit to receive fuel therefrom, a second fuel supply conduit connected to the delivery of said fuel pump, a plurality of main burners connected to receive fuel from said second supply conduit, restrictor means connected in said first fuel supply conduit, which restrictor means comprises an orifice with a valve member to vary the restriction of the orifice which valve member is movable by the fuel flow through the orifice in a manner to decrease the restriction and which is loaded to increase the restriction by a spring having a strength selected in relation to the effective area of the valve member to give a pressure drop across said restrictor means proportional to the fuel flow through it, a first pressure-sensitive device connected to be sensitive to the absolute delivery pressure of the engine compressor, a second pressure-sensitive device connected to be sensitive to the pressure drop in said first supply conduit across said restrictor means, said two pressure-sensitive devices being arranged to co-operate to control the output of the fuel pump to maintain the fuel/air ratio at the pilot burner substantially constant, a valve means in said second supply conduit to control the fuel flow therein, and means to increase the fuel supply to the pilot burner on initiation of the supply to the main fuel burners and to maintain said increased fuel supply in a fixed proportion to the air supply at the pilot burner.

13. A re-heat fuel system as claimed in claim 12, wherein said means to increase the fuel supply to the pilot burner comprises a branch conduit connected from said second conduit at a point in said first supply conduit to the pilot fuel burner which point is downstream of said restrictor means, and restrictor means in said branch conduit.

14. A re-heat fuel system as claimed in claim 13, wherein said restrictor means in said branch conduit is of the kind through which the flow of fuel is proportional to the pressure drop across it.

15. A re-heat fuel system for a gas-turbine engine, which re-heat fuel system comprises a variable-output fuel pump, a first fuel supply conduit connected to the delivery of said fuel pump, a pilot burner connected to said first supply conduit to receive fuel therefrom, a second fuel supply conduit connected to the delivery of said fuel pump, a plurality of main burners connected to receive fuel from said second supply conduit, restrictor means connected in said first fuel supply conduit, which restrictor

means comprises an orifice with a valve member to vary the restriction of the orifice which valve member is movable by the fuel flow through the orifice in a manner to decrease the restriction and which is loaded to increase the restriction by a spring having a strength selected in relation to the effective area of the valve member to give a pressure drop across said restrictor means proportional to the fuel flow through it, a first pressure-sensitive device comprising a first compartment divided into two chambers by a first flexible diaphragm and having a branch from one of the two chambers to a source of fluid pressure and having an evacuated capsule in the other chamber connected to load the first flexible diaphragm so that the first flexible diaphragm is loaded with the resultant load proportional to the absolute fluid pressure, a second pressure-sensitive device comprising a second compartment divided into two chambers by a second flexible diaphragm which has its axis parallel to the axis of the first diaphragm, a conduit connecting the chamber on one side of the second flexible diaphragm to the upstream side of said restrictor means in the first supply conduit and a second conduit connecting the chamber on the other side of the second flexible diaphragm to the downstream side of the restrictor means, a third pressure-sensitive device arranged to control the output of said variable-output fuel pump, a lever, said first and second pressure-sensitive devices being connected to load said lever which carries a bleed valve determining the pressure to which the third pressure-sensitive device is subjected, the lever fulcrum, and the points at which loads are applied to the lever by the first and second pressure-sensitive devices being located and the effective areas of said flexible diaphragms being selected so that increase of the fluid pressure alone results in increase in the output of the pump and so that increase of the pressure drop alone results in decrease of the output of the pump, and that the lever is balanced when the pressure-drop is in a fixed proportion to the fluid-pressure.

16. In a turbojet power plant including a compressor, and an afterburner, in combination means for automatically scheduling a predetermined air fuel mixture in said afterburner comprising a fuel pump operative to supply fuel under pressure at a variable rate to said afterburner, a pressure responsive device subject to variations in the pressure of air delivered by said compressor, an auxiliary turbine operative by air under pressure delivered by said compressor for driving said fuel pump, and valve means controlled by said pressure responsive device for varying the supply of air under pressure to the last named turbine whereby metered flow of fuel from said pump to said afterburner is insured.

17. In a gas turbine power plant having a compressor and afterburner means the combination of a fuel pump operative to supply fuel to said afterburner means, an auxiliary turbine for driving said pump operable by compressed air bled from said compressor by way of a supply communication, a valve controlling said communication, fluid pressure responsive means for measuring the mass air flow through said power plant, fuel flow measuring means responsive to the rate of supply of fuel from said fuel pump to said afterburner means, and servo mechanism controlling operation of said valve in accordance with the mass air flow and the flow of fuel from said fuel pump to said afterburner means, said mechanism including a valve element operatively connected to said fluid pressure responsive means and also to said fuel flow measuring means.

18. In a gas turbine power plant having a compressor and afterburner means, the combination of a centrifugal fuel pump operative to supply fuel to said afterburner means, a conduit connecting said fuel pump and the afterburner means, an auxiliary turbine for driving said pump operable by compressed air bled from said compressor by way of a supply communication, a valve controlling said communication, fluid pressure operated means responsive to the pressure of air delivered by said compressor, means for establishing a pressure differential in said conduit, said pressure differential being a measure of the rate of supply of fuel from said fuel pump to said afterburner means and servomechanism controlling operation of said valve and responsive to the rate of fuel flow from said fuel pump to said afterburner means, and to the pressure of air delivered by said compressor, said servo-mechanism including a fluid pressure responsive valve element subject to the pressure differential established.

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