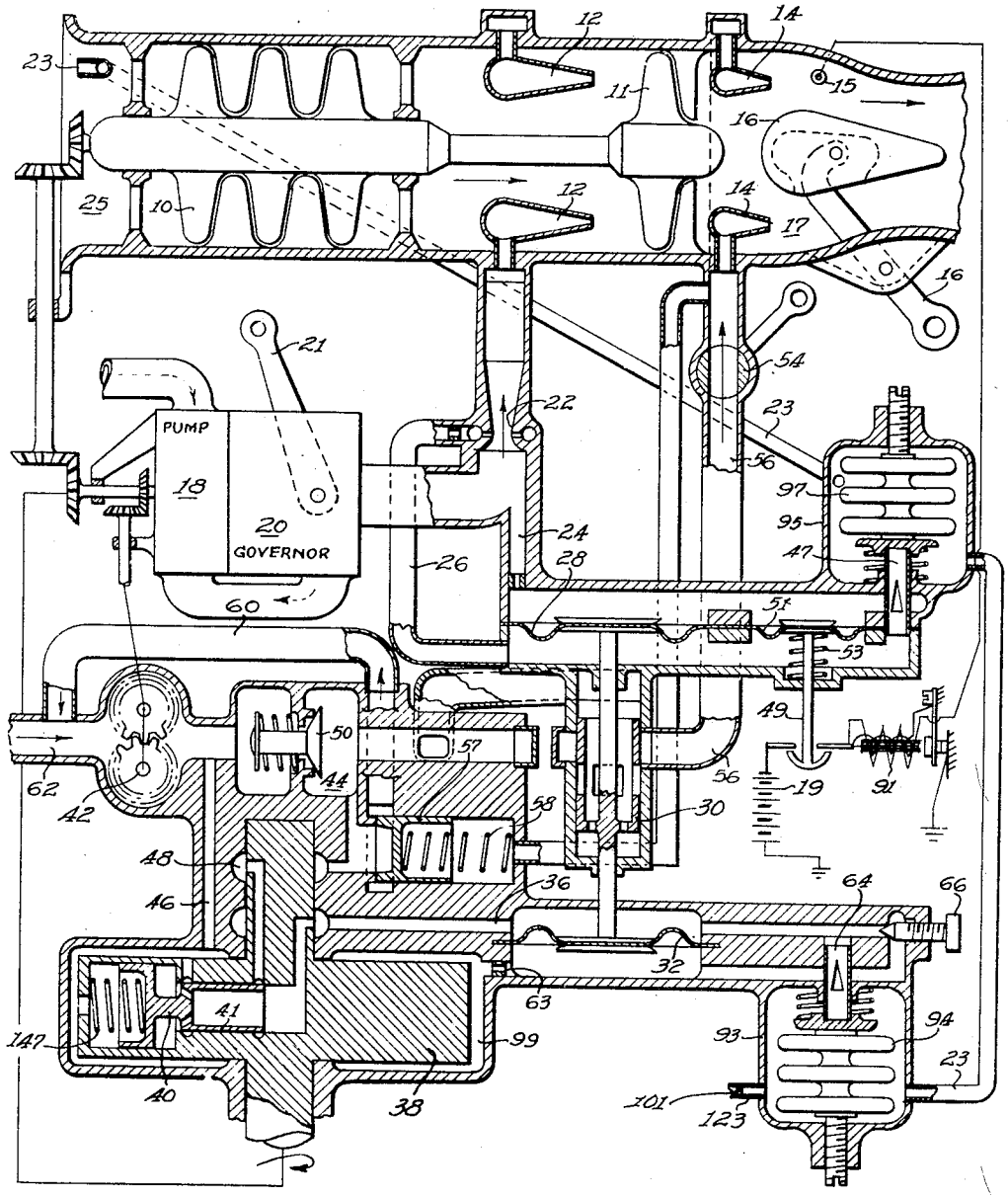
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GAS TURBINE TAIL BURNER FUEL CONTROL

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GAS TURBINE TAIL BURNER FUEL CONTROL

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The object of this invention is to supplement the power developed by a gas turbine in an ordinary airplane installation (jet propulsion) with "After Burning" (tail burner).

The figure shows the preferred form of my invention.

In the figure, 10 is the compressor delivering compressed air to the burner 12 which drives the compressor 10 through the gas turbine 11. 14 is the "After Burning" burner (tail burner). 16 is the control of the area of the tail outlet and 17 is the second stage combustion chamber. 15 is the spark plug therein to ignite the tail burner 14. 18 is the main fuel pump for the gas turbine fuel. 20 is the speed governor for the gas turbine, both driven by the gas turbine 11. 21 is the manual control for selecting the speed. 22 is a venturi in the fuel outlet leading to the main burner 12 of the gas turbine 24 and 26 are two passages, 24 at the high pressure and 26 at the lower pressure in the throat of the venturi 22, leading to the opposite side of the moving wall (diaphragm) 28. Moving wall 28 moves down in response to high fuel flow through venturi 22 and closes "After Burner" control valve 30. Valve 30 moves with wall 28 and admits more or less fuel to the nozzle 14 through the passage 56. The pressure difference acting on the wall 28 is increased at high altitude by valve 47 and decreased at sea level when valve 47 opens into the position shown. If the burner 14 blows out then the pressure in chamber 17, downstream from gas turbine 11, drops and the turbine speeds up and governor 20 cuts down main fuel through venturi 22. Micro-switch 49 then closes and the electrical circuit is completed and the spark plug 15 is reactivated by the battery 19 and the coil 91. A diaphragm 51 and a spring 53 are adjusted so that normally the fuel flow through venturi 22 opens the micro-switch 49.

A second moving wall (diaphragm) 32 opposes the motion of the first moving wall (diaphragm) 28; the centrifugally responsive weight 40 moves out as the engine speeds up and establishes a pressure difference to balance said centrifugal force. The higher the speed the lower the pressure in the passage 36. This higher speed produced a pressure difference acting on the moving wall 32 to open up the flow of fuel past valve 30 to the "After Burning" burner 14. The manually adjusted temperature control 66 and the automatic temperature control 64 reduce the pressure difference between the two sides of moving wall 32 as temperature rises so as to reduce afterburning at high atmospheric temperature.

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Automatic temperature responsive device may preferably be located in an air stream from passage 23, which passage has an entrance located in the air entrance 25 and directs air which flows around the altitude corrector 97, inside the chamber 95, and temperature corrector 94, inside the chamber 93. Partially evacuated bellows 97 being more completely evacuated than the bellows 94. There is a restricted outlet 123 from chamber 93.

The tail burner fuel pump 42 is driven by the gas turbine 11 and draws fuel from passage 62 and delivers fuel to fuel passage 56 via passage 44, past check valve 50, past automatic valve 30 and shut off valve 54 in passage 56.

The rate of flow across the valve 30 is determined by the position of the two moving walls 28 and 32 and the pressure drop across the valve 30. A valve 57 and spring 58 maintain this pressure drop constant and return excess fuel to the passage 60 which returns this fuel to the pump 42.

Passage 46 delivers fuel under pressure to act on the outer left hand side of piston 40, inside rotating wheel 38. Passage 48 delivers lower pressure fuel to act on the right hand (inner) side of the piston 40 whereupon the cylindrical valve 41, carried by the piston 40, admits fuel from passage 48 to passage 36. Actually pressure in passages 36 is intermediate between low pressure in passage 48 and high pressure in passage 46. A stabilizing spring 147 is added pushing the floating piston in the same direction that the pressure in passage 46 acts.

The essential element of my invention is the establishment of a balance between a pressure on diaphragm 32 responsive to revolutions per minute squared and the pressure responsive to the rate of fuel flow to the gas turbine squared acting on the diaphragm 28. When these two pressures are out of balance, the balance is restored by an automatic valve 30, controlled by both of these two pressures and controlling the flow of fuel to the afterburners 14. The amount of power output of the tail burner 14 is only ¼ of the power output of the gas turbine burners 12 per pound of fuel burnt per minute. Hence, the need for limiting the utilization of the afterburning.

Operation

For the sake of clarity two assumptions are made—(1) 16 partly closed (2) 16 open.

(1) The tail burners 14 get no fuel at all because flow through 22 is sufficient to overcome the

feeble force of the speed responsive force acting on the diaphragm 32 and valve 30 remains closed.

(2) Flow from the main gas turbine burners 12 immediately drops because the restriction around 16 is less and the power to drive compressor 10 is diminished and it thus takes much less fuel to maintain the gas turbine speed selected by manually controlled lever 21. When the force responsive to the flow through venturi 22 falls, the valve 30 opens and micro-switch 49 closes responding to diaphragm 51 and spring 53. The spark plug 15 is immediately reactivated. Igniting burner 14 raises pressure in tail burner compressor chamber 17 and speed tends to drop, hence, governor automatically increases flow through venturi 22 and the ignition is thus automatically disconnected.

What I claim is:

1. A gas turbine compressor unit having an air entrance and a first combustion chamber and a first burner therein located upstream from said gas turbine and downstream from said compressor, a second combustion chamber located adjacent to and downstream from said gas turbine, a second burner referred to as the tail burner therein, a variable outlet from the second combustion chamber, a flow control valve located therein downstream from said second burner, a first fuel pump and a selectively controlled speed governor driven by said gas turbine and discharging a governed quantity of fuel to said first burner, a second fuel pump also driven by said gas turbine and having an outlet therefrom leading to said second burner, a fuel restriction in the outlet from said first fuel pump, a first fuel chamber, a first moving wall therein dividing said chamber into two parts, fuel passages connecting these two parts to the fuel outlet at said restriction so as to subject the first moving wall to the pressure drop at said restriction due to flow of fuel therethrough, a second chamber, a second moving wall therein dividing said second chamber into two parts, turbine speed responsive means automatically adapted to create a pressure difference in the two parts of said chamber that varies with the square of the speed of the turbine, a tail burner control valve controlling the flow from said second fuel pump to said tail burner connected to both of said moving walls in such a way that the increase in the fuel flow to the first burner closes and an increase in turbine speed opens said tail burner control valve.

2. A device as set forth in claim 1 in which there is a valve to maintain a constant drop in pressure at said tail burner fuel control valve.

3. A device as set forth in claim 1 in which there is a chamber connected to the air entrance to the gas turbine so as to be at the atmospheric pressure existing therein, a pressure responsive element in said chamber, a bypass around said first moving wall, a valve therein connected to said pressure responsive element so as to reduce the pressure difference acting on said first moving wall at sea level.

4. A device as set forth in claim 1 in which there is a chamber connected to the air entrance to the gas turbine so as to be at the atmospheric temperature existing therein, a temperature responsive element in said chamber, a bypass around said second moving wall, a valve therein

connected to said temperature responsive element so as to reduce the pressure difference acting on said second moving wall at high temperature.

5. A device as set forth in claim 1 in which there is an ignition device in the second combustion chamber, electric activating means therefor, a switch controlling the electrical means, a third moving wall located in said first fuel chamber, yieldable means tending to close said switch, the pressure drop in said fuel restriction acting on said third moving wall so as to open said switch at high fuel flow through said fuel restriction.

6. A device as set forth in claim 1 in which there are means responsive to the pressure of the air in the air entrance to the gas turbine to reduce the fuel flow to said tail burner at high altitudes and low air pressures.

7. A device as set forth in claim 1 in which there are means responsive to the temperature of the air in the air entrance to the gas turbine to reduce the fuel flow to said tail burner at high air temperatures.

8. A device as set forth in claim 1 in which there are spark ignition means in said second combustion chamber, electric activating means therefor, a switch controlling the electrical means, means responsive to the fuel flow to the first combustion chamber to open the switch at high fuel flow and to close the switch at low fuel flow.

9. A gas turbine air compressor power unit having a source of fluid fuel under pressure and an air entrance and an air compressor therein driven by said gas turbine, a first combustion chamber downstream from said air compressor having a fuel entrance connected to said source, said gas turbine being rotated by the gases from said first combustion engine, a second combustion chamber located downstream of said gas turbine, a fuel entrance connected to said source and leading into said second combustion chamber, a fuel control for said first and second combustion chambers comprising manual means for regulating the fuel flow to the first combustion chamber and automatic means for controlling the flow to the second combustion chamber including first means responsive to an increase in fuel flow to first combustion chamber, second means responsive to an increase in temperature of the air entering the air compressor, third means responsive to an increase in pressure of the air entering the air compressor, the flow to the second combustion chamber being regulated inversely to the first, second and third means.

10. A fuel control device as set forth in claim 9 in which there are speed responsive means responsive to the speed of the turbine compressor tending to increase the fuel flow to said second combustion chamber at the high turbine compressor speeds.

11. A fuel control device as set forth in claim 9 in which there are fuel ignition means for said second combustion chamber, activating means therefor, automatic control means for said activating means responsive to the first and third means which open the second fuel control.

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