Feb. 5, 1957 C. W. BRISTOL, JR 2,780,055

IGNITER CONTROL FOR ENGINES

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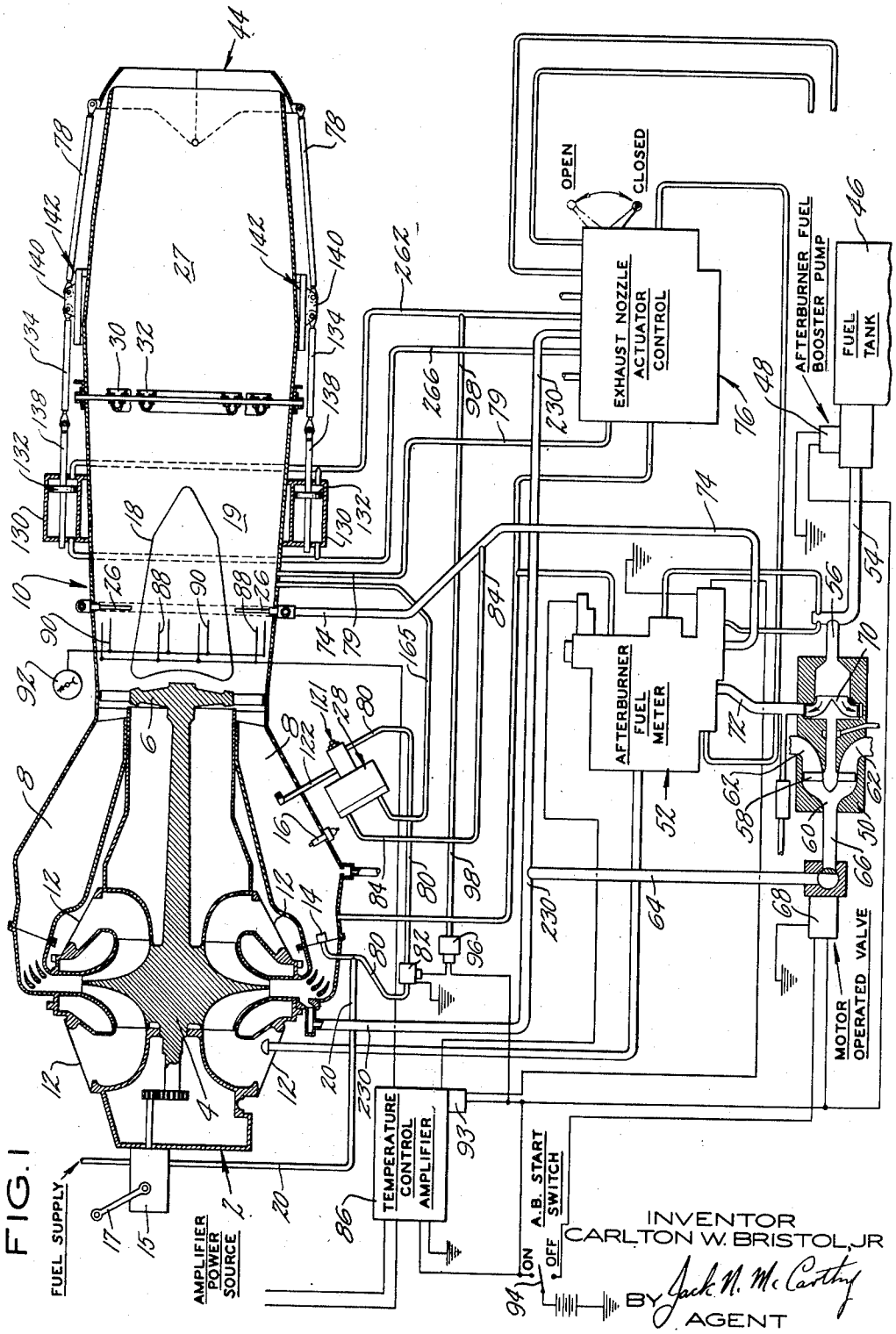


FIG. 1

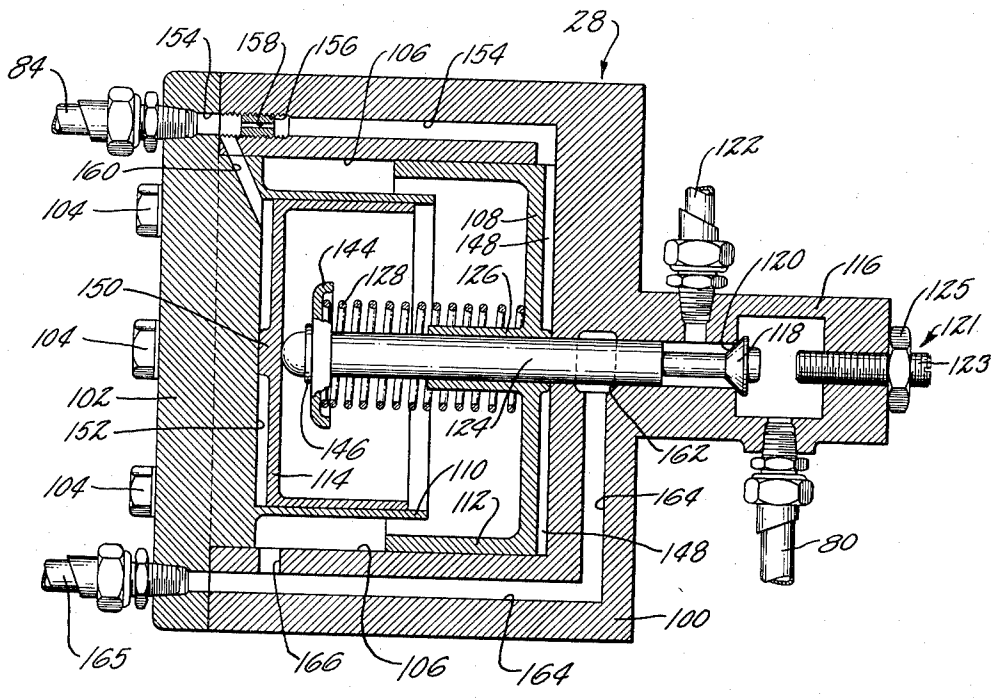
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FIG. 2



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IGNITER CONTROL FOR ENGINES

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6 Claims. (Cl. 60—35.6)

This invention relates to an igniter control for the afterburner of a jet engine.

An object of this invention is to provide an igniter control which will ignite fuel entering the afterburner by momentarily enriching the mixture in a combustion chamber of the jet engine which results in the burning of said mixture beyond the turbine and into the afterburner.

Another object is to obtain an igniter which will permit only a controlled amount of fuel to be injected into the burner of the jet engine at any one time.

A further object is to provide an igniter control which senses fuel flow to the afterburner and is actuated by said fuel flow.

Other objects and advantages will be apparent from the specification and from accompanying drawings which illustrate the invention.

Fig. 1 is a side elevation in cross section of a turbojet engine with an afterburner attached showing the igniter control.

Fig. 2 is an enlarged view of the igniter control.

The turbojet engine 2 has a compressor 4, which, in the arrangement shown, is a centrifugal type, driven by a turbine 6. Combustion chambers 8 therebetween deliver air from the compressor to the turbine. An afterburner 10 is attached at the turbine outlet to provide a means of increasing the thrust.

The engine 2 has two axially-spaced annular intake openings 12 to direct the incoming air into the two oppositely facing annular compressor inlets. Compressed air discharging from the compressor 4 passes to the turbine through the combustion chambers 8 where it is mixed with fuel from fuel nozzles 14. These fuel nozzles 14 receive fuel from the governor 15 through conduit 20. The fuel-air mixture is initially ignited within the combustion chambers 8 by a spark igniter 16. The governor 15 maintains the rotative speed of the turbine rotor assembly in accordance with the value selected by the power lever 17 by controlling fuel flow supplied through conduit 20 and nozzles 14 to the combustion chambers 8.

From the turbine, the gases pass around a cone 18 into the diffuser section 19 of the afterburner. When the afterburner is operating, fuel is discharged into these gases from a plurality of fuel nozzles 26 extending radially into the diffuser 19. Since the gases leaving the turbine 6 contain considerable unburned oxygen, the additional fuel introduced by fuel nozzles 26 provides a combustible mixture which may be initially ignited within combustion chamber 27 by an ignition means hereinafter described. The burning of this combustible mixture is stabilized in the afterburner combustion chamber 27 by flameholders 30 and 32. The burned gases discharge from the engine through the variable area nozzle 44.

The variable nozzle 44 operates between a minimum opening for engine operation without afterburning and a maximum opening for operation of the engine with afterburning. A nozzle and actuating system, similar to the one shown with this invention, is shown and claimed in co-pending application Serial No. 193,734, filed November 2, 1950, now Patent No. 2,714,285, issued August 2, 1955. The actuating system consists of the cylinder 130, piston 132, connecting control rod 134, nozzle control rod 78, piston rod 138, a car 140, and a track mechanism 142 for said car.

The afterburner control system can be divided into three main parts, (1) the fuel system, (2) the ignition means and (3) the exhaust nozzle actuator control. These three parts are closely coordinated by fluid conduit connections and an electrical system.

The fuel system consists of the fuel tank 46, the fuel booster pump 48, the fuel pump 50, the fuel meter 52 and the fuel nozzles 26. The fuel booster pump 48 is mounted on the fuel tank 46 and is connected to the fuel pump 50 by conduits 54 and 56. The fuel pump 50 shown is of the turbine type having a turbine rotor 58 mounted therein with an intake passage 60 and exhaust passages 62 for the working fluid. The working fluid, which is shown as compressed air supplied from the compressor outlet of the engine, is delivered to the intake passage 60 by conduits 230, 64 and 66. A motor operated valve 68 is located at the junction of conduits 64 and 66 to control the operation of the fuel pump by regulating the flow of compressed air to the pump. The turbine rotor 58 drives an impeller 70 which provides the pumping action. The fuel pump 50 delivers fuel to the fuel meter 52 through conduit 72. The fuel meter 52 meters the fuel therein and injects it into the engine through conduit 74 and nozzles 26. The fuel meter represented herein may be any one of many types some of which are shown and claimed in co-pending applications Serial No. 196,423, filed November 18, 1950, and Serial No. 196,414, filed November 18, 1950, now Patent No. 2,714,803 issued August 9, 1955.

The exhaust nozzle actuator control 76 is a device to divert a pressure to the exhaust nozzle actuating cylinders 130 either to open or to close the exhaust nozzle as required. Compressed air from the compressor 4 is delivered to the nozzle control 76 by conduit 230 to provide the operating pressure. Conduit 262 connects the nozzle control to the side of the cylinders 130 nearest the nozzle which causes the nozzle 44 to open when the operating pressure is applied thereto and conduit 266 connects the nozzle control to the side of the cylinders 130 farthest from the nozzle which causes the nozzle 44 to close when the operating pressure is applied thereto. Turbine exhaust gas static pressure which is delivered to the control 76 by conduit 79 automatically controls this nozzle control to connect conduit 230 to either conduit 262 or 266. An exhaust nozzle actuator control of this type is shown and claimed in co-pending application Serial No. 196,424, filed November 18, 1950, now Patent No. 2,715,311 issued August 16, 1955.

The igniter control 28 injects an amount of fuel, in addition to that normally supplied, into a combustion chamber 8 where it is ignited resulting in flame propagation through the turbine into the afterburner for igniting a combustible mixture in the afterburner. Fuel is provided to the igniter control 28 from the main fuel system by conduit 80 which has a solenoid actuated shut-off valve 82 connected therein. The igniter control is connected by conduit 84 to conduit 74 which provides the actuating pressure to inject the additional fuel to provide ignition in the afterburner.

The igniter control 28 (see Fig. 2) has a two part body which includes a housing 100 and a cover 102 held on the housing by bolts 104. The housing 100 has a bore 106 into which a piston member 108 fits. A cylindrical flange 110 extending from the inner side of the cover 102 projects into the housing and within a skirt 112 on piston member 108. A second piston member 114 has a slidable engagement within the circular flange 110.

A valve housing 116, attached to housing 100, contains a valve 118 controlling flow through an orifice 120 from conduit 80 to conduit 122. Housing 116 also supports an adjustable stop 121 for controlling the opening movement of said valve 118, said stop 121 consisting of a bolt 123 and lock nut 125.

A piston rod 124 extends from within housing 100 into housing 116 through a boss 126 on piston member 108. Rod 124 is made of a smaller diameter at one end and attached to valve 118. This smaller diameter permits flow past the valve. The other end is biased against piston member 114 by a spring 128 which is mounted around said rod 124 between member 108 and holding disk 144. The disk is held on said rod by a snap ring 146. Boss 126 projects on either side of piston member 108 around said rod. The part projecting on the inner side in the skirt of the piston acts as an actuating member when moving in the direction to close the valve 118. The part projecting on the outer side permits member 108 to form a chamber 148 with said housing 100 when it is against the housing. Member 114 has a projection 150 on the outer side to form a chamber 152 with the cover plate 102 when it is against the cover plate.

The igniter control has a passage 154 for connecting conduit 84 with chamber 148. A removable insert 156 having a restriction 158 is located in said passage. The duration of flow of ignition fuel is controlled by selection of the area of the restriction 158. Passage 160 connects passage 154 upstream of said insert 156 with chamber 152.

An annular groove 162 is located around the rod 124 in the wall of housing 100. This groove is connected to conduit 165 by passage 164. This venting of groove 162 prevents leakage of afterburner fuel along the rod 124 from the chamber in the igniter during afterburner operation. Passage 166 connects passage 164 to the chamber in housing 100 located between pistons 108 and 114. The chamber between the pistons is vented in this manner to prevent unintentional actuation of the igniter control by tail pipe pressure which is transmitted to chambers 148 and 152 when the afterburner is not in operation and at the same time carry away leakage from chambers 148 and 115 past pistons 108 and 114 during afterburner operation.

The electrical system may include a temperature control amplifier 86 which during afterburner operation is sent a signal by thermocouples 88 which sense turbine discharge temperature. Thermocouples 90 also sense turbine temperature but send their signal to temperature gage 92. This amplifier when energized sends a signal to the fuel meter 52 to modulate flow in accordance with turbine discharge temperature and controls the operation of a normally closed solenoid operated shut-off valve in the fuel meter 52. The afterburner switch 94 controls the amplifier 86, sets the motor operated valve 68, controls the fuel booster pump 48, and controls the opening of normally closed solenoid actuated shut-off valve 82.

Operation

Afterburner operation is initiated by placing switch 94 in its "on" position. This movement energizes the temperature control amplifier which in turn opens a normally closed solenoid operated shut-off valve in the fuel meter and sends a signal to the afterburner fuel meter for attenuating fuel flow therethrough. This movement of the switch also places motor operated valve 68 in the open position, starts the fuel booster pump 48 and opens normally closed solenoid actuated shut-off valve 82.

The operation of the fuel booster pump forces fuel from the fuel tank 46 through conduits 54 and 56 to the impeller 70 of the fuel pump 50. The opening of the motor operated valve 68 allows compressed air to be directed from the outlet of the engine compressor 4 through conduits 230, 64 and 66 against turbine 58 to drive the impeller 70. The impeller 70 then delivers fuel to the afterburner fuel meter 52. This fuel meter 52

meters fuel under the influence of compressor pressure rise and the temperature control amplifier, and this fuel passes by a normally closed solenoid shut-off valve, which is now open, through conduit 74 to the fuel nozzles 26.

The opening of the normally closed solenoid actuated shut-off valve 82 permits a source of fuel to be supplied through conduit 80 to the igniter 28 as far as valve 118. The pressure of the fuel in conduit 74 is transferred to the igniter by conduit 84 which pressure when sufficient actuates piston 114 moving it to the right compressing spring 128 and opening valve 118 until it contacts adjustable stop 121, thereby permitting fuel to pass from conduit 80 to conduit 122 and into combustion chamber 8. Ignition of the injected fuel results in flame propagation through the turbine to the tail pipe resulting in ignition in the afterburner of the fuel being introduced through nozzles 26.

Fuel from conduit 84 is meanwhile slowly bleeding through the restriction 158, first building up pressure behind piston 108 in chamber 148 and then moving piston 108 to the left. The actuating part of boss 126 contacts holding disk 144 and through snap ring 146 and the end of rod 124 acts upon piston 114, and since piston 108 has a greater area than piston 114, it overpowers piston 114 and continues moving until it closes valve 118 shutting off the igniter fuel supply to the burner.

The ignition of fuel within the afterburner results in an increase in turbine exhaust gas pressure above that normally obtained without afterburning. This increase in pressure is transmitted to the exhaust nozzle actuator control through conduit 79. The control 76 in accordance with this pressure directs compressor discharge air from conduit 230 through conduit 262 to the side of the cylinders nearest the nozzle which causes the nozzle to open and connects conduit 266 to a vent. The pressure in this conduit 262 is transmitted by conduit 98 to a normally closed pressure switch 96 in the electrical line to the normally closed solenoid actuated shut-off valve 82 which opens said switch thereby closing the shut-off valve 82 preventing a flow of fuel to the igniter 28.

To stop the operation of the afterburner the afterburner switch 94 is turned to its "off" position. This turns the temperature control amplifier 86 off thereby turning off a supply of current to a normally closed solenoid operated shut-off valve in the fuel meter. The movement of the switch to the "off" position also closes the motor operated valve 68 and turns off the afterburner fuel booster pump 48. It will be seen that with no fuel flow combustion cannot be maintained in the afterburner. The reduction of fuel pressure in conduit 74 permits spring 128 to move piston 108 of the igniter to the right thereby preparing the igniter for the next afterburner start. The decrease in afterburner pressure is transmitted to the exhaust nozzle actuator control thereby directing compressed air through conduit 266 from conduit 230 to the side of the cylinder 130 which causes nozzle 44 to close. This reduction of pressure in conduit 262 is conveyed to normally closed pressure switch 96 by conduit 98 thereby permitting the switch to be closed to permit current to pass to valve 82 upon the next starting of the afterburner.

Although a specific igniter has been shown and described herein for purpose of illustration, it will be evident to those skilled in the art that the invention is capable of various modifications and adaptations within the scope of the appended claims. The control system for an afterburner as shown in this application is shown and claimed in co-pending application Serial No. 196,425, filed November 18, 1950, and an igniter control of the type shown in this application is shown and claimed in co-pending application Serial No. 196,426, filed November 18, 1950.

I claim:

1. In combination, an engine, means for supplying air to said engine, means for supplying fuel to said engine, means for igniting the fuel-air mixture in the engine formed by said first and second named means, an afterburner, means for supplying combustion supporting gas

to said afterburner, means for supplying fuel to said afterburner, and means for igniting the fuel-gas mixture in the afterburner formed by said fourth and fifth named means, said last named means including a valve for controlling a flow of additional fuel into said engine thereby enriching the fuel-air ratio in the engine and piston means responsive to the fuel supplied to said afterburner for regulating said valve, said piston means including two pistons, one piston being movable in a direction to open said valve and the second piston being movable in a direction to close said valve, said first piston being actuated directly by the fuel supplied to said afterburner, and means for delayed actuation of said second piston by the fuel supplied to said afterburner.

2. In combination, an engine, means for supplying air to said engine, means for supplying fuel to said engine, means for igniting the fuel-air mixture in the engine formed by said first and second named means, an afterburner, means for supplying combustion supporting gas to said afterburner, means for supplying fuel to said afterburner, and means for igniting the fuel-gas mixture in the afterburner formed by said fourth and fifth named means, said last named means including a valve for controlling a flow of additional fuel into said engine thereby enriching the fuel-air ratio in the engine and piston means responsive to the fuel supplied to said afterburner for regulating said valve, said piston means including two pistons, one piston being movable in a direction to open said valve and the second piston being movable in a direction to close said valve, said first piston being actuated directly by the fuel supplied to said afterburner, and means including a restriction for delayed actuation of said second piston by the fuel supplied to said afterburner.

3. Valve controlling means including a housing, a cover for said housing, two pistons mounted within said housing, one piston being slidably engageable with said housing, a circular flange projecting into said housing, the other piston being slidably engageable with said circular flange, a rod adapted to be attached to a valve, said rod passing through said housing and one piston, a stop on said rod between said pistons, a spring mounted around said rod between said stop and one piston biasing the rod in one direction against one piston and biasing the two pistons apart, an inlet passage to said housing, a second passage connecting one side of one piston to said first passage, a third passage connecting one side of the other piston to said first passage, and a restriction in one of the last two named passages.

4. A device for injecting an amount of fluid comprising a valve, an inlet to said valve, an outlet from said valve, a valve stem on said valve, and means for operating said valve including a housing, a first piston in said housing, a second smaller piston in said housing, said valve stem extending into said housing and through said first piston, a stop on said stem between said pistons, a spring, said spring being mounted around said valve stem between said stop and said first piston biasing said valve to a closed position, said spring also biasing said pistons apart, an inlet passage to said housing, a second passage connecting a side of one piston to said first named passage and a third passage connecting a side of the other piston to said first named passage.

5. An igniter control comprising a housing, a cover, a first piston in said housing, a circular flange on the inside of said cover and projecting into said housing, a second piston in said flange, said first piston forming a first chamber with the housing, said second piston forming a second chamber with the cover, a valve housing, a valve in said valve housing, an inlet on one side of said valve, an outlet on the other side of said valve, a valve stem, said valve stem extending into said first named housing, a boss on the first piston, said valve stem extending through said boss, a holding disk mounted on the end of the stem in the first named housing between the first piston and the second, a spring, said spring being mounted around said stem between the holding disk and the first piston for holding the valve closed and said pistons apart, an inlet passage in said housing, a second passage connecting said inlet passage to said first chamber, a third passage connecting said inlet passage to said second chamber, and a restriction in said second passage.

6. A gas turbine power plant including a compressor, a turbine driving the compressor, a combustion chamber into which air from the compressor is discharged and from which the products of combustion are delivered to the turbine, means for supplying fuel to the combustion chamber to be burned with a portion of the air therein, and an afterburner connected to the exhaust side of the turbine and into which combustion supporting gas from the turbine is delivered, in combination with means for admitting fuel to the afterburner to mix with the gas therein, and means for igniting the mixture of fuel and gas therein, said last named means having a valve for controlling a flow of additional fuel into said combustion chamber thereby enriching the fuel-air ratio in said chamber, and piston means responsive to the fuel supplied to said afterburner for regulating said valve, said piston means including two pistons, one piston being movable in a direction to open said valve and the second piston being movable in a direction to close said valve, said first piston being actuated directly by the fuel supplied to said afterburner, said second piston being actuated after a delay by the fuel supplied to said afterburner.

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