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SEQUENTIAL FUEL CONTROL

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FIG. 1

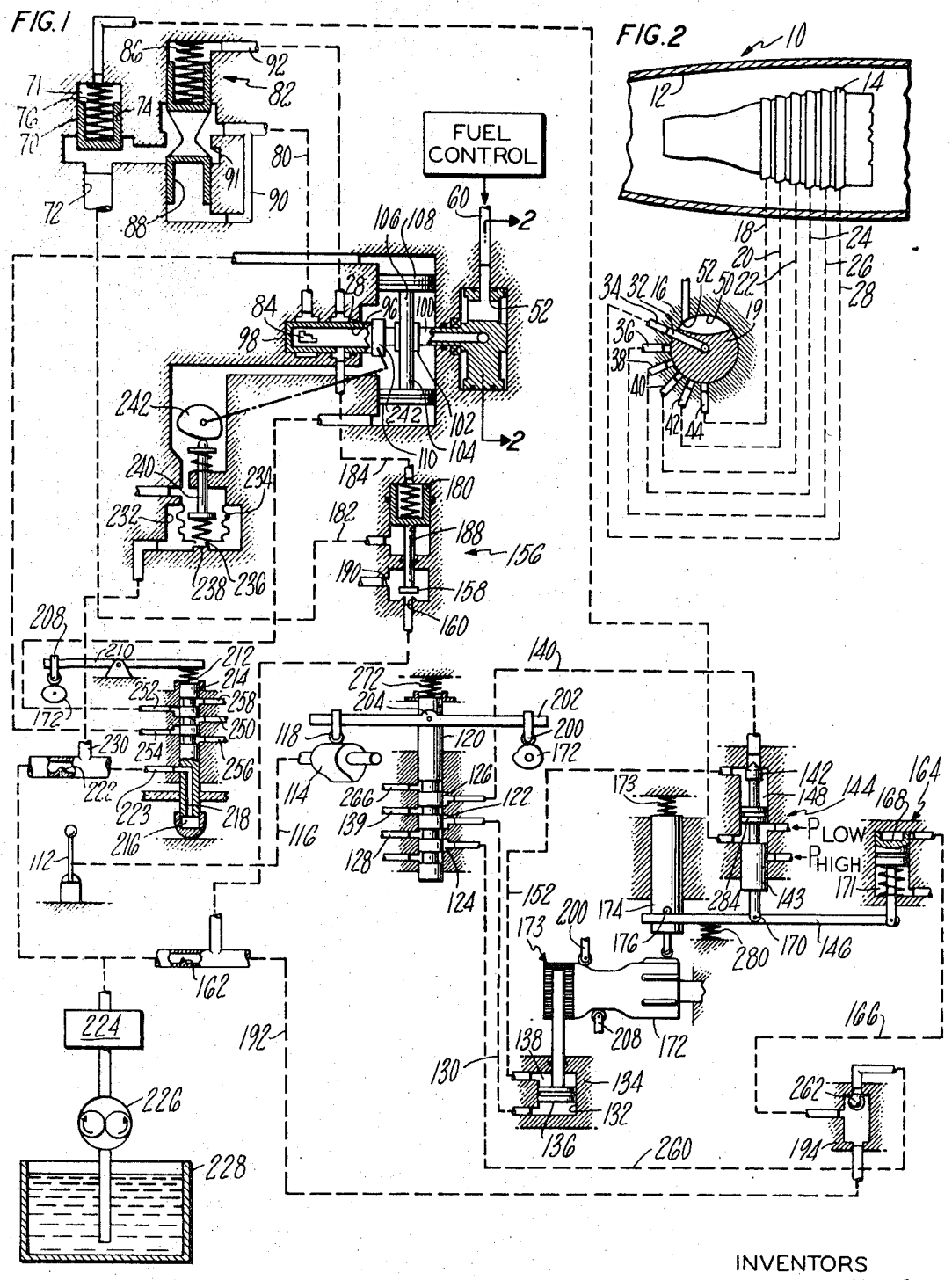


FIG. 2

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SEQUENTIAL FUEL CONTROL

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U.S. Cl. 60—39.28 9 Claims

ABSTRACT OF THE DISCLOSURE

A rotary distributor valve sequentially operated in response to power lever position and fill flow interconnects metered fuel from a main fuel control and burner segments of a powerplant only after the segments and their interconnecting flow lines are filled with fuel.

CROSS-REFERENCE TO RELATED APPLICATION

This invention is related to an invention entitled "Sequencing Mechanism for a Fuel Control," application Ser. No. 836,774, filed by G. A. Fisher and C. F. Stearns of even date and assigned to the same assignee.

BACKGROUND OF THE INVENTION

This invention relates to fuel controls and particularly to a rotary distributor valve and sequencing control therefor admitting fill flow to a plurality of nozzles in a combustion chamber in response to power lever and fill flow parameters.

As is well known in certain types of jet engines, it is customary to mount a plurality of nozzles at various locations in the combustion section to optimize combustion efficiency and is desirable to sequentially feed these nozzles with fuel in a predetermined pattern such that certain segments of nozzles are fed with fuel prior to feeding the other segments. Thus, not only does this control provide proper sequencing of fuel flow to the nozzles, it also provides means for controlling the sequence so that fuel flow may be stopped and/or reversed at any number of scheduled segments. To this end the sequence segment control allows scheduling of any number of segments in such a manner that metered flow is not allowed to enter a segment until it is filled with fuel.

SUMMARY OF INVENTION

A primary object of this invention is to provide a segment sequence control for delivering fuel to combustion sections of a turbine type of powerplant subsequent to filling the individual nozzles with fuel. It is to be understood that combustion section is defined as being a nozzle located in any station of the engine where combustion occurs.

A still further object of this invention is to provide a rotary type of distributor valve operable in response to power lever position and fill flow parameters for sequentially filling and connecting burner segments with fuel.

A still further object of this invention is to provide hydraulic latching means responding to flow of fuel in the lines interconnecting a segment for overriding the power lever input signal.

Other features and advantages will be apparent from the specification and claims and from the accompanying drawings which illustrate an embodiment of the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a schematic illustration, partly in sectional, showing the details of this invention.

FIG. 2 is a schematic illustration showing the sequence control distributor valve connected to the segments in the burner section of a bypass of a jet engine partially shown.

DESCRIPTION OF THE PREFERRED EMBODIMENT

As can be seen in FIG. 2, a jet engine generally indicated by numeral **10**, only a portion being shown, includes a ducted fan section **12** in which is disposed a series of nozzle segments **14** which in this instance takes the form of annular rings varying in size and disposed at different stations within the engine, connected to the distributor valve **16** through the interconnecting lines **18**, **20**, **22**, **24**, **26**, and **28**. Obviously, there are as many lines as there are nozzle segments and the number and pipes of nozzle segments not being limited but depending rather from the design criteria of the particular engine. Distributor valve **16** comprises a rotary valve element **19** having a central bore **21** formed therein communicating with a radial passage **32** adapted to selectively register with a plurality of circumferentially spaced ports **34**, **36**, **38**, **40**, **42**, and **44**. In addition, an arcuate slot is formed therein having sufficient area to span the entire arc of ports including **34** through **44**, inclusively. Thus, rotation of valve element will first place radial passage **32** in line with **34** for receiving fuel from a separate source to be described hereinbelow prior to communicating with passage **50** defined by the arcuate slot **52** formed in the rotary valve element. Rotation of the valve element to the next port **36** places in communication the port **34** and the annular space **50** to which is fed metered fuel as will be described hereinbelow.

Therefore, from the foregoing, it is apparent that selectively positioning the radial passage **32** to register with radial passages **34** through **44** inclusively will first place fuel from a separate source to fill the lines communicating with the respective ports prior to placing the metered fuel evidenced in the chamber defined by the arcuate slot **52** for delivering metered fuel to the respective segments of the engine's combustion chamber. As noted from FIG. 1, metered fuel is admitted to the distributing valve through drilled passage **60** and into chamber **50** for selectively being admitted to the various flow lines interconnecting ports **34** through **44** inclusively and the burner segments.

The fill flow which is fuel pressurized by the fuel pumping system is admitted to fill flow shutoff valve **70** via line **72**, valve **70** serving to assure that the fuel is not admitted into the system until actuated by the latching mechanism generally indicaed by reference numeral **144** consisting of valves **174** and **143**. As noted from FIG. 1 valve element **74** moves against the compression spring **76** and the pressure in chamber **71** delivering fuel to the fill flow throttle valve generally indicated by numeral **78** via line **80** and pressure regulator generally indicated by numeral **82**. The shutoff valve will be described in more detail hereinbelow. The pressure regulator serves to maintain the pressure drop across the metering orifice **84** at a constant value, which is dictated by the force of spring **86**. The valve operates by sensing upstream and downstream pressure across metering orifice **84** by admitting upstream pressure to act on one face of valve element **88** and downstream pressure to act on the opposing face of element **88**, pressure being admitted thereto respectively via passages **90** and **92**. Since the area is equal, the force created by spring **86** acting in concert with downstream pressure urges valve element **88** to open valve metering element **92** with respect to the valve seat **94**. This force is counteracted by the force acting on the underside of valve element **88**. When the total force of the pressure on the upperside of valve element **88** and spring **86** counterbalance the force acting on the underside, the pressure drop (ΔP) across metering orifice **84** will be equal to the force of spring **86**. Any deviation from the balance will adjust valve element **88** until the ΔP is returned to its selected value.

Fuel admitted into orifice **84** passes through an axial drilled passage **96** formed in the fill flow throttle valve **98** and communicates with radial passage **32** formed in the rotating distributing valve element **19**.

From the foregoing it is apparent that the rotary distributor valve element **19** serves to fill the one line interconnecting the burner segment with fuel delivered from one source and then proceeds to fill the next adjacent segment, which fuel being metered from the main fuel control, shown in blank, enters the fuel section to deliver metered fuel to that particular connecting segment ring just filled. By contouring orifice **84** as shown, it is possible to select the rate at which each segment will fill. It is understood, as is obvious to one skilled in the art, that the outer window (orifice) cooperating with the inner window has a fixed metering area and the total metering area will be dictated by the portion of the windows that is exposed to the fuel flow.

The next portion of the description will describe the actuation of the rotary distributor valve **19**. As noted from FIG. 1, the fill flow throttle valve **98** is connected to the rotary distributor valve **19** by an axial hollow shaft **100**. Shaft **100** carries pinion gear **102** which is in mating relation to the rack gear **104**, the details of both being eliminated for the sake of convenience as any means of actuation will fall within the purview of this invention. The rack gear **104** is made integral with the connecting shaft **106** interconnecting the pistons **108** and **110**. Fluid admitted to these pistons serves to position them with a consequential movement of the rack **104** and a likewise rotary movement of the distributor valve **19**. This movement is made in response to the power lever generally indicated by numeral **112** which serves to control the power lever servo **136** and the cooperating cam **172** which, in turn, schedule the segments in a predetermined manner but assuring that the fill is manifested before the various burner segments are connected to the metered fuel. Power lever adapted to be positioned for admitting fuel to the segments is connected to cam **114** via the schematically illustrated connection **116**. Cam **172** is adapted to schedule one or all of the segments in sequential order and by moving it to the extent of its travel which will be the high point of the node, follower **118** is forced upwardly causing the pilot valve **120** to move in an upward position. As would be obvious to one skilled in the art, cam **172** can be used to adjust the fuel control so as to properly schedule metered fuel flow with the actuated segments. The lands on valve **120** uncover ports **122**, **124** and **126** for communicating high pressure line **128** with line **130** for admitting pressurized fluid into chamber **132** of piston actuator **134**. However, piston **136** will remain stationary until fluid present in chamber **148** formed on the back side of piston **136** is drained. Draining of this chamber is effectuated by latching mechanism **144**. As can be seen from the drawing, latching mechanism **144** is connected to the lever **146** and serves to open chamber **148** to drain by positioning valve element **142** downwardly. Hence, piston **136** will remain stationary notwithstanding the admittance of pressurized fluid in chamber **132** until line **152** is connected to drain via line **140**, pilot valve **120**, and drain connection **138**.

The latching mechanism **144** is controlled by fill sensor generally indicated by numeral **156**. The fill sensor measures the fluid being admitted to the various fill lines and responds to the fluid in the line communicating with the source of fill fluid. While the particular means for sensing when a segment line is filled does not form a limitation to the invention, in this instance the fill sensor measures the pressure drop across orifice **84** and when that approaches zero, the flapper valve **158** will shut off the flow from orifice **160** to build up the pressure downstream of restrictor **162** which ultimately is admitted into actuator **164** via connecting line **166**. Thus, when the pressure drop across orifice **84** is at zero, pressure is admitted behind piston **168** urging it against spring **171** in a downward direction for positioning lever **146** downwardly and with a like movement of valve element **142** being connected thereto by the pin connection **170**. This movement interconnects line **152** with line **140** for draining chamber **148**. Piston **136** is then urged upwardly and by virtue of the rack and pinion connection generally indicated by numeral **173** causes the power lever servo cam **172** to rotate and position valve element **174** upwardly. Lever **146** abuts against the projecting pin **176** and since it is moved upwardly likewise lever **146** also moves upwardly repositioning valve element **142** to the closed position and hence latching the system until the next segment is filled.

As noted, the fill sensor **156** consists of piston **180** having one surface exposed to pressure upstream of orifice **84** via line **182** and the other surface to pressure downstream of orifice **84** via line **184**. Hence, the pressure acting across orifice **84** and the force of spring **181** is felt by piston **180** and moves flapper **154** relative to orifice **160** by virtue of the connecting rod **188**. High pressure discharging from **160** is normally dumped to drain (i.e., pump inlet) via port **190** so that closure of flapper valve **158** builds up pressure downstream of orifice **162** disposed in line **192** which in turn is transmitted to chamber **164** via line **166** and the Most selector valve **194**.

Thus, from the foregoing, it is apparent that the admittance of pressure into chamber **132** and the dumping of pressure from chamber **148** permits piston **136** to move axially for rotating cam **172**. The cam motion is picked up by follower **200** suitably attached to the lever **202** which is also pinned to the pilot valve **120** by pin **204**. This feeds back the signal to the pilot valve to return it to its null position such that the lands **122**, **124**, **126** are in line-on-line with the respective ports which will occur only when the signal scheduled by the pilot lever **112** as seen on cam **114** is matched by the number of segments actuated. Thus if the power lever is positioned to fill the six segments, then the null position will be reached solely when the six segments are filled.

In addition, the motion of cam **172** is also picked up by follower **208** which is suitably connected to fulcrumed lever **210** having one end bearing against spring **212** disposed on the top surface of pilot valve **214**. Pilot valve **214** serves to position pistons **108** and **110** for controlling movement of the segment distributor valve **19**. This is effectuated by applying a pressure signal to chamber **216** via drilled passage **218** and line **220**. This is accomplished by controlling the pressure drop across fixed restriction **222** disposed in line **220** which is in communication with regulated pressure discharging from the pressure regulator indicated in blank by reference numeral **224** which is fed by pump **226** in communication with reservoir **228**. As noted from FIG. 1, the branch line **230** downstream of fixed restriction **222** feeds into chamber **232** which has disposed therein bellows **234**. Formed on the free end of the bellows and centrally disposed thereof is orifice **236** which is in proximity to the projection **238**. Movement of the bellows **234** positions orifice **236** relative to projection **238** for effectuating closure thereof. The bellows is controlled by the push rod **240** which is urged against cam **242** attached to the hollow shaft **100**. Rotation of the hollow shaft **100** rotates cam **242** to position push rod **240** relative thereto and for each position of came **242** there will be a corresponding position of orifice **236** and likewise there will be a corresponding presssure in chamber **216** for positioning the land of spool **214** relative to the various ports. Thus, high pressure admitted into port **250** is either directed to line **252** or **254** depending whether the spool has beeen moved upwardly or downwardly. If **252** is connected to high pressure, then **254** is connected to drain via line **256**. Conversely, if high pressure is admitted to **254**, then line **252** is connected to drain via line **258**. Lines **252** and **254** are in communication with

the ends of pistons **110** and **108** respectively, for effectuating movement thereof. The force of the pressure acting on the end of spool **214** created by the pressure in chamber **216** is counteracted by the force produced by spring **212**. When these forces are balanced, no movement of pistons **108, 110** will occur. Accordingly, for each position of rotary distribution valve **19** there will be a corresponding position of cam **242** and a likewise corresponding position of lever **210** and pilot valve **214** will be at the null position.

To effectuate closure of the various segments, the pilot lever is returned to its original position rotating cam **114** to the lower point imparting an unbalance to lever **202** with a consequential downward movement of pilot valve **120**. This positions lands **122, 124,** and **126** downwardly to uncover the various communicating ports for applying high pressure from line **128** to the Most selector valve **194** via line **260**. This moves the ball **262** downwardly to block off flow from line **192**. Piston **168** moves downwardly for disarming the latching mechanism **136** by a consequential downward positioning of valve element **142**. High pressure is then applied from line **266** into line **140** by land **126** for applying high pressure into chamber **148** via the latching valve **136** and line **152** urging piston **136** downwardly for rotating the power lever servo cam **172** by the rack and pinion mechanism generally indicated by numeral **173**. Pilot valve **120** is continuously urged in a downward direction by action of spring **272**. Obviously, rotation of cam **172** in a downward direction will cause an unbalance on spring **212** by the movement of lever **210**. As the load decreases by rotating lever **210** counterclockwise, the pilot valve will move so that the lands are positioned to communicate the pressure behind piston **110** and the pressure behind piston **108** so that it will move in a decreasing direction. It will continue to move until the scheduled signal imposed by cam **114** is satisfied. Any number of nozzles can be shut off in a descending manner. Thus, movement of power lever if advanced, initiates the various segments sequentially in an ascending order and if retracted, turns off any given number of segments in a descending order.

OPERATION OF THE SEQUENCE SEGMENT CONTROL

Assume the pilot is calling for the full number of segments to be turned on, he will advance the pilot lever to the full open position. This, in turn, rotates cam **114** to the high point creating an unbalance on fulcrum lever **202** for positioning the pilot valve **120**. This, in turn, admits high pressure servo fluid into the pilot lever servo piston **136** for urging it upwardly. Since chamber **148** is filled with fluid, the piston will not move until this fluid is dumped. Dumping of fluid from chamber **148** is effectuated by actuating the latching mechanism **144** by unseating valve **142** is response to the fill sensor **156** sensing fill line **96** by measuring the pressure drop across orifice **84**. When the line is filled, i.e., when the ΔP across **84** is substantially zero, and this will occur since the pressure drop is being felt across the nozzles when the line is filled, this signal is transmitted to latching servo **164** by closing off the flapper orifice **160** with flapper element **158**. As noted from FIG. 1, the pressure drop is measured across the fill flow shutoff valve **74** and in line pressure regulator **82** inasmuch as this is an indication of the ΔP across orifice **84**. As would be obvious to one skilled in the art, any other pressure indicative of ΔP across orifice **84** can be utilized. This, in turn allows the pressure in line **192** to increase and this pressure is in turn felt on the back side of piston **168** being in communication with line **166** which is in communication with line **192**. Piston **168** moves down forcing lever **146** to pivot clockwise about pin **176** therefore carrying valve **142** downwardly to open up line **140** to line **152**. Since land **126** has moved upwardly, drain line **139** communicates with line **140** for draining the fluid in chamber **148**, and permitting the piston **136** to move upwardly for rotating cam **172** allowing lever **146** which is balanced by spring **280** to move to its latching position. The metering land of valve **284** serves to assure that the shutoff valve **74** is closed when the filling process is completed. Hence, once the line is filled with fuel from a separate source, says directly from the pumps, the distributor valve **19** is allowed to rotate so as to place metered fuel from the main fuel control in communication with the segment just filled. The rotation of the metering valve then places the radial passage **32** of distributor valve **19** in communication with the next line **36**. Line **36** fills up in a similar manner and when it is completely filled, the pressure drop across **84** again becomes zero reactivating the latching mechanism **136** to allow the distributor valve to move in the manner just described above. Of course, the movement of the distributor valve is dictated by the position of cam **172** which controls the pilot valve **214** for applying and draining pressure from pistons **108** and **110** respectively, depending on whether the nozzles are filling or emptying.

It should be understood that the invention is not limited to the particular embodiments shown and described herein, but that various changes and modifications may be made without departing from the spirit or scope of this novel concept as defined by the following claims.

What is claimed is:

1. A fuel control for a turbine type powerplant having a burner section that includes a plurality of burner segments, each segment having its own fuel connecting line,

(a) a distributor valve for sequentially filling said fuel connecting lines with fuel prior to interconnecting said fuel connecting lines with additional fuel whose quantity has been precalculated commensurate with desired burning characteristics,

(b) said distributor valve having a rotatable generally cylindrical shaped member,

(c) a plurality of fixed ports circumferential spaced adjacent said rotatable member each of which communicate with each of said fuel connecting lines,

(d) control means for imparting movement to said rotary member for sequentially and successively registering a radial fuel feed passage in said rotary member with each of said ports and an opening in said rotary member communicating with the ports succeeding the port being in register relation with the radial passage.

2. A fuel control as claimed in claim **1** including a control bore formed in said rotary member interconnecting said radial passage and an orifice formed in said rotary member which orifice is in serial flow relation to said radial passage.

3. A fuel control as claimed in claim **2** including means for varying the area of said orifice.

4. A fuel control as claimed in claim **3** wherein said means for imparting rotary movement includes a hydraulic actuated piston and means interconnecting said piston and said rotatable member.

5. A fuel control as claimed in claim **4** including a pilot lever, means responsive to the position of said pilot lever for controlling the position of said hydraulic actuated piston and means responsive to the pressure drop across said orifice for rendering said hydraulic actuated piston inoperative until a predetermined value of said pressure drop has been obtained.

6. A fuel control as claimed in claim **5** wherein said control means includes cam means, another hydraulic piston for imparting movement to said cam means, a pilot valve hydraulically coupled to one side of said other hydraulic piston, a flow line connected to the other side of said hydraulic piston and latching means regulating the flow of hydraulic fluid in said flow line, and means for actuating said latching means.

7. A fuel control as claimed in claim **6** wherein said flow regulating means respond to the pressure drop across said orifice.

8. A fuel control as claimed in claim 7 including a feedback connection interconnecting said cam and said pilot valve for returning said pilot valve to its null position in time relation with said latching means.

9. A fuel control as claimed in claim 5 wherein said pressure drop responsive means includes a single sensor monitoring singularly the flow of fuel during said filling of each of said fuel connecting lines.

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