July 29, 1958 F. F. HUTTON 2,845,079

FUEL FLOW DIVIDER

Filed Feb. 6, 1956 4 Sheets-Sheet 1

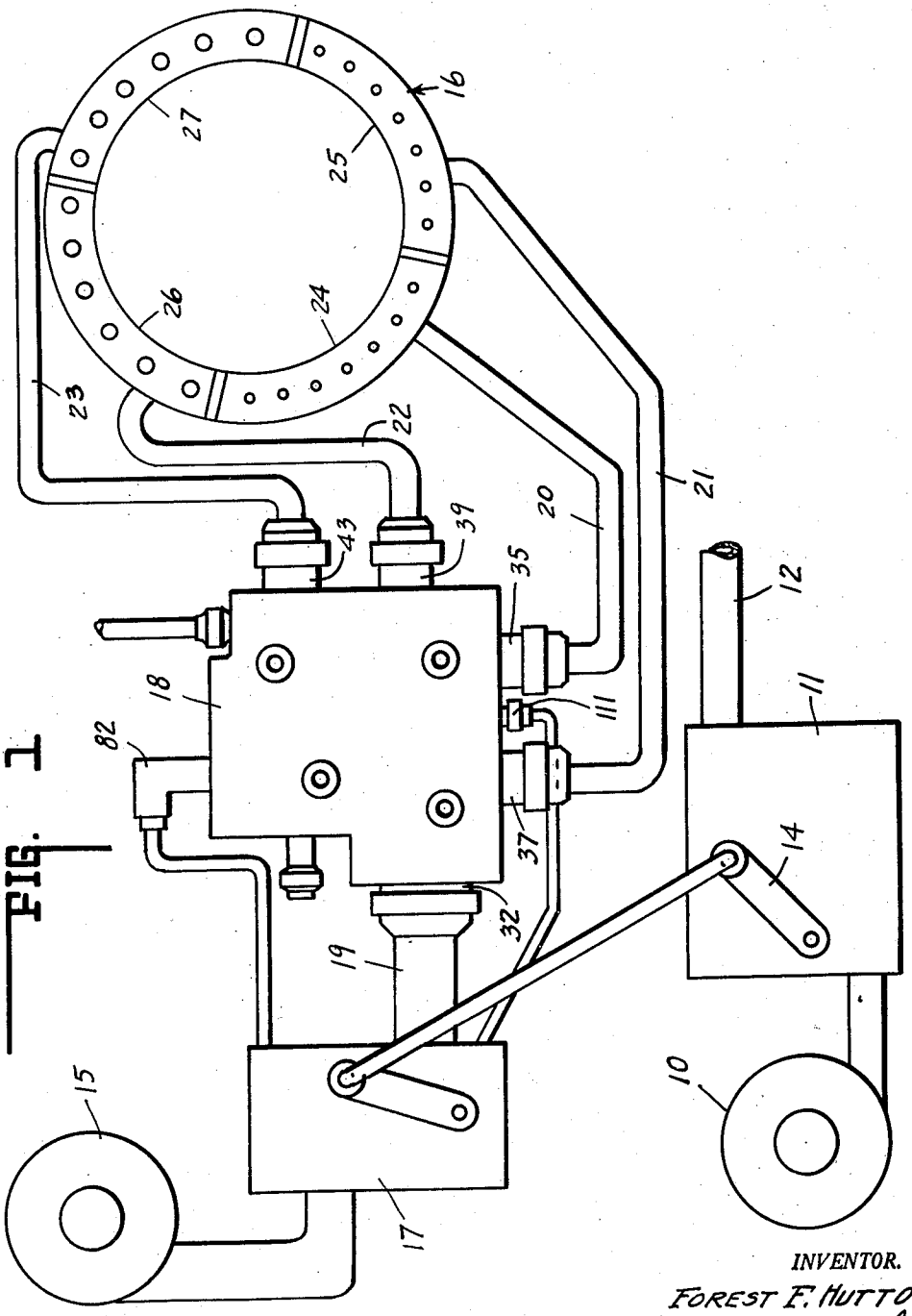

FIG. 1

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FUEL FLOW DIVIDER

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FIG. 2

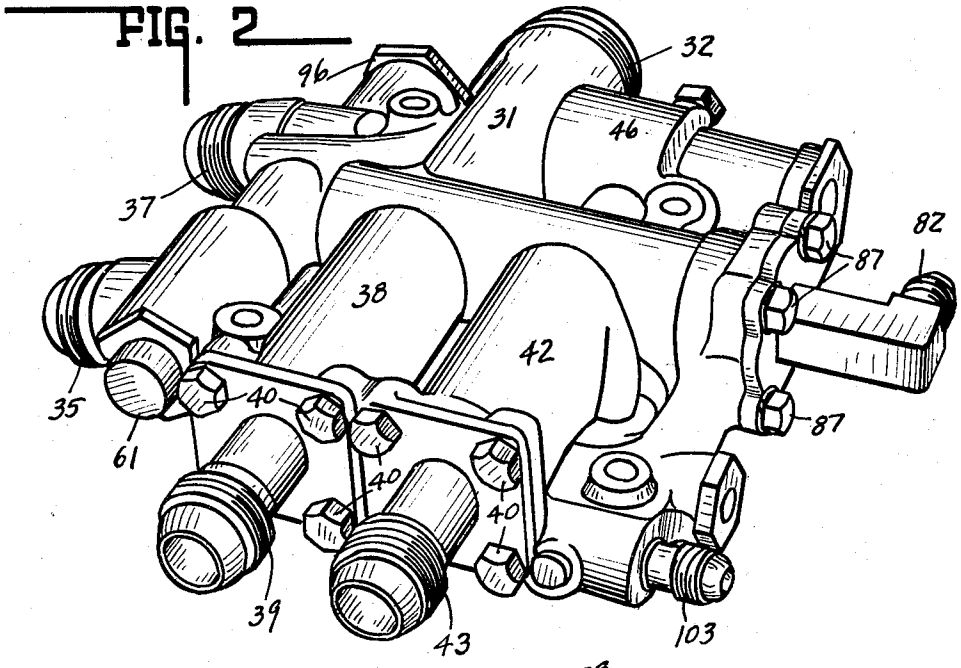
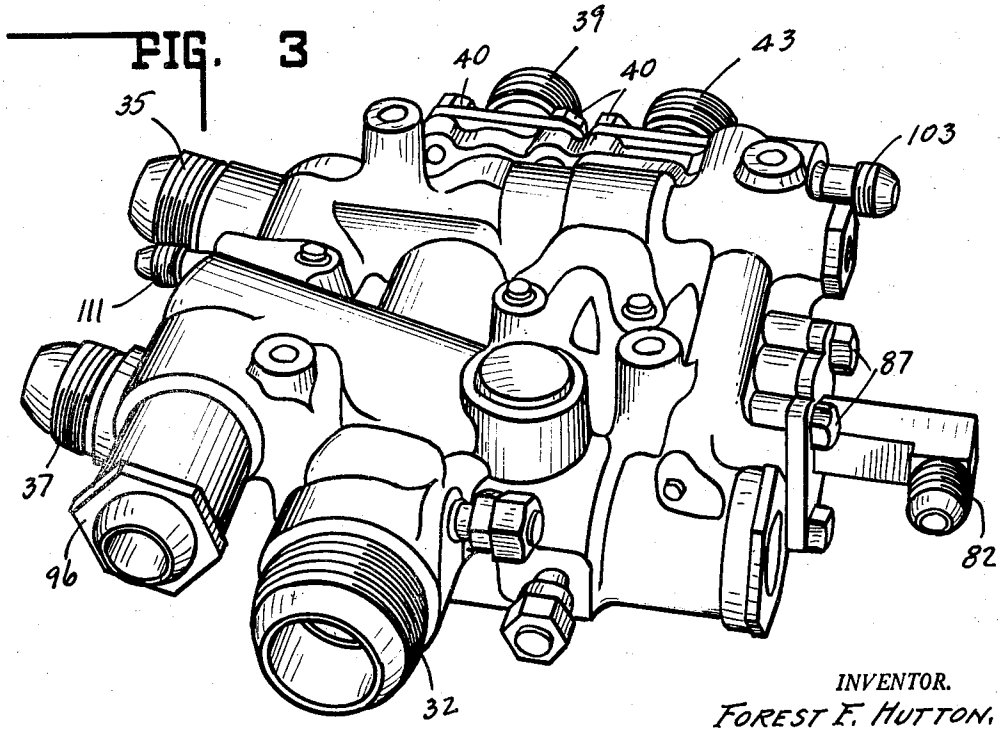


FIG. 3



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FUEL FLOW DIVIDER

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FIG. 4

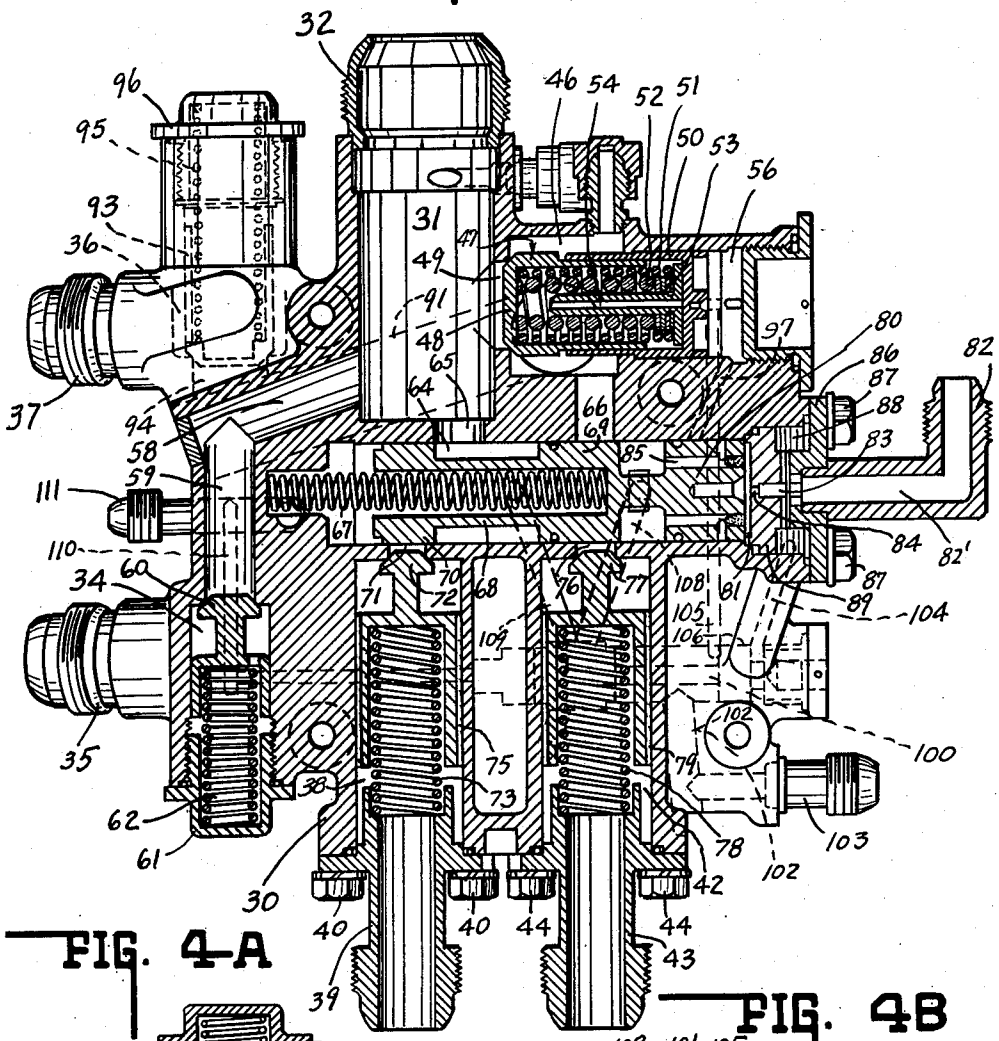


FIG. 4A

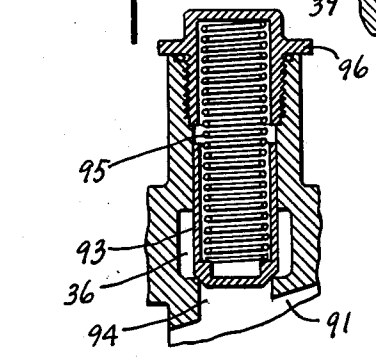
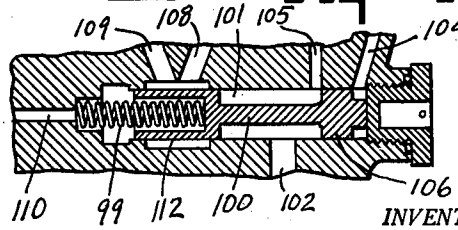


FIG. 4B



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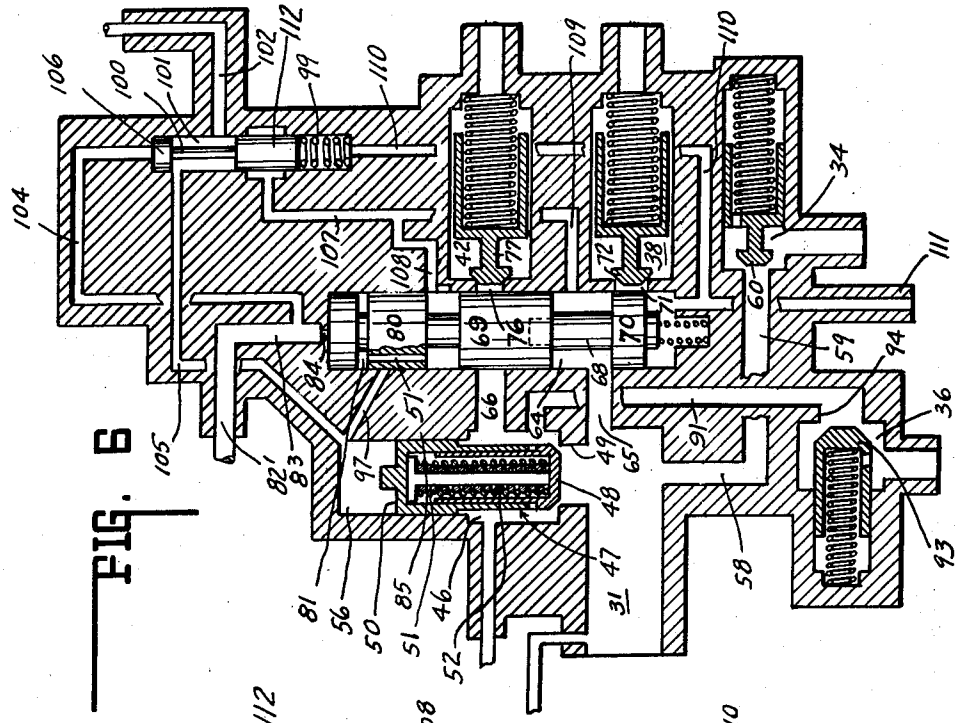

FIG. 6

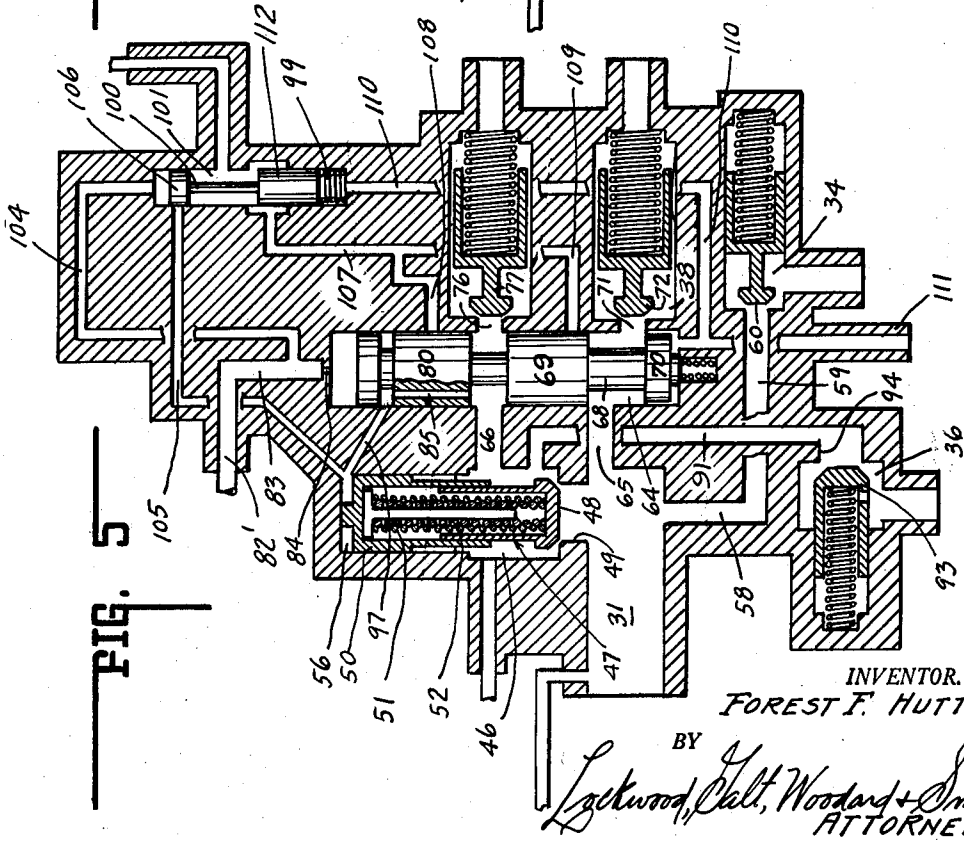

FIG. 5

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United States Patent Office 2,845,079 Patented July 29, 1958

2,845,079

FUEL FLOW DIVIDER

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Application February 6, 1956, Serial No. 564,101

17 Claims. (Cl. 137—118)

This invention relates generally to fuel-flow control systems for jet engines and it relates more particularly to a flow dividing and selecting valve for dividing and scheduling flow of fuel into the after-burner manifold of a jet engine.

Conventional control devices for dividing and scheduling flow of fuel into an after burner include electrically operated valves and in order to prevent damage to such valves from the heat generated in the engine, it is necessary that they be located a substantial distance from the after-burner manifold. As a consequence, the fuel lines between the valves and the burners are of substantial length and contain a substantial amount of fuel. As a result, there is uncontrolled burning of fuel in these lines and coking of fuel therein which causes stoppage within the lines and faulty operation of the jet engine.

The use of electrical controls for such flow-divider valves naturally requires a rather complex electrical circuit and a substantial number of electrical conductors extending between the pilot's control position and the valves of the engine. Accordingly, conventional control systems are subject to the usual troubles inherent in electrical circuits.

The principal object of this invention is to provide, in the fuel-supply system of a jet engine, a means of controlling division and scheduling of fuel flow which requires no control connections other than the usual fuel lines.

Another object of this invention is to provide, in a fuel-control system for a jet engine, a means of controlling division and scheduling of fuel flow which is not affected by high-fuel temperatures or high or low ambient temperatures.

Still another object of this invention is to provide a fuel-flow dividing and scheduling apparatus adapted to respond to pressure signals in the fuel-supply lines for controlling division of fuel flow in accordance with said pressure signals.

A further object of this invention is to provide a fuel-flow dividing and scheduling valve for jet engines which utilizes the fuel as a control medium for providing hydraulic forces to which the valve mechanism may respond.

A still further object of this invention is to provide fuel-flow dividing and scheduling apparatus for jet engines which operates by means of pressure signals to schedule division of flow of fuel to an after burner and to provide a predetermined fuel-to-air ratio throughout the complete range of engine power requirements at all altitudes of operation.

A still further object of this invention is to provide in a fuel-supply system for a multiple section burner in a jet engine, a means of scheduling flow of fuel to each section of said burner and of maintaining a predetermined ratio of fuel to certain sections of said burner throughout the complete range of engine power requirements at all altitudes of operation.

A still further object of this invention is to provide, in a fuel-flow system for a jet engine, a combined selector valve and flow-divider valve in a single unit or enclosure to

afford maximum protection from heat, thereby to shorten fuel lines to the burners and eliminate uncontrolled burning of fuel in said lines and coking of fuel therein.

In accordance with this invention there is provided a fuel-flow dividing and scheduling apparatus adapted to cooperate with a pilot operated control mechanism and a multiple sector burner for jet engines which comprises a plurality of pressure-responsive valves, each of which is connected to one of the sectors of said burner, one of said valves being responsive to a predetermined minimum inlet pressure for initiating fuel flow to a first section of said burner, a flow-divider valve responsive to a higher inlet pressure and coupled to a second one of said valves for initiating flow to a second sector of said burner, and a selector valve coupled between the flow-divider valve and the others of said valves and responsive to a still higher inlet pressure for initiating flow of fuel to the remaining sectors of said burner.

The full nature of the invention will be understood from the accompanying drawings and the following description and claims:

Fig. 1 is a schematic diagram of a fuel-control system in which the flow divider and scheduling valve of this invention is utilized.

Fig. 2 is a perspective view showing the top side of the flow divider and scheduling valve as provided in accordance with this invention;

Fig. 3 is a perspective view showing the bottom side of the valve shown in Fig. 2;

Fig. 4 is a longitudinal cross-section taken on a line through the axes of the primary sector valve, primary uniform valve, secondary uniform valve, inlet chamber and flow divider valve shown in Fig. 2.

Fig. 4A is a longitudinal cross-section of the secondary sector valve.

Fig. 4B is a longitudinal cross section of the squirt flow valve;

Fig. 5 is a schematic diagram illustrating a longitudinal cross section similar to that shown in Fig. 4 and illustrating the valve mechanism in one phase of operation; and

Fig. 6 is a schematic diagram similar to that of Fig. 5 but illustrating the valve mechanism in another phase of operation.

Referring to Fig. 1, this invention is utilized in a fuel-flow control system comprising a source of fuel (not shown) having connected thereto a first fuel supply pump **10**, a main control throttle **11** connected to pump **10** and a fuel supply line **12** connected to the burners of a jet engine (not shown). Flow of fuel through supply line **12** is controlled by the first 90° of movement of the throttle lever **14**.

A second supply pump **15** supplies fuel to the manifold **16** of the after burner of a jet engine through an after-burner control valve **17** and a flow divider and selector valve **18**. The valve **18** constitutes the principal feature of this invention and includes a fuel inlet **19**, together with pressure-operated valves adapted to schedule and divide the flow of fuel coming from inlet **19** through the lines **20**, **21**, **22**, and **23** connecting with the primary sector **24**, secondary sector **25**, primary uniform **26**, and secondary uniform **27**, respectively, of the after-burner manifold **16**.

The flow divider and scheduling valve **18** consists of a body member **30** which may be in the form of a single casting having an inlet chamber **31** adapted to be coupled to the inlet line **19** by means of a suitable coupling **32**. The primary sector line **20** may be coupled to the primary sector valve chamber **34** by means of a conventional coupling member **35** while the secondary sector valve chamber **36** may be coupled to a secondary sector fuel line **21** by means of a conventional coupling member **37**.

The primary uniform fuel line 22 may be coupled with the primary uniform valve chamber 38 by means of a coupling 39 bolted to the body 30 by means of bolts 40. Similarly, the secondary uniform fuel line 23 may be coupled with the secondary uniform valve chamber 42 by means of a coupling member 43 bolted to the body 30 by means of bolts 44.

A chamber 46 is formed in the body 30 for housing a flow-divider valve 47. This valve consists of a cylindrical valve member 48 normally closing the port 49. A cylindrical sleeve 50 fits over the stem portion of valve 48 and normally compresses a relatively light spring 51 and a relatively heavy spring 52 into engagement with the head portion of the valve 48. The heavy spring 52 may be compressed to exert a predetermined amount of pressure on valve 48 by means of a plurality of washers 53 mounted over a locating stem 54, whereby the spring 52 is centered by means of stem 54 and the spring 51 is centered over the exterior of the spring 52. The cylindrical sleeve member 50 is normally held downwardly (Fig. 6) by means of fluid pressure within chamber 56, thereby to hold valve 48 closed.

Chamber 31 is provided with the passage 58 opening into a passage 59 connecting with the valve chamber 34 of the primary sector valve 60. The primary sector valve 60 normally closes passage 59 and a cap member 61 is suitably fixed to body 30 to confine a valve-closing spring 62 which normally holds the valve 60 in closed position.

The inlet 31 is connected to a selector valve chamber 64 by a passage 65 and the flow-divider valve chamber 46 is also connected to the selector valve chamber by means of a passage 66. For controlling flow of fuel from inlet 31 and flow-divider chamber 46, there is provided a selector valve 68 biased by spring 67 and having a land 69 normally closing passage 66 and a second land 70 positioned normally to close the passage 71 opening from chamber 64 into a chamber 38 containing a primary uniform valve 72. The valve 72 is held in closed position by means of a spring 73 seated within a counter bore in coupling member 39 and normally exerting pressure on valve 72 holding it in closed position. In order to permit flow of fuel when valve 72 is opened, it is provided with longitudinal grooves, such as 75, whereby fuel may flow outwardly through coupling 39.

The selector valve 68 also closes, by means of land 69, a passage 76 opening from chamber 64 into the secondary uniform valve chamber 42. The secondary uniform valve 77 is normally held in closed position with respect to passage 76 by means of the spring 78 nested at one end within a counterbore in coupling member 43, as shown in Fig. 4. Spring 78 bears on the head portion of valve 77, as shown in Fig. 4, for holding this valve normally closed. As in the case of the primary uniform valve 72, valve 77 is provided with longitudinal grooves 79 which permit flow of fuel to coupling member 43 when the valve is opened.

The selector valve 68 includes another land 80 which normally is positioned as shown in Fig. 4 leaving a small chamber 81 which is connected to the passage 82' in coupling member 82 by means of the passage 83 having a restricted portion 84. The coupling member 82 is fixed to a cover 86 secured to body portion 30 by means of bolts 87. Land 80 includes a by-pass 85. A plurality of washers 88 serve to hold a plate member 89, having passage 84 therein, in position over the land 80 of selector valve 68.

The flow-divider valve chamber 46 is also connected to the secondary sector valve chamber 36 by means of the passage 91 shown in dotted lines in Fig. 4. A secondary sector valve 93 is also shown in dotted lines in Fig. 4 and in cross-section in Fig. 4A, and it normally closes a passage 94 connecting the secondary sector chamber 36 with the passage 91. The secondary sector valve includes a spring 95 bearing on the inner surface of a cap 96 and serving normally to hold valve 93 in closed position.

For controlling timing and sequence of operation of the flow-divider valve 47 and the selector valve 68 and therewith the primary and secondary uniform valves 72, 77, together with the primary and secondary sector valves 60 and 93, there is provided a squirt-flow valve 100 (Figs. 4 and 4B), biased by spring 99 operable within a chamber 101 and connected by passage 102 through coupling member 103 to an auxiliary fuel pump supply (not shown) which applies pressure within chamber 101 as will be described.

Chamber 101 is connected through a passage 104 with passage 83. Chamber 101 is connected with chamber 56 over the flow-divider valve by means of a passage 105 and this passage is normally open with respect to land 106 of squirt valve 100. Chamber 56 is connected by a bleeder passage 97 with chamber 64 and land 80 normally closes this passage. The chamber 101 is also connected with chamber 64 of the selector valve by means of a passage 108 (Fig. 4B) opening into chamber 64 at a point normally below (Fig. 6) the land 80 of valve 68. Another passage 109 opens into chamber 64 below (Fig. 6) the land 69. Passages 108 and 109 are normally closed by lower land 112 of valve 100. This is shown schematically in Figs. 5 and 6 wherein passage 107 is shown for convenience as coupling passages 108 and 109 to chamber 101. Chamber 101 is connected by still another passage 110 to the lowermost (Fig. 6) end of chamber 64 and also to the coupling member 111 which connects with the low-pressure side of the control apparatus 17.

In operation of a jet engine at normal flight speeds, the pilot causes the control lever 14 to swing through an arc of approximately 90° in which portion of the arc the control feeds the proper amount of fuel to the turbine section of a jet engine. During such periods the normal fluid pressure within inlet 31 is less than sixty pounds per square inch and is not sufficient to open the flow-divider valve 47 or the primary sector valve 60. The springs of these valves are designed to hold them closed until the control lever 14 is operated into the last 20° of its arc of operation.

The springs of valves 60, 72, 77, and 93 are designed to operate or to crack at a minimum pressure of sixty pounds per square inch. Therefore, the pressure within inlet 31 will become sufficient to open the primary sector valve 60 when the arc of operation of lever 14 exceeds 90°, and fuel will flow through line 20 to the primary sector 24 of the after burner 16, thereby to start its operation.

It will be noted that no fuel can flow to any of the other burners because the springs 51 and 52 of the flow-divider 47 are compressed by the valve head 50. This head is held in a lower position by pressure from the squirt-flow supply coming through passage 102, chamber 101 of the squirt-flow valve, and passage 105. Bleeder passage 97 is closed by land 80 of valve 68 and, therefore, selector valve 68 must operate before head 50 can move upwardly (Fig. 6). Also, fuel flow is cut off from the primary uniform valve 72 by the land 70 of the sector valve.

It may be assumed that lever 14 is gradually moved from its 90° position to its 110° position or this movement may be substantially instantaneous. In either case, the pressure within the inlet 31 will build up while fuel flow continues through the primary sector valve 60. When the inlet pressure reaches 120 pounds, for example, it overcomes the spring force on flow-divider 47, causing it to open slightly, at which time fuel can flow from inlet 31 through the port 49, chamber 46, passage 91, and port 94, thereby to open the secondary sector valve 93. This causes fuel to flow through line 21 to the secondary sector 25 of after burner 16.

From the foregoing description, it will be apparent

that control lever **14** and the after burner control valve **17** cause pressure signals to be generated, the first of which causes the primary sector valve **60** to open and the second of which causes the flow-divider valve **47** and the secondary sector valve **93** to open. By means of these pressure signals, flow of fuel is divided and scheduled with respect to the primary sector and secondary sector of the after burner.

As the fluid pressure within inlet **31** continues to increase, a point is reached where there is a differential of 100 pounds per square inch between the pressure in the passage **82'** of coupling member **82** and the return line coupled to the coupling **111**. As a result of this differential in pressure, the force of spring **99** is overcome and the squirt-flow valve **100** begins to open by the flow of fluid through passage **104** which connects to the chamber over the land **106**. Simultaneously, there is restricted flow through passage **84**, thereby starting movement of the selector valve **68**.

The squirt-flow valve **100** immediately moves downwardly (Fig. 5) to its lowermost position closing the passage **105**. Meanwhile, land **80** of valve **68** opens passage **97** and the pressure in chamber **56** will decrease by reason of flow from this chamber through passages **97** and **85** into the chamber **64** between lands **69** and **80** of the selector valve (Fig. 5).

When the squirt-flow valve **100** moved downwardly to the position shown in Fig. 5, fluid pressure was transferred to the selector valve through passages **107**, **108**, and **109**. This flow ceases when the lands **69** and **80** close off passages **109** and **108**, respectively, as shown in Fig. 5.

At this point, the selector valve **68** will have connected port **65** and port **71**, thereby applying pressure to the primary uniform valve **72** and opening it to permit flow of fuel through line **22** to the primary uniform burner **26**.

The port **66** will have been connected with port **76**, applying fluid pressure to the secondary uniform valve **77**. The fluid pressure will overcome the force of spring **78**, opening valve **77** to permit flow of fuel through line **23** to the secondary uniform burner **27**.

It will be understood that the flow-divider valve **47** will have opened completely when passage **97** was opened allowing the operating head **53** to move to its uppermost position shown in Fig. 5. This action disengaged the heavy spring **52** from the valve head **48**, leaving only the light spring **51** in control of this section. In this manner, the flow-divider valve moves to its fully open position and there is full flow of fuel through all of the valves **60**, **72**, **77**, and **93**.

If the pressure within inlet **31** drops to 80 pounds per square inch, for example, under the control of the pilot, the light spring **51** will close the flow-divider valve **47**, thereby cutting off flow of fuel to the secondary sector valve **93** and the secondary uniform valve **77**. The two primary valves **60** and **72** still receive flow of oil through the passages **58**, **59**, and **65**, respectively, because passage **58** is always open to inlet **31** and the selector valve **68** is still in its open position.

Another control action by the pilot can then occur which may boost the inlet pressure above 90 pounds per square inch and the flow-divider valve **47** may re-open, thereby re-opening the secondary sector valve **93** and the secondary uniform valve **77** thereby restoring burning in sectors **25** and **27**. Valve **47** can open at this lower pressure because the head **50** is up and heavy spring **52** is ineffective.

When the pilot creates a control condition which causes the differential pressure between couplings **82** and **111** to decay to a value less than 100 pounds per square inch, the operating spring of the squirt-flow valve **100** quickly returns this valve to closed position, shown in Fig. 6. The lower land **112** of the squirt-flow valve **100** immediately closes passage **107** to the selector valve **68**. Simultaneously, passage **105** to the chamber **56** of the flow-divider valve **47** is opened. The main selector valve **68**, under the influence of spring **67**, moves slowly upwardly (Fig. 5) because of the restricted flow through passage **84**, thereby closing the passage **97** to the flow-divider chamber **56**. In this manner, the squirt-flow pressure is connected to chamber **56**, causing the piston **50** to move downwardly (Fig. 6) engaging the heavy spring **52** with the valve head **48**. If the pressure in inlet **31** has decreased, then the port **49** will be closed by valve **47**. Also, the upward movement of the selector valve **68** will close the ports **71** and **76** of the primary and secondary uniform valves **72** and **77**, respectively. Thus, flow of fuel to burners **26** and **27** will be cut off.

From the foregoing description, it will be apparent that the valve provided in accordance with this invention responds to changes of pressure in order to divide and schedule flow of fuel to different burners. The division and scheduling of fuel flow may be determined by designing the valve-operating springs and the valve orifices so that the valves will open and close when predetermined pressures occur.

By utilizing pressure changes as signals to cause valve operation, it is possible to eliminate auxiliary, electrical, or hydraulic systems for operating the valves. The flow-divider and scheduling device as provided in accordance with this invention can be located in close proximity to the burners where the ambient temperatures are intense and would prohibit the use of hydraulic and electrical devices. The resultant shortening of fuel lines prevents uncontrolled burning of fuel therein and the coking of fuel which would cause faulty operation of the burners.

The invention claimed is:

1. Apparatus for dividing and scheduling flow of fuel to a multiple sector burner comprising an inlet, means for increasing or decreasing the pressure within said inlet, a first valve having spring means responsive to relatively low inlet pressure permitting said valve to open and supply fuel to a first sector of said burner, second, third, and fourth valves each including spring means for normally holding said valves in closed position, means for coupling said second, third, and fourth valves to second, third, and fourth sectors of said burner, a flow-divider valve coupled to said inlet and including spring means responsive to a predetermined higher pressure for permitting said flow-divider valve to open, a passage coupling said flow-divider valve to said second valve, whereby said second valve opens in response to said higher pressure to permit fuel flow to a second sector of said burner, a selector valve coupled between said flow-divider valve and said third and fourth valves and normally operative to isolate said third and fourth valves to maintain them in closed position, and a squirt-flow valve coupled to said control means and said selector valve and responsive to a predetermined third value of pressure for opening said selector valve and admitting pressure from said flow-divider valve to said third and fourth valves, thereby to supply fuel to the third and fourth sectors of said burner.

2. Apparatus for dividing and scheduling flow of fuel to a multiple sector burner comprising an inlet, means for increasing or decreasing the pressure within said inlet, a first sector valve having spring means responsive to relatively low inlet pressure permitting said valve to open and supply fuel to a first sector of said burner, other sector valves each including spring means for normally holding said valves in closed position, means for coupling said other sector valves to other sectors of said burner, a flow-divider valve coupled to said inlet and including spring means responsive to a predetermined higher pressure for permitting said flow-divider valve to open, a passage coupling said flow-divider valve to one of said other sector valves, whereby said other sector valve opens in response to said higher pressure to permit fuel flow to a second sector of said burner, a selector valve coupled between said flow divider valve and still others of said sector

valves and normally operative to isolate said others of said sector valves to maintain them in closed position, and a squirt-flow valve coupled to said control means and said selector valve and responsive to a predetermined third value of pressure for opening said selector valve and admitting pressure from said flow-divider valve to said others of said sector valves, thereby to supply fuel to still other sectors of said burner.

3. Apparatus for dividing and scheduling flow of fuel to a multiple sector burner comprising an inlet, means for increasing or decreasing the pressure within said inlet, a first sector valve having spring means responsive to relatively low inlet pressure permitting said valve to open and supply fuel to a first sector of said burner, other sector valves each including spring means for normally holding said valves in closed position, means for coupling said other sector valves to other sectors of said burner, a flow-divider valve coupled to said inlet and including spring means responsive to a predetermined higher pressure for permitting said flow-divider valve to open, a passage coupling said flow-divider valve to a second sector valve, whereby said second sector valve opens in response to said higher pressure to permit fuel flow to a second sector of said burner, a selector means normally operative to maintain the remaining sector valves in closed position, and means responsive to a predetermined third value of pressure for operating said selector means to open said remaining sector valves, thereby to supply fuel to said other sectors of said burner.

4. Apparatus for dividing and scheduling flow of fuel to a multiple sector burner comprising an inlet, means for increasing or decreasing the pressure within said inlet, a first sector valve having means responsive to relatively low inlet pressure permitting said valve to open and supply fuel to a first sector of said burner, other sector valves normally in closed position, means for coupling said other sector valves to other sectors of said burner, a flow-divider valve coupled to said inlet, means responsive to a predetermined higher pressure for permitting said flow-divider valve to open, a passage coupling said flow-divider valve to a second sector valve, whereby said second sector valve opens in response to said higher pressure to permit fuel flow to a second sector of said burner, and means responsive to a predetermined third value of pressure for admitting pressure from said flow-divider valve to the remaining sector valves, thereby to supply fuel to the remaining sectors of said burner.

5. Apparatus for dividing and scheduling flow of fuel to a multiple sector burner comprising an inlet, means for increasing or decreasing the pressure within said inlet, a first sector valve having spring means responsive to relatively low inlet pressure permitting said valve to open and supply fuel to a first sector of said burner, second, third, and fourth sector valves each including spring means for normally holding said valves in closed position, means responsive to a predetermined higher pressure for permitting said second valve to open in response to said higher pressure to permit fuel flow to a second sector of said burner, and selector means operative in response to a predetermined third value of pressure for opening said third and fourth valves, thereby to supply fuel to the third and fourth sectors of said burner.

6. Apparatus for dividing and scheduling flow of fuel to a multiple sector burner comprising an inlet, means for increasing or decreasing the pressure within said inlet, a first valve means responsive to relatively low inlet pressure to supply fuel to a first sector of said burner, second, third, and fourth valve means responsive to an equally low pressure, flow-divider valve means coupled to said inlet and responsive to a predetermined higher pressure for permitting said flow-divider valve to open, a passage coupling said flow-divider valve to said second valve means, whereby said second valve means opens in response to said higher pressure to permit fuel flow to a second sector of said burner, and valve means responsive to a predetermined third value of pressure for admitting pressure from said flow-divider valve to said third and fourth valves, thereby to supply fuel to the third and fourth sectors of said burner.

7. Apparatus for dividing and scheduling flow of fuel to a multiple sector burner comprising a first valve means responsive to relatively low pressure thereon to supply fuel to a first sector of said burner, second, third, and fourth valve means responsive to an equally low pressure, flow-divider valve means including means responsive to a predetermined higher pressure thereon for permitting said flow-divider valve to open, a passage coupling said flow-divider valve to said second valve means, whereby said second valve means opens in response to said higher pressure thereon to permit fuel flow to a second sector of said burner, and valve means responsive to a predetermined third value of pressure thereon for admitting pressure from said flow-divider valve to said third and fourth valves, thereby to supply fuel to the third and fourth sectors of said burner.

8. Apparatus for dividing and scheduling flow of fuel to a multiple sector burner comprising an inlet, means for increasing or decreasing the pressure within said inlet, a first valve means responsive to relatively low inlet pressure to supply fuel to a first sector of said burner, second, third, and fourth valve means responsive to an equally low pressure, flow-divider valve means coupled to said inlet and including spring means adjustable to respond to predetermined higher pressures for permitting said flow-divider valve to open, passages coupling said flow-divider valve to said second, third, and fourth valve means, whereby said second, third, and fourth valve means open in response to said higher pressures to permit fuel flow to other sectors of said burner, and valve means responsive to a predetermined third value of pressure for adjusting said spring means to change the pressure to which said flow-divider valve responds.

9. Apparatus for dividing and scheduling flow of fuel to a multiple sector burner comprising an inlet, means for increasing or decreasing the pressure within said inlet, a plurality of valves operable to open in response to a relatively low pressure in said inlet, flow-divider valve means coupled to said inlet and responsive to a predetermined higher pressure in said inlet for permitting said flow-divider valve to open, passages coupling said flow-divider valve to said valves, whereby said valves open in response to said higher pressure to permit fuel flow to the sectors of said burner, and valve means responsive to a predetermined third value of pressure for adjusting said flow-divider valve means to change the pressure at which said flow-divider valve responds.

10. Apparatus for dividing and scheduling flow of fuel to a multiple sector burner, a first valve means responsive to relatively low pressure to supply fuel to a first sector of said burner, second, third, and fourth valve means responsive to an equally low pressure, flow-divider valve means adjustable to respond to predetermined higher pressures for permitting said flow-divider valve to open, a passage coupling said flow-divider valve to said second valve means, whereby said second valve means opens in response to said higher pressure to permit fuel flow to a second sector of said burner, and valve means responsive to a predetermined third value of pressure for changing the pressure at which said flow-divider valve opens and admitting pressure to said third and fourth valves, thereby to supply fuel to the third and fourth sectors of said burner at different pressures.

11. Apparatus for dividing and scheduling flow of fuel to a multiple sector burner comprising a plurality of valve means responsive to a relatively low pressure, adjustable flow-divider valve means responsive to predetermined higher pressures for permitting said flow-divider valve to open, passages coupling said flow-divider valve to said plurality of valve means, whereby said plurality

of valve means open in response to said higher pressure to permit fuel flow to said burner, and valve means responsive to a predetermined third value of pressure for adjusting the pressure at which said flow-divider valve responds.

12. Apparatus for dividing and scheduling flow of fuel to a multiple sector burner comprising a first valve means responsive to relatively low pressure to supply fuel to a first sector of said burner, second, third, and fourth valve means responsive to an equally low pressure, flow-divider valve means adjustable to respond to predetermined higher pressures for permitting said flow-divider valve to open, a passage coupling said flow-divider valve to said second valve means, whereby said second valve means opens in response to said higher pressure to permit fuel flow to a second sector of said burner, a selector valve coupling said flow-divider valve to said third and fourth valve means, and means responsive to a predetermined third value of pressure for changing the pressure at which said flow-divider valve opens and operating said selector valve to admit pressure to said third and fourth valves, thereby to supply fuel to the third and fourth sectors of said burner at different pressures.

13. Apparatus for dividing and scheduling flow of fuel to a multiple sector burner comprising a first valve means responsive to relatively low pressure to supply fuel to a first sector of said burner, second, third, and fourth valve means responsive to an equally low pressure, flow-divider valve means responsive to predetermined higher pressures for permitting said flow-divider valve to open, a passage coupling said flow-divider valve to said second valve means, whereby said second valve means opens in response to said higher pressure to permit fuel flow to a second sector of said burner, and valve means coupling said flow-divider valve means to said third and fourth valve means and responsive to a predetermined third value of pressure for admitting pressure to said third and fourth valves, thereby to supply fuel to the third and fourth sectors of said burner at different pressures.

14. Apparatus for dividing and scheduling flow of fuel to a multiple sector burner comprising a plurality of valve means responsive to relatively low pressure, flow-divider valve means responsive to predetermined higher pressure for permitting said flow-divider valve to open, passages coupling said flow-divider valve to said plurality of valve means, and selector valve means in at least one of said passages and responsive to a predetermined third value of pressure for controlling admission of pressure to one of said valve means, thereby to supply fuel to said burner at different pressures.

15. Apparatus for dividing and scheduling flow of fuel to a multiple sector burner comprising a plurality of valves responsive to a relatively low pressure, flow-divider valve means adjustable to respond to predetermined higher pressures for permitting said flow-divider valve to open, passages coupling said flow-divider valve to said plurality of valves, a selector valve coupling said flow divider valve to at least one of said plurality of valves, and means responsive to a predetermined third value of pressure for changing the pressure at which said flow-divider valve opens and operating said selector valve to admit pressure to said one valve.

16. Apparatus for dividing and scheduling flow of fuel to a multiple sector burner comprising a first valve means responsive to relatively low pressure to supply fuel to a first sector of said burner, second, and other valve means responsive to an equally low pressure, flow-divider valve means adjustable to respond to predetermined higher pressures for permitting said flow-divider valve to open, a passage coupling said flow-divider valve to said second valve means, whereby said second valve means opens in response to said higher pressure to permit fuel flow to a second sector of said burner, and scheduling means responsive to a predetermined third value of pressure for changing the pressure at which said flow-divider valve opens and admitting pressure to said other valve means, thereby to supply fuel to other sectors of said burner at different pressures.

17. Apparatus for dividing and scheduling flow of fuel to a multiple sector burner comprising a first valve means responsive to relatively low pressure to supply fuel to a first sector of said burner, other valve means responsive to an equally low pressure, flow-divider valve means responsive to predetermined higher pressure for permitting said flow-divider valve to open, a passage coupling said flow-divider valve to said other valve means, whereby said other valve means opens in response to said higher pressure to permit fuel flow to a second sector of said burner, and scheduling means responsive to a predetermined value of pressure for admitting pressure to said other valve means, thereby to supply fuel to other sectors of said burner.

References Cited in the file of this patent

UNITED STATES PATENTS

2,606,066	Thompson	Aug. 5, 1952
2,724,239	Fox	Nov. 22, 1955
2,750,953	Helsey et al.	June 19, 1956