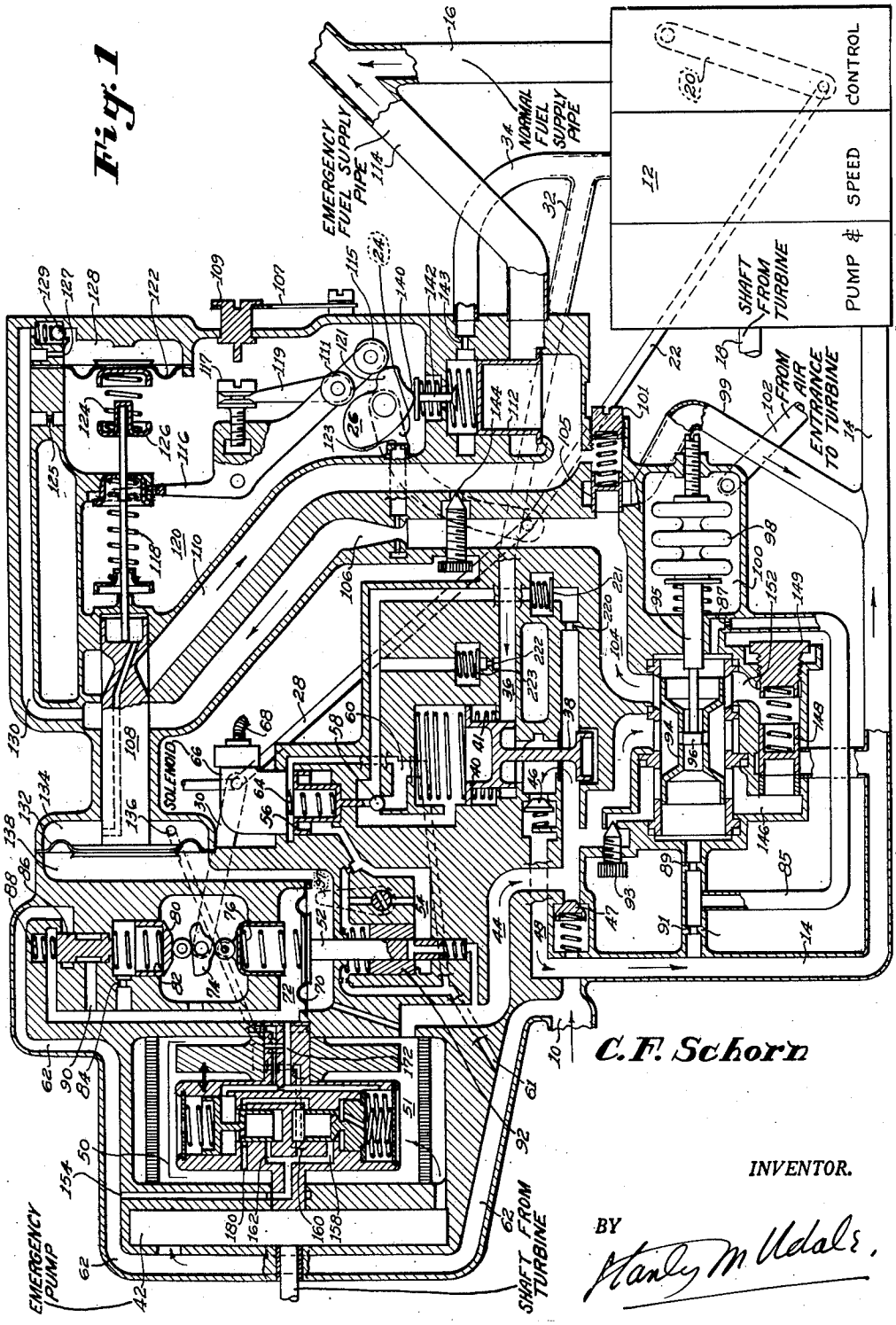
May 26, 1953 C. F. SCHORN 2,639,584

EMERGENCY FUEL SUPPLY SYSTEM

Filed May 15, 1948 4 Sheets-Sheet 1

Fig. 1



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EMERGENCY FUEL SUPPLY SYSTEM

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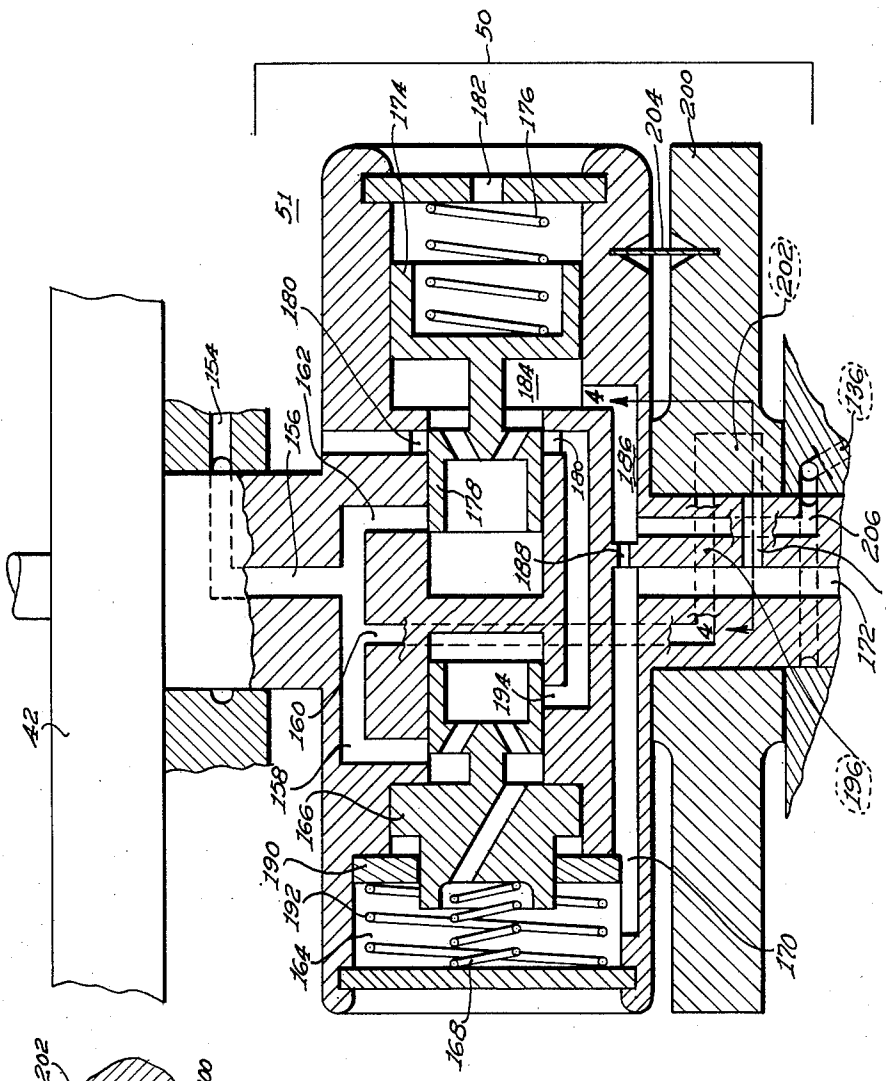


Fig. 2

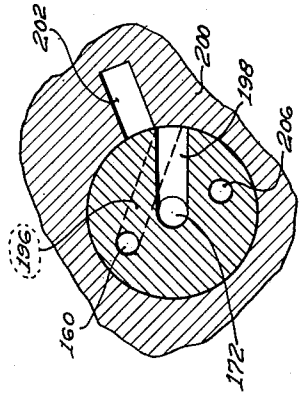


Fig. 4

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EMERGENCY FUEL SUPPLY SYSTEM

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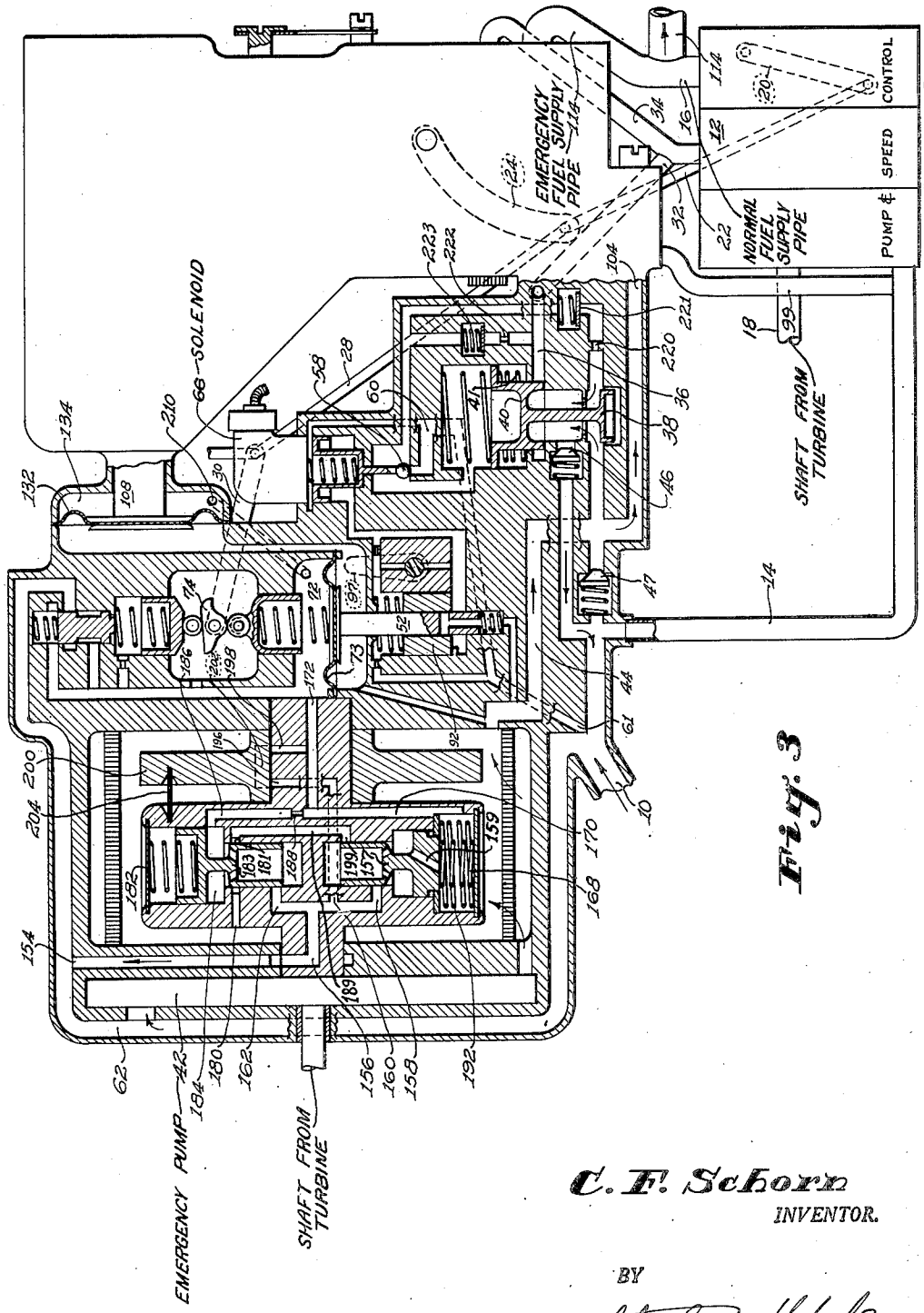


Fig. 3

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EMERGENCY FUEL SUPPLY SYSTEM

Filed May 15, 1948 4 Sheets-Sheet 4

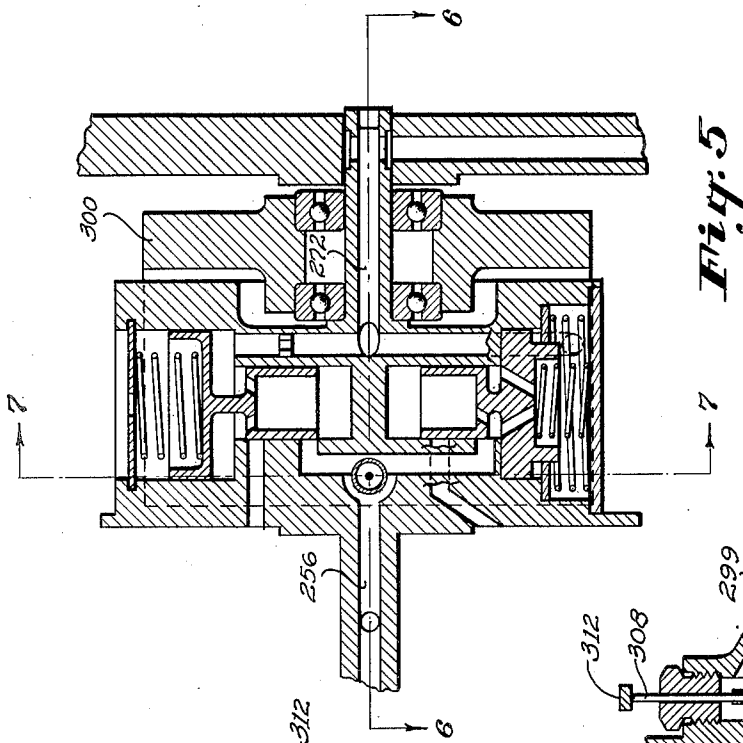


Fig. 5

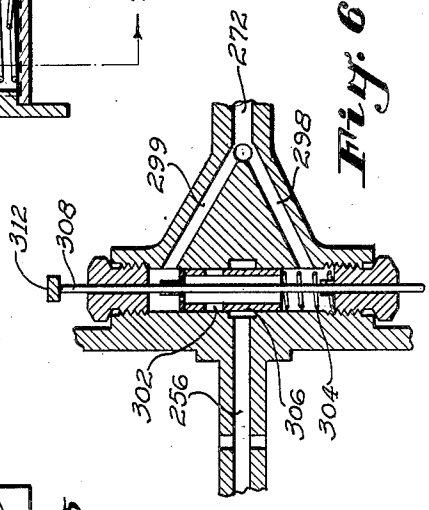


Fig. 6

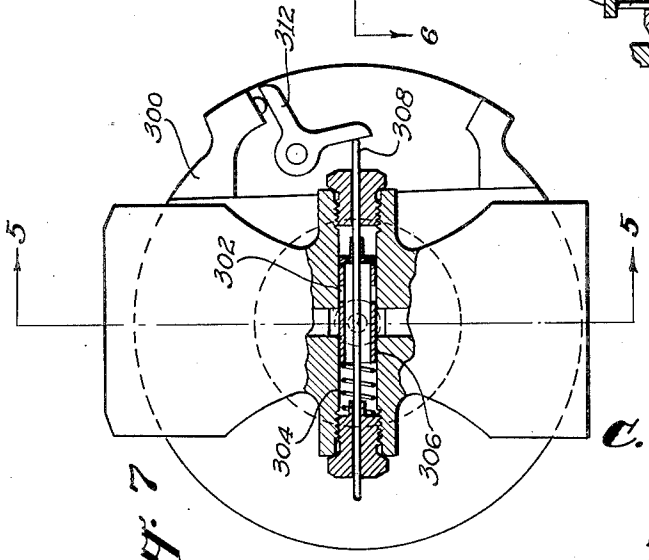


Fig. 7

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Patented May 26, 1953

2,639,584

UNITED STATES PATENT OFFICE

2,639,584

EMERGENCY FUEL SUPPLY SYSTEM

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Application May 15, 1948, Serial No. 27,187

12 Claims. (Cl. 60—39.28)

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The object of this invention is to provide an emergency pump and fuel control system for a gas turbine when the normal fuel control system fails to function correctly.

Specifically, the object is to bring in an emergency pump and control system whenever the normal system fails to maintain the speed up to the manually selected speed of the normal system and thereafter to maintain this speed with the emergency system.

An additional object is to operate the emergency pump at a low pressure when it is standing by for an emergency.

Fig. 1 shows diagrammatically the preferred form of the invention.

Fig. 2 shows an enlarged detail of the speed responsive means which controls the emergency system.

Fig. 3 shows a simplified form of the invention.

Fig. 4 shows a cross-section on plane 4—4 of Fig. 2.

Figs. 5, 6 and 7 show a modified form of the acceleration device.

Fig. 5 is a cross-sectional elevation taken on plane 5—5 of Fig. 7.

Fig. 6 is a partial cross-sectional plan view taken on plane 6—6 of Fig. 5.

Fig. 7 is a partial cross-sectional elevation taken on plane 7—7 of Fig. 5.

In Fig. 1, 10 is the fuel entrance. 12 is the normal fuel supply and control means, supplied through the pipe 14. 16 is the outlet from the normal control 12. 18 is the drive shaft driven by the gas turbine which drives the control 12 which contains a pump and a speed control. 20 is the lever which determines the speed of the normal control system 12. 22 is the link connected to the lever 20 which is also connected to the lever 24 and cam 26 which controls the emergency system, the subject of this invention. The lever 24 is connected to the link 28 which is connected to the lever 30 which controls the speed responsive device 50 through the cam 74.

In the position shown the device is operating on the normal fuel supply and control means 12. For this reason the normal escape pipe 32, connected to the passage 36, is closed by the selector valve 40 which is shown down. The emergency escape valve 38, which is integral with the lower portion of the valve 40, is shown open. This permits the emergency pump 42 to discharge freely through the passage 44, past the valve 38, past a check valve 46, to a passage 48 which connects to the fuel entrance 10.

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The spring back of valve 46 is arranged so that the pump 42 will not overheat during the period it is standing by awaiting an emergency. The pressure, as determined by the valve 46, acts on the clearance around the under side of the selector valve 38—40 and provides the force which causes valve 38—40 to rise when the pressure above 40 is released.

A minimum pressure (less than 50 pounds per square inch) is maintained by the spring loaded valve 46.

The emergency system consists of the emergency pump 42 and the speed responsive element 50 which is shown in greater detail and to a larger scale in Fig. 2. 52 is the pilot valve controlling the flow of operating fluid from the passage 44 to chamber 54. The chamber 54 communicates with the underside of annular piston 56. This piston 56 controls the pressure above the selector valve 40. The rise of piston 56 causes the low pressure in the chamber 60, which communicates with the passage 61 which is in free communication with the fuel entrance 10, to reduce the pressure pressing down on the valve 40 so that the valve 40 then rises.

When the normal fuel supply control means 12 is in operation the spring 64 keeps the valve 58 on its seat. An electromagnetic element 66, controlled by an electric wire 68, operates to rise the valve 58 whenever the operator wishes to test the emergency system. This is one of two manual override controls of the speed responsive element 50. Lever and valve 97 is the other control which is opened whenever the operator wishes to substitute the normal system for the emergency system to be described later

The pilot valve 52 is connected to a diaphragm 70. The underside of the diaphragm 70 is in free communication with the fuel passage 44. The pressure in passage 44 is maintained by check valve 47. The chamber 72, above the diaphragm 70, communicates with the fuel entrance pressure in the passage 62 through the passages 154—172 of the speed responsive element 50, as explained when describing Fig. 2. When operating with the normal fuel supply system 12 the pilot valve 52 is in the inoperative position in which it is shown which cuts off communication between the passage 44 and chamber 54 so that the valve 58 remains closed.

The cam 74, controlled by the lever 30, when rotated anti-clockwise compresses the spring 76, which spring engages with the upper side of the diaphragm 70 and tends to push the pilot valve 52 down into its operative position. This motion

is opposed by the pressure difference acting on the diaphragm 70 which pressure difference is controlled by the speed responsive element 50 as hereinafter described.

A piston 80 is held against the cam 74 by a spring 82. A restriction 84 causes the pressure generated by a rapid upward movement of the piston 80 to momentarily move a piston valve 86 against the pressure exerted by a spring 88. When the element 86 rises the low pressure passage 62 is put into communication with the passage 90. That is to say the pressure in the chamber 72 falls to the pressure in the fuel entrance 10. Thus during the rapid opening of the normal device 12, by the opening movement of the lever 30, the pilot valve 52 is inoperative despite the fact that the cam 74 increases the pressure on the spring 76 and thus tends to push the pilot valve 52 down into its operative position. This takes care of a too rapid movement by the pilot of the control linkage 20—22—24—26—30. An element 183 responsive to centrifugal force uncovers a port 181 and lowers the pressure in chamber 186 until the difference in pressure between the chamber 184 and the pressure generated by the emergency pump 42 which acts through the screen 182 balances the centrifugal force of the element 182. It is understood that an element 157 also responsive to centrifugal force has meanwhile moved radially under centrifugal action uncovering port 199 in passage 189 and compressing the relatively weak spring 168. This movement of the element 157 occurs at relatively low speed and places chamber 72 above diaphragm 73 in communication through passsage 172 with passage 170 through a passage 159 in the element 157 and through port 199 and a passage 189 to port 181.

Emergency system—Operative

Assume that the pilot valve 52 has descended because the speed of the turbine is not great enough to create pressure differences large enough to hold the valve 52 in the position shown. This is due to the operation of the speed responsive element 50, which will be described later. Under these circumstances the cam 74 causes the spring 76 to push the pilot valve 52 down into its operative position. When that happens a sleeve 92 moves up under the influence of the fuel pressure 44 and 54 as the pilot valve 52 moves down because the pilot valve 52 admits fuel under pressure from the emergency fuel pump 42 to the underside of the sleeve 92. This fuel under pressure acts on the piston 64 and opens the ball check valve 58.

The valve 40 rises under the influence of the emergency pressure acting on the bottom of valve 38. This pressure is transmitted through the clearance around the skirt of the valve 38. This pressure is assisted by a spring 41. Valve 40 then opens the passage 36 permitting the fuel delivered from the normal fuel system 12 to escape below the valve 40, past the check valve 46, through the passage 48 to the fuel entrance 10.

Before the valve 38—40 rose fuel under pressure from the normal fuel supply 12 was admitted above the valve 40, along the passage 36, past a restriction 222 and a spring loaded check valve 223 to the upper side of valve 40. After the valve 38—40 has risen fuel under pressure from the emergency pump 42 is admitted through the restriction 220, past the spring loaded check valve 221, past the ball valve 58 (which is now open) into the chamber 60, and along passage 61. The moment the ball valve 58 is closed the fuel under pressure from the emergency pump 42 is thus available to reclose the valve 38—40 as pressure above the valve 40 builds up, immediately the valve 58 is closed.

Considering now the emergency operation of the gas turbine; the valve 38 has risen and the fuel from emergency pump 42 can no longer escape past the check valve 46. Under these circumstances the pressure rises to 300 or 400 pounds per square inch and the fuel flows to the fuel divider valve 94, controlled by the servo-valve 96, which is controlled by the barometric element 98 inside the chamber 100. Chamber 100 communicates with a passage 102 and with the air entrance to the air compressor of the gas turbine, not shown. At high altitude a large portion of the fuel is allowed to return to the low pressure pipe 14 as the bellows 98 expands and valve 96 travels to the left.

The flow divider valve 94 discharges a portion of the fuel to the passage 104 through the venturi 106, past the control (governor speed responsive) valve 108, down the passage 110, past the valve 112, along the passage 114 to the gas turbine, not shown. In order that this supply of emergency fuel can take place the cam 26 has been manually rotated clockwise and a lever 116 has been rotated anti-clockwise compressing the spring 118 which pushes the fuel control valve 108 to the left into the position which permits fuel to flow from the venturi 106, down the passage 110, past the valve 112 and out through the passage 114.

The throat of the venturi 106 communicates with the chamber 120 to the left of the diaphragm 122. Diaphragm 122 forms a wall of the chamber 128 and engage with a spring 124, to the left of the diaphragm 122 and to the right of the washer 126, which washer engages with the valve 108. The chamber 128, to the right of the diaphragm 122, communicates through restriction 127 and also past a check valve 129 with the passage 130, which communicates with the passage down stream of the venturi 106. A small restriction 125 maintains a slight flow through the chamber 120 to the throat of the venturi 106 through the opening 123 and acts as a vent to chamber 120.

The valve 108 is engaged and controlled by the diaphragm 132. The chamber 134, to the right of the diaphragm 132, communicates with a passage 136 and to the speed responsive element 50 as shown in Fig. 2. Chamber 138, to the left of the diaphragm 132, communicates with the outlet from the emergency fuel pump 42 past the underside of the diaphragm 70. The diaphragm 132 is therefore pushed to the right by the pressure differences controlled by the speed responsive element 50 and is not influenced by acceleration.

The diaphragm 122 is pushed to the left by the flow responsive pressures created by the venturi 106 and by the pressures imposed by the spring 118 which is controlled by the position of the linkage 22—28 and of the cam 26 connected thereto, that is, by the manual control means. The flow through the venturi 106 creates a relatively low pressure in the chamber 120, which pressure is transmitted through the restriction 123. Diaphragm 122 thus responds to this low pressure as the right hand side of diaphrgam 122 is connected through passage 130 with the down-stream end of venturi 106.

When the cam 26 first leaves the position in which it is shown in the drawing a cam lobe 140 moves to the left, a valve 142 is permitted to rise and the pressure above the valve 112 is reduced to the pressure existing in the passage 34 which communicates through the restriction 143 with the chamber above the valve 112. Pipe 34 communicates with the pipe 32, which pipe is now at the low pressure existing in the fuel entrance 10 plus the slight pressure imposed by the check valve 46. The valve 112 is, however, subjected on its lower face to the pressure created by the emergency fuel pump 42 as modified by the valve 108. Valve 112 is thus pushed up into its open position, that is, the position it must assume during emergency operation to permit fuel to flow from passage 110 to passage 114.

A small amount of fuel is bypassed around valve 108, that is, it is supplied direct from the passage 104 through the adjustable restricted opening 144, this being the idle adjustment.

A cam lobe 121 engages with a lever 119 mounted on the lever 116. An adjustable cap screw 117 adjusts the relative position of the valve 108 to the lever 24 at idle speeds. When the linkage is first moved from the low speed position in which it is shown a roller 115 rides on the cam lobe 121 and is carried by the lever 119. A low speed adjustment device 109 is provided which is normally held out of action by a spring 107. During the ordinary operating condition cam lobe 26 engages with the roller 111 which is mounted directly on the lever 116.

The fuel divider valve 94 supplies part of the fuel admitted from the pump 42 to the passage 104 and discards a portion of the fuel through the passage 146, past the balanced cylindrical valve 148 to the pipe 14. The valve 148 is subjected on its left hand side to the pressure in passage 152 which is the pressure in the passage 104, plus a spring pressure. This spring pressure is adjusted by an adjustable plug 149.

A similar valve 105 is subjected on its left face to the pressure in the passage 104 and on its right face to the pressure in the passage 110, plus a spring pressure. This spring pressure is adjusted by an adjustable plug 101. When the valve 105 opens fuel escapes down a pipe 99 to the low pressure pipe 14.

The shaft 95, attached to the bellows 98, is of such a size that at high speeds, when the pressures generated by the emergency pump 42 gives the equivalent of a false barometric reading, the servovalve 96 moves over to the right slightly so as to give a slightly richer mixture just before the speed responsive diaphragm 132 takes hold of the fuel throttle valve 108.

This is known as a biasing effect and improves the regulation of speed. The absolute pressure acting on the shaft 95 is determined by the restriction 87—89—91 and the pipe 85 balances the pressure on both ends of the valve 94.

The position of the valve 94 is regulated by the position of the barometric element 98. The chamber 100, enclosing the barometric element 98 is connected to the air entrance to the supercharger of the turbine, not shown, through a pipe 102.

Speed sensing element 50 (Figs. 2 and 4)

In Fig. 2 154 is the low pressure passage connecting with the axial passage 156 of the governor mechanism 50 and with the low pressure in passage 62. (See Fig. 1). Passage 156 has three branches 158, 160 and 162. Passage 180 communicates with the liquid in chamber 51 surrounding of the element 50, which chamber 51 at the pressure generated by the emergency pump 42.

The mechanism in Fig. 2 is shown operating below the normal idling speed. In Fig. 1 a similar mechanism is shown operating above the idling speed. Port 158 is thus shown closed in Fig. 1 and is shown open in Fig. 2. In Fig. 2 port 158 communicates with the chamber 164, to the left of the speed responsive weight 166. The spring 168 engages with the weight 166 and pushes it to the right so as to keep open the passage 158 leading to the chamber 164. The chamber 164 communicates through the passage 170 to the axial passage 172 which communicates with the chamber 72, above the diaphragm 70 (Fig. 1). Under these conditions the centrifugal force acting on the weight 174 engages with the spring 176. This spring is ground to a definite length and is made of a specific rate of stiffness so that the valve portion 178, of the weight 174, just closes the passage 162 and also just closes the passage 180. Passage 180 communicates with the liquid in the chamber 51 surrounding the governor mechanism 50, that is to say with the liquid at the pressure of the fuel downstream from the emergency pump 42 and upstream from the check valve 46 and 47.

The spring 176 is designed purely to lend stability and has negligible effect on the pressure differential acting on the two sides of the weight 174. The right hand side of weight 174 is in free communication through the opening 182 with the chamber 51, that is, with the fuel delivered from the pump 42. The moment the weight moves the slightest distance to the right, away from its neutral position in which it is shown, the port 162 is opened and the port 180 is closed. For this reason the pressure in the chamber 184, to the left of the weight 174 is controlled so that its value plus the centrifugal force of the weight 174 just balances the fluid pressure admitted through the opening 182 plus a slight pressure from the spring 176. This pressure difference between the pressure in the chamber 51 and the pressure in the chamber 184 thus varies as the speed is squared. The pressure in the chamber 184 is transmitted through a passage 186 to an axial passage 172, through a restriction 188.

As the speed increases above idling the weight 166 moves to the left compressing the spring 168 until it is stopped by the washer 190. The port 158 is then closed so that flow ceases along the passage 170 and the pressure in the chamber 184 becomes effective through the restriction 188, passage 172 and so to the chamber 72. Thereafter the pilot valve 52 responds to changes in speed, which changes in speed cause changes in the pressure in chamber 184 to keep valve 178 in equilibrium.

At extremely high and dangerous speeds the weight 166 pushes the washer 190 to the left compressing the spring 192. This movement uncovers the port 194 which communicates with the port 180, which port is at the pressure delivered by the emergency fuel pump 42 in the chamber 51 surrounding the element 50. The pressure of the fuel pump 42 is thus transmitted through the radial passage 170, through the axial passage 172, to the chamber 72. This action decreases the pressure difference on the diaphragm 70. The spring 76 then acts on the pilot valve 52 and causes the emergency system to become operative as emergency fuel pump pressure becomes effective in the chamber 54 and valve 53 is opened.

Thus the system is placed in the emergency position.

Acceleration (Fig. 4)

The third passage **160** communicates through the passage **196**, and with the radial passage **198** under the following circumstances.

A flywheel **200** is provided with a slot **202** and is driven by the speed responsive element through a spring **204**. When the flywheel **200** lags behind the speed responsive element during acceleration the slot **202** acts as a bridge to bring the passage **196** into communication with the passage **198**. Lowspeed fuel pressure is thereupon transmitted through the passage **160**, along the passage **196**, through the slot **202**, through the radial passage **198** and along the axial passage **172**. Hence, the action of the pilot valve **152** in response to speed changes is delayed during the acceleration period.

The passage **136**, referred to in the description of Fig. 1, communicates with the passage **206** which is a passage parallel to the axial passage **172**. Passage **206** communicates with the chamber **184** through the passage **186**, to the right of the restriction **188**.

The result of this construction is that the pressure in chamber **134** in Fig. 1 responds to speed changes even during acceleration periods. However, the flow divider valve **94** is then operative to keep the fuel available for acceleration within safe limits at high altitudes.

Figure 3

A passage **210** communicates with chamber 72 and passage **172** below restriction **188**, that means that during acceleration element **200** now controls pressure in chamber **134** as well as in chamber 72. This causes valve **108** to travel to the right to cut down the fuel received by the gas turbine during acceleration and to anticipate the action of the governor. This eliminates the need for the flow divider **94**, etc., shown at the bottom of Fig. 1. However, the altitude correction is sacrificed to the simplicity thus gained.

As before the emergency pump pressure acts through restriction **220**, check valve **221**, to the topside of valve **38—40** and starts it on its way down. This interrupts flow from the normal escape pipe 32, past selector valve **40** and pressure from normal system **12** builds up and acts through restriction **222** and valve **223** to the top of valve **40** and completes the closure of the valve **40**. This holds the spring surrounding valve **40** compressed during the normal operation of the system.

Restrictions **220** and **222** are needed to make selector valves **38—40** return to position shown after valve **58** has risen, for any reason and has been returned to its seat.

In both Figs. 1 and 3 a manual override valve and lever **97** is shown. When this valve is opened by anti-clockwise rotation of the lever the sleeve **92** is returned by the spring above, to the stop below, that is to the position shown and the system is thus returned to its normal operating position, that is, to the position shown.

When electricity is manually allowed to flow by a switch (not shown) through the electromagnet **66** the valve **58** is opened and the emergency system is caused to take over. Assuming that the emergency system is satisfactory the return to normal is made by momentarily opening the manual override **98**, this action forces down the sleeve **92** and closes the pilot valve **52**. The system immediately returns to the control of the normal system. The downward movement of the annular piston **92** is checked by a positive stop.

Normal control means

The lever **20** of the normal control device **12** controls the speed of the prime mover (gas turbine) by varying the speed at which a centrifugal governor similar to **50** controls the flow of motive fluid. That is, the lever **20** corresponds to lever **116** and engages with a spring corresponding to spring **118** to control a throttle valve corresponding to valve **108**.

Acceleration (Alternative)

In Figs. 5, 6, and 7 **272** is a passage corresponding to **172** of Fig. 3. **298** and **299** are two passages corresponding to **198** of Fig. 3. **256** is a passage corresponding to **156** of Fig. 3. **272** is a passage corresponding to **172** of Fig. 3. **300** is a flywheel corresponding to **200** of Fig. 3. **304** is a spring corresponding to **204** of Fig. 3. **302** is a port corresponding to **202** of Fig. 3 in the valve **306**. A bell crank lever **312** engages with a rod **308** on which is mounted the valve **306**.

During a sudden acceleration the weight **300** lags behind (rotation being anticlockwise in Fig. 4). A bell crank lever **312** combined with the compression spring **304**, mounted on the main body **350** of the speed responsive device, corresponds to the spring **204** of Fig. 3. The bell crank lever **302** engages with a piston valve **306** mounted on a rod **308** and is kept in engagement by the compression spring **304**.

The valve **306** normally closes the communication between the two passages **256** and **272** but during acceleration the pin **308** in Fig. 7 moves to the left and thus places the two passages **256** and **272** in communication with each other.

Otherwise the operation of the speed responsive device shown in Figs. 5, 6, and 7 corresponds exactly to the device shown in Fig. 3. That is, when acceleration exceeds about 200 revolutions per minute per second the bell crank lever **302** rotates clockwise and the valve **306** allows the low pressure fluid in passage **256** to freely enter passage **272** which prevents the control valve **52** (Fig. 3) from descending during acceleration above this minimum figure.

What I claim is:

1. A fuel control system for a prime mover in which the speed of the prime mover is responsive directly to fuel flow, a prime mover speed responsive device including operative fluid under hydraulic differential pressure, said device being adapted to increase the hydraulic pressure difference as the speed of the prime mover increases, an acceleration responsive device adapted to modify the increase in pressure by delaying the increase controlled by the speed responsive device during a rapid increase in speed of the prime mover, driving means for both devices from said prime mover, a normal fuel supply system including a first fuel supply pump driven by said prime mover and a first manual control means, a first escape outlet therefrom, an emergency fuel supply system including a second fuel supply pump also driven by said prime mover, a second escape outlet therefrom, a selector valve having two valve seats, one located in each escape outlet and designed so that as one opens the other closes, a pilot valve controlling the movement of said selector valve, a first moving wall controlling said pilot valve, a chamber on each side of said wall, a pas-

sage from one chamber to the hydraulic operating fluid under pressure, a passage from the other chamber to the hydraulic pressure responsive to speed modified by acceleration so that the moving wall is moved by the pressure responsive to speed and acceleration, a first manually controlled variable spring pressure arranged to oppose the motion of said first moving wall, a second moving wall, a chamber on each side of said second moving wall, a passage from one chamber to the hydraulic pressure responsive to speed, a passage from the other to the pressure generated by said emergency fuel pump to move said second wall in response to speed changes, a second manually controlled variable spring pressure arranged to oppose the motion of said second moving wall, said second manual control means being interconnected with the first manual control means, two fuel outlet passages from the first pump and from the second pump leading to said prime mover, an emergency fuel throttle valve connected to said second moving wall in said emergency fuel outlet passage, an emergency shut off valve in the end of said emergency fuel outlet passage, hydraulic means for holding the said shut off valve closed responsive to the pressure in the escape passage from said normal fuel supply system, hydraulic means for opening the emergency shut off valve responsive to the rise in pressure in said emergency fuel outlet passage when the selector valve moves to open the escape passage from the normal fuel supply system and to close the escape passage from the emergency fuel supply system.

2. A device as set forth in claim 1 in which there is a third escape passage from the emergency system, a balanced valve therein responsive to the pressure drop at said emergency fuel throttling valve, yieldable means opposing the opening of said balanced valve.

3. A device as set forth in claim 1 in which there is a passage through which the acceleration responsive pressure is also applied to said second moving wall to modify the pressure responsive to speed so as to delay the motion of said wall and the opening of said emergency fuel throttle.

4. A device as set forth in claim 1 in which there is a fuel venturi in the said emergency fuel outlet passage, a third moving wall responsive to the drop in pressure in said venturi, a yieldable connection from said third moving wall to said emergency fuel throttling valve, the motion of said third moving wall in response to fuel flow to the prime mover being adapted to open said fuel throttling valve to improve the speed regulation of the prime mover.

5. A device as set forth in claim 1 in which there is a flow divider located in the emergency fuel passage, barometric means for moving said divider valve to reduce the flow to said prime mover at high altitude and to permit the balance of the fuel to escape.

6. A device as set forth in claim 1 in which there is a flow divider located in the emergency fuel passage, barometric means for moving said divider valve to reduce the flow to said prime mover at high altitudes and to permit the balance of the fuel to escape, a balanced valve controlling said escape, the pressure downsteam of said divider valve on the escape side tending to open said valve, the pressure downstream of said divider valve on the prime mover side tending to close said valve, yieldable means tending to close said valve.

7. A device as set forth in claim 1 in which there are low and high speed responsive means associated with the speed responsive means, said low speed means being adapted when starting and when running below idle speed to apply a minimum pressure to the low pressure side of said first moving wall to prevent the pilot valve being moved during this period and said high speed responsive means equalizing the pressure on both sides of said first moving wall so that the yieldable means then moves the pilot valve into the position in which it operates the selector valve when a predetermined critical speed of the prime mover is exceeded.

8. The combination with a prime mover of the type in which the flow of motive fluid fuel controls the speed of the prime mover, a normal fuel supply pump, a normal passage for the flow of said motive fluid fuel, pump and speed responsive control means for said motive fluid fuel, a first manual control therefor, a first escape passage for the normal fluid fuel on the pressure side of said normal fuel pump, a first fuel shut off valve in said escape passage, an emergency pump for supplying emergency motive fluid; when the normal supply and regulating means fails to maintain the speed of the prime mover above the selected speed and below the critical high speed, an emergency fluid fuel passage and a second escape passage therefrom on the pressure side of said pump, a second shut off valve in said second escape passage, an emergency speed responsive control valve for said emergency motive fluid fuel and a second manual control therefor to vary the speed to which the valve responds, and connected to the first manual control means, a governing system for said cutoff valves, comprising means driven by said prime mover providing a fluid pressure difference varying as the square of the speed of said prime mover, means for closing the escape shut off valve of the emergency pump and simultaneously opening the escape shut off valve of the normally operated fluid fuel pump when the normal control means fails to maintain the speed of the prime mover up to the selected speed and also when the normal control means fails to maintain the speed of the prime mover below a predetermined high critical speed.

9. A device as set forth in claim 8 in which there is a second escape passage upstream from said emergency speed responsive control valve, a divider valve therein, barometric means controlling the position of said divider valve to reduce the flow towards said emergency speed responsive control valve at high altitudes.

10. A device as set forth in claim 8 in which there is a second escape passage upstream from said emergency speed responsive control valve, a second valve therein, spring loaded means moving said escape valve toward its closed position, means responsive to the pressure drop at said control valve to open said balanced valve against said spring loading means.

11. The combination with a prime mover having a normal speed responsive means driven by said prime mover for admitting normal motive fluid fuel thereto under pressure and also for regulating the flow of said fluid fuel, manual means for varying the speed at which the normal speed responsive means controls the flow of normal fluid fuel to said prime mover, a first escape passage and valve therein for releasing the pressure of said normal motive fluid fuel, an emergency speed responsive means driven by

said prime mover for substituting emergency motive fluid fuel for normal motive fluid thereto under pressure and also for regulating the flow of said emergency fluid fuel, second manual means interconnected with first manual means for varying the speed at which the speed responsive means controls the flow of the emergency fluid fuel, a second escape valve for releasing the pressure of said emergency motive fluid fuel, a hydraulic governor for said first and second escape valve, comprising means for developing a variable fluid pressure varying as the square of the speed of said prime mover, a pilot valve, means for moving said pilot valve in opposition to means responsive to said variable speed responsive fluid pressure for moving said pilot valve to open said first escape valve and to close said second escape valve whenever the normal regulation means fails to maintain the speed of the prime mover up to the speed selected by said manual means.

12. A device as set forth in claim 11 in which there is also an acceleration responsive device comprising a rotating flywheel driven by the hydraulic governor, a spring interposed between flywheel and governor, a valve moved by the relative motion between the hydraulic governor and the rotating flywheel, said valve being adapted to release the pressure difference created by the hydraulic governor when the acceleration exceeds 100 revolutions per minute per second.

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No references cited.