Feb. 16, 1937. G. B. WARREN 2,071,268

ELASTIC FLUID POWER PLANT

Filed April 25, 1933

Fig. 1.

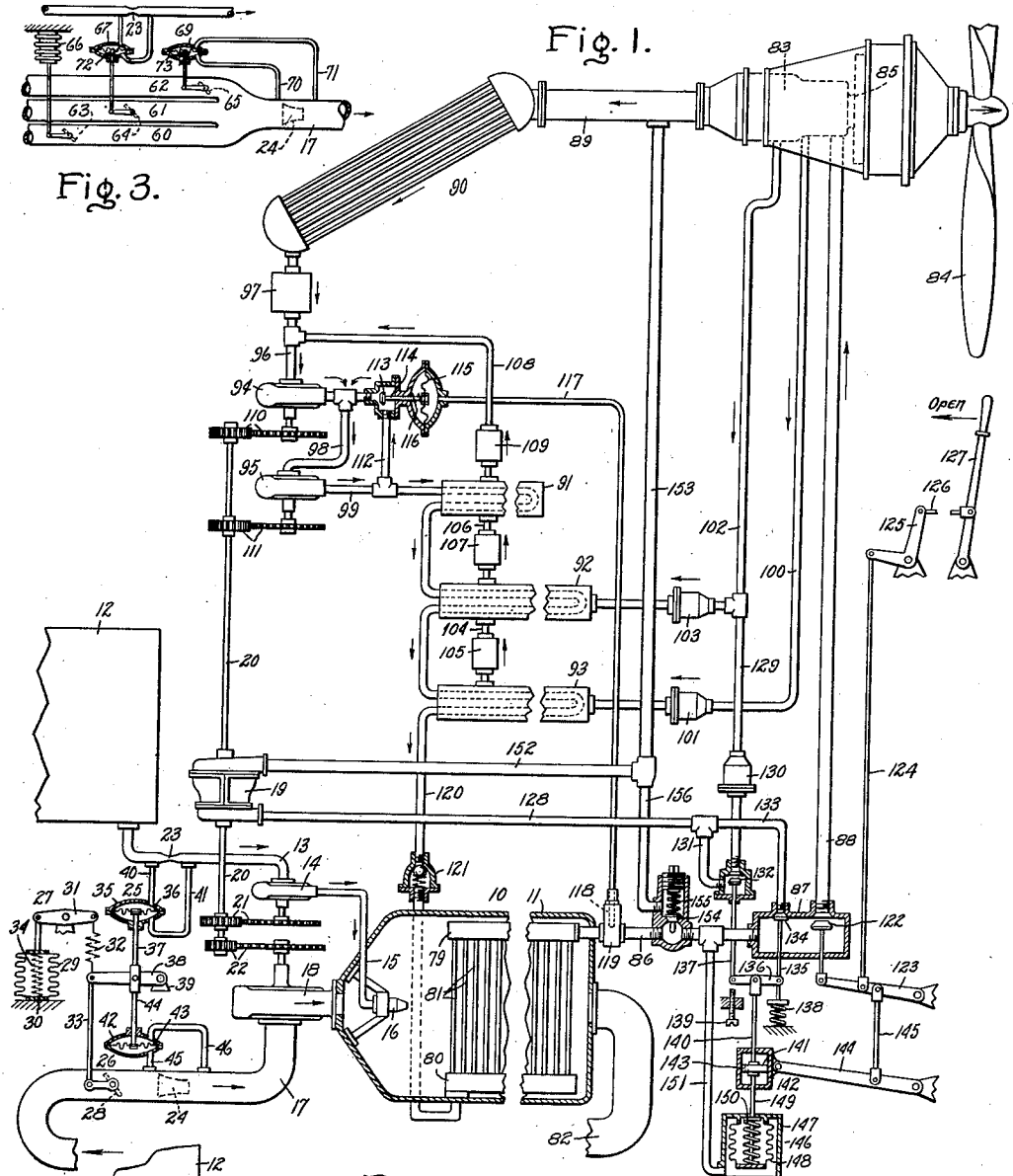


Fig. 3.



Fig. 2.

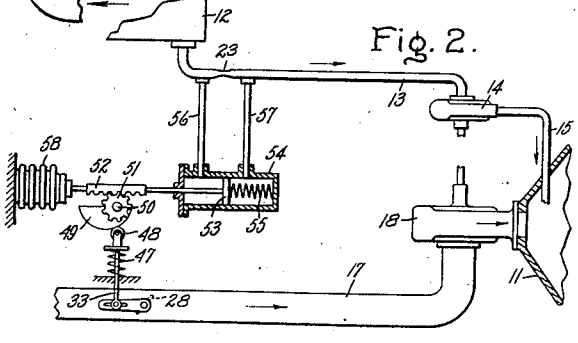
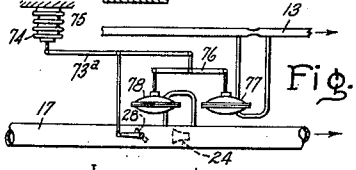


Fig. 4.



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# UNITED STATES PATENT OFFICE

2,071,268

## ELASTIC FLUID POWER PLANT

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Application April 25, 1933, Serial No. 667,812

12 Claims. (Cl. 60—106)

The present invention relates to elastic fluid power plants in which elastic fluid, for instance, steam or vapor, is produced in an elastic fluid generator and consumed in a consumer. The elastic fluid generator usually comprises a boiler, that is a container or containers such as drums and heating tubes in which liquid is heated and evaporated, means including a preheater for supplying and controlling the supply of make-up or feed fluid to the boiler, a furnace for heating the boiler, and means for supplying and controlling the supply of fuel and air to the furnace. The consumer may comprise an elastic fluid turbine, means for conducting and regulating the flow of elastic fluid to the turbine, and means including a condenser for receiving exhaust fluid from the turbine. The means for supplying and regulating the supply of feed fluid to the boiler and the means for supplying combustible material and air to the furnace may include pumps and a blower driven by auxiliary motors or prime movers such as elastic fluid turbines receiving drive medium from the boiler.

The object of the present invention is to provide an improved arrangement for power plants of the type specified whereby the control and regulation of the various apparatus is accomplished in a simple manner.

For a consideration of what I consider to be novel and my invention, attention is directed to the following description and the claims appended thereto, in connection with the accompanying drawing.

In the drawing, Fig. 1 represents a power plant embodying my invention, and Figs. 2, 3 and 4 show modifications of the control arrangement of a certain part of the power plant.

In Fig. 1 I have shown by way of example a power plant according to my invention adapted to be used in aircrafts. The elastic fluid generator comprises a furnace 10 having a casing 11, and means for supplying fuel and air to the furnace. The fuel supply means include a source of fuel, such as a tank 12 containing oil, a conduit 13 connected to the fuel tank 12, a fuel pump 14 and a conduit 15 for conducting the fuel to a burner 16 located within the furnace. The air supply means include a channel or suction conduit 17 and a blower 18 having a discharge conduit connected to the furnace. The pump 14 is preferably a positive displacement pump. Both the pump 14 and the blower 18 are driven by a common motor or prime mover, in the present instance shown as an auxiliary turbine 19 having a shaft 20 connected to the pump 14 and the blower 18 by gears 21 and 22 respectively.

In accordance with my invention I proportion the blower 18 including the suction or inlet conduit 17 so that for a certain condition an amount of air is supplied to the furnace which is sufficient to maintain the combustion of the fuel such as oil supplied by the pump 14 to the furnace. By a "certain condition" is meant a certain barometric pressure and the drop in pressure in the suction conduit which depends upon the relative velocity of the airplane with respect to the current of air outside the inlet or suction conduit 17. We may assume that the speed of the motor or auxiliary turbine 19 changes in accordance with the demand for elastic fluid output in the elastic fluid generator. The means for accomplishing this will be described later. With this assumption the pump 14 and the blower 18 serve to supply an amount of fuel and air for maintaining the combustion, which amount under the above mentioned "certain condition" is sufficient to generate the necessary elastic fluid at varying loads. To obtain the right proportioning between the fuel and air supply at other conditions, I provide in accordance with my invention regulating means for regulating the flow of air in the inlet or suction conduit 17 of the blower in response to changes in barometric pressure, changes in the flow of air in the suction conduit 17, and changes in the flow of fuel in the fuel conduit 13. The control arrangement comprises a nozzle 23 in the conduit 13, a nozzle 24 in the conduit 17, flow responsive means 25 and 26 connected to the nozzles 23 and 24 respectively, a barometric pressure responsive device 27 and a valve 28 shown as a butterfly valve in the air suction conduit 17. More specifically, the barometric pressure responsive device has a bellows 29 with a lower portion fixed to a support 30 and a top portion connected to one end of a fulcrumed lever 31 which has its other end connected by means of a spring 32 to a link 33 for moving the valve 28. A spring 34 provided between the bottom and top portions of the bellows and the spring 32 prevent the bellows from collapsing.

With this arrangement a decrease in barometric pressure which occurs whenever the airplane increases its altitude causes expansion of the bellows whereby the lever 31 is turned in clockwise direction and causes downward movement of link 33, to the effect that valve 28 opens and permits an increased volume of air to maintain constant the amount or weight of air delivered by the

blower. By "amount or weight of air" is meant the weight of air delivered during a certain period of time. The flow-responsive device 25 comprises a casing 35 having an upper half and a lower half with a diaphragm 36 therebetween. The central portion of the diaphragm is connected to a stem 37 which has its lower end pivoted to an intermediate point of a lever 38 turning about a fulcrum 39 and being connected to the link 33. The upper casing half communicates with the conduit 13 ahead of the nozzle 23 by means of a pipe 40. The lower casing half communicatees with the conduit 13 behind the nozzle 23 as regards the direction of flow through the conduit 13 by means of a pipe 41. The flow-responsive device 26 is similarly arranged. It comprises a casing 42 with a diaphragm 43 connected to the lever 38 by a stem 44 and pipes 45 and 46 for connecting the lower and upper casing halves respectively to the conduit 17 ahead and behind the nozzle 24 respectively as regards the direction of flow through the conduit 17. The flow-responsive device 26 controls the flow of air through the conduit 17 in response to changes in pressure drop in conduit 24 caused by changes in the velocity of air through the conduit 24, more specifically by changes of the relative speed between the conduit 24 and the current of air outside the conduit. As stated above, the blower 18 is dimensioned to supply as nearly as possible, under certain conditions, an amount of air sufficient to maintain the proper combustion of the fuel supplied by the pump 14. In the case of an airplane power plant it is preferable to make the arrangement so that at normal speed of the airplane, which may be 100 miles per hour, the pump supplies sufficient air to the furnace for maintaining combustion of the fuel supplied by the fuel pump 14. The inlet of conduit 17 is located in forward direction, so that air is forced into the conduit during flight of the airplane, the amount of air flowing into the conduit increases as the speed of the airplane increases, and vice versa. With this arrangement an increased speed causes an increased flow of air through the suction conduit 17 which without the provision of special control means would cause an excessive amount of air being supplied to the furnace. With the arrangement of the flow-responsive device 26 an increased flow of air in the conduit 17, due to an increased relative velocity between the conduit and the current of air, causes the diaphragm 43 in casing 42 to be forced upward, owing to the increased pressure drop in the conduit 17, whereby the lever 38 turns in clockwise direction about its fulcrum and effects closing of the valve 28 in the conduit 17. Thus the amount of air conducted through the conduit 17 is maintained constant.

In the arrangement shown in the drawing, the stems 37 and 44 of the flow-responsive devices are arranged in alinement so that no spring means are needed for balancing the pressures acting on the diaphragms 36 and 43. The pressures acting on the two diaphragms balance each other. By properly dimensioning the diaphragms or using different materials for the diaphragms, any desirable characteristic of the control arrangement is obtained.

If the flow of fuel through the conduit 23 changes, owing, for instance, to the variation of the fuel head in tank 12, the flow-responsive device 25 automatically causes positioning of the valve 28 in terms of change in flow of fuel. If, for example, the flow of fuel increases, the diaphragm 36 of the flow-responsive device is moved downward and causes through the lever 38 and the link 33 opening movement of the valve 28, resulting in an increased flow of air. If the flow of fuel through the conduit 23 decreases, a similar action takes place with the different parts moving in opposite direction and resulting in closing of the valve 28.

The two flow-responsive devices 25 and 26 and the barometric pressure-responsive device 27, together with the valve 28, represent in substance means for automatically controlling the supply of air to the furnace in response to changes in fuel supply, changes in relative speed between the conduit 17 of the airplane and the current of air, and in response to changes in barometric pressure.

In Fig. 2 I have shown a modification of this automatic control arrangement. Like parts are designated with like reference characters. The stem 33 of the valve 28 is biased in this arrangement in upward direction by means of a spring 47, and carries at its upper end a roller 48 bearing against the cam surface of a cam 49 fastened to a shaft 50. Adjacent the cam is a pinion 51 fastened to the shaft 50 and meshing with a rack 52. Connected to the rack 52 is a piston 53 movable in a cylinder 54 and biased towards the left by a spring 55. The cylinder 54 has a left-hand portion connected by means of a pipe 56 to the inlet of the nozzle 23 and a right-hand portion connected to the outlet side of said nozzle by means of a pipe 57. The left-hand end of the rack 52 is connected to a barometric pressure responsive device including a bellows 58. If with this arrangement the flow of fuel increases, the piston 53 in cylinder 54, which in substance represents a flow-responsive device, is moved towards the right and thereby causes the cam 49 to rotate in clockwise direction, resulting in an opening movement of the valve 28 and accordingly an increased flow of air in the conduit 17. If the barometric pressure increases, the bellows 58 collapses somewhat and causes the rack 52 to move to the left, resulting in a closing movement of the valve 28. Similar operations take place with movements in opposite directions if the flow of fuel in the fuel conduit 23, and the barometric pressure decrease. The device shown in Fig. 2 does not include any means for controlling the flow of air in response to changes in the relative speed between the conduit 17 and the current of air outside the conduit.

In both arrangements of Fig. 1 and Fig. 2 the control means for the valve 28 are connected together, that is, in Fig. 1 the two flow-responsive devices 25 and 26, as well as the barometric pressure responsive device 29 are connected to a common lever 38, and in Fig. 2 both the flow-responsive device 53, and the barometric pressure responsive device 58 are rigidly connected to the rack 52.

In Figs. 3 and 4 I have shown arrangements in which the three control devices may act independently from each other, that is, movement of the one has no direct effect and particularly does not exert a biasing force on the other. This is accomplished in the arrangement shown in Fig. 3 by providing the air inlet conduit 17 for the blower with three branches 60, 61 and 62, of which each includes a valve means 63, 64 and 65 respectively. The valve 63 in branch 60 is controlled by a barometric pressure responsive device 66. The valve 64 in branch 61 is controlled by a flow-responsive device 67 connected to the fuel supply conduit 23 corresponding to the con-

duit 23 in Figs. 1 and 2. The valve 65 in branch 62 is controlled by a flow-responsive device 69 including pipes 70 and 71 connected to the nozzle 24 in the conduit 17. The flow-responsive devices 67 and 69 are similar to the flow-responsive devices 25 and 26 in Fig. 1 except that each includes a biasing spring 72 and 73 respectively.

During operation, a decrease in barometric pressure causes expansion of the bellows 66 whereby the valve 63 is opened and the flow of air through the branch 60 is increased. Similarly, an increase of flow of fuel through conduit 23 causes the diaphragm of the flow-responsive device 67 to be forced downward to effect opening of the valve 64. An increase in the flow of air through the conduit 17, due to a change in relative speed between the conduit 17 and the current of air, causes the flow-responsive device 69 to close the valve 65.

In Fig. 4 I have shown an arrangement in which the valve 28 in the suction conduit 17 of the blower is connected to a floating lever 73a. The left-hand end of the floating lever is pivoted to the bellows 74 of a barometric pressure responsive device 75 and the right-hand end of the floating lever 73a is linked to an intermediate point of another floating lever 76. The right-hand end of the latter is connected to a device 77 responsive to the flow of fuel in the conduit 13, and the left-hand end of the floating lever 76 is connected to a device 78 responsive to the flow of air in the conduit 17. This is a preferable arrangement because the control of each device is independent from the positions of the other devices. During operation, an increase in barometric pressure causes the left-hand end of lever 73a to move up, the lever thereby turns about its right-hand end as a fulcrum and causes closing of the valve 28. An increase in flow of fuel in conduit 13 causes the right-hand end of the lever 76 to move down, the lever 76 thereby turns about its left-hand end as a fulcrum and due to its connection with lever 73a causes the latter to turn down about its left-hand end as a fulcrum, resulting in opening of the valve 28. A decrease in flow of air through conduit 17 causes in a similar manner through the flow-responsive device 78 an opening movement of the valve 28.

The mechanism so far described represents an arrangement for automatically controlling the supply of fuel and air to a furnace. Located in the furnace are containers or headers 79 and 80 connected by tubes 81 for containing liquid such as water or mercury to be heated and evaporated. Heat is transmitted to the containers and the tubes by radiation and conduction. The fire gases escape through a flue 82 which has an opening in rearward direction of the aircraft. The elastic fluid produced in the boiler is supplied to a consumer shown as an airplane turbine or main turbine 83 driving a propeller 84 through the intermediary of a reduction gearing 85. A turbine of this type is more fully disclosed in my copending application Serial No. 632,932, filed September 13, 1932. The path of fluid between the boiler and the turbine is defined by a conduit 86, a chest 87 and a conduit 88 between the chest and the inlet of the turbine. The turbine has an exhaust conduit 89 connected to a condenser 90 for condensing the exhaust elastic fluid of the turbine.

The condensate is returned to the boiler through the intermediary of a preheater which forms a part of the elastic fluid generator. In the present instance I have shown three preheaters 91, 92 and 93. The condensate is pumped through the preheaters into the boiler. This is accomplished by the provision of two pumps 94 and 95. The suction conduit of pump 94 is connected by means of a conduit 96 to a well 97 which receives the condensate from the condenser 90. The discharge conduit of the pump 94 is connected by a conduit 98 to the inlet or suction conduit of the pump 95 and a discharge conduit 99 of the latter is connected to the preheater 91. The two pumps and the three preheaters as will be readily seen are connected in series. The preheater 93 which is the last preheater as regards the direction of flow of fluid through the preheaters discharges into the lower header 80 of the boiler through a conduit 120 including a check valve 121. The boiler feed liquid passing through the preheater 93 is heated by means of elastic fluid extracted from an intermediate stage of the turbine. In the present instance I have shown a conduit 100 including a check valve 101 for conducting elastic fluid from an intermediate turbine stage to the preheater 93. Similarly the fluid passed through the preheater 92 is preheated by elastic fluid extracted from a lower stage of the turbine by a conduit 102 including a check valve 103. The heating fluid supplied to the preheater 93 is drained therefrom and supplied to the preheater 92 through a conduit 104 including a drip valve or an orifice 105, and the heating fluid supplied to the preheater 92 together with the condensated heating fluid received from the preheater 93 is conducted to the preheater 91 through a conduit 106 including a drip valve or an orifice 107. The heating fluid is drained from preheater 91 through a conduit 108 including a drip valve or an orifice 109 and conducted into the suction conduit 96 of the feed pump 94. No heating fluid is directly supplied from the turbine to the preheater 91. This preheater receives heating liquid through the drip valve 107 from the preheaters 92 and 93 and therefore may be termed a "drip preheater". The drip valves or orifices are provided to allow only condensate to flow out from the preheaters.

The pumps 94 and 95 for forcing make-up or boiler feed liquid into the elastic fluid generator are driven from the shaft 20 of the auxiliary turbine 19 through gearings 110 and 111 respectively. Preferably I provide positive displacement pumps for feeding liquid into the elastic fluid generator whereby the amount of boiler feed liquid delivered by the pumps is primarily determined by the speed of the pumps which in turn is fixed by the speed of the motor or auxiliary turbine 19. Assuming again that the speed of the turbine 19 is regulated in response to demand for elastic fluid, then the supply of boiler feed liquid is regulated in response to the demand for elastic fluid from the generator. In addition I provide a control arrangement for regulating the feed water supply in response to changes in temperature of the elastic fluid in the boiler. This is accomplished by the provision of a bypass 112 between the discharge and the suction conduits of the pump 95 and a valve 113 in the bypass which is moved in response to temperature changes of the generated elastic fluid. The valve 113 has a stem 114 connected to a diaphragm 115 of a pressure responsive device. The valve is biased towards open position by a spring 116 surrounding the valve stem and the right-hand casing half of the pressure responsive device has a conduit 117

with a sealed end 118 projecting into a chest 119 of the boiler discharge conduit 86.

If during operation the temperature of the elastic fluid increases it causes expansion of a gas such as air entrapped in the conduit 117 and the left-hand casing half of the pressure responsive device, to the effect that the valve 113 is moved towards closed position. This decreases the amount of liquid which is bypassed between the discharge conduit 99 and the suction conduit 98 of the pump 95 and accordingly increases the amount of boiler feed liquid delivered from the discharge conduit 99 to the preheater. The bypass 112 together with the temperature responsive device represent a means for automatically maintaining constant the temperature of the elastic fluid in the boiler, and the pumps together with the bypass and the temperature responsive device represent means for automatically regulating the amount of feed liquid to the boiler in response to the demand for elastic fluid. The last named means together with the arrangement for supplying and controlling the supply of fuel and air to the furnace represent in substance means for automatically controlling the amount of elastice fluid generated in the boiler in terms of demand for elastic fluid.

The demand for elastic fluid depends upon a number of factors, primarily the speed of the propeller. The flow of elastic fluid to the turbine is regulated by means of a valve 122 connected to a fulcrumed lever 123 which in turn is connected by means of a link 124 to one arm of a bell crank lever 125 having its other arm connected by a link 126 to an intermediate point of a fulcrumed hand lever 127. Movement of the hand lever to the left effects downward movement of link 124 and opening movement of valve 122 which thereby admits an increased flow of elastic fluid to the turbine. The increased flow of fluid to the turbine, that is, the increased demand for elastic fluid generated in the boiler necessitates an increased supply of fuel and air to the furnace and also an increased supply of make-up liquid to the boiler. This is accomplished by increasing the speed of the motor or auxiliary turbine 19, in the present instance, by increasing the amount of elastic fluid supplied to the turbine 19. The auxiliary turbine has an inlet conduit 128 receiving elastic fluid from a lower extraction stage of the turbine through a conduit 129 which in substance forms a continuation of the conduit 102. The conduit 129 includes a check valve 130 and has its lower end connected to conduit 128 by means of a conduit 131 including a valve 132. When the valve 132 is fully opened, live elastic fluid may be supplied to the auxiliary turbine through a conduit 133 having one end connected to the joint between the conduits 128 and 131 and its other end to the chest 87. A valve 134 for regulating the amount of live elastic fluid supplied to the auxiliary turbine is provided within the chest 87. The stem 135 of the valve 134 is pivoted to the right-hand end of a floating lever 136 which has its left-hand end connected to the stem 137 of the valve 132. The valve 134 is biased towards closed position by means of a spring 138. The downward movement of the stem 137 of the valve 132 is limited by an adjustable stop 139. Connected at an intermediate point of the lever 136 is a stem 140 to which is fastened a piston 141 slidably arranged in a dashpot 142. The piston has an opening 143 which permits communication and displacement of a fluid contained in the upper portion and the lower portion of the dashpot. The dashpot is pivoted to a fulcrumed lever 144 which in turn is connected to the fulcrumed lever 123 by means of a link 145. Connected to the piston is a pressure responsive device 146 comprising a casing 147, a bellows 148 having a top portion fastened to the casing 147 and a bottom portion fastened to a stem 149 which in substance forms an extension of the stem 140. The bellows is biased in downward direction by a spring 150 surrounding the stem 149. The pressure responsive device is subject to the pressure of the elastic fluid in the boiler through a pipe 151 between the casing 147 and the discharge conduit 86 of the boiler.

During operation, the opening movement of the lever 127, indicated by an arrow, causes downward movement of the link 124 and, as explained above, opening of the turbine admission valve 122 whereby the flow of elastic fluid to the turbine increases. The downward movement of the link 124 causes at the same time a downward movement of the left-hand end of fulcrumed lever 144. The dashpot 141, together with the piston 143, thereby are moved downward owing to the fact that the comparatively short period of time during which the movement of the fulcrumed lever 144 takes place does not permit a substantial displacement of fluid, which may be oil, between the upper and lower part of the dashpot. In other words, for short or sudden movements the dashpot acts like a rigid connection between the lever 144 and the piston 143. The movement of the lever 136 causes, at first, opening movement of the valve 132 which permits an increased supply of extraction elastic fluid to the auxiliary turbine. The valve 134 is retained in closed position by the biasing spring 138 until the valve 132 is fully opened, that is, until the left-hand end of lever 136 engages the adjustable stop 139. In this position further downward movement of the stem 140 causes opening of the valve 134 against the biasing force of the spring 138 to permit live elastic fluid being supplied to the auxiliary turbine.

Thus the valves 132 and 134 represent means for controlling the auxiliary turbine or the motor 19 in response to movement of the regulating means, that is the valve 122 for the main turbine. The auxiliary turbine or motor 19, together with the control means for this turbine, the pumps, and the blower driven by said turbine, represent a means for automatically regulating the generation of live elastic fluid in the elastic fluid generator in response to demand for live elastic fluid, or, from another viewpoint, in response to movement of the regulating means for the main turbine.

The pressure responsive device 146 serves to adjust the regulating means for the auxiliary turbine in response to pressure conditions in the boiler. If the demand for elastic fluid increases, one or both of the valves 132 and 134 are opened to increase the supply of elastic fluid to the auxiliary turbine 19. This causes an increased supply of fuel and air to the furnace and feed water to the boiler. Whereas the increased demand for elastic fluid causes, at first, a drop in pressure in the boiler, the increased supply of fuel to the furnace thereafter causes a rise in pressure. The rise in pressure effects through the pressure responsive device 146 a repositioning of one or both of the valves 132 and 134 to maintain substantially constant the power supply to the auxiliary turbine 19. More specifically, the rise in pressure causes the bellows to collapse against

the biasing force of the spring 150. The stem 149, together with the piston 143 move upward and effect closing movement of one or both of the valves 132 and 134. In case the valve 134 is already closed, the valve 132 will be further closed and if valve 134 is partly opened then this valve will first be closed and as soon as it has been shut the valve 132 may be partly closed. The closing movement of the valves takes place slowly owing to the provision of the dashpot. The dashpot cylinder in this case remains stationary whereas the piston 141 moves within the dashpot, causing displacement of fluid between the upper and lower portions thereof through the opening 143 in the piston 141.

The auxiliary turbine 19 has been shown as having an exhaust connected by means of conduits 152 and 153 to the exhaust conduit 89 of the main turbine 83. The elastic fluid generator is provided with a blow-off valve 154 in the discharge conduit 86. If the pressure in the boiler exceeds a predetermined value, the blow-off valve opens against the biasing force of a spring 155 to permit relieving of the elastic fluid pressure. The elastic fluid discharged through the blow-off valve is conducted through a conduit 156 which forms a continuation of the conduit 153 into the exhaust conduit 89 of the turbine.

Summarizing, a few of the important features of the operation of my elastic fluid power plant: In order to decrease the output of the turbine, to lower for instance the speed of an aircraft, the lever 127 is moved towards closing position, that is, towards the right. This effects closing of the turbine valve 122 and accordingly a decreased supply of elastic fluid to the turbine, and simultaneously a closing movement of one or both of the valves 134 and 132 for the auxiliary turbine whereby the speed of the latter decreases and automatically effects a decreased generation of elastic fluid in the boiler. The pressure in the boiler thereby decreases and effects through the pressure responsive device 146 a repositioning of the regulating means for the motor or auxiliary turbine 19 to maintain substantially constant the output of the latter.

A change in boiler temperature through the temperature-responsive device 115—117 and the bypass 102 for the feed pumping means automatically causes a charge in the supply of boiler feed liquid to the elastic fluid generator.

If the relative speed between the power plant and the curent of air, or the supply of fuel to the furnace, or the barometric pressure, changes, then the flow of air in the suction conduit of the blower is accordingly automatically changed under action of the flow-responsive devices 25 and 26 and the barometric pressure-responsive device 30, so that under any condition the supply of air to the furnace is proportioned to maintain proper combustion of the fuel supplied to the furnace.

The entire operation of the elastic fluid power plant is automatic. All that is necessary to change the operation is to move the lever 127 towards opening or closing position. Movement towards opening position causes an increased load output of the turbine and towards closing position a decreased load output. The complete automatic operation of the power plant is of particular significance in case the power plant is used in connection with an aircraft because it does not need the attention of a special operator but can be handled by the pilot of the aircraft. The lever 127 which is the main controlling lever for the entire power plant may be easily arranged in reach of the pilot. Movement of this lever effects a change in the supply of elastic fluid to the main turbine. This change rapidly causes an automatic positioning of the various regulating devices in accordance with the changed demand for load output.

Having described the method of operation of my invention, together with the apparatus which I now consider to represent the best embodiment thereof, I desire to have it understood that the apparatus shown is only illustrative and that the invention may be carried out by other means.

What I claim as new and desire to secure by Letters Patent of the United States is:

1. In an elastic fluid generator, the combination of a furnace, means including a pump for supplying fuel to the furnace, means including a blower having a suction conduit for supplying air to the furnace to maintain combustion, valve means in the suction conduit, and means for positioning the valve means in response to the barometric air pressure, the velocity of the current of air outside the suction conduit, and the flow of fuel to the furnace.

2. In a power plant, the combination of an elastic fluid generator comprising a furnace, a boiler, a fuel pump and a boiler feed pump, an auxiliary turbine for driving said pumps, a main turbine connected to the boiler, means for regulating the supply of elastic fluid to the main turbine, conduit means for conducting elastic fluid from an intermediate stage of the main turbine and from the boiler to the auxiliary turbine, and valve means in said conduit means connected to the regulating means for the main turbine.

3. In a power plant, the combination of an elastic fluid generator comprising a furnace, a boiler a fuel pump and a boiler feed pump, an auxiliary turbine for driving said pumps, a main turbine connected to the boiler, means for regulating the supply of elastic fluid to the main turbine, conduit means for conducting elastic fluid from an intermediate stage of the main turbine and from the boiler to the auxiliary turbine, valve means in said conduit means, means for positioning said valve means in response to movement of the main turbine regulating means, and means for controlling the valve means in response to changes of fluid condition in the boiler.

4. In a power plant, the combination of a boiler, means including a motor for regulating the generation of elastic fluid in the boiler, a main turbine connected to the boiler, an admission valve for the main turbine, means for controlling the admission valve, means for controlling the motor in response to movement of said admission valve and pressure changes in the boiler.

5. In a power plant, the combination of a boiler for generating elastic fluid, a main turbine connected to the boiler, valve means for controlling the supply of elastic fluid to the main turbine, and means for automatically controlling the generation of elastic fluid in the boiler comprising an auxiliary turbine, a conduit including a valve for conducting live elastic fluid to the auxiliary turbine, a spring for biasing the valve towards closed position, another conduit including a valve for conducting elastic fluid from an intermediate stage of the main turbine to the auxiliary turbine, a dashpot having a piston connected to the two last named valves and a cylinder connected to the main turbine valve means, and a device responsive to changes in fluid condition

of the live elastic fluid in the boiler connected to the dashpot piston.

6. In a power plant for an aircraft, the combination of a boiler, a turbine for driving a propeller receiving elastic fluid from the boiler, a condenser for the turbine, means including a preheater receiving condensate from the condenser and heating fluid from an extraction stage of the turbine for automatically supplying condensate to the boiler in response to the demand for elastic fluid and temperature changes in the boiler, a motor for operating the last named means, and means for controlling the motor in response to the demand for elastic fluid and the pressure of elastic fluid in the boiler.

7. In a power plant, the combination of an elastic fluid generator comprising a boiler and auxiliaries, a main turbine connected to the boiler, said auxiliaries including an auxiliary turbine, a first conduit including a first valve between an extraction stage of the main turbine and the auxiliary turbine, a second conduit including a second valve between the boiler and the auxiliary turbine, a main valve for the main turbine, and a mechanism for transferring movement of the main valve to said first and second valves.

8. In a power plant, the combination of an elastic fluid generator comprising a boiler and auxiliaries, a main turbine connected to to the boiler, said auxiliaries including an auxiliary turbine, a first conduit including a first valve between an extraction stage of the main turbine and the auxiliary turbine, a second conduit including a second valve between the boiler and the auxiliary turbine, a main valve for the main turbine, a mechanism for transferring movement of the main valve to said first and second valves, and means for normally biasing the second valve towards closing position and permitting opening thereof in a certain position of the first valve.

9. In a power plant, the combination of an elastic fluid generator comprising a boiler and auxiliaries,, a main turbine connected to the boiler, said auxiliaries including an auxiliary turbine, a first conduit including a first valve between an extraction stage of the main turbine and the auxiliary turbine, a second conduit including a second valve between the boiler and the auxiliary turbine, a main valve for the main turbine, a mechanism for transferring movement of the main valve to said first and second valves, and means for positioning the first and second valves in response to changes in elastic fluid conditions in the boiler, said means being independent from the transferring mechanism.

10. In an elastic fluid generator, the combination of a furnace, means including a first conduit for supplying fuel to the furnace, other means including a second conduit having a plurality of parallel branches for supplying air to the furnace, a valve in one of the branches, means for controlling the valve in response to flow of fuel in the first conduit, another valve in another branch, and other means for controlling the other valve in response to changes of air condition in the second conduit.

11. In an elastic fluid generator, the combination of a furnace, means including a pump for supplying fuel to the furnace, means including a blower having a suction conduit for supplying air to the furnace to maintain the combustion, valve means in the suction conduit, means for positioning the valve means comprising a barometric air pressure responsive device, and other devices responsive to the flow of fuel and the flow of air, and a mechanism for connecting the devices to the valve means to permit independent control of the valve means by each of the devices.

12. In a power plant, the combination of an elastic fluid generator comprising a furnace, a boiler, a fuel pump, a boiler feed pump, an auxiliary turbine for driving said pumps, a main turbine connected to the boiler, means for regulating the supply of elastic fluid to the main turbine, conduit means for conducting elastic fluid from an intermediate stage of the main turbine to the auxiliary turbine, and other conduit means including a valve for temporarily conducting elastic fluid from the boiler to the auxiliary turbine in response to sudden increases in demand for load output from the main turbine.

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