

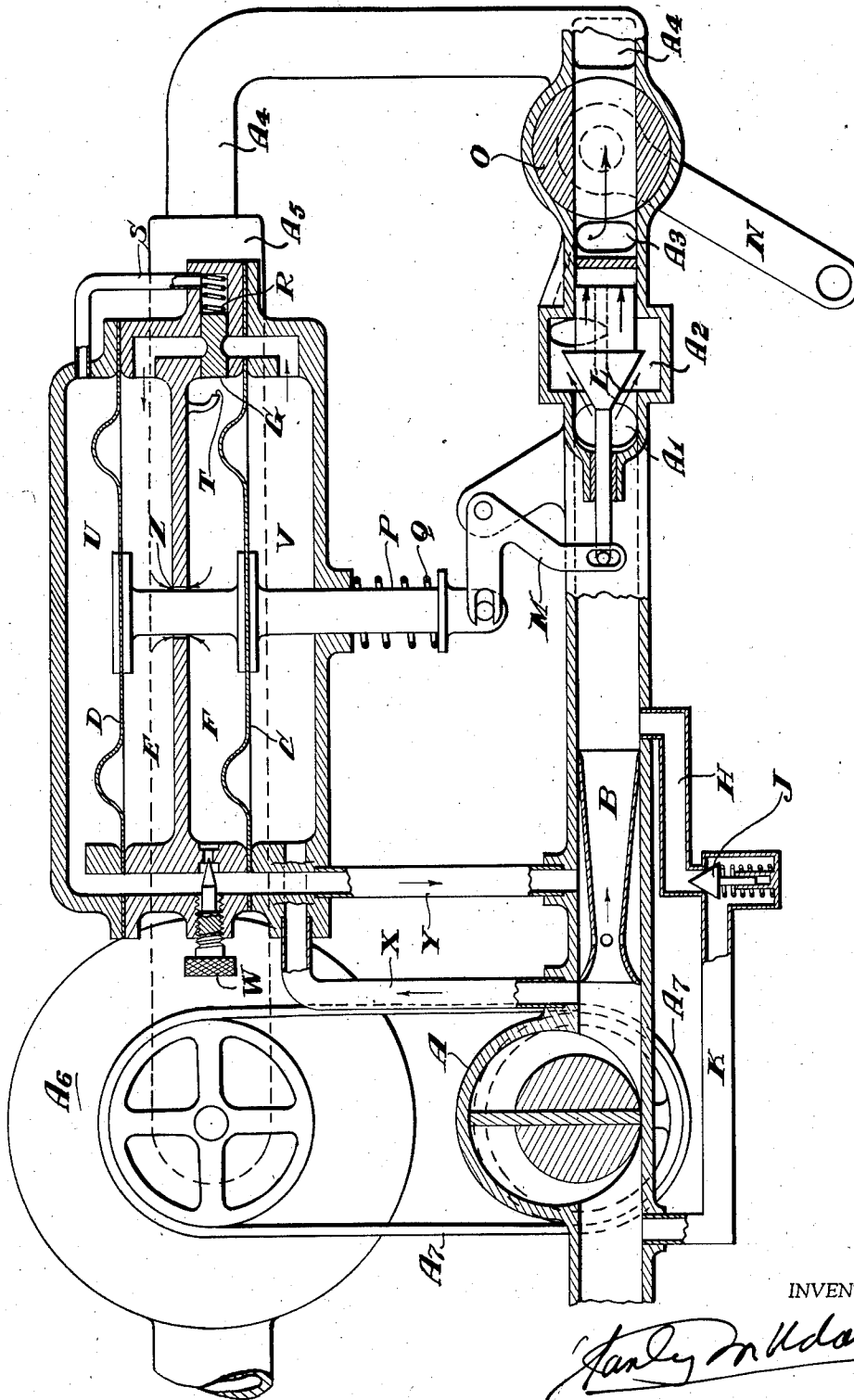
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GOVERNOR

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GOVERNOR

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The object of this invention is to govern the flow of liquid fuel to a burner in a gas turbine.

It is desirable that the speed shall not exceed the governed speed. If the turbine is accelerated, the speed will naturally exceed the governed speed unless the governor can be made to anticipate the speed increase.

To arrive at an increase in speed, it is necessary to have a period when speed is increasing. During this period, it is desirable to utilize the rate of increase in speed to check the speed. If the speed is increased gradually, no problem exists. If the speed is increased rapidly, a serious problem is presented due to the fact that the means to check the speed will only come into action when the desired speed has been reached. During the interval of time which the governor takes to become active, the speed will rise above the desired maximum speed.

The figure shows diagrammatically the elements of my invention.

Pump A of positive displacement circulates a liquid through a venturi B. The pressure on the upstream side of the venturi B acts on the chamber V below diaphragm C through passage X. The relative suction in the venturi B acts on the chamber U on the upper side of diaphragm D through the passage Y. The chambers E and F are normally at the same pressure due to the leakage between the two through the opening Z. However, when the speed changes, there is a sudden increase in suction in the chamber U above diaphragm D, and a valve G is drawn by the suction transmitted through pipe S to the right against a spring R to the position shown in the drawing. This allows the pressure from the pump A to enter the chamber E below the diaphragm D so that the diaphragms C and D are both operated by the full pressure difference.

When the speed becomes stable, however, the valve G is pushed to the left against the stop T by the spring R, and the pressure in the chambers E and F equalizes through the leakage path Z provided.

A bypass H-K downstream of the venturi B is controlled by a spring-loaded valve J and thus cooperates with a throttle valve O controlled by a lever N. A balanced valve L controlled by a lever M is operated by a link P connected to the two diaphragms C and D. The outlet from the venturi B is in free communication with the passage A₁. The outlet chamber A₂ on the downstream side of the valve L is in free communication with the passage A₃, which is in communication with the outlet passage A₄ through the

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valve O. The fuel regulated by the balanced valve L flows into a chamber A₅ where it is consumed. The products of combustion flow to a chamber A₆, which contains a gas turbine which drives a belt A₇, which drives the pump A at a speed proportional to engine speed. A spring Q is provided to balance the effect of the flow through the venturi B. An adjustment W is provided. The restriction formed around the end of the needle W delays the pressure drop in the throat of the venturi B, being transmitted to the chamber F quite as quickly as this drop in pressure is transmitted through the pipe Y to the chamber U.

Operation

The pump A, which is driven by the turbine combination, rotates at some speed proportionate to the speed of the gas turbine. Let us assume that the throttle lever N is moved so that valve O is opened suddenly, and the pump A accelerates as the engine picks up speed; the flow through the venturi B therefore also accelerates. The suction acting on the right of valve G causes valve G to assume the position shown in the drawing. The pressure in V below the diaphragm C (which equals pressure upstream of the venturi B) is thus applied to the bottoms of both the diaphragms C and D. The suction (relative) in the throat of the venturi B is applied to chambers U and F—that is to the upper surfaces of both diaphragms C and D.

Hence, the link P rotates the lever M and thus closes the balanced valve L and temporarily checks the rate of increase in flow and thus in speed. When the acceleration period is over, the valve G is pushed by its spring to the left. The pressure in the two chambers E and F is equalized by the leakage past the annular opening Z. The low pressure in the chamber above the diaphragm D then is the only force governing the speed. The spring Q thus governs the normal speed of rotation of the pump A, but the governor acts faster when accelerated. When the flow of fuel is accelerated by the sudden opening of valve O, the suction due to the increased flow of fuel through the venturi B is transmitted instantly through the unobstructed passage Y to the chamber U. Subsequently, chambers E and F also are subjected to the suction in the venturi B but in the interim the suction in the chambers E and F is less than the low suction instantly applied to the chamber U because of the fact that the communication between the chamber F and the passage Y is past the adjustable needle valve

W, that is it is restricted and the communication between the chamber F and the chamber E is through the very restricted annular passage Z. During this interim the valve G is moved away from the stop T against which it is normally pressed by the spring R and the valve G is thus moved into the position in which it is shown in the drawing. In this position the pressure in the chamber V is transmitted directly to the chamber E past the valve G and to the chamber F through the very restricted passage Z.

Obviously the pressure in the chamber E becomes instantly equal to the pressure in chamber V and the pressure in the chamber F rises slightly due to the small flow through the leakage passage Z and out to the passage Y past the needle valve W.

Hence the force acting in an upward direction on the rod P is considerably greater than it was when valve G was pushed over to the left against its stop T by the spring R. As the suction in the venturi B continues to slowly increase in spite of the gradual closure of the control valve L, the suction in the chamber U also increases.

As the diaphragms D and C rise the volume of the chambers U and F are decreased. The volume decrease of the chamber U has no influence on the pressure in the chamber U.

The volume decrease of the chamber F—due to the restricted passage past the needle valve W—causes a temporary increase in pressure in the chamber F. After a short period of time the suction in the chamber F also increases and eventually—depending on the adjustment of the valve W, the valve G returns to its original position in which position the passage connecting chamber V directly with chamber E is obstructed.

When the valve G obstructs this passage then the pressure in the two chambers E and F quickly equalizes through the leakage passage Z. In effect normally only one diaphragm is acting. In effect when in its open position, that is the position in which it is shown, then the chamber F is at some suction less than the suction in the chamber V because of the leakage past the leakage passage Z but substantially equal to more than one-half the suction in the chamber U. By this means the pull upwardly on the rod P is at least fifty percent greater than that due to the suction or pressure difference acting on the single diaphragm U. Thus the tendency to start the valve L to close occurs before the critical speed has been reached which would be too late to prevent over-speeding. After the critical speed has

been reached the difference in suction between the chamber U and chamber F is not sufficient to keep the valve G in the position in which it is shown, and valve G is pushed back into place by spring R.

Hence there is normally only one diaphragm in operation to regulate the speed of the power plant except during acceleration when the equivalent of $1\frac{1}{2}$ or of $1\frac{3}{4}$ diaphragms are in operation to prevent over-speeding.

Hence during acceleration the governor anticipates the ultimate increase in speed so that before the increased governor speed has been reached the governor valve L has already started to move so that it can be moved into its ultimate position before the power plant has exceeded the desired speed.

The adjustment W, when closed prevents the governor anticipating the change in speed. When adjusted, the degree of anticipation can be regulated.

What I claim is:

An anticipatory hydraulic governor of the type which regulates the speed, when the speed is increasing, before the speed reaches the desired speed, adapted for use with a liquid fuel pump connected to a prime mover which is adapted to be driven by the fuel supplied by said pump and to drive said pump at a speed proportional to the speed of the prime mover, said liquid fuel pump being of the type that has a constant displacement per revolution, an outlet from said pump, a fuel venturi therein, a balanced throttle valve in said outlet, a diaphragm responsive to the pressure difference created by the flow through said venturi connected to said valve, a second diaphragm also responsive to the pressure difference created by said flow and also connected to said throttle valve, a passage connecting the pressure side of said venturi to the pressure side of one of said diaphragms, a passage connecting the pressure side of said diaphragms together, an automatic valve therein, yielding means operating to move said automatic valve into the position in which said passage is obstructed so that only one of said diaphragms is operative, means responsive to a sudden increase in speed of flow to move said automatic valve against said yielding means so as to open said connecting passage to render both of said diaphragms operative, so as to close said throttle valve rapidly when the speed of the prime mover is increasing rapidly.

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