

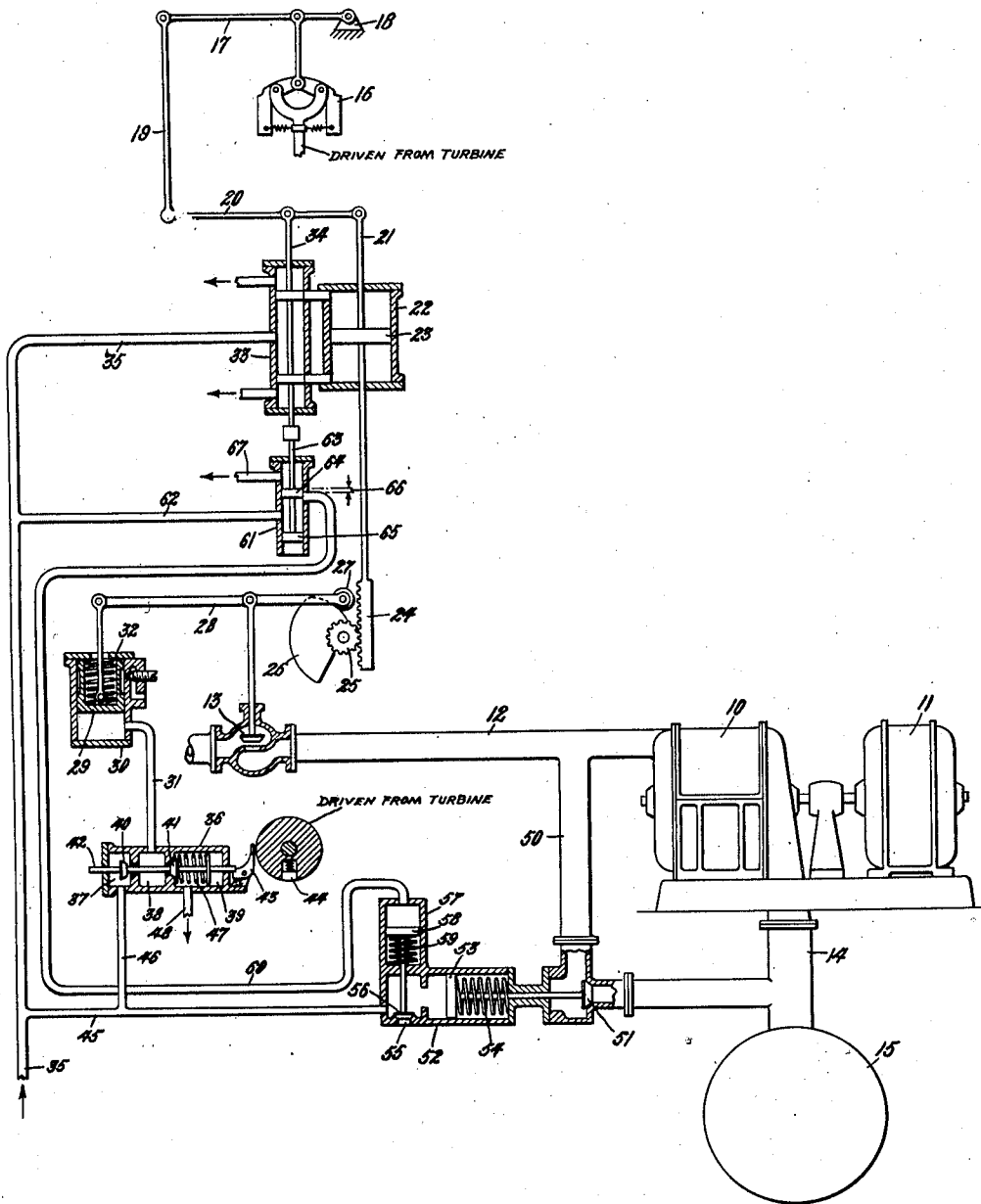
Jan. 4, 1944.

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2,338,548

ELASTIC FLUID TURBINE ARRANGEMENT

Filed June 4, 1941



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UNITED STATES PATENT OFFICE

2,338,548

ELASTIC FLUID TURBINE ARRANGEMENT

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Application June 4, 1941, Serial No. 396,562

7 Claims. (Cl. 137—158)

The present invention relates to elastic fluid turbine arrangements including a turbine having an inlet conduit with a valve for controlling the flow of elastic fluid thereto and a governing mechanism including an element such as a speed governor responsive to changes of an operating condition for controlling the inlet valve. More specifically the invention relates to the kind of arrangements in which the inlet conduit is of considerable length and the inlet valve is arranged at a considerable distance from the turbine. Difficulties have heretofore been experienced with this kind of arrangement because of the considerable amount of elastic fluid that may be entrapped in the inlet conduit and may cause dangerous speeding up of the turbine beyond the emergency speed in the case of a sudden drop or loss of load.

The object of my invention is to provide an improved construction and arrangement of elastic fluid turbines and mechanisms for controlling them whereby the aforementioned difficulties are overcome.

This is accomplished in accordance with my invention by the provision of an arrangement which includes a bypass conduit with a valve connected at one end to the inlet conduit behind the inlet valve as regards the direction of flow of fluid thereto and connected at the other end to the exhaust conduit of the turbine. With an arrangement of this kind the elastic fluid entrapped in the inlet conduit upon closing of the inlet valve may be bypassed to the exhaust conduit or a condenser connected to the turbine upon closing of the inlet valve. In a preferred embodiment of my invention I provide a governing mechanism including a device such as a speed governor responsive to an operating condition of the turbine for operating the inlet valve and means responsive to the lag between the movements of the speed governor and the inlet valve for opening the by-pass when said lag exceeds a predetermined magnitude.

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

The single figure of the drawing illustrates diagrammatically a preferred embodiment of my invention.

The arrangement comprises an elastic fluid turbine 10 arranged to drive a generator 11 and having an inlet conduit 12 with an inlet valve 13 for controlling the flow of elastic fluid thereto.

The fluid is exhausted from the turbine through an exhaust conduit 14 into a condenser 15.

The inlet valve 13 is controlled by a governing mechanism comprising a speed governor 16 having flyweights connected to a lever 17 which has one end supported on a fulcrum 18 and another end pivotally connected by a link 19 to the left-hand end of a floating control and follow-up lever 20. The right-hand end of the lever 20 is connected to a stem 21 of a hydraulic motor 22 with a piston 23. A lower extension of the stem 21 forms a rack 24 meshing with a gear 25 for rotating a cam 26 fixed to the shaft of the gear 25. The cam 26 engages a roller 27 held on the right-hand end of a lever 28. An intermediate point of the lever 28 is pivotally connected to the valve 13 and the left-hand end of the lever 28 is connected to a piston 29 of a hydraulic motor 30 having an inlet conduit 31 for receiving operating fluid under pressure. The piston 29 is normally forced into an upper end position by fluid pressure acting on its lower side against the biasing force of a spring 32.

The hydraulic motor 22 is of the double-acting type and is controlled by a conventional pilot valve 33 with a stem 34 pivotally connected to an intermediate point of the floating lever 20. The pilot valve is connected by a pipe 35 to a source of oil or like operating fluid under pressure, not shown.

During operation, an increase in turbine speed causes outward movement of the flyweights of the speed governor 16 whereby the lever 17 is turned counterclockwise about the fulcrum 18, thereby causing downward movement of the link 19 and counterclockwise movement of the lever 20 about its right-hand end. This in known manner causes downward movement of the pilot valve stem 34 whereby the pilot valve heads uncover their ports and permit the supply of fluid under pressure to the lower side of the piston 23 and draining of fluid from the upper side thereof. This effects upward movement of the piston 23 and the rack 24 connected thereto whereby the cam 26 is turned counterclockwise and permits downward movement of the valve 13 towards its closing position.

Upward movement of the piston 23 also causes counterclockwise turning movement of the lever 20 about its left-hand end whereby the pilot valve stem 34 is moved upward and restored to its original position with its valve heads in line-to-line position with its ports.

During a drop in turbine speed, due to increased load demand, the operation of the mechanism

is similar except that the elements move in a direction opposite from that described above to cause opening of the valve 13 to permit an increased supply of fluid to the turbine. During operation of the valve 13 as a throttle or control valve, the left-hand end of the lever 23 is held in fixed position.

The arrangement shown in the drawing includes means for operating the valve 13 as an emergency stop valve to effect quick shutdown of the turbine in response to a predetermined maximum speed. To this end, the left-hand end of the lever 28 is connected to the hydraulic motor 30 and means are provided for quickly relieving the fluid pressure in the motor 30 upon the occurrence of emergency speed. This means comprises a known type of valve 35 forming three chambers 37, 38 and 39 with valve seats between them in cooperative relation with valves 40 and 41 secured to a stem 42. The valve stem 42 is normally held in the position shown by a latch 43 in cooperative relation with an emergency speed governor 44 driven from the turbine shaft. In the position shown the valve head 40 is open and the valve head 41 engages its seat so that operating fluid under pressure may be supplied from the pipe 35 through connecting pipes 45, 46 and the chambers 37, 38 to the pipe 31. During emergency, the flyweight 44 of the emergency speed governor engages and turns the latch 43 whereby the valve stem 42 is forced into reversed position by a compression spring 47 to effect engagement of the valve head 40 with its seat and disengagement of the valve head 41 from its seat. In reversed position the pipe 31 and the chamber 38 are disconnected from the chamber 37 and connected to the chamber 39 whereby oil is drained from the hydraulic motor 30 through the chambers 38, 39 to a drain conduit 48.

The arrangement so far described comprises a turbine with an inlet conduit and a combined throttle and emergency stop valve provided in the inlet conduit at a considerable distance from the turbine together with a speed-governing control mechanism for adjusting the inlet valve in response to speed changes of the turbine and an emergency speed-governing mechanism for quickly shutting the inlet valve as the turbine assumes a predetermined high speed.

During normal operating condition with a slowly decreasing load and a correspondingly slow, slight increase in speed, the pilot valve 34 is moved downward a short distance only of the order of forty thousandths of an inch. This constitutes a measure of the time lag of the mechanism. With the continued slow increase in speed this time lag will remain substantially constant because of the follow-up action of the hydraulic motor, that is, as the speed governor moves the left-hand end of the lever 20 further downward, at the same time the piston 23 of the hydraulic motor 22 moves the right-hand end of the lever further upward. In other words, the motor 22 follows the action of the governor. If, however, a sudden considerable increase in speed takes place, due to a sudden substantial drop or complete loss of load on the turbine, an increased time lag of the mechanism takes place. The left-hand end of the lever 20 is moved downward at a greater angular speed than that of the right-hand end of the lever 20 moving upward. During such condition, the pilot valve stem 34 is moved a substantial distance in downward direction, that is, out of its line-to-line position.

From another viewpoint, if the flyweights of the speed governor 16 could be directly connected to the valve 13 there would be no time lag between the movement of the governor and the valve.

The position of the valve 13 would always correspond to that of the governor. As the small force of the flyweight is not sufficient to move the heavy valve 13, a hydraulic servo-motor or power amplifier is inserted between the governor 16 and the valve 13. Such servo-motor causes a time lag between the movement of the governor 16 and the movement of the valve 13. The time lag is partly due to the fact that a certain period of time is required to displace operating fluid in the hydraulic motor 22. Clearly the time lag is a function of the acceleration or deceleration of the turbine, that is, if the governor 16 moves slowly due to a slow change in speed of the turbine the time lag will be small, and if the governor 16 changes its position rapidly there will be a greater time lag. The length of movement of the pilot valve 33 is a measure of the time lag. A greater time lag, as pointed out before, causes a correspondingly greater movement of the pilot valve.

In accordance with my invention, I provide means for by-passing elastic fluid from the turbine inlet conduit to the exhaust conduit in response to a predetermined time lag of the governing mechanism, that is, as the pilot valve for the main hydraulic motor is moved a predetermined distance away from its line-to-line position. This means comprises a by-pass conduit 50 connected between the inlet conduit 12 and the exhaust conduit 14 and including a valve 51 normally held in closed position, as shown in the drawing, by means of a hydraulic motor 52 having a piston 53 connected to the valve 51 and biased in opening direction of the valve 51 by a spring 54. The piston 53 is normally held in the position shown by fluid under pressure supplied from the aforementioned pipe 45. The hydraulic motor 52 has a drain port 55 normally closed by a valve 56, which latter is controlled by an auxiliary hydraulic motor 57 having a piston 58 connected to the valve 56 and engaged by a compression spring 59. Fluid under pressure is supplied to the motor 57 to hold the valve 56 in closed position against the biasing force of the spring 59 by a pipe 60 connected to the pipe 35 through the intermediary of an auxiliary pilot valve 61 and a pipe 62. The auxiliary pilot valve 61 has a stem 63 adjustably connected to the stem 34 of the main pilot valve and provided with valve heads 64 and 65. The valve head 64 normally uncovers partly a port connection to the pipe 60 and the pipe 62 is connected to a port between the normal position of the heads 64, 65 so that fluid under pressure may be continuously supplied from the pipe 35 through the pipe 62, the auxiliary pilot valve 61, the pipe 60 to the motor 57.

During operation, downward movement of the main pilot valve stem 34 causes similar downward movement of the auxiliary pilot valve stem 63 and its heads 64, 65. Such movement of the auxiliary pilot valve remains without effect until the distance of the movement exceeds a predetermined value, indicated by a reference numeral 66 in the drawing. As the movement exceeds this distance, the pilot valve 64 connects the pipe 60 to a drain pipe 67, thus permitting draining of operating fluid from the auxiliary motor 57 whereby the piston 58 is forced upward by the compression spring 59 to open the valve 56 and to effect draining of operating fluid from the

motor 52 causing the piston 53 of the motor to move towards the left by the action of the compression spring 54 and resulting in opening of the valve 51. With the valve 51 open, elastic fluid is conducted from the inlet conduit 12 through the bypass 50 to the exhaust conduit 14.

Thus the mechanism as described above opens automatically the bypass conduit upon the occurrence of a predetermined lag of the main governing mechanism. The arrangement also causes automatic closing of the valve 51 once it has been opened as soon as the lag of the governing mechanism is again within the predetermined value as determined by the overlap 66 between the valve head 64 and the port connection to the pipe 60, that is, as soon as the main pilot valve stem 34 is moved upward into a position as shown in the drawing fluid under pressure is again supplied through the auxiliary pilot valve and the pipe 60 to the auxiliary motor 57 to cause closing of the valve 56. With the valve 56 closed, fluid under pressure supplied from the pipe 45 to the left-hand end of the motor 52 forces the piston 53 towards the right against the biasing force of the spring 54 into closing position of the valve 51.

Thus, with my invention I have accomplished an improved construction and arrangement of elastic fluid turbines and governing mechanisms for controlling them whereby overspeeding of a turbine due to elastic fluid entrapped in the inlet conduit between the inlet valve and the turbine or due to timelag of the governing mechanism is substantially eliminated. As the timelag, that is, the lag of movement between the hydraulic motor or the throttle valve and the speed governor or the pilot valve moved thereby, exceeds a predetermined value, a valve in the bypass between the turbine inlet and exhaust conduits is automatically opened to permit the bypassing of steam with regard to the turbine. This bypass valve is automatically closed as the hydraulic motor and the turbine inlet valve reach the position called for by the controlling element or speed governor. In the preferred embodiment described above the bypass valve is normally held in closed position by a hydraulic motor having a pressure chamber indirectly controlled by an auxiliary pilot valve through the intermediary of an auxiliary motor for maintaining a drain valve in the pressure chamber in closed position. The auxiliary pilot valve has a valve head for controlling the flow of operating fluid under pressure to the auxiliary motor and normally held in out-of-line position, that is, in a position in which a port connection to the auxiliary motor is opened a distance corresponding to the maximum permissible timelag of the governing mechanism. As this timelag is exceeded said port is connected to a drain port to cause draining of oil from the auxiliary motor and quick opening of the drain valve in said pressure chamber. The permissible time lag is exceeded whenever the governing mechanism is subjected to an increase in turbine speed or a change of like operating condition of the turbine beyond a predetermined amount and in excess of a predetermined rate.

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. Elastic fluid turbine arrangement comprising an elastic fluid turbine having an inlet conduit with a valve for controlling the flow of elastic fluid thereto and an exhaust conduit for receiving fluid exhausted from the turbine, the inlet control valve being located at such a distance from the turbine inlet that a considerable amount of elastic fluid is normally entrapped in the inlet conduit, a bypass with a valve connecting said conduits, a governing mechanism for operating the inlet valve in response to speed changes of the turbine, and means associated with said governing mechanism and operative when said governing mechanism is subjected to an increase in turbine speed beyond a predetermined amount and in excess of a predetermined rate to open said bypass valve and to close said bypass valve in the absence of such increase to prevent overspeeding of the turbine due to such entrapped fluid.

2. Elastic fluid turbine arrangement comprising an elastic fluid turbine having an inlet conduit with a valve for controlling the flow of elastic fluid thereto and an exhaust conduit for receiving fluid exhausted from the turbine, a bypass with a valve connecting said conduits, a governing mechanism for operating the inlet valve in response to departure of an operating condition of the turbine from a predetermined value normally to control the flow of fluid to the turbine, means for normally holding the bypass valve in closed position, said means including a fluid pressure-operated hydraulic motor and a control valve connected to the governing mechanism and operative to cause draining of operating fluid from the hydraulic motor when said governing mechanism is subjected to a change of such operating condition beyond a predetermined amount and in excess of a predetermined rate.

3. Elastic fluid turbine arrangement comprising an elastic fluid turbine having an inlet conduit with a valve for controlling the flow of elastic fluid thereto and an exhaust conduit for receiving fluid exhausted from the turbine, a bypass with a valve connecting said conduits, a governing mechanism for operating the inlet valve in response to departure of an operating condition of the turbine from a predetermined value normally to control the flow of fluid to the turbine, the governing mechanism comprising a governor responsive to an operating condition of the turbine, a pilot valve operated by the governor, a fluid pressure-operated hydraulic motor controlled by the pilot valve and connected to the inlet valve, and means for normally holding the bypass valve in closed position and for opening the bypass valve when the governing mechanism is subjected to a change of such operating condition beyond a predetermined amount and in excess of a predetermined rate.

4. Elastic fluid turbine arrangement comprising an elastic fluid turbine having an inlet conduit with a valve for controlling the flow of elastic fluid thereto and an exhaust conduit for receiving fluid exhausted from the turbine, a bypass with a valve connecting said conduits, a governing mechanism for operating the inlet valve in response to departure of an operating condition of the turbine from a predetermined value normally to control the flow of fluid to the turbine, the governing mechanism comprising a governor responsive to an operating condition of the turbine, a pilot valve operated by the governor, a

hydraulic motor controlled by the pilot valve and connected to the turbine inlet valve, follow-up means between the pilot valve and the motor, and means for normally holding the bypass valve in closed position and for opening the bypass valve when the governing mechanism is subjected to a change of such operating condition beyond a predetermined amount and in excess of a predetermined rate, said means comprising a fluid pressure-operated hydraulic motor having a piston connected to the bypass valve and means for controlling the motor comprising an auxiliary pilot valve connected to the first mentioned pilot valve and having a port and a valve head normally in out-of-line position with the port a predetermined amount to effect displacement of fluid in the last-named motor upon movement of the first-named pilot valve in excess of said predetermined amount.

5. Elastic fluid turbine arrangement comprising an elastic fluid turbine having an inlet conduit with a valve for controlling the flow of elastic fluid thereto and an exhaust conduit for receiving fluid exhausted from the turbine, a bypass with a valve connecting said conduits, a governing mechanism for operating the inlet valve in response to departure of an operating condition of the turbine from a predetermined value normally to control the flow of fluid to the turbine, the governing mechanism comprising a governor responsive to an operating condition of the turbine, a pilot valve operated by the governor, a hydraulic motor controlled by the pilot valve and connected to the turbine inlet valve, follow-up means between the pilot valve and the motor, means for normally holding the bypass valve in closed position and for opening the bypass valve when the governing mechanism is subjected to a change of such operating condition beyond a predetermined amount and in excess of a predetermined rate, said means comprising a fluid pressure-operated hydraulic motor having a piston connected to the bypass valve and a pressure chamber with a drain port, means for conducting fluid under pressure to the pressure chamber, a valve in cooperative relation with the drain port, an auxiliary hydraulic motor for normally holding the last-named valve in closed position and an auxiliary pilot valve connected to the

main pilot valve for controlling the flow of operating fluid to the auxiliary hydraulic motor.

6. Elastic fluid turbine arrangement comprising an elastic fluid turbine having an inlet conduit with a valve for controlling the flow of elastic fluid thereto and an exhaust conduit for receiving fluid exhausted from the turbine, a bypass with a valve connecting said conduits, a governing mechanism for operating the inlet valve in response to departure of an operating condition of the turbine from a predetermined value normally to control the flow of fluid to the turbine, said governing mechanism comprising a lever having a portion connected to the inlet valve, speed-governing means connected to another portion of the lever, a hydraulic motor having a piston with a stem connected to a third portion of the lever normally to form a fixed fulcrum, means for conducting fluid under pressure to the motor, an emergency speed-governing mechanism to effect dumping of operating fluid from said motor during emergency speed condition to cause closing of the inlet valve, and means including a member connected to the governing mechanism for normally holding the bypass valve in closed position and for automatically opening the valve when the governing mechanism is subjected to an increase in turbine speed beyond a predetermined amount and in excess of a predetermined rate.

7. Elastic fluid turbine arrangement comprising an elastic fluid turbine having an inlet conduit with a valve for controlling the flow of elastic fluid thereto and an exhaust conduit for receiving fluid exhausted from the turbine, a bypass with a valve connecting said conduits, a governing mechanism for operating the inlet valve in response to departure of an operating condition of the turbine from a predetermined value normally to control the flow of fluid to the turbine, and means associated with said governing mechanism and operative when said governing mechanism is subjected to a change of such operating condition beyond a predetermined amount and in excess of a predetermined rate to open said bypass valve and to close said bypass valve in the absence of such increase.

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