Feb. 28, 1933. R. J. CAUGHEY 1,899,556

ELASTIC FLUID TURBINE

Filed Oct. 1, 1931

Fig. 1.

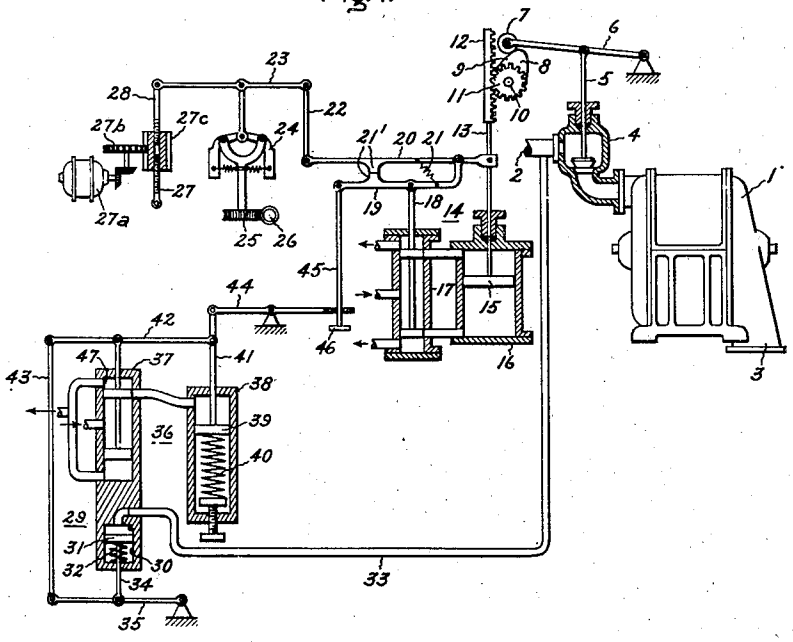
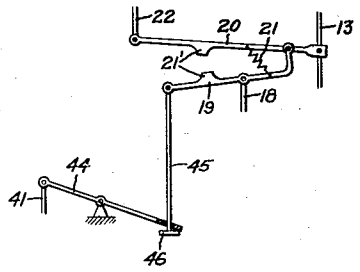


Fig. 2.



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UNITED STATES PATENT OFFICE

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ELASTIC FLUID TURBINE

Application filed October 1, 1931. Serial No. 566,292.

The present invention relates to elastic fluid turbines and particularly to the regulating mechanism for the admission valve means of such turbines.

There are cases in which turbines are supplied from a source of fluctuating elastic fluid pressure. In such cases if the admission valve of the turbine is completely opened, owing to a low fluid pressure and a high demand for elastic fluid, and the elastic fluid pressure suddenly increases it may endanger the diaphragm and the shell of the first stage of the turbine.

The object of my invention is to provide an improved regulating mechanism for turbines operating from a source of fluctuating pressure which serves to safeguard or protect the diaphragm and the shell of the first stage of the turbine from excessive pressure.

For a consideration of what I believe to be novel and my invention, attention is directed to the following specification and the claims appended thereto.

In the drawing, Fig. 1 is a diagrammatic view of a turbine equipped with a regulating mechanism embodying my invention, Fig. 2 is a part of the lever mechanism, shown in Fig. 1, in a different operative position.

Referring to the drawing, 1 designates by way of example an elastic fluid turbine having an inlet 2 and an exhaust 3. Provided in the inlet is a valve 4 for regulating the admission of elastic fluid having its stem 5 connected to a lever 6, which in turn is fulcrumed at one end and has provided on its other end a roller 7 resting on a cam 8. The latter has a surface 9 which may be termed a valve opening surface and is carried by a shaft 10 on which is mounted a pinion 11 meshing with a rack 12 on the rod 13 of a fluid actuated motor 14. 15 indicates the piston of the fluid actuated motor, slidably arranged in a cylinder 16 and secured to the lower end of stem 13. 17 is the controlling means for the motor, in the present instance shown as an ordinary pilot valve. The motor for moving valve 4 has been shown by way of example as a hydraulic relay, which operates as follows: If the pilot valve is moved upwardly, oil or like fluid is forced into the upper part of cylinder 16 and drained off from the lower part thereof to the effect that piston 15 moves downward. This causes a corresponding movement of the pilot valve whereby the latter resumes its original position. When piston 15 moves downwardly the cam 8 is turned in a counter-clockwise direction whereby it opens the admission valve 4. Stem 18 of the pilot valve is connected to a floating lever 19 which in turn is pivoted to another floating lever 20 and has a yielding support formed by a spring 21 connected to intermediate points of levers 19 and 20. The spring normally causes the two levers to move together. Each of the levers has a projection 21′ which latter normally engage each other. The projections 21′ are separated from each other when the upward movement of lever 20 or the downward movement of lever 19 exceeds a certain value, as shown in Fig. 2, and described hereafter. The left-hand end of floating lever 20 is connected by means of a link 22 to another floating lever 23. A governor, in the present instance shown as a flyweight governor 24, driven by a worm gear 25 from the shaft 26 of the turbine is connected to an intermediate point of lever 23. The left-hand end of lever 23 may be connected to a synchronizing arrangement comprising a motor 27*a*, a gear 27*b* engaging a double-threaded nut 27*c* provided on screw-threaded rods 27 and 28 the latter of which is pivoted to floating lever 23.

The lower end of threaded rod 27 may be fulcrumed on a fixed support or connected to other control means, not shown in the drawing. During operation of the synchronizing motor 27*a* the nut 27*c* is rotated whereby rods 27 and 28 move towards or away from each other depending on the direction of rotation of the motor. It will be

clearly seen that the up or downward movement of rod 28 causes setting of the speed governor in a manner well known in the art.

The mechanism so far described may be considered as typical of any control system for regulating the supply of elastic fluid to a turbine in response to load conditions.

The operation of this mechanism is briefly as follows; if the speed of the turbine increases, for instance, owing to a decrease in load, the flyweights of governor 24 move outwardly to the effect that the right-hand end of floating lever 23 moves downwardly. This causes downward movement of the left-hand ends of floating levers 19 and 20 and of pilot valve stem 18 to permit oil or like fluid to be pressed into the lower part of cylinder 16 and drained off from the upper part thereof, resulting in a closing movement of valve 4 as described above.

If the load of the turbine increases it will cause a decrease in speed and accordingly an inward movement of the governor flyballs, resulting in a movement of the lever mechanism in an opposite direction with the effect that valve 4 is opened.

According to my invention I provide additional means for initiating a closing movement of valve 4 when a sudden increase in steam pressure occurs while the turbine is being supplied with low pressure elastic fluid and the valve is in balanced condition with respect to the speed governor position. This has been shown in the present instance as a pressure responsive device 29 comprising a cylinder 30, a piston 31 freely movable therein and normally forced in upward direction by a spring 32; the upper part of the cylinder being connected by means of a pipe 33 to the inlet of the turbine ahead of admission valve 4 as regards the direction of flow. Piston 31 is provided with a slidable stem 34 which in turn is connected to fulcrumed lever 35, the left-hand end of which may be connected directly to floating lever 19 or, as shown in the present instance, through the intermediary of a fluid actuated motor 36 comprising a pilot valve 37 of which the cylinder is shown as being integrally formed with cylinder 30 of the pressure responsive device and a hydraulic cylinder 38 having a piston 39 freely movable therein and normally forced upwardly by an adjustable spring 40. Piston stem 41 is connected to the right hand end of a floating lever 42 having an intermediate point connected to the stem of pilot valve 37 and its left hand end connected by means of a link 43 to the fulcrumed lever 35. Stem 41 is also connected to a fulcrumed lever 44 having its right hand end slidably arranged with respect to a link 45 pivoted to floating lever 19. Link 45 has an abutment 46 located beneath the right hand end of floating lever 44 thus forming a lost motion connection between the pressure responsive device and the lever mechanism 19, 20.

The operation of the pressure responsive device in connection with the fluid actuated motor 36 is as follows: If the pressure ahead of admission valve 4 increases it causes a corresponding increase of pressure in the upper part of cylinder 30 of the pressure responsive device, thus forcing piston 31 downward and causing a downward movement of pilot valve 47 which thereby permits oil to be drained off from the upper part of hydraulic cylinder 38, resulting in an upward movement of stem 41 to the effect that the lost motion connection formed by the right hand end of lever 44 and rod 45 causes downward movement of the left hand end of the floating lever 19, as shown in Fig. 2. This causes an actuation of fluid actuated motor 14 to move valve 4 downward. A dangerous increase of pressure in the first stage of the turbine is thereby prevented. It will be seen that the pressure regulating mechanism does not affect the speed governor position. If however, the valve 4 is near closed position, no actuation by the pressure responsive device 29 would occur owing to the fact that in this case the right hand end 44 is too far away from the abutment 46, and accordingly no engagement between both can take place. Thus the protecting means including the pressure responsive device is inoperative at loads below a predetermined value, but causes closing of the valve at loads exceeding said value. The lost motion connection which is a part of the protecting means forms in substance a means for preventing the pressure responsive device from closing the valve at loads below a predetermined value.

On the other hand, if a sudden decrease in pressure of elastic fluid occurs, an actuation of the pressure responsive device will be caused in a direction to move the right hand end of lever 44 upward. This will allow a movement of the pilot valve 18 only if the projections 21′ of levers 19 and 20 are out of engagement. In this case the upward movement of the right hand end of lever 44 permits spring 21 to turn the left hand end of floating lever 19 upwardly until the projections 21′ engage each other. The pilot valve thereby is moved upward and causes opening movement of main valve 4 to the effect that an increase of flow of elastic fluid takes place.

In this manner my arrangement for protecting the first stage of an elastic fluid turbine serves also as a means for maintaining the load of the turbine substantially constant. This is particularly advantageous in all cases where the turbine drives an electric generator operating in parallel with other generators connected to a line of constant frequency as it avoids the transfer of load from the turbine supplied from a source of fluctuating pressure

to other turbines or like prime movers for driving said other generators.

Regarding the operation of the arrangement in response to changes of speed governor position, it will be readily seen that the speed governor may always effect a closing movement of valve 4. In these cases the left-hand end of lever 20 is turned downward, forcing lever 19 in the same direction if the projections 21′ engage each other, resulting in a downward movement of the pilot valve 18. If projections 21′ are out of engagement, as indicated in Fig. 2, the downward movement of lever 20 will at first be without effect on the pilot valve.

If however, the speed governor position changes in a direction to call for an opening of valve 4, whereby the left hand end of lever 20 is turned in an upward direction, the lever 19 will only follow this movement and thereby cause an upward movement of the pilot valve if the abutment 46 is out of engagement with the right hand end of fulcrumed lever 44. In case the abutment 46 engages lever 44 no upward movement of the pilot valve can take place. This is important whenever the admission valve is substantially opened and the speed governor calls for a further opening movement. With my protective arrangement such movement can only take place if the elastic fluid pressure does not exceed a predetermined value. In other words, the pressure responsive device has full control over the turbine and prevents opening of the admission valve under conditions where an increase of flow of fluid may endanger the shell and diaphragm of the first stage. The right hand end of lever 44 may therefore be considered as an adjustable means for stopping the opening travel of the lever mechanism caused by the action of the speed governor. With opening travel I mean a movement of levers 19, 20 in which they cause further opening of valve 4. The pressure responsive device 29 and the hydraulic motor 36 then form a means for automatically adjusting the stop formed by the right hand end of lever 44 in terms of elastic fluid pressure conditions ahead of valve 4 as regards the direction of flow.

With my invention I have accomplished a simple and reliable arrangement for protecting elastic fluid turbines against elastic fluid pressures in the first stages thereof.

Having described 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. The combination with an elastic fluid turbine having an admission valve to which an elastic fluid of fluctuating pressure is supplied, and a speed governor for controlling the valve, of additional means inoperative at loads below a predetermined value for closing the valve at loads exceeding said value without affecting the speed governor position in terms of increase in pressure of the elastic fluid supplied to the valve.

2. The combination with an elastic fluid turbine having an admission valve, means for supplying an elastic fluid of fluctuating pressure to the valve, and a speed governor for controlling the valve in terms of load conditions, of means comprising a pressure responsive device subjected to the pressure of elastic fluid ahead of the valve as regards the direction of flow for closing the valve in response to increase in fluid pressure and another means for preventing the pressure responsive device from closing the valve at loads below a predetermined value.

3. The combination with an elastic fluid turbine having an admission valve, means for supplying elastic fluid of fluctuating pressure to the valve, a lever mechanism, and a speed governor for controlling the valve in terms of load conditions, of means comprising a pressure responsive device subjected to the pressure of elastic fluid ahead of the valve as regards the direction of flow and a lost motion connection between the lever mechanism and the pressure responsive device for moving the valve in terms of pressure whereby dangerous fluid pressure in the first stage of the turbine is prevented.

4. The combination with an elastic fluid turbine having an admission valve, means for supplying elastic fluid of fluctuating pressure to the valve, a speed governor, a lever mechanism for normally moving the valve in terms of speed governor movement, of means comprising a pressure responsive device subjected to the pressure of elastic fluid ahead of the valve as regards the direction of flow, a rod having a stop and being pivotally connected to the lever mechanism, and a lever moved by the pressure responsive device and engaging said stop if the pressure increases beyond a certain value whereby movement of the lever mechanism and the valve may be caused in terms of elastic fluid pressure.

5. The combination with an elastic fluid turbine, a valve for controlling the admission of elastic fluid to the turbine, a motor for moving the valve, a control means for the motor, of a pressure responsive device connected to the inlet of the turbine, another motor actuated by the pressure responsive device, and means for transferring the movement of said other motor to said first mentioned motor comprising a fulcrumed lever and a link having an abutment and being slidably engaged by one end of the fulcrumed lever.

6. The combination with an elastic fluid

turbine having an admission valve, means for supplying elastic fluid of fluctuating pressure to the valve, a speed governor, and a lever mechanism for normally causing movement of the valve in terms of speed governor movement, of adjustable means for stopping the opening travel of the lever mechanism, and means for automatically adjusting the last named means in terms of elastic fluid pressure conditions ahead of the valve as regards the direction of flow.

In witness whereof, I have hereunto set my hand.

REED J. CAUGHEY.