May 17, 1927. 1,629,319

R. G. STANDERWICK

REGULATING MEANS FOR ELASTIC FLUID TURBINES

Filed Nov. 28, 1925

Fig. 1.

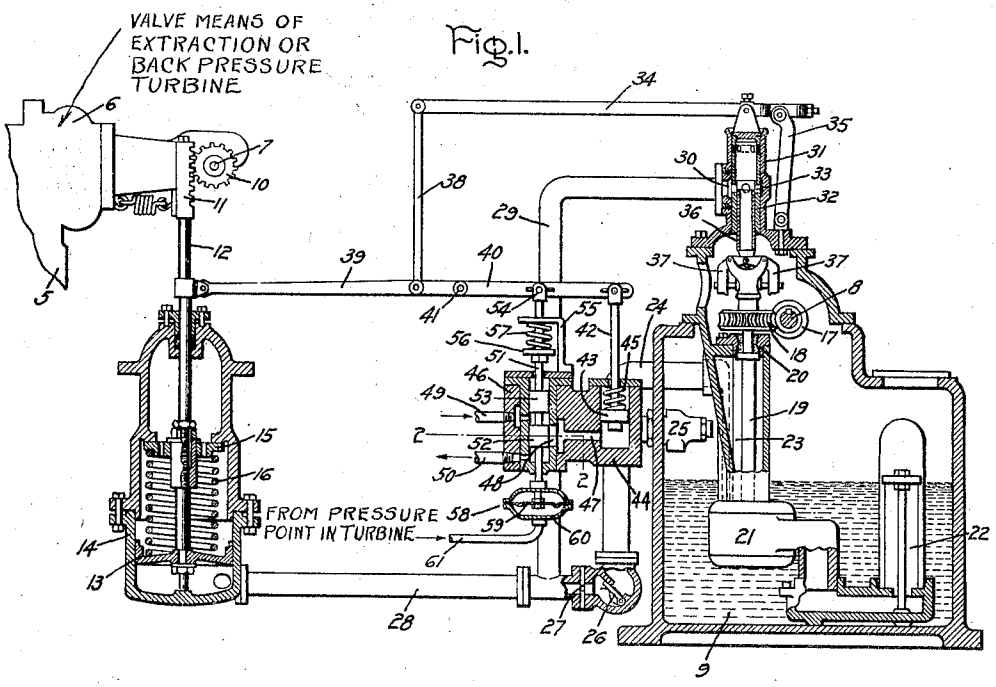
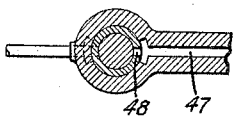


Fig. 2.



Inventor:
Reginald G. Standerwick,
by Alexander S. Lunt
His Attorney.

Patented May 17, 1927. 1,629,319

UNITED STATES PATENT OFFICE.

REGINALD G. STANDERWICK, OF MARBLEHEAD, MASSACHUSETTS, ASSIGNOR TO GENERAL ELECTRIC COMPANY, A CORPORATION OF NEW YORK.

REGULATING MEANS FOR ELASTIC-FLUID TURBINES.

Application filed November 28, 1925. Serial No. 72,056.

The present invention relates to elastic fluid turbines, and is especially well adapted for use in connection with elastic fluid turbines which supply elastic fluid for industrial purposes or for feed water heating purposes, and wherein the supply of elastic fluid to the turbine is controlled by the demand for elastic fluid for industrial or feed water heating purposes. It is not limited to use with such turbines however. In such turbines, the elastic fluid supplied for industrial purposes or for feed water heating purposes may be taken from an intermediate stage of the turbine or it may be the exhaust from the last stage of the turbine, the turbine, when operated in the latter way, being termed usually a back pressure turbine.

The demand for elastic fluid for industrial purposes or feed water heating purposes may be gauged by measuring the pressure of the elastic fluid supplied, since the pressure increases when the demand decreases, and decreases when the demand increases. With such arrangements, therefore, it is desired to maintain the elastic fluid supplied for industrial purposes or for feed water heating purposes at a constant pressure. To this end, a pressure-responsive device is connected to the valve gear of the turbine in a manner such that when the pressure to which the pressure-responsive device is subjected increases, it functions to diminish the amount of elastic fluid being supplied to the turbine, while when the pressure to which the pressure-responsive device is subjected decreases, it functions to increase the amount of elastic fluid supplied to the turbine. In other words, the turbine is regulated with the purpose in view of maintaining the pressure in the extraction stage or the pressure of the exhaust at a constant value. However, with ordinary pressure-regulating means this has not been accomplished because it has been necessary to provide a certain range in pressure between no extraction and full extraction on the turbine (i. e., a certain width of regulation), in order to ensure stable governing.

The object of my invention is to provide an improved pressure-regulating means whereby in a turbine regulated in accordance with pressure, I am enabled to maintain the pressure constant and at the same time provide stable governing, and for a consideration of what I believe to be novel and my invention, attention is directed to the accompanying description and the claims appended thereto.

In the drawing, Fig. 1 is a diagrammatic view of a regulating means embodying my invention, and Fig. 2 is a detail sectional view taken on line 2—2, Fig. 1.

Referring to the drawing, 5 indicates the admission end of an elastic fluid turbine to which elastic fluid is supplied by suitable valve means 6 which is opened and closed by turning movements of a cam shaft 7. The valve means and the cam arrangement for operating it may be of the same general type as that shown in the patent to E. D. Dickinson and myself, No. 1,560,416, granted November 3, 1925. The turbine shaft is indicated at 8 and the oil tank is indicated at 9. The illustration of the turbine in Fig. 1 is wholly diagrammatic. The turbine casing 5 and the shaft 8 are not shown in correct relation to each other but the turbine casing is brought around into the plane of the paper in order to illustrate more clearly the arrangement of the governing mechanism and its connection to the turbine valve gear. On the end of cam shaft 7 is a pinion 10 which meshes with a rack 11 formed on the upper end of a rod 12. The lower end of rod 12 is connected to a piston 13 which slides in a suitable cylinder 14. Arranged between the upper side of piston 13 and a spring plate 15 is a spring 16 which biases piston 13 toward the lower end of cylinder 14 and the valve gear 5 toward closed position. With the piston in the position shown in Fig. 1 of the drawing, the valve means is partly open. The arrangement is such that when piston 13 moves upward it opens valve means 6 and when it moves downward it effects the closing of the valve means. Any suitable valve means may be used in connection with my invention, the arrangement

indicated being shown only by way of example.

On turbine shaft 8 is a worm 17 which meshes with a worm wheel 18 mounted on a vertical shaft 19. Shaft 19 is mounted in suitable bearings, one of which is indicated at 20, and at its lower end is connected to drive an oil pump 21 located in tank 9. The pump 21 takes oil from tank 9 through a suitable intake strainer 22 and delivers oil through a conduit 23 to a pipe 24. Connected to pipe 24 is a pressure relief valve 25 which discharges back to tank 9 and which is set to maintain essentially constant in pipe 24 a certain desired pressure.

Pipe 24 delivers oil through a non-return valve 26 and an orifice 27 to a pressure pipe 28 and a bypass pipe 29 which branches therefrom. Since there is essentially constant pressure in pipe 24 oil will be delivered through orifice 27 to pipes 28 and 29 always at a definite rate depending upon the pressure existing in such pipes. Pipe 28 is connected to cylinder 14 beneath piston 13 and conveys pressure to the underside of the piston for effecting operation of valve means 6. By-pass pipe 29 is connected to an annular chamber 30 in the inner wall of a pilot valve casing 31. In casing 31 is a bushing or sleeve 32 provided with ports 33 located in alignment with chamber 30. Bushing 32 extends throughout the length of casing 31 and is connected at its upper end to a lever 34 which is fulcrumed on the upper end of an arm 35 which in turn is pivotally supported on a flange at the base of pilot valve casing 30. Inside the bushing or sleeve 32 is a pilot valve member 36 which is in the form of a tube or sleeve and is connected at its lower end to the weight arms 37 of a centrifugal speed governor so as turn therewith. For the purpose of this diagrammatic illustration, I have shown the weight arms 37 pivotally connected directly to the lower end of pilot valve tube 36. This direct connection or any other suitable connecting arrangement may be used. In actual practice, I prefer to use the specific arrangement disclosed in the application of E. D. Dickinson, Serial No. 692,615, filed February 13, 1924. The speed governor is connected to and is driven by shaft 19 whereby it is rotated at a speed proportional to the speed of the turbine. With this arrangement pilot valve tube 36 rotates with the speed governor. The upper end of pilot valve tube 36 terminates adjacent to chamber 30 and serves to cover it to a greater or lesser extent. When the speed increases, the pilot valve tube is lowered in bushing 32 to uncover chamber 30 and when the speed decreases the pilot valve tube is raised in bushing 32 to cover chamber 30.

Lever 34 is connected by a link 38 to a lever 39 which at its left hand end is pivotally connected to rod 12. The other end of lever 39 is fulcrumed on the end of a lever 40, the fulcrum point being indicated at 41. The other end of lever 40 is connected to a stem 42 which at its lower end is connected to a piston 43. Piston 43 is mounted in a cylinder 44 and is biased toward the lower end of the cylinder by a spring 45. Adjacent cylinder 44 is a pilot valve structure comprising a casing 46 connected to cylinder 44 beneath piston 43 by a passage 47. Passage 47 connects with the interior of pilot valve casing 46 through a narrow elongated slot 48. Connected to pilot valve casing 46 is a supply conduit 49 and a discharge conduit 50. Conduit 49 may be connected at any suitable supply of fluid pressure and conduit 50 may lead to any suitable discharge point.

In pilot valve casing 46 is a stem 51 upon which is mounted a valve 52 which is of a length such that it normally covers exactly elongated slot 48. Also the stem 51 has an enlargement 53 which fits pilot valve casing 46 to prevent leakage of oil in an upward direction. The upper end of stem 51 is connected to lever 40 as is indicated at 54. Adjacent stem 51 is a stationary bracket 55 having an opening through which stem 51 passes freely and arranged between bracket 55 and a collar 56 on stem 51 is a spring 57 which exerts a pressure downward on stem 51. The lower end of stem 51 is connected to a pressure responsive device 58 which may be of any suitable type. In the present instance it is shown as being in the form of a diaphragm 59 mounted between the halves of a casing 60. Connected to casing 60 beneath diaphragm 59 is a pipe 61 which is connected to the region wherein the pressure is to be maintained constant. In the case of a back pressure turbine this is the exhaust conduit of the turbine. The underside of diaphragm 59 is thus subjected to the pressure of the fluid, the pressure of which is to be maintained constant.

In operation, assuming that turbine 5 is tied in with other turbines on the same line, the speed of the turbine will be set by that of the other machines, (i. e., by the frequency of the system), and speed governor 37 will assume a certain definite position corresponding to the speed defined by the system and will position pilot valve sleeve 36 at a certain definite point. Also, assuming a certain definite opening of valve means 6, then pilot valve bushing 32 will be in a definite position corresponding to such opening. And, also, assuming that the pressure in the region to which pipe 61 is connected is of the desired value, then pilot valve 52 will stand in a position wherein it covers exactly slot 48, and piston 43 will have assumed a certain definite position in cylinder 44. Piston 13 will have a certain position in cyl-

inder 14 corresponding to the opening of valve means 6.

With the turbine running, pump 21 supplies oil through pipe 24 and orifice 27 to pressure pipe 28 and bypass pipe 29. The maximum pressure of the oil in pipe 24 is fixed at a definite value by pressure relief valve 25 so that oil is supplied to pipes 28 and 29 at a definite pressure. Oil escapes continuously from pipe 29 through chamber 30 to the interior of pilot valve casing 31 from whence it runs down through tubular pilot valve sleeve 36 to tank 9. The pressure in pipe 28 and hence that to which piston 13 is subjected depends directly upon the rate at which oil is bypassed through pipe 29 and this in turn depends directly upon the extent to which chamber 30 is uncovered. The extent to which chamber 30 is uncovered depends upon the relative positions of pilot valve sleeve 36 and pilot valve bushing 32, and since the position of pilot valve sleeve 36 is fixed, due to the speed of the turbine being fixed by other machines with which it is tied in, the amount which the ports are uncovered becomes dependent upon the position of the bushing 32 only.

If now the pressure in the region to which pipe 61 is connected increases, due for example in the case of a back pressure or extraction turbine to a decrease in the demand for elastic fluid the pressure under diaphragm 59 will increase and the diaphragm will be raised, thereby raising pilot valve 52. When this takes place, lever arm 40 will be turned on the upper end of stem 42 as a fulcrum and through link 38 and lever 34 will raise pilot valve sleeve 32 in casing 31, lever 34 pivoting on the end of link 35. This will effect a further uncovering of chamber 30 thereby permitting the more rapid escape of fluid from conduit 29 and 28. As a result, the pressure under piston 13 will be decreased, permitting spring 16 to force piston 13 downward, thereby closing off somewhat the valve means 6. This will serve to decrease the amount of elastic fluid supplied to turbine 5 and hence the pressure of the elastic fluid in the region to which pipe 61 is connected. When piston 13 moves downward, it carries with it the left hand end of lever 39 and through link 38 lowers the left hand end of lever 34 and pilot valve sleeve 32, thus serving to move sleeve 32 down toward its original position. Also, as soon as the pressure in the region to which pipe 61 is connected decreases, spring 57 will force pilot valve 52 downward toward its original position. This movement also, through lever 40, lever 39, link 38 and lever 34 serves to move sleeve 32 down toward its original position. There are thus two separate movements tending to restore sleeve 32 and the result of the two, ordinarily, would be to restore sleeve 32 not to its original position, but to a position slightly higher than its original position because of the new position taken by piston 13. This would correspond to a pressure on diaphragm 59 somewhat higher than before. However, it is desired to restore diaphragm 59 to exactly its original position since this would mean that the pressure was then exactly the same as before. This result is accomplished by the following means: when diaphragm 59 moves upward, pilot valve 52 uncovers elongated slot 48 to a certain extent which permits fluid to escape from beneath piston 43, whereupon piston 43 is moved downward by spring 45 thus lowering the right hand end of lever 40 and hence raising its left hand end, which means that pivot point 41 is raised. When pivot point 41 is raised, it lifts sleeve 32 through the intermediary of link 38 and lever 34, and this reacts on piston 13 to effect a further closing movement of valve means 6 which serves to lower further the pressure in the region to which pipe 61 is connected. This action takes place until pilot valve 52 again exactly covers elongated slot 48.

When the pressure under diaphragm 59 decreases, due, for example, in the case of an extraction or back pressure turbine, to an increase in the demand for elastic fluid, the diaphragm will be lowered, thereby moving pilot valve 52 downward. The action already described, except that it takes place in the opposite direction, then occurs, the net result being a repositioning of valve means 6 to admit additional elastic fluid sufficient to restore the pressure to its original value again.

As will be clear in either case, equilibrium cannot be restored until pilot valve 52 again exactly covers elongated slot 48, and since it can only cover it when the pressure in the region to which pipe 61 is connected is at the desired value, it follows that the resultant of the regulating movements is the positioning of valve means 6 so that the amount of steam supplied to the turbine will be such as to maintain the pressure in the region to which pipe 61 is connected at the desired value.

The connection of lever 39 to rod 12 forms a usual type of follow-up or restoring connection for the valve gear. The mechanism comprising piston 43 and pilot valve 52 forms what may be termed a correcting mechanism or device since it corrects for what is the usual operating range of the governor between no load and full load. It is desirable that this correcting mechanism should lag behind the follow-up mechanism in its operation to insure the stability of the governing. To accomplish this, slot 48 is made long and comparatively narrow so that the flow through it will be slow and hence the action of piston 43 retarded.

Speed governor 37 is normally inactive so far as controlling the turbine is concerned, since the speed of the turbine is fixed due to its being tied in with other machines. However, when conditions require it, it can come into action and take control of the machine.

In accordance with the provisions of the patent statutes, I have described the principle of operation of my invention, together with the apparatus which I now consider to represent the best embodiment thereof, but 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 a turbine which supplies elastic fluid from a region beyond its admission end, of valve means which is operated to maintain the pressure in said region constant, a fluid-actuated motor including a pilot valve for moving the valve means, a movable member responsive to the pressure in said region, means including a follow-up connection connecting the movable member to the fluid-actuated motor and pilot valve, a pressure correcting motor, and means for effecting movement of the correcting motor to modify the action of said movable member on the valve means.

2. The combination with an elastic fluid turbine, of valve means which is operated to maintain constant the pressure in a region beyond the admission end of the turbine, a fluid-actuated motor including a pilot valve for moving the valve means, a movable member responsive to the pressure in said region, means connecting it to the pilot valve, a follow-up connection for the pilot valve, and correcting means which operates the pilot valve to effect movement of the valve means to maintain the pressure always at the same value.

3. The combination with an elastic fluid turbine, of valve means which is operated to maintain constant the pressure in a region beyond the admission end of the turbine, a fluid-actuated motor including a pilot valve for moving the valve means, a movable member responsive to the pressure in said region, means connecting it to the pilot valve, a follow-up connection for the pilot valve, and means controlled by the position of the movable member for effecting movement of the pilot valve whenever the movable member occupies a position other than that corresponding to the desired constant pressure.

4. The combination with an elastic fluid turbine, of valve means which is operated to maintain constant the pressure in a region beyond the admission end of the turbine, a fluid-actuated motor including a pilot valve for moving the valve means, a movable member responsive to the pressure in said region, means connecting it to the pilot valve comprising a lever forming a follow-up connection for the pilot valve and a second lever pivotally connected to the first lever, and a pressure correcting motor connected to the second lever.

5. The combination with a turbine having means for controlling the admission of elastic fluid thereto, of a pressure responsive device for effecting regulation of said controlling means, and means operative when the pressure-responsive device occupies a position other than that corresponding to a desired pressure for effecting supplementary movement of said controlling means.

6. The combination with a turbine having valve means for controlling the admission of elastic fluid thereto, of a fluid-actuated motor including a pilot valve for moving the valve means, a pressure-responsive device, means connecting it to the pilot valve to effect movements of the pilot valve for actuating the valve means, and means controlled by the pressure-responsive device for effecting supplementary movements of the pilot valve when the pressure-responsive device occupies a position other than that corresponding to the desired pressure.

7. The combination with a turbine having valve means for controlling the admission of elastic fluid thereto, of a fluid-actuated motor including a pilot valve for moving the valve means, a pressure-responsive device, means connecting it to the pilot valve to effect movement of the pilot valve for actuating the valve means, a fluid-actuated motor connected to the pilot valve, and means for admitting actuating fluid thereto whenever the pressure-responsive device occupies a position other than that corresponding to the desired pressure.

8. The combination with a turbine having elastic fluid controlling means, of a pressure responsive device for effecting regulation of said controlling means, and means operative when the pressure-responsive device occupies a position other than that corresponding to a desired pressure for effecting supplementary movement of said controlling means.

9. The combination with a turbine which supplies elastic fluid from a region beyond its admission end, of valve means controlling the flow of such elastic fluid, a fluid-actuated motor including a pilot valve for moving the valve means, a movable member responsive to a condition appurtenant to said fluid, means including a follow-up connection connecting the movable member to the fluid-actuated motor and pilot valve, a correcting motor, and means for effecting movement of the correcting motor to modify the action of said movable member on the valve means.

10. The combination with a turbine which supplies elastic fluid from a region beyond

its admission end, of valve means controlling the flow of such elastic fluid, a movable member responsive to a condition appurtenant to such fluid for effecting regulation of said valve means to maintain such condition at a constant value, and means operative when said movable member occupies a position other than that corresponding to the desired value for said operating condition for effecting supplementary movement of said valve means.

In witness whereof, I have hereunto set my hand this 24th day of November 1925.

REGINALD G. STANDERWICK.