May 8, 1928. 1,669,108

D. F. WARNER

GOVERNING MECHANISM FOR ELASTIC FLUID TURBINES

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Fig. 1.

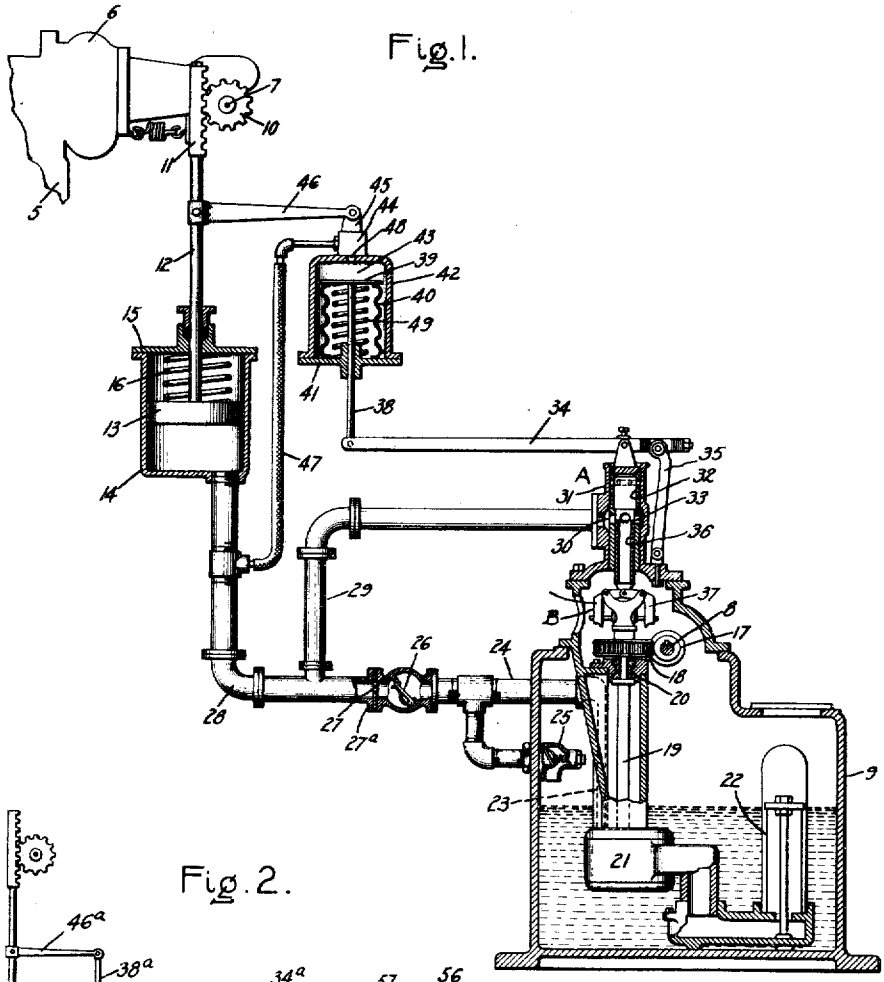
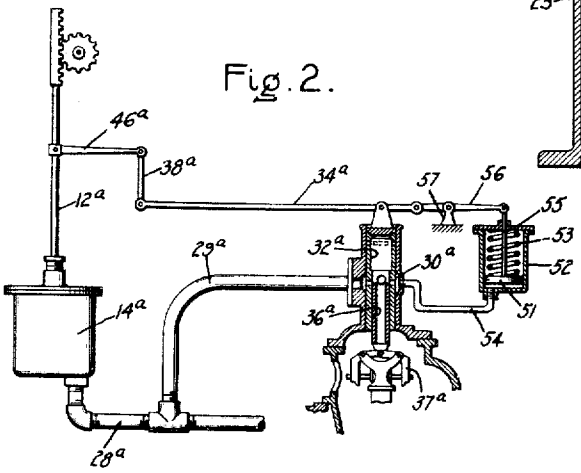


Fig. 2.



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UNITED STATES PATENT OFFICE.

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GOVERNING MECHANISM FOR ELASTIC-FLUID TURBINES.

Application filed September 13, 1926. Serial No. 134,952.

The present invention relates to governing mechanisms for controlling the speeed of prime movers, such as elastic fluid turbines and the like, and especially to governing mechanisms of the type known generally as single actuating governing mechanisms, it being understood that by such governing mechanisms I mean those wherein the valve means which controls the admission of operating fluid to the prime mover is positioned by fluid pressure acting against a biasing force, such as the force of a spring. In such governing mechanisms, the amount of valve opening is determined by the value of the fluid pressure which in turn is controlled by a primary governor, such as a speed governor.

In connection with the operation of a valve mechanism of this type, there is a definite fluid pressure for every load on the machine, i. e., for every valve opening, and for theoretically perfect operation, whenever the load changes thereby bringing the primary governor into action to effect a change in the fluid pressure, the governing mechanism should respond instantly to the change in fluid presure to modify the position of the valve means. However, in actual practice, it is found that due to inherent characteristics of the governing mechanism, such as, for example, friction and reaction of the elastic fluid on the valve means, the valve means will not respond immediately to small pressure changes but on the other hand requires sufficient pressure change to overcome the friction and other effects tending to hold the parts to be moved against movement. For example, suppose the valve means is operating at a point which requires a pressure of a certain value to maintain it in the desired position and that the friction effect and other effects at this point are such that a change in pressure of + or − "X" lbs. is required in order to effect movement of the parts to be moved. This means, therefore, that the pressure must change by an amount equal to "X" lbs. before any correcting effect by the governing means will take place. As a result, therefore, there is a gap or speed range over which the governor has no control of the valve gear motion and hence there exists a tendency to require a too great speed change on the part of the primary governor before the valve means operates.

The object of the present invention is to provide an improved construction and arrangement of governing mechanism whereby the change required on the part of the primary governor to effect operation of the valve means is materially reduced, 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 the invention, and Fig. 2 is a similar view showing a modification.

Referring to the drawing, 5 indicates the admission end of an elastic fluid turbine to which elastic fluid is supplied by a suitable valve means 6 which is opened and closed by turning movements of a cam shaft 7. The valve means and cam arrangement for operating it may be of the same general type as that shown in the patent to E. D. Dickinson and R. G. Standerwick, No. 1,560,416, dated November 3, 1925, or it may be of any other suitable type. The turbine shaft is indicated at 8 and the oil tank is indicated at 9. The illustration of the turbine and regulating means 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 governor 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 the cover plate 15 of cylinder 14 is a spring 16 which biases piston 13 toward the lower end of cylinder 14 and the valve means 6 toward closed position. With the piston in the position shown in 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 illustrated being 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 it is connected to drive an oil pump 21 located in tank 9. Oil 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 in pipe 24 a certain desired pressure.

Pipe 24 delivers oil through a non-return valve 26 and an orifice 27 in a plate 27ª to a pressure pipe 28 and a bypass pipe 29 which branches therefrom. Since there is essentially a 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. Bypass pipe 29 is connected to a pilot valve structure A comprising an annular chamber 30 in the inner wall of pilot valve casing 31. In casing 31 is a bushing or sleeve 32 provided with holes 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 31. Inside bushing or sleeve 32 is a pilot valve 36 which is in the form of a tube or sleeve and is connected at its lower end to the weight arms 37 of centrifugal speed governor B so as to turn therewith. This speed governor is the primary governor for the turbine. For the purpose of this diagrammatic illustration, I have shown weight arms 37 pivotally connected directly to the lower end of pilot valve 36. This direct connection or any other suitable connection may be used. In actual practice, I prefer to use the specific arrangement disclosed in the application of E. D. Dickinson, Sr. 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 36 rotates with the speed governor. The upper end of pilot valve 36 terminates adjacent to the top edge of holes 33 which communicate with annular chamber 30 and serves to cover such holes to a greater or lesser extent. When the speed increases the pilot valve is lowered in bushing 32 to uncover holes 33, and when the speed is decreased, the pilot valve is raised in bushing 32 to cover holes 33. Lever 34 is connected by a rod 38 to a plate 39 which forms the upper end of a bellows structure 40. The lower end of bellows structure 40 is connected to a base plate 41 with a fluid-tight connection. Rod 38 extends loosely through the opening in base plate 41. Mounted on base plate 41 is a casing 42 which forms with the base plate a sealed chamber 43 in which bellows 40 is located. The upper end of casing 42 is provided with a hollow coupling 44 having an ear 45 to which is pivotally connected one end of an arm 46, the other end of arm 46 being rigidly connected to rod 12. Chamber 43 is connected to pressure pipe 28 by a suitable flexible connection 47, the connection to chamber 43 being through hollow coupling 44 and a suitable opening 48. With this arrangement, it will be seen that bellows 40 is subjected at its upper end to the pressure existing in pipe 28 which is the pressure applied to piston 13. Inside bellows 40 is a spring 49 which opposes collapsing of the bellows. The pressure in chamber 43, acting on bellows 40 and tending to collapse it, is balanced by the bellows and by spring 49 so that at a certain pressure plate 39 occupies a definite position in casing 42. When the pressure in chamber 43 increases, plate 39 will be moved downward thus lowering the left hand end of lever 34 and hence pilot valve sleeve 32 and when the pressure in chamber 43 decreases, plate 39 will be moved upwardly thus raising the left hand end of lever 34 and pilot valve sleeve 32. This movement of plate 39, lever 34, and sleeve 32 due to changes in pressure, it will be seen, is effected independently of casing 44 and lever arm 46.

With the above described arrangement, when the turbine is running pump 21 supplies oil through pipe 24 and orifice 27 to pressure pipe 28 and bypass pipe 29. The 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 ports 33 to the interior of pilot valve casing 31 from whence it runs down through tubular pilot valve 36 to tank 9. The pressure in pipe 28 and hence that to which piston 13 is subjected depends directly on the rate at which oil is bypassed through conduit 29 and this in turn depends directly upon the extent to which ports 33 are uncovered. The extent to which ports 33 are uncovered depends upon the relative position of pilot valve 36 to pilot valve bushing 32.

Assume that the turbine is running, piston 13 being held in a certain position by the oil pressure in pipe 28 so as to hold the valve means open to a certain extent and that due to an increase in load the speed of the turbine decreases. When this occurs the governor weights 37 move inwardly somewhat. This raises tubular pilot valve 36 relatively to sleeve 32, thereby covering to a greater extent ports 33. This decreases the

rate at which oil can escape through bypass pipe 29, with the result that the pressure in pipe 28 increases. The increased pressure is applied to the lower side of piston 13 raising it somewhat to open further valve means 6, thereby admitting additional elastic fluid to the turbine in an effort to restore it to its former speed.

When the pressure in pipe 28 increases, the increased pressure is applied to bellows 40 serving to collapse it somewhat against the action of spring 49. This serves to move the left hand end of lever 34 downwardly, thereby lowering pilot valve sleeve 32 and closing further the ports 33. Thus it will be seen that as soon as pilot valve 36 moves upwardly and the pressure in conduit 28 begins to increase the increased pressure serves to effect a further closing off of ports 33, thus augmenting the action of the governor in increasing the pressure applied to piston 13. In other words, as soon as the pressure in conduit 28 begins to increase due to upward movement of pilot valve sleeve 36, such increase in pressure sets into action means which serves to assist the governor in effecting movement of piston 13. As a result, the friction and other forces tending to hold piston 13 from movement are overcome quickly whereby prompt response of the governing mechanism to the speed changes is obtained. When piston 13 moves upwardly, it carries with it the arm 46 and such upward movement lifts the left hand end of lever 34, thereby raising the sleeve 32 relatively to pilot valve 36 to again uncover somewhat the ports 33. Thus it operates as a follow-up mechanism to restore the ports to a position such that there will be maintained under piston 13 a pressure sufficient to maintain it in its new position against the action of spring 16, the new position being one such that valve means 6 is held open to an extent to supply sufficient steam to the turbine to carry the increased load.

When the load decreases, the speed of the turbine tends to increase, thus throwing weight arms 37 outwardly and lowering pilot valve 36. This serves to uncover somewhat ports 33 permitting oil to escape more rapidly through bypass pipe 29, thereby lowering the pressure under piston 13 which is then lowered by spring 16 to decrease the opening of valve means 6. When pilot valve 36 moves downwardly decreasing the pressure in conduit 28, the pressure is lowered in chamber 43 whereupon spring 49 distends somewhat bellows 40, thus lifting pilot valve sleeve 32 to uncover further ports 33. This additional uncovering of ports 33 serves to augment the action of the speed governor after the manner explained above so as to effect prompt action of the governing mechanism in response to the increased speed.

In connection with the construction illustrated, it will be seen that lever 34 and its connection to rod 12 provides a usual arrangement of follow-up connection to prevent overtravel of the governing mechanism and that bellows 40 and casing 42 form an intermediate adjustable section in the follow-up connection. Also, it will be seen that pilot valve sleeve 36 and pilot valve bushing 32 form in substance two valve members the movements of either of which serves to effect change in pressure in conduit 28.

In Fig. 2 is illustrated a modification wherein the pressure responsive device corresponding to the bellows 40 of Fig. 1 is in the form of a piston 51 which moves in a cylinder 52 against the action of a spring 53. Cylinder 52 beneath piston 51 is connected by a pipe 54 to oil chamber 30^a, the piston being thus subjected at all times to the oil pressure in the governing system. Carried by pistons 51 is a stem 55 which at its upper end is pivoted to one end of a lever 56 fulcrumed at 57 and having its other end connected to a lever 34^a corresponding to lever 34 of Fig. 1. Otherwise the arrangement shown in Fig. 2 may be the same as that shown in Fig. 1 and the same reference numerals with the exponent "a" added have been used to designate corresponding parts.

The Fig. 2 arrangement operates after the manner of the Fig. 1 arrangement, piston 51 being moved in response to changes in pressure in the system and so moving bushing or sleeve 32^a to augment the action of the speed governor.

This modification has the advantage that since piston 51 is located in close proximity to the speed governor it responds very quickly to pressure changes inaugurated by the speed governor.

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 prime mover having a governing mechanism comprising a movable element, means biasing it in one direction, means for supplying fluid under pressure to move said element in opposition to said biasing means, and a governor controlling said second-named means, of means controlled by changes in pressure of said fluid for augmenting the action of said governor.

2. The combination with a prime mover having a governing mechanism comprising a

movable abutment, a spring biasing it in one direction, a conduit for supplying fluid under pressure to said abutment to move it against the action of said spring, a valve means which controls the pressure in said conduit, and a governor connected to said valve means, of means responsive to change in pressure in said conduit for augmenting the action of the governor on said valve means.

3. The combination with a prime mover having a governing mechanism comprising a movable abutment, a spring biasing it in one direction, a conduit for supplying fluid under pressure to said abutment to move it against the action of said spring, a valve means which controls the pressure in said conduit, and a governor connected to said valve means, of a second valve means which also controls the pressure in said conduit, and means responsive to change in pressure of said conduit for effecting movement of said second valve means in a direction to augment the action of said governor.

4. The combination with a prime mover having a governing mechanism comprising a movable abutment, a spring biasing it in one direction, a conduit for supplying fluid under pressure to said abutment to move it against the action of said spring, a valve means comprising a pilot valve and a restoring bushing which controls the pressure in said conduit, a governor connected to said pilot valve and means forming a follow-up connection for the restoring bushing, of means responsive to change in pressure in said conduit for effecting movement of said restoring bushing to augment the action of said governor.

5. The combination with a prime mover having a governing mechanism comprising a movable abutment, a spring biasing it in one direction, a conduit for supplying fluid under pressure to said abutment to move it against the action of said spring, a valve means comprising a pilot valve and a restoring bushing which controls the pressure in said conduit, and a governor connected to said pilot valve, of means forming a follow-up connection for the restoring bushing, said follow-up connection including an intermediate adjustable section, and means responsive to change in pressure in said conduit for effecting movement of said intermediate adjustable section to augment the action of said governor.

In witness whereof, I have hereunto set my hand this tenth day of September, 1926.

DONALD F. WARNER

CERTIFICATE OF CORRECTION.

Patent No. 1,669,108. **Granted May 8, 1928, to**

DONALD F. WARNER.

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction as follows: Page 4, line 22, claim 3, for the word "of" first occurrence read "in"; and that the said Letters Patent should be read with this correction therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 5th day of June, A. D. 1928.

(Seal)

M. J. Moore,
Acting Commissioner of Patents.

movable abutment, a spring biasing it in one direction, a conduit for supplying fluid under pressure to said abutment to move it against the action of said spring, a valve means which controls the pressure in said conduit, and a governor connected to said valve means, of means responsive to change in pressure in said conduit for augmenting the action of the governor on said valve means.

3. The combination with a prime mover having a governing mechanism comprising a movable abutment, a spring biasing it in one direction, a conduit for supplying fluid under pressure to said abutment to move it against the action of said spring, a valve means which controls the pressure in said conduit, and a governor connected to said valve means, of a second valve means which also controls the pressure in said conduit, and means responsive to change in pressure of said conduit for effecting movement of said second valve means in a direction to augment the action of said governor.

4. The combination with a prime mover having a governing mechanism comprising a movable abutment, a spring biasing it in one direction, a conduit for supplying fluid under pressure to said abutment to move it against the action of said spring, a valve means comprising a pilot valve and a restoring bushing which controls the pressure in said conduit, a governor connected to said pilot valve and means forming a follow-up connection for the restoring bushing, of means responsive to change in pressure in said conduit for effecting movement of said restoring bushing to augment the action of said governor.

5. The combination with a prime mover having a governing mechanism comprising a movable abutment, a spring biasing it in one direction, a conduit for supplying fluid under pressure to said abutment to move it against the action of said spring, a valve means comprising a pilot valve and a restoring bushing which controls the pressure in said conduit, and a governor connected to said pilot valve, of means forming a follow-up connection for the restoring bushing, said follow-up connection including an intermediate adjustable section, and means responsive to change in pressure in said conduit for effecting movement of said intermediate adjustable section to augment the action of said governor.

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