June 2, 1931. R. J. CAUGHEY 1,808,528

ELASTIC FLUID TURBINE

Filed May 19, 1928

Fig. 1.

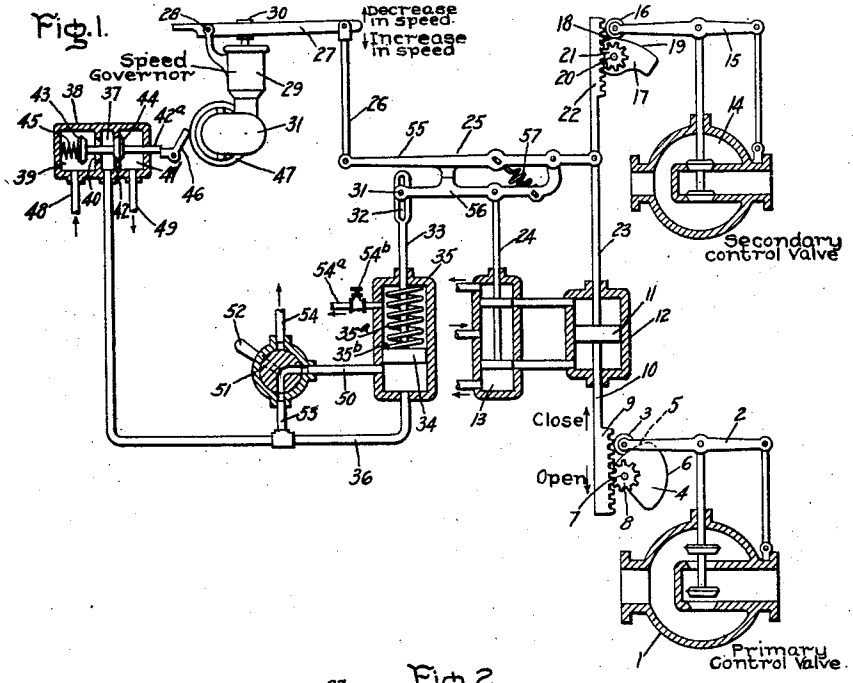


Fig. 2.

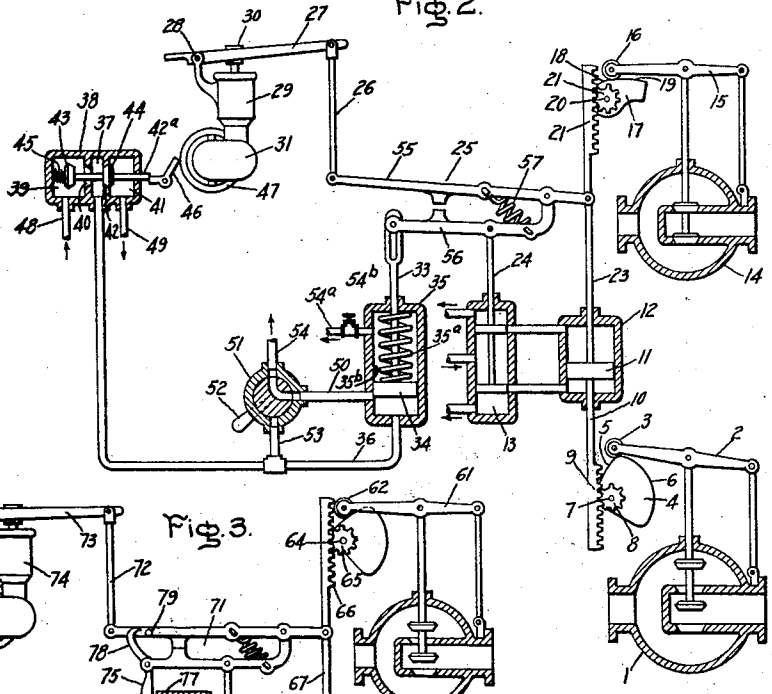


Fig. 3.

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UNITED STATES PATENT OFFICE

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ELASTIC FLUID TURBINE

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In the starting of elastic fluid turbines, it is the practice first to warm up the turbine at a reduced speed and then gradually to bring the turbine up to operating speed by means of a manually-operated valve. After the turbine has been brought up to operating speed, the manually-operated valve is opened wide and the speed governor-operated valve gear then takes control of the admission of the elastic fluid to the turbine. After the turbine has been brought up to speed and placed under control of the governor-operated valve gear, the load is then applied. Even after the turbine has been warmed up and then brought up to operating speed, it is still desirable that the load be applied gradually and that the turbine be operated for a considerable time at lighter loads before full load is applied, in order to insure the even heating of the turbine structure and to prevent unequal expansion.

One object of my present invention is to provide an improved construction and arrangement whereby only a predetermined load can be initially applied to the turbine, it being necessary for the operative to make special adjustments in order to apply full load to the machine. A further object of my invention is to provide an improved construction whereby when the turbine is shut down it cannot be started up again without first adjusting the mechanism which prevents initially the application of more than a predetermined load to the turbine.

My invention may be carried out in connection with a turbine having any suitable type of valve gear. Some turbines have a valve means comprising only a valve or a plurality of valves which admits elastic fluid directly to the first stage. Other turbines are provided not only with a valve means comprising a valve or a plurality of valves for admitting elastic fluid to the first stage, but also with what is termed an overload valve means or secondary valve means which admits elastic fluid to a lower stage of the turbine. My invention may be applied to turbines of either type. In the case of turbines of the first type the arrangement may be such that the valve means for admitting elastic fluid to the first stage of the turbine can be only partially opened during the initial period. In the case of turbines of the second-referred to type, the arrangement may be such that the valve means admitting elastic fluid to the first stage of the turbine, which valve means is termed usually the primary valve means, may be fully opened during the initial starting period but the overload or secondary valve means cannot be opened. In the latter case, by my invention I prevent the starting of the turbine with the overload valve means open.

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

In the drawings, Fig. 1 is a diagrammatic view of a valve gear embodying my invention, the same being shown applied to an elastic fluid turbine having a primary valve means and a secondary or overload valve means; Fig. 2 is a view similar to Fig. 1 showing the operating parts in a different position, and Fig. 3 is a modification.

Referring to the drawings, Figs. 1 and 2, 1 indicates a primary control valve having a stem connected to an operating lever 2, the free end of which is provided with a roller 3 which rests on a cam 4. Cam 4 has a surface 5 which may be termed the valve opening surface and a concentric surface 6 which moves under roller 3 and serves to maintain the valve open upon continued movement of the cam in a counter clockwise direction. Cam 4 is carried by a shaft 7 on which is mounted a pinion 8 which meshes with a rack 9 on the rod 10 of a fluid-actuated motor. 11 indicates the piston of the fluid-actuated motor, 12 the cylinder and 13 the pilot valve. When piston 11 moves downward in cylinder 12, cam 4 is turned in a direction to open valve 1 and when piston 11 moves upward in the cylinder, cam 4 is turned in a direction to permit the valve to close. 14 indicates a secondary or overload control valve, the stem of which is connected to an operating lever 15. On the free end of operating lever 15 is a roller 16 which rides on a cam 17 having a concentric surface 18 and an opening surface

19. Cam 17 is mounted on a shaft 20. When shaft 20 moves in a counter clockwise direction valve 14 is opened, while when it moves in a clockwise direction valve 14 is permitted to close. On shaft 20 is a pinion 21 which meshes with a rack 22 on a rod 23, which forms in substance an extension of piston rod 10. The arrangement is such that when piston 11 moves downward in cylinder 12, primary valve 1 is first opened after which secondary valve 14 is opened, while when piston 11 moves upward in cylinder 12 secondary valve 14 is closed after which primary valve 1 is closed.

The stem 24 of pilot valve 13 is connected to a floating lever 25, one end of which is connected to rod 23 and the other end of which is connected by a link 26 to the free end of a governor lever 27. Governor lever 27 is pivoted on a bracket arm as is indicated at 28 and is connected to a suitable speed governor 29, as is indicated at 30. 31 indicates the gearing through which speed governor 29 is driven from the turbine shaft. The arrangement is such that when the speed decreases, governor 29 moves the free or outer end of lever 27 upward and when the speed increases governor 29 moves the free or outer end of lever 27 downward. When the free end of lever 27 moves upward pilot valve 13 is lifted, thereby effecting a movement of piston 11 in a direction to open the control valves, while when lever 27 moves downward, pilot valve 13 is moved in a direction to effect a movement of piston 11 in a direction to close the control valves.

The arrangement so far described is a known one and is to be taken as typical of any suitable governor-operated valve means for controlling the admission of elastic fluid to a turbine, the connections including a fluid operated motor and a usual form of follow-up arrangement. The illustration is diagrammatic, but the arrangement of the parts in connection with an elastic fluid turbine is well-known to those familiar with this art.

According to the embodiment of my invention shown in Figs. 1 and 2, I provide on floating lever 25 a projecting pin 31 which stands in a slot 32 formed in the upper end of a piston rod 33, whereby there is formed a lost motion connection between the floating lever and the rod. Piston rod 33 is connected to a piston 34 located in a cylinder 35. In cylinder 35 is a spring 35^a which tends normally to force piston 34 downward in the cylinder. 35^b is a stop which serves to limit upward movement of piston 34 in the cylinder. Connected to the lower end of cylinder 35 is a pipe 36 which at its other end is connected to a chamber 37 in valve casing 38. Chamber 37 communicates with an admission chamber 39 through an opening 40 and with a discharge chamber 41 through an opening 42. In valve casing 38 is a valve stem 42^a upon which is arranged a valve 43 for closing opening 40 and a valve 44 for closing opening 42. 45 is a spring which tends to move valves 43 and 44 to a position wherein valve 43 closes opening 40 and valve 44 uncovers opening 42. Valves 43 and 44 are held normally in the position shown in Figs. 1 and 2 by means of a trip finger 46 with which the end of valve stem 42^a engages. 47 indicates diagrammatically a suitable overspeed governor which when the speed of the turbine exceeds a predetermined high value moves trip finger 46 away from the end of valve stem 42^a thereby permitting the spring 45 to reverse the positions of valves 43 and 44. Overspeed governor 47 may be a governor of a type such as that disclosed in the patent to Dryer 1,666,490 dated April 17, 1928.

Connected to admission chamber 39 is a supply pipe 48 which may lead to any suitable source of fluid supply. For example, it may be connected with the lubricating system for the turbine. Connected with discharge chamber 47 is a drain pipe 49 which may lead to any suitable joint.

Connected to cylinder 35 a predetermined distance from its lower end is a pipe 50 in which is located a two-way valve 51 having an operating handle 52. When the operating handle 52 is in the position shown in Fig. 1 of the drawings, valve 51 connects pipe 50 to conduit 36 through pipe connection 53, while when operating handle 52 is turned to the position shown in Fig. 2, valve 51 connects pipe 50 to a discharge pipe 54. Connected to the upper end of cylinder 35 is a drain pipe 54^a of comparatively small size. It may be provided with a valve 54^b which may be set to regulate the rate of flow of fluid through pipe 54^a.

When piston 34 is in the position shown in Fig. 1 of the drawing, rod 33 is raised to an extent such that slot 32 does not interfere with the normal operation of speed governor 29, the speed governor being then able to move floating lever 25 to bring the primary and secondary control valves to fully open positions. When piston 34 is in the position shown in Fig. 2 of the drawings, stem 33 is located in a position such that the speed governor may move floating lever 25 sufficient to effect the opening of the primary control valve but cannot move floating lever 25 to an extent such as to effect opening of the secondary control valve. When piston 34 is at the bottom of cylinder 35, rod 33 is so positioned that the speed governor cannot open either the primary or secondary control valves.

In order to take the strain off the speed governor, floating lever 25 preferably comprises two arms 55 and 56 which are pivoted to each other and are connected together by a spring 57. Speed governor 29 is connected

to arm 55 while pilot valve stem 24 and rod 33 are connected to arm 56. As long as floating lever 25 is free to move, arms 55 and 56 move together as a unit, arm 55 being moved through the intermediary of spring 57. However, when arm 56 is held from moving by rod 33 the speed governor can still move arm 55, spring 57 then yielding to permit arm 55 to move relatively to arm 56. This is illustrated in Fig. 2 of the drawings.

The operation is as follows:—

Referring to Fig. 1, the parts are shown in their normal positions. Piston 34 is held in its uppermost position by oil pressure which enters through pipe 48 and flows through conduits 36 and 50 to the underside of the piston. When held in this position, speed governor 29 is free to operate the primary and secondary control valves as the load requires, it being possible to put full load on the turbine.

If the turbine is shut down either manually or due to emergency conditions, such as overspeeding, trip finger 46 is moved away from the end of stem 42ª whereupon spring 45 reverses the positions of valves 43 and 44. When this occurs, valve 43 shuts off the the supply of fluid pressure to cylinder 35 and valve 44 connects pipe 36 to discharge pipe 49, thereby permitting the fluid pressure under piston 34 to escape. Spring 35ª thereupon moves piston 34 to the bottom of cylinder 35. This moves rod 33 down to a position such that both the primary and secondary control valves are closed. In this connection it will be seen that irrespective of the position of the speed governor 29, piston 34 can move arm 56 against the action of spring 57 to lower pilot valve 13 thereby effecting the closing of the primary and secondary control valves.

In order to again start the turbine, it is necessary first to open valve 43 and close valve 44 and at the same time reset trip finger 46. This serves again to supply fluid pressure through pipe 36 but piston 34 will not be raised because when at the bottom of cylinder 35 it is below the connection of pipe 50 to the cylinder. As a result, fluid pressure supplied through pipe 36 flows through pipes 53 and 50 to the upper side of piston 34 so that the pressure on the two sides of the piston is equalized to an extent such that piston 34 will not be raised against the action of spring 35ª. This results from the fact that drain pipe 54ª is of limited area compared to pipe 50. To effect an upward movement of piston 34 in cylinder 35 the operative now moves valve 51 from the position shown in Fig. 1 to that shown in Fig. 2. This serves to close off pipe 53 and to connect pipe 50 to discharge pipe 54. Fluid pressure is now no longer supplied to the upper side of piston 34 so that the fluid pressure supplied to the under side of it raises the piston a certain amount as is indicated in Fig. 2. The piston is raised until its lower edge uncovers pipe 50 to an extent such that the escape of fluid pressure through pipe 50 will reduce the pressure under the piston to a value such that the pressure under the piston just balances the pressure of spring 36. This locates slot 32 in a position such that it permits the speed governor to open the primary valve means but prevents it from opening the secondary valve means. This is illustrated in Fig. 2 of the drawing.

In order to permit opening of the secondary control valve, it is necessary for the operative to move valve 51 from the position shown in Fig. 2 back to the position shown in Fig. 1. When this is done fluid pressure through pipes 36 and 50 moves piston 34 to its uppermost position.

With the above described arrangement therefore, it will be seen that after the turbine has been shut down, the primary and secondary valves being closed, the turbine can be started up again only by the operative first manipulating valve 51 so as to move piston 34 to a position such that the primary valve means can be opened and then again moving valve 51 to a position such that the secondary control valve means may be opened. This requires two successive acts on the part of the operative and prevents the accidental starting up of the machine with the secondary control valve means open.

In Fig. 3 is illustrated a modification of the invention wherein a single valve means controls the flow of elastic fluid to the turbine the arrangement being such that the operative may set the mechanism so as to prevent the valve means being opened beyond a predetermined amount without first performing a separate act. In Fig. 3, 60 indicates a valve means controlling the flow of elastic fluid to a turbine. Its stem is connected to a lever 61 having a roller 62 on its free end which engages with a cam 63 carried by a shaft 64. On shaft 64 is a pinion 65 which meshes with a rack 66 on the upper end of a rod 67 which at its lower end is connected to the piston 68 of a fluid-actuated motor. 69 indicates a cylinder of the fluid-actuated motor and 70 a pilot valve. The stem of pilot valve 70 is connected to a floating lever 71 similar in construction to that of lever 25 shown in Figs. 1 and 2. One end of floating lever 71 is connected to rod 67 and the other end is connected by a link 72 to the free end of the governor lever 73. Connected to governor lever 73 is a speed governor 74 similar to the speed governor 29 of Figs. 1 and 2.

The arrangement so far described illustrates a simple valve means operated by a speed governor through the intermediary of a fluid-actuated motor the connections including a usual form of follow-up device. The arrangement is similar to that shown in

Figs. 1 and 2 and is to be taken as typical of any suitable arrangement of this type.

According to the embodiment of my invention, shown in Fig. 3, I provide a pivoted hook 75 having an end 76 adapted to hook over a stationary lug 77 which in the present instance is shown as being a part of the casing of pilot valve 70. When hook 75 is hooked under lug 77 it prevents speed governor 74 from moving floating lever 71 to an extent beyond that required to open valve means 60 a predetermined amount. On the other hand, when hook 75 is moved away from lug 77 the speed governor is free to fully open control valve means 60.

I may, with advantage, combine with hook 75 a second hook 78 adapted to engage a pin 79 projecting from the one arm of floating lever 71, the arrangement being such that when hook 75 is moved away from lug 77 hook 78 engages pin 79 thereby locking the two arms of the floating lever together, while when hook 75 is moved into engagement with lug 77 hook 78 is moved away from pin 79. With the arrangement shown in Fig. 3, it will be seen that the operative may lock the floating lever 71 in a position such that valve means 60 can be opened only to a predetermined extent. With this arrangement, hook 75 having been moved into engagement with lug 77, it is necessary that the hook be disengaged from lug 77 before the operative can fully load the turbine.

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 an elastic fluid turbine having primary and secondary valve means, a governor, and mechanism through which the governor effects the positioning of said valve means, of means for locking said mechanism whereby the governor is prevented from effecting opening of said secondary valve means.

2. The combination with an elastic fluid turbine having primary and secondary valve means, of means for preventing starting of the turbine when the secondary valve means is open.

3. The combination with an elastic fluid turbine having valve means controlling the flow of elastic fluid to the turbine, a governor, and mechanism through which the governor moves the valve means, of means which when the turbine is shut down locks said mechanism so that the governor cannot open said valve means, and means for moving said locking means in successive steps to release the mechanism.

4. The combination with an elastic fluid turbine having valve means controlling the flow of elastic fluid to the turbine, a governor, and mechanism through which the governor moves the valve means, of means which when the valve means is closed, automatically locks the valve means in closed position and prevents its being opened by said governor until the locking means is released.

5. The combination with an elastic fluid turbine having valve means controlling the flow of elastic fluid to the turbine, a governor, and mechanism through which the governor moves the valve means, of means which when the valve means is closed, automatically locks the valve means in closed position and prevents its being opened by said governor until the locking means is released, and means whereby the locking means must be released in successive steps.

6. The combination with an elastic fluid turbine having valve means controlling the flow of elastic fluid to the turbine, a governor, and mechanism through which the governor moves the valve means, of means which when the valve means is closed, automatically operates to lock the valve means so that the valve means cannot be again fully opened by the governor until said locking means is released.

7. The combination with an elastic fluid turbine having primary and secondary valve means, a governor, and mechanism through which the governor effects the positioning of said valve means, of means which when the valve means are closed, operates to lock said mechanism so that the governor cannot again open the secondary valve means until said locking means is released.

8. The combination with an elastic fluid turbine having valve means for controlling the admission of elastic fluid to the turbine, a fluid actuated motor including a pilot valve for moving the valve means, a speed governor, and a floating lever connecting the speed governor to the fluid actuated motor, of means associated with said floating lever and adapted to move it to bring the pilot valve to a position wherein it effects closing of the valve means, and means for restoring the said means associated with said floating lever to its initial position in successive steps.

9. The combination with an elastic fluid turbine having valve means for controlling the admission of elastic fluid to the turbine, a fluid actuated motor including a pilot valve for moving the valve means, a speed governor, a floating lever connecting the speed governor to the fluid actuated motor, and an overspeed governor, of means controlled by the overspeed governor for effecting movement of the floating lever to bring the pilot valve to a position wherein it effects closing

of said valve means, and means for releasing said floating lever in successive steps.

10. The combination with an elastic fluid turbine having valve means for controlling the admission of elastic fluid to the turbine, a fluid actuated motor including a pilot valve for moving the valve means, a speed governor, a floating lever connecting the speed governor to the fluid actuated motor, and an overspeed governor, of a fluid actuated piston associated with the floating lever and adapted to effect movement of it to bring the pilot valve to a position wherein it effects closing of said valve means, and valve means which controls the application of fluid pressure to said piston and which is manipulated to restore the piston to its normal position in successive steps.

11. The combination with an elastic fluid turbine having valve means for controlling the admission of elastic fluid to the turbine, a fluid actuated motor including a pilot valve for moving the valve means, a speed governor, a floating lever connecting the speed governor to the fluid actuated motor, and an overspeed governor, of means controlled by the overspeed governor for effecting movement of the floating lever to bring the pilot valve to a position wherein it effects closing of said valve means, said overspeed governor controlled means comprising a movable rod and a lost motion connection between said rod and the floating lever.

12. The combination with an elastic fluid turbine having valve means for controlling the admission of elastic fluid to the turbine, and a fluid actuated motor including a pilot valve for moving the valve means, of a speed governor, a two-part floating lever, yielding means connecting said two parts together, means connecting the speed governor to one of said parts, means connecting the pilot valve to the other of said parts, an overspeed governor, and means controlled by the overspeed governor for effecting movement of said last referred to floating lever part to bring the pilot valve to a position wherein it effects closing of said valve means.

13. The combination with an elastic fluid turbine having valve means for controlling the admission of elastic fluid to the turbine, and a fluid actuated motor including a pilot valve for moving the valve means, of a speed governor, a two-part floating lever, yielding means connecting said two parts together, means connecting the speed governor to one of said parts, means connecting the pilot valve to the other of said parts, an overspeed governor, and means controlled by the overspeed governor for effecting movement of said last referred to floating lever part to bring the pilot valve to a position wherein it effects closing of said valve means, said overspeed governor controlled means comprising a movable rod and a lost motion connection between the rod and the last referred to floating lever part.

14. The combination with an elastic fluid turbine having valve means for controlling the admission of elastic fluid to the turbine, and a fluid actuated motor including a pilot valve for moving the valve means, of a speed governor, a two-part floating lever, yielding means connecting said two parts together, means connecting the speed governor to one of said parts, means connecting the pilot valve to the other of said parts, an overspeed governor, and means controlled by the overspeed governor for effecting movement of said last referred to floating lever part to bring the pilot valve to a position wherein it effects closing of said valve means, said overspeed governor controlled means comprising a piston and a lost motion connection between said piston and the last referred to floating lever part.

In witness whereof, I have hereunto set my hand this 18th day of May, 1928.

REED J. CAUGHEY