J. WILSON.

BALANCING DEVICE.

APPLICATION FILED SEPT. 5, 1918.

1,344,193. **Patented June 22, 1920.**

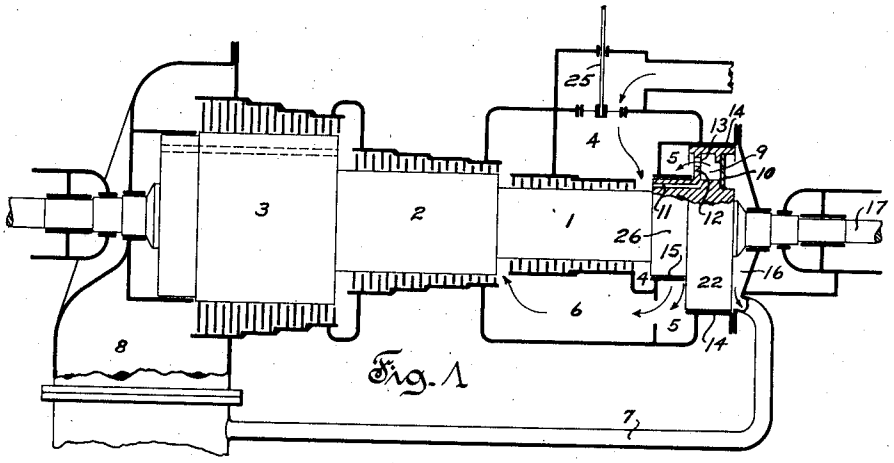


Fig. 1

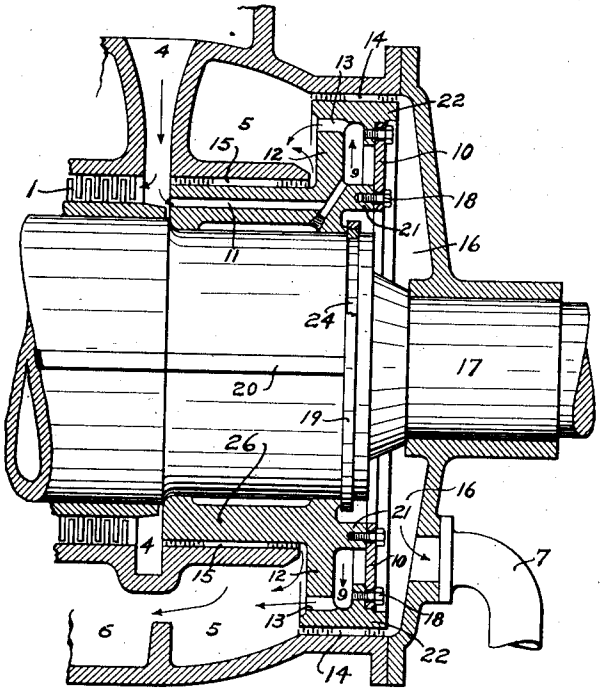


Fig. 2

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BALANCING DEVICE.

1,344,193. Specification of Letters Patent. Patented June 22, 1920.

Application filed September 5, 1918. Serial No. 253,109.

To all whom it may concern:

Be it known that I, JAMES WILSON, a subject of the King of Great Britain, residing at West Allis, in the county of Milwaukee and State of Wisconsin, have invented a certain new and useful Improvement in Balancing Devices, of which the following is a specification.

This invention relates in general to improvements in the construction of elastic fluid turbines, and relates specifically to improvements in balancing devices for counterbalancing the end thrust on the rotors of reaction elastic fluid turbines.

An object of the invention is to provide a turbine rotor which is simple in construction and efficient in operation. A more specific object of the invention is to provide a rotor element which is not readily distorted by sudden variations in temperature. A further object is to provide means for rapidly equalizing the temperatures adjacent to a rotor by providing means for simultaneously conducting elastic fluid at the same temperature, along opposite sides of the rotor. Still another object is to provide means for utilizing the energy of the steam delivered from the temperature equalizing means. Still another object is to provide improved details of construction and operation of balance pistons which will facilitate manufacture and enhance the efficiency thereof.

While the invention has been disclosed as specifically applied to the balance piston of a steam turbine of the reaction type, it is not intended to limit the scope thereof by such illustrative disclosure. The elastic fluid utilized in the embodiment of the invention herein shown will be designated as steam, without thereby contemplating specific limitation of the invention.

A clear conception of an embodiment of the invention may be had by referring to the drawing accompanying and forming a part of this specification in which like reference characters designate the same or similar parts in the various views.

Figure 1 is a diagrammatic transverse sectional view through a multi-stage turbine of the reaction or Parsons type.

Fig. 2 is an enlarged detail view of the high pressure end of an elastic fluid turbine of the reaction or Parsons type, showing the details of construction of the balance piston and associated elements.

Referring specifically to Fig. 1, the turbine comprises a high pressure section or stage 1, an intermediate section or stage 2, and a low pressure section or stage 3, the high pressure stage 1 being communicable at its inlet end with a source 4 of high pressure steam supply and the low pressure stage 3 being communicable at its exhaust end with a region 8 of low pressure ordinarily communicating with a condenser. The high pressure steam admission is controllable by means of a valve 25 of usual construction. The intermediate stage 2 besides receiving steam directly from the exhaust end of the high pressure stage 1, is adapted to receive steam from a passage 6 communicating with a chamber 5 and possibly from some additional auxiliary source of steam supply.

The balance piston which is associated with the main shaft 17 of the turbine directly adjacent to the high pressure stage 1, comprises a cylindrical portion 26 of relatively small diameter, a ring portion 22 of relatively large diameter, a ring portion 21 of relatively small diameter located within and concentrically of the ring portion 22, and a wall 12 integrally uniting the ring portions 22, 21 and located at an end of the portion 26, see Fig. 2. The wall 12 is of relatively heavy construction making it capable of readily resisting the forces acting upon the ring portion 22 secured to the outer edge of this wall. Secured to the ring portions 22, 21 and movable relatively thereto, is a relatively thin plate or wall 10. The attachment of this plate 10 to the ring portions 22, 21 is effected by means of a series of cap bolts 18 having screw thread coaction with threaded holes in the ring portions and passing through openings in the wall 10 which are somewhat larger in diameter than the adjacent bolts 18. The balance piston is restrained against longitudinal displacement along the shaft 17 in one direction, by means of locking rings 19 which coact with an end of the piston and with a groove 24 formed in the shaft, and in the opposite direction by means of a shoulder on the shaft 17 which engages the opposite end of the piston. The balance piston is

prevented from rotating relatively to the shaft 17 by means of one or more keys 20 co-acting with adjacent slots in the adjoined elements.

The relatively small cylindrical portion 26 is provided at its periphery with a labyrinth packing 15 for preventing free flow of steam through the space between the portion 26 and the adjacent stationary casing. The relatively large ring portion 22 is likewise provided with a labyrinth packing 14 for preventing excessive leakage through the space between the ring 22 and the adjacent stationary casing. The longitudinally spaced walls 10, 12 and laterally spaced ring portions 22, 21 provide within the balance piston an annular chamber 9. This chamber 9 is connected with the high pressure inlet source 4 by means of one or more relatively small holes or conduits 11 which extend through the piston portion 26 and through the wall 12. The size of the holes is such that the drop in pressure of the steam passing therethrough from the source 4 to the chamber 9, is substantially equal to the drop in pressure past the labyrinth packing 15. The chamber 9 communicates with the annular chamber 5 formed in the stationary turbine casing, through one or more holes or conduits 13 which penetrate the wall 12. The chamber 5 is in open communication with the passage 6 which as above stated communicates with the inlet end of the intermediate stage 2. The end surface of the balance piston remote from the turbine, is in direct communication with an annular chamber 16 which communicates with the region 8 of low pressure through a pipe or conduit 7.

The low pressure end of the turbine may be provided with other balancing means for counter-balancing the reactive thrust upon the low pressure stage 3. The turbine may be either direct or otherwise connected to an energy absorbing device in the usual manner.

During the normal operation of the turbine, high pressure steam is admitted from the supply source 4 and passes successively through the stages 1, 2, 3, the spent fluid being delivered to the region 8. Some of the high pressure steam from the supply source 4 flows directly through the conduits 11 to the chamber 9 and from the chamber 9 through the conduits 13 to the chamber 5. Other high pressure steam from the supply source 4 flows past the labyrinth packing 15 and into the chamber 5. The steam delivered from the conduits 11 and from the end of the labyrinth packing 15 has substantially the same pressure and flows outwardly in parallel along the opposite sides of the wall 12. The steam which is at a considerably reduced pressure in the chamber 5, passes from this chamber into the conduit 6 from which it is delivered into the inlet end of the intermediate stage 2 to therein deliver energy to the turbine rotor. Any steam which passes from the chamber 5 to the chamber 16 past the labyrinth packing 14 is delivered at a considerable reduction in pressure over that in the chamber 5, to the region 8 through the conduit 7. The end thrust upon the rotor due to the action of the steam upon the turbine buckets, is balanced by the pressure of the steam acting upon the surfaces of the balance piston which face the turbine rotor. The pressures upon the surfaces of the piston within the chamber 9 are balanced. The reduction of pressure within the chamber 16 and upon the end surfaces of the balance piston remote from the turbine rotor, resulting from the connection of this chamber 16 with the region 8, provides a maximum effective balancing pressure upon the opposed balancing surfaces.

It will be obvious, that if the pressure of the steam in the source 4 varies, the pressures within the chambers 5, 9 will vary. Such variation in pressure will result in variation in temperature in these chambers 5, 9. This variation in temperature will be simultaneous on opposite sides of the wall 12 and will cause this wall to expand or contract uniformly in a direction perpendicular to the turbine axis. The ring portion 22 and the packing elements associated therewith will therefore always move only in a direction perpendicular to the turbine axis, thereby avoiding destruction of the packing elements. During this movement of the ring portion 22 relatively to the ring portion 21, due to the expansion and contraction of the wall 12, the wall 10 will also expand and contract. The expansion and contraction of the wall 10 may however be at a different rate than that of the wall 12, thereby necessitating relative movability between at least the ring portion 22 and the wall 10. Such relative movability is permitted by the enlarged holes in the wall 10 through which the cap screws 18 pass. It will thus be noted that expansion and contraction of the wall 12 without distorting the ring portion 22, may take place irrespective of the extent of expansion or contraction of the wall 10.

By causing the steam which is utilized for equalizing the expansion of the wall 12, to mingle with the steam in the chamber 5 which passes the labyrinth packing 15, and utilizing this mixture of steam in the intermediate stage 2, there results practically no loss of energy. With the arrangement of elements as shown, the temperatures on opposite sides of the wall 12 will be effectively equalized irrespective of the rapidity of the change in pressure in the source 4. The balance piston may be readily constructed

and attached to the turbine rotor and is effectively protected against distortion due to temperature variations.

It should be understood that it is not desired to limit the invention to the exact details herein shown and described for obvious modifications within the scope of the appended claims, may occur to persons skilled in the art.

It is claimed and desired to secure by Letters Patent:

1. In combination, a fluid pressure turbine, a hollow balance piston associated with said turbine, means for admitting fluid to the interior of said piston, and means for delivering said fluid to said turbine.

2. In combination, a multiple stage fluid pressure turbine, a source of high pressure fluid communicable with said turbine, a hollow balance piston associated with said turbine, means of communication between said source and the interior of said piston, and means of communication between the interior of said piston and a stage of said turbine.

3. In combination, a multiple stage fluid pressure turbine, a source of high pressure fluid communicable with said turbine, a region of low pressure communicable with said turbine, a hollow balance piston associated with said turbine, means of communication between said source and the interior of said piston, means of communication between the interior of said piston and an intermediate stage of said turbine, and means of communication between an end of said piston and said region.

4. In combination, a multiple stage reaction fluid pressure turbine, a source of high pressure fluid communicable with said turbine, a hollow balance piston associated with an end of said turbine and exposed on opposite sides to different pressures, means of communication between said source and the interior of said piston, means of communication between the interior of said piston and the high pressure side thereof, and means of communication between said high pressure side of said piston and an intermediate stage of said turbine.

5. In combination, a multiple stage reaction fluid pressure turbine, a source of high pressure fluid communicable with said turbine, a region of low pressure communicable with said turbine, a hollow balance piston associated with an end of said turbine and exposed on opposite sides to different pressures, means of communication between said source and the interior of said piston, means of communication between the interior of said piston and the high pressure side thereof, means of communication between said high pressure side of said piston and an intermediate stage of said turbine, and means of communication between the low pressure side of said piston and said region.

6. In combination, a hollow balance piston exposed on opposite sides to different pressures, means for admitting high pressure fluid to the interior of said piston, and means of communication between the interior of said piston and the high pressure side thereof.

7. In combination, a hollow balance piston exposed on opposite sides to different pressures, means for admitting high pressure fluid to the interior of said piston, means of communication between the interior of said piston and the high pressure side thereof, means of communication between the low pressure side of said piston and a region of low pressure, and means for preventing the flow of fluid from one side of said piston to the other.

8. In combination, a balance piston exposed on opposite sides to different pressures, said piston comprising spaced concentric ring portions and a wall exposed to the high pressure side of said piston and integrally uniting said ring portions, and a second wall spaced from said first wall and exposed to the low pressure side of said piston, said second wall being loosely attached to said ring portions.

9. In combination, a balance piston exposed on opposite sides to different pressures, said piston comprising a ring portion and a plurality of walls associated with said portion, one of said walls being exposed to the high pressure side of said piston and having perforations therein, and the other of said walls being exposed to the low pressure side of said piston and being imperforate.

10. In combination, a balance piston exposed on opposite sides to different pressures, said piston comprising a perforated wall at the high pressure end of said piston, and an imperforate wall at the low pressure end of said piston, said walls being spaced apart.

11. In combination, a balance piston comprising two spaced walls one of which is exposed to high pressure fluid on both sides thereof, and the other of which is exposed to said high pressure fluid on one side and to a lower pressure on the opposite side.

12. In combination, a balance piston comprising a wall having peripheral means of communication between opposite sides thereof, and means for producing a flow of steam at the same temperature along opposite sides of said wall and through said means of communication.

13. In combination, a balance piston comprising a wall having peripheral means of communication between opposite sides thereof, and means for producing a flow of steam

at the same pressure along opposite sides of said wall and through said means of communication.

14. In combination, a rotor comprising a wall having peripheral means of communication between opposite sides thereof, and means for producing flows on opposite sides of said wall and through said means of communication of steam at the same temperature.

15. In combination, a rotor comprising a wall extending transverse to the axis of said rotor and having peripheral means of communication from one side to the other thereof, and means for producing outward flows on opposite sides of said wall of steam at the same temperature.

16. In combination, a balance piston comprising a wall, and means for producing a continuous flow of high pressure steam at the same pressure along opposite sides of said wall.

17. In combination, a balance piston comprising a wall, and means for producing a continuous flow of high pressure steam at the same temperature along opposite sides of said wall.

18. In combination, a turbine, a balance piston comprising a wall, means for producing a flow of high pressure steam at the same temperature along opposite sides of said wall, and means for conducting said steam to said turbine.

19. In combination, a rotor comprising a wall, and means for producing flows on opposite sides of said wall of high pressure steam at the same temperature.

20. In combination, a rotor comprising a wall extending transversely to the axis of said rotor, and means for producing outward flows on opposite sides of said wall of high pressure steam at the same temperature.

In testimony whereof, the signature of the inventor is affixed hereto.

JAMES WILSON.