F. HODGKINSON.

BALANCING MEANS FOR FLUID PRESSURE MOTORS.

APPLICATION FILED SEPT. 1, 1909.

1,012,638. Patented Dec. 26, 1911.

2 SHEETS—SHEET 1.

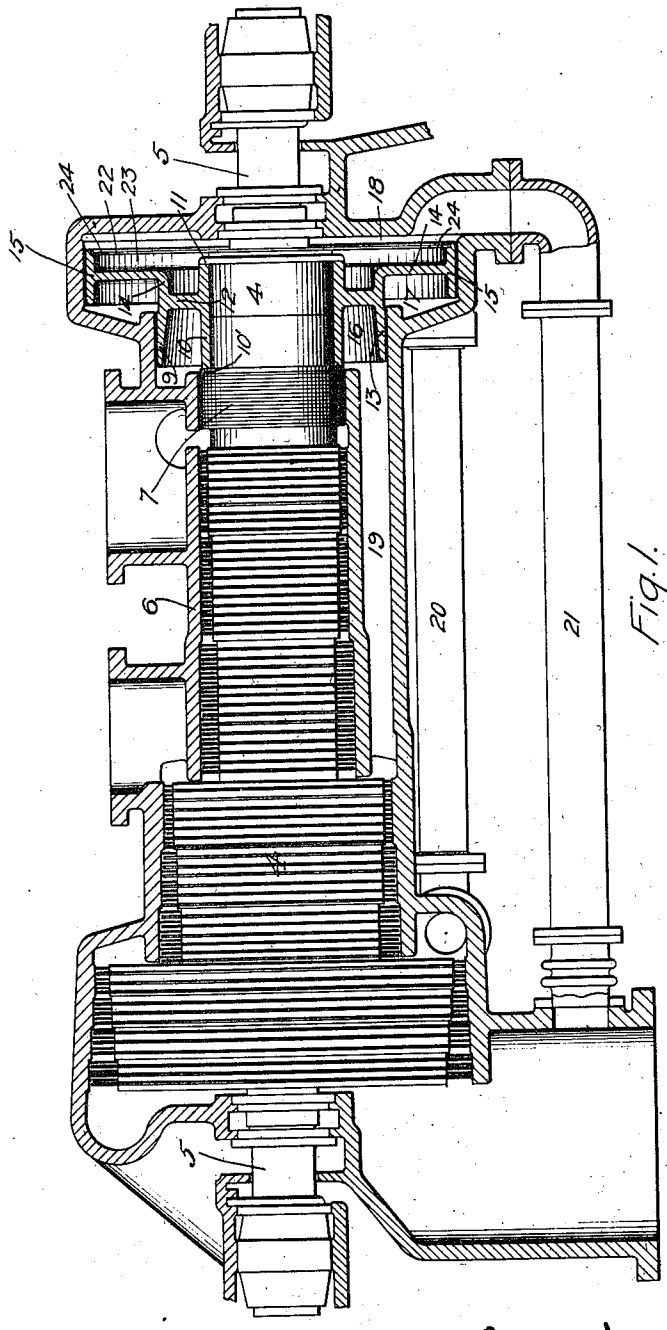

Fig. 1.

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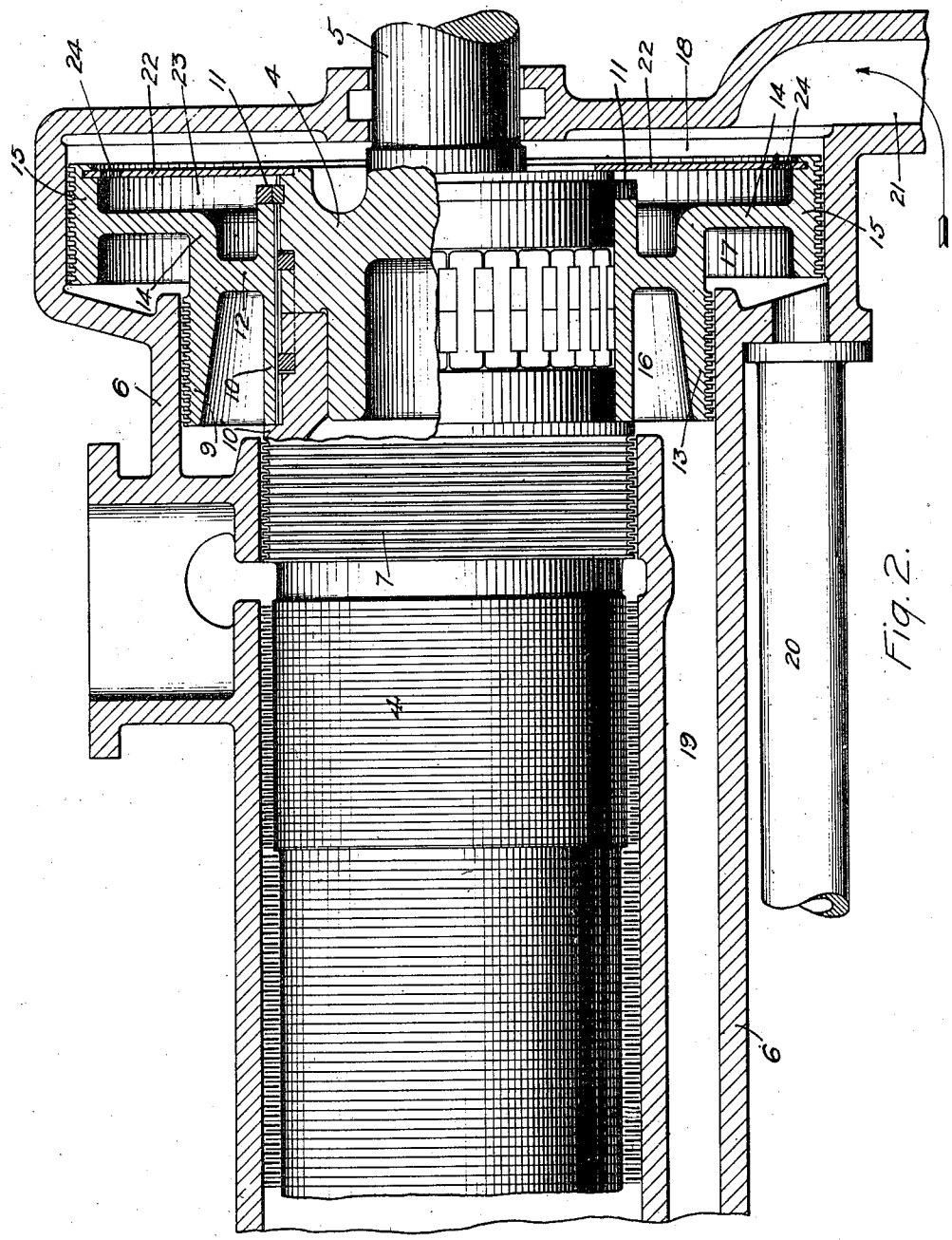

Fig. 2.

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UNITED STATES PATENT OFFICE.

FRANCIS HODGKINSON, OF EDGEWOOD PARK, PENNSYLVANIA, ASSIGNOR, BY MESNE ASSIGNMENTS, TO THE COLONIAL TRUST COMPANY, TRUSTEE, OF PITTSBURGH, PENNSYLVANIA, A CORPORATION OF PENNSYLVANIA.

BALANCING MEANS FOR FLUID-PRESSURE MOTORS.

1,012,638. Specification of Letters Patent. Patented Dec. 26, 1911.

Application filed September 1, 1909. Serial No. 515,553.

To all whom it may concern:

Be it known that I, FRANCIS HODGKINSON, a subject of the King of Great Britain and Ireland, and a resident of Edgewood Park, in the county of Allegheny and State of Pennsylvania, have made a new and useful Invention in Balancing Means for Fluid-Pressure Motors, of which the following is a specification.

This invention relates to balancing means for fluid pressure motors.

In certain types of fluid pressure motors and especially in reaction turbines, it is necessary to provide balancing pistons to counterbalance the longitudinal thrust exerted by the motive fluid (which, for convenience, will hereinafter be called steam) as it traverses the working passages of the turbine. It is customary to divide the working passages of such turbines into a convenient number of stages or sections of different diameters and to provide a separate balance piston for each stage or section. The balance pistons are mounted on the rotor element of the turbine and a lateral face of each piston is exposed to the pressure at the inlet end of the corresponding working stage or section. The pistons are so proportioned that the steam exerts a pressure on them equal and opposite to the longitudinal thrust encountered in the working stage. Labyrinth packings are provided between the turbine casing and the balance pistons for the purpose of preventing steam from leaking past the pistons. These packings consist of a number of grooves or ridges formed on the peripheral face of the pistons and interleaving with oppositely disposed grooves or ridges formed on the inner face of the casing of the turbine. It is essential with such a packing to keep the clearances particularly close and for this reason a small deflection of a balance piston will affect the operation of the turbine and is apt to cause trouble.

An object of this invention is to produce a balance piston which is so constructed as to overcome difficulties heretofore encountered and which is simple in its construction and effective in operation.

A further object is to produce a balance piston in which the separate parts are so located and so proportioned that the centrifugal strains induced throughout the piston combine to produce a radial strain on the piston.

A further object is to produce a balance piston provided with means for equalizing the temperature strains in the piston.

In the drawings accompanying this application and forming a part thereof: Figure 1 is a transverse section of a turbine casing shown in connection with a partial side and a partial sectional elevation of the rotor element in place in the casing; and Fig. 2 is an enlarged sectional view of one end of the turbine and shows a section of a balance piston embodying my invention.

The turbine shown consists of rotor element 4 mounted on shafts 5 and a stationary casing 6 which surrounds the element 4. The rotor element carries the moving blades and is constructed in different diameters to accommodate the different stages or sections. The casing is correspondingly formed in sections of different diameters and it carries the stationary blades which coöperates with the moving blades of the rotor element.

The turbine illustrated is divided into high, intermediate, and low pressure stages or sections. The high pressure stage is balanced by means of a balance piston 7 mounted on the rotor. The intermediate and low pressure working stages are balanced by a piston 9 mounted on the rotor, and which discloses an embodiment of my invention. The hub portion 10 of the piston 9 is mounted on the rotor 4 of the turbine and is held in place between a shoulder 10′, formed on the rotor and a compound ring 11 consisting of an inner ring cut into segments and an outer ring shrunk onto the inner ring and which holds the segments of the inner ring in place in a groove provided for them in the rotor element.

The piston 9 consists of the hub portion 10, a short web 12, formed integrally with the hub portion, a laterally projecting annular flange 13, and a web 14 formed coaxially with the flange 13 but which is turned at right angles to the flange and is provided at its outer or peripheral edge with an annular flange 15.

Labyrinth packings of the ordinary construction are provided between the peripheral faces of the flanges 13 and 15 and the

inner surface of the casing 6. These packings, with a packing located between the peripheral face of the high pressure balance piston 7 and the inner surface of the casing 6, divide the end of the turbine casing, inclosing the balance piston, into three balancing chambers 16, 17 and 18. The chamber 16 communicates with the inlet end of the intermediate stage of the turbine through the passage 19; the chamber 17 communicates with the inlet end of the low pressure stage of the turbine through the pipe 20; and the chamber 18 communicates with the exhaust passage of the turbine through the pipe 21. The packing between the flange 13 and the casing separates the chambers 16 and 17 and the packing between the flange 15 and the casing separates the chambers 17 and 18. These packings are maintained by close lateral adjustment of the rotor element and consequently it is essential that the piston 9 does not distort and thereby destroy t' e close lateral adjustment. The tendency of the piston to distort, under the influence of the centrifugal strains, is overcome by the construction.

The flanges 13 and 15 are so constructed, proportioned and located that the centrifugal stresses combine to produce a radial strain on the piston. The centrifugal stresses induced in the flange 13 tend to cause a deflection or distortion of the piston in one direction. This distorting tendency is counteracted by the centrifugal stresses induced in the flange 15 which tend to cause a distortion of the piston in the opposite direction. The resultant of the centrifugal strains on the web 12 are radial and, therefore, there is no tendency for the piston to distort.

The piston 9 is exposed on one side to exhaust pressure through the pipe 21 and to intermediate and low pressure steam on the other side. The temperatures of the chambers 16 and 17 correspond respectively to the temperatures of steam at a pressure corresponding to the pressure in the chamber and are higher than the temperature of the chamber 18 which corresponds to the temperature of steam at exhaust pressure; consequently there is a tendency for the webs 12 and 14 to expand unequally on opposite sides and to cause a lateral distortion of the piston. I overcome this, in the apparatus illustrated, by securing a plate 22 to the low pressure end of the rotor element 5 and to the flange 15 so as to segregate a portion 23 of the low pressure chamber, between the piston 9 and the plate 22. This plate 22 is provided with an annular row of openings 24 located near its outer periphery so that ample communication is had between the chamber 18 and the segregated portion 23. The pressure in the chamber 23 is the same as the pressure in the chamber 18, but the steam or other fluid contained therein receives heat through the web of the piston 9 and is maintained at a higher temperature than steam or other fluid in the chamber 18. This temperature in the chamber 23 will approximate the temperature in the chambers 16 and 17 and consequently the tendency of the piston to distort, due to unequal temperature strains, will be substantially overcome.

I find it advisable to provide the openings 24 near the outer edge of the plate, for the reason that the moist and heavy steam or the air contained in the chamber 23 is moved by the centrifugal force to the outer portion of the chamber 23 and is then discharged into the chamber 18 through the opening 24. The chamber 23 is then filled with dry and superheated steam which is a relatively poor conductor of heat and consequently assists in maintaining the temperature of the chamber 23 about equal to the temperature of the chambers 16 and 17. Another advantage in providing the plate 22, is that the water leaking from the liquid seal, located between the shaft 5 and the casing of the turbine, is not evaporated upon coming in contact with the plate 22 but is discharged into the exhaust with the steam or water leaking past the interleaving seal, located between the flange 15 and the casing. If the plate were not provided, such liquid upon leaking into the chamber 18 would come in contact with the web 14 of the balance piston and be evaporated by the high temperature of the web and deposit a sediment on the piston. This sediment by falling off the piston in spots would tend to unbalance the piston and to detrimentally affect the operation of 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 can be carried out by other means.

What I claim is:

1. In a fluid pressure motor, a balance piston exposed to different pressures of motive fluid on opposite sides and a temperature equalizing plate, located on one side of said piston and provided with a row of openings located along the outer peripheral edge.

2. In a fluid pressure motor, a balance piston exposed on opposite sides to different pressures and provided with an equalizing chamber and means communicating with said chamber for discharging the moist and heavy fluid therefrom.

3. In a fluid pressure motor, a balance piston provided with flanges so located that the centrifugal pressure induced in one flange combines with the centrifugal forces

induced in another flange to produce a radial strain in said piston.

4. In a fluid pressure motor, a balance piston provided with flanges so located that the centrifugal stresses induced in said flanges combine to produce radial strains in said piston.

5. In a fluid pressure motor, a balance piston comprising separate portions so located that the centrifugal stresses induced in one portion combine with the centrifugal stresses in another portion to produce radial strains, a temperature equalizing chamber located on one side of said piston and means communicating therewith for discharging heavy and moist fluid therefrom.

6. In a fluid pressure motor, a balance piston exposed on opposite sides to different pressures and comprising separate portions so located that the centrifugal strains induced in one portion combine with the centrifugal strains in another portion to produce radial strains and a temperature equalizing chamber located within said piston.

7. In a fluid pressure turbine, a balance piston exposed on one side to the same pressure as a working stage of said turbine and on the other side to exhaust pressure, and temperature equalizing means located on the exhaust side and provided with means for discharging fluid therefrom.

8. In a fluid pressure motor, a flanged balance piston exposed on opposite sides to different pressures of motive fluid and means secured to the flange of said piston for causing substantial equalization of the temperature strains in said piston.

In testimony whereof, I have hereunto subscribed my name this 26th day of August, 1909.

FRANCIS HODGKINSON.

Witnesses:
C. W. McGhee,
Wm. H. Larimer.