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H. T. HERR

EMERGENCY THRUST BALANCING MEANS

Filed May 10, 1921

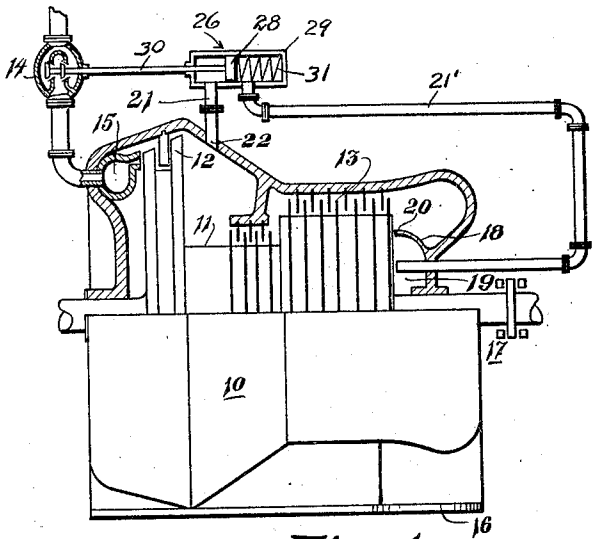

Fig. 1.

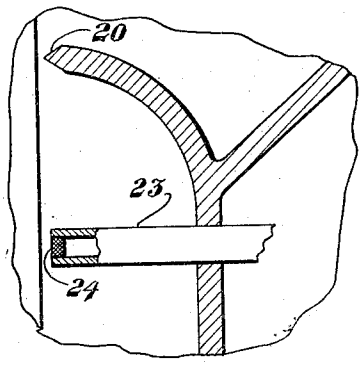

Fig. 2.

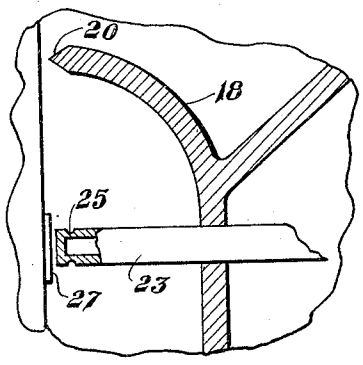

Fig. 3.

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UNITED STATES PATENT OFFICE.

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EMERGENCY THRUST BALANCING MEANS.

Application filed May 10, 1921. Serial No. 468,411.

To all whom it may concern:

Be it known that I, HERBERT T. HERR, a citizen of the United States, and a resident of Merion, in the county of Montgomery and State of Pennsylvania, have invented a new and useful Improvement in Emergency Thrust Balancing Means, of which the following is a specification.

My invention relates to emergency thrust balancing means for turbines and similar rotating apparatus, and it has for its object to provide means of the character designated which shall be simple and inexpensive in construction, which shall in no wise affect the efficiency during normal operation and which shall be effective in function, when called upon.

Referring to the accompanying drawing, Figure 1 is a side view, partially in section and partially in elevation, of a steam turbine constructed in accordance with a preferred form of my invention and Figures 2 and 3 are detailed sectional views illustrating alternative forms of fluid-pressure releasing means to be employed in the structure of Figure 1.

In the operation of steam turbines, the pressure of the steam or other motive fluid against the inclined blade causes rotation thereof, and also develops a component of force along the shaft, ordinarily known as end thrust. In like manner, one end of the turbine spindle, particularly if of the single-flow type, is normally subject to relatively high-pressure motive fluid, whereas the other end is normally subject to relatively low-pressure motive fluid pressure. These two factors, taken in conjunction, normally develop a relatively heavy end thrust, which more particularly in large turbines, has hitherto been counter-acted in general by use of the well known dummies.

Inasmuch as a dummy occupies considerable space and, furthermore, entails a continuous and undesirable leakage of steam, it has been proposed to do away therewith and to carry the entire end thrust by a suitable thrust-bearing, as for example, the well known Kingsbury or tilting shoe type.

Upon the failure of the thrust bearing in a construction of this character, it is obvious that excessive end movement of the spindle takes place, seriously injuring the blading.

I, therefore, provide a pressure chamber, preferably adjacent the low-pressure end of the turbine spindle, this pressure chamber normally being subject to relatively low fluid pressure. I then provide a suitable conduit from a relatively high pressure space within the turbine to the interior of said pressure chamber, this conduit terminating in a closed end closely adjacent to the rotating spindle. Excessive end movement of the spindle breaks off or otherwise opens this conduit end, admitting relatively high-pressure fluid to the pressure chamber and counteracting the end thrust.

Referring to the drawing for a more detailed understanding of my invention, I show a turbine casing at 10 in Figure 1, this casing enclosing a spindle 11 provided with impulse blading 12 and with reaction blading 13, all as is well known in the art.

High pressure steam or other motive fluid is admitted through a throttle valve 14 and a nozzle chamber 15 and, after suitable expansion, is exhausted at 16.

Thus, there is developed a heavy end thrust in the direction of the low-pressure end and I normally care for this end thrust in a thrust bearing 17, illustrated as of the Kingsbury type.

A septum or partition 18 is provided within the turbine casing at the low-pressure end thereof, this partition forming a pressure chamber 19 adjacent the low-pressure end of the spindle. The septum 18 preferably terminates in a thin edge adjacent to, but not touching the end of the spindle, as shown at 20. Under normal conditions, it will be obvious that the relatively low fluid pressure existing at the low-pressure end of the turbine is transmitted through the annular space between the spindle and the thin edge 20 so that the space 19 is normally at a relatively low pressure.

A conduit 21 is tapped through the turbine casing near the high-pressure end thereof, as at 22, and terminates within the chamber 19 closely adjacent the end of the spindle, as shown in greater detail at 23 in Figures 2 and 3. The end of the conduit 21 may be closed by a small block of fusible material, as shown at 24 in Figure 2 or the end of the conduit may be radically weakened, as shown at 25 in Figure 3.

If desired, a fluid-pressure motor device 26 may be connected in the conduit 21 and arranged to operate the throttle valve 14.

The motor device 26 comprises an operating piston 28 arranged within the operating cylinder 29, the piston having a rod 30 connected to the valve 14. The piston 28 normally occupies a position in the cylinder 29 between the conduit connection 21 with an inter-stage space of the turbine and the conduit connection 21′ leading to the chamber 19. As the end of the conduit in the chamber 19 is normally closed, steam may leak by the piston 28 and result in the building-up of pressure therebeyond, tending to urge the piston in such a direction as to open the valve 14. This tendency is also assisted by a spring 31 arranged between one end of the operating cylinder and one face of the piston. As soon as the end of the conduit is opened in either of the ways referred to, pressure on the spring side of the operating piston 28 is suddenly relieved with the result that the turbine inter-stage pressure is effective to move the operating piston 28 in a direction to close the valve 14 and to occupy a position beyond the connection of the conduit portion 21′ with the operating cylinder 29 such that the connections 21 and 21′ are in free communication to supply steam directly from the inter-stage space to the chamber 19.

Having thus described the arrangement of apparatus embodying my invention, the operation thereof is as follows: Under normal conditions, the spindle 11 is maintained in its proper longitudinal position by the thrust bearing 17 and does not bear against either the edge 20 of the septum 18 or against the end 23 of the conduit 21, and the conduit 21 is sealed so that no steam leakage occurs therethrough.

If, by the failure of the bearing 17, or for other reasons, the spindle 11 moves toward the low-pressure end under the action of the end thrust imposed thereupon and to such an extent as to endanger the blading, the spindle comes in contact with the thin edge 20, substantially closing chamber 19 and the end of the conduit 23 is then opened or unsealed, in the construction shown in Figure 2 by the fusion of the block 24 caused by the frictional heat engendered and by fracturing at the point 25 in the construction shown in Figure 3, the breaking off of the end of the conduit being facilitated by lugs 27 which may be mounted upon the spindle. The opening of the end of the conduit 23 at once admits fluid pressure to the substantially closed space 19 to such an extent as to substantially equalize the pressures exerted upon the spindle 11, causing the same to assume and maintain its proper position.

When the fluid-pressure motor device 26 is inserted in the conduit 21, the motion of fluid through this conduit into the chamber 19 causes the throttle valve 14 to close, shutting down the turbine or, if desired, the device 26 may be caused merely to ring an alarm device as where it is essential that the turbine remain in service.

While I have shown my invention in but two forms, it will be obvious to those skilled in the art that it is not so limited, but is susceptible of various other changes and modifications without departing from the spirit thereof, and I desire therefore, that only such limitations shall be placed thereupon as are imposed by the prior art or as are specifically set forth in the appended claims.

What I claim is:

1. The combination with a rotatable member subject to end thrust, of a thrust bearing for normally assuming said thrust, a source of fluid pressure, and means whereby, upon the failure of said thrust bearing and the consequent longitudinal movement of said rotatable member, said fluid pressure is released to act against said rotatable member to oppose said longitudinal movement thereof.

2. The combination with a fluid-pressure turbine having a spindle developing an end thrust, of a thrust bearing for normally assuming said thrust, and means whereby, upon the failure of said bearing to withstand said thrust and the consequent longitudinal movement of said spindle, pressure of motive fluid is applied to said spindle in opposition to said thrust.

3. The combination with a fluid-pressure turbine having a spindle, the longitudinal fluid pressure on said spindle normally being unbalanced, of mechanical means for normally counteracting said unbalance, and fluid-pressure means, operable upon a failure of said mechanical means, for counteracting said unbalance.

4. The combination with a fluid pressure turbine wherein an end thrust is developed upon its shaft, of a thrust bearing for normally assuming said thrust, a pressure chamber adjacent the spindle of said turbine, and normally subject to relatively low pressure, and means for admitting relatively high-pressure fluid to said chamber upon longitudinal movement of said spindle in excess of a predetermined amount, whereby said end thrust is counteracted.

5. The combination with a fluid-pressure turbine wherein an end thrust is developed upon its shaft, of a thrust bearing for normally assuming said end thrust, means for providing a pressure receiving surface on said spindle facing in the direction of thrust, an opposed fixed surface normally spaced therefrom, by a slight amount, and means whereby, upon longitudinal movement of said spindle in excess of a predetermined amount, said spacing is reduced and fluid pressure is admitted to the space between

said faces for the development of a pressure to substantially balance said end thrust.

6. The combination with a fluid-pressure turbine wherein an end thrust is developed upon its shaft, of a thrust bearing for normally assuming said end thrust, means for providing a pressure receiving surface on said spindle facing in the direction of thrust, an opposed fixed surface normally spaced therefrom by a slight amount, and a conduit connected to a source of fluid pressure and terminating in a closed end disposed between said surfaces, the arrangement being such that upon longitudinal movement of said spindle in excess of a predetermined amount, the end of said conduit is opened and fluid pressure is admitted to the space between said surfaces for the development of a pressure substantially balancing said end thrust.

7. The combination with a fluid-pressure turbine wherein an end thrust is developed upon its shaft, of a thrust bearing for normally assuming said end thrust, means for providing a pressure-receiving surface on said spindle facing in the direction of thrust, an opposed fixed surface normally spaced therefrom by a slight amount, a conduit connected to a source of fluid pressure and terminating in a closed end disposed between said surfaces, the arrangement being such that upon longitudinal movement of said spindle in excess of a predetermined amount, the end of said conduit is opened and fluid pressure is admitted to the space between said surfaces for the development of a pressure substantially balancing said end thrust, and means whereby the flow of fluid through said conduit cuts off the supply of motive fluid to said turbine.

8. The combination with a fluid-pressure turbine wherein an end thrust is developed along its shaft, of a thrust bearing for normally assuming said thrust, the spindle of said turbine presenting a substantially plane surface in the direction of said thrust, a fixed cup-shaped member annularly disposed about the shaft of said turbine and concave toward said plane surface, said cup-shaped member being provided with a thin edge adjacent to said plane face, and a conduit connected to a source of fluid pressure and terminating in a closed end closely adjacent to said plane face and within said cup-shaped member, the arrangement being such that upon longitudinal movement of said spindle in excess of a predetermined amount, said plane face substantially contacts with said thin edge and further contacts with the end of said conduit, opening said closed end and admitting fluid pressure to the substantially closed space thus formed, setting up a fluid pressure against said spindle to substantially balance said end thrust.

9. The combination with a fluid-pressure turbine wherein an end thrust is developed along the shaft, of a thrust bearing for normally assuming said thrust, the spindle of said turbine presenting a substantially plane surface in the direction of said thrust, a fixed cup-shaped member annularly disposed about the shaft of said turbine and concave toward said plane surface, said cup-shaped member being provided with a thin edge adjacent to said plane face, a conduit connected to a source of fluid pressure and terminating within said cup-shaped member and closely adjacent said plane face in a closed end, the arrangement being such that upon longitudinal movement of said spindle in excess of a predetermined amount, said plane face substantially contacts with said thin edge and further contacts with the end of said conduit, opening said closed end and admitting fluid-pressure to the substantially closed space thus formed, setting up a fluid pressure against said spindle to substantially balance said end thrust, and fluid pressure means whereby the flow of fluid through said conduit cuts off the supply of motive fluid to said turbine.

10. The combination with a fluid-pressure turbine wherein an end thrust is developed along the shaft, of a thrust bearing for normally assuming said thrust, the spindle of said turbine presenting a substantially plane surface in the direction of said thrust, a fixed cup-shaped member annularly disposed about the shaft of said turbine and concave toward said plane surface, said cup-shaped member being provided with a thin edge adjacent to said plane face, and a conduit connected to a source of fluid pressure and terminating within said cup-shaped member and closely adjacent said plane face in a closed end, said conduit being radically weakened a short distance back from said end, whereby, upon a movement of said spindle in the direction of thrust in excess of a predetermined amount, said cup member substantially contacts with said conduit end, breaking it off and admitting fluid pressure to said closed space for the development of a fluid pressure within said closed space substantially balancing said end thrust.

11. The combination with a fluid-pressure turbine wherein there is a gradation in pressure along the spindle resulting in an unbalanced end thrust on said spindle, of a thrust bearing for normally assuming said end thrust, a pressure chamber adjacent said spindle and normally subject to relatively low pressure, and means for connecting said pressure chamber to a relatively high-pressure space of said turbine upon the longitudinal movement of said spindle in excess of a predetermined amount and in the direction of said thrust, whereby a pressure is excited against said spindle to substantially balance said end thrust.

12. The combination with a fluid-pressure turbine, wherein there is a gradation in pressure along the spindle resulting in an unbalanced end thrust on said spindle, of a thrust bearing for normally assuming said end thrust, a pressure chamber adjacent said spindle and normally subject to relatively low pressure, and a conduit connecting said pressure chamber with a relatively high-pressure space in said turbine, said conduit terminating within said pressure chamber in a closed end closely adjacent an end portion of said spindle, whereby upon excessive endwise motion of said spindle, said conduit end is opened and relatively high pressure fluid is admitted to said pressure chamber to counteract said end thrust.

In testimony whereof, I have hereunto subscribed my name this 3rd day of May, 1921.

HERBERT T. HERR.