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Fischer

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[54] **MOISTURE REMOVAL DEVICE FOR A STEAM TURBINE**

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[73] Assignee: **Westinghouse Electric Corporation**, Pittsburgh, Pa.

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[52] **U.S. Cl.** **415/168**, 415/DIG. 1

[51] **Int. Cl.** **F01d 25/32**, F01d 15/00

[58] **Field of Search** .....415/DIG. 1, 121 A, 168

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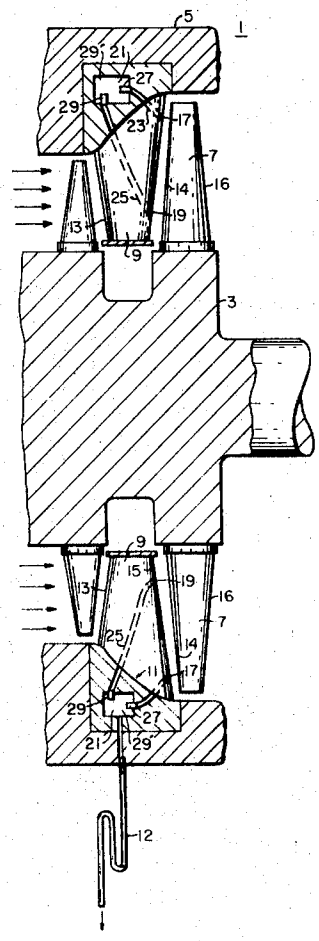
[57] **ABSTRACT**

A row of stationary blades of the steam turbine having interconnecting cavities in the base portions thereof to form an annular chamber which cooperates with inlet and outlet ports disposed adjacent the trailing edges of these blades and adjacent the casing and rotor respectively to remove water and steam from the stationary blades, to separate the water and steam, and to direct the steam toward an adjacent row of rotating blades and the water to a drain.

8 Claims, 2 Drawing Figures



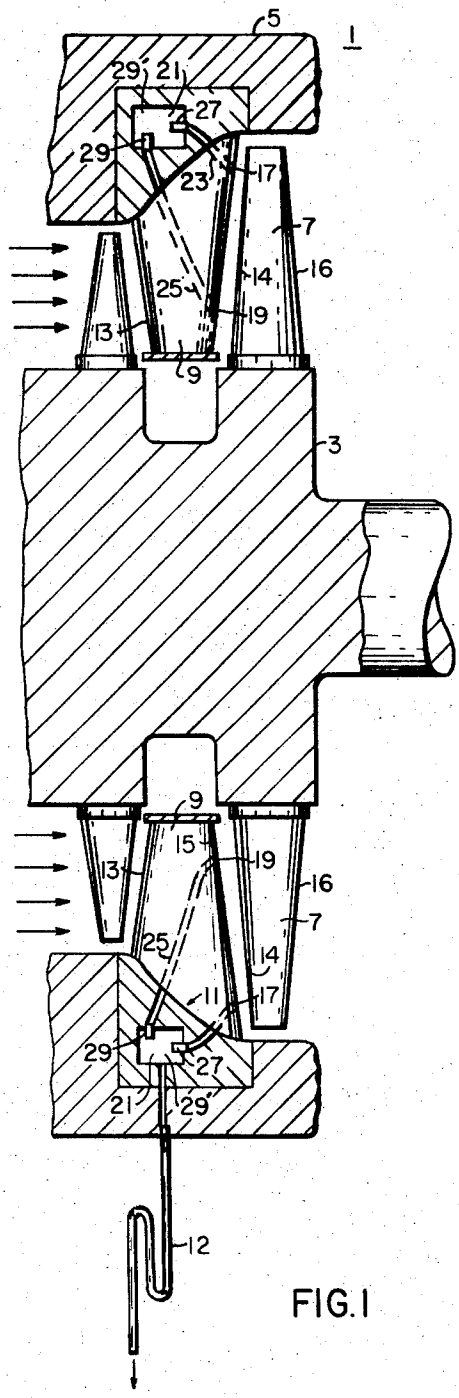

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FIG. 1

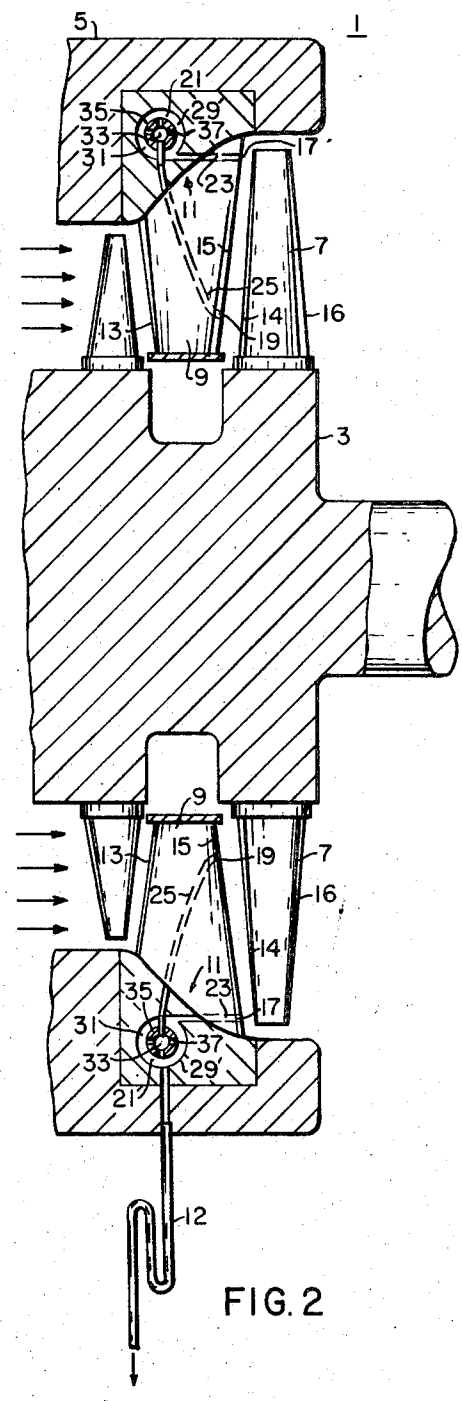
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FIG. 2

MOISTURE REMOVAL DEVICE FOR A STEAM TURBINE

BACKGROUND OF THE INVENTION

This invention relates to removing water from the motive steam which drives a steam turbine and more particularly to removing water from the casing end of the low pressure stationary blades of a steam turbine.

Water droplets, which collect on the trailing edges of the low pressure stationary blades are swept off by the steam passing thereby. The droplets are large and move at relatively low velocities compared to the velocities of the tips of the rotating blades. Thus, as the water droplets collide with the rotating blades the impact is high resulting in erosion of the rotating blade.

Since the tips of the leading edges of low pressure rotating blades are the primary erosion areas, it is a common practice to coat or form the tips of these blades with a hard erosion resistant material, such as Stellite. However, providing the erosion resistant leading edge on the rotating blades is expensive and may weaken the blades.

Low pressure rotating blades may also be protected from erosion caused by water droplets by providing a suction slot adjacent the trailing edge of the stationary blades and connecting the slots directly to the condenser. While this removes much of the water, it also extracts steam, which could be utilized to perform work.

Increasing the spacing between the rotating blades and the stationary blades will increase the velocity of the water droplets and reduce the impact velocity of the water droplets as they impinge on the rotating blades to reduce erosion. However, this increases the turbine length, weight, and cost.

SUMMARY OF THE INVENTION

In general, a turbine operated by motive steam, when made in accordance with this invention, has a rotor, a casing encircling the rotor, an annular array of circumferentially spaced rotatable blades, an annular array of circumferentially spaced stationary blades, a condensate drain and a device disposed in the stationary blades for removing water and steam from the motive steam, separating the steam and water, returning the steam to perform additional work on the rotating blades, and directing the water to the drain.

BRIEF DESCRIPTION OF THE DRAWINGS

The objects and advantages of this invention will become more apparent from reading the following detailed description in connection with the accompanying drawings, in which corresponding reference characters indicate corresponding portions in the various drawings and in which;

FIG. 1 is a partial sectional view of a turbine having stationary blades made in accordance with this invention; and

FIG. 2 is a partial sectional view similar to FIG. 1 showing a modification.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring now to the drawings in detail, FIGS. 1 and 2 show a steam turbine 1 having a rotor 3, a casing 5 encircling the rotor 3, an annular array of circumferentially spaced rotatable blades 7 fastened to the rotor 3, an annular array of circumferentially spaced stationary blades or nozzles 9 fastened to the casing 5 and a device 11 disposed in the stationary blades 9 for removing water and steam from the motive steam as the water passes over the stationary blades, separating the steam from the water, returning the steam to perform additional work on the rotating blades 7 and directing the water to a drain 12.

Motive steam flows through the blades 7 and 9 from left to right, as shown in the drawings, and the blades 7 and 9 have a general air foil shaped cross section with the leading edges 13 and 14 on the left and the trailing edges 15 and 16 on the right.

As shown in FIG. 1, the device 11 comprises an inlet or first port 17 disposed adjacent the casing 5 and trailing edge 15 of the stationary blades 9, an outlet or second port 19 disposed adjacent the rotor 3 and trailing edge 15 of the stationary blade 9, and a chamber 21 placed in communication with the ports 17 and 19 by inlet or first ducts 23 and outlet or second ducts 25, respectively. The ducts 23 and 25 terminate in the chamber 21 and have short nozzles 27 and 29, respectively, which extend into the chamber 21 to prevent reentrainment of the water and steam which separate due to a reduction in the velocity of the mixture entering the chamber 21. Water separated from the mixture flows by gravity to the drain 12 and moisture-free steam flows to the outlet port 19 as a result of the difference in pressure between the inlet and outlet ports 17 and 19, resulting from their respective locations and the higher pressures which are created adjacent the casing due to the centrifugal forces acting on the motive steam. The same forces cause the moisture or water in the steam to be spun outwardly toward the casing.

The arrangement of the ducts 23 and 25 shown in FIG. 1 is such that there will be essentially no reentrainment of water droplets in the steam flowing through the discharge duct 25 irrespective of the radial orientation of the stationary blades.

The annular chamber 21 is formed from interconnecting, registering cavities 29 in the base portions of the stationary blades 9. If required, peripheral seals or gaskets may be disposed between adjacent base portions to form a seal around the cavity to produce the annular sealed chamber 21.

FIG. 2 shows a modification, wherein the annular chamber 21 has an outer compartment 31 and an inner compartment 33. The inlet port 17 is brought into direct communication with the outer compartment 31 by the inlet duct 23 and the outlet port 19 is brought in direct communication with the inner compartment 33 by the outlet duct 25. Walls 35, separating the inner compartment 33 from the outer compartment 31, have a plurality of opening 37, which allow steam to flow freely from the outer to the inner compartment. The outer compartment 31 has a larger volume than the inner compartment 33, so as to allow the steam and water mixture entering through the inlet ports 17 and ducts 23 to slow down so that the water separates from the steam. The water then flows by gravity to the drain 12, while the steam flows into the inner compartment 33 and out the outlet ducts 25 and ports 19. The inlet

and outlet ducts 17 and 19 may be disposed to cooperate with the inner and outer compartments 31 and 33 to foster centrifugal separation of the mixture of steam and water and thereby effectuate more complete separation.

The stationary blades with cooperatively associated chambers, ports, and ducts, hereinbefore described advantageously extract some steam with the moisture, which greatly enhances the effectiveness of the moisture removal from the blades and by separating the moisture from the steam and returning the steam to the main steam flow to perform additional work on the downstream rotating blade provides optimum moisture removal with a minimum loss of motive steam.

What is claimed is:

1. A turbine operated by motive steam and having a rotor, a casing encircling said rotor, an annular array of circumferentially spaced rotatable blades, an annular array of circumferentially spaced stationary blades, a condensate drain, and means disposed in said stationary blades for removing water and steam from the motive steam, separating the steam and water, returning the steam to perform additional work on the rotatable blades, and directing the water to the drain.

2. A turbine as set forth in claim 1, wherein the blades have a general air foil shaped cross section with leading and trailing edges and the removal and separating means comprises a first port disposed adjacent the trailing edge of the stationary blade and the casing, a second port disposed adjacent the rotor, and a chamber in communication with said ports, said chamber being sufficiently large to reduce the velocity of the steam and water mixture entering through the first port to cause separation thereof and the second port being disposed to allow steam to flow from said chamber to rejoin the motive steam.

3. A turbine as set forth in claim 2, wherein the second port is disposed adjacent the trailing edge of the stationary blade.

4. A turbine as set forth in claim 2, wherein interconnecting cavities in the stationary blades register to form the chamber.

5. A turbine as set forth in claim 2, wherein the first port communicates with said chamber through a first duct and the second port communicates with said chamber through a second duct and said first and second ducts are so disposed with respect to the chamber that they cooperate with the chamber to provide separation of water and steam irrespective of the radial orientation of the stationary blades.

6. A turbine as set forth in claim 2, wherein the chamber comprises an inner compartment and an outer compartment there being a variety of openings between said compartments and the first port is in direct communication with said outer compartment and the second port is in direct communication with the inner compartment.

7. A turbine as set forth in claim 5, wherein the inner compartments register to form an inner annular chamber and the outer compartments register to form an outer annular chamber containing said inner annular chamber.

8. A turbine as set forth in claim 7, wherein the volume of the inner annular chamber is less than the volume of the outer annular chamber.

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