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TIGHTENING DEVICE FOR RADIAL FLOW STEAM TURBINES

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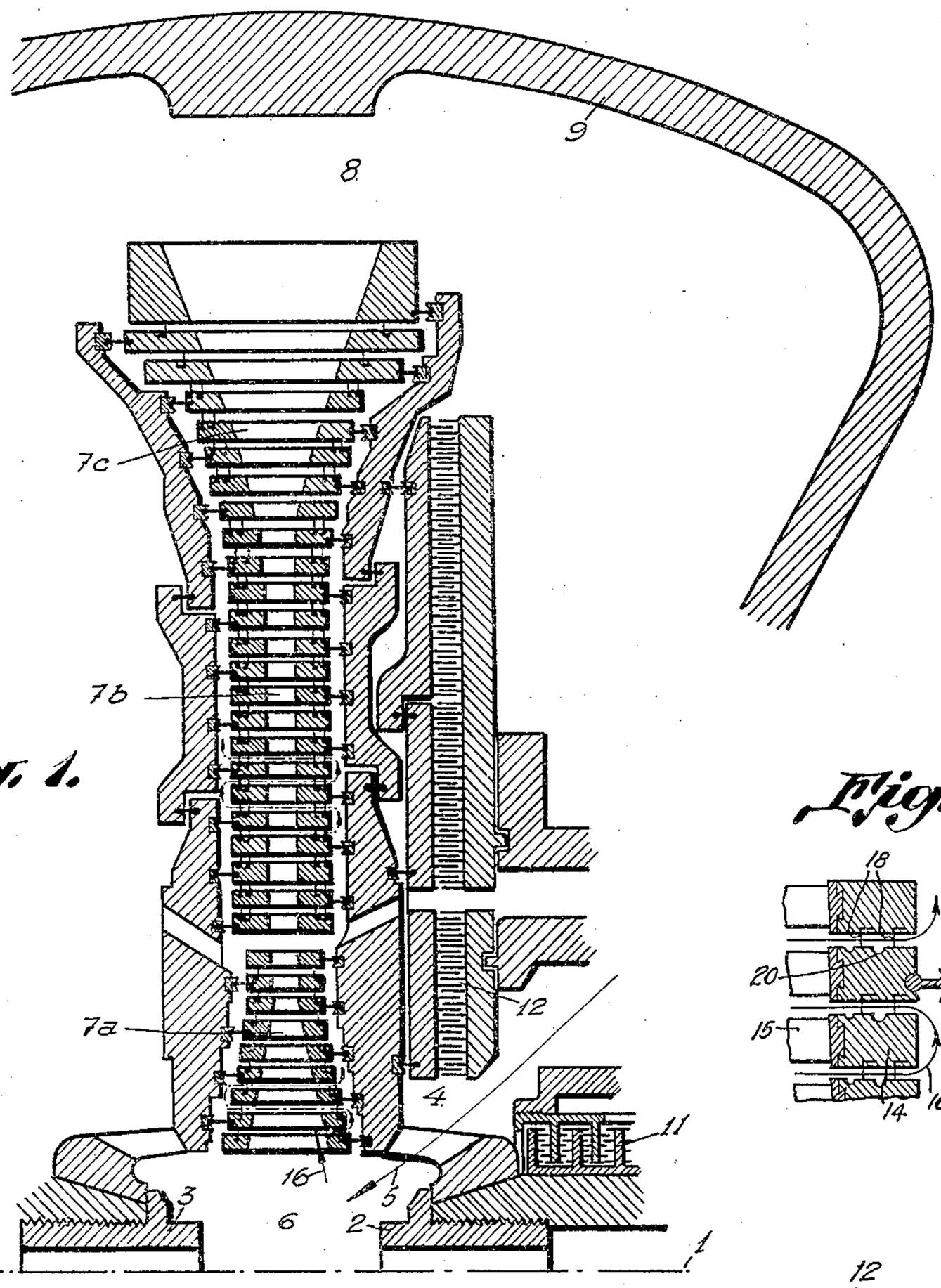

Fig. 1.

Fig. 3.

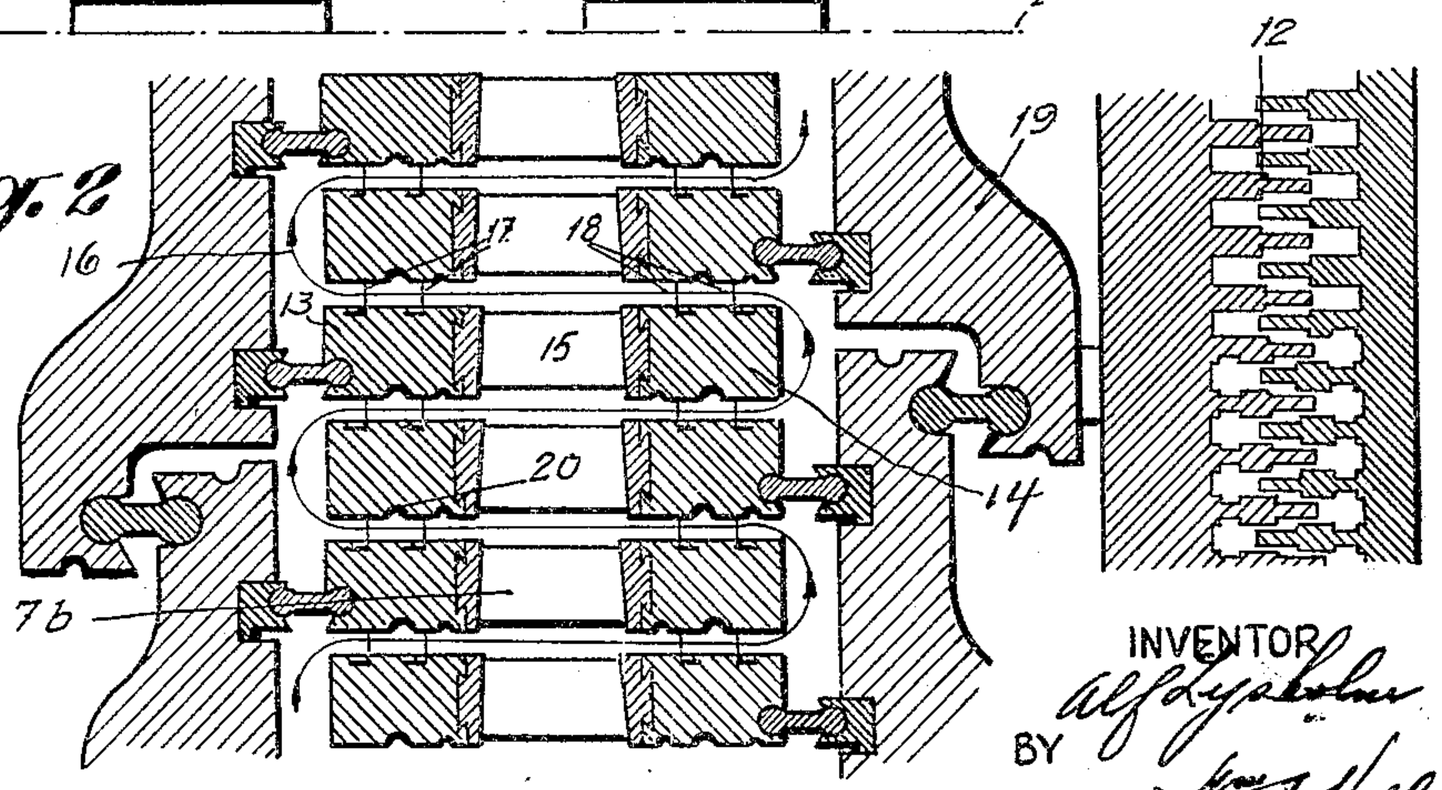

Fig. 2

INVENTOR
A. Lysholm
BY
Wm. A. Redmond
his ATTORNEY

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ALF LYSHOLM, OF STOCKHOLM, SWEDEN, ASSIGNOR TO AKTIEBOLAGET LJUNGSTRÖMS ÅNGTURBIN, OF STOCKHOLM, SWEDEN, A JOINT-STOCK COMPANY OF SWEDEN

TIGHTENING DEVICE FOR RADIAL FLOW STEAM TURBINES

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Radial flow gas or steam turbines have already been designed, in which a plurality of blade rings inserted in between each other each consists of two or several ring bonds having blades fixed between the bonds.

It has already been proposed to reduce the leakage of the steam passing from the center of the turbine radially through the blade rings under pressure and heat drop, which leakage is caused by lack of tightness between the concentrically arranged blade rings, by means of a radially disposed tightening edge applied to each of the ring bonds. As the development in the technology of steam has led to higher initial pressures of the live steam, which has caused certain modifications with respect to the dimensions of the various blades, the tightening devices hitherto known are no longer sufficient, and a great portion of the live steam can leak out in passing the various blades, whereby the efficiency of the turbine will be reduced.

The present invention relates to turbines of the above described type and has for a principal object the provision of new and improved tightening means which materially reduces or eliminates the losses due to leakage. In accordance with one phase of the invention two or more tightening edges, which individually may be of known type, are arranged on each of one or more of the ring bonds together with means between adjacent tightening edges for creating turbulence of flow of steam in the direction of leakage. In accordance with another phase of the invention, the number and arrangement of the tightening edges is made different in different pressure stages of the turbine, as will be more fully described in the following description of suitable embodiments of the invention, which by way of example are illustrated in the accompanying drawing forming a part of this specification.

Fig. 1 shows a section through a turbine according to the invention.

Fig. 2 shows a detail of Fig. 1 on a larger scale.

Fig. 3 shows a modification of a part of the detailed view shown in Fig. 2.

In Fig. 1, the center line of the turbine shaft is designated by 1, while 2 and 3 designate the turbine shafts rotating in opposite directions. The steam enters the turbine through the channel 4 in the direction of the arrow 5 and passes from the central space 6 through the blade rings 7*a*, 7*b*, 7*c* in radial direction to the outlet 8 which towards the outside is limited by the turbine housing 9. The steam being under high pressure in the central space 6 has a tendency to pass not only through the blade rings 7*a*, 7*b* and 7*c* but also to leak out through the stuffing boxes 11, the labyrinth packings 12 and between the blade rings, as indicated by the arrow 16. It can be assumed that the same amount of steam is passing continuously through the various blade rings. If the blade system comprises a great number of blade rings, then the steam leaking out therethrough has to follow a longer path with several throttling places, while if the blade system comprises a less number of blade rings, this path will have less throttling places and be shorter. In previous constructions in which each ring bond only had one tightening edge, the steam therefore had to pass a certain number of tightening places. As, however, nowadays a blade system can be constructed for the same initial pressure of the live steam but with a less number of blade rings, because each blade ring can be produced having a greater radial extension, the steam leaking out has now to pass a less number of tightening places. According to the invention, especially the intermediate blades 7*b* are provided with two tightening edges which are more clearly illustrated in Fig. 2.

Referring to Fig. 2, 13 and 14 designate ring bonds to which are affixed in known manner the blades 15, these parts together constituting a blade ring. Also in this figure there is to be observed the arrow 16 which indicates the path of the leaking steam between the blade rings. On each ring bond 13 or 14 are arranged two tightening edges 17 and 18 extending towards two adjacent parts, in this case towards the ring bond of the blade ring which lies radially outside the former ring. These tightening edges are of known type and united in known manner

with the ring bonds. In this form of embodiment the tightening edges may be arranged on the outside thereof, seen from the center of the turbine, and they extend then radially towards the ring bond situated on the outside thereof.

According to the invention, two or more tightening edges may, however, also be positioned, as shown in Fig. 3, on that side of the ring bond which is directed towards the center of the turbine and extend then radially towards the ring bond situated on the inside thereof. According to the invention there are, however, also arranged uneven grooves, ridges or the like between the tightening edges, which in such a case should be positioned in opposition to the direction of the steam passage, so that eddies will be produced to the greatest possible extent in the space between the tightening edges. In Fig. 2 grooves 20 in the ring bonds have been shown for this purpose. As already pointed out preferably only the ring bonds of the blade rings intermediate with respect to the direction of the steam passage are provided with double tightenings, while one or more of the first and the last ring bonds of the blade rings are provided with one tightening edge only. The double tightening edges therefore are arranged at such places in the turbine, at which the steam pressure in relation to the length of the tightening edge offers the possibility of greater leakage between the blades.

The invention is not to be limited to the single embodiment shown for the purpose of illustration, since several forms according to this invention are conceivable. For example, the invention does not depend upon the type of blades or ring bonds, or whether the turbine is a combined axial and radial flow system. Furthermore, it is immaterial whether the turbine is of the radial flow type having one rotating shaft or turbine disc or two.

What I claim as new and desire to secure by Letters Patent of the United States of America is:—

1. In a radial flow elastic fluid turbine, a plurality of radially spaced relatively rotatable ring bonds for carrying the turbine blades, tightening means comprising a plurality of axially spaced tightening edges extending in generally radial direction from one bond toward an adjacent bond and means for creating turbulence in the flow of fluid axially between said edges.

2. In a radial flow elastic fluid turbine, a plurality of radially spaced relatively rotatable ring bonds for carrying the turbine blades, tightening means comprising a plurality of axially spaced tightening edges extending in generally radial direction from one bond toward an adjacent bond and means comprising an irregular surface on one of said ring bonds axially between two adjacent tightening edges for creating turbulence in the flow of fluid axially between said edges.

3. In a radial flow elastic fluid turbine, a plurality of radially spaced relatively rotatable ring bonds for carrying the turbine blades, tightening means comprising a plurality of axially spaced tightening edges extending in generally radial direction from one bond toward an adjacent bond and means comprising a circumferential groove in said adjacent ring bond and axially between two adjacent tightening edges for creating turbulence in the flow of fluid axially between said edges.

4. In a radial flow elastic fluid turbine, a plurality of radially spaced relatively rotatable pairs of ring bonds for carrying the turbine blades, each ring bond of one or more of said pairs being provided with at least two tightening edges extending in generally radial direction toward adjacent ring bonds, and circumferential grooves in said adjacent ring bonds, there being a groove axially between each two of said tightening edges.

5. In a multiple-stage radial flow elastic fluid turbine, a plurality of radially spaced relatively rotatable ring bonds for carrying the turbine blades, the ring bonds in the high pressure stages and low pressure stages each having a single tightening edge extending therefrom in generally radial direction toward an adjacent ring bond and the ring bonds in the intermediate pressure stages each having a plurality of tightening edges extending therefrom in generally radial direction toward an adjacent ring bond, and means for creating turbulence in the flow of fluid axially between adjacent tightening edges in said intermediate pressure stage.

6. In a multiple-stage radial flow elastic fluid turbine, a plurality of radially spaced relatively rotatable ring bonds for carrying the turbine blades, the ring bonds in the high pressure stages and the low pressure stages each having a single tightening edge extending therefrom in generally radial direction toward an adjacent ring bond, the ring bonds in the intermediate pressure stages each having a plurality of tightening edges extending therefrom in generally radial direction toward an adjacent ring bond and circumferential grooves in the ring bonds of the intermediate pressure stages, said grooves being disposed axially between adjacent tightening edges.

ALF LYSHOLM.