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U. MEININGHAUS

BALANCING THE THRUST OF BLADED DISCS IN RADIAL FLOW ROTARY MACHINES

Filed Feb. 19, 1941

Serial No.
379,610

2 Sheets-Sheet 1

Fig. 1

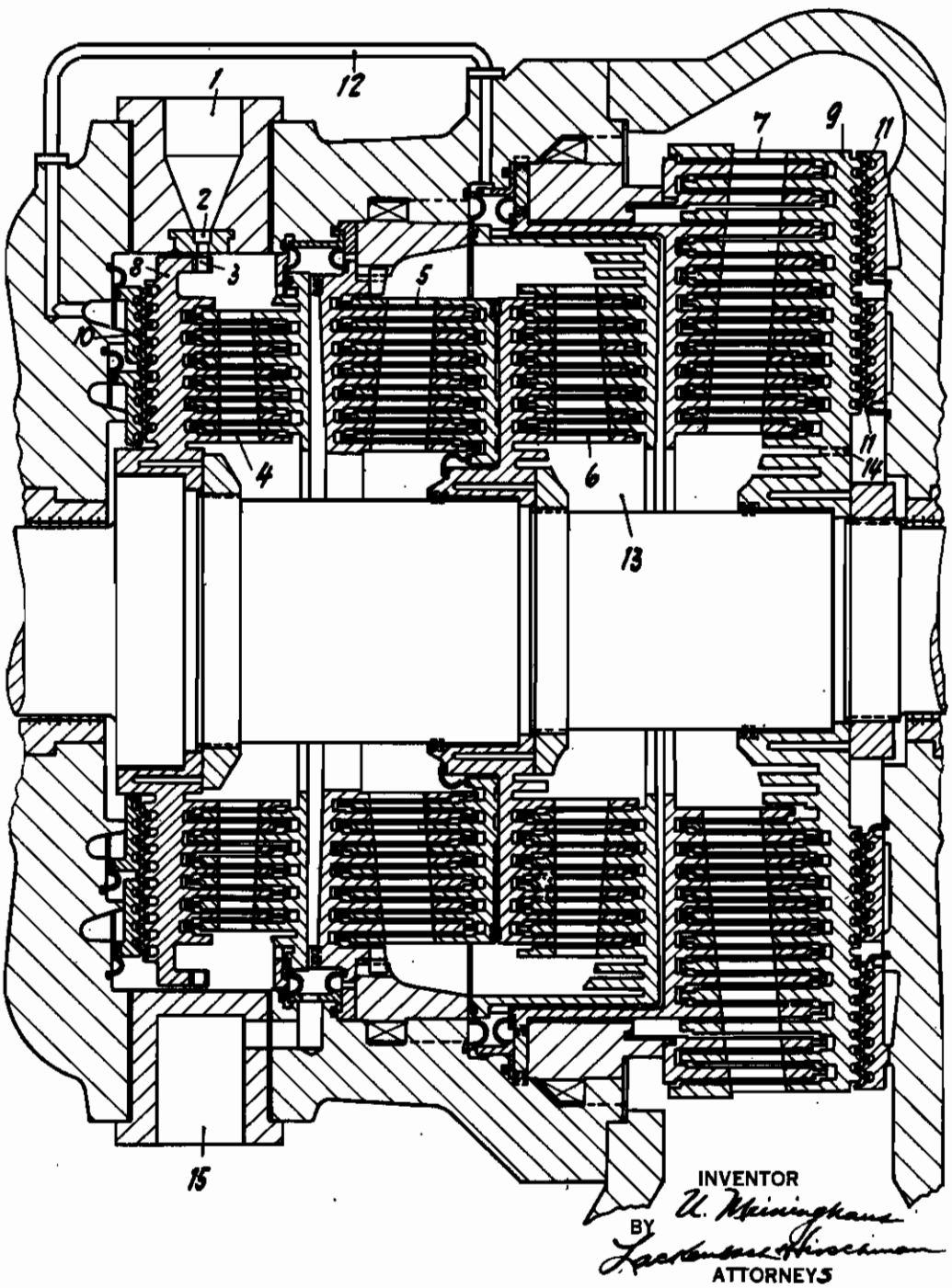

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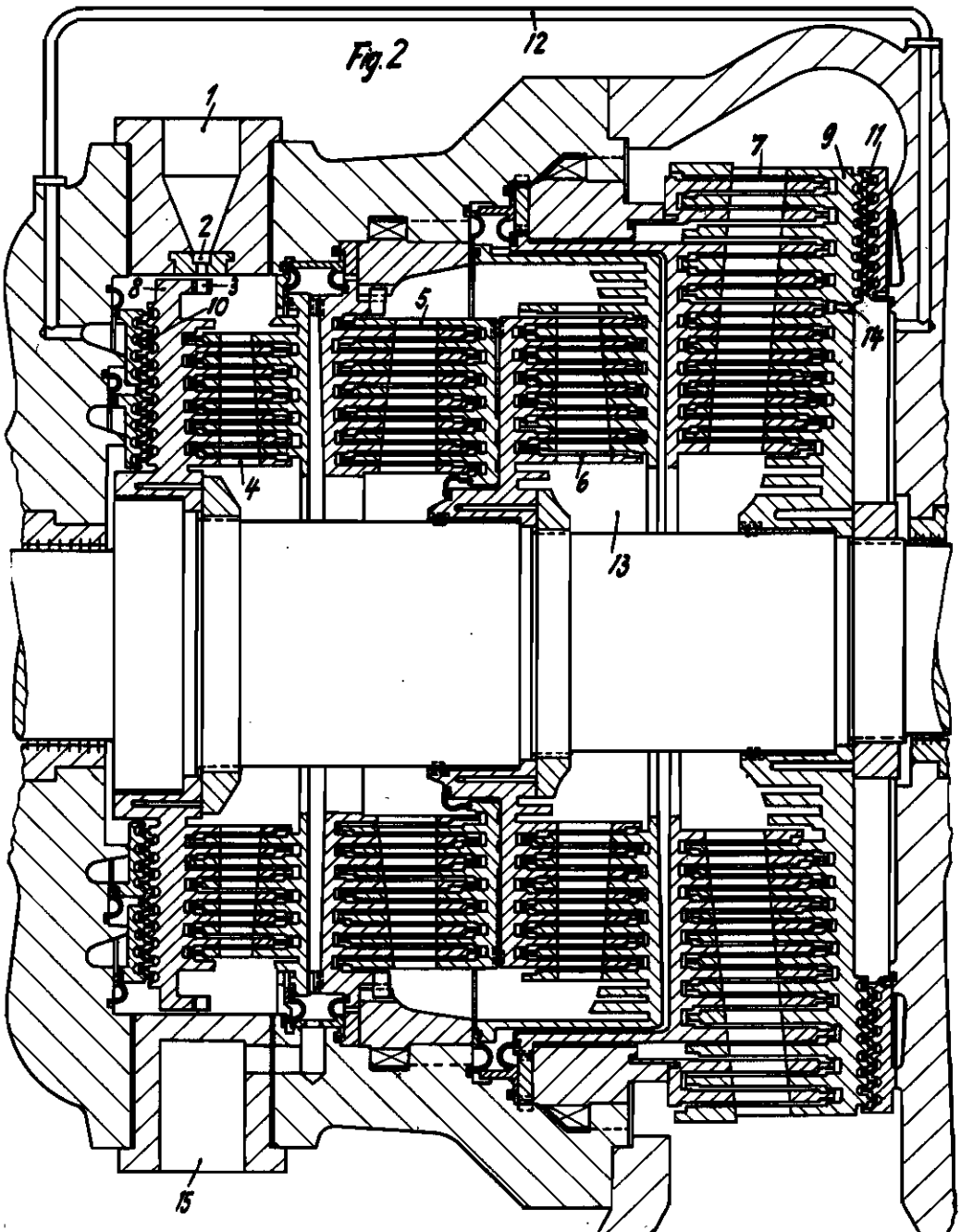
Fig. 2



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ALIEN PROPERTY CUSTODIAN

BALANCING THE THRUST OF BLADED DISCS IN RADIAL FLOW ROTARY MACHINES

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Application filed February 19, 1941

The present invention relates to rotary machines such as steam or gas turbines in which a working medium flows through a plurality of blades in a radial direction, varying in pressure during such flow.

It is the general object of the invention to provide an improved balancing of the thrusts of the discs carrying the radially traversed blades, and in particular to balance the thrusts of a plurality of such bladed discs by the thrust of one single inwardly traversed labyrinth and jet to secure an almost perfect balance at all conditions. Other, more specific objects of the invention will appear from the detailed description hereinafter.

The accompanying drawings illustrate by way of example two embodiments of the invention. Figs. 1 and 2 of the accompanying drawings are vertical sections through radial flow steam turbines constructed according to the invention.

In Fig. 1 the steam enters the turbine at 1, impinges the nozzles 2 and the blades 3 of the velocity stage and then flows through the radially traversed reaction blades 4 to 7. The rear sides of the wheels 8 and 9 which carry the blades 3 and 7 are each fitted with a labyrinth packing 10 and 11. The labyrinth packing 10 is connected at its outer circumference with the space behind the nozzles 2, that means with the steam before it enters the first radial flow blading 4; at its inner half, it is connected with the space 13 between the bladings 8 and 7 by means of the pipe 12. The steam of this space 13 flows to the labyrinth packing 11 through the holes 14 in the wheel 9. The labyrinth packing 11 equalizes in good approximation the axial thrust of the blading 7. It would be possible to guide the leaking steam from the pipe 12 directly to the labyrinth packing 11, but with the illustrated arrangement I gain the advantage that the hot leakage steam increases the work transformed in the blading 7 and that comparatively cold steam which gave off part of its heat content in the bladings 4 to 6 enters the labyrinth packing 11. The flange 15 between the bladings 5 and 4 may serve for admitting by-pass-steam or for bleeding.

By leading the first connection of the inner part of the inwardly traversed labyrinth packing 10 with the steam flow through the blading by means of the pipe 12 to a point behind the second plane of the radially traversed blading 5, but before the outlet of the last plane of the radially traversed blading 7 I obtain for the first time a characteristic of the change in thrust for the inwardly traversed labyrinth packing 10 which coincides surprisingly well with the characteristic of change in thrust for the radial flow blading. Generally these characteristics differ in a degree that makes the convenient form of the inwardly traversed labyrinth packing unfitted for balancing the thrust of high pressure turbines. The main reason for this disadvantage lies in the fact that the diameters of the labyrinths and therewith the size of the throttling areas decrease whilst the steam expands. The best effect is reached when the first connection of the inner part of the inwardly traversed labyrinth packing 10 with the steam flow through the blading is led as shown in Fig. 1 by means of the pipe 12 to a point between the third plane 6 and the fourth plane 7 of the radially traversed blading. It is then possible to admit by-pass-steam or to bleed steam at 15 between the second and third planes 5 and 6 without disturbing the balance of the thrusts. I prefer to provide an additional labyrinth packing 11 which is traversed in an outward direction to relieve the thrust of the labyrinth packing 10 at least by the thrust of one plane of the radial flow blading. Such outwardly traversed labyrinth packing 11 may advantageously be arranged at the rear side of the last wheel 9 and balance about the axial thrust of the blading 7 of such wheel. By such arrangement I obtain a practical perfect balance at all conditions with simple parts and a great compactness. When the steam volume is large, the wheel 9 may carry on the rear side also blades traversed parallel to the blading 7 instead of the labyrinth packing 11.

In Fig. 2 for which the same reference characters apply as for Fig. 1 the inner part of the outwardly traversed labyrinth packing 11 is taken off up to a diameter which about corresponds to the mean outer diameter of the bladings 4, 5 and 6. The connection of the inner part of the inwardly traversed labyrinth packing 10 with the steam flow in the blading leads through pipe 12 to the inner diameter of the outwardly traversed labyrinth packing 11 and through the holes 14 in the wheel 9 to the corresponding point of the blading 7. With this arrangement I balance the sum of the thrusts of the bladings 4, 5, 6 and of the inner part of the blading 7 by the thrusts of the inwardly traversed labyrinth packing 10. Only the thrust of the outer rim of the blading 7 is balanced by the outwardly traversed labyrinth packing 11. As the areas of the bladings 4 to 7 as far as they are balanced by the labyrinth packing 10 are approximately equal any change

in course of the pressure drop through such blading does hardly effect the balance. The pressure at the shaft glands is further reduced and the arrangement simplified as compared with Fig. 1. But the perfectness of balance at all conditions is the best with the arrangement of Fig. 1.

Obviously, my invention is not restricted to rotary machines of the specific form illustrated, but for example may be used with machines having axially traversed blades or labyrinths which are staggered in radial direction.

ULRICH MEININGHAUS.