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Keller et al.

[11] **3,861,821**

[45] **Jan. 21, 1975**

[54] **DEVICE FOR PRODUCING ANGULAR MOMENTUM IN A FLOW OF WORKING FLUID UPSTREAM OF THE FIRST ROTOR BLADE OF AN AXIAL-FLOW TURBOMACHINE**

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[22] Filed: **Mar. 14, 1973**

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[30] **Foreign Application Priority Data**

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[52] **U.S. Cl.** **415/101,** 415/184, 415/203

[51] **Int. Cl.** **F01d 3/02,** F01d 1/02, F01d 9/00

[58] **Field of Search** 415/185, 202, 101, 102, 415/103, 216, 217, 183, 208, 503, 203, 184; 239/468

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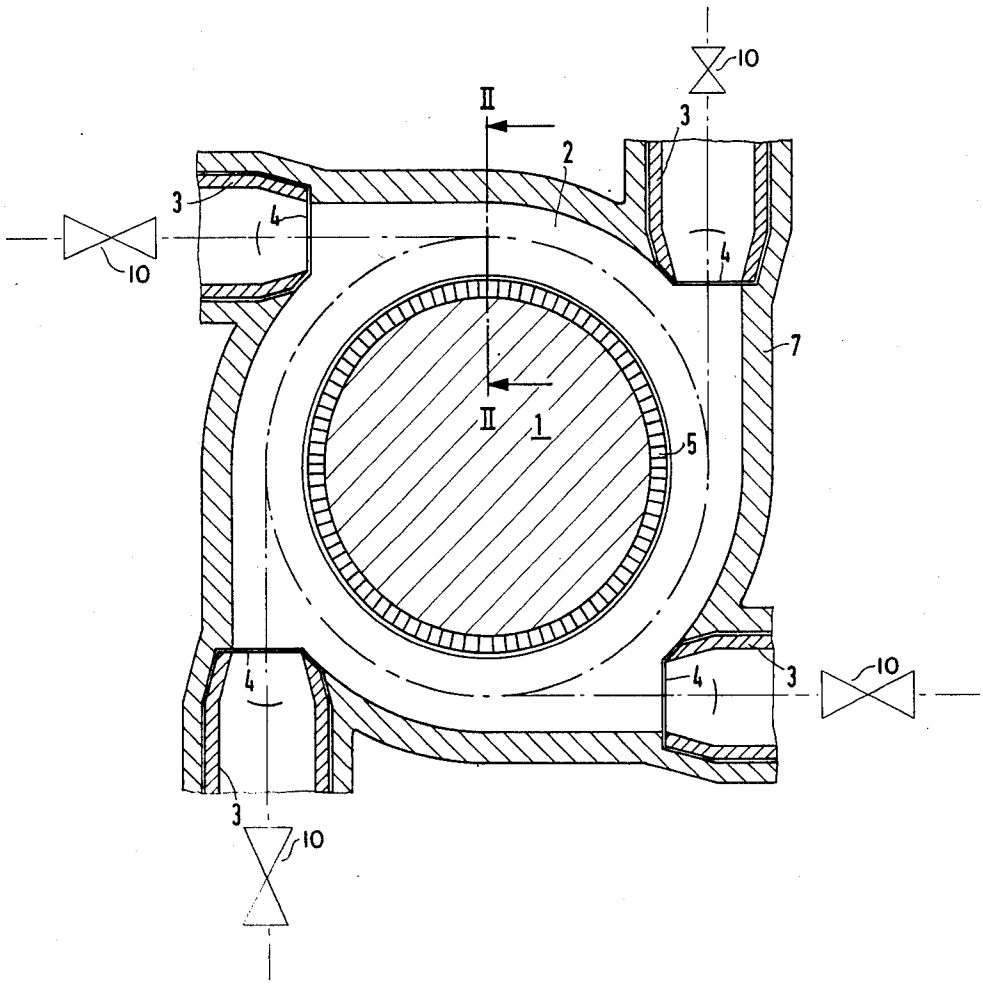
Assistant Examiner—Louis J. Casaregola
Attorney, Agent, or Firm—Herbert L. Lerner

[57] **ABSTRACT**

To produce angular momentum in a flow of working fluid at a location of an axial-flow turbomachine upstream of the first rotor blade ring thereof, there is provided a ring space located upstream of the first rotor blade ring in flow direction of a flow of working fluid which acts in axial direction directly upon the first rotor blade ring without first impinging on a preceding guide vane ring, at least one working fluid inlet extending tangentially to and communicating with the ring space, and being provided, if desired, with a throttling member for controlling the flow of working fluid through the working fluid inlet.

2 Claims, 4 Drawing Figures



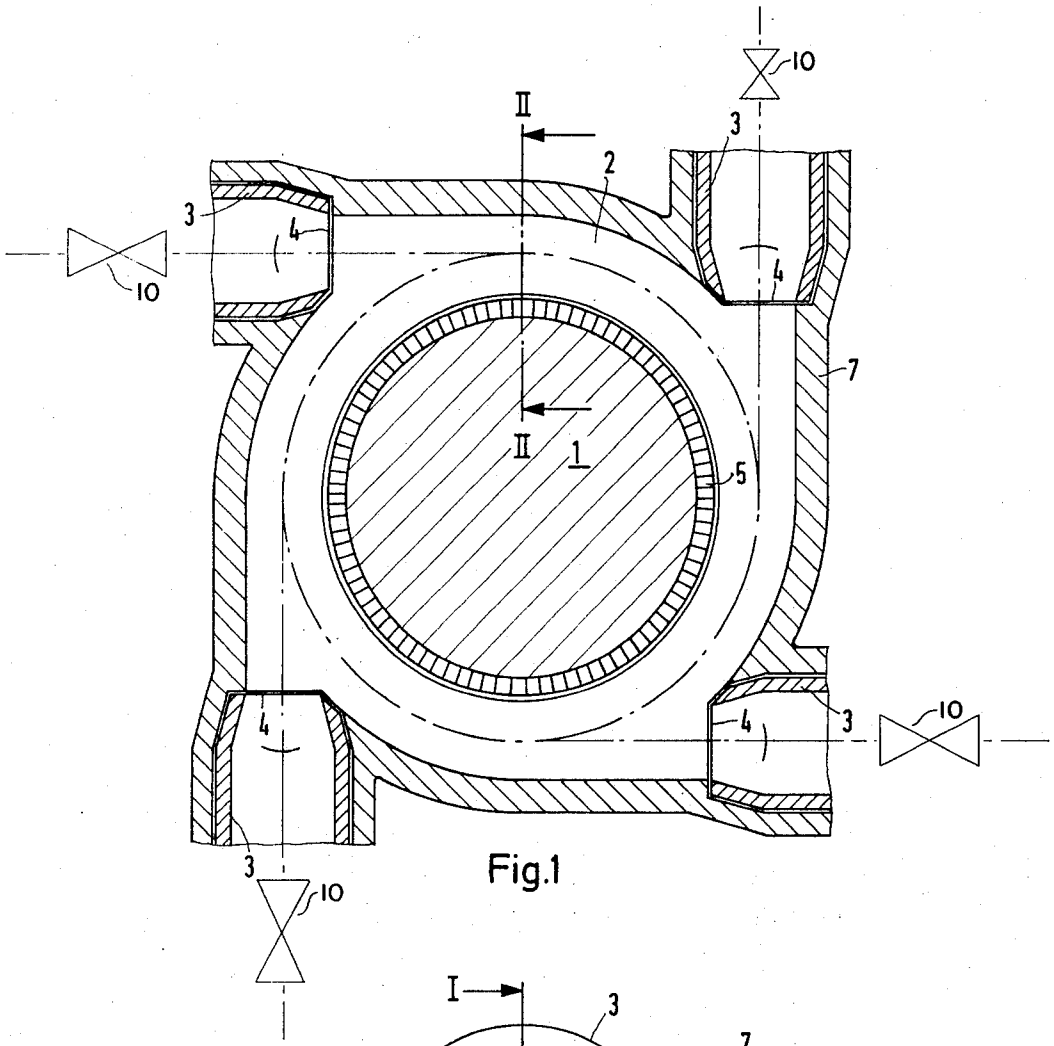


Fig.1

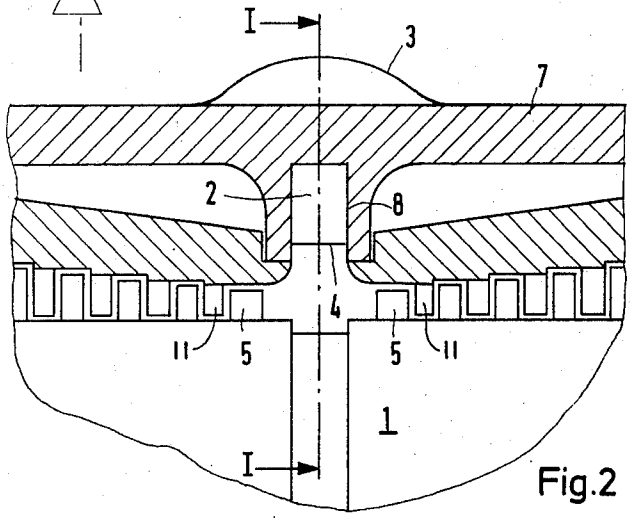


Fig.2

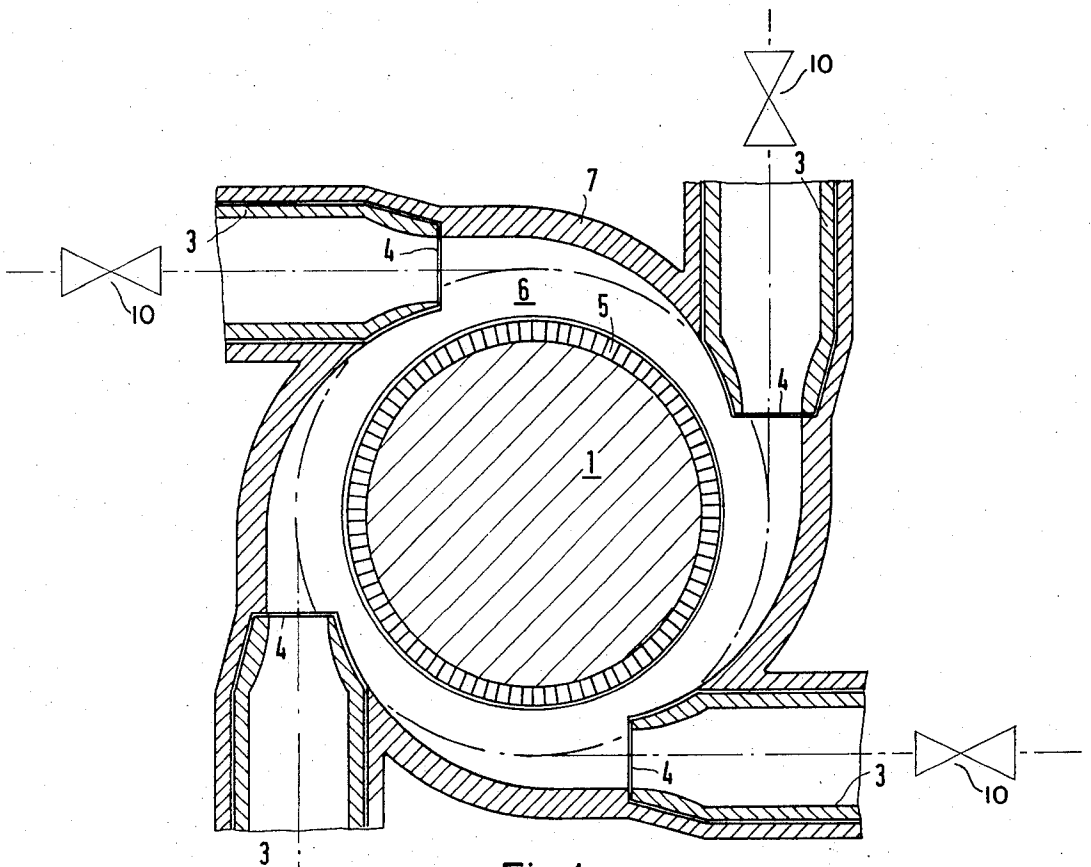


Fig.4

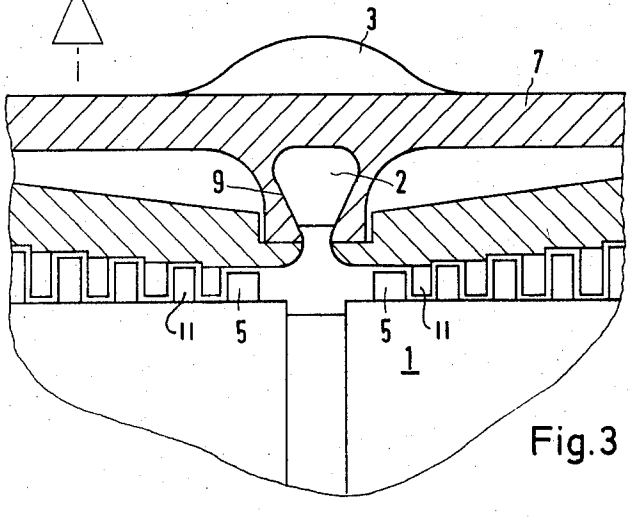


Fig.3

DEVICE FOR PRODUCING ANGULAR MOMENTUM IN A FLOW OF WORKING FLUID UPSTREAM OF THE FIRST ROTOR BLADE OF AN AXIAL-FLOW TURBOMACHINE

The invention relates to a device for producing angular momentum in a flow of working fluid upstream of the first rotor blade ring of an axial-flow turbogenerator, and more particularly a steam turbine having steam as working fluid.

In steam turbines, it is conventional to provide in the high-pressure part thereof, a control stage for controlling steam flow which is formed of several nozzles distributed over the periphery of the turbines and capable of being shut-off individually or in groups, steam being admitted through the open nozzles so as to act in axial direction on the so-called action wheel. Flow control with such a control stage becomes increasingly more difficult, however, with respect to construction costs, efficiency and operational reliability, as the size of the machines increases.

A proposal has consequently been made heretofore to provide a guide vane ring traversible radially-centripetally by working fluid and divided into nozzles or nozzle groups which can be shut off, the working fluid traversing the guide vane ring being applied fully to the succeeding rows of blades that are traversible by the working fluid substantially in axial direction. The improvement suggested by the foregoing proposal over the preceding conventional nozzle group control devices is merely that no separate row of rotor blades is required that must generally have larger diameters than the succeeding stages that are fully subjected to the working fluid. Particular difficulties are encountered, however, in the suspension and mounting or supporting of this radially traversed guide vane ring since it must be thermally movable or expansibly secured between two suspended structural members that are, in turn, thermally movable or expansible.

It is accordingly an object of the invention to provide a device for producing angular momentum upstream of the first ring of rotor blades of axial-flow turbomachines and for controlling the flow rate of working fluid therethrough which is of extremely simplified construction and which operates with great efficiency.

With the foregoing and other objects in view, there is provided, in accordance with the invention, in an axial flow turbomachine having rotor blade rings and guide vane rings alternately disposed in axial direction of the turbomachine, a device for producing angular momentum in a flow of working fluid at a location of the turbomachine upstream of the first rotor blade ring, comprising means of defining a ring space upstream of the first rotor blade ring and having a configuration for applying, in axial direction directly to the first rotor blade ring, working fluid supplied into the ring space, the first rotor blade being upstream of the first guide vane ring in flow direction of the working fluid, and at least one working fluid inlet extending tangentially to the ring space for supplying the flow of working fluid thereto. By supplying the working fluid or steam in tangential direction to the ring space, an axially or radially directed guide vane ring upstream of the first rotor blade ring can be dispensed with so that, after the steam or working fluid has been deflected into axial direction it can act directly on the first ring of rotor blades.

In accordance with another feature of the invention, the tangential working fluid inlet comprises a nozzle communicating with the ring space and having a narrowing outlet cross section in flow direction of the supplied working fluid.

In accordance with further features of the invention, the cross section at the narrowed-down end of the nozzle outlet is substantially rectangular or trapezoidal.

In accordance with an additional feature of the invention, the ring space extends substantially in radial direction of the turbomachine.

In accordance with an added feature of the invention, the radially outermost meridional width of the ring space is greater than the radially innermost meridional width thereof. In this regard the working fluid inlet is located in vicinity of the greater meridional width of the ring space, and the location of the turbomachine upstream of the first rotor blade ring is in the vicinity of the smaller meridional width thereof.

In accordance with yet another feature of the invention, the ring space narrows down spirally downstream of the working fluid inlet in flow direction of the working fluid, especially when there is preponderant operation with simultaneous supplying of working fluid or steam through all of the supply inlets therefor.

In accordance with a concomitant feature of the invention, throttling means for controlling the rate of flow of working fluid supplies to the working fluid inlet may be provided additionally. The throttling means are located upstream of each of the working fluid inlets communicating with the ring space, individual or respectively opposing tangential inlets being capable of being partially or fully closed by the throttling means.

In accordance with further features of the invention in a double-flow axial turbine wherein the turbine has two working fluid flow paths, the ring space is common to both of the flow paths. If the turbine has a two-stage mixed-pressure operation, the individual tangential working fluid or steam supply inlets can be supplied from different steam systems.

Other features which are considered as characteristic for the invention are set forth in the appended claims.

Although the invention is illustrated and described herein as embodied in device for producing angular momentum in a flow of working fluid upstream of the first rotor blade ring of an axial-flow turbomachine it is nevertheless not intended to be limited to the details shown, since various modifications and structural changes may be made therein without departing from the spirit of the invention and within the scope and range of equivalents of the claims.

The construction and method of operation of the invention, however, together with additional objects and advantages thereof will be best understood from the following description of specific embodiments when read in connection with the accompanying drawings, in which:

FIG. 1 is a cross-sectional view in vicinity of the ring space of an axial-flow turbine having a device for producing angular momentum in a flow of working fluid upstream of the first rotor blade ring thereof constructed in accordance with the invention.

FIG. 2 is a fragmentary longitudinal sectional view of FIG. 1 taken along the line II—II in the direction of the arrows showing a double-flow construction of the turbine with rectangular in-flow cross sections.

FIG. 3 is a view similar to that of FIG. 2 of another embodiment of the invention wherein the turbine has trapezoidal in-flow cross sections; and FIG. 4 is a cross-sectional view similar to that of FIG. 1 of yet another embodiment of the invention wherein the ring space narrows down spirally from the working fluid inlet.

Referring now to the drawing and first particularly to FIGS. 1 and 2 thereof, there is shown therein a turbine rotor 1 surrounded in the in-flow region of the working fluid or steam by a ring space 2 which extends radially outwardly and in the embodiment illustrated in FIGS. 1 and 2, substantially rectangular cross section 8. Into this ring space 2 there extend tangentially, four working fluid or steam inlets 3, for example, which are inserted into the outer turbine housing 7 and change over from a circular cross section to a rectangular cross section in the region of nozzle opening 4 at which they communicate with the ring space 2. The tangentially supplied working fluid or steam flows through the ring space or channel 2 in peripheral direction with an additional, radially inward-directed force and velocity component. In the radially inner region of the ring space 2, the radial component of the in-flowing steam is deflected into the axial direction of the turbine the steam then directly impinging on the first ring 5 of rotor blades with the yet unchanged angular momentum.

Accordingly, adequate angular momentum of the entering steam can be generated ahead or upstream of the first rotor blade ring without the additional use of a ring of guide vanes 11. The construction of the steam or working fluid in-flow region thereby becomes extremely simple, smaller losses of working fluid or steam and consequent increased efficiency being attained due to the limited deflection of the steam upstream of the first row of rotor blades.

To control the quantity of steam or working fluid to be supplied, the individual tangential supply steam inlets 3 are preceded by conventional throttling members 10 shown diagrammatically in the drawing. It is thereby possible to shut off one or more of the tangential steam or working fluid inlets 3 or to throttle the steam throughout.

Even if individual tangential steam or working fluid supply inlets are shut off, the admission to the first ring of rotor blades is relatively uniform, since the ring space 2 per se is not radially partitioned and the steam or working fluid can therefore flow uniformly toward the first rotor blades from the entire ring space. However, it is also possible to form the in-flow cross section of the nozzle openings 4 of trapezoidal shape. Then a cross section 9 of the ring space 2' as shown in FIG. 3 is obtained, wherein the meridional width of the ring space 2' is greater in the vicinity of the nozzle openings 4 than in front or upstream of the first ring 5 of rotor blades. The height of the ring space 6 at the nozzle openings 4 can thereby be made smaller, so that in the case of partial loading of the nozzle openings 4, only very small dead spaces behind or downstream of the individual shut-off nozzles are produced.

It may also be advantageous, however, in order to increase the efficiency of the turbine to make the ring space 6 spirally narrower behind or downstream of each nozzle opening 4 as may be seen from FIG. 4, by drawing the inner wall of the housing 7, by which the ring space or channel 6 is bounded on the outside, spirally inwardly to the opening of the succeeding nozzle opening 4 which follows it in the peripheral direction of the ring space 6. A result thereof, especially for equal supplying of all steam or working fluid inlets 3, is an improved filling of the ring space 6 and thereby, more uniform outflow therefrom.

We claim:

1. An axial flow turbine comprising rotor blade and guide vane rings alternately following one another in axial direction and having means for producing angular momentum for an incoming steam flow in front of the first rotor blade ring, comprising an annulus immediately in front of the first rotor blade ring, said annulus extending radially inward substantially to the radially inner ends of the rotor blades in said first rotor blade ring, and said annulus extending radially outward and continuously over an entire circumference, a plurality of steam inlets discharging tangentially into said annulus, each steam inlet having an individual and independent controllable throttle valve for regulating the amount of steam.

2. Apparatus as in claim 1, wherein said annulus is in complete and direct communication with said first rotor blade ring along its complete circumference.

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UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

PATENT NO. : 3,861,821

DATED : January 21, 1975

INVENTOR(S) : Herbert Keller, Bruno Krieg, Ludwig Römer

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

In the heading to the printed specification, line 4, after "BLADE" insert --RING--.

Signed and sealed this 20th day of May 1975.

(SEAL)
Attest:

RUTH C. MASON
Attesting Officer

C. MARSHALL DANN
Commissioner of Patents
and Trademarks