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 [33] **Switzerland**
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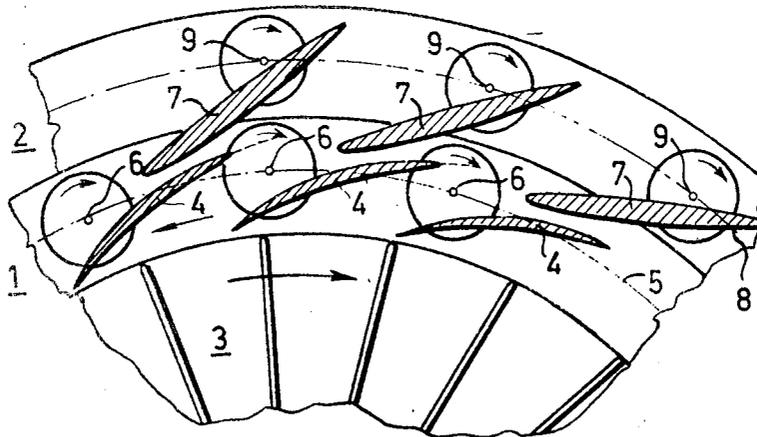
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[54] **DIFFUSER FOR A CENTRIFUGAL FLUID-FLOW TURBOMACHINE**
 4 Claims, 5 Drawing Figs.

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 415/181, 415/BL
 [51] Int. Cl..... **F01b 25/02,**
 F01d 1/02
 [50] Field of Search..... 415/13,
 143-167, 181, 160, 161, 162, 163; 230/114, 122
 (BL), 133 (C), 132;

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ABSTRACT: A centrifugal fluid-flow turbomachine has a diffuser provided with two coaxially arranged rows of rotatable guide vanes through which the fluid flows in succession. The pivot axes of the vanes of said two rows are displaceable in relation to one another in the circumferential direction of the rows.



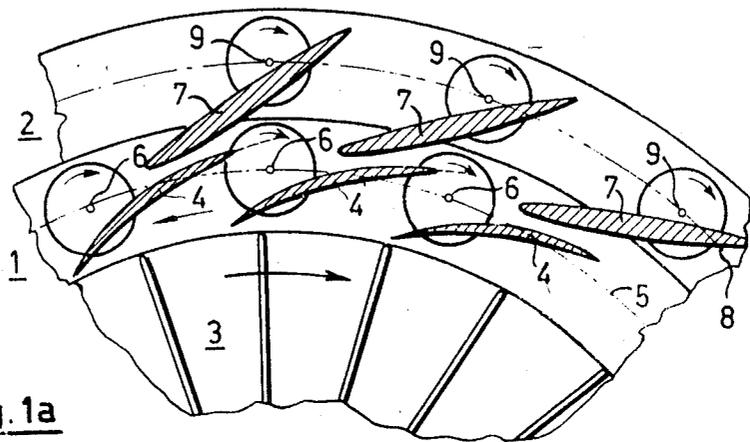


Fig. 1a

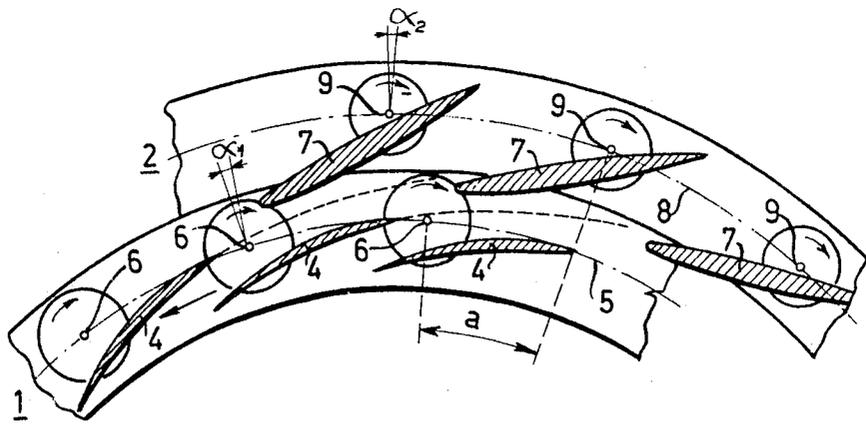


Fig. 1b

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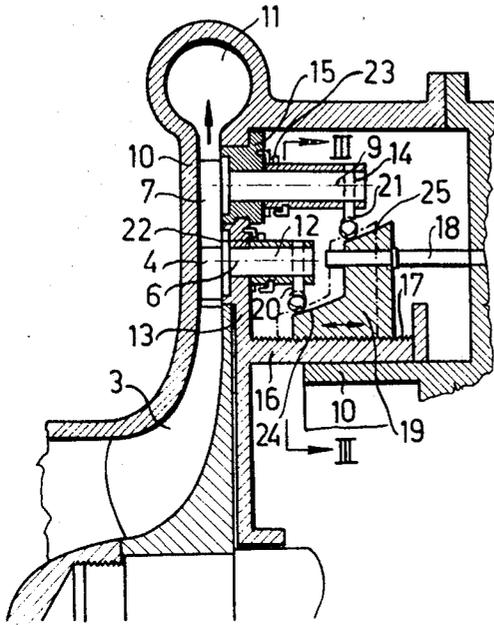


Fig. 2

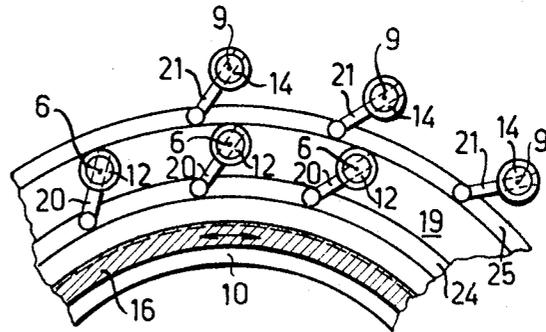


Fig. 3a

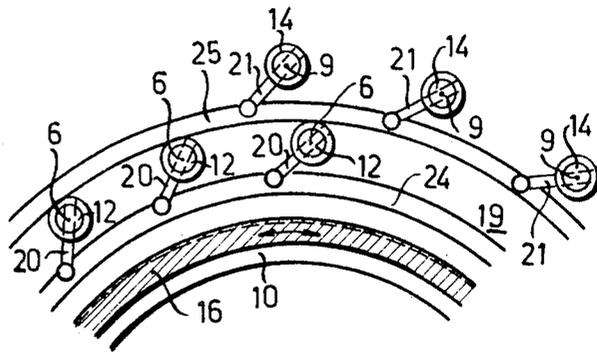


Fig. 3b

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DIFFUSER FOR A CENTRIFUGAL FLUID-FLOW TURBOMACHINE

BACKGROUND OF THE INVENTION

This invention relates to a diffuser vane system of a centrifugal fluid-flow turbomachine comprising two coaxial circular rows of rotatable vanes, through which the flowing medium passes in succession.

Diffusers which are provided with guide vanes and are arranged downstream of the impeller in centrifugal fluid-flow turbomachines such as compressors or pumps, are intended to decelerate the flowing medium issuing at high speed from the impeller and thus to convert the kinetic energy contained in the said medium into pressure energy. But it is known that there are limits to the slowing-down of the flow in a vane lattice, since at the vane surface a boundary layer with reduced flow speed forms which soon no longer has sufficient energy to accompany the pressure increase of the undisturbed flow. The flow then separates from the vane surface. In cases where a gas issuing at supersonic speed from the impeller has to be slowed-down and a compression shock wave occurs in the vane lattice, the danger of flow separation after the compression shock is particularly marked.

A known measure for reducing the risk of flow separation and tee flow losses occurring in the diffuser, and for increasing the pressure production possible in the diffuser, consists in that the slowing-down of the flow is shared by two coaxial circular rows of vanes through which the fluid flows in succession. If it is ensured that the undisturbed portion of the flow issuing from the first row of vanes flows on to the vanes of the second row, there forms at the vanes of the second vane lattice a new boundary layer which can then be capable of accompanying the further pressure increase without flow separation. Thus the choice of the positions of the two rows of vanes relatively to one another is of essential importance for the satisfactory operation of the diffuser.

To adapt the diffuser to varying operating conditions of the machine, it is also known to provide the diffuser with rotatable guide vanes. If this measure is applied to a diffuser having two rows of vanes through which the fluid flows in succession, on rotation of the guide vanes the direction of the flow issuing from the first row of vanes will be varied. The guide vanes of the second row, therefore, can get into a substantially more unfavorable position than before with regard to the boundary layers starting from the vanes of the first row. The sharing of pressure production by two rows of vanes in this case no longer affords any advantage, and the efficiency of the diffuser is made worse. The adaptability of the diffuser to varying operating conditions, which is aimed at by making the guide vanes rotatable, is thus achieved only to a limited extent.

SUMMARY OF THE INVENTION

The invention has for its aim to provide an improvement in this respect. In a diffuser arranged in a centrifugal fluid-flow turbomachine and having two coaxial circular rows of rotatable guide vanes through which the fluid flows in succession, for this purpose the pivoting axes of the vanes of one row of vanes are displaceable relatively to the pivoting axes of the vanes of the other row of vanes in the peripheral direction thereof.

This feature affords the advantage that in every angular position of the vanes of the two rows of vanes these can be brought relatively to one another into a position wherein the vanes of the second row of vanes are so situated in relation to the fluid flowing off the first row of vanes that the diffuser operates with the best efficiency, or with the best pressure conversion.

To adapt the diffuser to varying operating conditions, conveniently the adjusting mechanism for the relative displacement of the pivoting axes of the vanes is connected with the adjusting mechanism for the rotation of the vanes of at least one vane row about their axes for establishing a definite relationship between the pivoting of the vanes and the relative displacement of the axes.

BRIEF DESCRIPTION OF THE DRAWINGS

An example of embodiment of the diffuser according to the invention is shown in simplified manner in the drawings wherein:

FIG. 1a shows a partial sectional view at right angles to the machine axis through the two rows of vanes;

FIG. 1b shows a corresponding partial sectional view with the vanes pivoted relatively to the position shown in FIG. 1a and the rows of vanes displaced relatively to one another in the peripheral direction;

FIG. 2 shows an axial longitudinal sectional view through the machine in the region of the adjusting mechanism for the diffuser vane system and

FIGS. 3a and 3b each show a section taken on the line III-III of FIG. 2, in the positions of the diffuser vanes shown in FIGS. 1a and 1b respectively.

DESCRIPTION OF THE PREFERRED EMBODIMENT

According to FIGS. 1a and 1b, the diffuser has two circular rows of guide vanes which are arranged coaxially relatively to one another and through which the fluid flows in succession, namely an inner row 1 of vanes 4 and an outer row 2 of an identical number of vanes 7. The fluid issuing from the impeller 3 of a centrifugal compressor, said impeller rotating in the arrowed direction, arrives at the inner row 1 of the vanes 4 directly. The vanes 4 are pivotable about axes 6 which are parallel to the machine axis and are arranged uniformly distributed over a circle concentric therewith. The fluid issuing from the row 1 of the vanes 4 passes into the row 2 of the vanes 7, which are likewise pivotable and whose pivoting axes are arranged on a circle 8 and designated as 9.

The position of the vanes 4 and 7 of the diffuser shown in FIG. 1a is intended for an operating condition with a relatively considerable delivery quantity. The vanes 4 of the row 1 are so arranged in relation to the vanes 7 of the row 2 that their inlet edges are contacted by a flow line which passes approximately centrally between two vanes 4 of the row 1. The vanes 7 are thus acted upon by a part of the fluid which is off the region of the boundary layers forming at the vanes 4 of the row 1. Thus a new boundary layer forms at the vanes 7 which is capable of accompanying the further pressure increase aimed at in the row of vanes 2 without becoming subjected to flow separation.

With a reduced throughput quantity in the compressor, the fluid flows absolutely with a relatively slight inclination with respect to the peripheral direction from the impeller 3. Therefore, according to FIG. 1b, for an operating condition like this, the vanes 4 and 7 of the rows 1 and 2, respectively, are set at a shallower angle α_1 and α_2 relatively to the peripheral direction as compared with the position in FIG. 1a. If this pivoting of the guide vanes 4 and 7 were effected with the positions of the axes 6 and 9 unchanged, there would soon be a state wherein the flow line emanating from the outlet edge of a vane 4 would impinge on the inlet edge of the next vane 7 in succession of the row 2. Thus low-energy portions of the boundary layer of the vanes 4 would arrive at the vanes 7 and be further retarded at their surface. Separation of the boundary layer would then be expected soon.

But, as will be explained in more detail hereinafter, the row 1 of the vanes 4 can be rotated relatively to the row 2 of the vanes 7 in their entirety about the compressor axis. Thus the pivoting axes 6 of the vanes 4 of the row 1 are displaceable relatively to the pivoting axes 9 of the vanes 7 of the row 2 in the peripheral direction thereof.

As FIG. 1b shows, by displacing the axes 6 by an amount a relatively to the original position in the peripheral direction, the result is achieved that even with the vane angles shown in FIG. 1b the vanes 7 are not impinged upon by the boundary layer material emanating from the vanes 4 of the row 1. Thus the measure described makes it possible to bring the vanes of the two rows 1 and 2 into the most advantageous position relatively to one another in every operating condition.

FIGS. 2, 3a and 3b show with what constructional means the aforesaid displaceability of the pivoting axes of the vanes of

one row can be achieved relatively to the pivoting axes of the vanes of the other row, by way of example. 10 designates the housing of the centrifugal fluid-flow turbomachine which constitutes the lateral boundary of an annular discharge passage in which the vanes 4 and 7 of the diffuser vane system following the outlet side of the impeller 3 are arranged, and downstream thereof defines a preferably spirally shaped discharge chamber 11. The vanes 4 of the inner row 1 are provided with pivot pins 12 which are inserted in an annular vane carrier, namely a disc 13 rotatable about the machine axis, and whose axes form the axes of rotation 6 for the vanes 4. The vanes 7 of the outer row 2 have pivot pins 14 which are arranged in a ring 15 connected fast to the housing 10 and the axes of which form the pivoting axes 9 for the vanes 7. By rotating the disc 13 about the machine axis, therefore, the pivoting axes 6 of the vanes 4 of the inner row 1 can be displaced relatively to the pivoting axes 9 of the vanes 7 of the outer row 2 in the peripheral direction thereof.

With the adjusting mechanism illustrated, however, arrangements are also made for rotating the vanes 4 and 7 of the two rows about their pivoting axes 6 and 9 respectively in a specific relationship to one another simultaneously with the displacement of the pivoting axes 6 of the vanes 4 of the inner row 1. For this reason the disc 13 is provided with a tubular extension 16 which is arranged coaxially to the machine axis and is provided with screw threading 17 on the outer side. On this screw thread 17 there is fitted an annular member 19 which is displaceable in the housing 10 in the direction of the machine axis but is secured by guide pins 18 against rotational movement about the machine axis.

The pivot pins 12 and 14 are provided with adjusting levers 20 and 21 respectively, the outer ends of which, owing to the action of torsion springs 22 and 23 respectively, are always pressed against surfaces of revolution 24 and 25 formed by the member 19 and serving as guide ways for the levers 20, 21.

Then, if the disc 13 is rotated about the machine axis in order to displace the pivoting axes 6 of the vanes of the inner row 1 in the peripheral direction, the screw thread 17 on the tubular extension 16 of the disc 13 at the same time effects an axial displacement of the member 19, secured against rotational movement by the pins 18, so that it moves into e.g. the position shown in dot-dash lines in FIG. 2. Since with the member 19 the surfaces of revolution 24 and 25 arranged thereon are also displaced in the axial direction, said surfaces will also cause pivoting of the vanes 4 and 7 about their axes 6, 9 at the same time, depending on the form of the meridian. By appropriate configuration of the meridian curves of the surfaces 24 and 25, therefore, any desired relationship can be achieved between the pivoting of the vanes 4 and 7 about their pivoting axes and the relative displacement of the pivoting axes in the peripheral direction. In FIGS. 3a and 3b the position of the adjusting levers 20 and 21 is shown for the varying

positions of the member 19 according to FIG. 2.

Naturally it is also possible to use some other way, e.g. without providing an axially displaceable member, to establish a connection between the adjusting mechanism for the relative displacement of the pivoting axes of the vanes and the adjusting mechanisms for rotating the vanes about their axes, in order to obtain a given relationship between the pivoting of the vanes and the relative displacement of the axes. The axially displaceable member 19 shown in FIG. 2, with its guideways 24, 25, however, affords the advantage that these guideways can be constructed as surfaces of revolution which are common for all the adjusting levers of a row of vanes, whereas in the event of controlling directly from the rotary movement of the disc 13, special guides would have to be provided for each adjusting lever.

I claim:

1. In a centrifugal fluid-flow turbomachine having a housing with an impeller rotatably mounted therein for inducing radial fluid flow therethrough, said housing defining an annular discharge passage for the fluid leaving said impeller with an outward flow component: a diffuser vane system arranged in said discharge passage for the deceleration of the discharging fluid, comprising two coaxial circular rows of spaced rotatable vanes having respective pivot axes, namely an inner row and an outer row through which rows the fluid flows in succession in the order stated; and actuating means to displace the pivot axes of the vanes of one row relatively to the pivot axes of the vanes of the other row in the circumferential direction of said rows.

2. The combination defined in claim 1 in which the said actuating means includes an annular carrier in which the vanes of at least one of said rows are pivotably mounted, said annular vane carrier arranged coaxially with the impeller in the machine housing so as to be rotatable about the machine axis.

3. The combination defined in claim 1 which comprises means for establishing a definite relationship between the pivoting movements of the vanes of said two rows, respectively, and the relative displacement of the pivoting axes, so that boundary layer issuing from the vanes of the inner row does not flow on to the vanes of the outer row.

4. The combination defined in claim 3 in which said means for establishing a definite relationship between said pivoting movements and said relative displacement comprise an annular member arranged coaxially with the machine axis and axially displaceable, said member having guide ways as surfaces of revolution and the pivots of the vanes having levers guided by said guide ways, spring means being provided for pressing said levers against said guide ways; and screw means disposed to cause said annular member to displace axially on relative circumferential displacement of the pivots of the vanes of said two rows.

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