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REVERSIBLE INWARD RADIAL FLOW TURBINE

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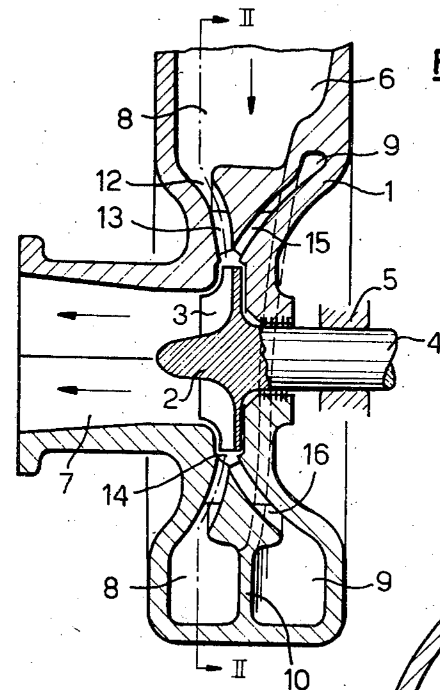
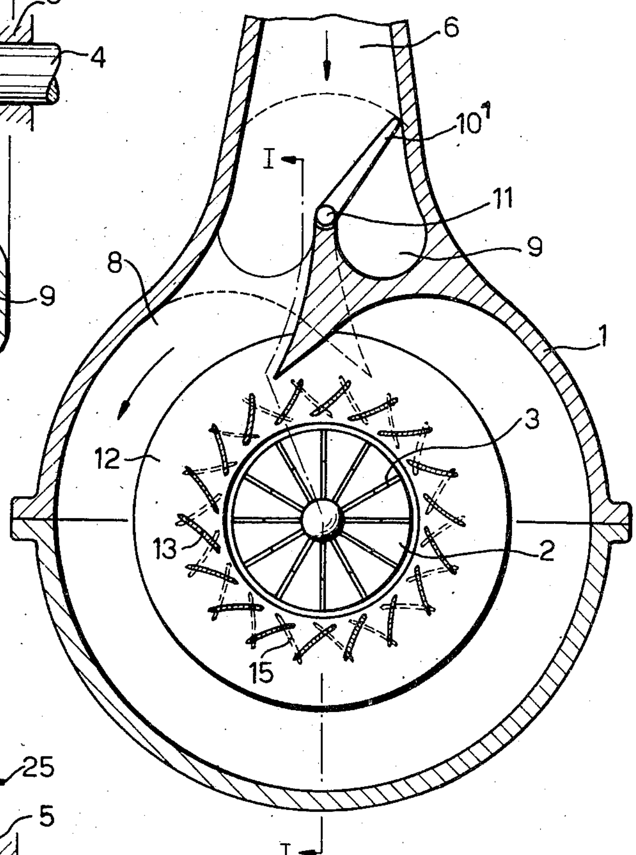


Fig. 1

Fig. 2



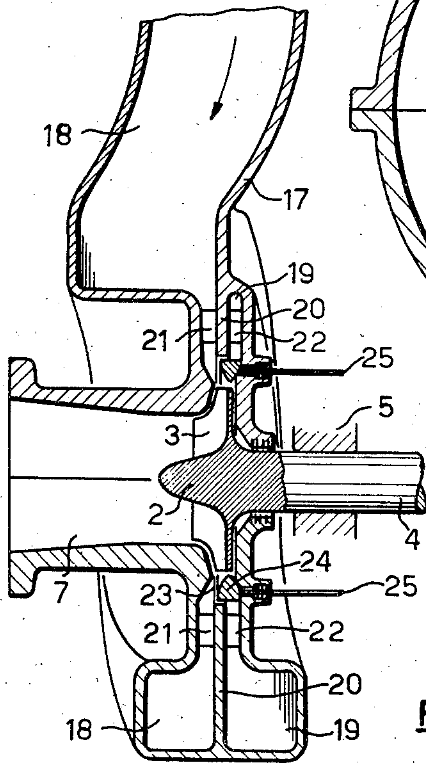


Fig. 3

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REVERSIBLE INWARD RADIAL FLOW TURBINE

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This invention relates to a reversible inward radial flow turbine, wherein the driving medium is fed in with a swirl from the outside to a rotor, more especially a hot-air or gas turbine.

In some power plants, such as those employed to propel craft, more especially ships, it is desirable to be able to reverse the normal direction of rotation of the power unit. For such purposes, it has already been proposed to employ an inward radial flow turbine in which the driving medium is fed in with a swirl from the outside to the rotor and is deflected in a substantially axial direction after flowing through the rotor. In a known form of construction of such a turbine, the direction of rotation is reversed by turning guide blades mounted before the inlet of the rotor, it being possible to impart a swirl in one direction or the other to the driving medium, depending upon the desired direction of rotation, by appropriate adjustment of the guide blades, which adjoin an annular chamber to which the driving medium is fed.

Such guide assemblies having rotatable guide blades, however, have in the first place the disadvantage that with a relatively large number of blades, that is to say, when the blade lattice has a narrow pitch, it is impossible to dispose the adjusting mechanism for each blade within the blade spacing. In addition, such a construction is advantageous from the viewpoint of flow technology only when it is possible to supply the driving medium more or less evenly from all sides. On the other hand, if the driving medium enters the annular chamber mounted before the guide blade lattice only at one point, and if the driving medium is distributed thereafter toward both sides of the periphery, the disadvantage arises that it encounters the guide blades of one half with impact. If, on the other hand, the driving medium is tangentially fed to the annular chamber, so that it flows in the same direction of rotation to the entire periphery, the guide blades are correctly subjected to the flow in the position intended for one of the two directions of rotation, but in this case the approach flow takes place with impact in the position intended for the other direction of rotation, which sometimes results in a loss of efficiency.

This disadvantage also arises when, as already proposed, there are employed instead of rotatable guide blades, two guide blade lattices having different directions of rotation, either one of which may be moved into a position in front of the rotor, or when, in accordance with another proposal, there is disposed between a fixed guide assembly and the rotor a second guide assembly for reversing the direction of rotation. Here again, an appreciable loss of efficiency results in one of the two directions of rotation.

Moreover, in the known forms of construction, the difficulty arises of constructing adjusting mechanisms for the guide assemblies which operate reliably at the higher driving medium temperatures of hot-air or gas turbines.

The invention has for its object to obviate these disadvantages. In accordance with the invention, to this

end, in a reversible inward radial flow turbine, more especially a hot-air or gas turbine in which the driving medium is fed in from the outside with a swirl to a rotor, two volute inlet chambers in which the driving medium flows in opposite directions of rotation are provided adjacent one another in the axial direction, reversible means being provided to guide the driving medium to the rotor through one or the other of these two volute chambers, depending upon the desired direction of rotation.

Two different embodiments of the subject of the invention are illustrated in simplified form by way of example in the drawings, in which:

Figure 1 is an axial section through an inward radial flow turbine.

Figure 2 is a section transverse to the axis along the line II—II of Figure 1, and

Figure 3 illustrates in axial section a modification of the arrangement of the volute chambers.

The turbine illustrated in Figures 1 and 2 comprises a housing **1** and a rotor **2** having radially disposed blades **3** which is arranged in overhung fashion on a rotatably supported shaft **4**. Of the mounting of the shaft, a bearing **5** adjacent the turbine housing is shown. The blades **3** define driving medium passages extending from a peripheral inlet portion of the rotor to a discharge portion radially inward thereof.

The driving medium flows through a supply connection **6** into the turbine and is fed with a swirl from the outside to the rotor **2** at the peripheral inlet portion thereof. After flowing through the rotor, it leaves the turbine by way of an axially directed outlet branch **7**.

The turbine housing **1** defines an annular inlet space for the driving medium, which surrounds the rotor. This space is axially divided, by a partition wall **10**, into two volute inlet chambers **8** and **9** having inlet portions which communicate with the supply connection **6**. The volute chambers **8** and **9** are designed for opposite directions of rotation of the driving medium.

A damper **10^1** is pivotally mounted on a pin **11** in the supply connection **6**. By appropriate adjustment of the damper **10^1** the inflowing medium may be guided, as desired, into the volute chamber **8** or into the volute chamber **9**. In Figure 2, the damper **10^1** is shown in a position in which the inflowing driving medium is fed to the volute chamber **8**, in which it receives a swirl in the clockwise direction as shown in Figure 2. The volute chamber **8** merges inwardly, in a substantially radial direction, into an annular communication passage **12**, in which fixed guide blades **13** are disposed and through which the driving medium is fed to the rotor **2**. The passage **12** here opens into an annular chamber **14** provided before the runner at the outer periphery. The volute chamber **8** and the guide blades **13** impart the rotational movement necessary for driving the rotor to the driving medium. The rotor thus turns in the counter-clockwise direction.

When the damper **10^1** is changed over to the left, on the other hand, the driving medium is guided into the volute chamber **9**, axially adjacent the volute chamber **8** and, according to Figure 2, situated beyond the latter. It receives a swirl in the clockwise direction and flows through a communication passage **16** provided with guide blades **15** into the annular chamber **14** disposed before the rotor. The guide blades **15** are so disposed that they impart to the driving medium an additional swirl in the clockwise direction. Thus, when the damper **10^1** is in this position the rotor is driven in a direction opposite to that in which it is driven when the damper **10^1** is in the position illustrated in Figure 2.

With the described form of construction, the advantage is obtained that in both the directions of rotation of the rotor the driving medium is fed to a volute chamber, the cross-sectional form of which may be correctly adapted to the gradual escape of driving medium toward the interior along the periphery. Both volute chambers guide the driving medium to the guide blades without impact. The turbine thus has high efficiency in both directions of rotation.

In the illustrated constructional form of the subject of the invention, the inlet portions of the two volute chambers 8 and 9 lie close together. The cross-sections of these volute chambers gradually decrease in the peripheral directions. Since the two volute chambers extend oppositely, the terminal cross-section of one volute chamber lies approximately adjacent the initial cross-section of the other volute chamber. With this arrangement, the sum of the cross-sections of the adjacent volute chambers remains substantially constant along the entire periphery. The external dimensions of the housing consequently remain substantially equal over the entire periphery, while only the internal subdivision of the cross-section over the two volute chambers changes.

At the point of admission into the volute chambers, the driving medium here undergoes a deflection from the radial direction into the peripheral direction, but only relatively small flow losses thus occur, since the driving medium velocities concerned are low.

If it is desired to supply the driving medium tangentially, as is usual in volute chambers, the inlets of the two volute chambers are preferably offset in the peripheral direction with an angle at the centre of approximately 180°, the separate feed ducts for the driving medium opening tangentially into the two volute chambers. In this case, the housing has a somewhat larger overall cross-section over one half of the periphery than over the other half of the periphery. When the working medium is tangentially introduced, the guide blades between the volute chamber and the rotor may, if desired, be omitted.

In the constructional form of the subject of the invention as illustrated in Figures 1 and 2, the communication passages 12 and 16 open in V-form into the annular chamber 14 disposed before the rotor. The two outer axial boundaries of the volute chambers are planes substantially perpendicular to the axis of the machine. The partition wall 10 between the two volute chambers extends helically with respect to the turbine axis in accordance with the reduction of the cross-section of one chamber, and the corresponding increase of the cross-section of the other chamber, along the periphery.

In contrast thereto, in the constructional form according to Figure 3, the partition wall extends in a plane perpendicular to the turbine axis. The turbine has a housing 17, which bounds two oppositely extending volute inlet chambers 18 and 19. The said chambers are disposed adjacent one another in the axial direction and are separated by a partition wall 20 extending in the centre plane passing through the inlet portion of the rotor 2 perpendicular to the turbine axis. The driving medium is fed to the rotor by communication passages 21, 22 separated by the same partition wall 20, and first enters an annular chamber 23 provided before the inlet of the rotor.

The outer axial boundaries of the housing in the region of the volute chambers in this constructional form extend obliquely to the axis in the manner of helical surfaces. The communication passages 21 and 22, on the other hand, extend over the entire periphery close to the centre plane of the runner. In the constructional form according to Figure 3, means are also provided to maintain a good guidance of the driving medium in the annular chamber 23 when one or other of the volute chambers is in use. For this purpose, there is disposed in the said annular chamber an annular closure member 24 having a radial inward portion of wedge-shaped cross-section, which can be axially displaced from the outside by means

of draw rods 25. In the illustrated position, the said member closes the communication passage 22 and serves at the same time to guide the driving medium in the annular chamber 23. When the volute inlet chamber 19 is serving to feed the driving medium it closes the communication passage 21 after having been moved into its extreme left-hand position and serves as a guide for the driving medium which arrives from the communication passage 22. If the change-over of the driving medium to one volute inlet chamber or the other is previously effected by a damper of the kind indicated by 10^1 in Figure 2, or by equivalent means, no tight closure of the annular passage not in use by the annular member 24 is necessary.

The form of the axially shiftable closure member is not restricted to that shown in Figure 3. The annular closure member 24, for instance, could also be given the form of a duct member. The said member would in this case be so designed as to connect one volute chamber, in one of two end positions, with the rotor through a first annular duct with impact-free guiding of the driving medium, while in the other end position a second annular duct would ensure the supply of the driving medium to the rotor. The guide blades could in this case also be disposed in the ducts of the axially displaceable closure member.

What is claimed is:

1. A reversible inward radial flow turbine comprising a housing; a rotor arranged to rotate about an axis within said housing and provided with driving medium passages extending from a peripheral inlet portion of said rotor to a discharge portion radially inward thereof; said housing defining an inlet space for the driving medium surrounding the rotor and having substantially parallel side walls which extend helically with respect to the turbine axis, a partition wall extending substantially in a center plane passing through the inlet portion of the rotor perpendicular to the turbine axis being provided within said inlet space, by which partition wall said space is axially divided into two volute inlet chambers, one thereof being formed so as to impart to the driving medium a swirl in one direction of rotation and the other being formed so as to impart to the driving medium a swirl in the opposite direction of rotation, and both having decreasing cross-section in the respective direction of rotation and being adapted to discharge the driving medium inwardly; and said housing further defining supply connections for the supply of driving medium to said volute inlet chambers and annular communication passages, axially adjacent one another, for directing the driving medium issuing from said volute chambers toward the peripheral inlet of the rotor with a rotational movement in the respective direction of rotation; an annular closure member arranged between the exits of said annular passages and the peripheral inlet of the turbine rotor so as to be axially shiftable from a position in which the passage leading the driving medium to the rotor in said one direction of rotation is closed into a position in which the passage leading the driving medium to the rotor in said opposite direction of rotation is closed; and means for operating said closure member from the outside of the housing.

2. The reversible inward radial flow turbine defined in claim 1, in which the closure member comprises a radially inward portion of wedge-shaped cross-section so as to afford a smooth guiding of the driving medium from the annular passage which is not closed by said member to the peripheral inlet of the rotor.

3. In a reversible turbine, the combination of a rotor of the radial inward flow type; a housing enclosing said rotor and defining a discharge and an annular entrance chamber which surrounds said rotor, the housing further enclosing two volute chambers each encircling said entrance chamber and each having an annular inwardly directed nozzle leading into said entrance chamber; means for imparting to fluid discharging through respective

nozzles into said entrance chamber relatively reverse swirls; means for directing flow through said volute chambers selectively, and bearing means for supporting said rotor in said housing.

4. The combination defined in claim 3 in which, as to at least one of the volute chambers the means for imparting a swirl comprises guide vanes in the nozzle.

5. The combination defined in claim 3 wherein the two volute chambers have respective inlet portions which are formed to impart to the entering fluid relatively reverse swirls.

6. The combination defined in claim 5 in which the said inlet portions issue from a common supply connection and the flow selecting means are arranged between said inlet portions and said supply connection.

7. The combination defined in claim 3 in which the means for directing flow through the volute chambers selectively, controls the discharges from the nozzles into the entrance chamber.

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