Feb. 11, 1958 J. C. GREY 2,823,008

ROTORS FOR FLUID FLOW MACHINES SUCH AS TURBINES

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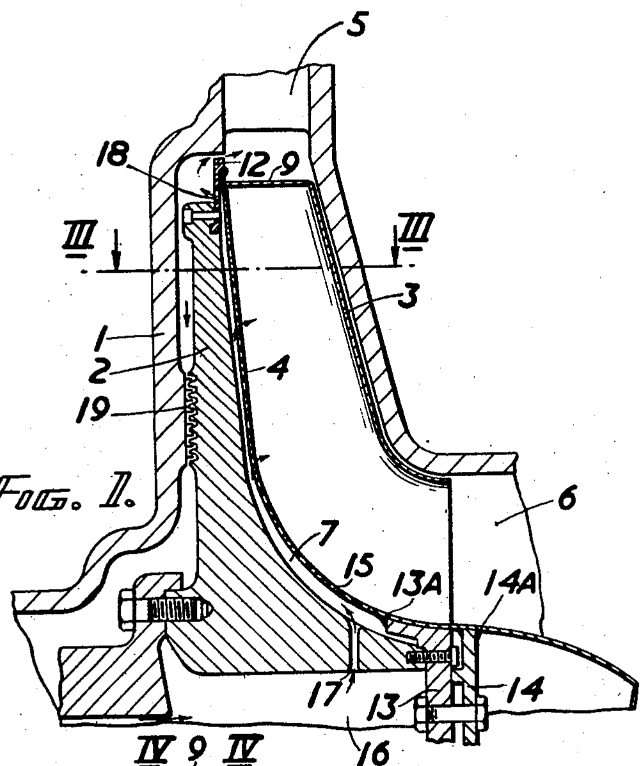


FIG. 1.

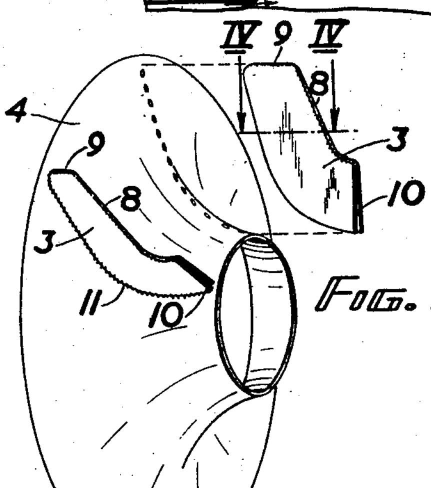


FIG. 2.

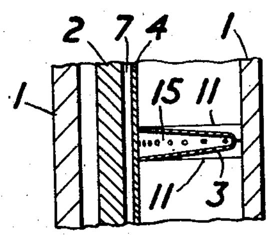


FIG. 3.

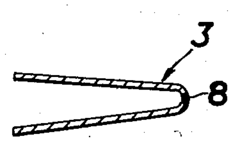


FIG. 4.

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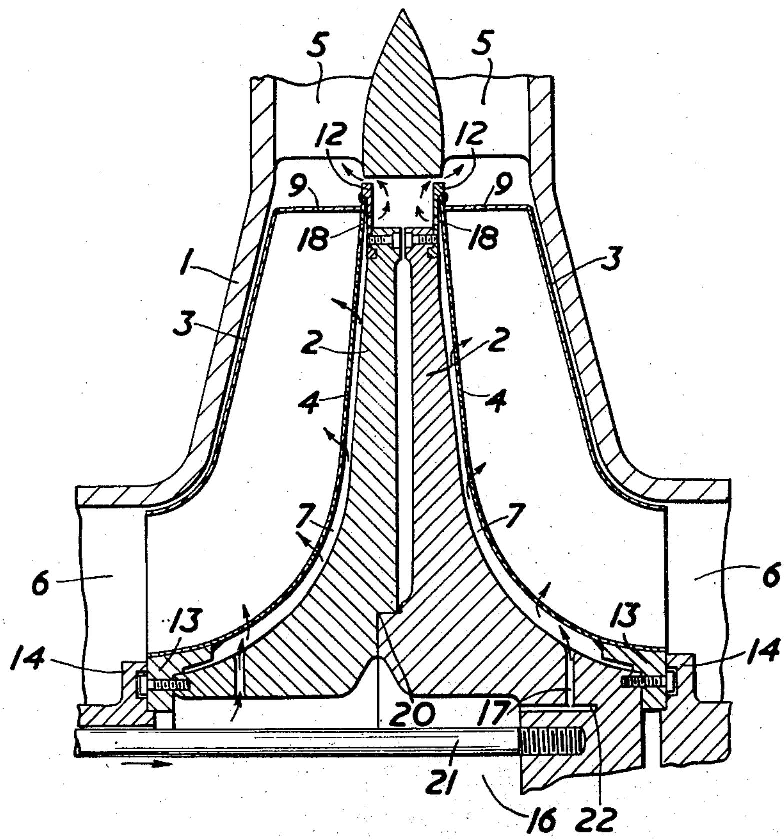


FIG. 5.

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United States Patent Office

2,823,008

Patented Feb. 11, 1958

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# ROTORS FOR FLUID FLOW MACHINES SUCH AS TURBINES

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Application February 14, 1952, Serial No. 271,583

Claims priority, application Great Britain February 15, 1951

6 Claims. (Cl. 253—39.15)

This invention relates to radial-flow turbo-machines, by which is meant radial inward-flow and radial outward-flow turbines, and centrifugal compressors.

The invention provides a radial-flow turbo-machine for operation with high-temperature gas, including a bladed rotor of which the parts swept by the hot gas are made of a highly heat-resistant metal, and form a unit or units attached to one or both sides of the rotor body but thermally insulated from said body, which latter is made of a less heat-resistant metal and is relatively massive compared with the said unit.

The rotor may be "single-sided," comprising a single heat-resistant unit attached to the body on one side of the central plane of said body.

Alternatively the rotor may be "double-sided," comprising two heat resistant units, each attached to the body on one side of the central plane of said body.

Each said unit may comprise an annular shroud member made of sheet metal and carrying on one face thereof hollow blades of like material, the shroud member being of such dimensions and so attached to the rotor body that shroud and body are separated by a space for a coolant medium. In this case the rotor body may be provided with passageways to permit of maintaining a flow of gaseous coolant through said space.

Turbines according to the invention are particularly suitable for incorporation in turbo-superchargers or in continuous-combustion gas turbine plant including a compressor and combustion means, since in either case the compressor provides a ready source of high pressure air which may be used as a coolant for the rotor.

The invention will now be described in more detail in terms of the examples of radial inward flow turbines illustrated in the accompanying drawings, in which:

Figure 1 is an axial half-section of a single-sided inward-flow turbine.

Figure 2 is a perspective view of the annular shroud member with one hollow blade welded in position and another hollow blade detached.

Figure 3 is a section on line III—III of Figure 1.

Figure 4 is a section in line IV—IV of Figure 2.

Figure 5 is an axial half-section of a double-sided inward-flow turbine.

The radial inward-flow turbine shown in Figures 1 to 4 comprises a casing **1** within which a single-sided impeller is mounted for rotation. The impeller comprises a relatively massive body disc **2** made of ferritic metal or similar material, and hollow metal blades **3** welded to an annular sheet metal shroud **4** which is itself secured to the body **2** by means described below. The hot working fluid enters via the nozzle vanes **5** and flows in a generally radial inward direction through the passages defined by the blades **3** and is discharged in a generally axial direction at **6**. The blades **3** and shroud **4**, being the main parts of the rotor swept by the hot gases, are made of high temperature-resisting austenitic material. The shroud is of similar contour to the body **2** and is fixed thereto so

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that a small clearance space **7** (say about ⅛" minimum for a small rotor) intervenes between shroud and body.

Each blade **3** is U-shaped in transverse section (see Figures 3 and 4) and comprises two similar halves welded together along the line **8**, at the base of the U as it were. As shown the resultant hollow blade is closed at the inlet end by pressing the edges together and welding at **9**, while at the outlet end the blades are left open at **10**, though the edges are pressed together slightly so that the opening **10** is a mere slit narrower than the width of the blade cross-section at its largest. Each blade thus completed (and with the outlet edges curved as necessary) is secured to the shroud **4** by welding at each side along the line **11**. The complete heat resistant unit (i. e. shroud **4** and blades **3**) is attached to the body **2** at the periphery by welding to a ring **12** which is bolted to the body **2** and which ring is made of austenitic metal since a part of it is in contact with the hot gases. At the hub the shroud **4** is welded at **13*a*** to a ring **13** bolted to the body **2** and is also welded at **14*a*** to a ring or disc **14** bolted to the part **13**. The components **13** and **14** may be made of ferritic material as they are not in contact with the hot gases.

From the description it will be seen that the expensive heat resisting austenitic material is confined to sheet metal parts while the relatively massive body **2** is made of ferritic steel and is more convenient to forge because it is not required to carry integral blades.

The shroud **4** is provided with radiating lines of holes **15** which are covered by the blades **3** when affixed so that these holes provide communication between the space **7** and the hollow interior of each blade. It should be mentioned that the order of assembly may be varied from what has been suggested above e. g. the shroud **4** may be fixed to the body **2** before the blades **3** are attached.

The rotor body **2** is centrally bored at **16** and to this boring is supplied a stream of cooling air which, if the turbine forms part of a gas turbine plant, may be derived from the compressor of such plant, since as will appear below the cooling air is required to be at a higher pressure than that of the working fluid flowing between the rotor blades. Passageways **17** radiate from the boring **16** and open into the space **7**, while the peripheral ring **12** is provided with an annular series of holes **18** which put the space **7** into communication with the back of the rotor body. Thus the cooling air assisted by centrifugal force flows upwards through the passageways **17** and through the space **7** so that the body **2** is thermally insulated from the shroud **4**. Some of the cooling air passes through the peripheral holes **18** and of this air some flows round the edge of the ring **12** and mixes with the working fluid while other air may flow radially inward over the rear face of the rotor towards the labyrinth seal **19**. Some air enters the interior of the hollow blades **3** by way of the holes **15** and it is expected that in operation conditions will be such that this air will flow through the slits or outlet openings **10** and join the working fluid at the exhaust.

Figure 5 shows a double-sided turbine comprising in effect two rotors according to Figure 1 placed back to back, with the necessary structural modification that this involves. For example the body discs **2** are spigoted for engagement at **20** and bolts **21** are provided to draw the two bodies together and attach them to a shaft. At one side of the rotor axial borings **22** provide communication with the radial passageways **17**. In other respects the construction is substantially the same as in Figures 1 to 4, and in Figure 5 the same reference numerals are used for parts which correspond or are similar to parts shown in Figures 1 to 4.

Although the invention has been described mainly in terms of turbines it is also applicable to the construction of centrifugal compressors should circumstances arise (for example in chemical process gas turbine plants) where it is desired to compress hot gases.

What I claim is:

1. A bladed rotor for a radial-flow turbo-machine comprising a rotor body, an annular shroud member axially spaced from one side of the said rotor body and hollow blades carried by the shroud member on the side remote from the rotor body, the shroud member having inner and outer peripheral regions at which the shroud member is attached to the said rotor body around the whole circumference of the said peripheral regions only, thereby forming an uninterrupted annular space between the said rotor body and the said shroud member, the rotor body having openings therein communicating with the said space for the flow of coolant therethrough, the shroud member having apertures communicating with the said hollow blades and the blades having outlet openings, flow of coolant through the blades thereby being permitted.

2. A bladed rotor for a radial-flow turbo-machine comprising a rotor body, a sheet metal annular shroud member axially spaced from one side of the said rotor body and sheet metal blades of hollow construction carried by the shroud member on the side remote from the motor body, the shroud member having inner and outer peripheral regions at which the shroud member is attached to the said rotor body around the whole circumference of the said peripheral regions only, thereby forming an uninterrupted annular space between the said rotor body and the said shroud member, the rotor body having openings therein communicating with the said space for the flow of coolant therethrough, the shroud member having apertures communicating with the said hollow blades and the blades having outlet openings, flow of coolant through the blades thereby being permitted.

3. A bladed rotor for a radial-flow turbo-machine comprising a rotor body, an apertured ring attached to the periphery of the said rotor body, a disc attached to the hub of said rotor body, an annular sheet metal shroud member which is welded to the said ring and disc respectively around the whole of the outer and inner peripheries only of the said shroud member and which, intermediately of the said ring and disc, is separated axially from the rotor body thereby forming an uninterrupted annular space, the rotor body having openings for the flow of coolant to the said space, the coolant leaving through the said apertured ring, and blades carried by the shroud member on the side remote from the rotor body, each of the said blades comprising two strips of sheet metal welded together to form a hollow blade of substantially U-shaped transverse section, the said strips being welded at the open end of the U to the said shroud member, which is provided with apertures communicating with the said hollow blades to allow flow of coolant from the said space into the blades.

4. A bladed rotor for a radial-flow turbo-machine comprising a rotor body, an annular shroud member axially spaced from one side of the said rotor body and hollow blades carried by the shroud member on the side remote from the rotor body, the shroud member having inner and outer peripheral regions at which the



shroud member is attached to the said rotor body, thereby forming an annular space between said rotor body and said shroud member, the rotor body having openings therein communicating with the said space for the flow of coolant therethrough, the shroud member having apertures communicating with the said hollow blades and the blades having outlet openings, flow of coolant through the blades thereby being permitted.

5. A bladed rotor for a radial-flow turbo-machine comprising a rotor body, an annular shroud member axially spaced from one side of the said rotor body and hollow blades carried by the shroud member on the side remote from the rotor body, the shroud member having inner and outer peripheral regions at which the shroud member is attached to the said rotor body, thereby forming an annular space between the said rotor body and the said shroud member, the rotor body having an axial throughway therein communicating with radially directed passages communicating with the said space at positions near to the hub of the rotor body for the flow of the coolant thereto and having apertures near to the periphery of the rotor body for the flow of coolant from the said space, the shroud member having apertures communicating with the said hollow blades and the blades having outlet openings, flow of coolant through the blades thereby being permitted.

6. A bladed rotor for a radial-flow turbo-machine comprising a rotor body, two annular shroud members which are attached one on each side of the said rotor body at the inner and outer peripheries of the said shroud members and which, intermediately of the said inner and outer peripheries, are spaced axially from the said rotor body, thereby forming two annular spaces between the said rotor body and the said shroud members and hollow blades carried by the said shroud members on their sides remote from the rotor body, the rotor body having openings therein communicating with the said spaces for the flow of coolant therethrough, the shroud members having apertures communicating with the said hollow blades and the blades having outlet openings, flow of coolant through the blades thereby being permitted.


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