BLADED STATOR OR ROTOR CONSTRUCTIONS WITH MEANS TO SUPPLY A FLUID INTERNALLY OF THE BLADES

Fig. 1.

Fig. 2.

Fig. 3.

Fig. 4.

Fig. 5.

Fig. 6.
BLADED STATOR OR ROTOR CONSTRUCTIONS WITH MEANS TO SUPPLY A FLUID INTER- 
NALLY OF THE BLADES

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This invention relates to bladed stator and rotor constructions for fluid machines, for instance, for axial flow turbines or compressors, which constructions employ blades supported in a drum or disc structure by attachment portions on the blades, which attachment portions have shoulders engaging correspondingly shouldered slots in the disc or drum, and which attachment portions afford between them tunnels extending across the drum or disc and suitable to convey a flow of fluid between the blade attachment portions. Such a bladed construction will be referred to hereinafter as "a bladed construction of the kind specified."

It is known to supply a fluid, such as compressed air, to the inner sides of blades for the purpose of cooling or heating them during operation of the fluid machine of which they form part and this invention is further concerned with bladed constructions of the kind specified in which the blades have internal passages to convey a heating or cooling fluid.

According to the present invention, a bladed construction of the kind specified comprises a plurality of blades each having at least an inlet lengthwise passage therein and a delivery lengthwise passage therein, which passages are interconnected at their ends remote from the attachment portion of the blade, and which passages extend through the attachment portion to open into the tunnels on opposite sides of the attachment portion, each blade being arranged so that its inlet passage opens into the same tunnel as the inlet passage of the next adjacent blade on one side of it and so that its delivery passage opens into the same tunnel as the delivery passage of the next adjacent blade on the other side of it, and blanking means to close-off at least the corresponding ends of alternate tunnels and the opposite ends of the remaining tunnels.

With the arrangement of this invention, the said alternate tunnels formed between blades of a row of blades may be employed to convey a supply of a fluid, say, compressed air, to the inlet passages in the blades and the remaining tunnels may be employed as exhaust outlets to receive the fluid exhausting from the delivery passages of the blades.

In one preferred construction as applied to a bladed rotor construction with the blades supported at the periphery of a rotor structure, the tunnels into which the inlet passages open, are blanked-off from the downstream side of the blade attachment portions and a pressure fluid which is conveniently compressed air is supplied on the upstream side of the blade attachment portions, and the pressure fluid flows from this space into the tunnels and then through the inlet and delivery passages in the blades into the remaining tunnels which are blanked-off from the upstream side of the blade attachment portions so that the pressure fluid exhausting from the blades flows into the space on the downstream side of the blade attachment portions.

In another preferred construction as applied to a bladed rotor construction, the tunnels into which the inlet passages open, are blanked-off at each end, and the tunnels into which the delivery passages open, are blanked-off from the space on the upstream side of the rotor disc, and a pressure fluid such as compressed air is fed into the first set of tunnels through ducting formed in the rotor disc.

The invention is especially suitable for use in bladed rotor constructions of the kind specified in which each blade attachment portion comprises a blade platform which together with the other platforms of a ring of blades form a complete annular shroud, a shouldered root fixing portion by which the blade is engaged with the root disc or drum, and a circumferentially-narrow, axially-extensive stem which joins the platform to the root fixing portion, so that spaces of substantial dimensions are formed between the pairs of adjacent stems and these spaces are conveniently used as the tunnels.

Two embodiments of this invention will now be described as applied to turbine rotor constructions, the description making reference to the accompanying drawings, in which—

Figure 1 is a form of blade suitable for use in the turbine constructions,

Figure 2 is a section on the line 2—2 of Figure 1,

Figure 3 is a view corresponding to part of Figure 1 showing the root end of a blade such as is assembled next to the blade of Figure 1,

Figure 4 is a section on the line 4—4 of Figure 1, drawn to a larger scale,

Figure 5 is a view similar to Figure 4 of a modified type of blade,

Figure 6 is a perspective view of part of one turbine rotor construction using the blades illustrated in Figures 1 to 4, the view being from the upstream side of the rotor,

Figure 7 is an axial view on part of the turbine rotor of Figure 6 from the downstream side,

Figure 8 is an axial view of the upstream side of a second construction,

Figure 9 is a section on the line 9—9 of Figure 8, and

Figure 10 is a section on the line 10—10 of Figure 9.

In the first embodiment, Figures 1 to 4 and 6 and 7, the invention is applied to the rotor of an axial-flow turbine of a gas-turbine engine, which rotor comprises a rotor disc 10 carrying at its periphery a ring of individual blade elements each of which comprises a vane portion 11 upon which, the working fluid of the engine impinges and at its radially inner end an attachment portion.

In this construction the attachment portion comprises (Figures 1 to 4) three essential parts, a blade platform 12 from which the vane 11 of the blade projects, a root fixing portion 13 for retaining the blade in position on the rotor disc structure, which root fixing portion 13 has a number of outwardly-facing shoulders 13a in its circumferentially-directed faces and which engages in a slot having complementary shoulders and cut in a thickened periphery 14a of the rotor disc 10, and a stem portion 14 which is in the form of a circumferentially-narrow, axially-extensive web so as to have a pair of circumferentially-facing surfaces 14a and which thus has a generally narrower cross section than either the platform 12 or the root fixing portion 13 and interconnects these parts. The platform 12 of ring of blades is operated in circumferential abutment to form a substantially complete annular shroud for the inner ends of the vanes 11 of the ring of blades, and the root attachment portions 12, 13, 14 form with the portions 15 of the rotor disc 10 between the slots a series of duct passages (16), referred to hereinafter as tunnel-like spaces 16, which extend axially across the periphery of the disc from the upstream side of the disc to the downstream side.

The vane portion 11 of each blade in the ring of blades is formed with three lengthwise passages 17, 18, 19,
of which passage 17 is of generally triangular section and is adjacent the leading edge of the blade, of which passage 18 is of generally rectangular section and is adjacent the trailing edge of the blade, and of which the passage 19 is of generally rectangular section between the two triangular section passages 17, 18 and adjacent the mid chord of the vane portion 11. The three passages 17, 18, 19 are separated in the length of the blade by a pair of narrow webs 20 which are at the thickness of one of the vane portion from the convex surface thereof to the concave surface thereof and these webs 20 are partly removed to form a chamber as indicated at 22 in Figures 4 and 5 adjacent the tip of the blade, so that the three passages 17, 18, 19 are interconnected adjacent the tip of the blade. The blades are provided with an outer chord portion 21 which may conveniently be formed as indicated in Figure 4 in one piece with the vane 11 or as indicated in Figure 5 separately from the vane 11 of the blade and brazed in position at the tip to close-off the passages in a manner preventing leakage therefrom while permitting fluid to flow between them. In the former case the chord portion 21 may have an aperture formed therein during manufacture to give access to the passages 17, 18, 19, which aperture is closed by a disc 23 welded in position in the aperture.

The longitudinal passages 17, 18, 19 have extensions 17a, 18a, 19a respectively through the platform 25 of the blade, and the extensions of the passages in the leading and trailing edges of the vane portion open at their inner ends through one circumferentially-facing surface 14a of the stem 14 and the extension 19a of the mid chord passage 19 opens to the other circumferentially-facing surface 14c of the stem 14. The passages are divided into two sets, one of which sets comprises blades each having their root attachment portions as shown in Figure 3 and having their leading and trailing edge passage extensions 17a, 18a opening to the right of the stem (as viewed axially from the upstream side of the rotor), and the other of which sets comprises blades having their root attachment portions as shown in Figure 3 and having their leading and trailing edge passage extensions 17a, 18a opening to the left of the stem 14. The blades are assembled in the disc 10 so that the blades of the two sets alternate with one another and thus each blade has its extension 17a, 18a of the leading and trailing edge passages 17, 18 opening into the same tunnel-like space 16 as the corresponding extensions of the next adjacent blade on one side, and has its extensions 19a of the mid chord passage 19 opening into the same tunnel-like space as the corresponding extension 19a of the mid-chord passage 19 of the blade next adjacent it on its opposite side.

Blanking means is provided to blank-off one end of each tunnel-like space 16. The blanking means is arranged so that the tunnel-like spaces 16 are left open alternately to the upstream side and the downstream side of the turbine disc 10, the tunnel-like spaces 16 into which the extensions 17a, 18a of the leading and trailing edge passages 17, 18 open, communicating with the upstream side of the turbine disc 10, and the other tunnel-like spaces 16 opening to the downstream side of the turbine disc 10 do so that the mid chord passage 19 communicates with the downstream side of the turbine disc 10.

The blanking means may comprise a series of plates fitted on to the rim 10a of the disc 10 and bearing against the end surfaces of the stems 14.

Referring to Figure 6, the blanking means for the upstream side is illustrated as comprising a number of plates 24 with cutaway portions opposite the tunnels 25 which are to be left uncovered, and having flanges along their outer edges to engage with undercut channels 26 in the upstream edges of the blade platforms 12 and having along the radially inner edges flanges 26 to rest on a ledge-like projection 27 from the disc periphery to locate the plate radially. The upstream end of each
plate 46 also has a T-shaped head 46a overlying the portion 15 to prevent it falling to the bottom of the channel 44 in assembly. The plates 46 are placed in position prior to mounting the blades in the disc periphery.

Referring particularly to Figure 8, the upstream ends of all the tunnels 16 are blanked off by blanking plates 47 which either co-operate with the roots of three blades or with the roots of four blades. Each blanking plate 47 has at its radial outer edge a short axial flange 48 to engage in undercut grooves in the platforms 12 of the blades with which it co-operates, has apertures 49 therein which engage over hooked features 50 projecting from the ends of the portions 15 between the blade slots and has tabs 51 at its radially inner edge which can be engaged in an axially-facing shallow channel 52a cut in the disc periphery. Those plates 47 which co-operate with four blade roots are partly cut away adjacent their mid circumferential dimension so that they need only interlock with a pair of hooked features 50.

The blanking plates 50 for the downstream ends of the tunnels 16 which are in communication with the passage extensions 17a, 18a may be formed as shown in Figure 7 or in any other convenient way. The downstream ends of the remaining tunnels 16, i.e., those into which passage extensions 19a open, are uncovered.

In use pressure sealing air is fed to space 53 between the rotating and the stationary structure 52 to prevent inward leakage of the working fluid at the upstream edges of the blade platforms 12, and it will thus be appreciated that since the space 40 bounded by the axial flange 41 is separated from the working fluid passage of the turbine through two labyrinth seals, and since the pressure between the labyrinth seals is maintained high for sealing purposes, the pressure within this space 40 can be maintained at an even higher value. As in the previous construction the pressure air may be abstracted from the compressor of the gas-turbine engine.

I claim:

1. A bladed construction of the axial flow kind comprising a rotor disc structure, a plurality of blades, the blades having at their radially inner ends integral blade attachment portions; the blade attachment portion of each blade element comprising a shouldered root-fixing portion engaging a corresponding shouldered slot in the rotor disc whereby the blade is retained in position on the rotor disc structure, a blade platform spaced radially from the root-fixing portion, the blade extending from the platform, said blade platforms together forming a substantially complete annular shroud, and a circumferentially-narrow axially-extending stem joining said platform to said root-fixing portion, whereby in the assembly of said blades on the rotor disc structure axially-extending spaces of substantial circumferential dimensions are formed between the pairs of adjacent stems, said axially-extending spaces forming duct passages, each blade having at least a lengthwise inlet passage therein and a lengthwise delivery passage therein, each blade having its inlet and delivery passages interconnected at their ends remote from the attachment portion of the blade, the inlet and delivery passages extending into the stem and opening through opposite sides thereof into the duct passages on each side of the attachment portion respectively, and each blade being arranged with its inlet passage opening into the same duct passage as the inlet passage of the next adjacent blade on one side of it whereby a cooling fluid supply to the blade and said adjacent blade on said one side can be effected through said duct passage, and with its delivery passage opening into the same duct passage as the delivery passage of the next adjacent blade on the other side of it whereby said latter duct passage forms an exhaust passage for cooling fluid from said blade and from said next adjacent blade on the other side.
tending over the opposite ends of the remaining duct passages to close them.

8. A bladed construction as claimed in claim 7, having the blanking means mounted on the rotor disc structure and extending over the duct passages into which the said inlet passages open, to close off the ends of said duct passages on the downstream side of the rotor disc structure, in combination with means supplying cooling fluid to the upstream side of the rotor disc structure.

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