Aug. 28, 1951 H. CONSTANT 2,565,594

TURBINE AND THE LIKE

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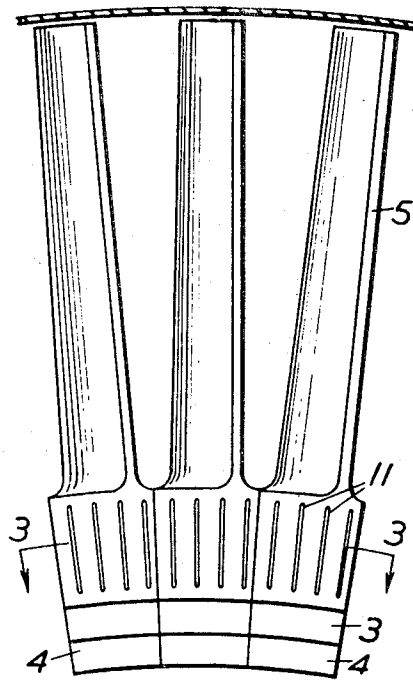


Fig: 2.

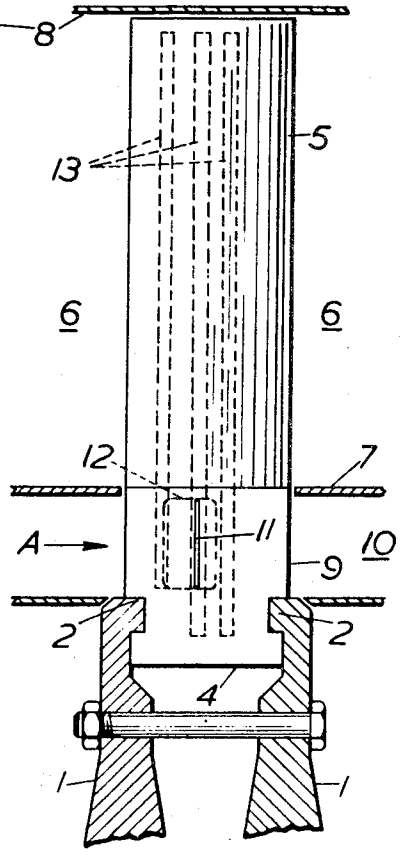


Fig: 1.

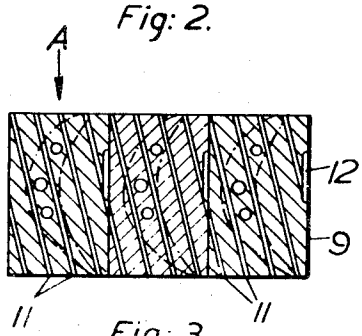


Fig: 3.

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TURBINE AND THE LIKE

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8 Claims. (Cl. 60—41)

1

This invention relates to axial flow turbines and similarly bladed fluid flow machines, such as axial flow compressors, required to run at high temperatures, and its chief object is to make improved provision for cooling the rotor blading of such machines, such improvement being partly derived from the construction of the blades themselves and partly from the method of integrating the blades with the general layout of the machine. Especially in relation to gas turbines, the practicable working temperature of the blading is frequently a limiting factor in the performance of the machine and it is possible to design a given machine for higher performance if the blading can be kept at a reduced working temperature. Alternatively for a machine of given performance, longer life may be achievable and it may be possible to use lower grade metal for the blading.

According to the present invention, there is provided an axial flow turbine or similarly bladed fluid flow machine required to run at high temperatures, and especially a combustion gas turbine, comprising at least one stage of rotor blading which is provided, between its working parts which lie in the working fluid channel of the machine, and the rim of the rotor, with intermediate parts together forming an annular structure enclosing the rotor rim and constituting peripherally an inner boundary wall of the working fluid channel; said annular structure registering with an annular coolant channel which extends both upstream and downstream of the rotor and is enclosed by the working fluid channel, and containing, in respect of each blade, a plurality of axial flow passages forming a continuation of the coolant channel so as to permit through flow of the coolant between the upstream and downstream sections thereof.

The features defined in the foregoing are preferably used in conjunction with internal means within the blades to promote the transference of heat from the working parts to the intermediate parts thereof and such means may take the form of "Perkins tube" arrangements in which each rotor blade has common both to its working and its intermediate part at least one closed internal cavity, containing a coolant medium which circulates convectively in the conditions of operation, said cavity extending between adjacent axial flow passages in said intermediate part. In such case a plurality of internal coolant cavities may be provided and the passages in the intermediate parts are arranged so as to avoid intersecting these whilst exposing as effective an

2

area to the coolant air flow as may be possible having regard to general design considerations.

According to a further feature of the invention, which is of considerable importance in minimising the effect of centrifugal bending loads on the structure of said intermediate parts and in reconciling the requirement of adequate cross sectional area of these parts for supporting the weight of the blades with that of adequate heat-transfer capacity, the passages in said intermediate parts are made radially extending, being preferably in the form of radial slits lying in radial planes inclined to the axis of rotation. These passages, further, may be formed to act as turbine blading taking work out of the coolant flow through the intermediate structure.

It will be appreciated that the invenion includes also, as an independent article of manufacture, a blade having the characteristics required to construct a machine in accordance with the foregoing.

The invention will be better understood from the following description of the accompanying drawing, in which:

Figure 1 is a fragmentary axial section of a turbine constructed in accordance with the invention, only the peripheral part of the rotor being shown;

Figure 2 is a face view of a group of three adjacent blades corresponding to the Figure 1 construction;

Figure 3 is a section on line 3—3 of Figure 2.

In the drawing 1, 1, represent the two halves of a two part turbine rotor, each of which has a peripherally extending lip 2 engaging corresponding peripherally extending channels 3 in the upstream and downstream faces of blade anchorage roots 4. Each blade comprises a working part 5 which lies in an annular working fluid channel 6, defined by inner and outer walls 7, 8 and an intermediate part 9. The intermediate parts 9 of all the blades together form an annular wall structure substantially enclosing the turbine rim and registering on both the upstream and downstream sides with an annular coolant channel 10 enclosed by the working fluid channel 6 and supplied in the direction of the arrow A with, for example, air under pressure, which may balance or approximately balance the pressure in the channel 6.

The intermediate parts 9 of the blades are provided with radial slits 11, lying in planes inclined to the axis of rotation to allow axial flow through the parts 9 from one part of the channel 10 to another, a slot 11 emerging in the side of

one part 9 mating with an enlarged entry 12 to a corresponding slit 11 in the part 9 adjacent. By suitable formation, the passages 11 may be made to operate as turbine blading taking work out of the cooling air.

It will be appreciated that by reason of the construction described an intensively cooled zone is provided between the base of the blade working parts 5 and their roots 4, so that there will be a heat flow in that direction and also the rotor will be insulated from the heating effect of the working fluid. In order, however, to render the cooling of the blade parts 5 fully effective for very high temperature conditions, it is proposed, in addition, to provide each blade with one or more closed internal cavities 13 (three in the case illustrated) extending from the parts 4 to the parts 5 of the blades and passing between the slits 11 in the latter. Each cavity contains a suitable coolant medium, examples of which are sodium, caesium or aluminum chloride or bromide, which will satisfy the requirement of becoming capable of convective circulation, whether in a liquid or a gaseous state, in the conditions of use. With an arrangement of this kind the intensively cooled structure 9 provides the cool zone required for the convection cycle, it being borne in mind that in the conditions of use gravity will be superseded by centrifugal force as the weight influence in the cycle.

I claim:

1. An axial flow turbine or similarly bladed fluid flow machine required to run at high temperature, and especially a combustion gas turbine, having a rotor, blading attached peripherally thereto comprising working parts for cooperation with the working fluid of the machine, root portions for attachment to said rotor, and, therebetween, intermediate parts segmentally shaped to form collectively an annular structure peripherally surrounding said rotor; and stationary structure defining an annular coolant channel registering with said intermediate parts of said blading and extending upstream and downstream thereof, said intermediate parts each containing a plurality of slit-like apertures extending in the axial direction to afford interconnecting flow passages between the coolant channel upstream and downstream thereof, and in the radial direction to bound segmental portions thereof.

2. An axial flow turbine or similarly bladed fluid flow machine as defined in claim 1, wherein each rotor blade has common both to its working and its intermediate part at least one closed internal cavity containing a coolant medium which circulates convectively in the conditions of operation, said cavity extending between adjacent axial flow passages in said intermediate part.

3. An axial flow turbine or similarly bladed fluid flow machine as defined in claim 1, wherein the passages in said intermediate structure are formed to act as turbine blading taking work out of the coolant flow therethrough.

4. An axial flow turbine or similarly bladed fluid flow machine as defined in claim 1, wherein the passages in said intermediate structure are radially extending and lie in radial planes inclined to the axis of rotation, a passage emerging at the side of one intermediate part mating with the entrance to a passage in the side of the adjacent intermediate part.

5. An axial flow rotor blade for a turbine or similarly bladed fluid flow machine required to run at high temperature comprising a working part for cooperating with the working fluid of the machine, a root portion for attachment peripherally to the rotor of the machine, and an intermediate part therebetween segmentally shaped so as to form, with other similar blade parts, an annular structure peripherally surrounding the rotor of the machine, said intermediate part containing a plurality of slit-like apertures extending in the axial direction (with respect to the rotational axis of the machine), to permit passage of a coolant from one side to another thereof, and in the radial direction to bound segmental portions thereof.

6. A blade as defined in claim 5, having common both to its working and its intermediate part at least one closed internal cavity containing a coolant medium which circulates convectively in the conditions of operation, said cavity extending between axial flow passages in said intermediate part.

7. A blade as defined in claim 5, wherein the passages in said intermediate part are formed to act as turbine blading adapted to take work out of a coolant flow therethrough in use.

8. A blade as defined in claim 5, wherein the passages in said intermediate part are radially extending (with respect to the axis of rotation when in use) and lie in planes which are radial and inclined to such an axis, one of the passages communicating with the side of the intermediate part whereby to render it adaptable for coaction with a complementary passage in the adjacent part of an adjacent blade.

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