Feb. 18, 1941. C. KELLER 2,232,611

GUIDE APPARATUS FOR AXIAL FLOW TURBOMACHINES

Filed Oct. 24, 1938

Fig. 1

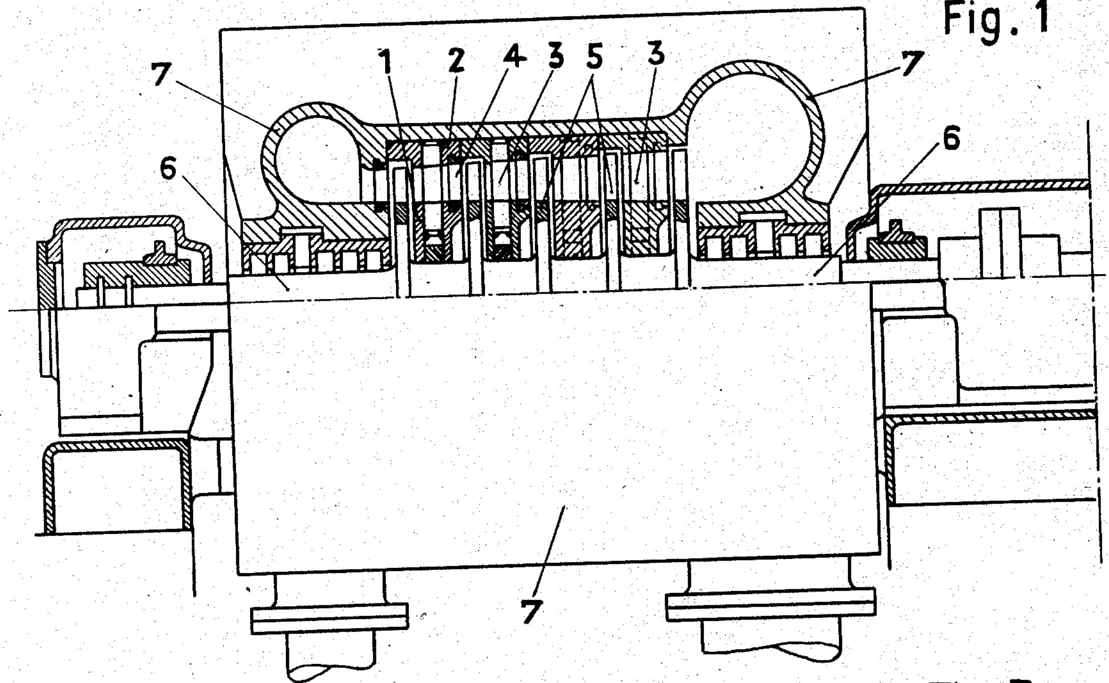


Fig. 2

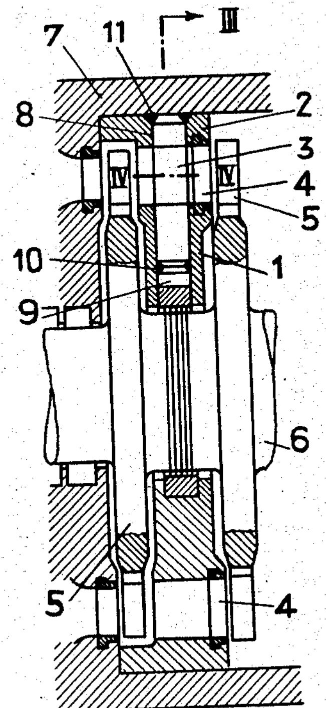


Fig. 3

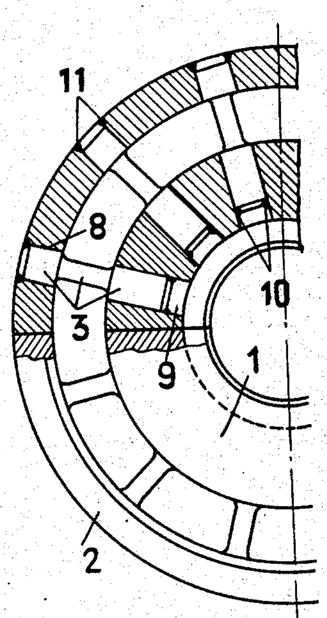


Fig. 5

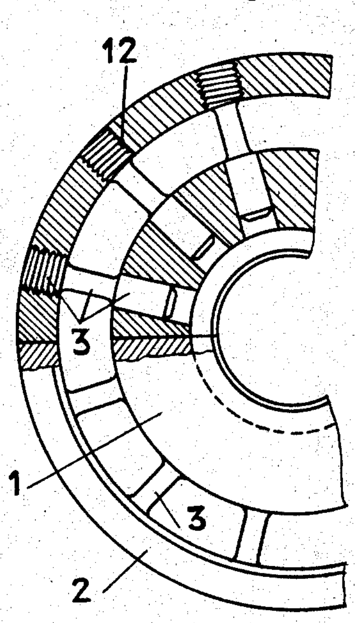
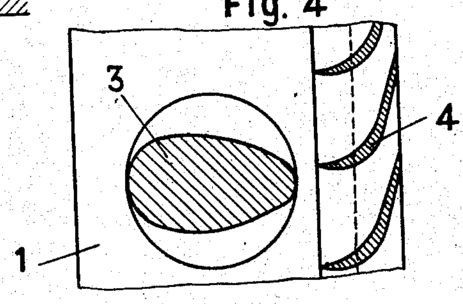


Fig. 4



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UNITED STATES PATENT OFFICE

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GUIDE APPARATUS FOR AXIAL FLOW TURBOMACHINES

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In Switzerland November 3, 1937

3 Claims. (Cl. 253—78)

This invention relates to a guide apparatus for axial flow turbomachines; more especially turbines and blowers intended for operation at high temperatures and in which the deflecting or guide blades proper are let into a guide disc and an outer ring or rim surrounding the latter and connected to it by supporting or strut blades located in front of the said guide blades. A construction of this kind has the advantage that the guide blades do not have to transmit the forces acting on the guide disc, this function being taken over by the struts which present a high moment of resistance mainly in a direction parallel to the axis of the machine. In most cases the outer ring, the struts and the guide disc are cast in one piece and such constructions are quite suitable for working media at comparatively low temperatures. For higher temperatures, however, it is essential to make the cast structure of a material which is highly resistant to heat, in order that the maximum stresses set up in the struts can be resisted with a sufficient margin of safety. At temperatures over about 500° C. the resistance to heat and, still more, the creep resistance fall off very rapidly in all kinds of steel, so that, when relatively high differences of pressure have to be provided for the only possible expedient is to employ a large number of thick struts.

The difficulties arising in the manufacture of such complicated castings are greatly aggravated when those kinds of cast steel which are highly resistant to heat have to be used. Unless special precautions be taken, in such cases, pipe holes and fissures are likely to form at the points where the struts meet the comparatively thick ring or the thick disc and in this way the guide wheel is greatly weakened, even if it is not rendered quite unserviceable.

The object of the present invention is to eliminate this drawback and, for this purpose, the struts in a guide apparatus of the kind referred to, are introduced according to the said invention through radial bores in the outer ring into radial cavities in the guide disc and are secured against radial displacement. In this way a composite guide apparatus is provided, in which the outer ring and the guide disc are connected by struts constructed as separate elements. The separate struts, the outer ring and the guide disc can, therefore, be made independently of each other. Accordingly, the outer ring and the guide disc may be made of an ordinary cast or forged material, while the struts, which have to withstand the greatest stresses, are manufactured from a high grade material which, however, is more expensive. Thus only a comparatively small amount of the expensive but highly heat resistant material has to be used in constructing a guide wheel. A further advantage of the new type of construction is that the parts over which the current of working medium flows, that is to say, the exposed parts of the struts, the inner wall of the outer ring and the outer wall of the guide disc, can be accurately machine finished, as by milling or turning, before assembly.

The struts, after being passed through the outer ring and into the guide disc may be held against radial displacement by welding them to these parts.

The invention is described more particularly hereinafter with reference to the accompanying drawing, which shows constructional embodiments of the invention, by way of example. In this drawing:

Fig. 1 is partly a front view and partly an axial longitudinal section through an axial flow turbine.

Fig. 2 shows a portion of the axial longitudinal section through the turbine of Fig. 1 on an enlarged scale.

Fig. 3 is partly a side elevation and partly a section on the line III—III of Fig. 2 through a guide apparatus according to the invention.

Fig. 4 is a section taken on line IV—IV of Fig. 2, developed in the plane of the drawing, and drawn to a larger scale than Fig. 2, and

Fig. 5 is partly a side elevation and partly a section through a second embodiment of a guide apparatus.

The reference 1 denotes two-part guide discs, 2 two-part outer rings or rims surrounding the discs and 3 a plurality of radial strut blades connecting the members 1 and 2 together. 4 denotes the guide blades proper, which are let into the guide discs 1 and the outer rings 2. The rotor wheels 5 of the turbine are integral with the turbine shaft 6 and 7 is a turbine casing, in which the guide apparatus 1, 2, 3 are mounted in such a way as to be prevented from displacement both axially and radially, and the two respective halves of the bipartite members 1 and 2 bear against each other in the usual way. Each guide structure thus serves to separate from each other two successive stages in the turbine, the outer ring sealing with the casing and the inner ring or disc forming a running seal with the shaft 6 between the rotor wheels 5, as conventionally represented in Fig. 2.

A number of radial bores 8 (Figs. 2 and 3) of round cross section, pass right through each outer ring 2. The struts 3 are introduced through these bores 8 and entered into corresponding radial cavities or bores 9 in the allotted guide disc 1. The struts 3 should be a good fit in the bores 8 and 9 and when in place, these struts are welded at their ends to the members 1 and 2 respectively, as indicated in Figs. 2 and 3 at 10 and 11. The exposed part of each of the struts 3 is preferably of the streamlined cross section, as shown in Fig. 4, so that it shall offer as little resistance as possible to the flow of the working medium.

Instead of welding the struts 3 to the members 1 and 2 these struts may be prevented from moving radially by threading them into the outer ring 2, as shown in Fig. 5, where 12 denotes screw threads.

The struts 3 are preferably made of forged metal while the outer rings 2 and the guide discs 1 are made of a weldable casting metal or alloy. In any case the material of the struts should be more resistant to heat and to fatigue than the material of the outer rims and the guide discs.

In some cases the struts may be subjected to initial stress when fitting them in place, for instance, they may be a force fit in the guide disc and in the outer ring or these elements may be shrunk on to them.

Since, in this guide apparatus, a highly heat resistant material can be used for the construction of the struts, these latter can be relatively fewer in number and relatively thinner than in the case of guide apparatus cast in one piece. Losses due to friction are reduced accordingly, as the current of working medium encounters fewer and smaller resistance bodies (struts) as it flows through the guides.

What is claimed is:

1. Guide apparatus for turbomachines including a casing and a rotor-wheel shaft mounted in said casing, said guide apparatus comprising an inner ring adapted to encircle the shaft and having radial cavities extending inward from its outer periphery, an outer ring concentric with and encircling said inner ring and adapted to be fixedly mounted in said casing, said outer ring having an internal diameter larger than the external diameter of the inner ring and being provided with radially extending bores corresponding in number with and aligned with the radial cavities in the inner ring; guide blades proper sustained by said rings and extending across the interval therebetween; separately formed struts of high strength material characterized by high creeping strength and resistance to high temperature, said struts being located in advance of said guide blades and each extending through a corresponding bore of the outer ring into an aligned cavity of the inner ring, and means for fixing said struts in position.

2. The combination defined in claim 1 in which the struts are of forged material and the rings are of cast material and welded to said struts.

3. A multi-stage axial flow turbomachine comprising a generally cylindrical casing; a rotor shaft with a plurality of axially spaced rotor wheels fixed thereon in spaced relation, said shaft being mounted to rotate coaxially in said casing; and a plurality of interstage guide structures, one interposed between each pair of adjacent wheels and each comprising an inner ring closely encircling said shaft and having on its outer periphery a circumferential series of radial cavities, an outer ring surrounding and spaced from said inner ring, and sustained by said casing against motion in the direction of and transverse to the axis of said shaft, each outer ring being provided with radially extending bores corresponding in number with and aligned with the radial cavities in the corresponding inner ring, guide blades proper sustained by and extending across the interval between said inner and outer rings and in coactive relation with said rotor wheels, separately formed struts of high strength material characterized by high creeping strength and resistance to high temperature, said struts being located in front of the guide blades proper and extending into the aligned bores of the two rings, and means for fixing said struts in position in said bores.

CURT KELLER.