Feb. 12, 1952 E. A. STALKER 2,585,871

TURBINE BLADE CONSTRUCTION WITH PROVISION FOR COOLING

Filed Oct. 22, 1945 2 SHEETS—SHEET 1

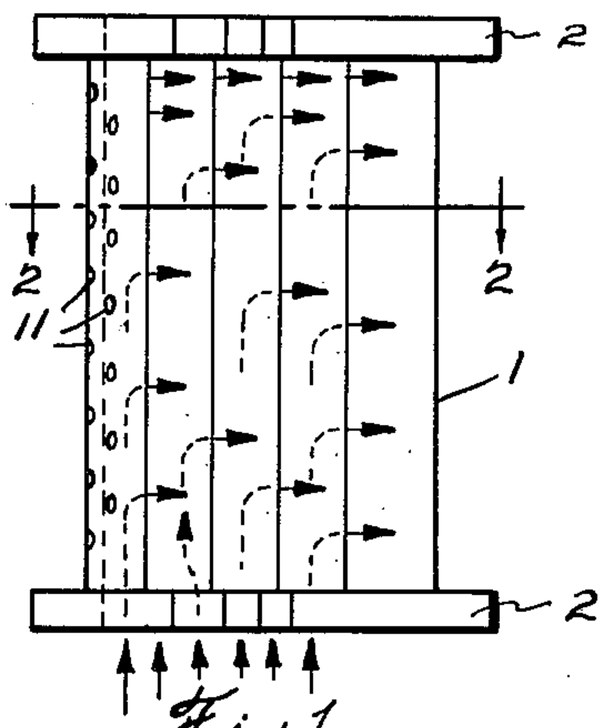

Fig. 1

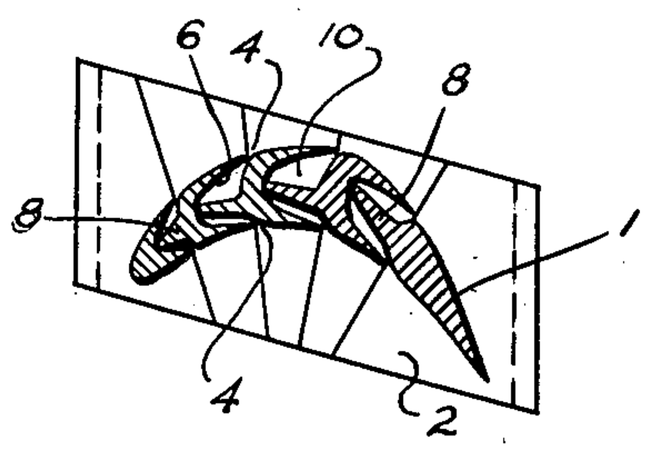

Fig. 2

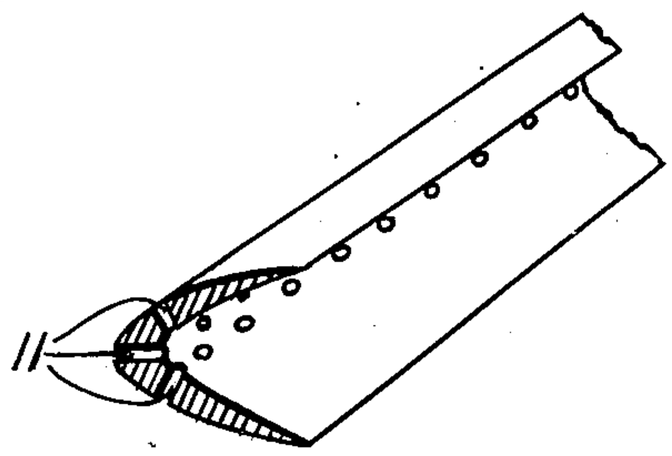

Fig. 3

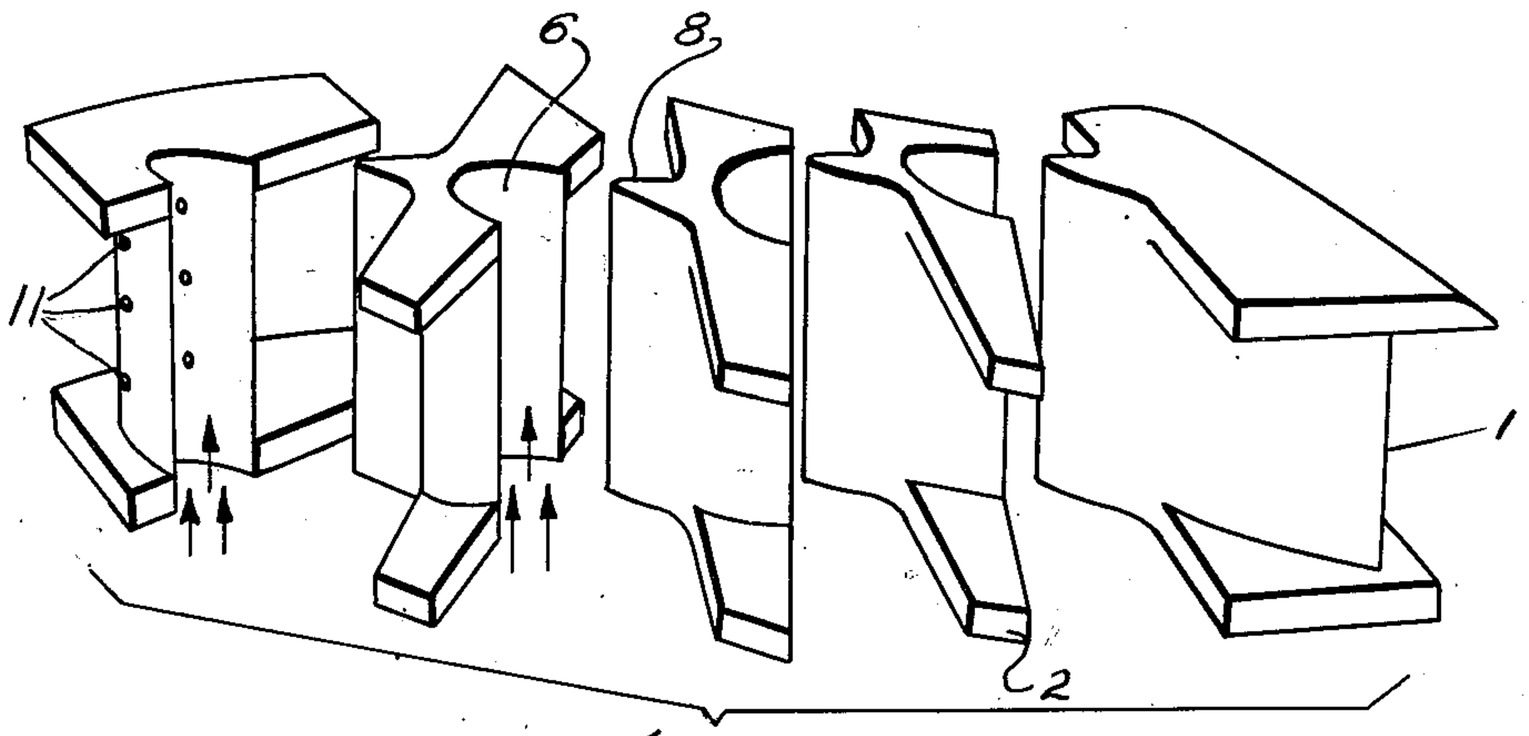

Fig. 4

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TURBINE BLADE CONSTRUCTION WITH PROVISION FOR COOLING

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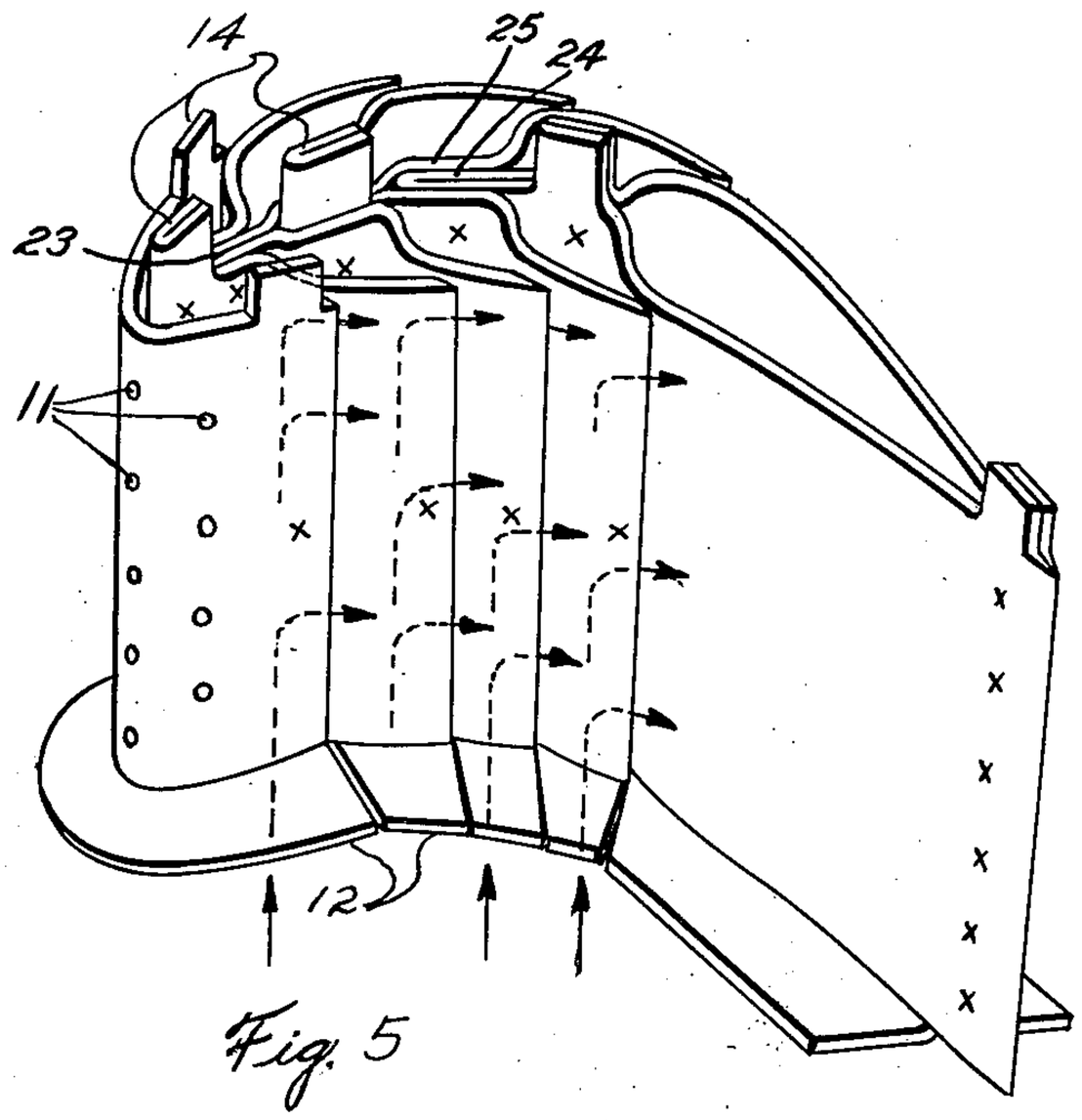

Fig. 5

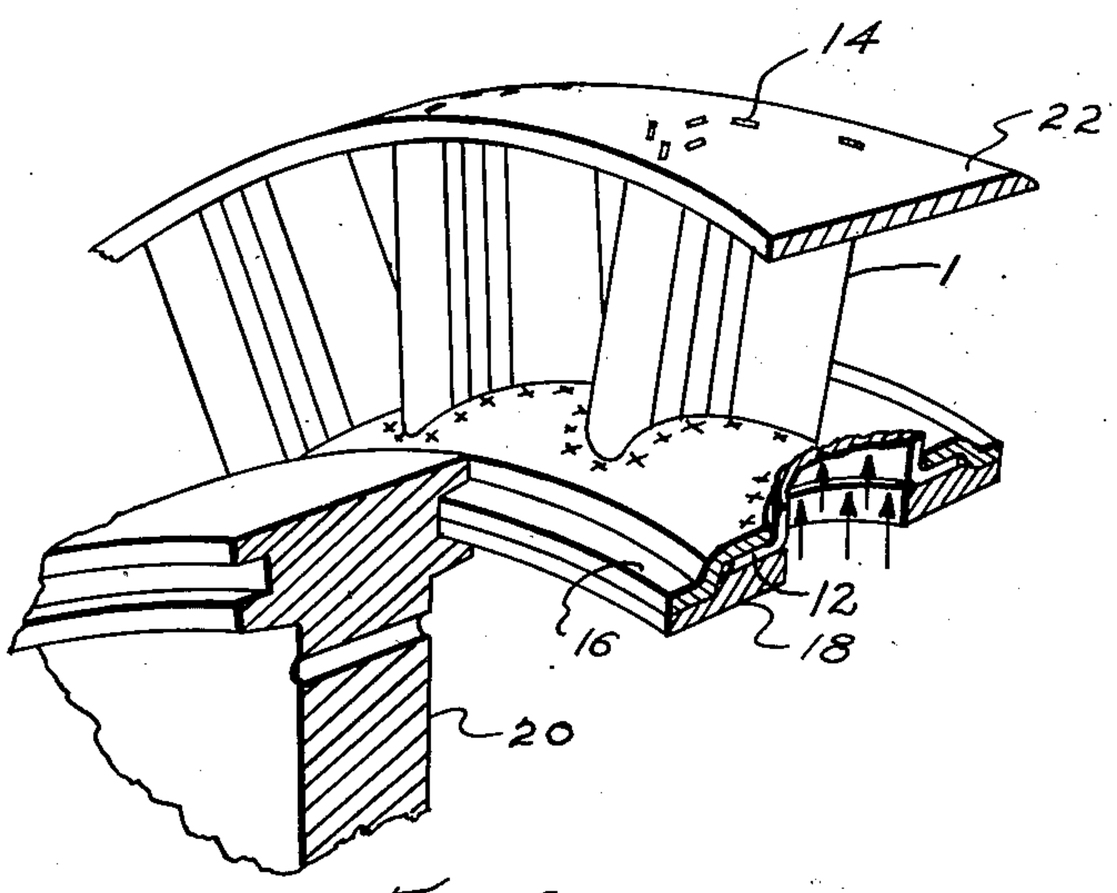

Fig. 6

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UNITED STATES PATENT OFFICE

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TURBINE BLADE CONSTRUCTION WITH PROVISION FOR COOLING

Edward A. Stalker, Bay City, Mich.

Application October 22, 1945, Serial No. 623,695

9 Claims. (Cl. 253—39.15)

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My invention relates to blades of fluid machines and in particular to turbine blades.

An object is to provide a slotted blade structure.

Another object is to provide a method of fabricating a slotted blade.

It is also an object to provide a slotted blade structure incorporating different materials.

I accomplish the above objects by the means illustrated in the accompanying drawings in which—

Figure 1 is a side view of a blade;

Figure 2 is a section of the blade along line 2—2 in Figure 1;

Figure 3 is a perspective view of a fragment of the nose piece;

Figure 4 is an exploded view of the blade;

Figure 5 is a perspective view of an alternate blade construction; and

Figure 6 shows a fragment of a rotor incorporating blades like Figure 5.

In my U. S. Patent No. 2,489,683 issued on application Serial No. 510,884 filed November 19, 1943, entitled "Turbines," I have disclosed means of cooling turbine blades by interposing a cool stream between the hot gas and the surfaces of the blades. This application discloses a novel blade structure which makes it possible to realize the slot flow with adequate strength in the blade. It also makes possible the use of forged material which is desirable to resist vibration forces. It provides a relatively inexpensive method of constructing a blade, and a further cost reduction is obtained by using a high cost alloy only for the nose piece and a low cost metal for the bulk of the blade.

Referring particularly to the drawings, the blade is composed of a plurality of elements or segments 1 carrying flanges 2 at either or both ends. These flanges are to be fused together with the airfoil elements of the blade nested together and spaced to provide slots 4 extending spanwise of the blade preferably in both upper and lower surfaces of the blade.

Some of the segments have a trough-like recess 6 on one side and a tongue 8 on the other. The tongue preferably extends the length of the slots and serves to partition the upper surface slots from the lower surface slots.

The lower projections or flanges 2 are for insertion in a slot in the rotor hub. The upper flanges can be butted against each other to form a shroud about the tips of the blades. Although only a single projection is shown on each side it is to be understood that more than one may be used for the hub attachment as is common in turbine practice to provide additional strength.

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The spanwise spaces 10 within the blade have access through one end, preferably the inner end, to a source of fluid flow for cooling or improving the aerodynamic characteristics of the blade by the flow out the slots 4. Like-wiise the nose piece may be provided with a series of spaced holes 11 through which the cooling flow is distributed to cool the entire nose area of the blade.

The tongues 8 also serve to space the elements or segments of the blades to give the proper slot widths when they are fused together. The tongues preferably butt against the forward segment but are preferably not welded thereto.

The flanges 2 of the segments can be fused together by electric welding. They may also be heated by other means and pressed together as a weld. For this purpose induction or gas heating may also be used.

In another form of the invention the elements are assembled in nested relationship as in the form first discussed but they are made from sheet stock as shown in Figures 5 and 6.

In Figure 6 flanges 12 are bent outward to provide a means of holding the blades in the rotor hub at the root end and prongs 14 are shown for attachment of a shroud ring at the tip end.

The blade flanges 12 which are welded to the holding ring 16 have the welds spaced from the corner formed by the walls of the blade and the flange 12. That is, the spots of welding on the flanges are well under the ring 16 where they will not be subject to vibration forces which normally cause cracking about the weld spot. The tongues 23 and 24 (Fig. 5) are inserted into spanwise grooves 25 which restrain the elements from lateral vibration while allowing small relative movement spanwise and chordwise under the action of heating and cooling, this movement relieving thermal stresses which otherwise would occur between the several elements.

The assembled blades are inserted outward through appropriate holes or openings in holding ring 16 having substantially the contour of the root section of the blades, and are then spot-welded, or otherwise bonded to the ring by means of the flange 12 which overlaps the inner surface of the ring adjacent the openings. Retaining ring 18 is made in two or more segments, the flange 12 of the blade being received between such retaining ring and the ring 16 adjacent the openings in the latter, and the assembly is clamped between hub sections 20. Outer ring 22 may be shrunk in place after which prongs 14 are riveted over.

It is a feature of this invention that the fusing of the parts together is done at the ends of the

blades so that the slots are open and can pass a cooling stream of air over the whole portion of the length of the blade bathed by the hot motive gas of the turbine.

The blade of Figure 2 exhibits horizontal and vertical partitions within, the tongues 8 being the horizontal ones. These partitions besides serving a structural purpose also conduct the heat away from the external surfaces and dissipate it to the internal flow. Thus they may be considered as internal cooling fins which divide up the inner flow passages so as to make heat transfer contact with more air.

Cross reference is made to divisional application, Serial No. 106,570, filed July 25, 1949, directed to the mounting for the turbine blades.

I have now described suitable embodiments of my invention which are now preferred. It is to be understood however that the invention is not limited to the particular construction illustrated and described and that I intend to claim it broadly as indicated by the scope of the appended claims.

I claim:

1. In combination to form a gas turbine blade, a nose piece having a plurality of spaced holes in its surface for discharge of a flow of cooling fluid therefrom, a plurality of body pieces each having a spanwise tongue projecting forward, and means to hold said nose piece and said plurality of body pieces in tandem relation to form a blade having top and bottom compartments substantially separated by said tongues, said pieces being spaced at the top and bottom surfaces to form spanwise slots having walls overlapping rearward to direct a slot flow out of the blade rearward substantially along the surface aft of each slot.

2. In combination to form a gas turbine blade, a nose element having a recessed chordwise cross section, a plurality of body elements of recessed channel cross section, means holding said elements in tandem chordwise relation with the nose of each element nested in the recess of the preceding element in spaced relation to form an upper and lower surface slot leading out of a hollow interior within the blade to provide for a flow of cooling fluid therefrom, said means comprising a weld joining said elements at the hub and tip ends.

3. In combination, a plurality of elements, some of said elements having a recess along a portion of their lengths and transversely projecting flanges along the opposite sides of the ends of said elements, and means to fix said elements in tandem relation with said flanges in contiguous relation and the central portions of each element in chordwise spaced relation to form surface slots, the assembly of said elements forming a slotted blade whose slots lead out of the interior of said blade to provide for a flow of cooling fluid therefrom.

4. The combination of claim 3 wherein some of said elements have spanwise tongues projecting chordwise to partition the space within the blade into compartments each communicating with a said surface slot.

5. In combination, a plurality of nested elements fixed in tandem relation to form a turbine blade having a plurality of chordwise spaced discharge slots between adjacent said elements for discharge of a flow of cooling fluid therefrom, said blade having a plurality of walls internally spaced from each other and extending spanwise of said blade defining flow passages for supplying said cooling fluid to said discharge slots.

6. In combination, a plurality of nested elements fixed in tandem relation to form a turbine blade having a plurality of chordwise spaced slots between adjacent said elements for discharge of a flow of cooling fluid therethrough, said elements forming a plurality of partitions internally spaced within said blade defining flow passages for supplying said cooling fluid to said slots.

7. In combination to form a gas turbine blade, a nose element, a plurality of nested elements assembled in tandem chordwise relation therewith to form a blade having an airfoil surface, said elements being spaced from each other on said airfoil surface to form spanwise slots between adjacent elements for the discharge of flows of cooling fluid therethrough, and means for securing said elements in said assembled relation.

8. In combinatiin to form a gas turbine blade, a plurality of nested elements assembled in tandem chordwise relation to form a blade having an airfoil surface, said elements having interfitting recesses and tongues forming a pair of compartments between each two adjacent elements, said elements being spaced from each other on said airfoil surface to form spanwise slots between adjacent elements communicating with said compartments respectively for the discharge of flows of cooling fluid therethrough, and means for securing said elements in said assembled relation.

9. In combination, a plurality of nested elements fixed in tandem relation to form a turbine blade having a plurality of slots between adjacent said elements in both the upper and lower surfaces thereof for discharge of a flow of cooling fluid therethrough, said elements forming a plurality of vertical and horizontal partitions within said blade defining flow passages for supplying said slots, adjacent said elements having a tongue and groove relationship to restrain the same from lateral vibration while allowing limited relative movement in other directions to relieve thermal stresses.

EDWARD A. STALKER.

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