July 30, 1957 H. ROSSKOPF 2,801,072

HOLLOW BLADE FOR FLUID FLOW OPERATED MACHINE

Filed May 3, 1951 2 Sheets-Sheet 1

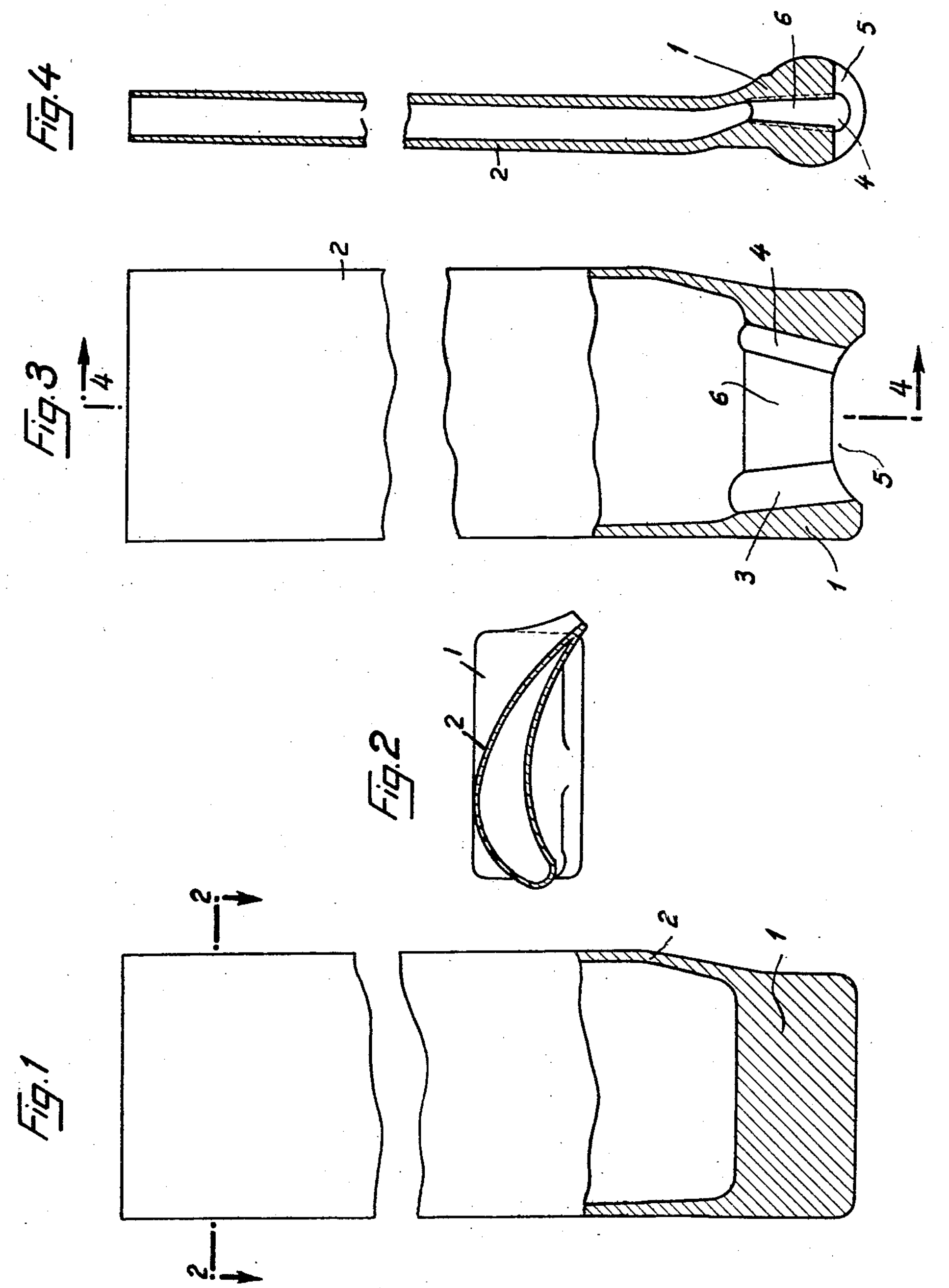

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Fig. 7

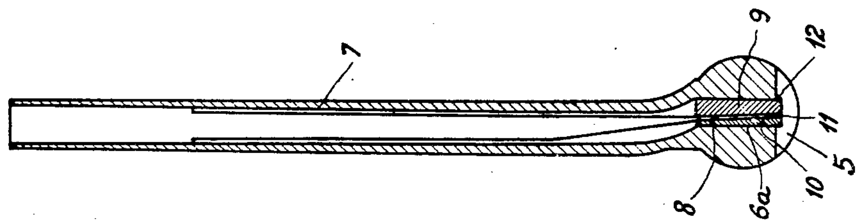


Fig. 6

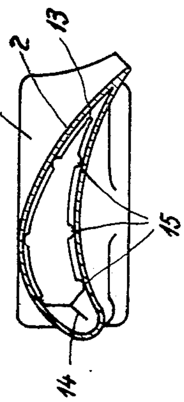
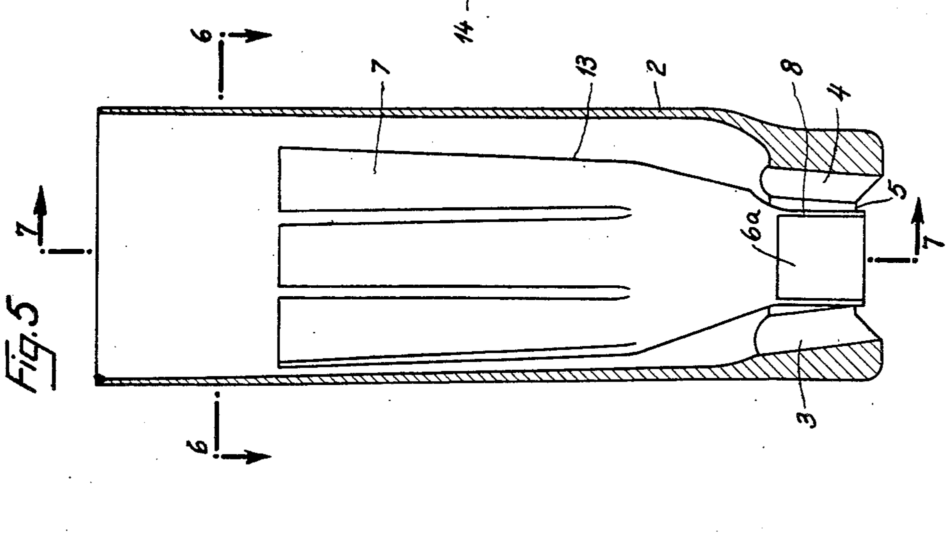


Fig. 5



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HOLLOW BLADE FOR FLUID FLOW OPERATED MACHINE

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1 Claim. (Cl. 253—39.15)

For fluid flow operated machines, particularly gas turbines, for example for aircraft engines, it has already been proposed to provide hollow blades produced from suitably shaped metal sheets with associated separate parts, the whole being welded into a unit. However, the weld beads in such blades which in some cases are arranged for inner cooling can interfere with safety in operation by reason of high stresses to which the units are exposed.

Hollow blades manufactured from stamped metal sheets without any bead and welding have also been proposed. Such blades are secured in the blade holder or disk by means of pins fitted in two grooves provided approximately in axial direction in faces of the blade root. With cooled blades, the grooves further provide a passage of cooling fluid through a portion thereof, but a considerable amount of cooling fluid is thus lost. Such a leakage is not much reduced by the overlap provided for successive blades.

It is an object of my invention to provide an improved blade for which welding is also omitted altogether or at least employed to a very restricted extent, and which is constructed for a better transmission of forces developed in the blade working portion to the blade-root and the root holder.

A further object is to provide as improved blade and blade-holder combination whereby a fluid-tight assembly is obtained with blades arranged for inner cooling.

According to this invention, I provide an improved hollow blade for fluid flow operated machines, particularly gas turbine, wherein a tubular portion having a wall which tapers to the blade tip starts integrally from a thick, blade root block preferably of the Laval type.

Further features and objects of my invention will appear from the following description with reference to the appended drawings which illustrate the preferred embodiment taken as an example.

Fig. 1 is a front elevation of my improved blade, the lower part being shown in section.

Fig. 2 is a cross-section taken along line 2—2 on Fig. 1.

Fig. 3 is a view similar to Fig. 1, showing a modified blade, arranged for inner cooling.

Fig. 4 is a longitudinal cross-section taken along line 4—4 of Fig. 3.

Fig. 5 is a longitudinal section of a modified type of blade, with a cooling jacket.

Fig. 6 is a cross-section taken along line 6—6 on Fig. 5.

Fig. 7 is a longitudinal section taken along line 7—7 on Fig. 5.

According to Fig. 1, my blade comprises a solid, root block **1**, preferably of the Laval type, and an integral tubular portion **2** produced from a blank of material, preferably an austenitic alloy. The production is effected in one process combining a deep stamping with a die-pressing; through the deep stamping step, the starting blank is converted into an upper sleeve portion having a wall of upwardly decreasing thickness, and an integral, lower portion which is a solid body; upon pressing in a suitable die, the sleeve portion is shaped to the desired cross-section and the solid body portion to a solid root block having opposed semi-cylindrical surfaces. Fig. 2 illustrates the shape of portion **2** in cross-section and the relative position of said portion with respect to the root block. The front face of the root block on the right side of Fig. 2 is partly hidden by the trailing edge of portion **2**.

Referring to Figs. 3 and 4, wherein the the same characters denote like parts, passages are provided through the root block **1** for ingress of cooling fluid, preferably air. It is preferred to have a pair of bores **3**, **4** in substantial alignment with the leading or upstream edge of portion **2** and the trailing or downstream edge respectively; bores **3** and **4** are preferably slanting towards the corresponding blade edges so that the inner wall of said edges can efficiently be swept by cooling air. Bores **3** and **4** have different diameters. The bigger bore **3** is adjacent to the leading edge which is generally hotter while the smaller bore **4** is adjacent to the less hot, trailing edge. Consequently it will be understood that provision is made for a suitable distribution of cooling air streams.

As cooling air is usually conveyed to each blade preferably through one passage in the blade-holder, (not shown), a middle recess **5** is formed in the lower end of root block **1** to provide for supply of cooling air to both bores **3** and **4**. However it will be appreciated from Fig. 3, that the recess does not extend to the marginal portions of the end of root block **1**, leaving the same unaltered so that fluid-tightness is preserved where the blade contacts the blade holder.

According to Figs. 3 and 4, a passage **6** is provided between bores **3**, **4** and has a cross-section (Fig. 4) which may taper towards the blade tip.

As illustrated by Figs. 5–7 an air guiding and distributing device generally denoted by reference character **7** is arranged within the blade, to cause cooling air from passages **3** and **4** to flow and impinge along the inner surface of the tubular blade portion. The device **7** has a foot portion **8** disposed in passage ***6a*** and held therein by wedges **9**, **10** which are welded to the foot portion **8** and root block **1** as at **11**, **12** after being set in passage ***6a***. It will thus be seen that the weld beads, located in recess **5**, do not project from the root block. The device **7** may be produced from sheet metal cut to the required form and doubled back along folding line **13** to provide a tubular sleeve portion in its middle and upper part and a two-ply portion in its lower part or foot portion **8**, opposite edges of the original sheet being assembled together along line **14** as shown; the assembly is suitably curved to have a substantially aerofoil cross-section approximating that of tubular blade portion **2** as shown. Furthermore, the sheet metal is preferably formed with longitudinal corrugations **15** having such a relief as to come into contact with the inner surface of tubular blade portion **2** as shown in Fig. 6. It will thus be realized that the cooling air stream rising through passages **3**, **4** is split into several adjacent separate flat streamlets that flow over the inner wall of tubular blade portion **2**; the cross-sectional area of the air passages as defined between device **7** and blade portion **2**, generally diminishes upwards from the outlet side of passages **3** and **4**.

What I claim is:

A hollow blade for a fluid flow operated machine, particularly a gas turbine, which is an integral metal unit comprising a solid root portion having a middle recess in its lower end and a tubular portion projecting upwardly from the upper end of said root portion, said tubular portion having an upwardly thinning, tapering wall and an aerofoil cross-section so as to have a leading edge and a trailing edge, said root portion further having a couple of bores extending from said middle recess to the inner space enclosed by said tubular portion, said bores being slanted, each at an angle to the general lengthwise direction of said tubular portion toward its adjacent blade edge in order that cooling fluid passed therethrough impinges the inner face of said tubular portion along said leading edge and said trailing edge respectively, and said root portion being formed with an additional passage extending upwardly therethrough from the middle recess, said passage intersecting the slanted bores and a fluid guiding and distributing device having a foot portion seating within and anchored in said passage in the root portion and having air guiding and distributing means extending upwardly into the tubular portion of the blade.

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