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HOLLOW SHEET METAL BLADE OR VANE CONSTRUCTION

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FIG. 1

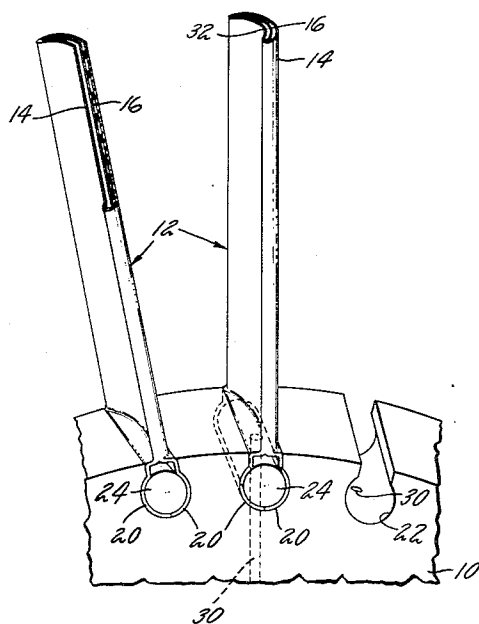


FIG. 2

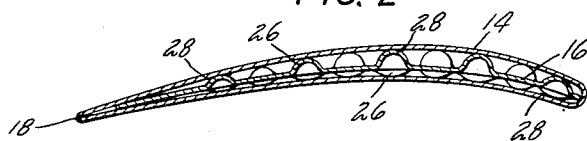


FIG. 3

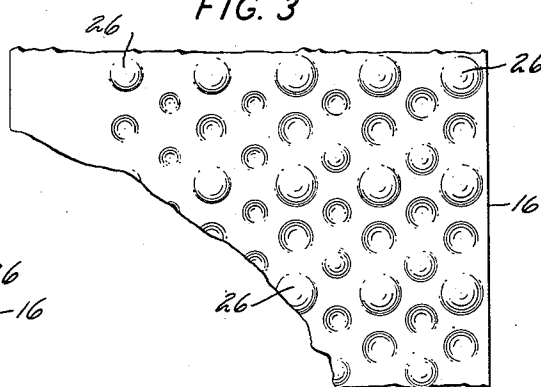
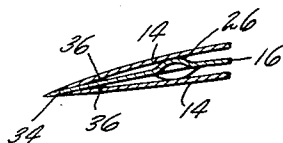


FIG. 4



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HOLLOW SHEET METAL BLADE OR VANE
CONSTRUCTION

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5 Claims. (Cl. 253—77)

This invention relates to elastic fluid turbines, more particularly to the construction of hollow, sheet metal blades and vanes of airfoil cross section.

The blades and vanes used in elastic fluid turbines usually are made in a single piece because of the difficulty of fabricating hollow blades and vanes, and to give sufficient rigidity to the member to withstand the loading imposed thereon. A sheet metal construction affords a decided simplicity of fabrication and a considerable savings in weight, but this construction does not provide the rigidity required. Further, when a liquid or compressed gas is passed through a hollow, sheet metal blade or vane for heating or cooling purposes, the member tends to "balloon" and change its contour, or, when used in an environment of high pressure, the member may collapse or be compressed out of shape.

The present invention provides a hollow, sheet metal blade or vane which is satisfactory for use in elastic fluid turbines, particularly gas turbine power plants, which reduces the weight of the blade or vane to a minimum and which overcomes difficulties encountered in the use of hollow blades and vanes. A feature of this invention is a sheet metal blade and vane construction which is relatively simple to fabricate and of minimum weight, without a sacrifice of rigidity. Another feature is a hollow blade or vane construction which retains the original contour, overcoming the problem of ballooning and collapse, and which permits the control of scrubbing of the inner wall by liquids or gases passing through the blade or vane for heating or cooling purposes.

Blades and vanes which are to be subjected to high temperatures, such as the turbine blades and nozzle vanes in a gas turbine power plant, must be made of a metal or material capable of withstanding the corrosive and erosive effect of hot gases passing thereover. Such metals are expensive and the supply is limited. Still another feature of this invention is a blade and vane construction which minimizes the quantity of "strategic" metals used in the member and which permits more extensive use of readily available metals.

Other features and advantages will be apparent from the accompanying drawing which illustrates embodiments of the invention. It is to be noted that the invention is equally applicable to rotor blades and stator vanes and that the term "blade" as used herein is intended to include both blades and vanes.

In the drawing:

Fig. 1 is a fragmentary perspective of a gas turbine power plant rotor having blades thereon constructed according to the invention.

Fig. 2 is a chordal section through one of the blades showing the details of construction.

Fig. 3 is an enlarged fragmentary view of an insert.

Fig. 4 is an alternate method of trailing edge construction.

In Fig. 1, numeral 10 designates a portion of a rotor having a plurality of blades 12 projecting from its circumference. Each blade is comprised of a sheet metal skin

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14 wrapped around a single thickness sheet metal insert 16, the skin being welded together along the trailing edge 18 of the blade. At the radially inward end of the blade are projections 20, integral with skin 14, which fit into slot 22 in the rotor periphery and which together with pin 24 serves to hold the blade in position on the rotor. Other blade retention schemes are equally adapted to use with this blade construction.

As best shown in Figs. 2 and 3, insert 16 is indented or embossed, having a plurality of depressions or dimples formed in both sides of its surface. The dimples or nubs are in rows substantially parallel to the longitudinal axis of the blade and form protuberances or nubs 26 on the opposite side of the insert. The arrangement, shape and height of the nubs determines the contour of the surrounding skin since the latter is in contact with the tips of these nubs, as shown in Fig. 2. By varying the pattern and dimensions of the nubs, substantially any contour can be determined. While in the embodiment shown adjacent nubs in the same longitudinal row extend from opposite sides of the insert, any pattern can be selected. The pattern selected, of course, will be one best suited to the desired contour. The insert is comparatively simple to manufacture, the dimples, as well as any curvature in the insert as the crescent shape of the insert in Fig. 2, being formed by stamping or pressing a piece of flat metal. The dimples or depressions need not be spherical as shown, but may be of the shape best suited for establishing the contour of, and supporting, the surrounding skin. The nubs are spaced apart both chordwise and spanwise of the blades and the height of the nubs is varied chordwise of the blade on both sides of the insert.

Sheet metal skin 14 is jointed to the tips of the protuberances, as by spot welding at 28, affording rigidity to the structure and permitting the use of a relatively thin skin without the attending ballooning or collapsing encountered in other hollow blade constructions. It is not essential that the skin be welded to each of the nubs, the number and the location of the welds being determined by the thickness of the skin and the forces to be imposed upon the blade in operation.

The hollow construction of the blade lends itself to heating or cooling the blade by passing liquids or gases therethrough. As shown in Fig. 1, the interior of the right-hand blade is connected to passage 30 extending through pin 24 and rotor 10 and which in turn communicates with a passage in the rotor shaft, not shown. Gases are ducted to the blade through this passage and the nubs on the insert cause turbulence of the gases passing through the blade and exhausted through the open tip 32. By regulating the location and the spacing of the nubs 26, scrubbing of the interior wall of skin 14 by the gases can be controlled so that the most effective heat transfer characteristics are obtained.

In the blade construction of Fig. 2, insert 16 is completely surrounded by skin 14 and, consequently, the insert is not subject to the detrimental effect of hot gases, as is the skin. For this reason a common metal having a high strength characteristic would be completely satisfactory as an insert material. The surrounding skin 14 would of necessity have to be made of a material which is resistant to the prolonged effect of high temperature as well as to corrosion and erosion resulting from the flow of hot gases thereover. Metals having characteristics making them suitable for use as skin material are costly and scarce. Since only skin 14 need be of special metal, a considerable savings in the amount of material used is effected by this construction over solid blade or other blade constructions.

In the construction shown, the thickness of the material of the skin 14 as well as that of insert 16 may de-

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crease towards the open end of the blade. Since the tip end of the blade does not have to be as strong as the root end, tapering of the material will afford a savings both in the amount of material used and in the weight of the blade.

There may be a disadvantage in welding the trailing edge of the blade as shown in Fig. 2 at 18 since gases passing over the trailing edge might, in some installations, cause the weld to fail. An alternate scheme of trailing edge construction is shown in Fig. 4 where insert 16 is extended to form a solid trailing edge 34 and the ends of skin 14 are joined to the insert by welds 36 upstream of the trailing edge. This construction removes the weld from the trailing edge and may be preferable depending upon the use to which the blade is to be put.

It is to be understood that the invention is not limited to the specific embodiments herein illustrated and described but may be used in other ways without departure from its spirit as defined by the following claims:

I claim:

1. A hollow blade having a leading and trailing edge and comprising a single-thickness sheet metal insert and a skin positioned around the insert, the insert having a plurality of nubs on both sides thereof in engagement with the inner surface of the skin on both sides of the insert, said nubs being spaced from one another both chordwise and spanwise of the blade, the height of the nubs being varied chordwise of the blade on both sides of the insert for defining the contour of the skin, the opposite edges of the skin being joined to one another along the blade trailing edge, and the skin being joined to certain of the nubs at the points of contact.

2. A hollow blade having an inner end with a root, and an outer end, said blade comprising a single-thickness sheet metal insert and a sheet metal skin positioned around the insert, the insert having a plurality of nubs thereon projecting from both sides thereof in engagement with the inner surface of the skin on both sides of the insert, said nubs being spaced from one another both chordwise and spanwise of the blade, the height of the nubs being varied chordwise of the blade such that the tips of said nubs define the contour of the surrounding skin, the thickness of the insert and skin tapering toward the outer end of the blade, the skin being attached to certain of the nubs.

3. A hollow blade comprising a single-thickness sheet metal insert and a sheet metal skin positioned around the insert, the insert having a plurality of nubs thereon on both sides thereof in engagement with the inner surface of the skin on both sides of the insert, said nubs being spaced from one another both chordwise and spanwise of the blade, the height of the nubs being varied at least chordwise of the blade such that the tips of said nubs define the contour of the surrounding skin, the skin

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being joined to a plurality of the nubs at the points of contact.

4. A cambered blade comprising a single-thickness sheet metal insert and a sheet metal skin positioned around the insert with the opposite edges secured to one another at the blade trailing edge, the insert being crescent-shaped in a chordal direction, the surface of the insert having projecting nubs on both sides thereof, said nubs being spaced apart spanwise of the blade and said nubs varying in height chordwise of the blade such that the tips of the nubs form the desired contour for the inner surface of the skin, said nub tips engaging with the inner surface of the skin to support the skin in the desired contour, certain of said nubs being welded to the surrounding skin at a plurality of the points where the nubs contact the skin.

5. A cambered blade comprising a single-thickness sheet metal insert and a sheet metal skin positioned around the insert and having its opposite edges attached to one another at the blade trailing edge, the insert being crescent-shaped in a chordal direction and having nubs projecting from each surface thereof into engagement with the inner surface of the skin, the nubs being in rows substantially parallel to the spanwise axis of the blade with a portion of the nubs extending from one side of the insert and the remaining nubs extending from the opposite side of the insert, the height of the nubs being varied chordwise of the blade and defining, by the tips thereof, the contour of the surrounding skin, the skin being welded to certain of the nubs at the point of contact between the nubs and the skin.

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