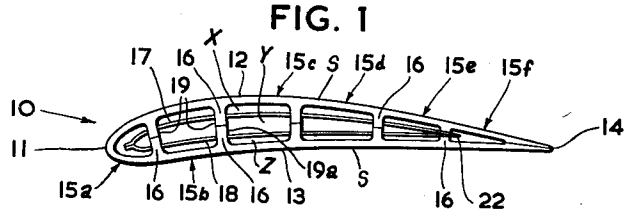
Feb. 2, 1960 J. O. CREEK 2,923,525

HOLLOW GAS TURBINE BLADE

Filed April 4, 1958

FIG. 1



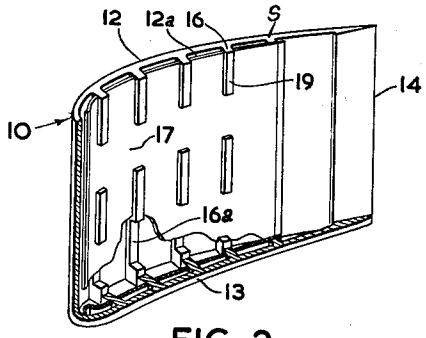


FIG. 2

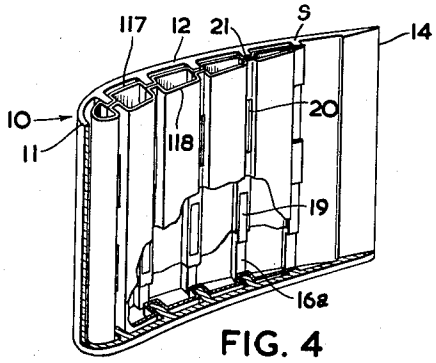


FIG. 4

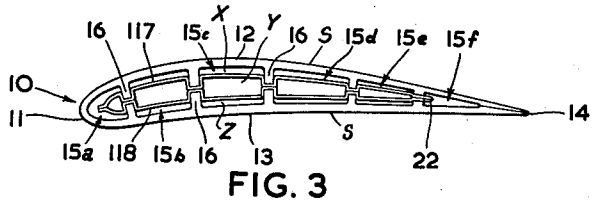


FIG. 3

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HOLLOW GAS TURBINE BLADE

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4 Claims. (Cl. 253—39.15)

This invention relates to hollow gas turbine blades.

It is well known that one of the factors limiting the efficiency of gas turbine engines is the restriction imposed upon the maximum gas temperatures that may be employed by the ability of the blading to withstand these temperatures. It will be therefore appreciated that if the blading can be adequately cooled, higher gas temperatures can be employed with an increase in efficiency; alternatively, or in addition, inferior or more common materials can be employed in the construction of the blades. In addition, due to the high rotational speeds of modern gas turbine engines, it is desirable to employ a gas turbine blade which is light in weight and the hollow gas turbine blade achieves this desirable result.

Hollow gas turbine blades are, in the main, rather difficult to manufacture since they involve either complicated castings or intricate work with sheet metal components.

It is an object of the present invention, accordingly, to provide a hollow gas turbine blade which is relatively simple to manufacture and which will possess the advantages of rigidity, dimensional stability and strength of the solid blade while possessing the advantages of lightness in weight and the ability to be cooled of a hollow turbine blade.

The invention will be described with reference to two embodiments illustrated in the accompanying drawings in which like reference numerals denote like parts in the various views and in which:

Figure 1 is a top plan view of a gas turbine blade made in accordance with one embodiment of the invention;

Figure 2 is a perspective view of the blade shown in Figure 1 with part of the side wall cut away to show the internal construction;

Figure 3 is a top plan view of a gas turbine blade made in accordance with a further concept of the invention, and

Figure 4 is a perspective view of the blade shown in Figure 3 with a portion of the side wall cut away to show the internal construction.

Before proceeding further with the specific description of this invention it is believed desirable to define certain terms which will be given a specific meaning in the following specification and in the claims.

Gas turbine blade.—In the present specification the term "gas turbine blade" is intended to mean a blade or bucket adapted for use in a gas turbine engine as either a compressor rotor blade, a compressor stator blade, a turbine rotor blade or a turbine stator blade. More specifically the term "gas turbine blade" is intended to denote primarily the aerofoil portion of the blade as distinct from the root portion of the blade, the present invention dealing only with the aerofoil portion which may be fitted to any conventional form of root or, alternatively, may be employed in certain environments without a conventional root of any kind.

Concave side of blade.—The concave side of the blade, with reference to the particular blades described in the present application is that side of the blade which, over its external surface, is of concave configuration.

Convex side of blade.—The convex side of the blade described in the present specification is that side of the blade which, over its external surface, is of convex configuration.

Inner.—When used in the specification and claims an "inner" surface is any surface which is substantially parallel to the immediately adjacent external surface of the blade and which surface faces away from that external surface towards a point mid-way between the adjacent surface and the opposite surface of the blade.

Outer.—When used in the present specification and in the claims the term "outer" such as "outer surface" denotes a surface which faces away from the interior of the blade.

Parallel.—In the present specification and in the claims the term "parallel" is intended to mean that two lines, surfaces or edges lie adjacent one another and are always the same distance apart throughout their length rather than being given the classical definition of two lines which, no matter how far extended, never intersect.

Having clarified the use of the above terms it will now be convenient to refer to Figures 1 and 2 of the accompanying drawings which illustrate a gas turbine blade made in accordance with the present invention.

Referring in particular to Figure 1 a hollow gas turbine blade **10** will be seen to comprise a skin **S10** formed from a piece of sheet metal bent over upon itself along a fold line, the fold line corresponding with the leading edge **11** of the blade, the skin S being formed to have a convex side **12** and a concave side **13**, two edges of the skin S substantially parallel to the fold line being joined together to form a trailing edge **14**. The edges of the skin S may be joined together to form the trailing edge **14** by any suitable means such as brazing.

The hollow interior of the blade will be seen to be divided up into a plurality of spanwise passages **15A**, **15B**, **15C**, **15D**, **15E** and **15F** by means of spars **16** extending across the thickness of the blade through the hollow interior.

Each of passages **15B** to **15E** inclusive is divided into three passages by means of a pair of baffles **17** and **18** which divides each of passages **15B** to **15E** inclusive into sub-passages indicated by reference characters *x*, *y* and *z*.

Referring now to Figure 2 it will be seen that the convex side **12** of the skin S is provided with a plurality of spaced, parallel ribs **16** extending inwardly from the inner surface **12***a* of the convex side **12**. The baffle **17** is secured to the inner surface **16***a* of these ribs **16** and, thereby, is held in spaced, parallel relationship to the convex side **12** of the blade. Projections **19** on the ribs **16** extend through apertures in the baffle **17** into the space between the baffles **17** and **18** as seen in Figure 1. Any given projection **19** on any given rib **16** engages and is secured to a corresponding projection **19***a* on a corresponding rib **16** on the other side of the blade **10** so that, as seen in Figure 1, there is a direct connection between the convex side **12** of the blade and the concave side **13** through the projections **19** and **19***a* on ribs **16**.

It will further be observed that there are an even number of spaced, parallel ribs **16** formed integrally with the convex side **12** of the skin S, the fold line constituting the leading edge of the blade **11** dividing the plurality of ribs into a first set integral with the inner surface of the convex side of the blade and a second set integral with the inner surface of the concave side **13** of the blade and equal in number to the first set. The

second set of ribs is directly opposed to the first set of ribs so that the projections **19** on the first set, extending into the space between the baffles through apertures in the first baffle **17** will engage and may be secured to the corresponding projections **19***a* on the second set of ribs extending into the space between the baffles through apertures in the second baffle **18**.

Referring now to Figures 3 and 4 an alternative embodiment of the invention will be described. This alternative embodiment will be seen, in substance, to be very similar to that described with reference to Figures 1 and 2 and constitutes a blade **10** having a skin S which includes a convex side **12**, a concave side **13**, a leading edge **11** and a trailing edge **14**. The convex side of the blade, on its inner surface, is provided with a first set of spaced, parallel ribs **16** extending inwardly from the interior surface and the concave side of the blade is provided, integrally with its internal surface, with a second set of spaced, parallel inwardly extending ribs **16** which, in conjunction with the first set of ribs divide the hollow interior of the blade **10** into a plurality of spanwise passages **15A**, **15B**, **15C**, **15D**, **15E** and **15F**. Spanwise passages **15B** to **15E** inclusive are divided into sub-passages *x*, *y* and *z* by means of a pair of baffles **117** and **118** which lie against the inner surfaces **16***a* of the ribs and are secured thereto. Each of the ribs **16** has a plurality of projections **19** which extend through apertures **20** in the baffles **117** and **118** and engage the corresponding projections **19** on the directly opposed ribs **16** on the other side of the blade.

The difference between the embodiment shown in Figures 1 and 2 and the embodiment shown in Figures 3 and 4, is that the baffles **117** and **118** are displaced outwardly between adjacent ribs **16** so that over that distance between adjacent ribs they lie closer to the skin of the blade than at the point **21** where they are secured to the surface **16***a* of the ribs **16**.

Referring now to Figures 1 and 3 it will be seen that the baffles **17** and **18** and **117** and **118** are secured together along a line substantially parallel to the leading edge, the line lying between the leading edge **11** and that rib **16** adjacent the leading edge **11** and, at their trailing edges, are secured together at **22** along a line substantially parallel to the trailing edge **14**, the line lying between the trailing edge **14** of the blade, and that rib **16** adjacent the trailing edge **14** of the blade. Thus, spanwise passages **15A** and **15F** are not divided into three sub-passages *x*, *y* and *z* as are passages **15B** to **15E** inclusive.

The blade manufactured in accordance with the present invention possesses certain advantages over other types of hollow gas turbine blades in that, although as light as a blade made from sheet metal it is more rigid due to the fact that the ribs **16**, in conjunction with the projections **19**, provide for integral spars joining the convex surface **12** with the concave surface across the thickness of the blade **10**. In addition, certain rigidity is imparted to the blade by virtue of the baffles **17** and **18** and **117** and **118** which are brazed to the surfaces **16***a* of the ribs **16** within the hollow interior of the blade. The bracing afforded by the ribs **16** and the projections **19** provides a greater dimensonal stability in the blade than has heretofore been obtainable in blades of sheet metal construction. The blade described in the present application is quite simple to manufacture, the manufacturing process comprising the steps of machining the ribs **16** in a flat sheet of material, there being provided an equal number of ribs on either side of the fold line **11**, machining the height of the ribs so as to provide for a suitable aerofoil cross-section when the sheet is folded over upon itself along the fold line, folding the sheet to the configuration shown in Figure 1 or 3, securing the two edges of the sheet together along the trailing edge **14** after having first inserted the baffles **17** and **18** or **117** and **118**. The entire assembly, is then placed in a brazing oven and brazed into a single unitary structure.

It is believed that a novel and improved form of gas turbine blade has been described in the present specification which is intended to be construed in an illustrative manner, minor modifications being contemplated by the invention within the scope of the appended claims.

What I claim as my invention is:

1. A hollow gas turbine blade comprising a one-piece skin of sheet metal having a convex side, a concave side, a leading edge and a trailing edge, a first set of at least two spaced ribs extending spanwise of the blade and extending inwardly from the interior of the convex side, a first sheet metal baffle secured to the surfaces of the ribs and spanning the space between the ribs, a second set of at least two spaced ribs extending spanwise of the blade and directly opposed to the first set and extending inwardly from the interior surface of the concave side of the blade, a second sheet metal baffle secured to the inner surfaces of the second set of ribs spanning the space between them and spaced from the first baffle, and spaced projections on the first set of ribs extending into the space between the baffles through apertures in the first baffle and secured to projections on the second set of ribs extending into the space between the baffles through apertures in the second baffle.

2. A hollow gas turbine blade comprising a one-piece skin of sheet metal having a convex side, a concave side, a leading edge and a trailing edge, a first set of at least two spaced ribs extending spanwise of the blade and extending inwardly from the interior of the convex side, a first sheet metal baffle in contact with and secured to the ribs and spanning the space between the ribs, the first sheet metal baffle being displaced towards the blade skin over the distance between the ribs so that it lies closer to the skin of the blade between the ribs than at the point where it contacts and is secured to the ribs, a second set of at least two spaced ribs extending spanwise of the blade directly opposed to the first set and extending inwardly from the interior of the concave side of the blade, a second sheet metal baffle spaced from the first sheet metal baffle secured to the second set of ribs and spanning the space between them, the second baffle being displaced toward the skin of the blade over the distance between the ribs so that it lies closer to the skin of the blade between the ribs than at the point where it is secured to the ribs and projections on the first set of ribs extending into the space between the baffles through apertures in the first baffle and secured to projections on the second set of ribs extending into the space between the baffles through apertures in the second baffle.

3. A hollow gas turbine blade as claimed in claim 2 in which one rib of each of the first and second set lies adjacent the leading edge of the blade and another rib of each of the first and second set lies adjacent the trailing edge of the blade.

4. A hollow gas turbine blade as claimed in claim 3 wherein the sheet metal baffles are joined together along a line substantially parallel to the leading edge of the blade, the line lying between the leading edge of the blade and that rib of each set adjacent the said leading edge and also joined together along a line substantially parallel to the trailing edge of the blade, the line lying between the trailing edge and that rib of each set adjacent the said trailing edge of the blade.

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