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COOLED HOLLOW TURBINE BLADES

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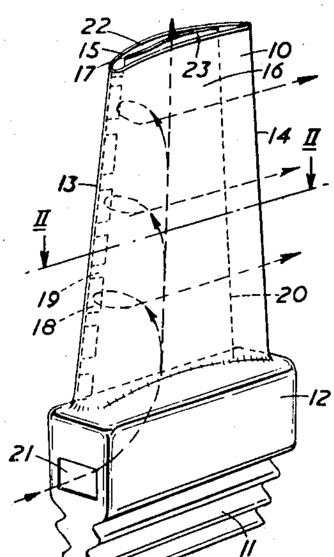

FIG. 1.

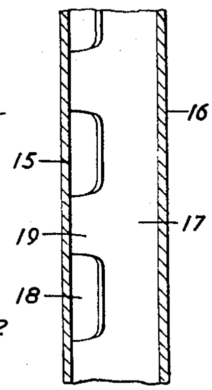

FIG. 3.

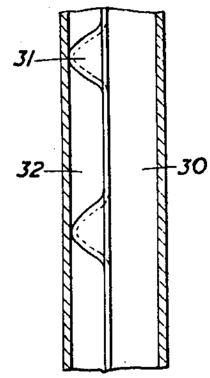

FIG. 4.

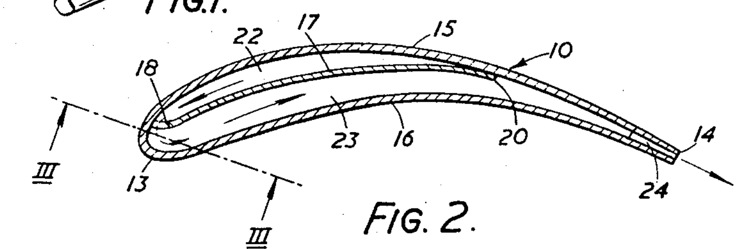

FIG. 2.

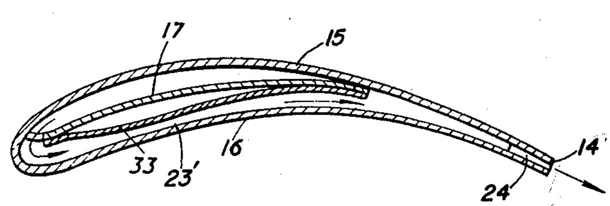

FIG. 5.

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COOLED HOLLOW TURBINE BLADES

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5 Claims. (Cl. 253—39.15)

This invention relates to cooled hollow turbine blades. It is known to cool hollow turbine blades by passing a cooling medium, such as relatively cool air, through their hollow interiors, this air taking up heat from the walls of the hollow blades and thereby cooling them. In cooled blades which have hitherto been proposed it has been the usual practice to cause the cooling medium to flow predominantly in the longitudinal direction along the internal surfaces of the blades.

According to the present invention, in a hollow turbine blades with provision for passing a cooling medium through it the cooling medium is caused to flow across the internal surface of the blade adjacent to the leading edge in a direction approximately transverse to the length of the blade.

The leading edge of the blade is usually the region that needs the most cooling, and it has been found that by adopting an approximately transverse flow of cooling medium in accordance with the present invention the cooling of the leading edge is considerably improved. While the invention is not dependent upon any particular theory, it is thought that this improvement is due largely to the cooling medium sweeping quickly round the sharp curvature of the internal surface of the blade adjacent to the leading edge and removing the boundary layer of cooling medium from this surface more effectively than is the case when the flow is predominantly in the longitudinal direction.

In one form of the invention the blade includes an internal member defining a longitudinal passage within the blade through which a cooling medium is passed from the blade root, and this passage has a slit or apertures disposed adjacent the internal surface of the blade in the vicinity of the leading edge and through which the cooling medium emerges from the passage in a direction approximately transverse to the length of the blade. Thus fresh cooling medium can be supplied along practically the whole length of the leading edge, providing substantially uniform cooling along this edge. On the other hand, with predominantly longitudinal flow the cooling medium would get progressively hotter as it advanced along the leading edge, and in consequence would provide progressively less effective cooling.

The longitudinal passage can be formed in various ways. For instance, it may be bounded on one side by the internal member which in this case will be a partition dividing the hollow interior of the blade chordwise, and on the other side by one flank of the blade, preferably the convex flank. The internal member may have a cross-section such that at least one of its sides is spaced by a small clearance from the adjacent flank of the blade so as to define at least one restricted passage for the flow of cooling medium, thereby ensuring that the cooling medium passes close to the internal surface of the blade on the flank or flanks as well as adjacent to the leading edge.

The internal member may be spaced from the flanks of the blade by forming raised pimples or weals thereon which touch the flanks of the blade.

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Preferably the blade has outlet apertures for the cooling medium along its trailing edge, so that when the cooling medium has left the longitudinal chamber in the blade it flows substantially transversely, not only adjacent the leading edge but also across one or both flanks of the blade. Alternatively, instead of cooling medium emerging through the trailing edge of the blade, the blade may be provided with an internal return passage for the cooling medium leading back to the blade root or platform which will be provided with an outlet for the cooling medium.

The invention may be performed in various ways, and one particular form of hollow turbine blade, and some modifications thereof, all embodying the invention, will now be described by way of example with reference to the accompanying drawings, in which:

Figure 1 is a perspective view of the blade, with the tip broken aawy to show the internal construction;

Figure 2 is a cross-section taken on the line II—II in Figure 1;

Figure 3 is a fragmentary sectional view taken on the line III—III in Figure 2;

Figure 4 is a view, similar to Figure 3, of a modification; and

Figure 5 is a cross-section, similar to Figure 2, of a further modification.

The hollow turbine blade shown in Figures 1 to 3 comprises an aerofoil portion **10**, a root portion **11** by which the blade is attached to the turbine rotor, and a platform portion **12**. The aerofoil portion **10** has a leading edge **13**, a trailing edge **14**, a convex flank **15** and a concave flank **16**. Secured within the hollow interior of the aerofoil portion **10** is a sheet metal partition **17**, the partition having a row of apertures **18** down its forward edge and the tongues of metal **19** between these apertures being bent towards the convex flank **15** to touch the interior surface of this flank adjacent the leading edge **13**. The rear edge **20** of the partition touches the interior surface of the convex flank **15** towards the rear of the latter. The platform portion **12** is provided with a cooling medium inlet aperture **21**, and an internal baffle (not visible) which is conveniently an extension of the lower end of the partition **17** directs the flow of cooling medium as indicated by the dotted line provided with arrows into a longitudinal passage **22** defined on one side by the partition **17** and on the other side by the interior surface of the convex flank **15**. The other side of the partition **17** and the interior surface of the concave flank **16** together define another passage **23** which communicates with the passage **22** through the apertures **18**. The trailing edge **14** is provided with a series of apertures **24** communicating with the passage **23**.

As the cooling medium advances longitudinally along the passage **22** portions of it escape through the apertures **18**. These portions flow transversely across the interior surface of the leading edge **13**, then flow transversely through the passage **23** and escape through the apertures **24** in the trailing edge. Thus all parts of the aerofoil portion are cooled by the cooling medium, the cooling effect being particularly great adjacent the leading edge **13** owing, it is believed, to the sweeping effect of the curved transverse flow of the coolant providing effective coolant boundary layer removal in this region.

In the modification shown in Figure 4 the partition **30** is provided, adjacent its forward edge, with raised pimples **31** which contact the convex blade flank **15** and provide apertures **32** corresponding to the apertures **18** of Figures 1–3.

In the modification shown in Figure 5 the partition **17** is provided with a backing piece **33** which reduces the cross-sectional area between the partition **17** and flank **16** to define a restricted passage **23'** and so provides a greater coolant flow velocity in this passage, thereby improving the cooling of the concave flank **16**. Except as to the addition of the back piece **33**, all parts in this modification are identical to the corresponding parts of the preferred embodiment shown in Figures 1 and 2 and are, therefore, designated by similar reference characters.

What I claim as my invention and desire to secure by Letters Patent is:

1. A hollow turbine blade having a root portion, inlet means for a cooling medium in said root portion, a hollow aerofoil blade portion having a leading edge, a trailing edge provided with cooling medium outlet apertures, a convex flank and a concave flank, a partition extending longitudinally through the interior of said hollow aerofoil blade portion said front edge of said partition being adjacent said leading edge of said hollow aerofoil blade portion and said rear edge of said partition being in contact throughout its length with one of said flanks forwardly of said trailing edge, said partition defining between itself and said one flank a longitudinal passage extending lengthwise of said aerofoil portion and communicating with said cooling medium inlet means, said partition defining between itself and the other of said flanks a second passage communicating with said cooling medium outlet apertures, said partition being imperforate and separating said passages except adjacent said leading edge, and being formed adjacent said leading edge with at least one aperture for directing all

of the said cooling medium from said first passage into said second passage at a location adjacent said leading edge and in a direction substantially transverse to the length of said blade.

2. A hollow turbine blade according to claim 1 in which said partition has a cross-section such that said front edge thereof provides at least one aperture adjacent said leading edge of said aerofoil blade portion defining at least one restricted passage for the flow of cooling medium from said longitudinal passage.

3. A hollow turbine blade according to claim 1 in which said partition has raised portions which contact one of said flanks and locate said partition in said aerofoil portion.

4. A hollow turbine blade according to claim 1 in which said partition consists of a single thickness of sheet metal.

5. A hollow turbine blade according to claim 1 in which said partition consists of a hollow body made of sheet metal.

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