Jan. 12, 1960 F. R. SPURRIER 2,920,866

HOLLOW AIR COOLED SHEET METAL TURBINE BLADE

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FIG. 1

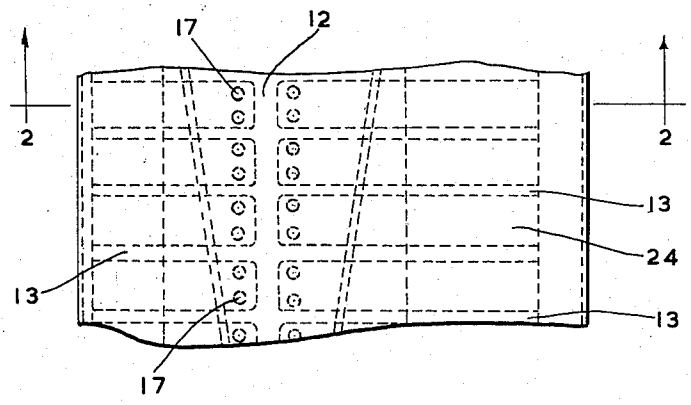
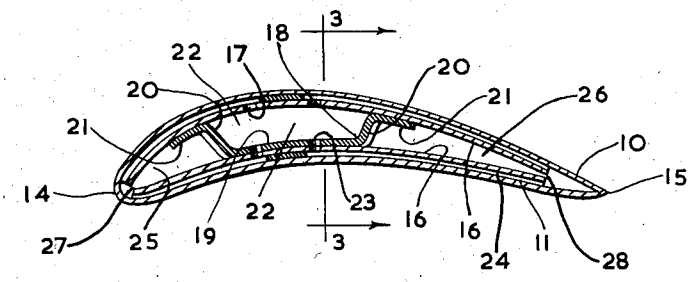


FIG. 2



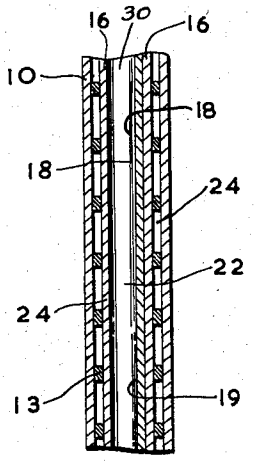


FIG. 3

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HOLLOW AIR COOLED SHEET METAL TURBINE BLADE

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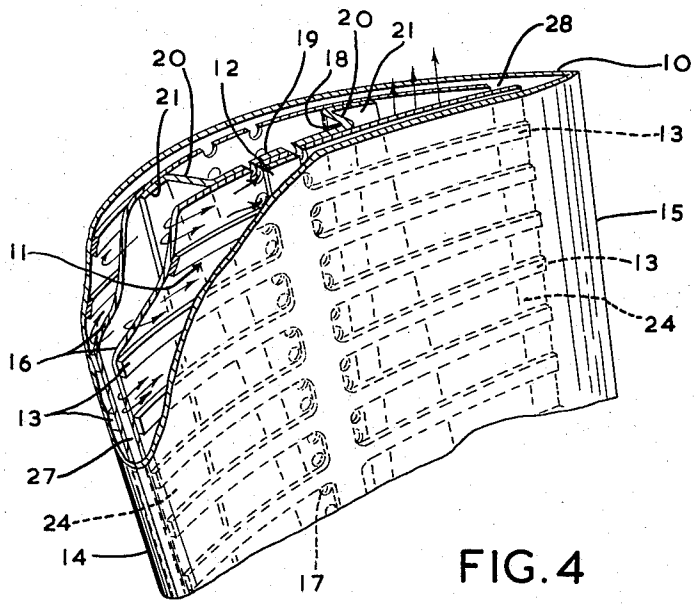


FIG. 4

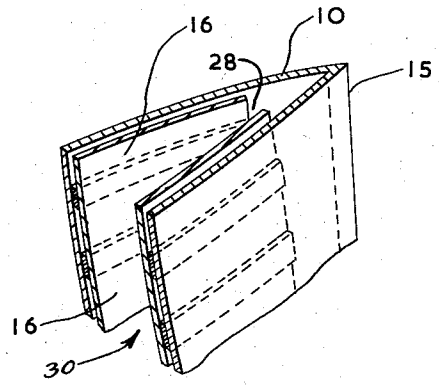


FIG. 5

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HOLLOW AIR COOLED SHEET METAL TURBINE BLADE

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Application December 20, 1954, Serial No. 476,424

2 Claims. (Cl. 253—39.15)

The present invention relates to an air cooled turbine blade construction particularly for use in combustion turbines in which the blades operate at a high temperature.

It is well known in the art that the efficiency of a gas turbine increases as its operating temperature rises. For some time designers of gas turbines have been faced with the problem of finding new materials that will withstand the higher temperatures encountered in turbines of advanced design. The difficulty of obtaining such materials has led to experiments with blades having internal passages through which passes a cooling fluid. These experiments have been, for the most part, unsuccessful as it has so far not been possible to cool a blade uniformly from the leading to the trailing edge with the result that the blade becomes distorted in operation. With the fine tolerances between moving parts and the critical shapes of turbine blades of gas turbine engines, even a very slight distortion is intolerable. The present invention solves the difficulties experienced in designing a cooled blade and has as its principal object the provision of a turbine blade which can be uniformly cooled from leading edge to trailing edge and from root to tip.

Another object is to provide such a turbine blade which is simple and economical to manufacture and which is adapted to assembly line production.

In the accompanying drawings in which the preferred embodiment of the invention is illustrated, and in which like parts are designated by like reference numerals throughout:

Fig. 1 is a fragmentary side elevation of a turbine blade;

Fig. 2 is a section along line 2—2 of Fig. 1;

Fig. 3 is a section along line 3—3 of Fig. 2;

Fig. 4 is a fragmentary perspective view of the blade partly cut away to show the internal construction; and

Fig. 5 is a detailed perspective view of a portion of the trailing edge of the blade.

In the drawings a turbine blade is shown having 3-ply side walls consisting of an outer skin **10**, a separator grid **11** and an inner skin **16** each of which is formed from sheet metal. The outer skin **10** may be made in one piece and folded and shaped to conform to the proper aerodynamic form and then welded along a seam which would usually be at the leading or at the trailing edge. It may also be made in two pieces welded together along two seams. The outer skin **10** in its finished form must be accurate to the required tolerances and must be finished to present an extremely smooth unbroken surface.

Lying against the inner surface of each side of the hollow outer skin is a separator grid **11** which, as seen in Fig. 4, partly in dotted lines, consists of a longitudinal member **12** having arms **13** extending from it on both sides at right angles and at spaced intervals along its length. The longitudinal member **12** is adapted to lie substantially parallel to the longitudinal axis of the blade with the arms **13** lying substantially parallel to the lateral

axis of the bade. The separator grid may conveniently be made from a sheet of metal which has been stamped to remove the material between the arms **13**. The grids **11** on each side of the blade are shaped to conform to the curvature of the blade and lie in close contact with the inner surface of the skin **10** throughout their extent. As seen particularly in Figs. 2 and 5, the grids **11** lie only against the concave and convex side surfaces of the blade and stop short of the leading edge **14** and the trailing edge **15**. It extends, however, completely from the root of the blade to the tip.

The separator grid **11** acts as a spacer between the outer skin **10** and the inner skin **16**. The inner skin consists of two pieces of sheet material which lie against the inner surfaces of the grids **11** and extend towards the leading and trailing edges as far as the arms **13** of the separator grid and also cover the inner surface of the grid from the root of the blade to the tip. The inner skin defines a central cavity **30** in the blade and encloses the spaces between the arms **13**, thus providing channels **24**. Since the inner skins **16** do not extend completely to the leading and trailing edges **14** and **15** respectively, slots **27** and **28** are left between the edges of the inner skins running parallel to the said leading and trailing edges. The inner skins are provided with holes **17** communicating with the channels **24** adjacent the longitudinal member **12**.

The opposed inner surfaces of the inner skins **16** define a central cavity **30** across which a bracing spar **18** extends. The spar **18** lies spanwise of the blade from the root to the tip and divides the central cavity into three passages, namely, a central passage, a passage adjacent the leading edge and a passage adjacent the trailing edge. The spar **18** has a surface **19** which is shaped to conform to the curvature of the inner surface of one inner skin **16** and has along each edge of the surface **19** a web **20** extending to the inner surface of the other inner skin **16** where each web is provided with an outwardly extending flange **21** which is also curved to lie in contact with the inner skin **16**. The width of surface **19** is considerably less at the root of the blade than at the tip and thus forms an outwardly flaring central passage **22** from the root to the tip of the blade defined by the surface **19**, the two webs **20** and the inner skin **16**. The areas between webs **20** and the leading and trailing edges of the blade also form passages **25** and **26** respectively from the root of the blade to the tip. These passages are tape ring or constricted near the tip to relatively small cross-section from the larger cross-section near the root. The portion **19** of the spar is provided with holes **23** which are in registration with the holes **17** in inner skin **16** thereby providing communication between the central passage **22** and the channels **24**.

All components of the blade shall be made from sheet metal of a type which will meet the structural and temperature requirements. The components may be stamped or cut to size, shape and curvature and secured together by welding, brazing, or furnace brazing. In production, the components will be supported by jigs during this operation which can be done by assembly line methods.

Having described the construction of the preferred embodiment the operation will now be explained.

Assuming that the blade has been mounted on a suitable root member and secured to a rotor, a cooling fluid is forced into passages **25** and **26** at the root of the blade. As the fluid passes upwardly through passages **25** and **26** it is constricted by the reduced cross-section of these passages and much of it is forced through slots **27** and **28** and passes towards the center of the blade through channels **24**. When the fluid reaches the ends of channels **24** it passes through holes **17** in inner skin **16** and

through holes 23 in portion 19 of the spar 18 and enters passage 22 where it continues to pass out through the tip of the blade.

From the foregoing description it will be seen that a hollow turbine blade has been provided which assures that cooling fluid will pass evenly over its interior surface to cool the blade uniformly from leading to trailing edge. The blade is simple and economical to construct and is adapted to assembly line production.

While a preferred embodiment of the invention has been described it is to be appreciated that modifications and alterations may be made within the spirit and scope of the invention as defined in the following claims.

What I claim as my invention is:

1. A hollow, sheet metal turbine blade comprising a continuous, unbroken outer skin, having an outer surface of aerofoil cross-section comprising a concave side and a convex side separated by a leading edge and a trailing edge and having an inner surface comprising a concave side spaced from a convex side, two separator grids, each grid lying against one side of the inner surface of the outer skin, each grid comprising a longitudinal member lying parallel to the longitudinal axis of the blade and having spaced arms extending at right angles from both sides thereof, the arms terminating at points spaced from the leading and trailing edges, an inner skin lying against each separator grid on the surface remote from the outer skin to define a central cavity, the inner skins enclosing the spaces between the arms thus providing channels therebetween which are open at the ends adjacent the leading and trailing edges of the blade and the inner skins having holes connecting the central cavity with each channel immediately adjacent the longitudinal member of the separator grids, two webs lying spanwise of the blade and extending across the central cavity to divide it into three passages open adjacent the tip of the blade, the passages adjacent the leading and trailing edges of the blade being open at their base and in communication with a source of cooling fluid and of smaller cross-section adjacent the tip of the blade than adjacent the base.

2. A hollow sheet metal turbine blade comprising a continuous, unbroken outer skin, having an outer surface of aerofoil cross-section comprising a concave side and a convex side separated by a leading edge and a trailing edge, and inner surfaces comprising a concave side and a convex side, two separator grids, each lying against one side of the inner surface of the outer skin, each grid comprising a longitudinal member lying parallel to the longitudinal axis of the blade and having spaced arms extending at right angles from both sides thereof, and terminating at points spaced from the leading and trailing edges, an inner skin lying against each separator grid on the surface remote from the outer skin to define a central cavity, the inner skins enclosing the spaces between the arms thus providing channels therebetween which are open at the ends adjacent the leading and trailing edges of the blade and the inner skins having holes connecting the central cavity with each channel immediately adjacent the longitudianl member of each separator grid, two webs extending across the central cavity and dividing it into a central passage, a passage adjacent the leading edge and a passage adjacent the trailing edge, a third web joining the two webs and lying adjacent the surface of one of the inner skins remote from the surface contacting the separator grid, the third web having holes which register with the holes in the inner skin, the passages adjacent the leading and trailing edges of the blade being open at their base and in communication with a source of cooling fluid, said passages being constricted towards the tip of the blade so that cooling fluid, when flowing through the blade will flow partly through the open ends of the channels adjacent the leading and trailing edges of the blade and into said channels, across the concave and convex sides of the blade in a lateral direction and into the central passage through the holes in the inner skins and in the third web.

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