

June 9, 1953

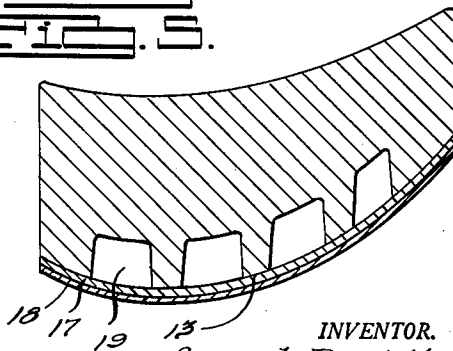
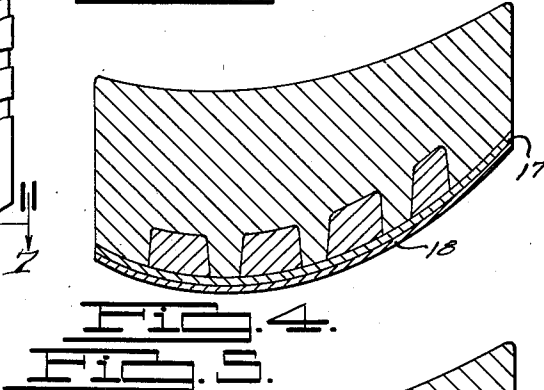
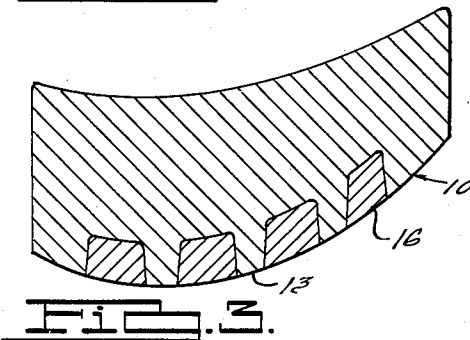
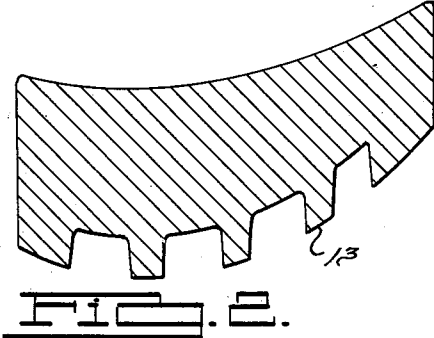
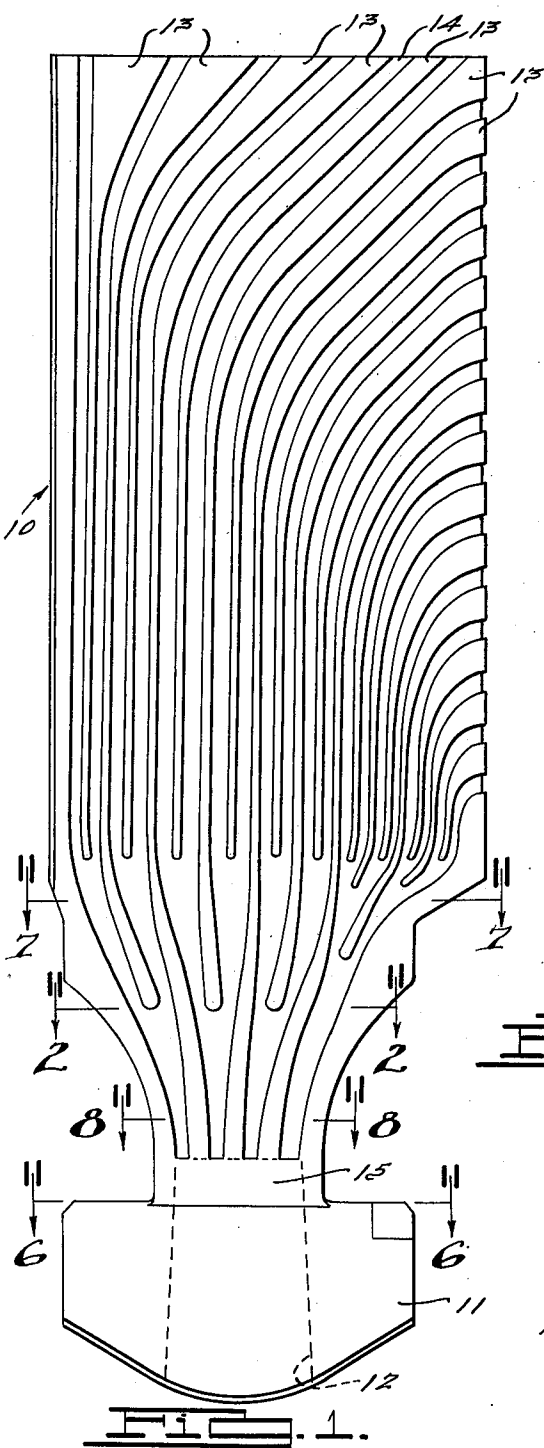
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2,641,439

COOLED TURBINE OR COMPRESSOR BLADE

Filed Oct. 1, 1947

3 Sheets-Sheet 1



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3 Sheets-Sheet 2

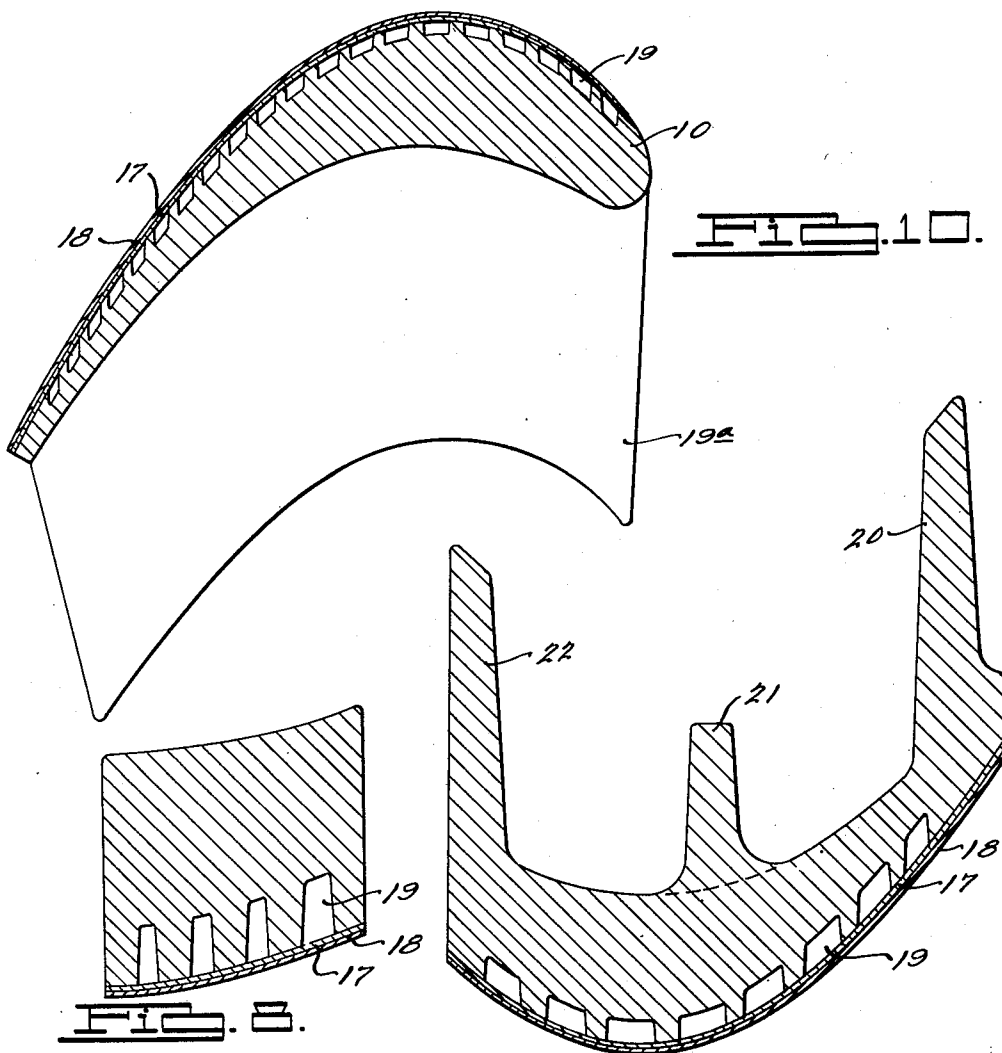


FIG. 8.

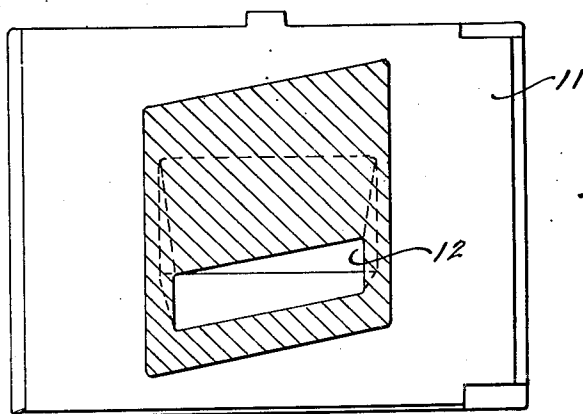


FIG. 7.

FIG. 6.

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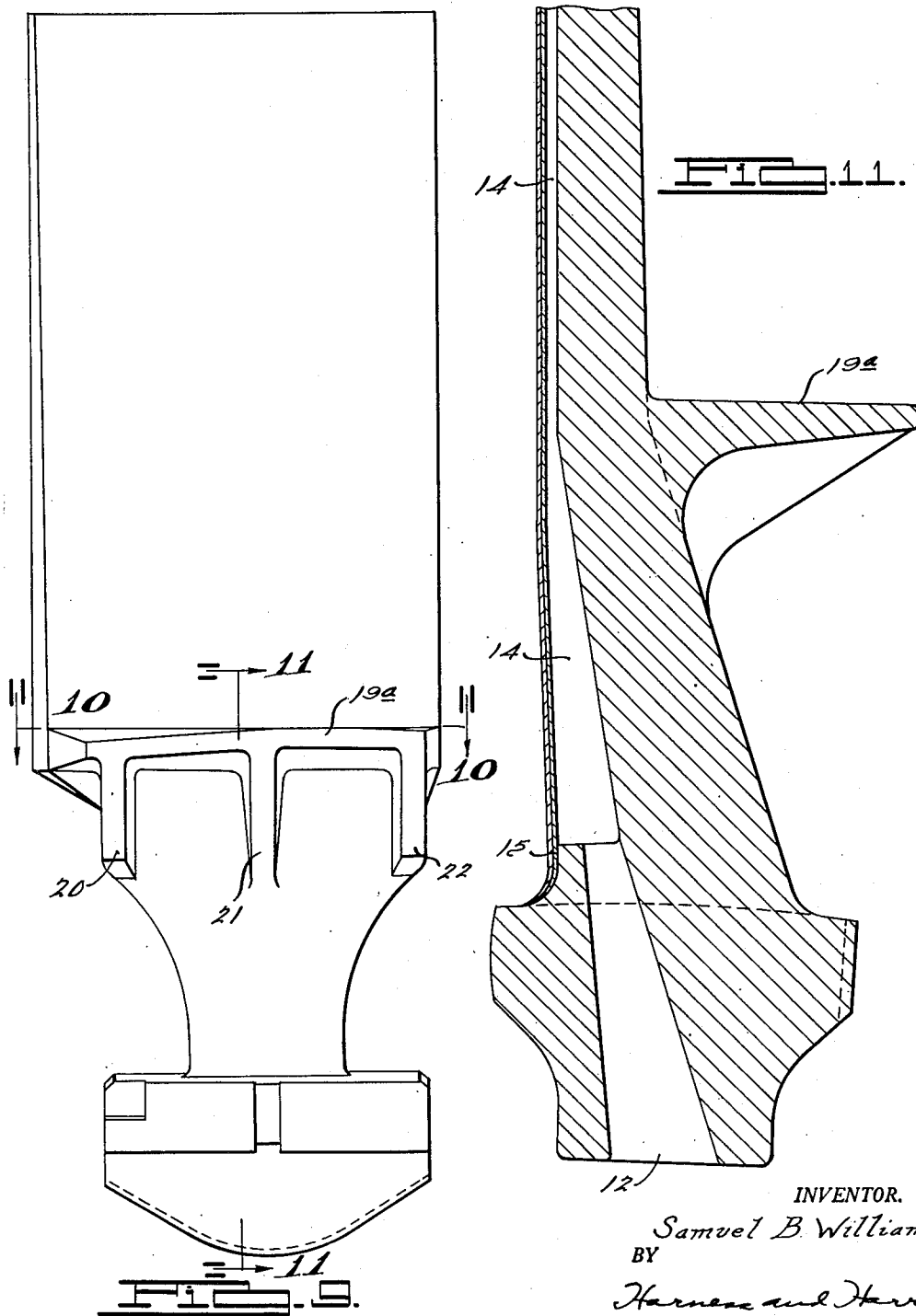
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2,641,439

COOLED TURBINE OR COMPRESSOR BLADE

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Application October 1, 1947, Serial No. 777,310

12 Claims. (Cl. 253—39.15)

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This application relates to a structure having passages therein. More specifically, it relates to the production of an object, which may be a turbine blade or the like having cooling passages formed therein.

An object of the present invention is to provide for the production of an article having a plurality of passages therein, which may be small in size and relatively close to the surface for the sake of cooling the article.

Other objects will appear from the disclosure. In the drawings:

Fig. 1 is a plan view of a blank of which a turbine blade is to be formed;

Fig. 2 is a sectional view taken along the line 2—2 of Fig. 1;

Figs. 3, 4, and 5 are sectional views similar to Fig. 2 showing the blank after successive steps have been formed upon it;

Fig. 6 is a sectional view taken along the line 6—6 of Fig. 1;

Figs. 7 and 8 are sectional views taken along the lines 7—7 and 8—8 after the steps illustrated in Figs. 3, 4, and 5 have been performed upon the blank;

Fig. 9 is a view of a completed blade formed from the blank; and

Figs. 10 and 11 are sectional views taken along the lines 10—10 and 11—11 of Fig. 9.

Fig. 1 shows a blank 10 from which a turbine blade is to be formed. The blank 10 has a root portion 11 through which an opening 12 is formed. Beyond the outer end of the opening 12 in the blade portion proper of the blank 10, there is formed in the surface of the blank a plurality of ridges 13 between which are formed grooves 14. Most of the grooves and ridges curve near their outer ends and terminate in the tip and one edge of the blank 10. Certain ridges 13 terminating in the tip of the blank grow noticeably wider at the tip of the blank and thereby increase the spacing of the grooves 14 formed between them. The blank 10 is approximately uniform in width throughout the greater part of the blade portion proper and commences to diminish in width at a region near the root 11. Just before the blank commences to diminish in width, alternate ridges 13 terminate; nearer the root 11, alternate ones of the remaining ridges terminate; and finally three ridges run as far as the outer end of the opening 12, where they terminate and their upper surfaces merge with the surface of the blank as indicated at 15 in Figs. 1 and 11. As indicated in Fig. 11, the grooves 14 are relatively shallow throughout the

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part of the blade portion proper that is of uniform width and then increase in depth at the region where the blank commences to narrow and merge smoothly at their bottoms with the bottom of the opening 12.

The blank 10 with its passage 12, ridges 13, and grooves 14 may be formed of Stellite by precision casting. Thereupon the grooves 14 are filled with a suitable filling material such as aluminum, cadmium, or a graphite-containing wax. The filling material is indicated by the reference character 16. Thereupon one side of the blank 10, which may predominantly be cobalt is plated with a suitable metal such as nickel by a process such as electrodeposition. The plating, which is indicated by reference character 17, extends over the surface 15 adjacent the root 11 and over the ridges 13 and the filling material 16 in the grooves 14. Then a coating or plating 18, which may be chromium, is applied to the nickel coating 17, for example, by the process of electrodeposition. Next the filling material 16 is removed through the passages 19 formed by the grooves 13 and the platings 17 and 18. When the filling material is aluminum, it may be removed by caustic soda. When the filling material is cadmium, it may be removed by heating to vaporization. When the filling material is a graphite-containing wax, it may be removed by melting. Finally the bond between the plating and blank 10 may be strengthened by appropriate heat treating to make the nickel plating alloy with the chromium plating and with the cobalt blank 10.

As seen in Figs. 9, 10, and 11, the turbine blade formed by the process just described, has a shelf-like portion 19^a projecting from the concave side of the blade. This portion serves to space the blade from an adjacent blade, which is not shown. Reinforcing ribs or flanges 20, 21, and 22 depend from the shelf-like portions 19^a.

In operation the blade will be rotated while being attached through the root portion 11, which is radially innermost. Air will flow through centrifugal action or by reason of an available pressure differential radially outwardly, or upwardly as seen in Fig. 1, through the blade. The air enters the opening 12 and continues on through the passages 19 finally escaping from the blade at one edge and at the tip. The purpose of the air passing through the blade is to cool the blade. The cooling is effective because the passages are shallow throughout most of the lengthened blade, allowing high flow velocities with a comparatively small amount of coolant flowing.

The above described process for forming the passages 19 and blade make it possible for the passages to be relatively shallow.

I claim:

1. A blade comprising a cast metal member having a plurality of ridges and grooves between the ridges and electrolytically deposited plating metal covering and alloyed with the ridges and bridging the grooves so as to cooperate with the grooves to form cooling passages adjacent one surface of the blade, said blade having a hub portion provided with an opening with which said grooves and passages establish communication, said grooves corresponding in number to said passages and including at least first, second, and third sets of grooves in series by sets in that order leading toward the hub opening, said second set of grooves being fewer in number than said first set and said third set being fewer in number than said second set, said first set of grooves combining at least by two's to form the grooves of said second set and said second set of grooves combining at least by two's to form the grooves of said third set.

2. A blade comprising a cast metal member having a hub portion provided with an opening and a blade portion having a plurality of ridges on one side and grooves between them communicating with the hub opening, some of the ridges extending to the hub portion, and plating metal covering the ridges and bridging the grooves so as to cooperate with the grooves to form cooling passages communicating with the hub opening.

3. A blade comprising a cast metal member having a hub portion provided with an opening and a blade portion having a plurality of curved ridges on one side defining grooves and terminating in the blade tip and a side edge and communicating with the hub opening, some of the ridges extending to the hub portion, other ridges terminating in spaced relation to the hub portion, still other ridges terminating in more greatly spaced relation to the hub portion, the grooves decreasing in depth from the hub portion to the tip, and plating metal covering the ridges and bridging the grooves so as to combine with the grooves to form cooling passages adjacent one side of the blade.

4. The blade specified in claim 3, the cast metal member being of Stellite, and the plating metal being nickel.

5. The blade specified in claim 3, the cast metal member being of Stellite, and the plating metal being nickel, the blade further including a coating of chromium on the nickel.

6. A structure comprising a metallic part having an opening in one end and an external surface provided with ridges and grooves between the ridges and a metallic electro-plating covering the ridges and bridging the grooves to cooperate with the grooves to form passages corresponding in number to the number of grooves, said plurality of grooves establishing communication with said opening and including at least first, second and third sets of grooves in series by sets in that order leading toward said opening, said second set of grooves being of a fewer number than the first set, and said third set of grooves being of a fewer number than the second set, said first set of grooves combining at least by two's to form the grooves of said second set and said second set of grooves combining at least by two's to form the grooves of said third set.

7. A turbine blade of the type adapted to be traversed internally by a plurality of streams of

the same fluid, said turbine blade having a hollow, open-ended root and a blade part proper connected to the root and having a tip edge and two side edges, and a series-connected progression of first, second, and third groups of internal passages in said blade extending in that order from perforations formed in at least one said edge of the blade part proper to the hollow interior of the root, said first group of passages combining at least by two's to form said second group of passages and said second group of passages combining at least by two's to form said third group of passages.

8. A blade according to claim 7, in which the tip edge and one side edge contain all the perforations aforesaid and in which the aggregate number of perforations corresponds to the number of passages in said first group.

9. In a turbine blade proper having concave and convex faces and consisting longways of a root portion, a neck portion and a blade portion having a tip edge, a relatively sharp side edge, and a relatively round side edge; a motive fluid conducting surface means, said motive fluid conducting surface means being in the form of a shelf affixed along the neck-blade boundary and projecting normalwise from the concave face, said motive fluid conducting surface means being adapted to provide one side of a gas-flow channel, and a coolant gas conducting surface means, said coolant gas conducting surface means internally traversing said blade proper longways and defining cooling passages establishing communication between said portions, said passages emerging, at an angle to said blade proper longways, from the blade portion in openings along said sharp edge and said tip edge.

10. A rooted turbine blade gradually widening from the root thereof and having an open mouth at the root end, a blade section proper provided with a tip edge and side edges, a throat connecting the blade section proper to the root, and means forming a progression of first, second, and third groups of cooling pores leading in that order from a tip and side edge toward the open mouth of the blade, said second group of pores being fewer in number than said first group and said third group of pores being fewer in number than said second group, said first group of pores combining at least by two's to form said second group, said second group of pores combining at least by two's to form said third group.

11. A rooted turbine blade gradually widening from the root thereof and having an open mouth at the root end, a blade section proper provided with a tip edge and side edges, a throat connecting the blade section proper to the root, and means forming a progression of first, second, and third groups of cooling pores leading in that order from at least the tip edge toward the open mouth of the blade, said second group of pores being fewer in number than said first group and said third group of pores being fewer in number than said second group, said first group of pores combining at least by two's to form said second group, said second group of pores combining at least by two's to form said third group.

12. A rooted turbine blade having an open mouth at the root end, a blade section proper provided with a tip edge and side edges, a throat connecting the blade section proper to the root, and means forming a progression of at least first, second, and third sets of cooling pores leading in that order from spaced orifices in the tip edge toward the open mouth of the blade, said first set of pores being equal in number to said orifices and

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combining at least by two's to form said second set of pores and said second set combining at least by two's to form said third set.

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