Aug. 19, 1958 B. E. SELLS ET AL 2,848,193

AIR COOLED TURBOMACHINE BLADING

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Fig. 1.

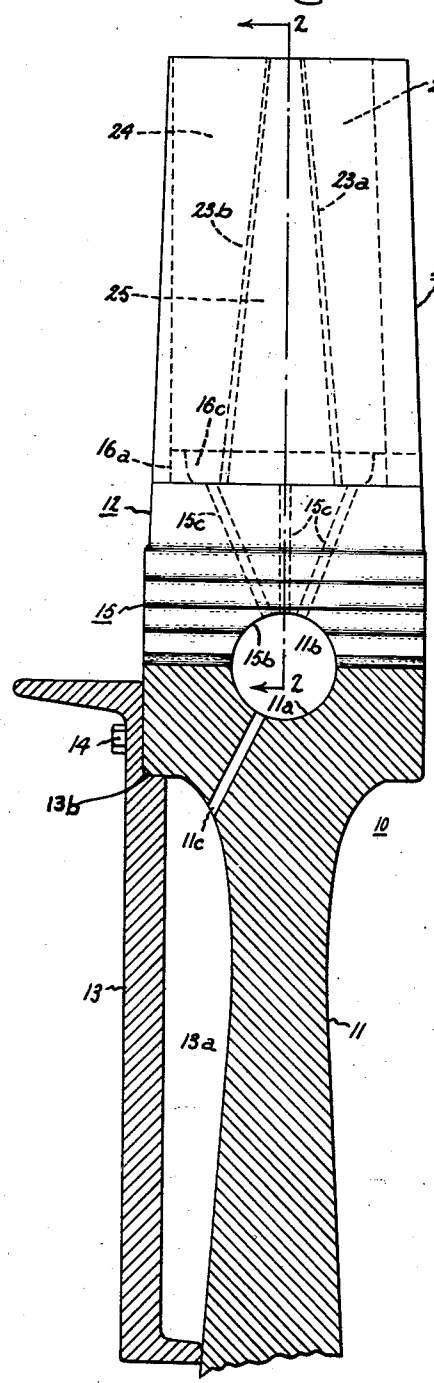


Fig. 2.

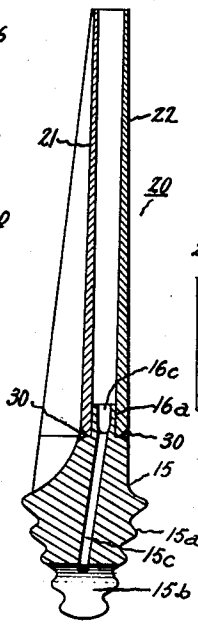


Fig. 3.

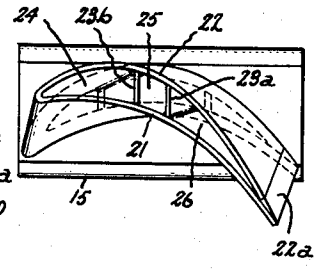
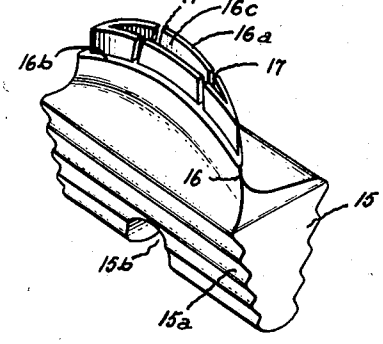


Fig. 4.



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AIR COOLED TURBOMACHINE BLADING

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7 Claims. (Cl. 253—39.15)

This invention relates generally to turbomachine structures using high temperature elastic fluid and specifically to means for cooling the blading used in structures such as gas turbines and the like.

High speeds produce centrifugal stresses in rotor blading which can be reduced somewhat by the use of sheet metal fabricated into proper blading form. Moreover, turbomachine operation at temperatures of 1500° F. and above may result in blading failures due to decreased strength of material with temperature rise, which can be alleviated somewhat by resort to blading cooling to permit raising the maximum allowable operating temperature. By using thin wall sections, it is possible to obtain a more uniform temperature distribution from the inner to the outer wall surfaces, with less internal stressing and warping of blading walls, as well as achieving economy in the use of high temperature steel alloys; but difficulty has arisen in securing hollow blading to the turbine rotor disk.

Accordingly, it is an object of this invention to provide an improved turbomachine blading structure.

It is another object of this invention to provide more effective turbomachine blading capable of sustained operation at high temperatures.

A further object of this invention is to provide an improved cooling arrangement for blading subjected to high temperature gases.

The above and other objects and advantages of the invention will be apparent from the following detailed description taken in conjunction with the accompanying drawing in which:

Fig. 1 is a cross sectional view of a portion of a rotor body provided with a preferred embodiment of our blading;

Fig. 2 is a cross section through the blading taken in the plane of line 2—2 in Fig. 1;

Fig. 3 is an end view of a preferred embodiment of our blading as shown in Figure 1; and

Fig. 4 is an isometric view of the base portion of our improved blading element.

In accordance with the objects of invention, our novel structure is a fabricated blading member, having reinforcing and dampening portions defining chambers for the conduction of a cooling medium, fastened to a base in such a manner as to reduce the possibility of fatigue failures.

Referring to the drawing, a portion of the rotor body is disclosed at **10**, comprising the rotor disk **11**, one of a plurality of blade members **12**, and cooling channel-defining flanged member **13** having a rabbet **13***b*, secured to disk **11** therealong by means such as screw bolts, one of which is indicated at **14**.

The blade member **12** comprises a base root portion **15** having means for fastening to a rotor disk, here shown at **15***a* as a conventional fir-tree configuration, although any other means for fastening blading could be used. Base member **15** also has a cutout portion at **15***b*, which with

a similar cutout portion **11***a* in rotor disk **11**, defines a cooling channel therewith, indicated as **11***b*.

Projecting from the base member **15** is a partial base portion **16**, shaped to the basic contour of the completed blading member and having a recessed projection **16***a* at its top defined by fillet **16***b*. Projection **16***a* has slits **17** positioned at an angle to the plane of rotation of the disk as viewed in Figure 1. The slits **17** are spaced inwardly from the opposite edges for a purpose to be described below, and also the projection **16***a* has a central hollow portion **16***c*, defined by thin walls, in communication with the cutout portion **15***b* by way of perforations or slots **15***c*.

The upper blade member is indicated generally at **20** and comprises front and back blade sections **21** and **22** respctively, and dividing partitions **23***a* and **23***b* joined respectively thereto, defining localized cooling chambers or passageways **24**, **25** and **26**. The alternate radially extending edges of the partitions are secured to the front and rear blade sections with the other radially extending edges of the partition being in contact with the blade sections **21** and **22**. The partition **23***a* has a free edge engaging the back section **22**, and the partition **23***b* has a free edge engaging the front section **21**. The upper blade member **20** can be formed from a single piece of tapered sheet stock and welded along one edge as indicated at **22***a* in Fig. 3; or it can be made of two formed or forged pieces and then welded together along the leading and trailing edges. When completed, the upper blade member is fastened to the base member at the fillet **16***b*, as indicated by the welding at **30** (Fig. 2), the hollow recessed projection **16***a* extending into the bottom of the upper blade member and the bottoms of the partitions **23***a* and **23***b* extending into the slits **17** and fastened therein, as by brazing or welding. The slits **17** and partitions **23***a* and **23***b* are positioned at an angle relative to the longitudinal axis of the projection **16***a* and upper blade member **20**. All the fastening by welding in the completed blade member **20** occurs in zones of equal material thickness so that little or no detrimental effect results from the welding heat. Furthermore, the projection of the blade root portion of the base above the weld zone will reduce bending stresses at the weld and will tend to reduce the possibility of fatigue failure.

In addition, the longitudinally extending radial partitions lie out of the plane of rotation of disk **11** as viewed in Figure 1 so that when fastened as indicated and the blade member is put under centrifugal load, the bending of the partitions will press against the front or rear blade section, as the case may be, to dampen out blade vibration and prevent breathing or "oil canning" of the blade member.

The localized cooling chambers **24**, **25** and **26** are in communication with main cooling channel **13***a*, supplied from an appropriate source (not shown) by way of passages **11***c*, **11***b*, and **15***c*.

Thus it will be seen that our invention provides a means for cooling turbomachine blading, and because of the particular mounting of the upper blade portion to the base member, blading which can expand in a radial direction with lessened chances of fatigue failure and decrease in its vibration.

While a particular embodiment of our invention has been illustrated and described, it will be obvious to those skilled in the art that various changes and modifications may be made without departing from the spirit of the invention, and it is intended to cover in the appended claims all such changes and modifications that come within the true scope of the invention.

What we claim as new and desire to secure by Letters Patent of the United States is:

1. As an article of manufacture, blading for a turbo-

machine comprising a base portion and a hollow upper blade member having front and back sections and longitudinal partitions whose planes extend angularly of the longitudinal axis of the blading and radially outwardly from the base portion, said partitions being disposed between and spacing said sections with alternate partitions being fastened to the same section.

2. As an article of manufacture, a turbomachine blading member comprising a base having a blade root portion with a hollow projection thereon defined by a fillet and cooling perforations extending through said base to said projection, and a hollow upper blade member having front and back sections joined along a contacting edge, partition members extending radially outwardly and angularly relative to the longitudinal axis of the hollow projection, said partitions members being fastened alternately to said back and front sections and forming cooling chambers communicating with respective said perforations in said base, said upper blade member being attached to said base at said fillet on said blade root portion.

3. In a turbomachine construction, a blade member comprising a base with a partial projecting portion having a recessed hollow end portion and a separate fabricated upper blade member having front and rear sections and a chamber formed therebetween by an angularly extending longitudinal partition secured to one of said sections, said upper blade member being secured to said projection at said recessed portion, said partition being fixed to said projection, said base having a passageway therein communicating with said upper blade member chamber whereby said bladed member is cooled by passage of fluid flow therethrough.

4. In combination, a rotor wheel and blade members peripherically secured thereto, each of said blade members being fabricated and comprising a base and an upper blade member secured together, said base being perforated and having a recessed projection, said upper blade member comprising a chambered structure defined by front and rear sections joined along a contacting edge and a partition member between and spacing said sections and fastened to one of said sections to define a chamber, said upper blade member being secured to said base at said projection, said projection extending into said upper blade member, said chamber having communication with a perforation in said base.

5. In a rotor disk for a high speed turbomachine, a circumferential row of blades secured thereto, each of said blades comprising a chambered upper blade member secured to a perforated base, said upper blade member being fabricated of front and rear sections and partition members joined alternately thereto whereby chambers are

formed in said upper blade member, said chambers having communication with the respective perforations in said base, said base having a partial base portion with a hollow end defined by a fillet, said base and upper blade member being fastened to each other at said fillet, said end projecting within said upper blade member.

6. In combination with a high speed turbomachine subjected to high temperature operating conditions such as in combustion gas turbines, a rotor member having blading members peripherally attached thereto, each blading member comprising a base portion for rotor attachment and an upper blade member having front and rear sections and chambers therebetween defined by angularly extending longitudinal partitions fastened alternately to said sections, said base portion having passages for respective communication with said chambers whereby cooling of said blading is accomplished, said base portion having a projecting partial blade portion with a hollow end defined by a fillet, said upper blade member extending over said hollow end and being fastened to said partial base portion at said fillet, said hollow end having angular slits receiving the ends of said partitions.

7. An article of manufacture comprising a fluid cooled turbomachine blading member comprising a base and an upper blade member fastened together, said base having means for attachment to a rotor wheel, a projecting partial base portion having a recessed, hollow extension defined by a fillet, said extension having angular slits spaced inwardly from the extension edges, said base having perforations communicating with said hollow extension, said upper blade member having front and back sections joined along an edge and spacing partitions therebetween, said partitions being fastened in alternate manner to said sections and extending longitudinally and angularly to define chambers, said upper blade member surrounding said hollow extension when fastened to said projecting base portion, the ends of said partitions projecting into said slits, said base and upper blade member being joined at said fillet.

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