

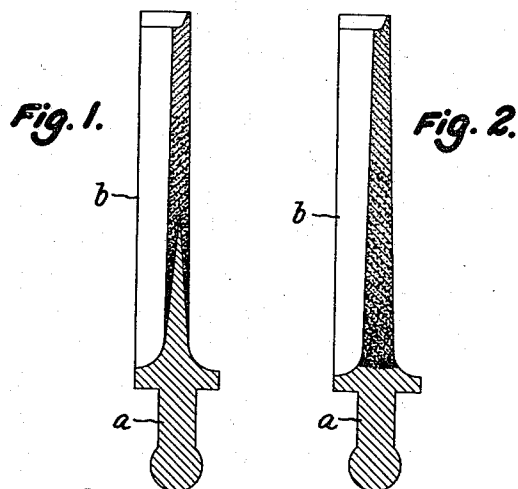
Nov. 25, 1947.

A. GAUDENZI

2,431,660

TURBINE BLADE

Filed Dec. 6, 1945



Inventor:
Arthur Gaudenzi,

By *Pierce & Scheffler,*
Attorneys.

UNITED STATES PATENT OFFICE

2,431,660

TURBINE BLADE

Arthur Gaudenzi, Wettingen, Switzerland, assignor to Aktiengesellschaft Brown, Boveri & Cie, Baden, Switzerland, a joint-stock company

Application December 6, 1945, Serial No. 633,196
In Switzerland December 1, 1944

Section 1, Public Law 690, August 8, 1946

19 Claims. (Cl. 253—77)

1

This invention relates generally to the construction of turbine blades or vanes and it has particular relation to blades for turbines which operate at extremely high temperatures.

A turbine blade for use with high temperature power-generating fluids, such as gas turbine blades, should have the following properties: high tensile strength in the temperature range above 700° C., low specific weight, high heat conductivity and capability of enduring temperature changes, relatively great surface hardness, capability of simple and durable installation, and resistance to oxidation, i. e. relatively free from slag formation.

In accordance with this invention the blade or vane has a metal foot or root portion to which is joined a top or working portion on which the high temperature fluid impinges and which is formed of, or provided with a covering or layer of, fritted metal and ceramic powder or ceramic-like powder, the metal content of the working portion decreasing with increasing distance from the foot portion of the blade. A turbine blade thus stratified and having a steel foot portion can be installed on a turbine rotor in exactly the same manner and as easily as one made wholly of steel. The steel foot portion may gradually merge into the interior of the composite top or working portion of the blade.

In the drawing, Figures 1 and 2 are side elevations, partly in section, of two different embodiments of the present invention.

In both of the illustrated embodiments of the invention, the foot or root portion *a* of the blade is formed of a suitable steel and shaped to conform to the design of the stator and rotor mountings of the turbine, for example a de Laval turbine, in which it is to be incorporated. As shown in Fig. 1, the root portion *a* is tapered outwardly and located within the working portion *b* which is composed of a fritted mixture of metal powder and ceramic or ceramic-like powder. The ratio of metal powder to ceramic powder decreases progressively with increasing distance from the steel root portion *a* of the blade. The metal powder content adjacent the steel root portion *a* is so high as to result in a welding of the fritted working portion *b* to the root portion *a*. The outer end of the working portion *b* of the blade, or at least the surface layer of the blade, is a fritted mass of ceramic or ceramic-like powder with little or no admixed metal powder. The outer fritted layer of ceramic or ceramic-like material is sufficiently compact to be substantially impermeable to the high temperature gases that im-

2

pinge upon the turbine blade. Alternatively, the metal powder may be of a corrosion-resistant steel that is not damaged by the high temperature gases that drive the turbine.

As shown in Fig. 2, the root section *a* need not extend into the interior of the blade section but may be welded to the inner end of the working portion *b* of the turbine blade. As in the turbine blade of Fig. 1, the composition of the fritted blade portion *b* changes gradually from a substantial all-metal section adjacent the steel root *a* to a substantially all-ceramic section or layer at the outer surface of the blade.

The metal powders of the fritted portion may be of a single metal or mixtures of metals such as iron, nickel, chromium, cobalt, tungsten, molybdenum or titanium; may be a steel including some of the recited refractory metals; or may be alloys of refractory metals, particularly steels or alloys of high tensile strength; metal powders of hard metal alloys such as tungsten carbide, either with or without additions of cobalt and/or nickel powders are also suitable.

The ceramic powder is selected from the refractory oxides of highly heat resistant materials and preferably from relatively stable oxides having relatively high heat conductivity; for example oxides of beryllium, aluminum, zirconium, magnesium and thorium. Mixtures of oxides are also suitable, such as spinel, zirconium silicate and others together with oxides having lower melting points such as quartz and titanium oxide; also porcelain comprising a mixture of kaolin, quartz and feldspar or the steatite group with talc or soapstone as the main component. Powdered glass may be used alone or in combination with the refractory oxides, the glass being of a hard or high temperature type such as the so-called oven glasses sold under the trade-marks "Pyrex" and "Duran."

The weight of the fritted blade portion is substantially less than that of an all-metal blade, and the stresses due to centrifugal force are therefore substantially reduced. Ceramic materials such as beryllium oxide or aluminum oxide are particularly useful as they have a heat conductivity similar to that of iron and steel. These oxides have melting points above 2000° C. and, when vitrified, have a surface hardness greater than that of hardened steels.

I claim:

1. A turbine blade or vane for use with high temperature pressure fluids said blade comprising a metal foot portion for attachment to a rotor or stator ring, and a working portion car-

ried by and extending from said foot portion, the working portion of the blade that is impinged upon by said fluids being a fritted mixture of metal and ceramic powders, the metal content of the blade decreasing as the distance from the foot portion increases.

2. The invention as set forth in claim 1, wherein the ceramic powder comprises oxides of highly fire-proof materials having high melting points.

3. The invention as set forth in claim 1, wherein the ceramic powder comprises oxides of highly fire-proof materials having high melting points and high heat conductivity.

4. The invention as set forth in claim 1, wherein the ceramic powder consists at least in part of beryllium oxide.

5. The invention as set forth in claim 1, wherein the ceramic powder consists at least in part of aluminum oxide.

6. The invention as set forth in claim 1, wherein the ceramic powder comprises a mixture of oxides.

7. The invention as set forth in claim 1, wherein the ceramic powder consists at least in part of porcelain.

8. The invention as set forth in claim 1, wherein the ceramic powder consists at least in part of steatites.

9. The invention as set forth in claim 1, wherein the ceramic powder consists at least in part of glass powder from hard glasses.

10. The invention as set forth in claim 1, wherein the metal powder consists at least in part of iron.

11. The invention as set forth in claim 1, wherein the metal powder consists at least in part of nickel.

12. The invention as set forth in claim 1, wherein the metal powder consists at least in part of chromium.

13. The invention as set forth in claim 1, wherein the metal powder consists at least in part of molybdenum.

14. The invention as set forth in claim 1, wherein the metal powder comprises an alloy of high tensile strength.

15. The invention as set forth in claim 1, wherein the metal powder comprises hard metal alloys of high tensile strength.

16. The invention as set forth in claim 1, wherein the foot portion protrudes into the working portion and merges into the same in the interior thereof.

17. The invention, as set forth in claim 1, wherein the working portion is provided with a protective layer of fritted metal and ceramic powder on all sides.

18. The invention, as set forth in claim 1, wherein the foot portion protrudes into the working portion and merges into the same in the interior thereof and the layer of metal and ceramic powder contains a slag proof metal alloy.

19. The invention, as set forth in claim 1, wherein the foot portion protrudes into the working portion and merges into the same in the interior thereof and the layer of metal and ceramic powder contains fritted chromium powder.

ARTHUR GAUDENZ.

REFERENCES CITED

The following references are of record in the file of this patent:

FOREIGN PATENTS

Number	Country	Date
380,391	Italy	1940

OTHER REFERENCES

Ser. No. 385,333, Schutte (A. P. C.) pub. May 25, 1943.