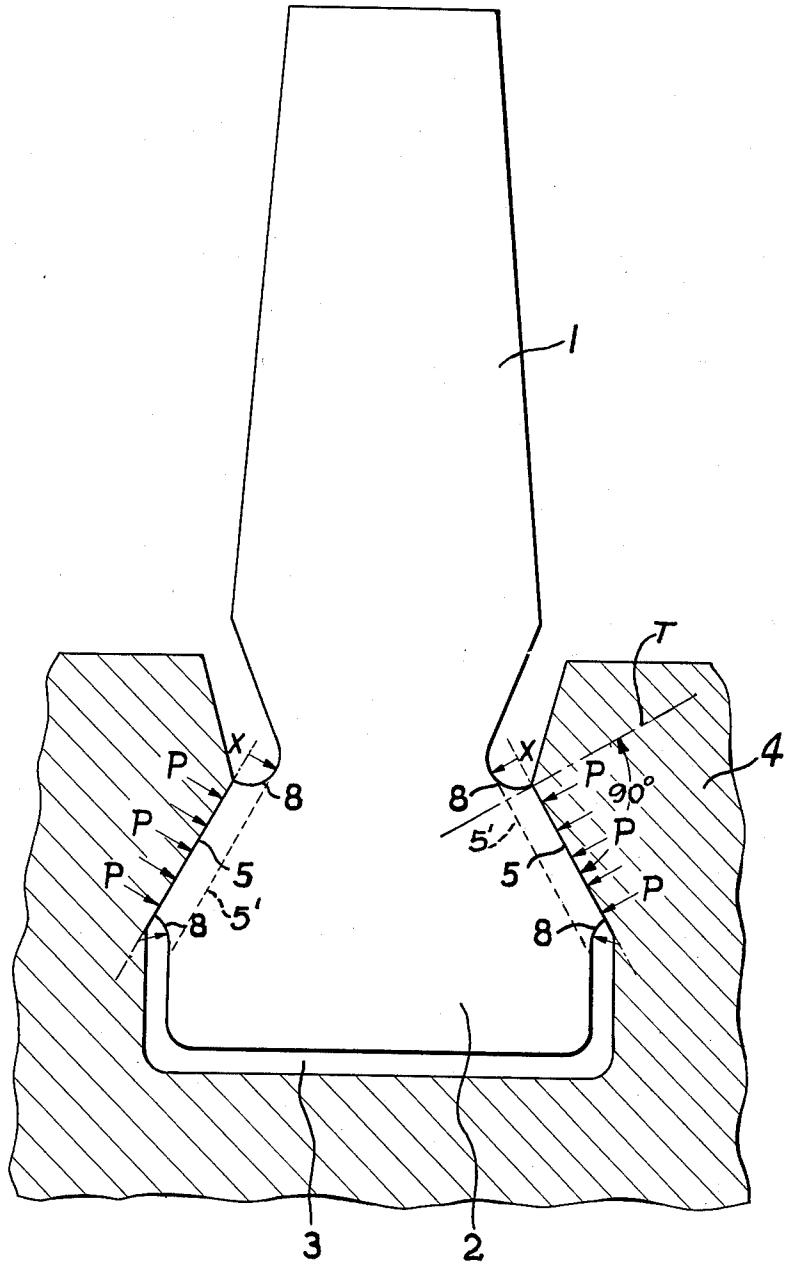
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SHAPED ARTICLE OF CERAMIC MATERIAL

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SHAPED ARTICLE OF CERAMIC MATERIAL

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4 Claims. (Cl. 253—77)

This invention relates to certain improvements in the shaping of engine parts or machine elements of ceramic material, more particularly, in the form of blades for gas turbines.

In engineering practice, ceramic materials are used primarily where in addition to mechanical stresses the parts are exposed to very high temperatures exceeding the upper temperature limit admissible for metallic materials. The mechanical strength of shaped articles of ceramic materials is not substantially changed by heating them from room temperature to very high temperature. However, in view of the relatively low mechanical strength of ceramic materials, it is necessary to pay special attention to the factors determining the rated fatigue limit of the respective part. This is especially true in case of highly stressed engine parts, such as, turbine blades or vanes. The main difficulty consists in the fact that the slightest peak strains which have been neglected in the design will cause break-down of the ceramic element if such peak load exceeds the strength of the material.

More particularly, it has been found that the equilibrium of the structural or internal strain which originates from the firing and is a characteristic feature of ceramic materials is disturbed by the machining of individual surfaces of the ceramic part, for instance by grinding, whereby the rated fatigue limit is substantially reduced. The critical points of a partly ground workpiece are at the transitions between the ground surface and the non-injured or unwrought natural surface or skin of the shard produced by the firing.

It is an object of the present invention to provide a design which offers optimum conditions as to the mechanical strength of engine parts or other shaped articles of the type referred to.

With this and further objects in view, according to the present invention the place of transition between the machined supporting or seating surface or surfaces and the unwrought surface or surfaces of the engine part, more particularly, of the root of a turbine blade, is shaped in the form of a hollow or flute. According to a further feature of the invention, such flute is arranged to have its center point, or its center axis, respectively, on a plane which is flush, or nearly flush, with the ground surface. It has been found that the deleterious influence of ground surfaces on the mechanical strength can be compensated particularly effectively in this way. Generally speaking, the ground surface should form a right angle with the returning non-ground surface. The machining or tooling allowance which is indispensable with ceramic materials for rendering it possible to adhere safely to the dimensions indicated in the drawing in spite of the large tolerances caused by the manufacturing process, and by the large shrinking differences inherent to this material, should be dimensioned so that after grinding to the specified measure the centers of the flutes are not located substantially above the plane of the ground surfaces. The important thing is to arrange the surfaces in such a way that the compressive forces act on the machined surfaces

in a normal direction while non-stressed parts of the shard adjacent to the surface acted upon by the force are avoided.

It will be understood that the invention is not restricted to its application in ceramic turbine blades but it may be used for other ceramic engine parts or machine elements as well.

Other and further objects, features and advantages of the invention will be pointed out hereinafter and appear in the appended claims forming part of the application.

One embodiment of the invention is illustrated by way of example and purely schematically in the accompanying drawing, showing a fragmentary sectional view of a conventional turbine wheel and a ceramic turbine blade seated in a dovetail groove of the turbine wheel.

Referring to the drawing, it will be seen that the turbine blade, consisting of a blade portion 1 and a root portion 2, is inserted in a dovetail groove 3 of a turbine rotor 4 and supported by means of its main seating surfaces or load carrying faces 5 on the supporting surfaces of the rotor 4.

Adjacent to the ground seating surfaces 5 the unwrought surface of the root of the blade is provided with hollows or flutes 8, the centers X of the circles defining the curvature of the flutes 8 being located in the same plane as the respective ground seating surfaces 5. It is not absolutely necessary for the flute to be cylindrical or for its center axis to be disposed accurately in the plane of the seating surface. The important thing is that the compressive forces P acting upon the seating surface 5 are introduced into these surfaces in a normal, i. e., perpendicular direction.

It will be noted from the dotted line 5' that the seating surfaces 5 are projected or extended outwardly from the conventional wedge shape blade root construction, and that, as noted above, a tangent T to the flutes or hollows 8 at the point of intersection thereof with the seating surfaces 5 forms a right angle with the seating surfaces.

While the invention has been described in detail with respect to a now preferred example and embodiment of the invention it will be understood by those skilled in the art after understanding the invention that various changes and modifications may be made without departing from the spirit and scope of the invention and it is intended, therefore, to cover all such changes and modifications in the appended claims.

What is claimed is:

1. A ceramic turbine blade having a working portion and a root portion extending therefrom for affixing said blade in position in use in a groove in the rim of a turbine, said root portion having a generally wedge shape dovetail configuration outwardly flared from said working portion and including load carrying surfaces outwardly projecting from said dovetail configuration and positioned to receive perpendicularly thereto substantially the entire forces acting on said root portion in use, said outwardly projecting surfaces being machine finished and bounded on opposite sides by concave arcuate walls which are not machine finished and the radii of curvature of which do not substantially exceed the extent of projection of said surfaces, and a tangent to said concave walls at the points of intersection with said load carrying surfaces forming substantially a right angle with said surfaces.

2. In a turbine having ceramic blades affixed around the rim of a turbine rotor, the combination which comprises seating surfaces in said rotor rim, corresponding dovetail seating surfaces on said blade for load bearing engagement with said rotor seating surfaces, said blade seating surfaces being outwardly and downwardly projecting from said blade and having accurately machined surfaces for fitting engagement with said rotor surfaces, said outwardly projecting blade seating surfaces being

bounded on opposite sides by concave curved wall portions the centers of curvature of which are substantially in the planes of said projecting seating surfaces, and said curved walls being unmachined and meeting said seating surfaces at substantially right angles.

3. A ceramic machine part subject to substantial load stress in use in a machine comprising a generally dovetail portion for affixing said part into position in a machine and including machine finished surfaces of substantial area for transmitting said load stress, another surface portion extending beyond said dovetail portion and which is not machine finished, said machine finished portions being bounded on opposite sides by unmachined concave arcuate walls the centers of curvature of which lie substantially no further from the center line of said ceramic part than said machine finished portions, and said concave arcuate walls meeting said machine finished portions at substantially a right angle.

4. A ceramic machine part subject to substantial load stress in use comprising a machine finished surface portion of substantial area for transmitting said load stress, another surface portion which is not machine finished and extends beyond said machine finished area, and concave arcuate walls joining said machine finished portion with said unmachined portion, the centers of curvature

of said concave walls lying substantially no further from the center line of said ceramic part than said machine finished portion and said concave arcuate walls being unmachined and meeting said machine finished portions at substantially a right angle.

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