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METHOD AND MEANS FOR PREVENTING DETERIORATION OF TURBO-MACHINES

Filed Jan. 17, 1935

Fig. 1

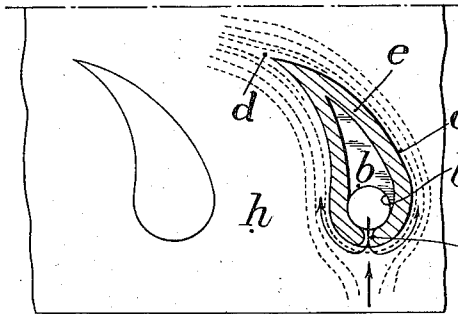


Fig. 2

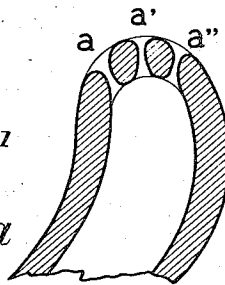


Fig. 3

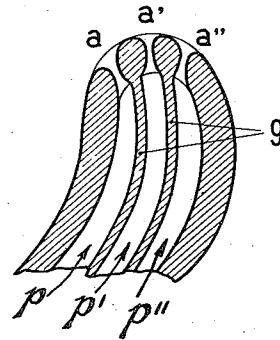


Fig. 4

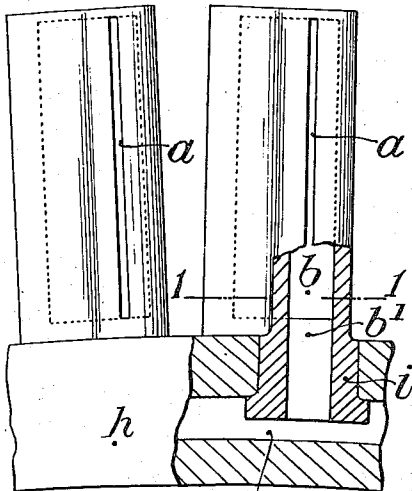


Fig. 5

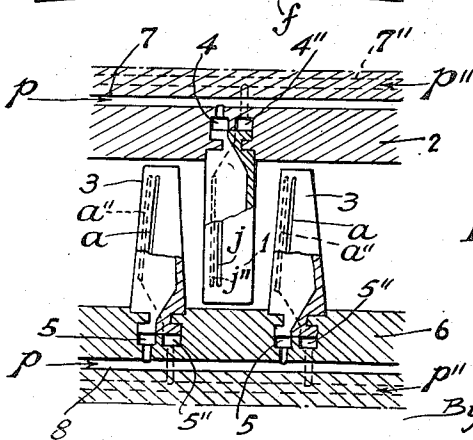
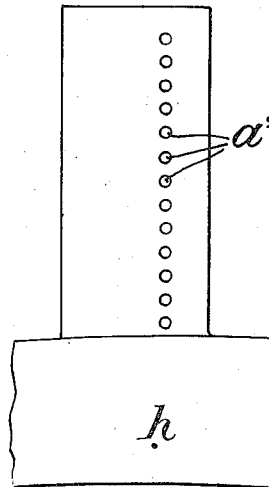


Fig. 6.

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UNITED STATES PATENT OFFICE

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METHOD AND MEANS FOR PREVENTING DETERIORATION OF TURBO-MACHINES

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4 Claims. (Cl. 60—41)

This invention relates to methods and means for preventing deterioration of parts of turbo-machines by the high temperature or the chemical action of the fluids passing through the same.

It consists in discharging a protecting fluid through one or more orifices located in the leading edge of the blade or similar member in such a position that the protective fluid escaping in a direction opposite to the working fluid is spread by the latter on said leading edge and spills smoothly and nearly equally on either side of this edge. Both the faces of the blade or similar member, are also covered by a protective laminar and continuous layer of cooler or noncorrosive fluid which separates them from the hot or corroding working fluid.

In order that the protecting layer should be maintained throughout the contour of the blade by avoiding its premature dispersion in the stream of the working fluid, the profile of the blade, of the known thick type, has moreover a regularly rounded continuous contour with a relatively large curvature radius on the leading edge, and without any other sharp edge than the trailing edge.

The optimum position of the orifice or orifices on the leading edge depends on the shape of the cross section of the blade, and on the direction of the relative speed of the working fluid relatively to the blade, so that, in general, the position of the orifices should vary according to the load of the machine.

Another object of the invention is to solve this difficulty and consists in discharging the protecting fluid at different points of the width of the leading edge of the blade and at different pressures in order to maintain the required distribution of this fluid on both faces of the blade when the load of the turbine varies.

The invention will now be described with reference to the appended drawing in which several embodiments of the method are shown by way of example.

Figure 1 is a plane view with, at right hand a cross sectional view along the line I—I of Fig. 4 of a gas-turbine blade according to this invention in which the protective fluid flows out of the blade through one single longitudinal slit arranged at the leading edge of the blade profile.

Figures 2 and 3 are fractional cross-sectional views through blades from which the protective fluid flows out through several slits distributed on the entering edge of the profile and is fed from one or several interior ducts.

Fig. 4 is an elevation showing a portion of a

turbine drum with two single blades, one of which is sectioned through its root.

Fig. 5 is an elevation of a blade having a series of holes instead of a slot.

Fig. 6 is an axial section of a portion of a turbine having blades each provided with two distinct internal ducts.

Figs. 1 and 4 show how a longitudinal slit *a*, having preferably rounded edges arranged at the leading or entering side of the profile of a rotor blade *e* close to the point where the working gas stream divides into two branches flowing along both sides of the blade, will allow a protective layer *c* adjacent to the hot stream to distribute over both faces of the blade.

As illustrated in Fig. 4, the protecting fluid coming from a source of supply (not shown) under a pressure slightly greater than that of the working fluid, reaches the slot *a* through an annular channel *f* provided in the drum *h* carrying the blades and with which the cavity *b* of each blade is connected by a channel *b*₁ formed in the blade root *i* secured on the drum.

In order that the protective air or fluid may overcome the pressure of the hot working gas it is only necessary that its total pressure, i. e. the sum of the static and the dynamic pressures, be at least equal to that of the hot gas stream.

Figs. 2 and 3 refer to the case where several such slits as *a*, *a'*, *a''* are used which may be required by the extensive displacement of the stream parting point along the profile of the leading edge depending on the load of the turbine, that is on the relative angle incidence of the hot stream on the blade. The various slits may be fed either from one single internal duct (Fig. 2) or as shown in Fig. 3 from several ducts separated by one or several partitions *g*, and in which unequal pressures *p*, *p'*, *p''* may exist, so that the delivery of the protective fluid can always be performed by both slits of the rounded front of the blade, even if the counter-pressure due to the working fluid differs at different loads from one slit to the other.

Experiments have shown that the use of three slits at the entering side of a blade rounded with a comparatively large radius of curvature will insure the maintenance of the protective air layer on both sides at all incidences through an angle of 90°.

Obviously, as represented by *a'* in the Fig. 5 each slit may be substituted by a row of apertures or ports arranged close to one another and having a suitable section, for instance a row of holes *a'* provided in the leading edge of the blade.

The invention applies as well to moving as to guiding or stationary turbine or turbo-machine blades.

Fig. 6, for instance, shows a portion of a turbine with movable blades 3 and stationary blades 1 fitted in the casing 2. These blades are similar to those shown in Fig. 3 except they have only two slits and two ducts, the slits of the blades 1 being designated j and j'' and the slits of the blades 3 being designated at a and a'' . The ducts adjacent the two concave faces of the blades are in communication at the root with channels 4 (or 5) and in the same manner the ducts adjacent the convex faces of the blades are in communication with distinct channels 4'' (or 5'').

The channels 4 and 5 are fed respectively from ducts 7 and 8 and the channels 4'' and 5'' from ducts 7'' and 8'' indicated in dotted lines and in which the pressure p'' may differ from the pressure p in the first named channels 7 and 8.

It will be understood that this invention is not limited to turbines nor to the use of cold air as a protective layer, as it may entail the use of any other fluid, such as more or less warm air, burned, flue or other gases, steam, preferably saturated which may be introduced into the blade or other part in the liquid state and vaporized there if the temperature of this blade is higher than the saturation temperature.

I claim:

1. A method for protecting the surface of a body having a rounded leading front subjected to fluid at high temperature and provided with orifices such as small slits in said leading front, consisting in conducting fluid of lower temperature, to said slits in order to protect the entire surface of the body with a protective layer of cooler fluid, spilling it evenly from these slits on

both sides of the body, without turbulence and in lamellar relation to the working fluid.

2. In a turbo-machine a hollow part subjected to a stream of working fluid and provided with a plurality of orifices adapted for the escape of a protective fluid in the leading front of this part, a distinct internal duct in communication with each orifice, whereby the protective fluid issued from each orifice can have the suitable and distinct pressure required by the changing of the incidence of the working fluid at different loads.

3. In a turbo-machine, a hollow turbine blade having an orifice extending lengthwise of the leading edge thereof for the escape of a protective fluid, a root on said blade, and means for conducting the protective fluid through said root to said orifice, the leading edge of said blade being rounded and the edges of said orifice being also rounded whereby the protective fluid escaping from said orifice is divided into two streams and spills evenly over both sides of the leading edge and prevents contact of the working fluid of the turbine with said blade by covering the entire surface thereof with a thin non-turbulent film in lamellar relation to the working fluid.

4. In a turbo-machine, a hollow turbine blade having a rounded leading edge and a plurality of slits extending lengthwise of said leading edge for the escape of a protective fluid, a root on said blade, means for conducting the protective fluid through said root to said slits, said slots being disposed in different planes radially of said leading edge to cause the spilling of the protective fluid on both sides of the blade at every load and whatever may be the angle of incidence in the working fluid.

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