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F. M. BURHANS
COMPRESSOR CASING LINING
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2,742,224

FIG. 1

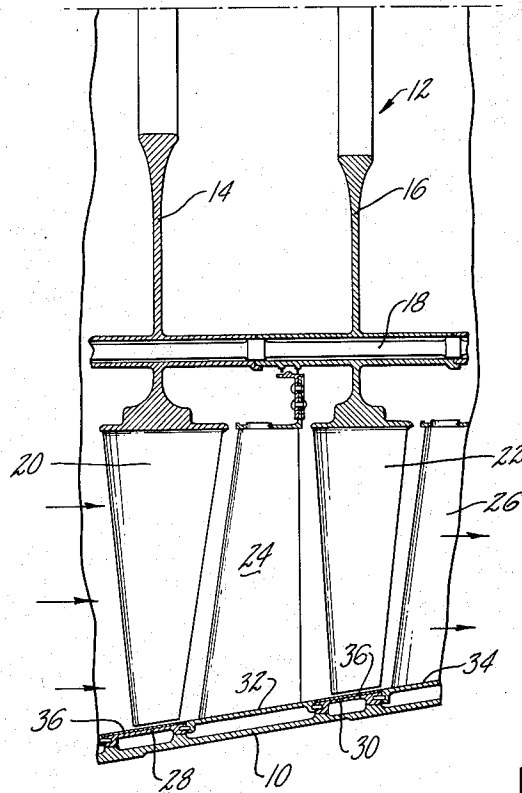


FIG. 3

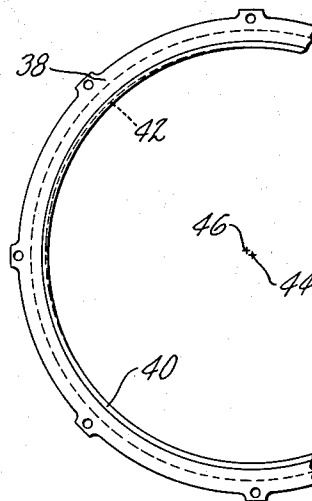
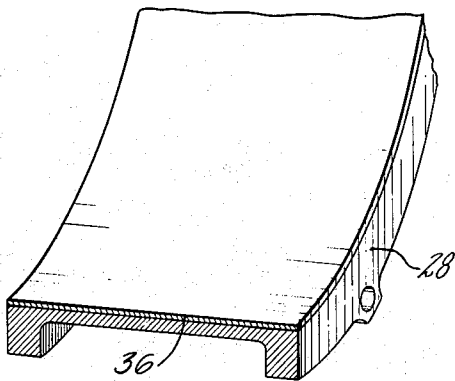


FIG. 2



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COMPRESSOR CASING LINING

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3 Claims. (Cl. 230—122)

This invention relates to a surface covering on parts having relative motion therebetween, more particularly to a lining on the surface or surfaces surrounding a rotating object.

In axial flow gas turbine power plants the compressor rotor comprises a plurality of bladed discs each constituting a stage, mounted on a single shaft, the shaft being supported at spaced points within the compressor casing. Differential expansion between various elements as well as a relative displacement of the axis of rotation of the compressor rotor requires the power plant to be assembled with clearance between the rotor elements and the surrounding compressor casing. However, to minimize losses due to recirculation, clearances are made as small as possible so that when the power plant is operating the rotating elements are barely out of contact with the casing. Deflection of the compressor shaft due to loads imposed thereon can cause rubbing against the casing with resultant damage to the rotor and to the casing.

To reduce the damage caused by rubbing, various remedies such as the use of a lining of soft metal on the compressor casing or the use of a narrow wearing strip mounted on the inside of the compressor casing opposite the rotating blades have been proposed. These remedies have their disadvantages. The soft metal, if rubbing occurs, has a tendency to fuse to the rotor blades thereby upsetting the balance of the rotor assembly. It is not uncommon for the fused material on the blades to act as a cutting tool and machine grooves in the surrounding casing. Wearing strips are not desirable as they prevent the inner surface of the compressor casing from being smooth and continuous, thus materially reducing compressor efficiency.

In accordance with the invention, damage due to rubbing can be substantially prevented by lining the compressor casing with a material having a relatively low melting temperature. This material should have the desirable characteristic of passing from the solid state to the liquid state at the melting temperature with substantially no intermediate plastic or mushy state. In this way any tendency of the material to fuse to the rotating blades is overcome. By choosing a material having a melting temperature slightly above the maximum temperature encountered during operation, only a small amount of friction heat would be required to melt the lining. Thus, in case of rubbing, the temperature increase due to friction can melt the lining without damage to either the rotor or the casing. The lining material which melts will pass into the airstream and be carried through the power plant in a harmless state.

Each stage of an axial flow compressor has a higher maximum operating temperature than its preceding stage. If individual shrouds are used around each compressor stage, each shroud can be lined with a material having a melting temperature slightly higher than the maximum operating temperature in its associated stage. In this fashion the greatest amount of protection can be given to the compressor assembly.

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An object of this invention is to provide a compressor casing lining which substantially prevents damage to the compressor rotor and to the compressor casing if rubbing should occur therebetween.

Another object of this invention is to provide a compressor casing lining which quickly melts under friction heat and is easily rubbed away by the compressor rotor, preferably passing from a solid state to a liquid state with substantially no intermediate plastic state.

Still another object is to provide a compressor casing lining which permits the use of minimum running clearances between the compressor rotor and the compressor casing without the concomitant danger of damage to the rotor or casing if rubbing should occur.

Other objects and advantages will be apparent from the specification and claims, and from the accompanying drawing which illustrates an embodiment of the invention.

In the drawing:

Fig. 1 is a fragmentary longitudinal section through the compressor section of a gas turbine power plant embodying this invention.

Fig. 2 is a section through a compressor shroud having a lining in accordance with this invention.

Fig. 3 is a plan view of a compressor shroud and shows the manner in which the lining is worn when the compressor rotor rubs the compressor shroud.

Referring to the drawing in detail, Fig. 1 shows compressor casing 10 having rotor assembly 12 therein. The rotor is comprised of a plurality of bladed discs, two of them being shown at 14 and 16, the discs being secured together by a circumferential row of bolts to form a barrel-like structure. One of the bolts is shown at 18. Compressor disc 14 has a series of blades 20 mounted thereon and compressor disc 16 has a series of blades 22 mounted thereon. Stationary guide vanes 24 and 26 are provided between adjacent rows of compressor blades.

Compressor casing 10 is a continuous ring having a stepped inner surface for piloting shrouds 28 and 30, surrounding discs 14 and 16, respectively, and guide vane assemblies 32 and 34. The constructional details of the compressor casing assembly are disclosed in the copending application of Walter A. Ledwith et al., Serial No. 209,556, filed February 6, 1951, now Patent No. 2,722,373 issued November 1, 1955.

The inside surface of each shroud has a lining 36 of a material having a melting temperature slightly higher than the maximum operating temperature encountered in the particular stage. It is conceivable that the complete shroud, or possibly the complete compressor casing, could be made of the material if fabrication and usage permits. In compressors having only one or a small number of stages, such materials as a fusible alloy, indium or tin could be used for the lining. With multi-stage compressors such as used in axial flow gas turbine power plants, the lining material would of necessity be one having a higher melting temperature than the material used with the first mentioned class of compressors. Cadmium, lead, zinc, aluminum-magnesium (33%) and aluminum-copper (33%) are examples of lining materials which would be satisfactory.

This invention can be used to advantage with multi-stage compressors in which each stage has a separate shroud. The lining on each shroud can be of a different material to conform with the temperature rise across the compressor. For example, if the maximum operating temperature adjacent to shroud 28 of Fig. 1 is 200° F., indium could be used as a lining material since its melting point is 320° F. If in the following stage of the compressor the maximum operating temperature adjacent to shroud 30 is 250° F., a zinc-tin alloy having a melting temperature of about 380° could be used as the lining material. Thus, by knowing the maximum operat-

ing temperature to be encountered in a particular compressor stage, a lining material which will give maximum protection against damage to the rotor and to the casing can be selected.

An additional advantage in the use of a lining material having a relatively low melting temperature is the fact that running clearances can be reduced to a minimum since there is little danger of damage to the compressor rotor or casing should rubbing occur therebetween.

The effect of rubbing is shown in Fig. 3 in which shroud 38 having lining 40 in accordance with this invention has been rubbed by the compressor rotor in the area 42. This was caused by deflection of the rotational axis of the compressor rotor from its normal position 44 to the position 46 due to a load imposed on the rotor. In this particular case the deflection was not sufficient to rub through the lining and possibly damage shroud 38. However, due to weight limitations in aircraft gas turbine power plants there is a limit to which the lining thickness must be held and a major deflection of the shaft due to the imposition of an excessively heavy load thereon possibly would cause the rotor to penetrate through the lining.

The material chosen as the lining for the compressor casing should have a melting temperature within the range of about 300° F. to about 1100° F., this being the range of melting temperatures useable in the operation of gas turbine power plant compressors. It appears that the most desirable material is a eutectic chosen for its low melting point and for its characteristic of passing from a solid state to a liquid state at the melting temperature with substantially no intermediate plastic or mushy state.

It is understood that the invention is not limited to the specific embodiment herein illustrated and described, but may be used in other ways without departure from its spirit as defined by the following claims.

I claim:

1. An axial flow compressor comprising essentially a rotor having a plurality of circumferentially extending rows of blades thereon, a casing surrounding the rotor and shrouds surrounding at least two rows of blades and forming part of said casing, in combination with a lining on at least two shrouds, at least one shroud being lined

with one lining material and at least one remaining shroud being lined with a different lining material, the lining material in each instance having a melting temperature slightly higher than the maximum operating temperature encountered adjacent to the shroud lined with said material so that the lining will readily melt under friction heat if rubbed by any of the rotor blades surrounded by said shroud.

2. An axial flow compressor comprising essentially a rotor having a plurality of circumferentially extending rows of blades thereon, a casing surrounding the rotor and shrouds surrounding rows of blades and forming part of said casing, in combination with a lining on each shroud, the lining on adjacent shrouds being of a different material and having that characteristic of a melting temperature slightly higher than the maximum operating temperature encountered adjacent to the shrouds lined with said material so that the lining will readily melt under friction heat if rubbed by any of the rotor blades surrounded by said shrouds.

3. An axial flow compressor comprising essentially a rotor having a plurality of circumferentially extending rows of blades thereon, a casing surrounding the rotor and a shroud surrounding each row of blades and mounted within the casing, in combination with a lining on each shroud, each shroud lining being of a different material and having that characteristic of a melting temperature slightly higher than the maximum operating temperature encountered adjacent to the particular shroud so that the lining will readily melt under friction heat if rubbed by any of the blades surrounded by the shroud.

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