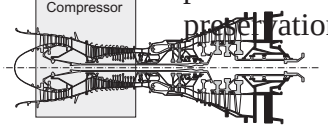
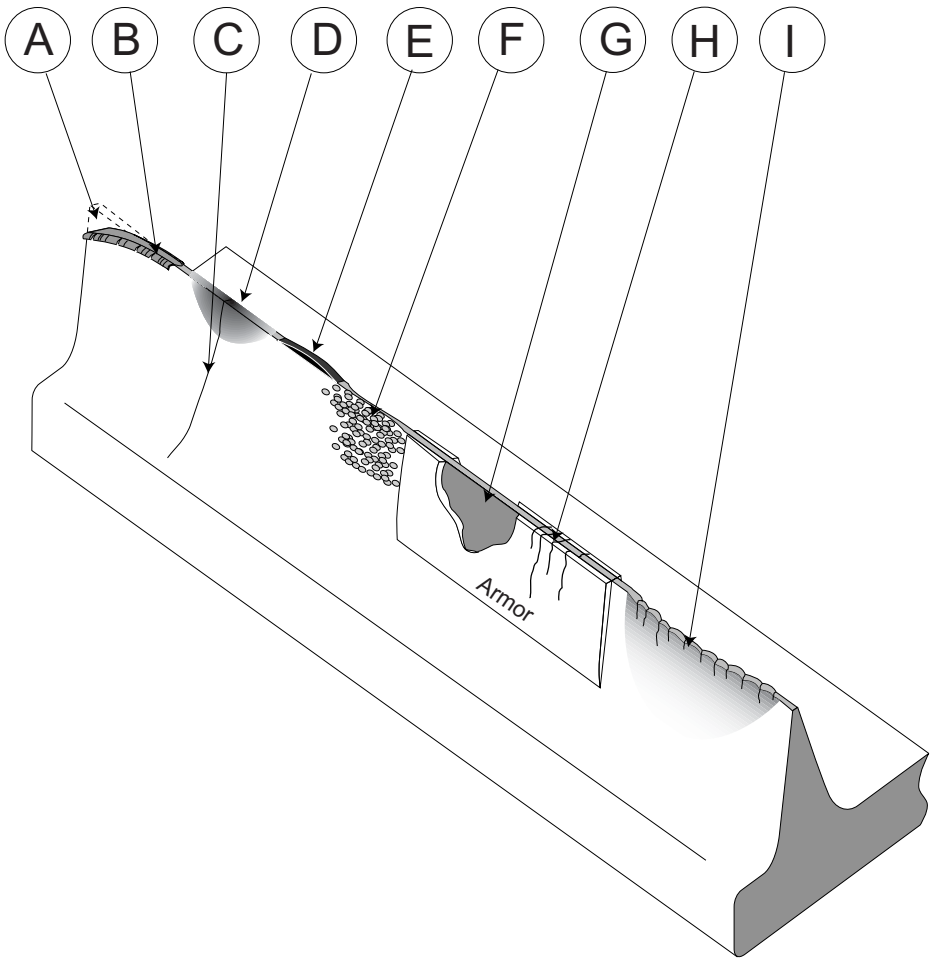


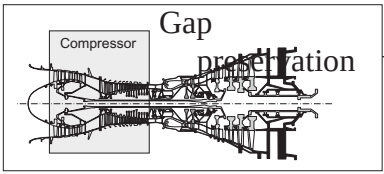
Typical damage to labyrinth fins.



Ill. 3.1.2.4-7.1

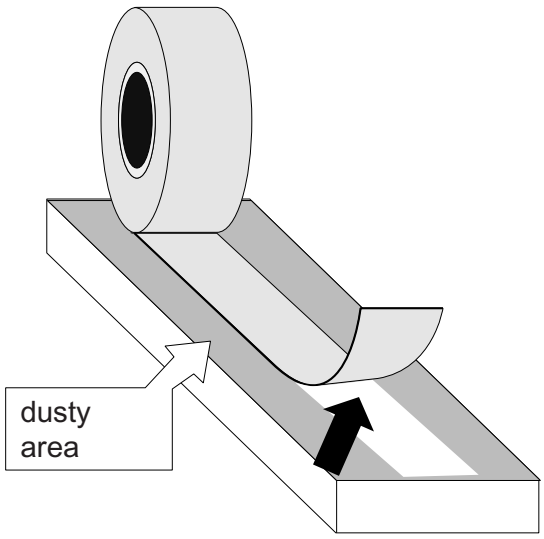
Ill. 3.1.2.4-7.1: *Characteristic,* ***load-specific damage symptoms*** *in labyrinth fins:*

The depth of the wear and the circumferential length of the wear zone depend on the ***radial infeed motion.*** *Infeed is caused by local distortion, shaft deflection, imbalances, or vibrations. Wear can occur along the entire circumference or only in a limited area. Typical symptoms in a rubbing zone are* ***burring*** *("**B**") and tarnishing or increased oxidation. These characteristics also indicate damaged sections of material (e.g., decreased hardness/strength; "**D**"). If the grain boundaries in these zones soften or melt, even small tensile stress can cause* ***hot cracks****. These cracks occur individually or in crack fields (see also "**H**"). They advance ("**C**") due to sufficiently high LCF- (thermal fatigue) or HCF-loads (labyrinth vibrations).*
*If material deposits remain on the fin (****smeared*** *"**E**"), they can increase the rubbing process to dangerous levels (Ill. 3.1.2.4-6).*

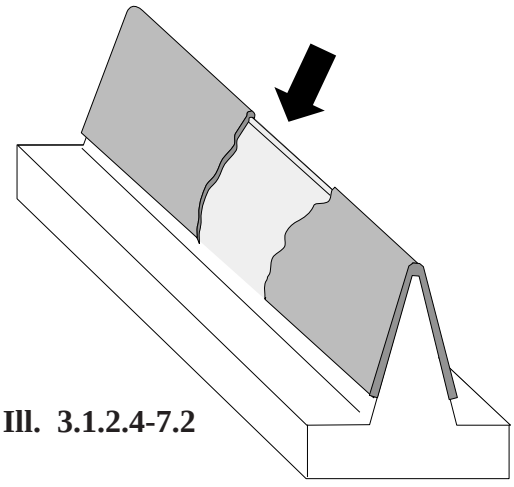


Erosion particles *in the shape of* ***spalled rub coatings*** *or removed material put erosive stress on the fins (“**F**“). The symptoms of this are similar to* ***“peppering“*** *(the impact points of the individual particles are still recognizable).*
Spalling or local delamination of ***hard-material armor*** *(e.g. Al_2O_3) is a common type of damage (“**G**“) and should be considered in connection with* ***manufacturing flaws*** *and/or* ***handling mistakes*** *(transport, mounting).*
*Not even armoring provides absolute protection against hot cracks (“**H**“). This is especially true if the armor is* ***not sufficiently cuttable*** *(which may be indicated by the coating roughness) which causes too much heat to be created in the rubbing zone (also see “**C**“).*
The labyrinth fin materials that, for example, are exposed to the hot gas flow due to the leakage air in the turbine area, must be ***sufficiently resistant to oxidation.*** *In oxidation-sensitive, highly heat-resistant materials or unsuitable welded deposits,* ***oxidation damages*** *have been observed that are similar to the* orange-peel effect *on the intake edges of overheated turbine blades (“**I**“). A typical symptom are many small cracks due to thermal fatigue caused by start-up/shut-down cycles.*

Dust is the enemy for the adherence strength of thermal spray coatings.



out-broken hard face coating
of a labyrinth tip



Ill. 3.1.2.4-7.2

Ill. 3.1.2.4-7.2: *The „**bead problem**“. This is a matter of a frequent* ***production caused*** *problem dealing with* ***debonding*** *respectively* ***breake outs*** *of* ***thermal sprayed coatings****. The effect is similar to the mechanism that accounts for a poor adherence of adhesive strips on a* ***dusty surface****. Lay* ***ricocheted*** *small solidified molten drops from the thermal spray process on the to be coated surface, the bonding strength suffers enormous. When failures of thermal sprayed coatings occur first of all is to look (scanning electronic microscope = SEM) at the debonding surface if such agglomerations of „**splash beads**“ exist.*