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(54) **Tip shroud attachment for stator vane**

(57) A stator vane segment and tip shroud segment assembly (10) comprising: a plurality of vanes (12), each having an airfoil portion 16 and a radially inner tip (20), each tip formed with at least one radially inwardly projecting tenon (18); and a tip shroud segment (26) extending over the radially inner tips of the vanes, the tip shroud segment (26) formed with a plurality of holes (28), each hole fitted with a bushing (34) that receives a respective one of the tenons (18).

jecting tenon (18); and a tip shroud segment (26) extending over the radially inner tips of the vanes, the tip shroud segment (26) formed with a plurality of holes (28), each hole fitted with a bushing (34) that receives a respective one of the tenons (18).

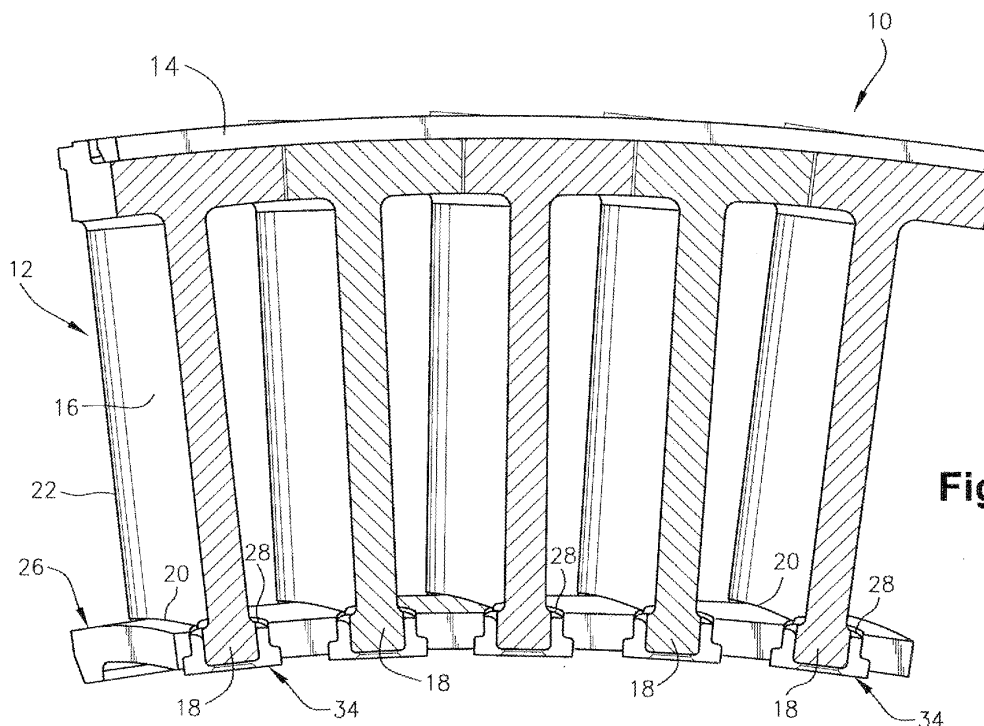


Fig. 2

Description

BACKGROUND OF THE INVENTION

[0001] This invention relates to turbine stator vanes and, particularly, to a mechanical attachment between a tip shroud segment and a group of stator vanes.

[0002] Tip shrouds on stator vanes provide a deterministic flow path for the particular stator stage, and also serve to increase the stiffness of the vanes. It is customary to assemble arcuate shroud segments over a number of vanes (e.g., 5, 7 or more), with the segments collectively forming a 360° shroud. The tip shroud segments are typically welded to the tips of the vanes.

BRIEF SUMMARY OF THE INVENTION

[0003] In accordance with an exemplary embodiment of this invention, each vane within a group of vanes to be covered by the shroud segment has a projecting tenon at its tip. The shroud segment is formed with corresponding holes that align with the tenons of the respective vanes. A bushing is seated in each of the shroud segment holes, and each bushing is formed with a center opening for receiving a respective one of the tenons. The center opening is counterbored, leaving an internal shoulder or seat for the tenon. The bushing is also formed with an external shoulder that allows the bushing to engage a shoulder surface of the corresponding shroud segment hole. This arrangement permits the bushing to be inserted into the shroud segment hole in a direction opposite the insertion direction of the vane tenons, with the external shoulder providing a stop limit to the bushing insertion. The vane tenons are subsequently welded to the internal bushing seat. Note that the bushings are not otherwise attached directly to the shroud segment but are nevertheless held in place radially by the tenon welds in one direction and the external shoulder engagement in the opposite direction.

[0004] Accordingly, in one aspect, the present invention relates to a stator vane segment and tip shroud segment assembly comprising: a plurality of vanes, each having an airfoil portion and a radially inner tip, each tip formed with at least one radially inwardly projecting tenon; and a tip shroud segment extending over the radially inner tips of the vanes, said tip shroud segment formed with a plurality of holes, each hole fitted with a bushing that receives a respective one of the tenons.

[0005] In another aspect, the invention relates to a stator vane segment and tip shroud segment assembly comprising: a plurality of vanes, each having an airfoil portion and a radially inner tip, each tip formed with at least one radially inwardly projecting tenon; a tip shroud segment extending over the radially inner tips of the vanes; the tip shroud segment formed with a plurality of holes, each hole fitted with a bushing that receives a respective one of the tenons; wherein the bushing is formed with an internal shoulder on which the respective tenon is seated;

and wherein each bushing is formed with an external shoulder engaged by the tip shroud segment.

[0006] In still another aspect, the invention relates to a stator vane segment and tip shroud segment assembly comprising: a plurality of vanes, each having an airfoil portion and a radially inner tip, each tip formed with at least one radially inwardly projecting tenon; a tip shroud segment extending over the radially inner tips of the vanes, the tip shroud segment formed with a plurality of holes, each hole fitted with a bushing that receives a respective one of the tenons; wherein each bushing is formed with an external shoulder engaged by the tip shroud; and wherein each bushing is formed with a center hole counterbored to provide an internal shoulder that provides a seat for the respective tenon and wherein the tenon is welded to the bushing at the internal shoulder.

[0007] Embodiments of the invention will now be described, by way of example only, in connection with the drawings identified below.

BRIEF DESCRIPTION OF THE DRAWING

[0008]

FIGURE 1 discloses a perspective view of a shrouded stator vane segment in accordance with an exemplary embodiment of the invention;

FIGURE 2 is a cross-section taken along the line 2-2 of Figure 1;

FIGURE 3 is a partial cross-section taken along the line 3-3 in Figure 1;

Figure 4 is a perspective view of another exemplary embodiment of the invention; and

Figure 5 is an enlarged detail similar to Figure 3 but taken from the assembly shown in Figure 4; and

Figure 6 is a perspective view of still another embodiment of the invention.

DETAILED DESCRIPTION OF THE DRAWINGS

[0009] With reference initially to Figures 1-3, a stator vane and tip shroud segment assembly 10 includes a plurality of stator vanes 12, each of which includes a dove tail mounting portion 14, an airfoil portion 16, and a radially projecting tenon 18 (Figure 2) that projects from the radially inner tip 20 of the vane. Typically, the tenon 18 is round or oval in cross section and is formed approximately intermediate the forward and trailing edges 22, 24 of the airfoil portion.

[0010] An arcuate tip shroud segment 26 spans and is attached to a selected member of stator vanes 12, such that the collective stator vane and tip shroud segments will form a 360° stator assembly.

[0011] The arcuate tip shroud segment 26 is formed with a plurality of holes 28 that are appropriately located to align with the stator tenons 18. As best seen in Figure 3, the holes 28 are counterbored in a radially outward direction to create a radially inwardly facing shoulder 30 that is adapted to be engaged by a corresponding radially outwardly facing shoulder 32 on a bushing 34. The bushing 34 is correspondingly shaped to be received in the segment hole 28 (i.e., round or oval), and, as already indicated above, is formed with an external shoulder 32 that engages the corresponding shoulder 30 on the arcuate tip shroud segment 26. The bushing 34 is also formed with a center opening 36 that is counterbored to provide an annular (or oval)-shaped, radially outwardly facing seat 38 that is adapted to be engaged by the marginal edge of a respective tenon end face 40.

[0012] With the bushings 34 inserted in the segment holes 28 in direction A (Figure 3), the airfoil tenons 18 are inserted into the bushing in direction B until the tenons are fully engaged with the seats 38. Subsequently, each airfoil tenon 18 is fixed to the bushing at the seat 38 by weld 42. It is significant that the bushing is not otherwise fixed to the tip shroud segment 26. As a result, some degree of movement between the airfoil portion 16 and the tip shroud segment 26 is permitted via bushing 34, thereby reducing stresses during operation. Note that the bushing is recessed relative to the radially inner face of the shroud segment so as not to protrude into the gas flowpath

[0013] In the exemplary embodiment, the bushing may be constructed of 316 Stainless Steel while the airfoil portion 16 (including the tenons 18) and the tip shroud segment 26 may be constructed of a harder 403 Stainless Steel, but the material compositions may vary.

[0014] Figures 4 and 5 illustrate another embodiment of a vane and tip shroud segment assembly 110 where the shapes of the tip shroud segment, bushing, and airfoil tenon as shown vary somewhat from the embodiment shown in Figures 1-3. Otherwise, the components and the interaction between the tip shroud segment, airfoil portion and bushing remains as previously described. For convenience, similar reference numerals are used, but with the prefix "1" added, to designate corresponding features, but no further description is required.

[0015] Figure 6 illustrates another vane segment configuration that incorporates the subject invention. In this figure, similar reference numerals are used to designate similar components, where applicable, but with the prefix "2" added. The vane and tip shroud segment assembly 210 incorporates bushings 234 as described in connection with Figures 1-3 and this aspect of the assembly need not be repeated here. In this embodiment, the portion (or dovetail mounting portions) 214 of the vanes are ganged together via a strap 244 and a plurality of bolts 246.

[0016] In an alternative arrangement that does not require welding, the tenons could be formed with subtenons that project beyond the tenon end face and the extended

subtenon may then be cold formed about the bushing end face. In yet another variation, the tenon could be formed with a tapped hole with a bolt passing through the center opening of the bushing and into a threaded hole in the tenon.

[0017] While the invention has been described in connection with what is presently considered to be the most practical and preferred embodiment, it is to be understood that the invention is not to be limited to the disclosed embodiment, but on the contrary, is intended to cover various modifications and equivalent arrangements included within the spirit and scope of the appended claims.

Claims

1. A stator vane segment and tip shroud segment assembly (10) comprising:
 - a plurality of vanes (12), each having an airfoil portion 16 and a radially inner tip (20), each tip formed with at least one radially inwardly projecting tenon (18); and
 - a tip shroud segment (26) extending over the radially inner tips (20) of the vanes, said tip shroud segment (26) formed with a plurality of holes (28), each hole fitted with a bushing (34) that receives a respective one of said tenons (18).
2. The assembly of claim 1 wherein said tenons (18) are attached directly to said bushings (34).
3. The assembly of claim 1 wherein said bushing (34) is formed with an internal seat (38) on which the respective tenon is seated.
4. The assembly of claim 1 wherein each bushing (34) is recessed relative to a radially innermost surface of said tip shroud segment (26) such that said bushing does not protrude into a flowpath along the airfoil portions of the vanes (12).
5. The assembly of claim 3 wherein each bushing (34) is recessed relative to a radially innermost surface of said tip shroud segment (26) such that said bushing does not protrude into a flowpath along the airfoil portions of the vanes (12).
6. The assembly of claim 1 wherein each bushing (34) is formed with an external shoulder (32) engaged by said tip shroud segment (26).
7. The assembly of claim 3 wherein each bushing (34) is formed with an external shoulder (32) engaged by said tip shroud segment (26).
8. The assembly of claim 1 wherein each bushing (34)

is formed with a center hole counterbored to provide an internal shoulder that provides a seat (38) for the respective tenon (18) and wherein said tenon (18) is welded to said bushing at said internal shoulder.

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9. The assembly of claim 2 wherein said bushings (34) are not otherwise attached to said tip shroud segment.

10. The assembly of claim 1 wherein said tenons (18) are welded to said bushings.

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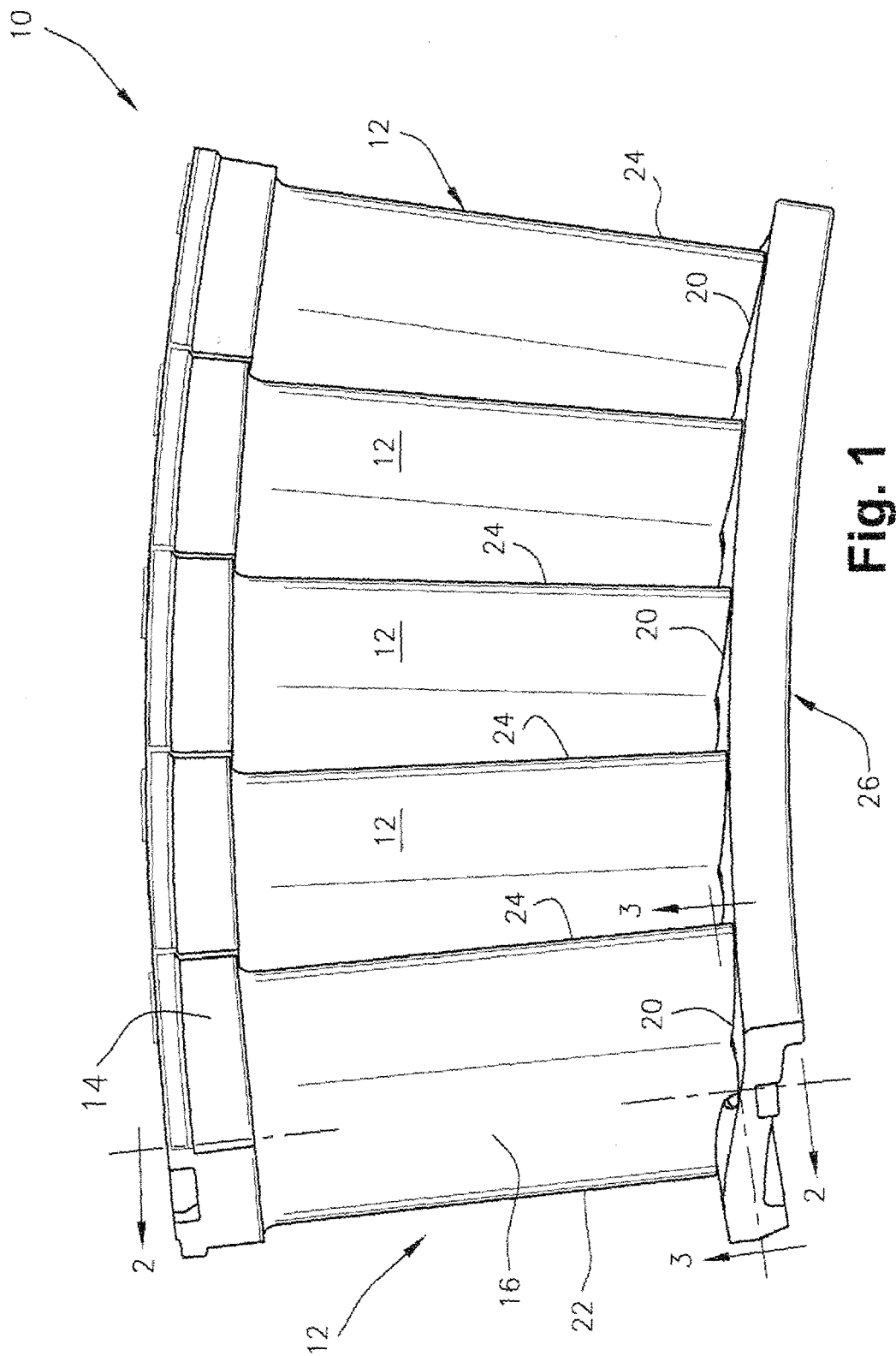
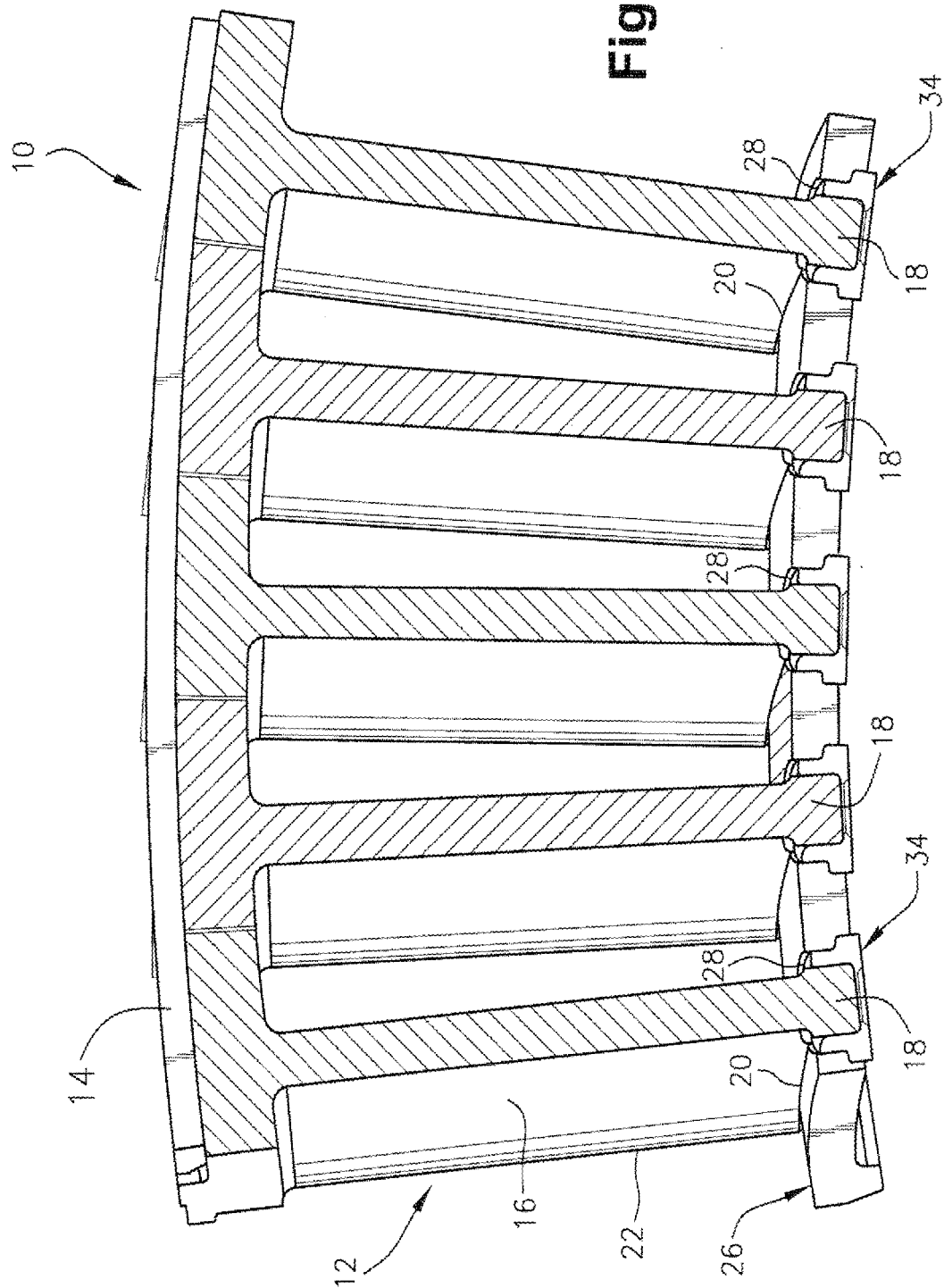


Fig. 2



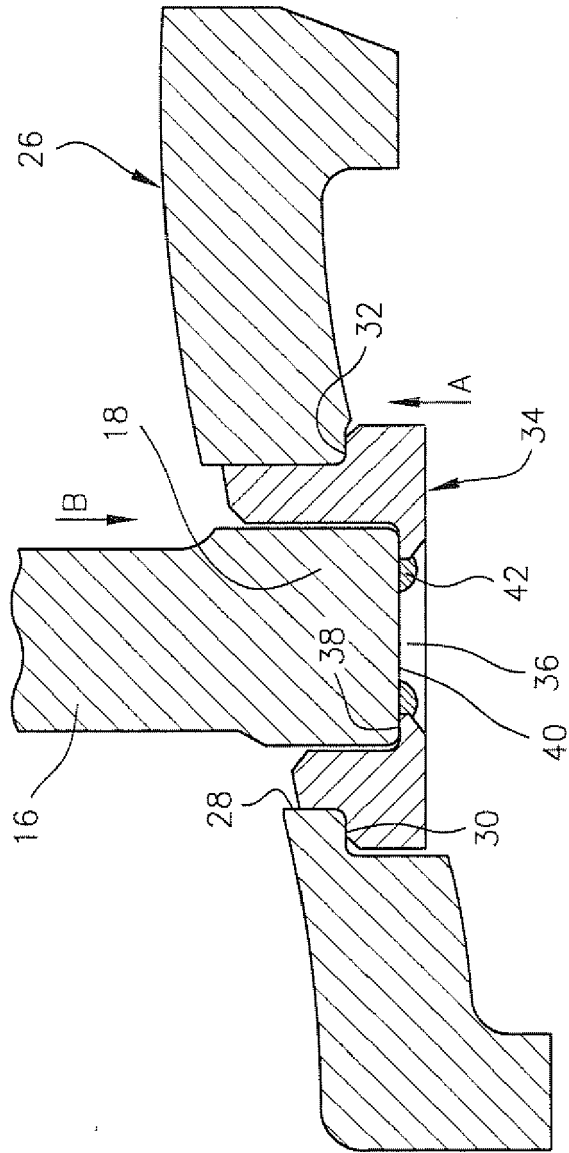


Fig. 3

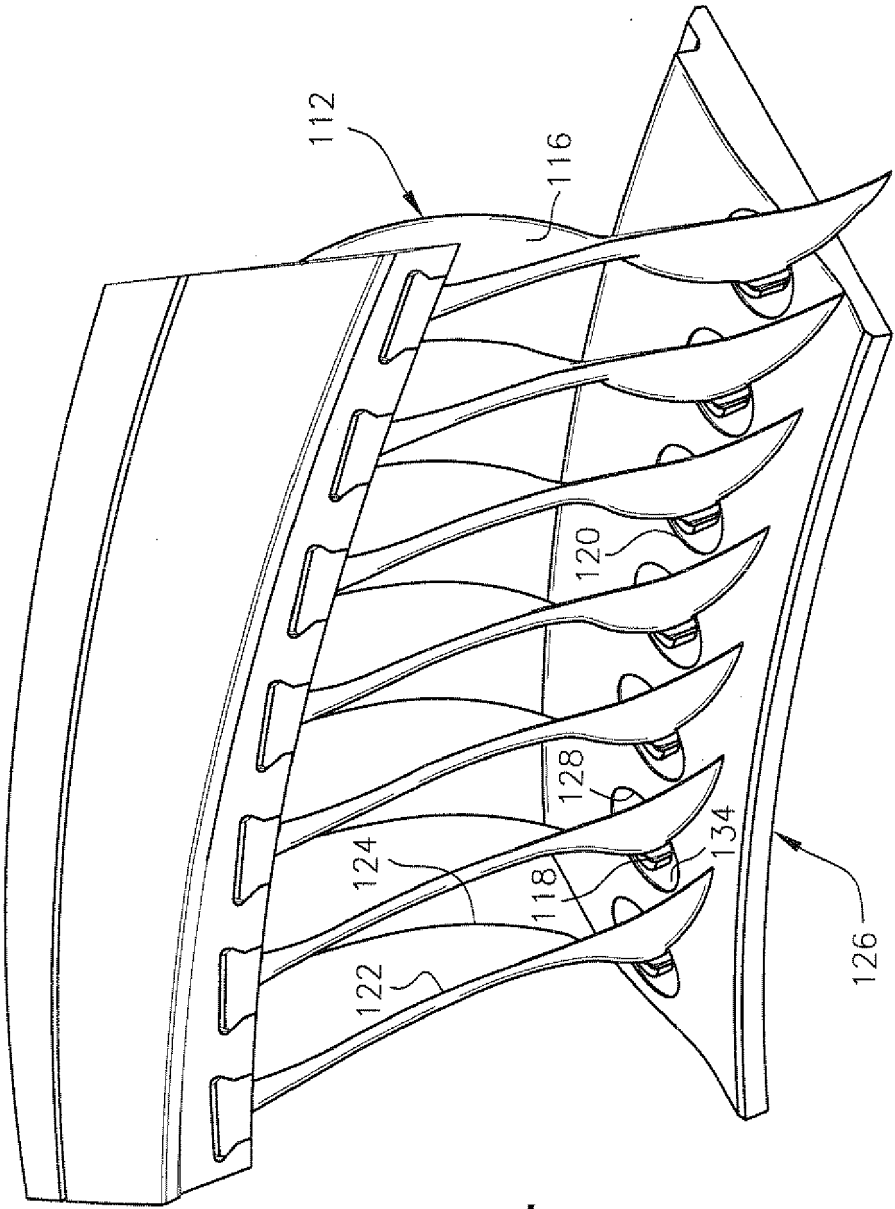
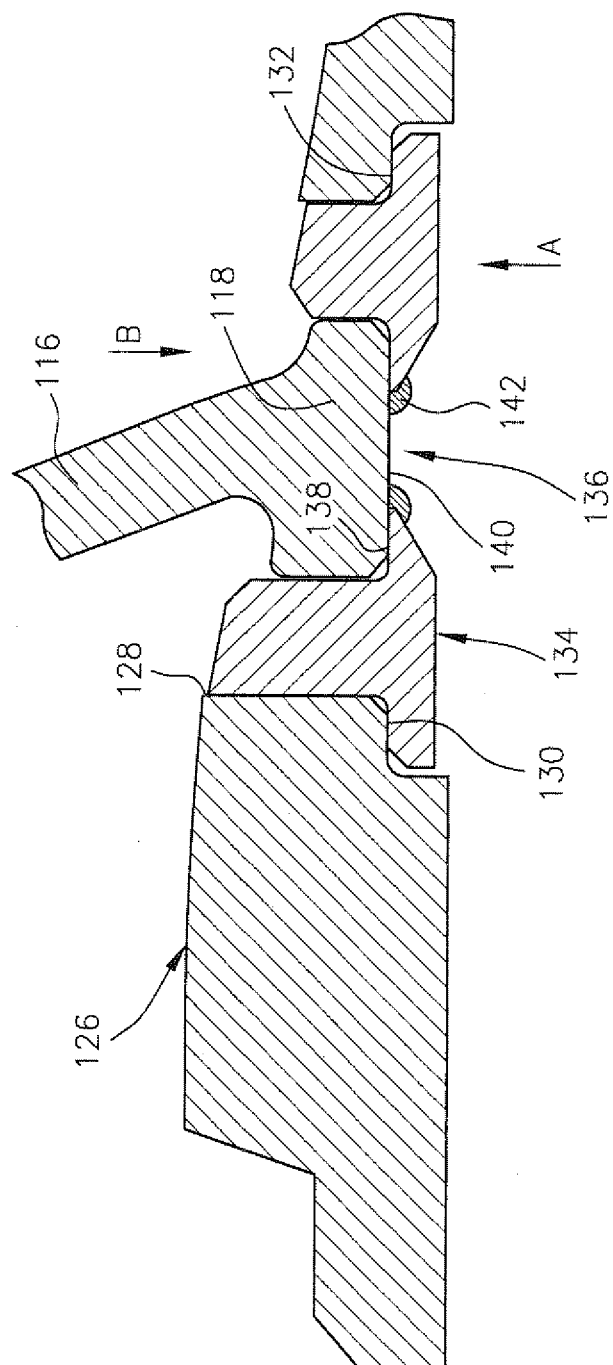
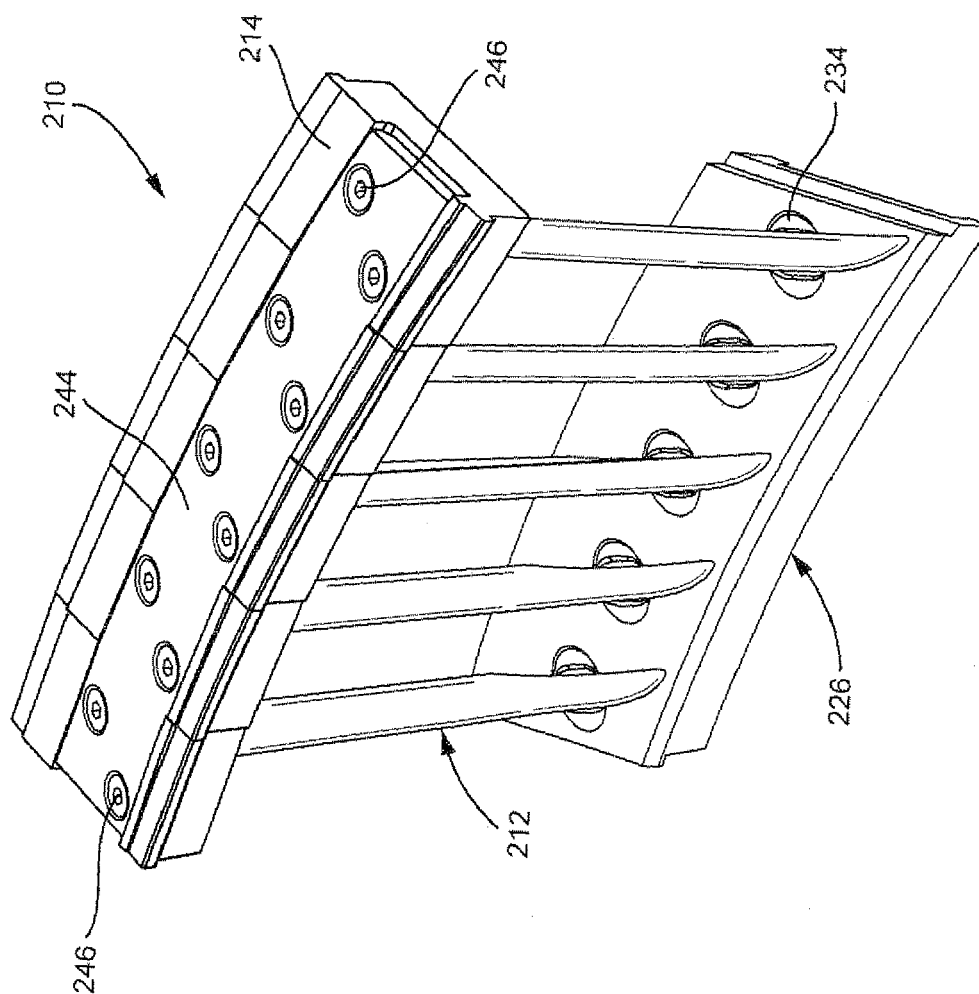


Fig. 4



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Fig. 6





European Patent
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EUROPEAN SEARCH REPORT

Application Number
EP 06 12 4935

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Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
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X	EP 1 205 638 A2 (GEN ELECTRIC [US]) 15 May 2002 (2002-05-15) * paragraphs [0019], [0020]; figures 3-5 *	1,2,7	
			TECHNICAL FIELDS SEARCHED (IPC)
			F01D
The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 28 February 2007	Examiner OECHSNER DE CONINCK
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document		T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document	

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EPO FORM 1503 03.82 (P04C01)

**ANNEX TO THE EUROPEAN SEARCH REPORT
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EP 06 12 4935

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
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