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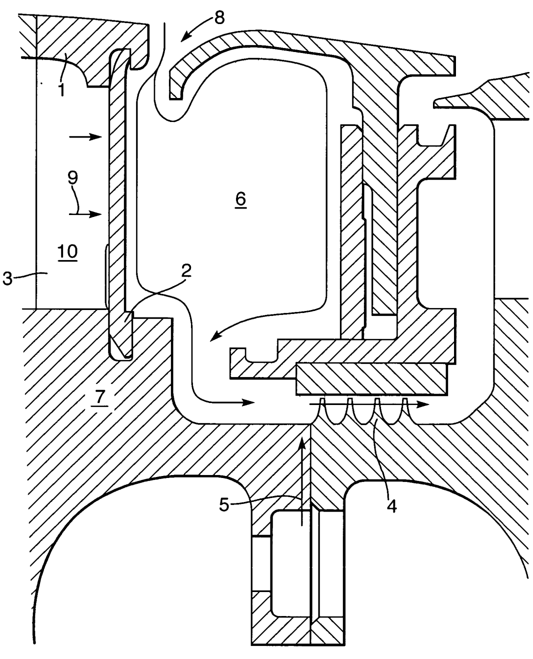
(54) Side plate

(57) In gas turbine engines it is found that leaked coolant flow through the lock plates 28, 29, 50, 60 can be used to insulate the rotor surfaces 33, 34 from the effects of hot gas ingestion. In order to enhance this effect chutes 39, 59, 69 are provided to guide the leakage airflow adjacent to the lock plate such that the ingested hot gas flow is prevented from coming into contact with the surfaces of the lock plate and other cavity surfaces 33, 34 to improve cooling effect. The chutes 39, 59, 69 create apertures 40, 53 which can be of dimensions to ensure that there is a high ratio between width and depth of the coolant flow 32 again facilitating heat exchange and cooling efficiency.

Fig.2.



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Description

[0001] The present invention relates to turbine engine cooling and more particularly to cooling with respect to the hot turbine stages of a gas turbine engine about the turbine blade mountings between turbine stages.

[0002] Referring to Fig. 1, a gas turbine engine is generally indicated at 10 and comprises, in axial flow series, an air intake 11, a propulsive fan 12, an intermediate pressure compressor 13, a high pressure compressor 14, combustion equipment 15, a high pressure turbine 16, an intermediate pressure turbine 17, a low pressure turbine 18 and an exhaust nozzle 19.

[0003] The gas turbine engine 10 works in a conventional manner so that air entering the intake 11 is accelerated by the fan 12 which produce two air flows: a first air flow into the intermediate pressure compressor 13 and a second air flow which provides propulsive thrust. The intermediate pressure compressor compresses the air flow directed into it before delivering that air to the high pressure compressor 14 where further compression takes place.

[0004] The compressed air exhausted from the high pressure compressor 14 is directed into the combustion equipment 15 where it is mixed with fuel and the mixture combusted. The resultant hot combustion products then expand through, and thereby drive, the high, intermediate and low pressure turbines 16, 17 and 18 before being exhausted through the nozzle 19 to provide additional propulsive thrust. The high, intermediate and low pressure turbine 16, 17 and 18 respectively drive the high and intermediate pressure compressors 14 and 13, and the fan 12 by suitable interconnecting shafts.

[0005] It will be appreciated from above that the turbine blades require appropriate mounting in order to allow rotation for operational performance in creating a propulsive axial gas flow, but also that the blades must be appropriately cooled. It will be understood that turbine engine efficiency is closely related to operational temperatures and that acceptable operational temperatures are dictated to a significant extent by the material properties of the components. In such circumstances by appropriate cooling it is possible to operate these components near to and occasionally exceeding the melting points for the materials for which they are constructed.

[0006] In order to provide cooling, generally coolant air is taken from the compressor stages of a gas turbine engine. Thus, this drainage of compressed coolant air reduces engine efficiency. It is an objective to utilise coolant air flows as effectively as possible in order to minimise the necessary coolant flow to achieve a desired level of component cooling for operational performance. In such circumstances generally there are relatively intricate coolant passageways provided within the engine components which are arranged to provide cooling as the coolant passes through these passages as well as provide generally nozzle projection of the coolant flows where required into cavities in order to create turbulence with hot gas flows for a cooling diluted effect.

[0007] Fig. 2 illustrates a schematic cross-section of a prior cooling arrangement as a schematic cross-section. Thus a blade root 1 forms a shank with a locking plate 2 presented across the root 3 of the blade. With a gas turbine engine, banks of turbine blades are provided and it is necessary to provide sealing between each turbine stage of the engine. Thus, seals 4 are provided in the form of a labyrinth seal arrangement with coolant airflow in the direction of arrowhead 5 presented upwardly into the cavity 6 formed between the mounting disc 7 for the blade 1 and the bottom of a nozzle vane defining the turbine stages. As can be seen there is a gap 8 through which hot gas is ingested to the cavity 6. It is found that cooling air leakage flow 9 generally creates a barrier layer around the surfaces of the cavity 6 particularly on the rotor surface. Previously, the coolant air 5 has been arranged to prevent excessive hot gas ingestion 8.

[0008] The lock plate acts to secure location of the blade shank such that coolant flow is contained or at least restricted below the blade shank. It will be appreciated that as described in US patent no. 6290464, an area 10 adjacent the lock plate is typically of what is known as a fir tree root nature and designed to allow coolant air to flow across it at its surface and possibly through passages (not shown) in the fir tree root in order to provide cooling. As turbine engines rotate about a central shaft they are inherently circumferential and it is therefore necessary that the lock plate is segmented. In such circumstances the gaps between the lock plates allow coolant leakage into the cavity. US 629464 describes provision of an outlet nozzle in order to project coolant flow through the fir tree root coolant passages into such a cavity in order to create turbulence and therefore cooling within that cavity. Such an approach does not utilise the boundary layer created by the lock plate leakage to protect the disc rim from ingestion of hot gas through the gap.

[0009] In accordance with the present invention there is provided a lock plate for a blade mounting assembly within a gas turbine engine, the lock plate integrally shaped to form a chute for direct outward marginal flow across the lock plate for presentation of a coolant flow substantially in alignment with the lock plate.

[0010] Typically, the chute is formed in an end of the lock plate. Alternatively, the chute is formed intermediately between ends of the lock plate. Alternatively, the chute is formed by a passage shaped within the width of the lock plate.

[0011] Generally, the chute extends substantially across the width of the lock plate. Possibly, the chute varies in dimensions dependent upon temperature.

[0012] Normally, the lock plate is formed by casting or moulding or machining.

[0013] Possibly, the lock plate incorporates spacer protrusions upon at least one end in order to provide regulation of spacing between adjacent lock plates in use.

[0014] Also in accordance with the present invention there is provided a plate mounting arrangement for a gas turbine engine, the arrangement comprising a lock plate associated with a mounting disc for a plurality of turbine blades, the lock plate defined as above.

[0015] Normally, a plurality of lock plates are provided in alignment about a mounting disc to form a circumferential barrier.

[0016] Generally, the chute is configured to co-operate with an overflow in order to retain the coolant flow adjacent to the lock plate.

[0017] Embodiments of the present invention will now be described by way of example only with reference to the accompanying drawings in which;

Figure 3 is a schematic perspective view of a blade mounting incorporating a lock plate arrangement in accordance with the present invention;
Figure 4 is a schematic perspective view illustrating adjacent lock plates in accordance with the present invention;
Figure 5 is a front perspective view in the direction X of a lock plate as depicted in Figure 3;
Figure 6 is a schematic plan view of the lock plate arrangement depicted in Figure 3 in the direction of arrowhead Y;
Figure 7 is a schematic front perspective of an alternative lock plate in accordance with the present invention;
Figure 8 is a front perspective view of the lock plate depicted in Figure 6 in the direction of arrowhead Z;
Figure 9 is a schematic cross-section in the direction of A-A of a lock plate depicted in Figures 6 and 7; and
Figure 10 is a schematic front perspective view of a further refinement of a lock plate in accordance with the present invention.

[0018] Those knowledgeable with respect to lock plates utilised within gas turbine engines will understand that it is not possible to provide a complete barrier seal between lock plates. A number of lock plates are required in order to create the circumferential barrier seal around a mounting disc for turbine blades and the junctions of these plates will lead to varying degrees of coolant air leakage.

[0019] Recent behavioural studies have indicated that cooling air emerging from lock plate type gaps into a turbine stator cavity 6 (Fig. 2) in the presence of a net gas ingestion at the rear of a turbine mounting disc has beneficial effects with respect to cooling. Net gas ingestion occurs when the flow requirement of an inter-stage labyrinth seal exceeds the supply of cooling air to the upstream stator well, that is to say resulting in a supplementary flow drawn from the turbine main annular gas flow drawn through the gap between the rotor and stator platforms.

[0020] Observation of this cooling air and gas ingestion has shown that the leakage air from the lock plate is retained within a disc rim boundary layer having a disproportionately beneficial effect on disc rim cooling when hot air ingestion is also present. Thus, there is a relatively enhanced effective cooling of the rotor by a relatively small coolant air supply provided by that lock plate to lock plate end gap leakage. Unfortunately, this leakage as indicated previously is variable with prior arrangements. Nevertheless, by providing more regulation with respect to this leakage it will be possible to provide significant savings in cooling air supply compared with more traditional approaches.

[0021] The process by which the coolant air acts is as a result of jets of higher pressure cooling air emerging from the lock plate between the lock plate end faces into the stator well cavity at the rear of a disc rim. This coolant air is held within the boundary layer travelling radially inwards towards the labyrinth seal rather than penetrating through the boundary layer. Clearly, coolant air retained adjacent to the cavity wall surfaces will have an enhanced effect with respect to cooling. It will also be understood that this effect increases the relative amount of coolant air and reduces the amount of annulus gas in the boundary layer significantly again maintaining relatively low local temperatures. For information and as indicated above, it was previously considered necessary to assume a thorough mixing of the ingested hot annulus gas and the cooling air for cooling effectiveness.

[0022] It will be understood that hot gas ingestion occurs whenever the cooling flow supplied to the rim gap is less than the critical value required to seal the rim gap. In the case of an inter-stage seal cavity where the labyrinth seal clearance is such that the cooling flow is drawn off to the lower pressure "sink", downstream of the stage nozzle guide vane, leaving the gap at the rear of the upstream rotor short of the necessary flow requirements to create the seal at the annulus. Thus, as engines complete more and more service cycles and the inter-stage seals tend to wear there is also an increase in the clearances and redistributing the normally fixed level of coolant flow towards the rear stator well. This increases the risk of hot gas ingestion in the front of the well.

[0023] It will be understood that cooling is a safety as well as operational priority so there is a requirement to ensure that there is always sufficient cooling air supply even when worst wear clearances are experienced. There is a balance between the cooling supply and hot gas ingestion dependent upon many factors including the static pressure in the gas turbine annulus, the losses in the cooling air feed system, any flow dependent on a vortex, rotating hole, clearance diameters or seal clearance subject to a combination of rotor speeds, the main annulus pressure ratios and transient effects such as seal clearances. In such circumstances, a range of conditions over which hot gas ingestion may occur and the level of ingestion will certainly vary. However, since entrainment flow is speed dependent, engines are normally most vulnerable at maximum shaft speeds.

[0024] Prior sealing systems deliver the bulk of the rim sealing air flow via radial holes in a disc drive arm. In addition to not making best use of the air flow cooling the disc rim, considerable work is put into the air to accelerate it to the speed of the rotor. This has a negative effect upon turbine efficiency. Thus, as the present invention utilises less cooling air it will be appreciated that less cooling air will require acceleration to the rotor speeds. Additionally, a significant proportion of the work done in accelerating the air to the speed of the rotor is recovered by directing the cooling air against the direction of rotation.

[0025] As indicated above it is necessary to regulate and meter the leakage flow between the lock plates in order to take full advantage of the boundary layer cooling effects. Thus, spacer protrusions are used in accordance with the present invention in order to regulate the gap between the ends of the lock plates. In such circumstances, there is a coolant leakage flow through the gaps between the lock plates and as described previously this is retained adjacent to the cavity wall even in the presence of the hot gas ingestion effect described above. It will be appreciated that chutes may also be provided in order to further enhance this leakage coolant air flow adjacent to the cavity wall.

[0026] Referring to Fig. 3 and as indicated above, the ingested hot gas drawn about the aligned lock plates 28, 29 is known to retain a leaked coolant flow 32 adjacent to the lock plates 28, 29. In such circumstances, utilisation of the coolant flow 32 should be optimised. In order to achieve this chutes 39 are provided. These chutes 39 act to direct the leakage flow 32 effectively adjacent to the lock plates 28, 29 both in terms of release of that flow 32 as well as protecting the rotor surfaces 33, 34 from the hot gas ingestion 35. By having the coolant flow adjacent to the wall surfaces of the lock plates 28, 29 as well as walls 33, 34 of the cavity 38 it will be understood that greater cooling effects with respect to the components forming these walls is achieved.

[0027] In contradiction to previously understood processes avoidance of turbulence is required in order to maintain the flow 32 adjacent to the lock plates 28, 29 as well as the wall surfaces 33, 34. Thus, the chutes 39 are arranged to have an aperture 40 which extends over a substantial proportion of the width of the lock plates 28, 29 such that there is limited jetting which may create turbulence. Furthermore, these chutes 39 are shown in the form of an incline or ramp created in the lock plates 28, 29 to allow the cooling airflow 23 to be introduced into the stator well cavity 38 in the most beneficial direction and for smooth deflection of hot gas flow 35 away from the rotor surfaces 33, 34. The lock plates 28, 29 will generally be formed by a casting or moulding or machining process in order to create the necessary chute for flow 32 to be retained within the disc boundary layer.

[0028] As depicted in Figure 3 generally the chutes 39 will be formed towards a rear end of the lock plates 28, 29 that is to say downstream of the rotation direction 25 for the arrangement. However, as will be described later, chutes may be formed between the ends of the lock plates as required by operational performance.

[0029] Referring to Figures 4 to 6 illustrating a lock plate arrangement in accordance with the present invention. Thus, a lock plate 50 is associated with a lock plate 51 such that respective ends abut each other at a joint 52. As indicated previously this joint is not perfect and therefore in use will tend to leak a coolant flow as described in Figure 1 by reference to arrowheads 32. Chutes 59 are provided at the ends of the lock plates 50, 51 generally downstream of the direction of rotation (arrowhead 55). The chutes 59 are formed such that a ramp effect is created to divert the ingested hot flow as described previously and provide an opening or aperture 53 for presentation of the coolant airflow 32 (Figure 3). The chutes 59 are integral with the lock plates 50, 51 and as indicated above are generally formed during a moulding or casting process.

[0030] Figure 5 illustrates the downstream end of the lock plate 50 in the direction X (Figure 4). Thus, the aperture 53 creates a flow passage for the coolant flow 32 (Figure 3) by outwards projection from an adjacent lock plate illustrated by broken line 54. In such circumstances, if coolant flow is projected out of the aperture 53 adjacent to that lock plate 54 and as described previously the effect of the ingested hot gas flow 35 (Figure 2) is to retain that flow adjacent to the lock plate 51 and other surfaces downstream.

[0031] It will be noted that the aperture 53 extends through a substantial proportion of the width of the lock plate 50 to again maximise the width of the coolant flow 32 (Figure 3) in comparison with the depth, that is to say the extent by which the flow 32 extends from adjacent to the surface of the lock plate 34. It will be understood that a thin coolant flow 52 relative to depth will substantially increase the "contact surface" between that flow 32 and the disc surfaces 33, 34 increasing cooling efficiency. Such spreading of the flow can be considered to create a marginal cooling flow layer adjacent to the component surfaces to be cooled.

[0032] Figure 6 provides a schematic plan view of the junction 52 between lock plates 50 and 51. Thus, the chute 59 extends outwardly along the aperture 53 through which the coolant air flow 132 passes. It will be noted that this flow 132 remains relatively close to a wall surface 56 for cooling efficiency. As described previously, ingested hot gas flow 135 passes over the chute 59 and constrains the flow 132 as a barrier layer adjacent to the surface 56 again to facilitate cooling efficiency.

[0033] The actual dimensions of the chute 59 will be determined by considerations as to the desired presentation of the flow 132 and the potential flow disturbing effects of the chute 59 upon the overlaying ingested flow 135. Nevertheless, as described above, generally the chute 59 will extend across a substantial proportion of the width of the lock plates to ensure a high width to depth ratio for the flow 132 maximising insulation effectiveness.

[0034] As indicated above there is a general leakage about the junction between lock plates and observation has noted that this leakage is retained in a boundary layer adjacent to the lock plate. Thus, Figures 7 to 9 illustrate an alternative embodiment of the present invention in which a chute 69 is formed within the width of a lock plate 60. In effect this chute 69 is a specifically shaped and formed slot formed in the lock plate 60 such that there is no surface protrusion whilst the chute 69 turns a coolant flow 232 for entrainment insulating the rotor surfaces 33, 34 from an ingested hot gas flow 235 as described previously. The chute 69 is shaped to meter and regulate the coolant flow 232 such that this flow expands efficiently using the pressure drop across the lock plate 60. In such circumstances the hot gas ingestion flow 235 is kept away from the disc surfaces 33, 34 with the coolant flow 232 forming a barrier flowing adjacent to a surface 66 of the lock plate 60 for best cooling effect. As previously the chute 69 extends substantially across the width W-W of the lock plate 60 to increase the potential barrier to hot gas ingestion on the rotor surfaces.

[0035] Most conveniently the slot 69 is forwarded by casting the lock plate 60 and then finalising the shape of that chute 69 through machining processes. Dependent upon requirements more than one intermediate chute can be provided in a lock plate in accordance with the present invention. Care must be taken with respect to the pressure differential utilised in order to generate coolant flow.

[0036] As indicated above it is provision of a relatively smooth coolant flow which can remain attached to surfaces for insulating effect under the blanketing flow of the ingested hot gas which provides the particular benefit and improving overall cooling efficiency relative to the volume of coolant used. In such circumstances spaces and protrusions can be utilised in order that the gap between the lock plates is regulated such that the coolant that flows through the gap is consistent and therefore can reduce the effects of the ingested hot gas flows. Figure 10 illustrates several lock plates 90 between which spacer protrusions 91 act to regulate the gap 92 between the ends of the lock plates 90. In such circumstances a regulated gap 92 is provided through which the leakage coolant flow can be presented to the rotor surface 33 and 34 Fig. 3 and through use of the spaces 91 this gap 92 can be consistent throughout the circumferential barrier created by the lock plates 90 of a gas turbine engine. Intermediate chutes 93 can be provided in order to refresh the coolant flow at intermediate positions between the ends of the lock plates 90 again with consistent cooling effect and efficiency.

[0037] It will be understood that the spacer protrusions 91 generally take the form of pips which prevent chocking and provide a controlled minimum gap 92. This gap 92 allows cooling air into the stator wall cavities etc. for cooling purposes as described previously adjacent to walls with those cavities.

[0038] As can be seen in Figure 3 spacer protrusions 31 can also be provided with respect to chutes formed at the ends of lock plates 28, 29 in order to again facilitate and regulate the coolant air flow 32 presented by the chutes 39. In these circumstances the spacer protrusions 31 are generally positioned towards the side edges of the ends of the lock plates 28, 29 to allow accommodation of the relatively broad chutes 39.

[0039] The spacer protrusions 31 may enter dimples in the opposed lock plate surface for location purposes.

[0040] Modifications and alterations to the embodiments of the present invention will be envisaged by those skilled in the art. Thus, with respect to chutes 39, 59 it may be possible to create an overhang which extends beyond the end of the lock plate in order to lay over a portion of the adjacent lock plate in order to further facilitate coolant flow presentation for retention adjacent to the lock plate surface and other wall surfaces of the turbine engine for cooling purposes.

Claims

1. A lock plate (28, 29; 50, 51; 60; 90) for a blade mounting assembly within a gas turbine engine, the lock plate **characterised by** being integrally shaped to form a chute (39, 59, 69) for direct outward marginal flow across the lock plate for presentation of a coolant flow (32; 132; 232) substantially in alignment with the lock plate.

2. A plate as claimed in claim 1 wherein the chute is formed in an end (37) of the lock plate.

3. A plate as claimed in claim 1 wherein the chute (59) is formed intermediately between ends of the lock plate (50, 51) .

4. A plate as claimed in claim 1 wherein the chute is formed by a slot (40, 53) shaped within the width of the lock plate.

5. A plate as claimed in any preceding claim wherein the chute 39 extends substantially across the width of the lock plate.

6. A plate as claimed in any preceding claim wherein the chute varies in dimensions dependent upon temperature.

7. A plate as claimed in any preceding claim wherein the lock plate is formed by casting or moulding or machining.

8. A plate as claimed in any preceding claim wherein the lock plate incorporates spacer protrusions (91) upon at least

one end in order to provide regulation of spacing (30) between adjacent lock plates in use.

9. A lock plate for a blade mounting assembly within a gas turbine engine substantially as hereinbefore described with reference to the accompanying drawings.

10. A lock plate mounting arrangement for a gas turbine engine, the engine comprising a plurality of blades (21) secured by lock plates (28, 29, 50, 51, 60, 90) in a mounting (22) whereby there is a coolant leakage flow 32, 132, 232) in use and an ingested hot gas flow 35, 135 about the blades (21) by the operational function of the blades, the arrangement **characterised by** the lock plates associated with the mounting for the plurality of turbine blades, being as claimed in any preceding claim, and the chute (39, 59, 69) being arranged to present the coolant flow (32, 132, 233) adjacent the lock plates for insulating the rotor surfaces 33, 34 from the effects of hot gas ingestion 35.

11. An arrangement as claimed in claim 10 wherein the plurality of lock plates are provided in alignment about a mounting disc to form a circumferential barrier.

12. An arrangement as claimed in claim 10 or claim 11 wherein the chute is configured to minimise the effect of the ingressed hot gas flow by retaining the coolant flow adjacent to the rotor surfaces 33, 34.

13. An arrangement as claimed in any of claims 10 to 12 wherein the chute extends over an edge of an adjacent lock plate.

14. A gas turbine engine incorporating a lock plate as claimed in any of claims 1 to 9.

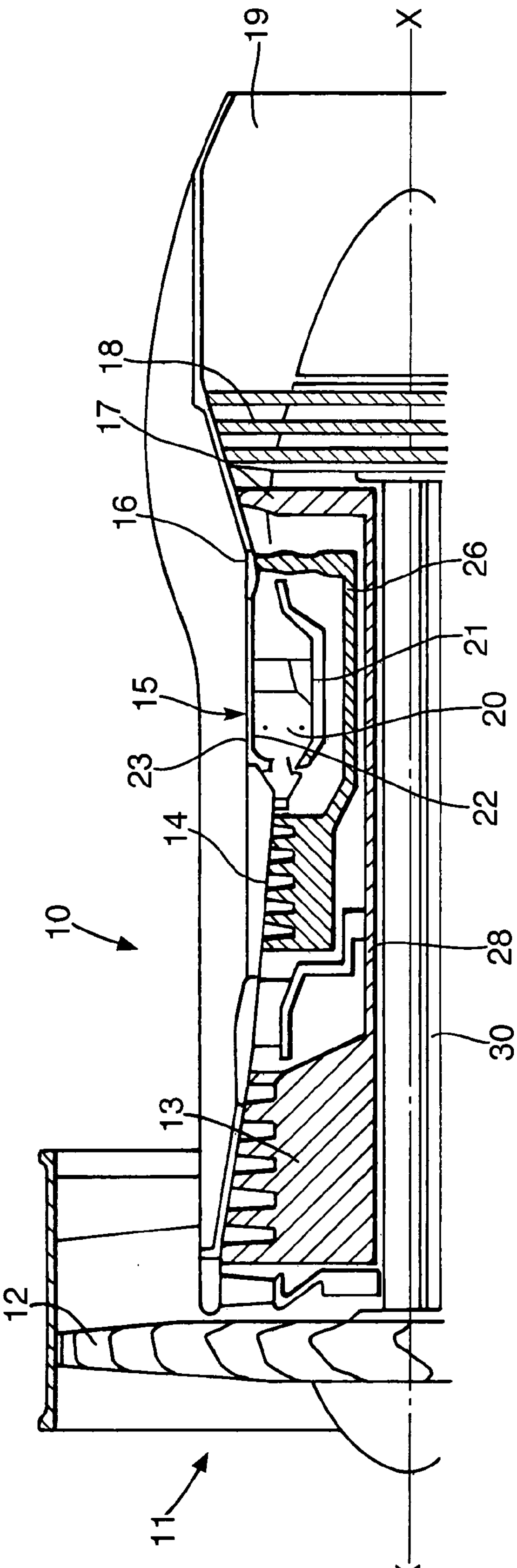

Fig.1.

Fig.2.

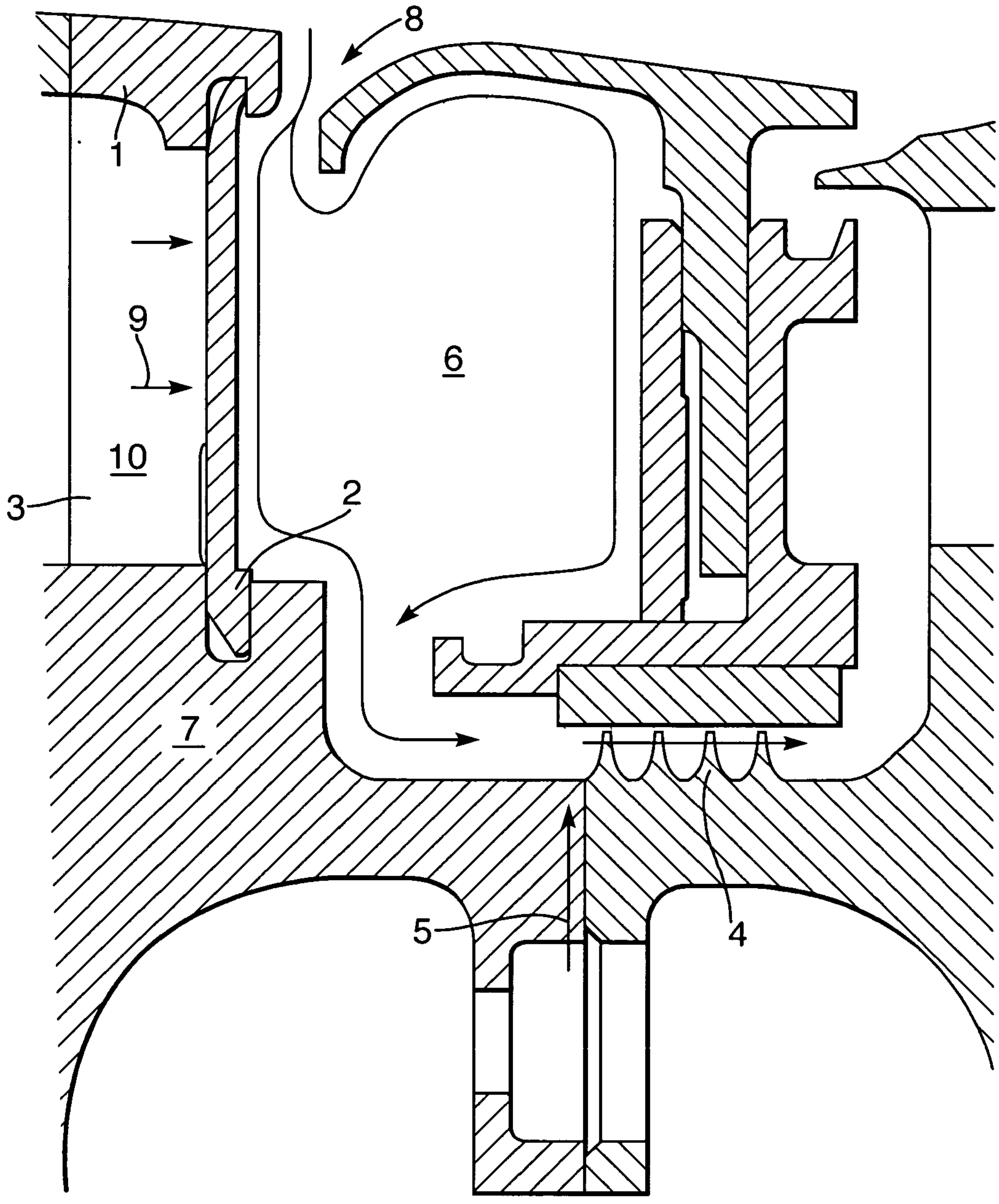

Fig.3.

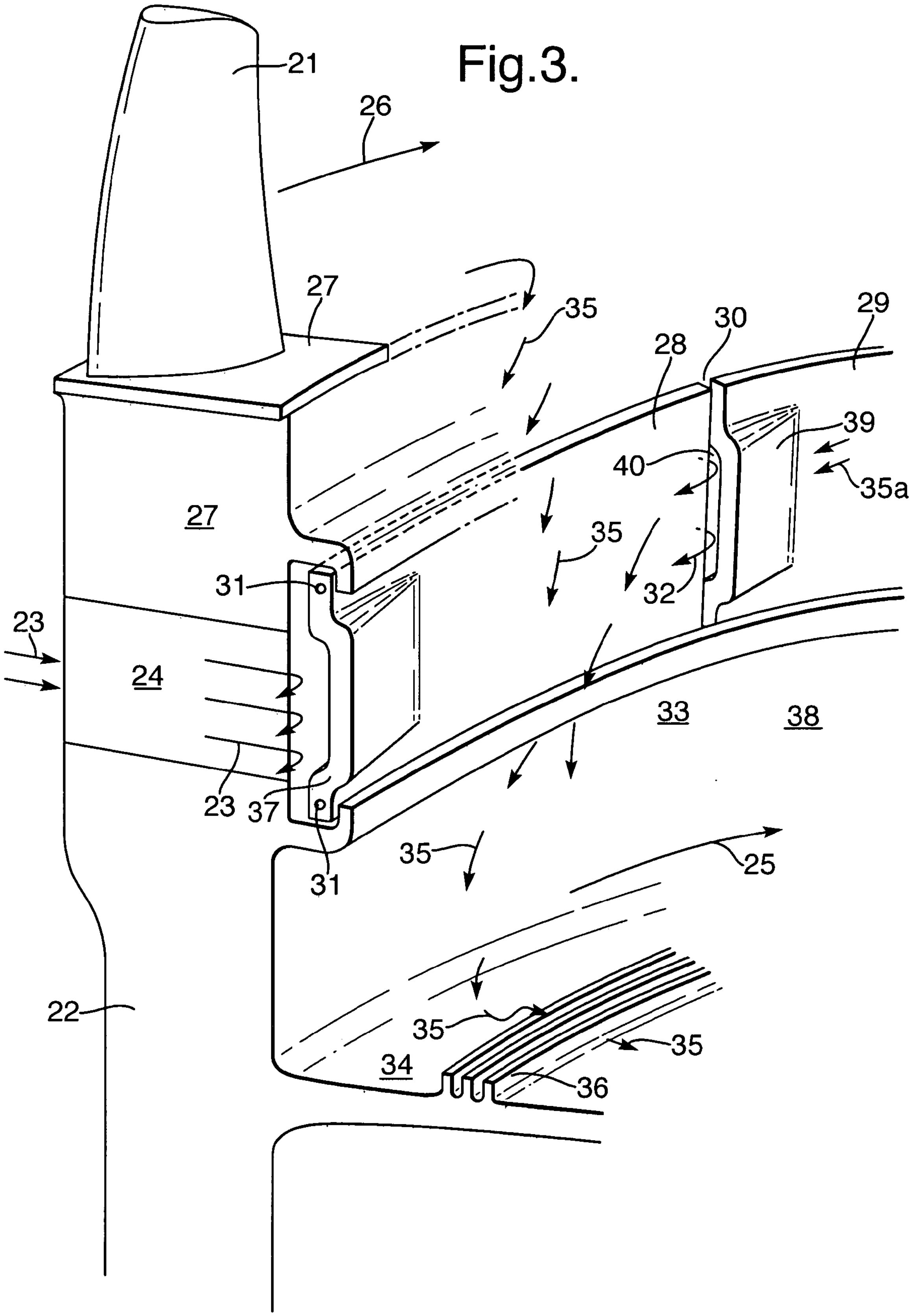
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Fig.4.

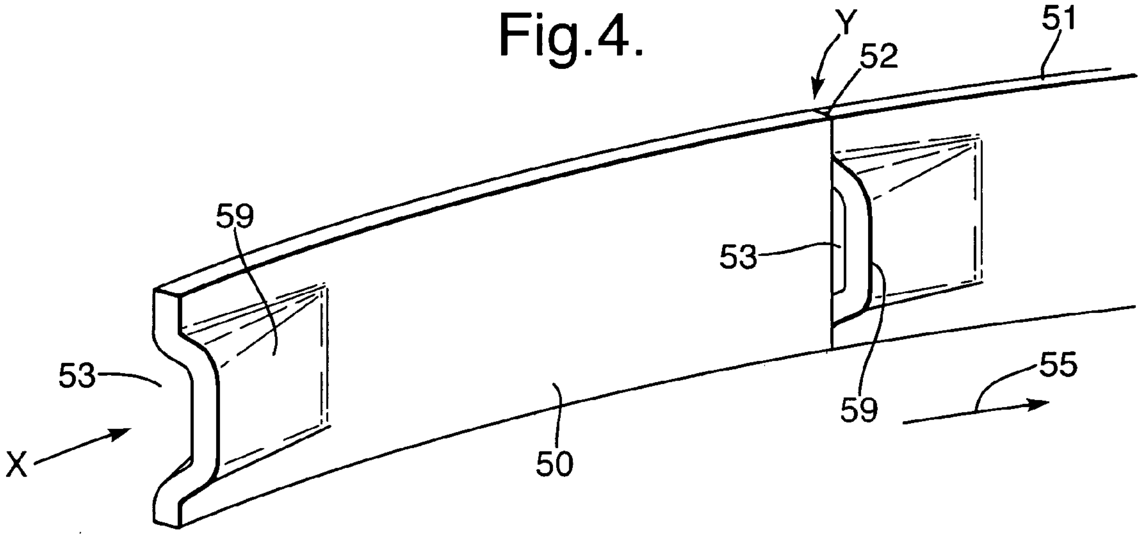


Fig.5.

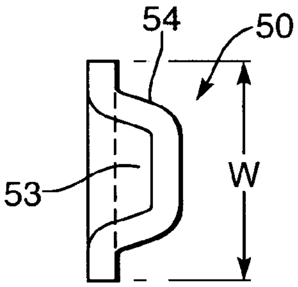


Fig.6.

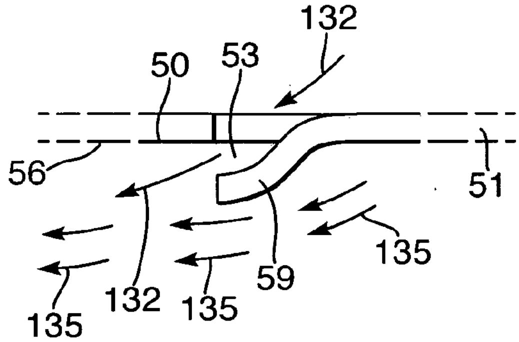


Fig.7.

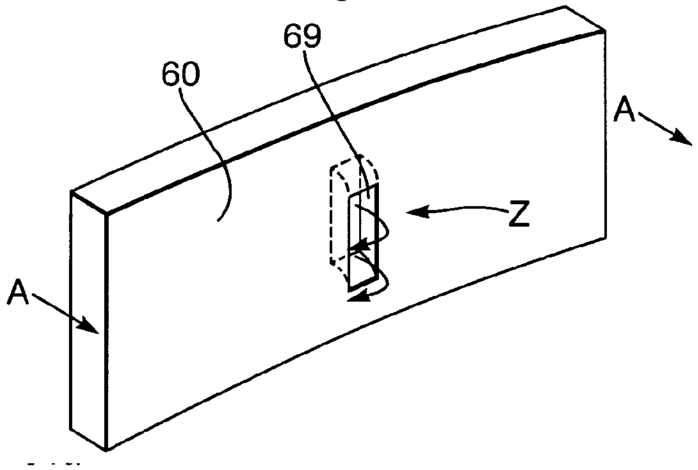


Fig.8.

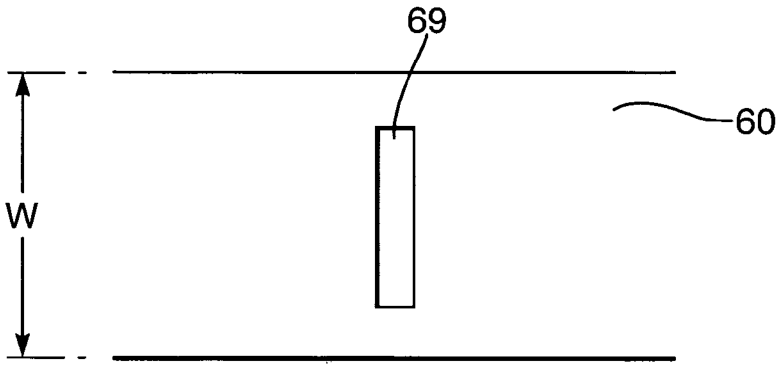


Fig.9.

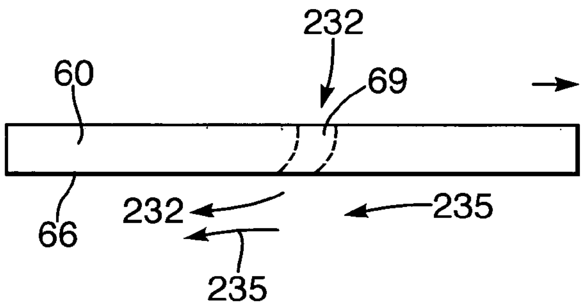
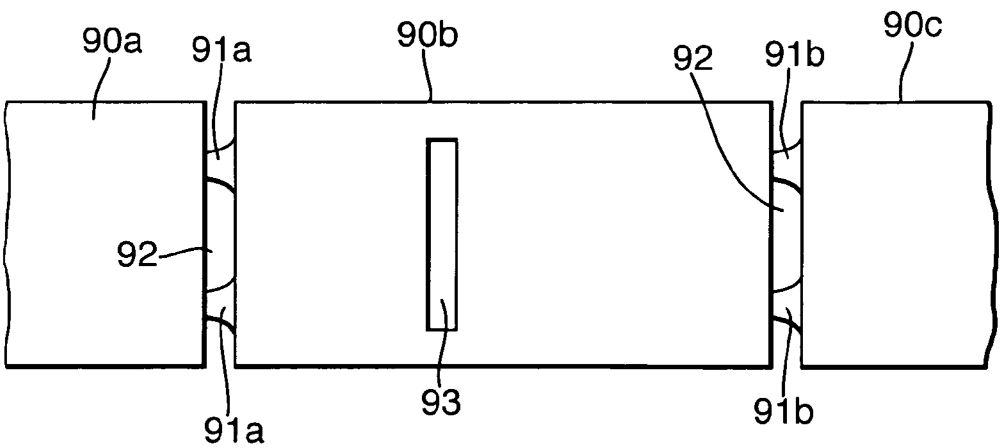


Fig.10.



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EUROPEAN SEARCH REPORT

Application Number
EP 06 25 0365

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	EP 0 916 808 A (ROLLS-ROYCE PLC) 19 May 1999 (1999-05-19) * paragraphs [0009], [0010], [0031], [0032]; figures 2,3 *	1,2,4-7, 10-12,14	INV. F01D5/30 F01D5/08
X	US 6 416 282 B1 (BEECK ALEXANDER ET AL) 9 July 2002 (2002-07-09) * figures 5-8 *	1-7, 10-12,14	
X	FR 1 426 933 A (GENERAL ELECTRIC COMPANY) 4 February 1966 (1966-02-04) * figures 1,2 *	1,3-7, 10-12,14	
D,X	US 6 290 464 B1 (NEGULESCU DIMITRIE ET AL) 18 September 2001 (2001-09-18) * figures 1a-1c *	1,3-7, 10-12,14	
X	US 5 941 687 A (TUBBS ET AL) 24 August 1999 (1999-08-24) * column 3, lines 1-10; figure 2 *	1,10	
			TECHNICAL FIELDS SEARCHED (IPC)
X	GB 1 209 419 A (WESTINGHOUSE ELECTRIC CORPORATION) 21 October 1970 (1970-10-21) * figures 1,3 *	1,3-8, 10-12,14	F01D
A	EP 1 284 338 A (GENERAL ELECTRIC COMPANY) 19 February 2003 (2003-02-19) * figure 5 *	1-14	

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	15 May 2006	Teusch, R

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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EPO FORM 1503 03.82 (P04C01)

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 06 25 0365

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15-05-2006

Patent document cited in search report		Publication date	Patent family member(s)			Publication date
EP 0916808	A	19-05-1999	DE	69812044	D1	17-04-2003
			DE	69812044	T2	21-08-2003
US 6416282	B1	09-07-2002	DE	19950109	A1	19-04-2001
			EP	1094199	A1	25-04-2001
FR 1426933	A	04-02-1966	NONE			
US 6290464	B1	18-09-2001	DE	19854908	A1	31-05-2000
			EP	1004748	A2	31-05-2000
US 5941687	A	24-08-1999	GB	2319308	A	20-05-1998
GB 1209419	A	21-10-1970	AT	296692	B	25-02-1972
			CH	489697	A	30-04-1970
			DE	1928184	A1	08-01-1970
			FR	2011594	A5	06-03-1970
			NL	6909198	A	30-12-1969
			SE	352926	B	15-01-1973
			US	3501249	A	17-03-1970
EP 1284338	A	19-02-2003	JP	2003065003	A	05-03-2003
			US	2003031555	A1	13-02-2003

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