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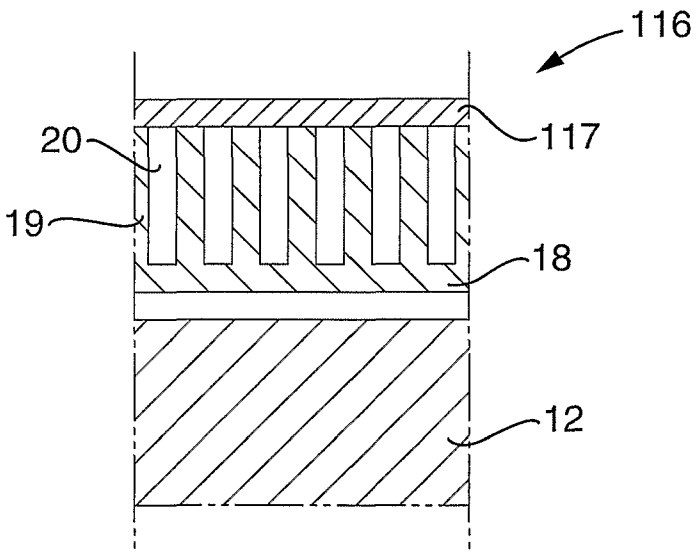
(54) Title: A LINER FOR A TURBINE SECTION, A TURBINE SECTION, A GAS TURBINE ENGINE AND AN AEROPLANE PROVIDED THEREWITH



(57) Abstract: A liner (16) for a turbine section, said liner (16) comprising a first wall (17), a plurality of webs (19) interconnected with and projecting from said first wall (17), and a plurality of cooling channels (20), each of said cooling channels (20) being delimited by two adjacent webs (19) and said first wall (17), wherein each cooling channel (20) presents a height corresponding to the height of its delimiting webs (19), and a width corresponding to the distance between its delimiting webs (19). At least one of said cooling channels (20) has a width/height ratio of below 5 or/and the material of the webs (19) has a higher thermal conductivity than the material of the first wall (17). The invention also comprising a turbine section, a gas turbine engine and an aeroplane provided with such a liner.

A liner for a turbine section, a turbine section, a gas turbine engine and an aeroplane provided therewith

TECHNICAL FIELD

The present invention relates to a liner for a turbine section, said liner comprising a first wall, a plurality of webs interconnected with and projecting from said first wall, and a plurality of cooling channels, each of said cooling channels being delimited by two adjacent webs and said first wall, wherein each cooling channel presents a height corresponding to the height of its delimiting webs, and a width corresponding to the distance between its delimiting webs.

The invention also relates to a turbine section provided with the liner of the invention, a gas turbine engine provided with a turbine section according to the invention, and an aeroplane provided with a gas turbine engine according to the invention.

Preferably, the turbine section is a load-carrying frame arranged adjacent to at least one gas turbine, possibly but not necessarily located between two adjacent turbines, i.e. a high pressure turbine and a low pressure turbine. The load-carrying frame may be a so-called turbine centre frame, which may comprise an inner wall, an outer wall and a plurality of radial struts extending between said inner and outer walls. Said frame forms an annular channel, subdivided by said struts, through which the gases from an upstream combustion chamber passes, said gases thereby also passing the turbine or turbines of the engine. The liner according to the invention may comprise sheets or plates that are to be applied as a heat-protecting cover on the surface of any of said inner wall, outer wall and struts, said surface being a surface directed towards said annular channel.

Typically, the diameter of the gas turbine section of the invention will be in the range of one to two metres. However the invention may be applicable to corresponding gas turbine sections with dimensions outside said range.

BACKGROUND OF THE INVENTION

A so called turbine centre frame of a turbine section of a gas turbine engine is often comprised by a load-carrying part which is provided with sheets or plates that ensures the cooling thereof. These plates or sheets are not load-carrying, i.e. the load-carrying function and the cooling function are, mainly, divided on different parts of said section.

Normally, said plates or sheets comprise a first wall and a second wall divided and interconnected by longitudinal webs, said webs delimiting parallel channels between the first and second walls. The first wall is directed towards the channel through which hot gases are flowing through the turbine, while the second wall is directed towards the part to which the plate or sheet is attached.

A problem encountered by these plates is that their cooling ability is delimited due to inherent limitations of the structure thereof. Normally, cooling air is to be conducted through the channels of said plates, but there are limitations as to the amount of air that can be blown through the channels, and the pressure fall of the air in the channels also sets a limit to the cooling rate that may be achieved. Therefore, the plates become very hot, and, accordingly, they are conventionally made of a high temperature resistant material.

In order to lower the temperature of the plates, the heat flow through and out of the plates should be increased. Principally, there are only two possible ways accessible in order to achieve such a goal, namely either to improve the cooling, as for example achieved by means of the flow of cooling air, or to increase the heat conductibility of the plates.

Conventional solutions are based on the principle that cooling air drawn or blown through the channels of the plate are to absorb heat through convection from the wall adjacent to the hot combustion gases. However, since normally the delimitations of

the engine do not permit a large flow of air of high velocity through the channels of the plates, it will not be easy to achieve the set target of lowering the wall temperature by increasing the cooling through the cooling medium in the channels.

THE OBJECT OF THE INVENTION

It is an object of the present invention to present a liner as initially defined, the design of which is such that it presents an improved ability of conducting heat there through, such that, for a given temperature of the gases to which a first wall thereof is subjected during operation, the temperature of said first wall is decreased in relation to corresponding liners of prior art.

SUMMARY OF THE INVENTION

The object of the invention is achieved by means of the initially defined liner, characterised in that at least one of said cooling channels has a width/height ratio of below 5. The claimed width/height ratio is markedly lower than what is common in prior art, as far as the applicant knows. By lowering said width/height ratio in relation to prior art, a larger proportion of the heat than before will be conducted to and through the webs, and a larger proportion of the heat than before will be transferred by means of convection from the webs to the cooling medium flowing through said channels during engine operation. Preferably, the liner comprises a plurality of parallel cooling channels, each delimited by two neighbouring webs, wherein a substantial part of said channels, preferably a majority thereof, and most preferably all of said channels present the claimed width/height ratio. It is also preferred that both of the neighbouring webs that delimit said at least one cooling channel have substantially the same height. It is further preferred that at least the majority, and most preferably all of the webs present the same height, as measured in a direction perpendicularly from the surface of the first wall from which they project.

Preferably, the width/height ratio is below 3, even more preferably below 1, or, most preferably said ratio is below 0,5. It is also preferred that the width/height ratio is above 0,1.

Preferably, for said at least one channel, the ratio between the width of said at least one channel and the width of at least one of its delimiting webs is < 2. Preferably, the width of said at least one channel and the width of each of its delimiting webs is < 2. Among a plurality of parallel channels, these features are preferred for a substantial part thereof, preferably a major part thereof, and most preferably all of said channels.

According to a preferred embodiment, the width, or thickness, of each of said webs that delimit said at least one channel is below 2 mm. Preferably, among a plurality of such webs, a substantial part thereof, preferably a major part thereof, and most preferably all thereof present said claimed width.

It is further preferred that the height of said at least one channel is above 2 mm., and preferably below 15 mm.

Preferably, the liner comprises a second wall interconnected with said first wall through at least some of said webs and located opposite to said first wall. Thereby, the liner present a number of separate cooling channels, each delimited by the first wall, the second wall and two neighbouring webs. Preferably, a substantial part of the webs, more preferably a major a part, and most preferably all of said webs interconnect said first and second walls, thereby being able to conduct heat from the first wall to the second wall, and also mechanically stabilising the liner.

The object of the invention is also achieved by means of the initially defined liner, characterised in that the material of the webs has a higher thermal conductivity than the material of the first wall. Thereby, a relatively larger proportion of heat than otherwise will be transferred through the webs, and, accordingly, a larger proportion of the heat will be transferred through convection from the webs to the cooling medium flowing through the channels of the liner. Preferably, such a design is

combined with a liner design with the one or more of the features already claimed in this text.

According to a preferred embodiment, the material of the first wall has a higher temperature resistance than the material of the webs. Thereby, the ability of the liner to resist the immediate affection of hot gases flowing through turbine section in which the liner is positioned during operation may be provided for. The material of the webs can then be optimised with regard to other properties relevant for the function thereof, such as thermal conductivity.

Preferably, the material of the first wall comprises steel. Thereby, at least a layer of the first wall that is to be directly subjected and in contact with the hot gases flowing through the turbine section may, preferably, be made of steel, since the latter will provide acceptable mechanical as well as heat resistant properties.

Preferably, the material of the webs comprises copper or a copper alloy as a main constituent. Thereby an improved thermal conductivity of the webs is provided for.

According to an alternative embodiment, the material of the webs comprises a material the density of which is lower than that of the first wall. Since weight saving is an important issue in connection to the design of gas turbine engines to be used in vehicles, in particular aircrafts, a lighter material than that of the first wall might be preferred for the webs, especially since the number of webs and the total volume occupied thereby is likely to increase with a design in accordance with the invention.

According to a preferred embodiment the material of the webs comprises aluminium as a main constituent, due to an advantageous combination of light weight, high thermal conductivity, machinability, and availability of the latter. Depending on the cooling air conditions, aluminium alloys may be used in order to secure high temperature material properties while maintaining a higher conductivity and lower density than steel materials.

A mixture of copper and aluminium may be used, i.e. copper in the webs and aluminium in the outer wall or a part of the outer wall, i.e. the wall which is not facing the hot gases. In order to facilitate the use of aluminium, a thermal barrier coating (TBC coating) may be applied to the hot gas side.

The invention also includes a turbine section, characterised in that it comprises a liner according to the invention. Preferably, the liner is attached to a load-carrying part of said turbine section, whereby said part may be any of a radial strut connecting an inner wall and an outer wall of said turbine section, an inner wall of the turbine section, or an outer wall of the turbine section. Preferably, the first wall of the liner is turned towards the turbine chamber, such that it will be subjected to hot gases flowing therein during turbine operation.

Preferably, the turbine section comprises a load-carrying frame arranged adjacent to at least one gas turbine, normally a frame located between a low pressure turbine and a high pressure turbine as seen in the gas flow direction through the engine.

Further features and advantages of the present invention will be presented in the following detailed description of a preferred embodiment, and in the patent claims.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a schematic representation of a first embodiment of a gas turbine engine provided with a liner according to the invention,

Fig. 2 is a perspective view showing a turbine section to be provided with a liner according to the invention,

Fig. 3 shows a part of the turbine section of fig. 2, provided with a liner according to the invention,

Fig. 4 is a partly cut part of a turbine section provided with a liner according to the invention,

Fig. 5 is a cross-sectional view of a liner of the invention, according to a first embodiment as arranged adjacent to a load carrying part of a turbine section,

Fig. 6 is a cross-sectional view of a liner of the invention, according to a second embodiment, as arranged adjacent to a load carrying part of a turbine section, and

Fig. 7 is a cross-sectional view of a liner according to prior art, as arranged adjacent to a load carrying part of a turbine section.

DETAILED DESCRIPTION OF THE INVENTION

Fig. 1 is an oversight view of a gas turbine engine 1 according to the invention provided with a turbine section 2 provided with a liner according to the invention. The gas turbine engine 1 shown in fig. 1 is of conventional construction and comprises, in axial flow series, an air intake 3, low pressure compressor 4, high pressure compressor 5, combustion equipment 6, high pressure turbine 7, low pressure turbine 8 and an exhaust outlet 9. During operation, the high pressure compressor is driven by the high pressure turbine via a first hollow shaft 10. Similarly, the low pressure compressor 5 is driven by the low pressure turbine via a second hollow shaft 11 which is coaxially disposed within the first hollow shaft 10.

The gas turbine engine1 operates in the conventional manner whereby air drawn in through the air intake 3 is compressed by the low pressure compressor 4 before passing into the high pressure compressor 5 where it is compressed further. The compressed air then flows into the combustion equipment 6 where it is mixed with fuel and the mixture combusted. The resultant hot combustion products then expand through the high and low pressure turbines 7, 8 before being exhausted to the atmosphere through the exhaust nozzle 9.

The turbine section 2 to be provided with a liner according to the invention is a load-carrying frame 12 (see fig. 2) arranged in a part of the turbine housing in which the gases flowing from the combustion chamber still have such a high temperature that the material of the load-carrying frame 12 has to be protected from the heat by means of a protective liner. The turbine section 2 is arranged downstream the combustion chamber as seen in the gas flow direction the gas turbine engine. The load-carrying frame 12 forms part of the stator of the engine. As in this embodiment, the load-carrying frame 12 provided with the liner according to the invention is located downstream and adjacent the high pressure turbine 7.

Fig. 2 shows the load-carrying frame 12 more in detail. It comprises an inner wall 13, an outer wall 14 and struts 15 extending between the inner wall 13 and the outer wall 14. The inner wall 13 and the outer wall 14 delimits an annular channel which is subdivided by the struts 15 into segments and through which the still hot gases from the combustion chamber pass during engine operation. Thereby, said walls 13, 14 and struts 15 are subjected to a significant heat.

In order to decrease the heat to which the load-carrying parts 13, 14, 15 of the frame 12 are subjected, a liner 16 according to the invention is attached to said parts 13, 14, 15 (see figs. 3 and 4). The liner 16 comprises plates or the like, a periphery of which matches the periphery of the load carrying part onto which they are to be attached. A plurality of plates may be attached to said parts and interconnected in order to form the liner 16. Preferably, there is provided a gap between the liner 16 and the load carrying part 13, 14, 15 which it covers. However, the arrangement of the liner 16 onto said parts 13, 14, 15 may be of a kind known per se, and will therefore not be discussed more in detail in this context.

Fig. 4 shows one of the struts 15, and indicates how the strut 15 is provided with said liner 16. The liner 16 covers the exterior of the strut 15, thereby protecting it from the heat of hot gases flowing through the engine during engine operation.

Figs. 5 and 6 show the design of the liner 16 more in detail. The liner 16 comprises a first wall 17, a second wall 18 and a plurality of webs 19 connecting and separating the first and second walls 17, 18. Channels 20 extending in parallel are delimited by said walls 17, 18 and webs 19. Figs. 5 and 6 show the liner 16 as attached to the inner wall 13 of the frame 12. However, it should be understood that a corresponding provision of the liner 16 on the outer wall 14 and the struts 15 is also included in the invention.

The first wall 17 of the liner 16 is directed towards, and subjected to direct contact with the hot gases flowing through the turbine section 2 during engine operation. The second wall 18, on the other hand, is turned towards the load-carrying part 13, 14, 15 to which the liner 16 is attached or which is covered by the liner 16. Preferably, the longitudinal direction of the channels 20 of the liner 16 attached to the inner wall 13 and the outer wall 14 of the frame 12 generally coincides with the longitudinal direction of said walls 13, 14, i.e. the longitudinal direction of the engine 1 and the gas flow direction through the latter. The longitudinal direction of the channels 20 of the liner 16 attached to the struts 15 may, however coincide with the longitudinal direction of said struts 15, i.e. from the inner wall 13 to the outer wall 14, i.e. cross-wise to the gas flow direction through the engine 1.

Moreover, there should be provided means (not shown) for introducing a flow of a cooling medium into said channels 20, and means for letting said cooling medium out of the channels 20. Such means may include any kind of compressor, a manifold via which the cooling medium is introduced into the channels 20 of the liner 16, and a conduit through which the cooling medium is guided from the compressor to said manifold. Preferably, the inlets to the channels 20 are closed towards the hot gases flowing through the turbine section 2 that comprises said frame 12. However, the outlets of the channels 20 might communicate with the turbine chamber in which the hot gases are to flow during engine operation, thereby possibly providing for a film cooling effect on the turbine wall downstream the section 2 provided with said liner 16. Alternatively, there might be provided subsequent liner segments in the longitudinal direction of the engine 1, whereby cooling air from the outlet of an

upstream segment is permitted to enter the turbine chamber and provide for film cooling of a subsequent downstream liner segment.

The cooling channels 20 has a width/height ratio of below 1, preferably below 0,75, and most preferably below 0,5. In this context, the width is referred to as the dimension thereof in a direction generally parallel with the plane of the first and second walls 17, 18, while the height is referred to as the dimension thereof in a direction perpendicular to said plane or planes. However, it should be understood that the first and second walls 17, 18 are not likely to be absolutely flat or plane, but will, in most cases, present a certain curvature, following the curvature of the load-carrying part 13, 14, 15 to which the liner 16 is attached or which is covered thereby. In other words, the plane in relation to which the height direction may be the normal may present a curvature.

In the embodiment shown in fig. 5, the material of the first wall 17, the second wall 18 and the webs is the same, preferably high temperature steel material such as haynes188 or Haynes 230.

In the embodiment shown in fig. 6, on the other hand, the material of the first wall 117 or at least of a part thereof that is directly subjected to flow of hot gases through the turbine section 2, differs from the material of the webs 19 connected thereto. Preferably, the material of the first wall 117 has a higher temperature resistance than the material of the webs 19, while, on the other hand, the material of the webs 19 has a higher thermal conductivity than the material of the first wall 117. By using a material of higher thermal conductivity in the webs 19, the webs 19 may contribute to the overall conduction of heat to a higher degree than before. The suggested design will permit an improved conduction of heat through the webs 19, from which a part of the heat may be transferred to the cooling medium by means of convection and a part of the heat may be transferred the second wall 18. Since a larger amount of the heat may now be transferred to the cooling medium via the high-conductive webs 19, a lower amount of heat than earlier will now be transferred to the second wall 18 through said webs 19. Since less heat than otherwise is transferred from the second

wall 18 to the load-carrying part 13, 14, 15 of the frame 12 to which the liner 116 is attached, said load-carrying part 13, 14, 15 of the frame 12 will be less subjected to heat and, accordingly, better able to fulfil its load-carrying task, thanks to a lower temperature.

Preferably, the material of the first wall 117 or said part thereof comprises steel as its main constituent, while the material of the webs 19 comprises copper as its main constituent. However, other combinations of materials of the first wall 117 and the webs 19 might as well be conceived and be within the scope of the invention. Preferably, the material of the second wall 18 is the same as that of the webs 19.

If the plate not is flat, it is an advantage to have a large copper content in the plate since copper is easier to shape with forming methods than the high temperature steels commonly used. Shaping is possibly needed to make the plate follow a not plane load carrying structure.

The cooling channels 20 may be provided by wire-electro discharge machining the channels out of a solid sheet forming the second wall 18, thereby also resulting in the provision of the webs 20. In case a part of or the whole first wall 17, 117 is made of the same material as the second wall 18 and the webs 19, also the first wall 17, 117 or part of it could be part of that one and the same sheet in which the channels 20 are formed by means of wire-electro discharge machining. Wire-electro discharge machining is a preferred solution compared to pin milling or disc milling for very narrow slots.

Fig. 7 shows a liner 216 according to prior art, in which the width/height ratio of the channels 220, as seen in a cross section of the liner, is 8,3 or more. The liner 216 is provided close to a load-carrying frame 212, and comprises a first wall 217, a second wall 218 and webs 219 that interconnect said first and second walls 217, 218, thereby defining said channels 220.

It should be understood that the above description of preferred embodiments has been made in order exemplify the invention, and that alternative solutions will be obvious for a person skilled in the art, however without departing from the scope of the invention as defined in the appended claims supported by the description and the drawings.

For example, the liner 16, 116 according to the invention may be covering only parts of the load-carrying frame 12, while other parts are covered by a conventional liner, for example like the one shown in fig. 7. Moreover, the materials of the parts of the load-carrying frame 12 as well as the liner 16 , 116 may be other than those suggested herein. Likewise, the arrangement of the liner 16, including its fixing and the distance thereof to the adjacent load-carrying frame, will be a design issue for every individual application and may, therefore, differ from construction to construction.

PATENT CLAIMS

1. A liner (16, 116) for a turbine section, said liner (16, 116) comprising a first wall (17, 117), a plurality of webs (19) interconnected with and projecting from said first wall (17, 117), and a plurality of cooling channels (20), each of said cooling channels (20) being delimited by two adjacent webs (19) and said first wall (17, 117), wherein each cooling channel (20) presents a height corresponding to the height of its delimiting webs (19), and a width corresponding to the distance between its delimiting webs (19), **characterised in** that at least one of said cooling channels (20) has a width/height ratio of below 5.

2. A liner (16, 116) according to claim 1, **characterised in** that said width/height ratio is below 3.

3. A liner (16, 116) according to claim 1, **characterised in** that said width/height ratio is below 1.

4. A liner (16, 116) according to claim 1, **characterised in** that said width/height ratio is below 0,5.

5. A liner (16, 116) according to any one of claims 1-4, **characterised in** that said width/height ratio is above 0,1.

6. A liner (16, 116) according to any one of claims 1-5, **characterised in** that, for said at least one channel (20), the ratio between the width of said at least one channel (20) and the width of at least one of its delimiting webs (19) is < 2.

7. A liner (16, 116) according to any one of claims 1-6, **characterised in** that the width of each of said webs (19) that delimit said at least one channel (20) is below 2 mm.

8. A liner (16, 116) according to any one of claims 1-7, **characterised in** that the height of said at least one channel (20) is above 2 mm.

9. A liner (16, 116) according to any one of claims 1-8, **characterised in** that the height of said at least one channel (20) is below 15 mm.

10. A liner (16, 116) according to any one of claims 1-9, **characterised in** that it comprises a second wall (18) interconnected with said first wall (17, 117) through at least some of said webs (19) and located opposite to said first wall (17, 117).

11. A liner (116) according to any one of claims 1-10, **characterised in** that the material of the webs (19) has a higher thermal conductivity than the material of the first wall (117).

12. A liner (116) according to any one of claims 1-11, **characterised in** that the material of the first wall (117) has a higher temperature resistance than the material of the webs (19).

13. A liner (116) according to any one of claims 1-12, **characterised in** that the material of the first wall (117) comprises steel.

14. A liner (116) according to any one of claims 1-13, **characterised in** that the material of the webs (19) comprises copper as a main constituent.

15. A liner (116) for a turbine section, said liner (116) comprising a first wall (117), a plurality of webs (19) interconnected with and projecting from said first wall (117), and a plurality of cooling channels (20), each of said cooling channels (20) being delimited by two adjacent webs (19) and said first wall (117), **characterised in** that the material of the webs (19) has a higher thermal conductivity than the material of the first wall (117).

16. A liner (116) according to claim 15, **characterised in** that the material of the first wall (117) has a higher temperature resistance than the material of the webs (19).

17. A liner (116) according to claim 15 or 16, **characterised in** that the material of the first wall (117) comprises steel.

18. A liner (116) according to any one of claims 15-17, **characterised in** that the material of the webs (19) comprises copper as a main constituent.

19. A liner (116) according to any one of claims 15-18, **characterised in** that it comprises a second wall (18) interconnected with said first wall (117) through at least some of said webs (19) and located opposite to said first wall (117).

20. A turbine section (2), **characterised in** that it comprises a liner (16, 116) according to any one of claims 1-19.

21. A turbine section (2) according to claim 20, **characterised in** that the first wall (17) of the liner (16, 116) is directed such that it will be directly subjected to hot gases flowing through the turbine section (2) during turbine operation.

22. A turbine section (2) according to claim 20 or 21, **characterised in** that the liner (16, 116) is attached to a load-carrying part (12) of said turbine section (2).

23. A turbine section (2) according to claim 22, **characterised in** that said load-carrying part (12) of the turbine section (2) comprises a radial strut (15) connecting an inner wall (13) and an outer wall (14) of said turbine section (2).

24. A turbine section (2) according to claim 22 or 23, **characterised in** that said load-carrying part (12) of the turbine section (2) comprises an inner wall (13) of the turbine section (2).

25. A turbine section (2) according to any one of claims 22-24, **characterised in** that said load-carrying part of the turbine section comprises an outer wall (14) of the turbine section (2).

26. A turbine section (2) according to any one of claims 20-25, **characterised in** that said turbine section (2) comprises a load-carrying frame (12) arranged adjacent to at least one gas turbine (7).

27. A turbine section (2) according to any one of claims 20-26, **characterised in** that it comprises means for introducing a flow of a cooling medium into said channels (20), and means for letting said cooling medium out of the channels (20).

28. A gas turbine engine (1), **characterised in** that it comprises a turbine section (2) according to any one of claims 20-27.

29. An aeroplane, **characterised in** that it comprises a turbine engine (1) according to claim 28.

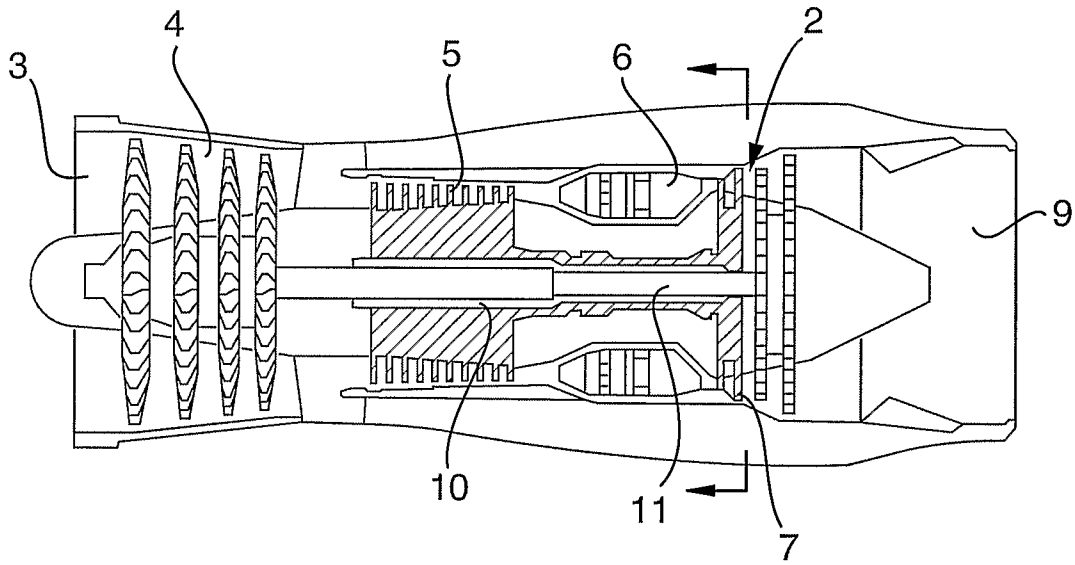


Fig 1

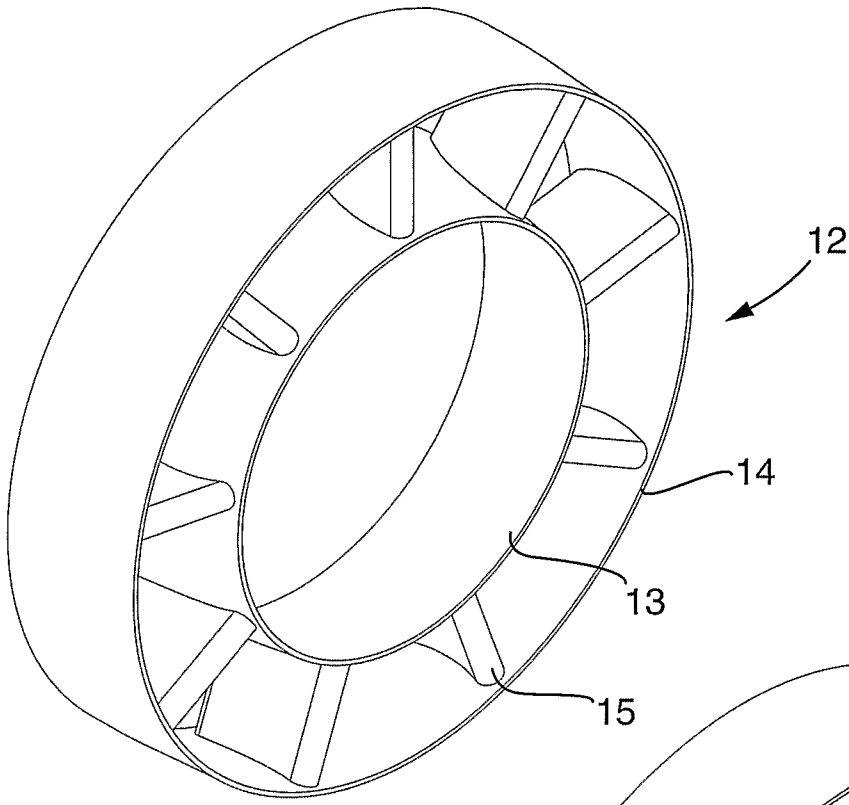


Fig 2

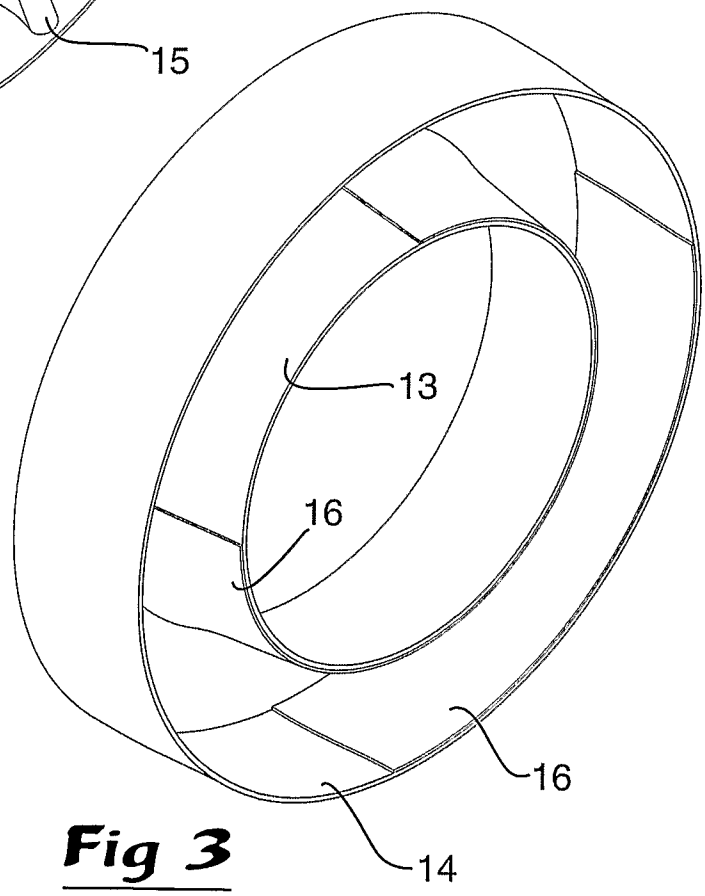


Fig 3

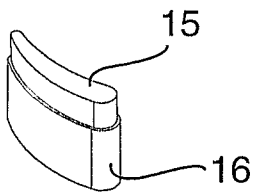


Fig 4

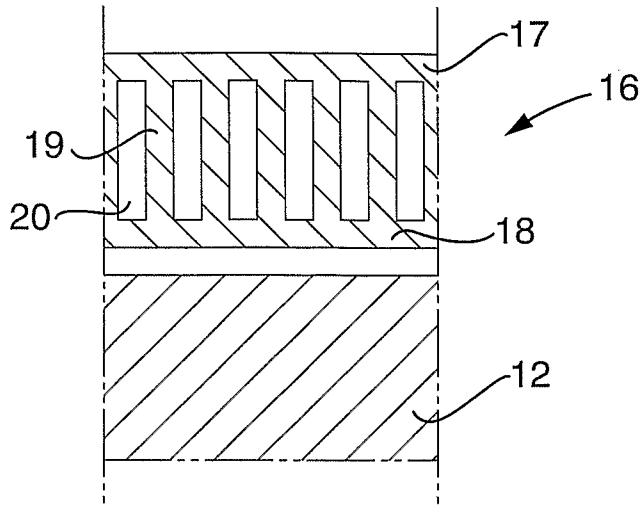


Fig 5

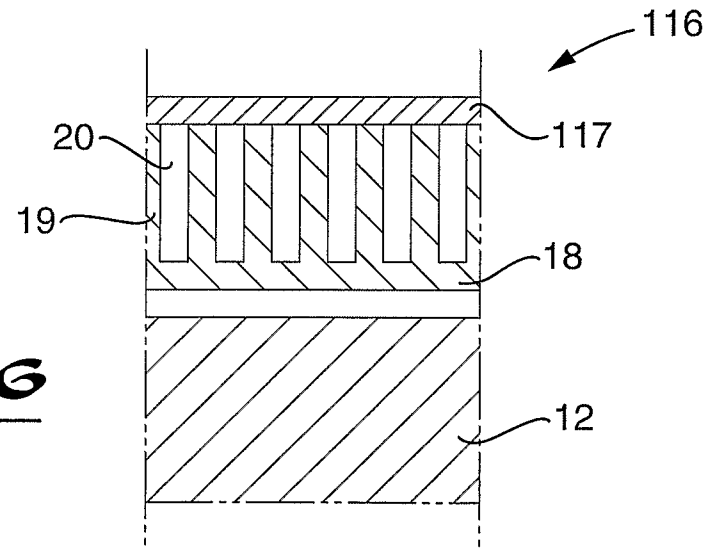


Fig 6

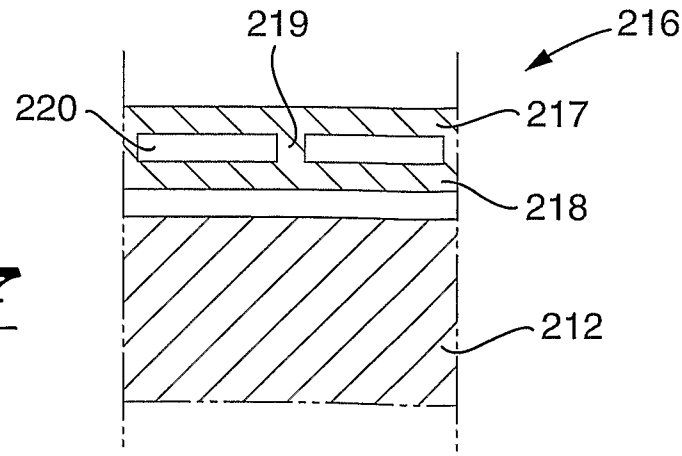


Fig 7

INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE2006/001389

A. CLASSIFICATION OF SUBJECT MATTER

IPC: see extra sheet
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC: F02K, F02C

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-INTERNAL, WPI DATA, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 20060213182 A1 (FINT ET AL), 28 Sept 2006 (28.09.2006), figure 7	1-11,14-15, 21-30
	--	
X	US 5154352 A (BUCKREUS), 13 October 1992 (13.10.1992), figure 2	1-11,14-15, 21-30
	--	
X	DE 10350735 A1 (EADS SPACE TRANSPORTATION GMBH), 9 June 2005 (09.06.2005), figure 2, claim 10	1-11,14-15, 21-30
	--	

☐ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance: the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance: the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
2 July 2007	04 -07- 2007
Name and mailing address of the ISA/ Swedish Patent Office Box 5055, S-102 42 STOCKHOLM Facsimile No. +46 8 666 02 86	Authorized officer Malin Christensson/CM Telephone No. +46 8 782 25 00

International patent classification (IPC)
F02K 9/64 (2006.01)
F02C 7/12 (2006.01)
F02K 9/97 (2006.01)

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- In English/Searches and advisory services/Cited documents (service in English) or
- e-tjänster/anförda dokument(service in Swedish).

Use the application number as username.
The password is **GNIEAQKGOA**.

Paper copies can be ordered at a cost of 50 SEK per copy from PRV InterPat (telephone number 08-782 28 85).

Cited literature, if any, will be enclosed in paper form.

INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE2006/001389

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

1: Claims 1-15 directed to a liner for a turbine section comprising cooling channels having a with/height ratio of below 5.
2: Claims 16-20 directed to a liner for a turbine section comprising cooling channels being delimited by two adjacent webs and a wall, wherein material of the webs has higher thermal conductivity than the material of the wall.

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.

2. ☒ As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.

3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.

☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.

☐ No protest accompanied the payment of additional search fees.

Box No. IV Text of the abstract (Continuation of item 5 of the first sheet)

A liner (16) for a turbine section, said liner (16) comprising a first wall (17), a plurality of webs (19) interconnected with and projecting from said first wall (17), and a plurality of cooling channels (20), each of said cooling channels (20) being delimited by two adjacent webs (19) and said first wall (17), wherein each cooling channel (20) presents a height corresponding to the height of its delimiting webs(19), and a width corresponding to the distance between its delimiting webs (19). At least one of said cooling channels (20) has a width/height ratio of below 5 or/and the material of the webs (19) has a higher thermal conductivity than the material of the first wall (17). The invention also comprising a turbine section, a gas turbine engine and an aeroplane provided with such a liner.

US	20060213182	A1	28/09/2006	NONE		
US	5154352	A	13/10/1992	DE	4015204 C	17/10/1991
				FR	2661950 A,B	15/11/1991
				GB	2249141 A,B	29/04/1992
				GB	9110174 D	00/00/0000
DE	10350735	A1	09/06/2005	NONE		