

OPINION UNDER SECTION 74A

Patent	EP(UK) 1246711
Proprietor(s)	MTU Aero Engines GmbH
Exclusive Licensee	
Requester	Winbro Group Technologies Ltd, on 3 July 2007
Observer(s)	MTU Aero Engines GmbH
Date Opinion issued	3 October 2007

1. This opinion relates to a request as to whether EP (UK)1246711 (“the patent”), in the name of MTU Aero Engines GmbH (“the proprietor”), is invalid with respect to the prior art, and whether it is infringed by a process carried out by the requester, Winbro Group Technologies Ltd (“the requester”).
2. As far as validity is concerned, the requester seeks an opinion that the claims of the patent lack an inventive step with regard to the following:

Patent documents:

US 5609779 (Crow et al)
US 3894208 (Bergmann)

Non-patent literature:

Mikrostrukturierung mit Femtosekundenlasern [Microstructuring with femto-second lasers], S. Nolte et al, LaserOpto, Vol. 31(3), April 15 1999. (“D1”)

Laser beam removal of micro-structures with Nd:YAG-Lasers, D. Hellrung et al, Lasers in Material Processing, Vol. 3097, pages 267-273, 16 June 1997. (“D2”)

Laser micromachining of metals, J.A. Ramos et al, EUROPTO Conference on Computer-Controlled Microshaping, Vol. 3822, pages 207-213, 14 June 1999. (“D3”)

The research and development of Nd:YAG laser engraving system, W. Wang et al, *Laser processing of Materials and Industrial Applications*, Vol. 2888, pages 207-212, September 1996. ("D4")

Processing of Ni-based Aero Engine Components with Repetitively Q-switched Nd:YAG Lasers", G. Bostanjoglo et al, *High-Power Lasers*, Vol. 2789, pages 145-157, September 1996. ("D5")

Laser Drilling Micro Vias, Gil White et al, Section B-ICALEO, 1998. ("D6")

Investigation of the Nd:YAG Laser Percussion Drilling Process Using High-speed Filming, P.W. French et al, Section B-ICALEO, 1998. ("D7")

Micro-structuring with Nd:YAG-Lasers, A. Gillner et al, *Laser Assisted Net shape Engineering 2*, Proceedings of the LANE'97, 1997. ("D8")

Observations

3. The proprietor filed observations on 24 August 2007, refuting the assertions of invalidity by the requester, and arguing that a case of non-infringement had not been made out.
4. The proprietor also objected in principle to the opinions process being used in this matter. It argues that since the patent relates to complex technology, it is not realistic to expect the proprietor to respond accurately and substantively within the short timescale required by the opinions process. Since, in their view, the opinions process timetable is biased in favour of the requester, they contend that it is in breach of Article 6 of the Convention on Human Rights. In particular, they argue that Rule 77F(7), which specifies the period for filing observations at 4 weeks, appears to be incompatible with Article 6.
5. In response, I would note merely that the period of 4 weeks was adopted by Parliament following a full and open consultation. In addition, the opinions process also provides additional safeguards for patent proprietors in its provisions on reviewing opinions.
6. The requester filed observations in reply on 3 September 2007, which again set out the case for invalidity and non-infringement.

The patent

7. The patent has a priority date of 16 December 1999, and was granted on 9 February 2005. It concerns a process for the production of an opening in a metallic component, in which at least one section of the opening comprises

a non-cylindrical funnel, the opening extending from a first surface of the component to a second surface, and being formed by a laser beam.

8. Such funnel-shaped openings are used in the aerospace industry as air cooling holes, also known as diffusers, in gas turbine components. Owing to the relatively small size and geometry of such openings, they are particularly suited to being formed by laser machining.
9. The description highlights that prior art methods, in particular that of US 5609779 (one of the documents relied upon by the requester to demonstrate a lack of inventive step), lead to inaccuracies in the shape of the diffuser being produced. It goes on to describe how this can be avoided through sublimation of the material, leading to greater accuracy of shape with low surface roughness.
10. The invention seeks to provide a method of producing openings "...with the best possible surface quality and accuracy of shape..." (p2 lines 5 to 6). To this end it seeks to overcome the drawbacks of the prior art by providing a process whereby a laser beam is used to remove layers of material by sublimation, the layers being of a substantially constant thickness, and the laser beam being moved over the surface of the component along a plurality of adjacent paths matched in length and number to the shape of the funnel as the layers are removed.

Claim construction

11. Section 125(1) of the Patents Act states that an invention for a patent shall be taken to be that specified in a claim of the specification of the patent, as interpreted by the description and any drawings. Case law in this area requires a 'purposive construction' to be applied to the claims; and it was held by Lord Hoffman, in *Kirin Amgen Inc v Hoescht Marion Roussel Ltd* [2005] RPC 9, that this should involve asking the question of what the skilled person in the art would have understood the proprietor to be using the language of the claim to mean.
12. Claim 1 of the patent is the only independent claim, and specifies:

"Process for the production of an opening in a metallic component, in which the opening (2), in at least one section, comprises a non-cylindrical funnel (9), extends from a first surface(5) to a second surface (6) of a component wall (3), and is formed by means of a laser beam (10), characterized in that during the formation of the funnel (9) the metal is removed mainly by sublimation brought about by a choice of the laser parameters, and the funnel (9) is formed by the laser removal of layers (11) having a substantially constant thickness, the laser beam (10) being moved over the respective surface (6) of the component (1) along a

plurality of adjacent paths(12) matched in length and number to the shape of the funnel (9) as the layers (11) are removed.”

13. This seems clear enough. However, the meaning of some of the terms used in this claim have been put at issue in the request, and in the subsequent rounds of observations. In particular:

i. “mainly by sublimation”

14. It is argued in the request that this term should be construed in light of the description, in particular the following passages at p2, lines 11 to 13, p5 lines 28 to 31, and p7 lines 9 and 10, which state respectively:

“An advantage of material removal by sublimation as a result of the high energy input per pulse is that uncontrolled deposits of viscous material in the area of the opening or funnel to be opened up, which result in increased roughness, are avoided.”;

“...the metal is sublimed away by appropriate choice of laser parameters for laser removal, so that the metal does not essentially melt and no viscous material that would worsen the surface quality can be deposited in the removal area.”;

“...the Nd:YAG laser is equipped with a Q-switch, and by appropriate choice of the laser parameters, is adjusted so that the metallic material to be removed is virtually completely sublimed during the formation of the funnel 9.”

15. The requester argues that these passages indicate that the word “sublimation” is being used in its normal, dictionary sense as being the process whereby material vaporizes without turning into liquid. They also assert that in view of the above passages the word “mainly” should be interpreted as having the same meaning as “substantially”. Reference is made to EPO Decision T79/99, *GASCO/Solid lipid microspheres* [2004] EPOR 419, in which the term “substantially free” was held to mean “free in so far as is practically and reasonably feasible”.

16. On the other hand, the proprietor argues that the word “mainly” is not a synonym for the word “substantially”, and that it should be construed according to its normal use in the sense of predominantly, or merely the largest proportion. They also argue that the ordinary use of the word “sublimation” in the art of laser cutting means that the material is “melted at the focal point of the laser beam” (my underlining added). In support of this they have supplied an extract of Dubbel’s *Handbook of Mechanical Engineering*, in particular page 59, where it states that in laser cutting:

“...The material that is melted (laser fusion cutting), burnt (laser flame cutting) or vaporized (laser sublimation cutting) at the focal point of the laser beam, depending on the intensity and the length of interaction, is expelled from the kerf by a stream of gas emitted from a nozzle coaxially to the optical axis.”

17. To me this passage clearly identifies three types of laser cutting; melted, burnt and vaporized. It refers to laser sublimation cutting only in the context of vaporization of the material, and is in accordance with the everyday meaning of the word, which is that of a solid turning to gas without passing through the liquid phase. I therefore conclude that laser sublimation does not, at least in theory, involve melted material.
18. Furthermore, I do not agree with the assertion by the proprietor that the term “mainly by sublimation” should be construed as meaning that just the majority of the material is removed by sublimation. This would therefore mean that the remaining material is being removed by other processes, which are not mentioned in the patent. As has been noted above, I need to consider what the skilled person would understand the language of the claim to mean. The use of the words “the metal does not essentially melt” and “the metallic material to be removed is virtually completely sublimed”, in the absence of any contradicting statements, leads me to conclude that the material is removed by sublimation in so far as is possible. Indeed, the whole thrust of the specification is directed towards the desirability of sublimation, since it leads to an improved surface quality over a process that involves melting.

ii. “plurality of adjacent paths”

19. The requester asserts that in the context of the description the word “adjacent” has the same meaning as “not overlapping”. They refer to the description on page 3 lines 7 to 8, which specifies:

“Overlapping of the individual paths is not necessary and is avoided in the most rational possible conduct of the process”.

20. They also refer to Figures 3 and 4 of the patent (reproduced below), which show the paths, and to the corresponding part of the description at page 6, lines 8 to 10, where it says that:

“The material of the individual layers 11 is removed by laser along paths 12 indicated respectively by broken lines and greatly enlarged, by moving the laser beam 10 relative to the surface 6 of the component 1 line by line”.

22. The proprietor argues that overlapping of the paths is allowed by the patent, though not in its most technically perfect implementation, and not to the high degree of overlap shown in the method of US5609779 (discussed below).
23. Although I do not agree, as is suggested by the requester, that the literal meaning of the word “adjacent” necessarily implies no overlapping, it does seem to me that the correct construction to place upon these words within the context of the description and drawings is that the adjacent paths do not overlap in so far as is possible, or if they do, the amount of overlap is kept to a minimum. Claim 1 is silent as to the amount of overlap; however, the only references in the description and drawings, as noted above, point to the paths not overlapping. Indeed, given that the stated aim of the invention is to achieve a surface with the best possible surface quality and accuracy of shape (p2 lines 5 and 6), the skilled person would be led away from overlapping the paths, since any overlapping areas are subjected to higher energy levels, resulting in pitting of the surface. Such an interpretation is backed up by the paths 12 illustrated in figures 3 and 4 of the patent, which are adjacent, and not overlapping. Furthermore, the final part of claim 1 specifies that the laser beam is moved “...*in a plurality of adjacent paths (12) matched in length and number to the shape of the funnel (9) as the layers (11) are removed*”. These words have clearly been included for a reason, and have no real meaning unless they qualify the feature of the paths not overlapping.
24. An additional point worth mentioning here with regard to these words concerns the final paragraph on p8 of the patent. This states that in another embodiment of the process, the material of the individual layers “can be removed by moving the laser beam 10 in a spiral path around the centre axis of the opening 2”. Although it is arguable that a spiral path is not the same as a “plurality of paths”, as required by claim 1, for the purposes of this opinion I shall treat this embodiment as falling within the scope of the claims.

Validity

25. No arguments have been put forward that the claims lack novelty. As I understand it, the requester alleges that the claim 1 of the patent lacks an inventive step when the disclosure of US5609779 is considered along with the common general knowledge, as exemplified by US3894208 and a number of scientific papers, D1 to D7. It also alleges that claims 2 to 10 lack an inventive step when US5609779 is considered in combination with D5 (Bostanjoglo et al). The proprietor disagrees. It should be noted that the requester has stated that the US equivalent of the patent has been found to lack an inventive step upon re-examination in light of US5609779 and D5 (Bostanjoglo et al). I should perhaps also note here that in an e-

mail dated 28 September 2007, the proprietor has argued that the requester has misrepresented the outcome of this re-examination. This e-mailed observation appears to be outside the time allowed for observations, and it is questionable whether I should take account of it. However, as the requester has also correctly stated, I am not in any way bound by the US re-examination, and this does not appear to be a matter for any great concern.

26. The recent decision in *Pozzoli SPA v BDMO SA* [2007] EWCA Civ 588 sets out a restated version of the well-known Windsurfing approach to inventive step. In particular, I have to consider the following:

(1)(a) Identify the notional “person skilled in the art”;

(1)(b) Identify the relevant common general knowledge of that person;

(2) Identify the inventive concept of the claim in question or if that cannot readily be done, construe it;

(3) Identify what, if any, differences exist between the matter cited as forming part of the “state of the art” and the inventive concept of the claim or the claim as construed;

(4) Viewed without any knowledge of the alleged invention as claimed, do those differences constitute steps which would have been obvious to the person skilled in the art, or do they require any degree of invention?

The person skilled in the art

27. I identify the person skilled in the art to be someone working on the design of processes for machining engineering components in the aerospace industry.

The common general knowledge

28. The requester argues that each of US3894208 and documents D1 to D7 show the common general knowledge of the skilled person at the priority date. These documents will now be discussed briefly in turn. For the avoidance of doubt, they were each published before the priority date of the patent, and so can be considered for inventive step, with the exception of D6 (White et al), which the requester relies upon to give a definition of a known technique in the art.

29. US3894208 and D1 (Nolte et al) are relied upon to demonstrate that sublimation is a well known technique in laser cutting. Taken along with the extract from Dubbel supplied by the proprietor (discussed above), I

believe it is clear that laser sublimation cutting was indeed part of the common general knowledge at the priority date.

30. I also understand the requester's argument to be that it was common general knowledge at the priority date to use lasers to remove material along a plurality of adjacent paths, where each layer has a substantially constant thickness. They rely on documents D2 to D7 to show this.
31. D2 (Hellrung et al) mentions how a microstructure is divided up into several slices with a definite thickness. It says (at p269) that this thickness corresponds to "*the average depth of removal per laser pulse, which mainly depends on the energy and the overlap of the laser pulses, the properties of the material and the wavelength of the laser radiation*". Page 270 goes on to state that "*With an increasing overlap the average removal depth per laser pulse, respectively the thickness of a single slice, grows*". It also mentions a situation where laser pulses do not overlap (at p270, line 1).
32. It seems to me that this document discloses a method of producing microstructures where material is removed along a plurality of adjacent paths, and where a number of layers are removed having a constant thickness, as can be seen from Figure 2.
33. D3 (Ramos et al) discloses (at p212, lines 4 and 5) "*...In laser micromachining technique creates a binary structure, where "0" corresponds to non affected surface, and where "1" correspond to machined surface of certain depth, in this case constant. The separation between the laser impacts is kept constant, producing thus a homogenous machining. The machining depth is achieved by repetition of process*" [sic]. It goes on to say (on the same page): "*...The laser micromachining process aloud an accurate elimination of material per each impact (around 7-10 microns diameter and 4-6 microns depth). This give the possibility to build relieves very accurately*" [sic]. Although to my mind this document does not actually specify a plurality of adjacent paths with material being removed in layers of constant thickness, I believe as much to be implicit from this document.
34. D4 (Wang et al) discloses a method of engraving. A laser beam is directed towards a surface to be engraved through a lens by computer controlled X-axis and Y-axis mirrors, and moved in a fixed path. Figures 3 and 5 show examples of a process that uses a plurality of adjacent paths, although there are no references to material being removed in layers of constant depth.
35. D5 (Bostanjoglo et al) discloses the use of a laser beam to machine holes in gas turbine components by trepan drilling. Trepan drilling is set out (at

p148) as the method whereby a hole is pierced into a workpiece, and then a circular cut is performed around the pierced hole. It also states (at p147) that: "Optimal trepan drilling is likely to be achieved, if the cutting head is moved by a numerically controlled XY-stage such that the focus follows a spiral-like path". It is noted also that the use of a spiral path is shown in figure 3 of D8 (Gillner et al), which is not specifically referred to in the body of the request.

36. It would seem that D6 (White et al) and D7 (French et al) have been provided by the requester to show that laser trepanning is well known in the art. Since this is clear from D5 (Bostanjoglo et al), I do not believe it is necessary to consider these documents any further.
37. Although no reference is made in the body of the request to D8 (Gillner et al), its contents are similar to D2 (Hellrung et al). However, it also discloses different material removal strategies whereby a spiral path can be used.
38. From a consideration of these documents, I believe that the following can be said about the common general knowledge of the skilled person at the priority date of the patent:
 - i. The technique of laser sublimation cutting was part of the common general knowledge.
 - ii. The use of a laser beam to remove material along a plurality of adjacent paths was well known, and it would also be within the mind of the skilled person that material could be removed in layers of constant thickness. Even though only one of the documents (D5) is clearly relevant to the art of machining gas turbine components, I consider that they nevertheless disclose basic principles that would be known to the skilled person.
 - iii. The amount of overlap between laser pulses would be a known consideration to the skilled man in designing a laser process, and following on from this I believe the skilled person would have been aware of the possibility of zero overlap between laser pulses, or laser paths.
 - iv. The general techniques of trepan drilling and spiral drilling were well known.

The inventive concept

39. This part of the test for inventive step is straightforward, and I identify it as being the matter specified in the characterizing part of claim 1. Therefore, I shall now turn to the differences between what the requester has submitted as the state of the art, US5609779, and the inventive concept of

the claim.

US 5609779

40. This document discloses a process of forming a non-cylindrical funnel in a turbine blade from a first surface of a component to a second surface, using a pulsed laser beam having a pulse rate and power sufficient to vaporize the metal.

41. It describes (at column 1 line 60 to column 2 line 8) how in conventional laser drilling of through holes in gas turbine engines, successive laser pulses fall on the same spot. The cumulative effect of the variation in energy of each pulse means that there can be significant variation in the configuration of the apertures formed.

42. It therefore provides a method of limiting the effect of the variation in energy between successive pulses. In order to do this, it sets out a process whereby a pulsed laser beam traverses the component starting at a centerline 30 in a number of traversals, 1-6 (as shown in Figure 4, reproduced below, and described at column 5 lines 59 to 66). During each traversal, the beam moves at an increasing speed so that each pulse vaporizes the metal at a laser spot S, such that successive laser spots overlap in decreasing amounts. Adjacent long trenches L1-L3 may have different lengths so as to form a diffuser having a substantially trapezoidal cross-section. A number of sequences of traversals may be used to form the diffuser.

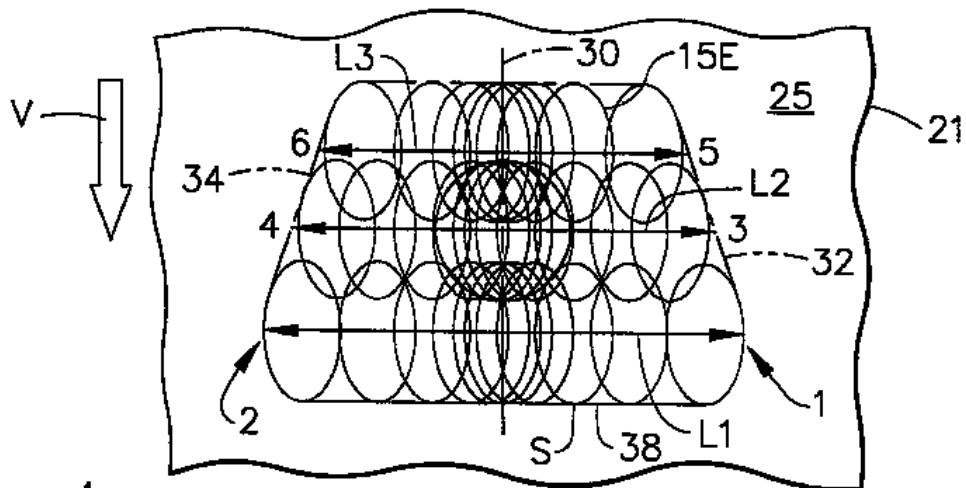


FIG. 4

Differences with the inventive concept of the claim

43. I consider that there are three main differences between what is disclosed

in this document and the above identified inventive concept of claim 1:

i. Although no explicit mention is made as to the depth of cut of each traversal, it is clear that by increasing the speed of each traversal towards an outside edge of the diffuser, more energy is concentrated near the centerline 30, and therefore each traversal will be deeper towards the centerline. In other words, there is no disclosure of each layer having “a substantially constant thickness”.

ii. Although the paths shown in the figures of US5609779 can be described as “adjacent”, they clearly overlap, as can be seen for example in figure 4. As has been discussed above, I agree with the requester that the patent requires no overlap between adjacent paths, or that the amount of overlap is kept to a minimum.

iii. There is no disclosure that the material is removed “mainly by sublimation”, or even by sublimation at all. There are a number of references within US5609779 to material being removed through vaporization of material. However, this does not necessarily indicate sublimation, since vaporization could be achieved through evaporation of melted material. It seems highly unlikely that sublimation does occur considering that high energies are required for sublimation, whereas the laser parameters specified in US5609779 are of several times lower magnitude than those of those specified in the patent, as shown in the table below.

	US5609779	The patent
Pulse frequency	10-50Hz	1-50kHz
Pulse duration	0.6-2ms	10-1000ns
Pulse power	30-300W	50kW-1MW

Would these differences be obvious to the skilled person?

44. It seems to me that the whole thrust of US5609779 is to the removal of layers of material by starting a laser beam at a centerline and increasing the speed of the beam such that successive spots overlap to a smaller extent; this avoids the problem of the accumulation of variations in energy per pulse. I can see no reason why the skilled, but unimaginative person would be led to performing any of the adaptations necessary to lead to the features of claim 1, let alone all three. For instance, it says at column 1 lines 54 to 59:

“... The sidewalls and bottom of the slot should preferably be relatively smooth for aerodynamic reasons.... The walls and bottom should also be sufficiently smooth to avoid undesirable stress concentrations....”. (my emphasis added)

45. The underlined words do not really suggest that high precision is the utmost consideration of this document, as it is in the patent. Although I have concluded above that sublimation cutting would have formed part of the common general knowledge of the skilled man at the priority date, I can see nothing in any part of US5609779 that would lead the skilled person to use it in the process described. Furthermore, although sublimation cutting seems to have been well known at the priority date, I have been provided with no evidence of its use in manufacturing diffusers for gas turbine components.
46. Even if such a step were taken, there is nothing within this document that would also suggest the possibility of the removal of material in layers having a constant thickness. It seems to me that the increasing speed with which the laser traverses the material is at the very heart of the invention described in this document. It is clear that the material removed by each layer would not have a constant thickness, and no argument to the contrary has been made by the requester.
47. Furthermore, the varying degrees of overlap used in the process of US5609779 is also a result of the increasing speed with which the laser makes each traversal. Again, I can see no reason that would induce the skilled person to alter this.
48. Finally, to adapt the process of US5609779 to use trepan or spiral drilling, as shown, for instance, in D5 (Bostanjoglo et al), does not appear to me to be at all feasible. Apart from the issues of sublimation; removal of layers having a constant thickness; or overlap between paths; the method of US5609779, where the laser starts at a centerline, could not easily be re-worked to a method of trepan or spiral drilling, owing to the completely different geometrical requirements of such methods. Trepan drilling would require the laser to start at the circumference of a circle to be cut, or the centre of a spiral. To my mind, such an alteration could only be achieved with the benefit of hindsight.
49. I therefore conclude that claim 1 involves an inventive step, as do the appendant claims.

Infringement

50. Having concluded that the claims are valid, I shall go on to consider the issue of infringement. The requester has provided information regarding its own process of laser cutting, which it submits does not infringe claim 1. This process is accompanied by four figures. As I understand it, the requester's process involves the following:

- Material is removed in the vapour phase, but there is always a pool of molten metal or melt from the workpiece beneath the focus of the laser beam, such that typically in excess of 30% of the material to be removed passes from the solid to the liquid phase during machining. The requester also states that its process does not use sublimation.
- The laser beam follows tracks as shown in Figure 2 accompanying the request, and adjacent paths overlap by 50%.

51. The absence of sublimation in the requester's process, and the use of a 50% overlap between adjacent paths leads me to conclude that claim 1 is not infringed by the process set out in the request. It therefore also follows that claims 2 to 10 are not infringed either.

Conclusion

52. The claims are novel and involve an inventive over the prior art.

53. The requester's process does not infringe the process of the patent.

Review

54. Under section 74B and rule 77H, the proprietor may within three months of the date of issue of this opinion, apply to the comptroller for a review of the opinion.

55. Under rule 77H(5) such an application for review may be made by the proprietor only on the grounds that by reason of its interpretation of the specification of the patent, the opinion wrongly concluded that a particular act would not constitute an infringement of the patent.

Gareth Prothero
Examiner