



PATENTS ACT 1977

APPLICANT	The Boeing Company
ISSUE	Inventive Step
HEARING OFFICER	Peter Mason

DECISION

Introduction

- 1 This decision concerns patent application GB 1620705.2 “Infrared Thermographic Porosity Quantification in Composite Structures” in the name of The Boeing Company, and whether the invention, as defined by the claims, comprises an inventive step as required by section 1(1)(b) of the Patents Act 1977 (herein after the “Act”). The application was filed on 6 December 2016 claiming priority to 7 December 2015 and was published on 28 June 2017.
- 2 In their initial combined search and examination report the examiner presented their view the independent claims were not novel or did not involve the inventive step required by section 1(1) of the Act. After several rounds of correspondence and amendment the claims are accepted as novel but the agent has been unable to convince the examiner that they are inventive. At this impasse, the agent has accepted the examiner’s suggestion to refer the application to a hearing officer, and in their letter of the 7 April 2020 they requested a decision to be made based on the state of the written file.
- 3 The application has been referred to me to decide if the invention involves an inventive step.

The invention

- 4 The application relates generally to structural analysis of composite structures. The nature of those composite structures is not described or exemplified, but the background of the application sets the scene that evaluation is of interest to various industries including the aerospace industry. Specifically, the application concerns analysis of porosity of a part which has a given thickness. This is understood to be that the thickness is known a priori analysis. The application presents the situation that the widely favoured means for measuring porosity is ultrasonic inspection but that this technique is flawed. The solution presented in the application is achieved in

general terms by utilising standard infra-red thermographic techniques but involves comparing the analysis with predetermined model data and using that comparison to determine the porosity of the test piece. The application states in the penultimate sentence of page 6:

“the presence of porosities within the test part 102 may hinder or slow the rate of transfer of heat, and thereby exhibit longer diffusion times or a perceived thickness that is greater than the actual thickness”

- 5 From reading the application as a whole, I would summarise this as: the thicker a part appears to be compared to its known thickness, the more porous it must to be.
- 6 The application goes on to explain the nature of the model data that is needed and gives sufficient direction on the comparisons to determine porosity (page 7).
- 7 The claims have been amended since filing and are now presented, as filed on 7 April 2020, as a method (claim 1), a controller (claim 3) and a system (claim 5):

Claim 1

A method of inspecting porosity of a composite test part with a given thickness, comprising:

emitting, by a thermal source, one or more heat pulses onto the test part;

detecting, by a thermal detector, infrared (IR) signals emitted from the test part;

determining thermal test data associated with the test part based on the IR signals, wherein the thermal test data includes one or more IR curves indicative of a perceived thickness of the test part, wherein the thermal test data includes at least temperature data and diffusion times derived from the IR signals;

retrieving thermal model data including one or more baseline curves indicative of a reference porosity for a model part having substantially the same thickness as the test part, wherein the thermal model data is retrieved from a plurality of porosity standards which interrelate different reference porosities for different thicknesses of the test part; and

determining porosity of the test part, comprising comparing the thermal test data and the thermal model data to determine a deviation therebetween, wherein the porosity of the test part is derived based on the deviation indicating an apparent increase in thickness of the test part over the known actual thickness of the test part.

Claim 3

A controller arranged for inspecting porosity of a composite test part of a given thickness, the controller in electrical communication with at least one thermal source and configured to control heat pulses emitted therefrom, the controller comprising:

a data analysis module configured to determine thermal test data based on infrared (IR) signals emitted from the test part, wherein the thermal test data includes one or more IR curves indicative of a perceived thickness of the test part, wherein the thermal test data includes at least temperature data and diffusion times derived from the IR signals, and wherein the data analysis

module is configured to communicate with a thermal detector to receive the IR signals;

a reference module configured to retrieve thermal model data including one or more baseline curves indicative of a reference porosity for a model part having substantially the same thickness as the test part, wherein the thermal model data is retrieved from a plurality of porosity standards which interrelate different reference porosities for different thicknesses of the test part;

a comparison module configured to compare the thermal test data and the thermal model data to determine a deviation therebetween; and

an assessment module configured to determine porosity of the test part based on the deviation indicating an apparent increase in thickness of the test part over the known actual thickness of the test part.

Claim 5

A system arranged for inspecting porosity of a test part of a given thickness, comprising:

at least one thermal source configured to emit one or more heat pulses onto the test part;

a thermal detector configured to detect infrared (IR) signals emitted from the test part; and

a controller according to any one of claims 3 to 4, the controller further being in electrical communication with the thermal source.

The law - Inventive step

- 8 Section 1(1) of the Act sets out the requirements which need to be met for a patent to be granted:

A patent may be granted only for an invention in respect of which the following conditions are satisfied, that is to say –

(a) the invention is new;

(b) it involves an inventive step;

(c) is capable of industrial application;

(d) the grant of a patent for it is not excluded by subsections (2) and (3) or section 4A below;

and references in this Act to a patentable invention shall be construed accordingly.

- 9 Section 3 of the Act sets out how inventive step is determined:

An invention shall be taken to involve an inventive step if it is not obvious to a person skilled in the art, having regard to any matter which forms part of the state of the art by virtue only of section 2(2) above (and disregarding section 2(3) above).

- 10 Matter which “forms part of the state of the art by virtue only of section 2(2)” is all matter which was made available to the public before the priority date of the application in question. In this case all matter published before 7 December 2015.

- 11 It is well-established that the approach to adopt when assessing whether an invention involves an inventive step or not is to follow the steps originally set out by the Court of Appeal in *Windsurfing*¹ and reformulated by the Court in *Pozzoli*²:

- (1) (a) *Identify the notional “person skilled in the art”*
(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?*

Arguments and analysis

- 12 The issue I must now consider is whether the invention as defined by the claims comprises an inventive step as required by section 1(1)(b) of the Act. As such, I will follow the so-called *Windsurfing/Pozzoli* steps set out above.

Step 1 – Identify the notional person skilled in the art and their common general knowledge

- 13 In their examination reports³ the examiner describes the skilled person as one familiar with the arts of non-destructive testing and the principles of thermography. The examiner also contends that the skilled addressee “would understand how to derive perceived thickness from the IR curve, and they would be aware of porosity standards and how to use them”⁴.
- 14 The agent does not explicitly contest the examiner’s definition of the skilled addressee and does not present any clear explanation of their general knowledge. However, there are implications that they disagree with the examiner’s view on the skilled person and I note for example their comment “even if...the skilled person was familiar with comparing thermal diffusivity...” in their letter of 11 July 2019.
- 15 I must decide for myself who the skilled person is and what their common general knowledge is. I must do this ahead of considering the scope of the claim so as to ensure I am in the position of the skilled person before they arrive at their invention – this was the intention of the reformulation of *Windsurfing* by *Pozzoli*.
- 16 To my mind, here we have a person concerned with the analysis of properties of materials, such as composite materials, and this has to include the awareness of various non-destructive testing methods. I do not think it is reasonable to assume they would have in-depth knowledge of any techniques except those which are the

¹*Windsurfing International Inc. v Tabur Marine (Great Britain) Ltd*, [1985] RPC 59

² *Pozzoli SPA v BDMO SA* [2007] EWCA Civ 588

³ Examination report 23 March 2018, paragraph 9; Examination report 22 May 2018, paragraph 5; Examination report 14 September 2018, paragraph 16

⁴ Examination report 14 September 2018, paragraph 16

most standard, but I am sure they would know where to turn to find out more once a clear signpost is given. This approach seems to follow the spirit confirmed in Raychem⁵.

- 17 I note the examiner stated their view that the skilled person “would understand how to derive [a] perceived thickness from [an] IR curve”⁶. My view is somewhat different. I do not believe the skilled person here will have this knowledge immediately to hand in their common general knowledge. That is not to say the skilled person trying to understand how to work an invention which clearly directs towards this would not know how to resolve it, but that particular skilled person is approaching from a different position than we are at now⁷. Here, I am sure the skilled addressee will know how to understand an IR curve, and if presented with that data they will recognise that it can be used to derive thickness of a material. But in order to appreciate the subtlety of whether that is a true or a perceived thickness will require some clear direction from the context of what they are reading.
- 18 I believe a similar point needs to be made in respect of the skilled person’s knowledge of porosity standards. Once directed to relevant porosity standards the skilled addressee will know how to investigate and will understand them, no doubt. But I do not think it’s reasonable to conclude any skilled addressee will naturally have this in their common general knowledge.

Step 2 – Identify the inventive concept of the claim in question, or if that cannot readily be done construe it

- 19 For the sake of completeness, I will state my view that the skilled addressee would have no issues in understanding the scope of the claims or of working them across their full breadth. The application as a whole presents sufficient signposts to the skilled addressee who is looking to work the invention.
- 20 Following the instruction made in Pozzoli, at this stage I do not take account of the prior art. Aiming to cover the common subject matter between the method and controller, I consider the inventive concept to be:
- (1) Inspecting porosity of a test part with*
 - (2) a given thickness,*
 - comprising:*
 - (3) determining thermal test data associated with the test part based on infra-red (IR) signals emitted by the test part,*
 - (4) wherein the thermal test data includes one or more IR curves indicative of a perceived thickness of the test part,*
 - (5) wherein the thermal test data includes at least temperature data and diffusion times derived from the IR signals;*
 - (6) retrieving thermal model data*
 - (7) including one or more baseline curves indicative of a reference porosity for a model part having substantially the same thickness as the test part,*

⁵ Raychem Corp’s Patents [1998] RPC 31 – quoted in the MoPP 3.30

⁶ Examination report 14 Sept 2018, paragraph 16

⁷ Manual of Patent Practice (MoPP) puts this eloquently in paragraph 14.64 and I do not need to repeat it here

- (8) wherein the thermal model data is retrieved from a plurality of porosity standards
- (9) which interrelate different reference porosities for different thicknesses of the test part; and
- (10) determining porosity of the test part, comprising
 - (11) comparing the thermal test data and the thermal model data to determine a deviation therebetween,
 - (12) wherein the porosity of the test part is derived based on the deviation
 - (13) indicating an apparent increase in thickness of the test part over the known actual thickness of the test part.

21 I have numbered each clause for ease of reference in my analysis that follows.

Documents relevant to the state of the art

22 In their final report of 16 April 2020, the examiner re-iterates their view that the most relevant prior art disclosures are:

Shepard, "Flash thermography of aerospace composites", IV Conferencia Panamericana de END Buenos Aires Octubre 2007. Published [online] by NDT.net. (*hereafter, Shepherd*)

Shepard et al., "Automated processing of thermographic derivatives for quality assurance", Optical Engineering, vol. 46(5), 051008. Published by SPIE, May 2007. (*hereafter, Shepherd et al*)

EP 1852697 A1 (SIEMENS) (*hereafter, Siemens*)

23 Shepherd is a conference paper from the Pan-American Conference for Non-Destructive Testing. Shepherd et al is a paper submitted to the journal Optical Engineering. The papers have similar disclosure, discussing techniques in the aerospace and automotive industries, respectively. Siemens is a patent document and its disclosure is distinct from the other papers. As such, I will discuss them separately in respect of steps 3 & 4.

Shepherd and Shepherd et al

Step 3 – Identify the differences between the state of the art and the inventive concept

24 Shepherd was published in October 2007. It describes the use of pulsed thermography for non-destructive testing and inspection (NDT). It is concerned primarily with the identification of subsurface defects and uses the example of composite materials. It makes reference to using pulsed thermography to understand the thickness of a sample, or the depth of a defect, from knowledge of the thermal diffusivity of that sample, and vice versa (paragraph bridging pages 3-4). It also notes the approach does not require reference or correlation to other samples (paragraph bridging pages 6-7). As such, Shepherd describes elements which meet clauses 3, 4 and 5 of the inventive concept.

25 Shepherd et al was published in May 2007 and is similar to Shepherd. It introduces the idea that thermography is used widely in NDT in some industries (eg aerospace) but has not been accepted in the automotive industry. It provides comparison with other inspection techniques such as X-ray and ultrasound. It describes the use of thermography for detection of defects and discontinuities and indicates detection relies on human manual analysis of contrast in an image (page 2, column 1). The document is concerned with detection of defects and states the nature of defects is not usually known (page 4, column 2 “3.1 Automated Defect Detection”; and page 5, column 2 “4 Conclusion”). The proposed solution is to identify deviation from the expected performance (page 5, column 1). The paper states the properties of samples under investigation vary depending upon thickness and thermal diffusivity. In its conclusion this paper teaches the reader towards building a knowledge base of pre-computed derivative characteristics for comparison inspection by thermographic, human, or complementary techniques. As with Shepherd, this document describes elements which meet clauses 3, 4 and 5 of the inventive concept. It also teaches toward clause 6 but does not clearly disclose detail on how to achieve it.

Step 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

26 While there are clearly similarities between the approach of the present inventive concept and the disclosure of these documents, it is clear to me that the differences between them are simply too great to be obvious. The features which are missing from those documents are not within the common general knowledge of the skilled person. Specifically, neither document provides any motivation to investigate porosity. With the benefit of hindsight one might be tempted to think of porosity as a necessary defect and so read the reference to defect within these documents as encouraging investigation into porosity. But viewed without the benefit of the present application’s disclosure I do not see any link.

27 Furthermore, neither document eludes to working with samples of known thickness. Each document suggests thickness can be determined, but this is quite distinct from the predetermined knowledge of the invention we’re considering. And even if the references to determining thickness could be understood to read on to a given thickness then it is not clear what feature would teach toward understanding the *perceived thickness* required by the invention.

28 If either of these documents did pique the interest of the skilled addressee then I do not see that either of them provides sufficient direction or motivation to encourage the skilled addressee to develop them in a direction that would – or even could – arrive at the inventions defined by the claims. The present invention is inventively distinct over each of these documents.

Siemens (EP1852697)

Step 3 – Identify the differences between the state of the art and the inventive concept

29 Siemens was published in November 2007. As is typical for many patent documents, it sets out the background to the application, aspects of the inventive concept and

then discusses detailed examples looking to provide enabled disclosure. I will set out the disclosure of Siemens and will comment when parts of the disclosure map across to the present inventive concept – this is for convenience of this reporting and does not indicate conflation of the thought process distinguishing steps 3 and 4 of the test.

- 30 Siemens concerns determining material parameters of an object using thermography. The object is exemplified as having layered coatings and might be a turbine blade (paras 0001-0002). Later in the document examples are provided as a metal substrate and ceramic coating (paras 0019, 0039, 0060). It acknowledges the use of thermography as a non-destructive testing (NDT) technique to detect defects or to determine thickness of coatings or the like (para 0004).
- 31 At this point I need to comment on whether the skilled addressee would consider Siemens. In their letter of 25 October 2018, the agent states their view that the skilled addressee would not look at this document because it is not concerned with composite materials. This suggests the skilled addressee must have an interest only in composite materials. However, I think it would be equally likely for the skilled addressee to be interested in non-destructive testing and so I do not think we can assume the skilled addressee would immediately dismiss it. In any case, the question isn't necessarily whether the skilled addressee would look for this document, but what the skilled addressee would do with the document's disclosure once they have seen it⁸.
- 32 Siemens' first aspect of the invention provides a method of determining material parameters based on measured surface temperature at a given time since a flash heating event (para 0009). That is, the temperature is measured as the heat diffuses. This is clearly the same process as the clauses 3 and 5 I labelled above. Paragraph 0010 teaches the advantages of deriving multiple parameters from a single test. To that end, the document focusses on determining at least two parameters and these are given as thermal thickness and thermal reflectivity (para 0014). Thermal thickness is a factor of geometrical thickness and thermal diffusivity, with thermal diffusivity in turn dependent on other factors such as density. Thermal reflectivity requires comparison of neighbouring layers and is also dependent upon density. The document then explicitly tells the reader that thermal thickness can be determined from the temperature-time (T-t) graphs (para 0015). That is, the skilled addressee now understands the implication of the T-t graph in determining a relative measure of thickness of the test part. If I take this opportunity to compare this with the present invention, the present invention only makes reference to "perceived thickness" and expects the skilled addressee to understand how to achieve this. Considering the implications and disclosure, I think this is a reasonable burden to expect once direction is given and as is set out on the present application's pages 6 and 7.
- 33 At this point I will note the agent's comments in their letter of 25 October 2018 that the prior art teaches toward complex equations while their client's invention uses only baseline curve comparisons. However, I think that is taking part of the prior art's disclosure out of context. The relevant part of the prior art here is the determination of the perceived/thermal thickness of the sample which is the same in both

⁸ Pfizer Ltd's Patent [2001] FSR 16 at paragraph 66 - MoPP 3.40

disclosures. Consequently, I am clear that Siemens also describes the fourth clause of the inventive concept.

- 34 Siemens goes on to describe how thermal reflectivity can be determined as the second of the parameters referred to as essential to its invention. But this does not appear to be relevant to the present application.
- 35 In a second aspect, Siemens defines a similar method for determining the same two parameters but for a sample comprising multiple layers. In respect of this aspect the disclosure makes a statement that thermal thickness and thermal reflectivity can be used to calculate other parameters which include porosity (para 0020). From this point in reading the document the skilled addressee has some indication of a relationship between porosity, thermal thickness and thermal reflectivity, but no clear direction has yet been given and it might appear that porosity requires knowledge of both thermal thickness and thermal reflectivity.
- 36 Further aspects of the Siemens invention concern the deconvolution of the data which is not essentially linked to the other aspects of the invention and its disclosure.
- 37 Turning to the specific examples and detail presented within Siemens, it teaches that the T-t graph for a homogeneous material will have a straight line with no inflections. While it briefly touches on homogeneous materials with finite thickness (p6, lines 1-14) it focusses its teaching on layered objects (fig 3, para 0038) and goes on to compare how results may differ with different layer thicknesses (paras 0039-44). Paragraph 0044 states the thermal thickness of the underlying substrate can be calculated based on "thickness or thermal diffusivity of the substrate" (p6, line 54). A statement is made that when one of either geometrical thickness or thermal diffusivity is known, the other can be then be determined once thermal thickness has been calculated (p6, lines 55-57). A summary is presented stating that for a two-layered object, three parameters can be extracted: thermal thickness of each layer, and thermal reflectivity coefficient of the layers together (para 45). Furthermore, porosity can be determined from these parameters using calibration tables (p7, lines 3-5). Comparing this disclosure with the inventive concept I have set out, the reference to determining porosity seems to meet a reasonable expectation of clause 1, and the earlier reference to knowledge of the geometrical thickness meets the expectation of clause 2.
- 38 In order to understand more of what Siemens means by determining material properties such as porosity and using calibration tables (paragraph 0045), we can read ahead to paragraph 0058. This paragraph teaches an approach to connect thermal reflectivity and thermal thickness with thickness and porosity. The statement is made that a relationship between thermal parameters and porosity must be known in advance from calibration measurements. Comparing this to the present inventive concept, the two certainly appear very close. Undoubtedly, Siemens gives the skilled addressee a clear motivation to prepare thickness and porosity data in advance and that is something akin to clauses 6 and 8 of the inventive concept, at least. That said, it does not clearly go as far as presenting anything that reads on to data for a baseline curve indicative of reference porosity (clause 7) or model data which interrelates different porosities for different thicknesses (clause 9).

39 If Siemens does not disclose clauses 7 and 9, then later dependent clauses 10-13 cannot be disclosed. At these differences I must move on to the fourth step of the test.

Step 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

40 Based on the differences between Siemens and the inventive concept, I must ask:

1) Would the skilled addressee prepare calibration measurements or standards which include data to compile a baseline curve of a reference porosity (clause 7)?

2) Would the skilled addressee prepare calibration measurements or standards which interrelate different reference porosities for different thicknesses of test part (clause 9)?

3) And if both of those are answered in the affirmative, would the skilled addressee determine porosity by comparing the test data and the standards to determine a deviation which indicates an apparent increase in thickness of the test part and from which porosity can be derived?

Question 1:

41 While Siemens does give these clear directions to prepare thermal parameter and porosity calibrations in advance (para 0058), it does not give any further help on how that might be achieved, leaving the skilled addressee to find their own solutions. It is here that we must consider skilled addressee's common general knowledge.

42 The examiner has attempted to understand that common general knowledge and in their report of 14 September 2018 they included documents exemplifying porosity standards. As examples, two of these describe compiling porosity standards with multiple sets of different porosities for similar thicknesses (EP2706345, WO2014/193601). However, while they describe compiling porosity standards they do not clearly describe data which would be used to form a baseline curve. While I am not convinced these can really be taken to be exemplary of the common general knowledge, even if they were then I do not see that they complete the gap over the prior art in respect of clause 7.

Question 2:

43 Turning again to the documents provided as examples of the common general knowledge, I must ask if they demonstrate that the skilled addressee would understand to retrieve standards which interrelate different reference porosities for different thicknesses of test part. Taking EP2706345 as the best example, this demonstrates the preparation of porosity standards where different reference porosities are compiled for the same thicknesses of test part. Even if this disclosure was part of the common general knowledge, or even if the skilled addressee has reason to look for it, then I do not see that this would bring them to the subject matter of the clause 9 of the present inventive concept.

Question 3:

- 44 As I have answered both questions 1 and 2 in the negative I do not need to consider the third question.
- 45 I therefore conclude that the differences between Siemens and the claims as construed would not be obvious to the person skilled in the art.

Conclusion

- 46 I find that the claims comprise an inventive step as required by section 1(1)(b) of the Act. I therefore refer the application back to the examiner to conclude the proceedings.

Appeal

- 47 Any appeal must be lodged within 28 days after the date of this decision.

Peter Mason

Deputy Director, acting for the Comptroller