

OPINION UNDER SECTION 74A

Patent	EP 2737180 B1
Proprietor(s)	United Technologies Corporation
Exclusive Licensee	
Requester	Rolls-Royce
Observer(s)	
Date Opinion issued	01 March 2019

The request

1. The comptroller has been requested by Rolls-Royce (the Requester) to issue an opinion on whether EP(GB) 2737180 B1 (the Patent), which relates to a flexible support structure for a geared architecture gas turbine engine, is valid. More specifically the Requester has asked for an opinion on validity on the following grounds:
 - (i) whether all the claims of the Patent lack an inventive step in light of documents D1-D17 provided by the Requester
 - (ii) whether the Proprietor is entitled to the Patent,
 - (iii) whether the disclosure is sufficiently clear and complete for the invention to be carried out by a person skilled in the art,
 - (iv) whether the Patent includes subject matter which extends beyond that disclosed in the application for the patent, and
 - (v) whether the Patent is entitled to its priority claim.
2. The request was received on the 8th November 2018 and was accompanied by a statement explaining the request as well as copies of the various documents relied on. These are as follows:
 - (D0) US 9133729 B1 (United Technologies)
 - (D1) US 8297916 B1 (United Technologies)
 - (D2) US 8297917 B1 (United Technologies)
 - (D3) EP 2532841 B1 (United Technologies)
 - (D4) EP 2532858 B1 (United Technologies)
 - (D5) US 2011/61494453P (United Technologies)
 - (D6) US 5433674 B1 (United Technologies)

(D7) US 6223616 B1 (United Technologies)
(D8) US 2010/105516 (United Technologies)
(D9) US 2011/0130246 A1 (United Technologies)
(D10) "Quiet Clean Short-Haul Experimental Engine (QCSEE) Main Reduction Gears Detailed Final Report", NASA CR-13872.
(D11) "Energy Efficient Engine Preliminary Design and Integration Studies" NASCAR-135396.
(D12) "Expansion of Epicyclic Gear Dynamic Analysis Programme; Final Report", NASA CR-179563.
(D13) "Load Sharing Behaviour in Epicyclic Gears: Physical Explanation and Generalizes Formulation", Singh.
(D14) ANSI-AGMA 6001-D97
(D15) ANSI-AGMA 9004-A99
(D16) ANSI-AGMA 6123-B06
(D17) ANSI-AGMA 940-A09
(D18) WO 2014/047040 (United Technologies)
(R1) <https://en.wikipedia.org/wiki/Stiffness> & https://en.wikipedia.org/wiki/Torsion_spring
(R2) "Dynamic Model of a Helical Gear Pair with Backlash and Angle-Varying Mesh Stiffness", Amezketa

3. Observations were filed by the Proprietor on the 21st December 2018. Observations in reply were filed by the Requester on 18th January 2019 in which the Requester seeks support for part of their argument in pre-grant communications from the EPO in relation to three related patent applications EP 3045684 A, EP 3098396 A and EP 3296526 A1.
4. Both sides sought to submit further observations. The Opinion Service however only provides for the three rounds of correspondence hence the submissions filed after the observations in reply have not been considered.

Whether all parts of the request are allowable

5. The comptroller will only issue an opinion in relation to a prescribed matter. This is by virtue of section 74A(1) of the Patents Act 1977 (the Act). The matters for which an opinion may be sought are prescribed in rule 93(6) of the Patents Rules 2007, as amended, (the Rules). These matters do not include whether the patent was granted to a person not entitled hence I am not able to give an opinion on that aspect of the request. Furthermore, these matters do not include whether the patent is entitled to an earlier priority date hence I am not able to give an opinion on that aspect of the request in isolation however it can be considered if it is necessary to determine the questions of novelty or inventive step
6. In this instance a number of the documents that the Requester relies on in respect of its inventive step attack do depend on the priority date of the patent. I will therefore consider it.

The priority date of the patent

7. The Requester alleges that the Patent is not entitled to its priority claim of 20th September 2012 which is based on the filing date of US9133729 (Document D0).

It argues that this patent is a continuation-in-part of US 13/342508 which was filed on January 3rd 2012, and granted as US8297916B (D1). D1 in turn claims priority from US61/494453P filed 8th June 2011. The Requester contends that much of the claimed subject matter of the patent in issue here was disclosed in D1 and that D0 should therefore be considered as a “second relevant application” under section 5(3) of the Act. That reads:

(3) Where an invention or other matter contained in the application in suit was also disclosed in two earlier relevant applications filed by the same applicant as in the case of the application in suit or a predecessor in title of his and the second of those relevant applications was specified in or in connection with the application in suit, the second of those relevant applications shall, so far as concerns that invention or matter, be disregarded unless -

(a) it was filed in or in respect of the same country as the first; and

(b) not later than the date of filing the second, the first (whether or not so specified) was unconditionally withdrawn, or was abandoned or refused, without;

- (i) having been made available to the public (whether in the United Kingdom or elsewhere);
- (ii) (ii) leaving any rights outstanding; and
- (iii) (iii) having served to establish a priority date in relation to another application, wherever made.

8. The Proprietor contends that the combined subject matter of the independent claims was disclosed for the first time in D0. It notes in particular that the relationship between the transverse stiffnesses of the claimed components is not disclosed in D1.
9. Having considered the various documents I am of the opinion that the Requester has not clearly demonstrated that the Patent is not entitled to its claimed priority in particular it has not shown that the relationship between the various transverse stiffnesses was disclosed in the earlier document. I will therefore proceed on the basis that the priority date of the P is 20th September 2012.
10. Both D1 and D2 were published on the 30th October 2012 and therefore are not prior art. I will therefore disregard these documents. Similar consideration is given to D5 which the Requester alleges was made public on the 12th December 2012.
11. D3 and D4 were filed on 1st June 2012 claiming an earliest priority date of 8th June 2011. D3 and D4 were both published on the 12th December 2012. They were both therefore published after the filing date of the patent but each has a priority date earlier than that of the Patent. These documents can be considered as part of the prior art but only in respect of considering novelty. The Proprietor's arguments in relation to D3 and D4 are however exclusively in relation to obviousness hence I can disregard these documents.
12. The Proprietor argues that D9 repeat arguments that have already been considered pre-grant. Furthermore, the Proprietor additionally argues that none of D6-D8 teaches anything beyond the disclosure of D9, and therefore ought also to be dismissed.
13. Under section 74A(3)(b) of the Act, the comptroller will also not issue an opinion if

for any reason he considers it inappropriate in all circumstances to do so. In particular, a request will be refused which does no more than repeat arguments already considered pre-grant.

14. Document D9 was discussed in relation to novelty and inventive step during the pre-grant prosecution of the Patent at the EPO. Any request for an opinion on validity that argues on the basis of prior art that has previously been cited in the X or Y category does not, other than in exceptional circumstances¹, raise a new question. D9 was cited in the X category during pre-grant proceedings. I do not consider the circumstances here exceptional and therefore I will not consider document D9.
15. Additionally, I am of the opinion that the Requester has not set out an argument in respect of documents D10-D17 that is clearly distinct from that made in relation to in particular D6-D8. I will therefore disregard D10-D17.
16. The request also seeks an opinion on various matters relating to whether the Patent discloses the invention clearly enough and completely enough for it to be performed by a person skilled in the art (sufficiency) and also whether the disclosure in the specification of the Patent extends beyond that disclosed in the application for the Patent, as filed (added matter) in relation to D18.
17. The Proprietor argues that an examiner will always examine for these matters and hence the lack of any specific objection during examination would indicate that the examiner is satisfied that the application is sufficient and does not add matter. The approach however taken by the IPO when a request has referred to these grounds is to provide an opinion unless the issue has been explicitly considered during examination.
18. The Request in respect of added matter focuses on what is often referred to as 'intermediate generalisation'. More specifically the Requester argues that claim 1 relates to only a three way stiffness relationship whereas the embodiments on which it relies disclose a five way relationship including also the lateral and transverse stiffness of a ring gear and planet journal bearing. The Requester alleges that, in the absence of any such five way relationship, the stiffness of the claimed components may be more or less than the lateral stiffness of the gear mesh. The Requester makes similar assertions in regard to claims 2-4.
19. The Requester also contends that the Patent is insufficient as whilst the disclosure is limited to a star or planetary epicyclic gear arrangement, the claims extend beyond such gear arrangements. Hence there is no disclosure that would enable the skilled person to realise the full scope of the claim. Further claims 1 to 4 cover arrangements where the lateral and transverse stiffness of the various components of the invention could be 0% of the reference stiffness. This would require unworkable and undisclosed infinite flexibility.
20. I am of the opinion that the request regarding added matter is valid, as is the request regarding sufficiency. The remaining matters relate to clarity and/or support and are therefore not provided for under the opinions service.

¹ BL 0/370/07

21. Hence having regard to the entirety of the request, which with attached documents runs to over 900 pages, and mindful of the reasons set out above together with the aim of the opinions procedure to be a relatively quick and simple process, I believe it is appropriate to limit my opinion to the following matters:

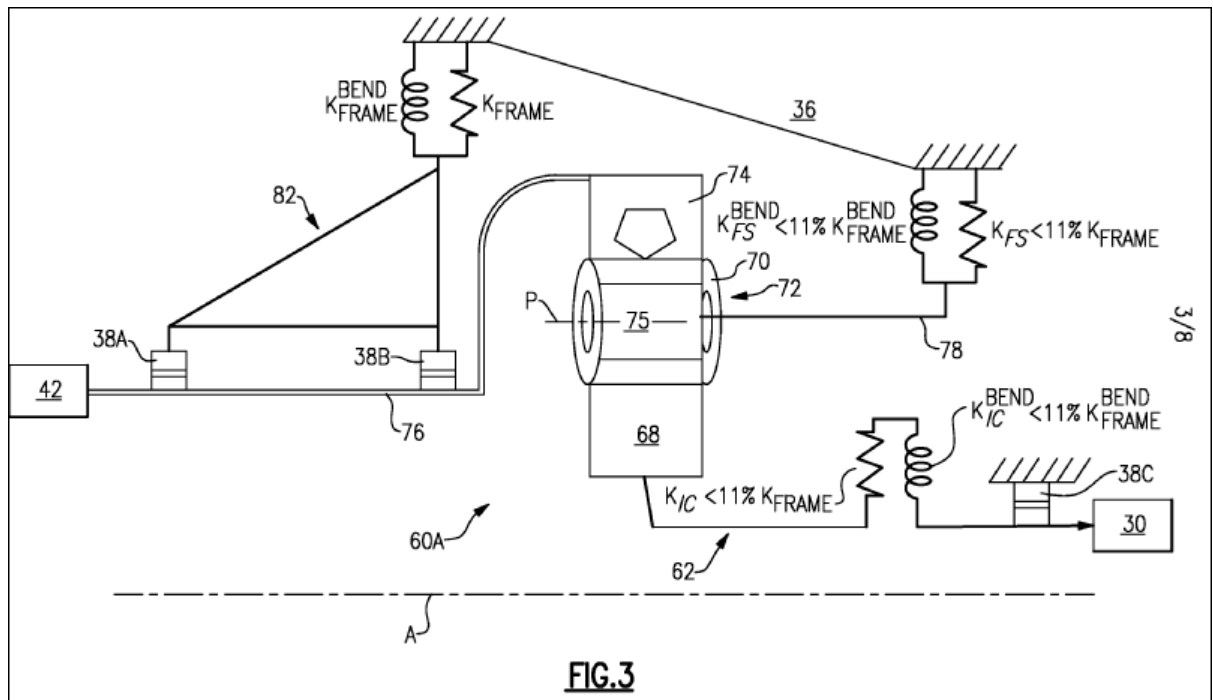
- (i) whether all claims of the Patent lack an inventive step in light of documents D6-D8 provided by the Requester, and
- (ii) whether the disclosure is sufficiently clear and complete for the invention to be carried out by a person skilled in the art, and
- (iii) whether claims 1-4 of the Patent includes added matter through intermediate generalisation.

The Patent

22. The Patent is entitled, "Flexible support structure for a geared architecture gas turbine engine" and was filed on 17th September 2013 having an earliest priority date of 20th September 2012. The Patent was granted on the 13th April 2016 and remains in force. The Patent derives from a European regional phase entry of International Patent Application PCT/US2013/060105.

23. The Patent relates to a geared gas turbine engine and specifically to a flexible support structure for a fan drive gear system (FDGS) of a gas turbine engine. A geared gas turbine engine allows the fan, which provides a large proportion of thrust, to be operated at an optimum speed independent from the speed of a core engine. This allows additional optimisation of fan size and bypass ratio. However, the gearing system is subject, during flight, to lateral and transverse loading that causes misalignment between gear train components; this reduces overall efficiency and inevitably leads to accelerated wear.

24. The Patent specifically relates to the supporting of a shaft, and the supporting of the gear system within the gas turbine engine such that the FDGS may be, to some extent, isolated from any lateral and transverse distortion thereby maintaining alignment with the shaft. The invention is defined by two distinct embodiments each relating to a similar concept of maintaining alignment between the FDGS and its output, for example a sun gear or a fan shaft of a gas turbine engine. The overarching principle is discussed below in reference to figure 3 of the Patent which illustrates a sectional view through a gas turbine engine.



25. The gas turbine engine of the Patent comprises a fan shaft 76 supported by a frame 82, typically via bearings 38A and 38B. A gearbox is at least partially supported by a flexible support 78. Both the frame 82 and the flexible support are mounted to a static structure which would typically be an annular core engine casing or similar load bearing structure of a gas turbine engine. The gearbox receives an input, typically from an engine shaft, via an input coupling 62. Under heavy load the casing 36 tends to deform whilst the fan shaft will maintain alignment with the gearbox as any deformation is compensated by the flexible support and the coupling, both of which will deform sooner than the fan shaft support frame.

26. The Patent contains claims 1-4 of which claims 1 and 3 are independent claims. Claims 1 and 3 read as follows;

Claim 1. A gas turbine engine (20) comprising:

a fan shaft (76);

a frame which supports said fan shaft (76), said frame defines a frame lateral stiffness (K_{frame}) and a frame transverse stiffness (K_{frame}^{BEND});

a gear system which drives said fan shaft (76);

a flexible support (78) which at least partially supports said gear system,

an input coupling (62) to said gear system (60)

wherein said flexible support (78) defines a flexible support lateral stiffness (K_{FS}) with respect to said frame lateral stiffness (K_{frame}) and a flexible support transverse stiffness (K_{FS}^{BEND}) with respect to said frame transverse stiffness (K_{frame}^{BEND}),

and said input coupling (62) defines an input coupling lateral stiffness (KIC) with respect to said frame lateral stiffness (Kframe) and an input coupling transverse stiffness (KIC^{BEND}) with respect to said frame transverse stiffness (Kframe^{BEND})

characterised in that

said flexible support lateral stiffness (KFS) is less than 11% of said frame lateral stiffness (Kframe); and

said flexible support transverse stiffness (KFS^{BEND}) is less than 11% of said frame transverse stiffness (Kframe^{BEND}).

and

Claim 3. A gas turbine engine (20) comprising:

a fan shaft (76);

a frame which supports said fan shaft (76),

a gear system which drives said fan shaft (76), wherein said gear system (60) includes a gear mesh that defines a gear mesh lateral stiffness (KGM) and a gear mesh transverse stiffness (KGM^{BEND})

a flexible support (78) which at least partially supports said gear system (60); and

an input coupling (62) to said gear system (60), wherein said flexible support (78) defines a flexible support lateral stiffness (KFS) with respect to said gear mesh lateral stiffness (KGM) and a flexible support transverse stiffness (KFS^{BEND}) with respect to said gear mesh transverse stiffness (KGM^{BEND}),

and said input coupling (62) defines an input coupling lateral stiffness (KIC) with respect to said gear mesh lateral stiffness (KGM) and an input coupling transverse stiffness (KIC^{BEND}) with respect to said gear mesh transverse stiffness (KIC^{BEND})

characterised in that

said flexible support lateral stiffness (KFS) is less than 8% of said gear mesh lateral stiffness (KGM); and

said flexible support transverse stiffness (KFS^{BEND}) is less than 8% of said gear mesh transverse stiffness (KGM^{BEND}).

Added matter – the law

27. The Requester alleges that the Patent has been amended such that the Patent

discloses matter extending beyond that disclosed in the original application. Section 76(2) of the Act reads;

No amendment of an application for a patent shall be allowed under section 15A(6), 18(3) or 19(1) if it results in the application disclosing matter extending beyond that disclosed in the application as filed.

28. The Requester argues that claims 1-4 add matter over D18 which the Requester alleges is to be taken to be an identical disclosure to PCT/US2013/060105. This approach seems appropriate.
29. The Requester argues that each of the claims of the Patent is restricted to a numerical relationship whereas the claims of D18 do not recite any such numerical relationship in the claims.
30. The Proprietor argues that claim 1 of the Patent is based on claim 1-3 as filed, supplemented with features disclosed in paragraph [0033]. The Proprietor additionally argues that claim 3 of the Patent is based on claims 6-8 as filed supplemented with further subject matter disclosed in paragraphs [0037] and [0043] which have been reproduced below with the relevant sections underlined;

[0033] In this disclosed non-limiting embodiment, the lateral stiffness (KFS; KIC) of both the flexible support 78 and the input coupling 62 are each less than about 11% of the lateral stiffness (Kframe). That is, the lateral stiffness of the entire FDGS 60 is controlled by this lateral stiffness relationship. Alternatively, or in addition to this relationship, the transverse stiffness of both the flexible support 78 and the input coupling 62 are each less than about 11% of the transverse stiffness (Kframe BEND). That is, the transverse stiffness of the entire FDGS 60 is controlled by this transverse stiffness relationship.

and

[0043] In the disclosed non-limiting embodiment, the transverse stiffness (KRG <BEND>) of the ring gear 74 is less than about 12% of the transverse stiffness (KGM BEND) of the gear mesh; the transverse stiffness (KFS BEND) of the flexible support 78 is less than about 8% of the transverse stiffness (KGM BEND) of the gear mesh; the transverse stiffness (KJB BEND) of the planet journal bearing 75 is less than or equal to the transverse stiffness (KGM BEND) of the gear mesh; and the transverse stiffness (KIC BEND) of an input coupling 62 is less than about 5% of the transverse stiffness (KGM BEND) of the gear mesh.

31. Paragraph [0023] is additionally relevant. This reads;

[0023] In the disclosed non-limiting embodiment, the lateral stiffness (KRG) of the ring gear 74 is less than about 12% of the lateral stiffness (KGM) of the gear mesh; the lateral stiffness (KFS) of the flexible support 78 is less than about 8% of the lateral stiffness (KGM) of the gear mesh; the lateral stiffness (KJB) of the planet journal bearing 75 is less than or equal to the lateral stiffness (KGM) of the gear mesh; and the lateral stiffness (KIC) of an input coupling 62 is less than about 5% of the lateral stiffness (KGM) of the

gear mesh.

32. The Requester does not appear to contest the Proprietor's argument in this regard, however the Requester alleges that placing the numerical values, stripped of their related features constitutes 'intermediate generalisation'² and relies on paragraphs 76.15.3 to 76.22 of the Manual of Patent Practice (the Manual), and in particular paragraphs 76.15.3 and 76.15.4 (reproduced below) to substantiate this.

76.15.3 Amendments which limit the scope of a claim by the introduction of one or more features from the description or claims may in certain circumstances add matter through what is known as "intermediate generalisation". This concept was explained by Pumfrey J in Palmaz's European Patents (UK) ([1999] RPC 47, upheld on appeal [2000] RPC 631):

"If the specification discloses distinct sub-classes of the overall inventive concept, then it should be possible to amend down to one or other of those sub-classes, whether or not they are presented as inventively distinct in the specification before amendment. The difficulty comes when it is sought to take features which are only disclosed in a particular context and which are not disclosed as having any inventive significance and introduce them into the claim deprived of that context. This is a process sometimes called 'intermediate generalisation'."

76.15.4 This definition has been endorsed in subsequent decisions of the courts, such as Vector Corp v Glatt Air Technologies Ltd [2007] RPC 12. In particular, if a feature is taken from only one, or a subset, of the embodiments, stripped of the other related features of the embodiment(s), and claimed as a defining feature of the invention, then unless the application suggests that this feature has a particular significance this is likely to constitute an intermediate generalisation; as in Datacard Corp. v Eagle Technologies Ltd. [2011] EWHC 244 (Pat), [2011] RPC 17.

33. The preamble of claim 1 of the Patent corresponds to claim 1 of D18. Claim 1 of the Patent further includes the features of claims 2-3 of D18 namely; "*wherein said flexible support lateral stiffness is less than said frame lateral stiffness, and said flexible support transverse stiffness is less than said frame transverse stiffness.*" Claim 1 of the patent further attributes a numerical value to the flexible support lateral and transverse stiffness wherein this flexible support is specifically less than 11% of the lateral and transverse stiffness of the frame.
34. The Requestor, in particular, argues that although claim 1 of the Patent, in conjunction with the embodiment shown at figure 3, concerns a 3-way relationship between a support frame, flexible support and an input coupling in order to support the FDGS such a system would inevitably require a five-way relationship. The Requestor identifies the additional components of any 5-way relationship to be a ring gear and a planet journal bearing, and that these components are omitted from Claim 1 of the patent.

² Pumfrey J in *Palmaz's European Patents (UK)* ([1999] RPC 47, upheld on appeal [2000] RPC 631):

35. The Requester additionally alleges that D18 does not disclose a flexible support which has both a lateral stiffness and a transverse stiffness wherein each are less than 11% of a corresponding frame stiffness.
36. I disagree. Claims 2-4 of D18, now incorporated into claim 1 of the Patent clearly places inventive significance on a flexible support having one, and both, lateral and transverse stiffness corresponding to frame stiffness. This is further exemplified in figure 3 of the patent which shows the FDGS being supported entirely by this 3-way relationship. The flexible support stiffness, relative to the frame stiffness, is exclusively disclosed in regard to “less than about 11%”. It is my understanding that whilst arguably necessary for the functionality of the gas turbine engine, it is not necessary to restrict the claim to particulars of a planet journal bearing or ring gear.
37. Therefore it is my opinion that Claim 1 of the Patent, and those claims directly appended to it do not add matter through intermediate generalisation. Similar reasoning is applied to Claim 3 of the Patent, and the remaining dependent claims.

Sufficiency – the law

38. The law relating to sufficiency is set out in section 14(3) of the Act, which states:

14(3) The specification of an application shall disclose the invention in a manner which is clear enough and complete enough for the invention to be performed by a person skilled in the art.

39. The Requester alleges that the Patent is insufficient by virtue of the terms ‘lateral stiffness’, ‘transverse stiffness’, ‘gear mesh’ and ‘gear mesh stiffness’. The Requester additionally alleges that the Patent is insufficient by virtue of the absence of any lower limit to the relative stiffness between the flexible support stiffness and the frame/gear mesh stiffness. This lack of a lower limit suggests the claim encompasses an infinitely flexible component. The Requester relies on R1 and R2 to support their assertions.

40. The Requester in support sets out the conventional definition of stiffness;

“The stiffness, k , of a body is a measure of the resistance offered by an elastic body to deformation. For an elastic body with a single degree of freedom (DOF), the stiffness is defined as

$$k = \frac{F}{\delta}$$

Where, F is the force on the body and δ is the displacement produced by the force along the same degree of freedom.”

41. The Proprietor provides no argument specific to the term ‘stiffness’ and I have no reason to accept that anything other than the conventional definition of the term is intended.

42. The Requester asserts that the term 'lateral stiffness' is understood to be 'a linear stiffness' and reflects a deflection in a direction of an applied force. For example the force may be radial/perpendicular and the resulting deflection a linear displacement in a radial/perpendicular direction with respect to the axis of rotation. The Proprietor makes no comment to counter this typical understanding.

43. The Requester further asserts that the term 'transverse stiffness' is understood to be 'a rotational stiffness' and reflects an angular deflection in response to a moment being applied to a particular component. The Requester directs my attention to paragraph [0018] of the Patent which reads;

"It is to be understood that the term "lateral" as used herein refers to a perpendicular direction with respect to the axis of rotation A and the term "transverse" refers to a pivotal bending movement with respect to the axis of rotation A so as to absorb deflections which may be otherwise applied to the FDGS 60"

44. The Proprietor makes no comment to counter the construction of these terms. Furthermore, there is nothing in the description that would allow me to deviate from this particular interpretation. Therefore I consider these terms to be as set out by the Requester above.

45. The Requester further alleges that, in the absence of any indication by which a free end of the flexible support or input coupling is constrained, the skilled person would be unable to work the invention and therefore the Patent is not sufficiently disclosed.

46. The Proprietor argues that figures 3 to 8, at least, show all the components and relative stiffness values that would be required for the skilled person to work the invention. The Proprietor further asserts that these figures clearly illustrate alternative constraint points for the relevant components.

47. I find myself in agreement with the Proprietor. Figures 3-8 each disclose embodiments illustrating each component and how these components could be constrained. The figures additionally disclose relative stiffness values of these components. Given a known or modelled stiffness, either lateral stiffness or transverse stiffness as considered above, the skilled person would be able to provide a second component having a relative stiffness using known tests. Therefore I consider these terms to be adequately disclosed.

48. The Requester additionally argues that the term 'gear mesh' *"...is an interaction between two moving bodies..."*. The Requester refers to R2 to allege that; *"...gear mesh stiffness is not a constant value, it is a variable, a variable parameter cannot be used as a reference against which to define a relationship parameter..."*

49. The Proprietor does not provide any comment to dispute the interpretation of this term and the description does not provide me with any basis on which to deviate from the normal construction of the term 'gear mesh'. That is to say that a 'gear mesh' is a point at which two gears of a geared architecture interact in order to transmit torque.

50. The Proprietor agrees with the Requester in regard to the variation in stiffness of the gear mesh during rotation, in this instance, the Proprietor observes; *“the rotation would be so rapid that only the average stiffness would be perceived”*. The Proprietor additionally argues that a force perpendicular to the rotation axis could be readily applied in order to determine the lateral or transverse stiffness of the gear mesh. The Proprietor relies on R2 to demonstrate that the skilled person would be able to model this accordingly both statically and dynamically.
51. I am of the opinion that term ‘gear mesh lateral stiffness’, and its component term, needs no special construction wherein stiffness would inevitably be determined using the relationship $k=f(F, \delta)$. The term is understood to be a measure of resistance offered by a system of interacting components of the gear mesh to deformation in direction perpendicular with respect to the axis of rotation of the gas turbine engine. Similarly, the term ‘gear mesh transverse stiffness’ needs no special constructions. The measure of resistance could be readily modelled by the skilled person trying to carry out the invention.
52. The Requester additionally alleges that the Patent is insufficient as the invention is claimed such that the relative lateral stiffness and transverse stiffness of the input coupling and flexible support could be 0%; that is to say that these components would be infinitely flexible.
53. The Proprietor argues that *“where the skilled person recognises that a range is intrinsically limited, such as where extremely high or low values cannot be obtained, this does not give rise to an insufficiency objection”*. The Proprietor additionally refers to paragraph 3.5 of EPO Board of Appeal decision T0487/89 which reads;
- Where, as in the present case, the claim seeks to embrace values which should be as high as can be attained above a specified minimum level, given the other parameters of the claim, then such open-ended parameters are normally unobjectionable.*
54. The issue in that decision was that the tenacity and toughness of a Polyhexamethylene adipamide fibre was claimed without an upper limit. The issue here is slightly different in that the Patent claims a stiffness without a lower limit. Whilst I am not bound by this decision I do nevertheless find it helpful in this matter, indeed I see no reason to deviate from it in this instance. Hence it is my opinion that the skilled reader would understand the function of the input coupling to be one of transferring torque from the spool of the gas turbine engine to the transmission of the gas turbine engine. The skilled person would understand that the minimum stiffness of this component would be such that it could perform this function and it is this function that provides the parameter of the claim that would inevitably provide a lower boundary to the range.
55. It is therefore my opinion that the specification discloses the invention in a manner which is clear enough and complete enough for the invention to be performed by a person skilled in the art.

Inventive step – the law

56. The Requester argues that claims 1 and 3 lack an inventive step in light of the disclosure of documents D6-D8 provided with the request. Section 1(1)(b) of the Act reads:

1(1) A patent may be granted only for an invention in respect of which the following conditions are satisfied, that is to say

(a) ...

(b) it involves an inventive step;

57. The provisions in relation to inventive step are found in section 3 of the Act which states:

3. 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)

58. The Court of Appeal in *Windsurfing*³ formulated a four-step approach for assessing whether an invention is obvious to a person skilled in the art. This approach was restated and elaborated upon by the Court of Appeal in *Pozzoli*⁴. Here, Jacob LJ reformulated the *Windsurfing* approach as follows:

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

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

(2) Identify the inventive concept of the claim in question or if that cannot be readily 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 that would have been obvious to the person skilled in the art or do they require any degree of invention?

59. In the first instance I will limit my consideration of the Patent, in relation to inventive step, to claims 1 and 3. If I find these claims to be obvious I will extend my consideration to the dependent claims.

The person skilled in the art and common general knowledge

60. Neither the Requester nor the Proprietor have sought to define the skilled person or the common general knowledge of that person. I consider this person to be a gas turbine engine engineer or team of engineers. Specifically the skilled person would be a specialist in the structural design of gas turbine engines and the mounting of accessories and auxiliary equipment including transmissions.

³ *Windsurfing International Inc. v Tabur Marine (Great Britain) Ltd*, [1985] RPC 59

⁴ *Pozzoli Spa v BDMO SA & Anor* [2007] EWCA Civ 588

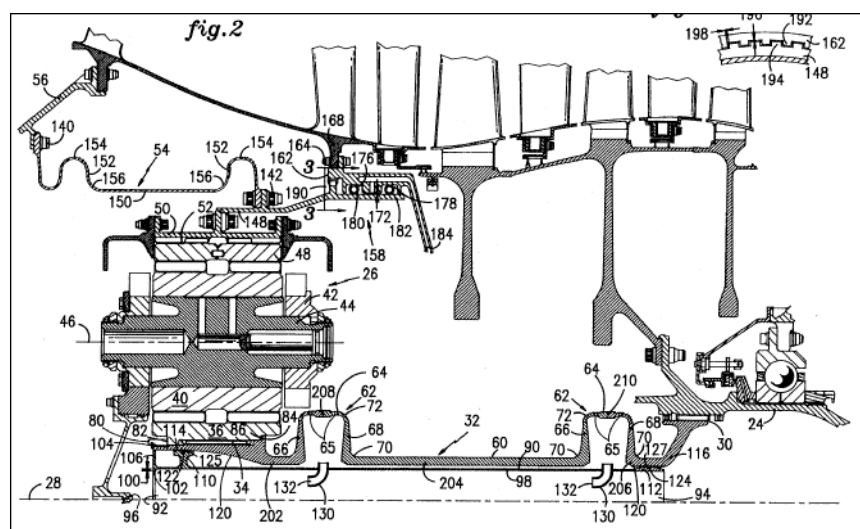
Identify the inventive concept of the claim in question or if that cannot be readily done, construe it

61. The Proprietor argues that the inventive concept of the claimed invention is the recognition that specific relative stiffnesses of certain components of the gear architecture support system are critical to the successful implementation of geared architecture in high-bypass geared turbofan engines. Based on this, and a purposive construction⁵ of the claims then I am prepared to accept that the inventive concept does lie in the specific relationships between the stiffnesses of various components set out in the claims.

62. I would note that neither the Requester nor the Proprietor identify any problem with understanding the constructional arrangement of components as set out in the claims above. Specifically there is no contention over the arrangement of a fan shaft, a fan shaft support frame, a gear system, a flexible support, input coupling or gear mesh as claimed in claim 1 and 3. Any disagreement on the construction of the claims is limited to the terms 'lateral stiffness', 'transverse stiffness', 'gear mesh' and 'gear mesh stiffness' which have already been concluded.

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.

63. D6 has a publication date of 18th July 1995 and is entitled 'Coupling system for a planetary gear train'. D6 specifically discloses an apparatus for supporting a planetary gear train in a gas turbine engine as shown in the figure below which illustrates a sectional view through a gas turbine engine. The planetary gear train is supported by a sun gear coupling 32 and a ring gear coupling 54. Both the sun gear coupling and the ring gear coupling are provided with flexible portions 154 and 64 providing compliance with respect to torsion about a vertical and lateral axis.

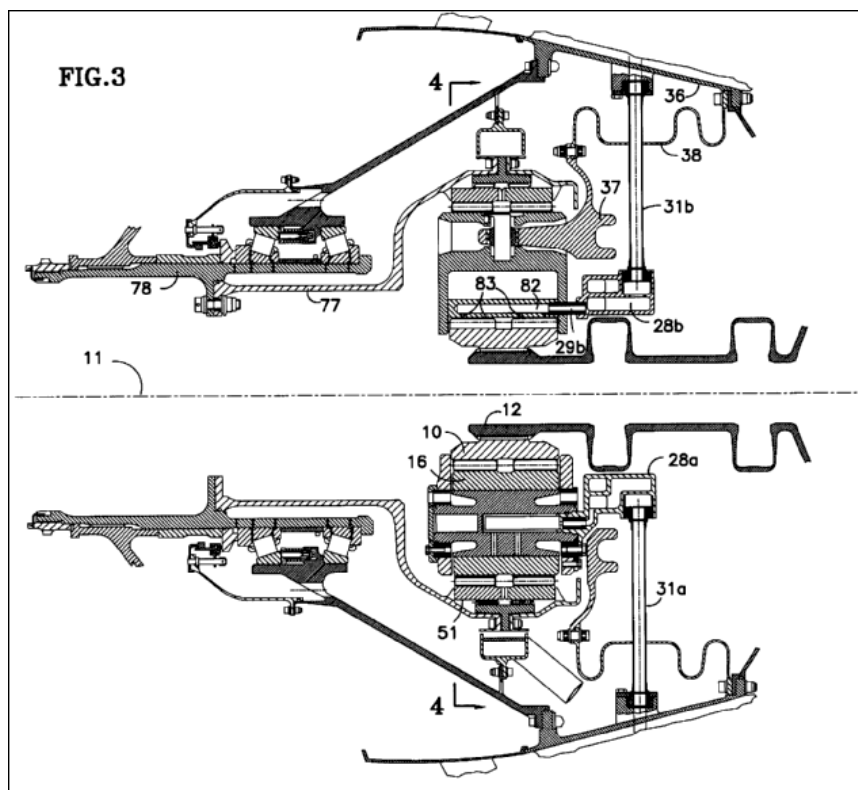


⁵ In *Generics UK Ltd (t/a Mylan) v Yeda* [2017] EWHC 2629 (Pat), Arnold J confirmed (at 134) the continuing requirement to interpret patent specifications purposively, having considered the earlier judgment of the UK Supreme Court in *Actavis v Eli Lilly* [2017] UKSC 48.

64. The Requester argues that the compliance with respect to torsion about a vertical and lateral axis is analogous to the lateral and transverse stiffness properties of the Patent. This is not contested by the Proprietor.

65. A rigid fan support frame is entirely conventional in the field of geared turbofans and the skilled person would expect this to be implied with regard to D6. I am therefore in agreement with the Requester in so much as D6 discloses the general arrangement of components as required by the claim 1 and 3. However D6 fails to disclose the specific stiffness properties as required by the claims.

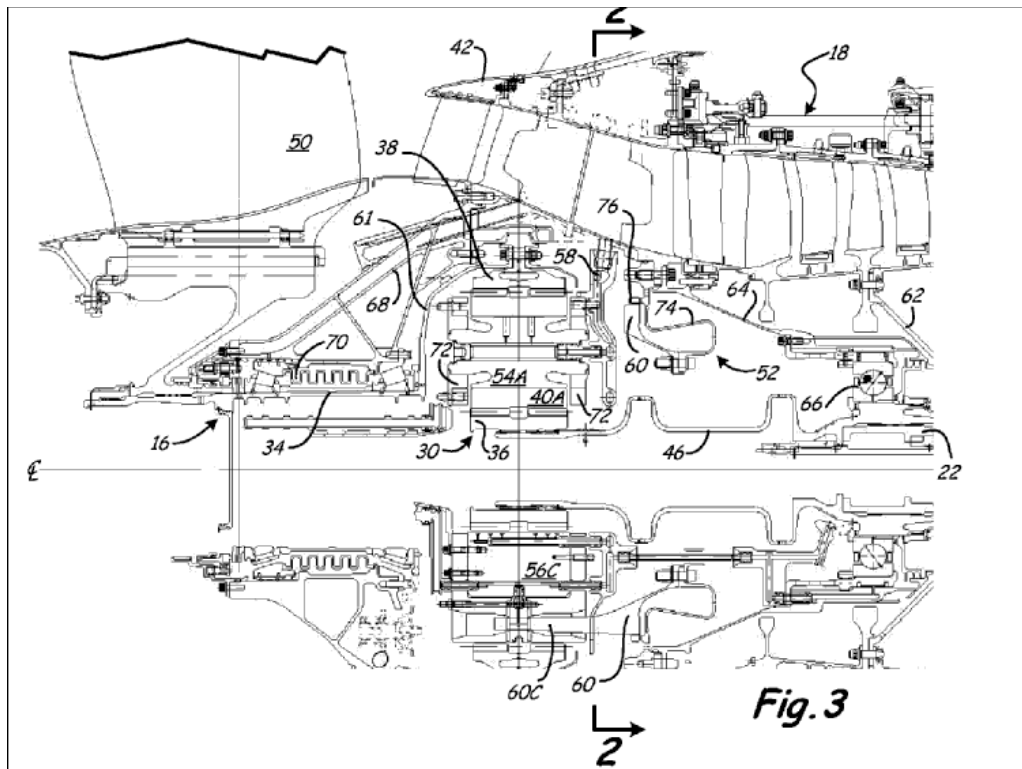
66. D7 has a publication date of 1st May 2001 and is entitled 'Star gear system with lubrication circuit and lubrication method thereof'. D7 is primarily directed towards a lubrication system for an epicyclic gear train of an aircraft engine as shown in the figure below. The epicyclic gear train is supported, within the aircraft engine, via an output shaft 77, a torque frame and flexible coupling 38, and a flexible input shaft 12.



67. The input shaft is flexible in order to minimise misalignment between intermeshing teeth of a sun gear and star gears of the gear train. The torque frame and flexible coupling conveys torque reactions from a gear carrier 17 to a case 36 of the engine, presumably, to permit some radial and circumferential displacement of the gear train with respect to the case.

68. The constructional features of D7 and their relevance to the Patent as argued by the Requester do not seem to be contested by the Proprietor. I am generally in agreement, however D7 does not relate specifically to a turbofan engine and fails to disclose the specific stiffness properties as required by the claims.

69. D8 has a publication date of 29th April 2010 and is entitled 'Coupling system for a star gear train in a gas turbine engine'. D8 primarily concerns coupling an epicyclic gear train with input and output shafts of a gas turbine engine so as to reduce excessive wear due to misalignment of the input and output shafts. An embodiment is shown in the figure below which illustrates a sectional view through a gas turbine engine. In order to reduce said misalignment D8 discloses a solution wherein a planetary gear train 30 is supported by an input shaft 46 and an output shaft 34 via a ring gear shaft 61, the solution additionally requires a torque frame 60 which appears to be connected to a gear carrier 72 of the planetary gear train.



- 70. The output shaft terminates at a fan assembly and therefore is understood to be a fan shaft. The fan shaft is understood to be rigidly supported from a nacelle 42 via support struts 68 and bearing assemblies 70.
- 71. The input shaft 46 is coupled to a low pressure shaft 22 and configured to transmit torque between the input shaft and the planetary gear train. It is important to note, as the Requester has done, that the document explicitly discusses the absence of support bearings for the input shaft thereby permitting relative displacement of the gear train. Therefore the input coupling is considered to be flexible, particularly in respect to the struts 62.
- 72. The torque frame 60 anchors a gear carrier of the gear train to a nacelle 42 via the support frame 64 and permits radial and circumferential displacement of the gear train.
- 73. The constructional features of D8 and their relevance to the Patent are argued convincingly by the Requester. The Requester's arguments in regard to the interpretation of D8, thus far, are not contested by the Proprietor.

74. I am in agreement in so much as D8 clearly and unambiguously discloses the general arrangement of components as required by the claim 1. Furthermore, in the absence of any disclosure to the contrary I understand D8 to imply a relatively rigid gear mesh as this is entirely conventional. Therefore D8 additionally discloses the general arrangement of components as required by claim 3. However D8 fails to disclose the specific stiffness properties as required by the claims.

75. The Requester identifies the difference between the disclosure of D6-D8 and claim 1 and claim 3 of the Patent to lie in the specific numerical values attributed to the individual component lateral and transverse stiffness. This is generally uncontested by the Proprietor, although the Proprietor does argue that none of these documents disclose a relative stiffness. I generally agree with the Requesters assessment at this stage in regard to D6 and D8 wherein both documents disclose, or at least imply, the constructional features of claims 1 and 3. D7 however does not relate specifically to a gas turbine engine having a fan and is therefore further from the Patent than D6 or D8. D7 does not disclose anything in addition to D6 or D8 that could otherwise be used to demonstrate that the Patent is obvious therefore there is no need for me to consider D7 any further.

76. The Requester further argues that the numerical values defined in the claims constitute selection inventions as the claimed range is arbitrary. The Proprietor refutes this argument and observes that none of the prior art disclose a range of relative stiffness values and therefore the claims cannot be selected from a previously disclosed broader range.

77. I am of the opinion that the differences between claim 1 of the Patent and the disclosure of D6 or D8 lie exclusively in the values attributed to the relative stiffness of the flexible support. and specifically;

- (i) the flexible support has a lateral stiffness of less than 11% of the frame lateral stiffness, and
- (ii) the flexible support has a transverse stiffness of less than 11% of the frame transverse stiffness.

78. Similarly, I am of the opinion that the differences between claim 3 of the Patent and the disclosure of D6 or D8 lie exclusively in values attributed to the relative stiffness of the flexible support. and specifically;

- (i) the flexible support has a lateral stiffness of less than 8% of the gear mesh lateral stiffness, and
- (ii) the flexible support has a transverse stiffness of less than 8% of the gear mesh transverse stiffness.

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

79. The Requester contends that there is nothing to suggest that the selection of these particular values is anything other arbitrary. It notes that at least in regard to the lateral stiffness of the flexible support, the Proprietor has admitted the selection is arbitrary in D5. It notes that the Proprietor in D5 also strongly indicates that this relationship is only beneficial if part of a three-way lateral stiffness relationship in which the lateral stiffness of the input coupling is also constrained to be less than 11% of the frame lateral stiffness.

80. The reference referred to in particular in D5 by the Requester is contained in an annex of D5 and reads:

“Notes:

Lateral spring rates on structural components are something we can measure and enforce.

Film stiffness, spline stiffness, journal bearing stiffness are difficult to interpret (therefore difficult to enforce).

The 11% is arbitrary. Larger is better.”

81. The Proprietor disputes the provenance of this note and in any event argues it does not constitute evidence. The Proprietor additionally argues that the key feature of the claim is that the lateral and transverse stiffnesses of the flexible support are both designed to be significantly lower than the intrinsic stiffness of the K-frame.

82. The Proprietor also notes that the prior art is silent about the practical significance of these relative stiffness values in the context of geared architecture. I agree. Indeed based on the material before me, which does not include expert evidence, I am not persuaded that the specific relationships set out in claims 1 and 3 are arbitrary.

Opinion

83. I am of the opinion that the Patent does not disclose matter extending beyond that disclosed in the application as filed under section 76 of the Act.

84. I am of the opinion that the specification discloses the invention clearly enough and completely enough for it to be performed by a person skilled in the art under section 14(4) of the Act.

85. On the basis of the evidence put forward regarding documents D6-D8, I am of the opinion that claim 1 and claim 3 of the patent involve an inventive step under section 3 of the Act.

Sean O'Connor
Examiner

NOTE

This opinion is not based on the outcome of fully litigated proceedings. Rather, it is based on whatever material the persons requesting the opinion and filing observations have chosen to put before the Office.