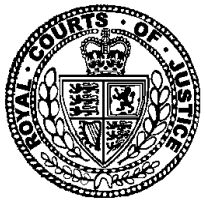


Neutral Citation Number: [2023] EWHC 1950 (Pat)

Case No: HP-2021-000032

IN THE HIGH COURT OF JUSTICE
BUSINESS AND PROPERTY COURTS IN ENGLAND AND WALES
INTELLECTUAL PROPERTY LIST (ChD)
PATENTS COURT

Rolls Building
Fetter Lane
London, EC4A 1NL

Date: 31 July 2023

Before:

MR JUSTICE ZACAROLI

- -

Between:

HERAEUS NOBLELIGHT LIMTIED	**Claimant**
- and –	
FIRST LIGHT LAMPS LIMITED	**Defendant**

- -
- -

Geoffrey Pritchard and Charles Brabin (instructed by **Mishcon de Reya LLP**) for the **Claimant**
Christopher Hall (instructed by **Mills & Reeve LLP**) for the **Defendant**

Hearing dates: 21, 22, 23, 26, 27 & 28 June 2023

- -

JUDGMENT

Mr Justice Zacaroli:

Introduction

1. The claimant, Hereaus Noblelight Limited ("Hereaus") brings this action for infringement of its patent, EP (UK) 1 598 845 (the "Patent").

2. The Patent, with a priority date of 19 May 2004, is a method for sealing the ends of quartz glass tubes used in the manufacture of arc lamps.

3. Quartz glass arc lamps generally consist of a hollow cylindrical tube filled with gas. Different lamps require the gas to be at different pressure levels. Inside the tube at each end is an electrode, fed by a wire (usually tungsten) which passes through the ends of the tube. When an electrical charge is passed through the gas, it forms a plasma and emits light.

4. Heraeus contends that the defendant, First Light Lamps Limited ("First Light") has infringed the Patent in adopting a method for sealing the ends of the lamps that closely follows that taught in the Patent. First Light denies infringement, on the basis that its method involves a material change (explained at §23. below) from the method taught in the Patent.

5. First Light also counterclaims for a declaration of invalidity and the revocation of the Patent on the grounds of obviousness over two instances of prior art.

Quartz Arc Lamps

6. A quartz arc lamp must be hermetically sealed to keep the gas inside. This can be done in a variety of ways, depending on the type of lamp and its intended use. This case is concerned only with those lamps that use a "rod seal" method. This involves the electric current being carried by a tungsten rod inserted into each end of the lamp, around which is attached a thin sleeve of sealing glass, the middle section of which is worked up to form a "bead". The bead is then fused with the outer glass tube of the lamp so as to form a hermetic seal. I will refer to the sealing glass as "GS10", because that is the type of sealing glass used by Heraeus. The size of the bead is at the centre of the argument about infringement, as explained in detail below.

7. This carries with it a problem, arising from the fact that tungsten and quartz glass have different coefficients of expansion. In order to fuse quartz glass it must be heated to approximately 1600C. If tungsten is heated to that temperature in order to be fused with the quartz glass, then the rate at which it contracts during cooling can cause the quartz glass to fracture. There is also a (smaller) risk of cracking during the heating and cooling of the lamp during use.

8. The common method of solving that problem, prior to the method described in the Patent, was by using a form of indirect seal. Under this method an intermediate layer (or layers) of GS10 is (or are) introduced between the tube and the bead. This solved the problem because GS10 can be fused using a lower temperature (approx. 1200C). Accordingly, the intermediate layer of GS10 can first be fused to the quartz glass at 1600C, and subsequently fused to the tungsten rod at the lower temperature. This is referred to as the "GS10 Dome Method", and involved the following steps:

   (1) A stick of heated GS10 is brought into contact with the rotating tungsten rod to form a sleeve around it.

   (2) The central region of the sleeve is then increased in thickness, whilst it is rotating, to form a "bead" of GS10.

   (3) Next, one end of the quartz tube is rotated and heated, and the heated end is then closed by spinning a bead of molten GS10 into and over it.

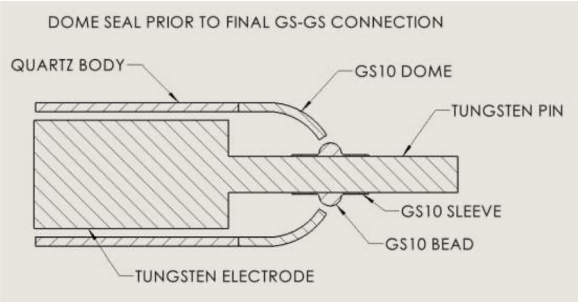
   (4) A smaller diameter tube of quartz glass is fused into the side of the main tube of the lamp, so as to extend radially from it. This is necessary to enable the internal pressure of the lamp tube to be varied during the assembly process. It is removed

following assembly of the lamp, commonly leaving a small "bump" of up to a few tenths of a millimetre on the outside of the tube.

(5) The pressure inside the quartz tube is now increased so that the GS10 bead that was fused to one end (in step 3 above) balloons outwards and is punctured. The punctured end (whilst kept hot) is now made concentric with the lamp tube axis by use of a carbon tool, and enlarged so as to be capable of receiving the electrode. This results in a GS10 extension to the quartz tube (referred to as the "arms" of the tube).

(6) The electrode, with its integral sleeved tungsten rod is now introduced into the end of the arms. Both are reheated and, with the assistance of a carbon tool, the arms are worked down so as to fuse to the bead. Since this is a fusion of GS10 to GS10, it is carried out at 1200C.

9. It is an essential feature of the GS10 Dome Method that, by introducing the GS10 arms on the end of the quartz tube, it results in the *indirect* sealing of the tube and the rod. The following diagram illustrates the GS10 Dome Method immediately prior to fusion between the "arms" and the bead:



10. The Patent, on the other hand, teaches a method of *direct* sealing between the tube and the rod, as described in the next section.

The Patent in more detail

11. The invention, as described at [0001] of the Patent:

> "refers to a mechanically strong and leak free sealing of bodies comprising a quartz glass tube and a high temperature material of an electrical feed through such as are used as flash lamps and laser lamps, and in particular to the construction of the ends of such lamps and a method of effecting the sealing of electrodes into the ends thereof."

12. The difficulties caused by the different coefficients of expansion of the tungsten used for the electrodes and wires in the lamp and the fused silica/quartz are described at [0003].

13. The GS Dome method is described at [0005] of the Patent, and at [0008] the following is said:

> "Lamps constructed in accordance with the above method have been found to possess a weakness in the end regions thereof where a GS to GS seal has been formed. Investigations have indicated possible reasons for this weakness and it is an object of the present invention to provide an improved method which reduces the chance of weakness being introduced into the structure by the manufacturing process."

14. The invention is summarised at [0009] to [0015], which include the following material points:

(1) The problem which the invention is intended to address is referred to as "a high derivation [it is common ground that this is meant to say "deviation"] in seal quality", and the object of the invention is described as "to increase the reliability of the seal by reducing the [deviation] … without a loss in quality of the seal."

(2) The invention involves a "direct sealing" of the glass tube with the seal around the metal rod. The fact that a (GS10) dome does not need to be sealed to the tube is said to be surprising.

(3) Compared to the prior art, the method is "very simplified" so that it is "extraordinarily quick manually" and allows for an automated process "which moreover guarantees a further minimizing of quality tolerance".

(4) It is pointed out that the beads used in the invention could have a "small deformation", so its final shape could have a "small notch and a little asymmetry."

(5) At [0013 to 0015] the key characteristic is identified in the fact that the glass tube and metal electrodes (and their feed) are "directly sealed with a sealing bead", and the benefits are repeated as enabling "the production of high quality seal with a small quality tolerance" and a seal that is "mechanically strong and leak free", in order to bring an electrical source into "any form" of lighting or discharge lamp.

15. At [0017] a preferred example of the invention is described as comprising the following steps:

> "(1) A tungsten pin is coated with sealing glass comprising a sheath and bead the bead being bigger than the internal diameter of the quartz tube but no bigger than the external diameter of the quartz tube. The quartz tube is that which forms the lamp housing, of typically 0,5 mm wall thickness.
>
> (2) The bead is heated to a soft state while rotating it on a lathe and inserted into the annulus of the lamp housing tube to form the seal.
>
> (3) After the insertion the seal is then heated to allow the sealing glass to wet on and to fuse with the housing tube.
>
> (4) After fusing the bead to the quartz both internally and to the end of the quartz tube and while the sealing glass is molten an internal positive pressure is applied causing the sealing glass inside the quartz tube to move back towards the previously open end to form a smooth internal radius. The process of applying pressure to move the sealing glass back towards the end of the quartz tube not only creates:
>
> (4a) a smooth radius between electrode or the electrical feed through and the quartz tube.
>
> (4b) an area on the internal diameter that now has a coating of sealing glass that transitions to the fused bead effectively creating an internal radius of sealing glass. This radius is critical to the seal."

16. A further example is described at [0018], in which the "end of the quartz glass tube is molten and softly pressed to a heated bead. Pre-forming or tooling of the quartz tube is possible to create different starting positions for this process." First Light places significant reliance on [0018] of the Patent in the context of its case on obviousness, and I will return to it in that context.

17. [0019] emphasises the benefits of the invention, as being much simpler than the appropriate methods in the state of the art, and doing away with the need for tooling and/or pre-processing of the quartz tube. This point is reinforced at [0020]: "No tooling is needed to form the seal, simply heat and pressure, which reduces the risk of seal contamination significantly."

18. Claim 1 essentially repeats the method outlined at [0017]. The bead of sealing glass on the electrical feed (the rod) is required to be "bigger than the internal diameter of the end of the tube but not bigger than the external diameter of the end of the tube." It is not suggested that "not bigger" has a different meaning from "no bigger" in [0017] of the specification.

19. Claim 2 is the same method as Claim 1, where the sealing glass has a coefficient of expansion between those of the electrode or the feed through and the quartz glass. Nothing turns on this. Claim 3 is the method according to claim 1 or 2, "wherein the quartz glass lamp is sealed using automatic equipment."

20. The Patent includes the following four diagrams:

Fig.1

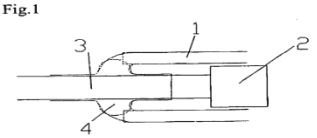


Fig.2

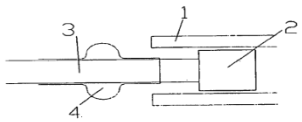


Fig.3

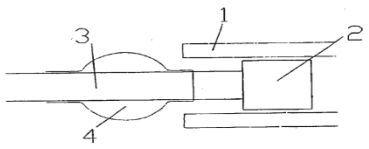
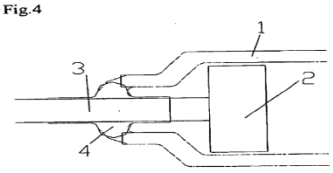


Fig.4



21. Figure 2 shows the bead and tube before assembly. Figure 1 shows a lamp tube and bead connected. Figure 3 shows a bead having an elliptical shape. Figure 4 shows "a lamp tube which is bent to a lower diameter to form the seal." This reflects the "further Example" described at [0018] of the Patent.

<u>First Light's allegedly infringing method</u>

22. Heraeus' claim is brought by reference to a sample lamp from a batch (batch 164) of First Light's "F985" lamp (the "F985-164 Sample"). This was manufactured by First Light some time prior to November 2020 pursuant to a "manual direct seal process". The process is described in Annex C to its product or process description ("PPD").

After November 2020, First Light modified the Annex C process by introducing a degree of automation, described in Annex D to the PPD. It is common ground that the Annex D process does not differ materially from the Annex C process. Accordingly, the parties have focused at trial solely on the Annex C process.

23. The Annex C process is essentially the same as that taught in the Patent, except for one change. That change is that the Annex C process requires the use of a bead around the tungsten rod that is bigger than the outside diameter of the glass tube. Specifically:

(1) Annex C specifies that the bead of sealing glass has a width of 3.7-4.1mm and a diameter of 0.1-0.3mm greater than the outside diameter of the quartz tube.

(2) A production operative collates stock tubing, which comes in various sizes, into groups with the same outside diameter to the nearest 0.1mm.

(3) Multiple groups are collated, with information for each being recorded on a work in progress sheet, which is passed on to the beading operative.

(4) The beading operative is also provided with manufacturing drawings which instruct him or her to build up the bead to the requisite width and diameter. The drawing specifies that "tolerances unless otherwise stated are: +/- 0.2mm".

(5) The beading operative uses either calibrated digital verniers or "go/no-go" hole gauges to measure each individual bead.

(6) Once the seal is made, if it is too large then a carbon paddle may be used to shape and flatten the seal.

24. I will refer to a bead whose diameter is 0.1mm to 0.3mm bigger than the outside diameter of the glass tube (i.e. one that is made strictly in accordance with Annex C) as an "oversized bead".

Infringement

25. Heraeus' case on infringement is put in one of three ways:

(1) On a purposive construction of the Patent, "not bigger" than the outside diameter of the tube means "not bigger by reference to tolerances that formed part of the common general knowledge" (and 0.3mm was within such tolerances), alternatively "not bigger such that it impairs the strength or utility of the seal" (and this encompasses oversized beads). Accordingly, even if a lamp is made strictly in accordance with Annex C it infringes the Patent. This is referred to as the "purposive infringement" case.

(2) Although Annex C specifies the use of oversized beads, in fact – due to inadvertence, not deliberate choice – beads used in the manufacture of the F985-164 Sample sometimes had a diameter no bigger than the outside diameter of the glass tube. This is referred to as the "literal infringement" case.

(3) A lamp manufactured with oversized beads infringes the Patent by the doctrine of equivalents. This is referred to as the "infringement by equivalents" case.

Infringement on purposive construction

26. The approach to the construction of patents was helpfully summarised by Jacob LJ in *Virgin Atlantic Airways Ltd v Premium Aircraft Interiors UK Ltd* [2009] EWCA Civ 1062, at §5:

> "[182] The task for the court is to determine what the person skilled in the art would have understood the patentee to have been using the language of the claim to mean. The principles were summarised by Jacob L.J. in *Mayne Pharma Pty Ltd v Pharmacia Italia SpA* [2005] EWCA Civ 137 and refined by Pumfrey J. in *Halliburton Energy Services Inc v Smith International (North Sea) Ltd* [2005] EWHC 1623 (Pat) following their general approval by the House of Lords in *Kirin-Amgen Inc v Hoechst Marion Roussel Ltd* [2005] R.P.C. 9. An abbreviated version of them is as follows:
>
> (i) The first overarching principle is that contained in Art.69 of the European Patent Convention;
>
> (ii) Art.69 says that the extent of protection is determined by the claims. It goes on to say that the description and drawings shall be used to interpret the claims. In short the claims are to be construed in context.
>
> (iii) It follows that the claims are to be construed purposively—the inventor's purpose being ascertained from the description and drawings.
>
> (iv) It further follows that the claims must not be construed as if they stood alone—the drawings and description only being used to resolve any ambiguity. Purpose is vital to the construction of claims.
>
> (v) When ascertaining the inventor's purpose, it must be remembered that he may have several purposes depending on the level of generality of his invention. Typically, for instance, an inventor may have one, generally more than one, specific embodiment as well as a generalised concept. But there is no presumption that the patentee necessarily intended the widest possible meaning consistent with his purpose be given to the words that he used: purpose and meaning are different.
>
> (vi) Thus purpose is not the be-all and end-all. One is still at the end of the day concerned with the meaning of the language used. Hence the other extreme of the Protocol—a mere guideline—is also ruled out by Art.69 itself. It is the terms of the claims which delineate the patentee's territory.
>
> (vii) It follows that if the patentee has included what is obviously a deliberate limitation in his claims, it must have a meaning. One cannot disregard obviously intentional elements.
>
> (viii) It also follows that where a patentee has used a word or phrase which, acontextually, might have a particular meaning (narrow or wide) it does not necessarily have that meaning in context.
>
> (ix) It further follows that there is no general "doctrine of equivalents."

> (x) On the other hand purposive construction can lead to the conclusion that a technically trivial or minor difference between an element of a claim and the corresponding element of the alleged infringement nonetheless falls within the meaning of the element when read purposively. This is not because there is a doctrine of equivalents: it is because that is the fair way to read the claim in context.
>
> (xi) Finally purposive construction leads one to eschew the kind of meticulous verbal analysis which lawyers are too often tempted by their training to indulge."

27. Although discovering the meaning of the Patent is a task for the Court, it does so through the eyes of the person skilled in the art, and by reference to what was already common general knowledge in the art or science to which the invention relates ("CGK") when the Patent was granted: see, e.g, Terrell on the Law of Patents, 19th ed., at §8-61. The Court is assisted in both respects by expert evidence.

The experts

28. Heraeus' expert is Lawrence Huxley. He is identified as the inventor of the Patent. He worked for Heraeus between 2001 and 2007, where he was tasked with introducing automation to increase productivity and output quality. Following some initial work on the automation of bead production, he started work on introducing automation to the lamp assembly process. This led him to the invention. The fact that he is the inventor carries with it the risk that he is less able to don the mantle of the skilled person, who is required to analyse the teaching in the Patent without any special "insider" knowledge. As against this, however, Mr Huxley was in the advantageous position of having himself experimented in the beading and assembly process.

29. First Light's expert is Barry Morris. He too once worked for Heraeus, between 1995 and 2003. In contrast to Mr Huxley, he had no experience of bead production or lamp assembly, whether doing the work himself or supervising others. This meant that he was less representative of the skilled person.

30. I found both experts to be honest witnesses, doing their best to assist the Court. I found, however, Mr Huxley's explanations for the views he held to be generally more carefully considered and cogently reasoned than Mr Morris' explanations. In fact, as I describe in more detail below, on a number of issues during the course of his cross-examination, Mr Morris abandoned key aspects of the conclusions reached in his reports and agreed with Mr Huxley's position. No doubt partly for this reason, Mr Hall (who appeared for First Light) suggested in closing argument that I may find the evidence of Heraeus' expert (Mr Huxley) of more probative value. I agree, both because I found Mr Huxley to be better representative of the skilled person and, more importantly, because of the clarity and cogency of his reasoning.

The skilled person

31. The skilled person is "a skilled technician who is well acquainted with workshop technique and who has carefully read the relevant literature. He is supposed to have an unlimited capacity to assimilate the contents of, it may be, scores of specifications but to be incapable of a scintilla of invention": *Technograph Printed Circuits Ltd v Mills & Rockley (Electronics) Ltd* [1972] R.P.C. 346, per Lord Reid at p.355.

32. The focus of the Patent is on sealing the end of the tube with glass. It is common ground that this is a technical and highly specialised area of work. Mr Huxley regarded the skilled person as "a scientific glass blower experienced in the development and manufacture of seals for, amongst other things, quartz laser and flash lamps". Mr Morris described the skilled person as a "lamp engineer", but did not regard that as substantively different to Mr Huxley's description.

33. The one area of dispute was the extent to which the skilled person would have an interest in automation, as First Light contends. Claim 3 of the Patent is for an automated process of the method taught in Claims 1 and 2, but the Patent does not teach any method of automation. Claim 3 merely claims a monopoly for the method described in Claims 1 and 2 where some part of the process is automated. Ultimately nothing turns – so far as the issues I need to decide – on the precise extent of the skilled person's knowledge of automation, and the parties were in broad agreement that the skilled person is aware of the automated processes used in this area but is not expert in them.

CGK

34. There was much common ground between the experts as to what constitutes CGK in this case. Of particular relevance to the issues I have to decide, it included the following which, save where I indicate otherwise, was common ground between the parties.

35. First, the problem of stress fractures I have described above, resulting from the differences in coefficients of expansion of quartz and tungsten.

36. Second, direct seals did not work in conjunction with a tungsten rod as used in the rod seal method. Although, as I develop below, a direct seal was used in one instance of prior art, it is accepted that this was not sufficiently widely known to constitute CGK. Accordingly, the skilled person would have had a technical prejudice against direct seals.

37. Third, the only known method for alleviating stress in manufacturing a lamp using the tungsten rod seal method was the GS10 Dome Method. The key feature of this is the use of intermediate sealing glass between the glass tube and the tungsten rod. It was CGK that there were two reasons for applying, then opening, a dome on the end of the tube. First, because the dome bears the stresses inherent in these kinds of lamp. Second, because fusion of quartz to GS10 requires a higher temperature than fusion of GS10 to GS10, and the former takes place, under the GS Dome Method, without the presence of the tungsten, which is a "significant heat sink".

38. Mr Hall submitted that it was also CGK that the GS Dome Method involved a smooth radius of GS10 between the rod and the tube, and that this was important in addressing stress. I agree that this was a part of the CGK, but accept Mr Pritchard's qualification that what was commonly known was that smooth curved surfaces *helped* in alleviating stress, but not that they could in themselves (isolated from the other key elements in the GS10 Dome Method described above) address the problems of stress. Mr Huxley's evidence, which I accept, was that it was CGK that stress concentrations are likely to occur where there are sharp internal surfaces, particularly at interfaces between materials, and that smooth surfaces alleviate this problem. He also accepted in cross examination that it was CGK that a smooth internal radius was achieved by applying positive internal pressure while the sealing glass was still molten.

39. Fourth, as in much engineering, there are tolerances dictated by the context and that, in general, tolerances of a few tenths of a millimetre were accepted in the assembly of lamps of the type in issue in this case. The parties were agreed that this formed part of the CGK, but Mr Hall contended that it was also known that there may be a specific requirement for a tighter tolerance according to the needs of a particular customer. This is relevant to the question of purposive construction, and I return to it under that heading.

40. Fifth, if too much GS10 is used in its construction, the bead (as it forms into the seal) can collapse. There was no precise definition of "too much" in this context, but it was CGK that this was not a problem that would be encountered merely because the diameter of the bead was a few tenths of a millimetre greater than the outer diameter of the tube, or that the resulting seal "bulged" to the same extent.

41. Sixth, it was CGK for everything to be rotated on a lathe, both in making the bead and in assembling the lamp.

42. The experts agreed that it was CGK that, given that manually spinning beads is an inherently variable process, the shape and proportions of beads can vary substantially between workers. First Light's contention, that it was CGK that in the GS10 Dome Method the bead used could be larger than the internal diameter of the body of the tube, is, however, disputed by Heraeus.

43. There was nothing in either expert's reports to support this contention. It was a point developed in closing based on a passage in Mr Huxley's cross-examination. Mr Huxley was shown a passage in the Patent which described the GS Dome Method. This included the sentence: "The electrode and its integral sleeved rod is now introduced axially into the opened end of the lamp tube whilst the latter is rotated until the annular bead makes contact with the end of the lamp tube." On a literal reading, this would suggest that the bead must have been as big as the internal diameter of the body of the tube (i.e. before the ends are worked down), otherwise it could not make contact. Mr Huxley's evidence, however, was that this must be an error because, as the bead is smaller than the electrode, and since the electrode is ahead of the bead as it is introduced axially into the tube, the electrode would collide with the tube, preventing it being pushed any further in. In the report of both experts, the CGK of the GS10 Dome Method was said to be one where the beaded electrode is inserted into the GS10 extension of the tube while it is still open, and it is then heated and worked down to make contact with the bead.

44. Moreover, an essential feature of the GS Dome Method is the GS10 "arms" extending from the end of the quartz tube, which are worked down to form a frusto-conical shape. That only makes sense if the bead to which the end of the arms makes contact is smaller than the internal diameter of the quartz tube itself.

45. Mr Hall relies on a passage in Mr Huxley's cross-examination, in which he accepted that a skilled person reading the relevant sentence in the Patent would understand that it was CGK that it was possible to have a bead that was bigger than the inner diameter of the tube. That has to be read, however, in the light of his earlier statement that he believed the sentence in the Patent was an error, and in light of the fact that both experts described the GS10 Dome Method in a way which required the bead to be smaller than the internal diameter of the tube, and the logical inconsistencies to which I refer above. Accordingly, I reject the submission that it was CGK that the GS10 Dome Method sometimes used a bead that was bigger than the internal diameter of the tube.

46. There was also some dispute as to whether it was CGK that the quartz tube could be flattened using only a flame (it being common ground that the seal could be flattened using only a flame).

47. Mr Hall referred to the fact that this was done in the process taught by the Mathijssen patent. That, however, was not CGK. He also referred to the fact that it was done in the GS Dome Method, although – as was made clear in Mr Morris' report – that involved shrinking the quartz tube which surrounded the electrode itself (after assembly of the lamp) and was done by heating the quartz area under vacuum. Accordingly, it was not the flame alone that achieved this. Mr Huxley accepted in cross-examination that applying heat to the quartz glass could cause it to contract "a little", but said that this would not lead to a "gross contraction" unless heat was applied over "lots and lots of time". Mr Morris did not address this possibility. The most the evidence established, in my judgment, was that it was CGK to use a flame to cause the quartz glass to contract a little.

Purposive construction: arguments and discussion

48. Heraeus contends that the requirement that the bead be "not bigger than" the outer diameter of the tube is not a hard limit, requiring great precision, but would be understood by the skilled person as a "fuzzy" limit. In essence, it contends that on a purposive construction "not bigger" means "not materially bigger", and it seeks to define materiality in one or other of two ways. Its narrow argument is that it means not bigger by reference to accepted tolerances, which the skilled person knew to be part of the CGK. Its broader argument is that it means "not bigger such that it impairs the strength or utility of the seal", it being common ground that using a bead that is up to 0.3mm bigger than the outer diameter of the tube would have no impact on the strength or reliability of the seal.

49. In support of its first argument, it contends that the experts agreed (following Mr Morris' cross-examination) that it was CGK that operators would work, in relation to each aspect of manufacturing an arc lamp, to tolerances of a few tenths of a millimetre.

50. This was certainly Mr Huxley's evidence. In his first report, he noted that it was CGK that there was a "passthrough" requirement, namely that the outer diameter of the lamp was dictated by the need for it to be mounted in a given device. He said that while a lamp assembler would aim for the seal to match the outside diameter of the tube, this was not a hard limit, but a "fuzzy" one, which could not cause a lamp to be rejected at the quality control stage if the seal was a few tenths of a millimetre larger than the outside diameter of the tube. He explained that this was the consequence of the fact that beading and sealing are both artisanal processes, performed by skilled operators with molten materials in a dynamic situation: "The degree to which such variation can be minimised is largely limited by the amount of effort expended by the operator. At a practical level this means that the tolerances in manufacture are primarily determined by necessity."

51. Mr Morris, in his first report, disputed that a tolerance of 0.1mm to 0.3mm was CGK, not because it would have any effect on the integrity of the seal, but relying on the fact that the Patent explains that the wall of the tube was 0.5mm, which meant that a variation of 0.1mm would correspond to 20% of the thickness of the tube wall (and, implicitly, that a variation of 0.3mm would correspond to 60% of the thickness of the tube wall). Mr Morris did not explain why this was the critical comparison as

opposed, for example, to comparing a tolerance of 0.1mm with the outer diameter measurement of the tube (where it was nearer to 1-2%).

52. In any event, in cross examination, Mr Morris abandoned that position. He first accepted that (as explained in the Heraeus Lamp Book, which he exhibited as part of the CGK) it was industry standard for there to be tolerances of +/- 0.3mm in the internal and external dimensions of the quartz tube. He then agreed (having been shown the extract from First Light's manufacturing drawing, including a drawing of the rod and bead which stated that tolerances were +/- 0.2mm unless otherwise specified) that such tolerances were industry standard in relation to the beads as well as the tube. He added that "general tolerances would apply only if there is not a specific tolerance on the drawing for that component". Mr Morris also agreed that if the tolerances are tightened, that would require more effort on the part of the lamp assembler, and that it was CGK that the skilled person would know that if the dome, in the GS10 Dome Method, was made to the dimensions of CGK tolerances, then it would work.

53. He added the caveat, however, that this was subject to any tighter tolerances being specified and that, in his view, the phrase in the Patent "not bigger than" was such a specification of tighter tolerances. This latter point goes to the construction of the words used in the Patent, a question for the Court, not the experts. In the absence of Mr Morris pointing to any particular attribute or knowledge of the skilled person relevant to their understanding of this integer in the Patent, I do not find Mr Morris' opinion on the meaning of the words of assistance.

54. The question for me, therefore, is whether – as a matter of construction of the Patent – the words "not bigger than" the outer diameter of the tube is to be read as imposing a stricter tolerance than that which the skilled person would understand to be CGK.

55. In his written closing argument, Mr Hall submitted that it does, first, because a strict interpretation is supported by the technical purpose behind the limits on bead size and, second, because the skilled person would be inclined to follow such limits in the same way they would follow any tolerances provided in a technical specification.

56. I can deal shortly with the second reason, which is based on a comment from Mr Morris in cross-examination, immediately after he had agreed that the CGK was that a person making a rod-seal with the GS Dome Method would work to a tolerance of 0.2mm or 0.3mm unless told to make it more accurately. He said that the instruction to make the bead no bigger than the outer diameter of the tube *was* indicating a strict tolerance limit. In my judgment, this comment was just another way of expressing Mr Morris' view as to the meaning of the words used in the Patent which, as I have noted above, is a question for the Court.

57. The starting point for the first reason given by Mr Hall is the explanation of the problem ("high [deviation] in seal quality"), and the aim of the invention ("to increase the reliability of the seal by reducing the [deviation] … without a loss in quality of the seal"), in [0009] of the Patent. Mr Hall submitted that the problem (or at least a material aspect of the problem) being referred to was the lack of consistency in the extent to which the seal matched the outer diameter of the tube. He said that the aim of the Patent was therefore to reduce deviation by ensuring that the seal is the same size as the outer diameter of the tube, and that this was the technical purpose behind the requirement that the bead be "no bigger" than the outer diameter of the tube.

58. I do not accept this submission. Mr Morris acknowledged that it was CGK that under the GS Dome Method lamps were made to a tolerance of a few tenths of a millimetre.

Neither expert suggested that it was part of the CGK that there was any problem with the GS10 Dome Method caused by the lack of precise matching between any parts of the assembly forming the outer diameter: e.g. between the arms and the quartz, or between the bead and the arms. Nor is there anything in the Patent which refers to this as a problem, let alone a problem that the Patent is intended to address.

59. The words in [0009] of the Patent upon which Mr Hall relies must be read in context. Importantly: [0001] identifies the especial feature of the invention being to form "a mechanically strong and leak free seal"; [0003] identifies the perceived problem in rod seal lamp assembly being the different coefficients of expansion of quartz and tungsten; and [0008], which comes just after the description of the GS10 Dome Method, identifies the problem with it as "a weakness in the end regions thereof where a GS to GS seal has been formed" and states the object of the invention as being "an improved method which reduces the chance of weakness being introduced into the structure by the manufacturing process". In that context, the most likely meaning of the "problem" in [0009] is to the weakness just referred to in [0008], and the aim of the invention is to address that problem. In contrast, the absence of any reference to there being a problem in the lack of precise matching between seal and the outer diameter of the tube, is a strong indication that that was *not* the problem which the invention aimed to address.

60. Mr Hall pointed to [0012] of the Patent, which emphasises the simplicity of the method as compared to the prior art, the speed of the manual process and the possibility of automation which could guarantee a further minimizing of quality tolerance. He submitted that the invention is "all about consistency".

61. In my judgment – in agreement with the submissions of Mr Pritchard who appeared for Heraeus – [0012] of the Patent is identifying the practical benefits which the invention carries with it. It is not defining the technical purpose behind any part of the claimed method, which is explained in the passages to which I have referred above.

62. It is true that consistency, in the sense of ironing out deviations in quality, is signalled as an important benefit of the invention. It is not, however, consistency for its own sake, but consistency in quality, specifically by addressing the problem identified of weakness in the end regions of the lamp. In other words, consistency is the by-product of the increased quality in the seal (in terms of being mechanically strong and leak free) that the Patent promises for the invention.

63. Mr Hall also pointed to [0015], which repeats that the invented method provides a mechanically strong seal, in order to bring an electrical current into "any form" of lighting or discharge lamp. He submitted that it was CGK that some customers to whom arc lamps are supplied may need to mount them in a way which required stricter tolerances than normal, so it was necessary for a bead that was strictly no bigger than the outer diameter of the tube to be used so that all lamps could meet the tolerance requirement of any customer. The evidential basis for this submission was said to be a passage in the cross-examination of Mr Morris, in which it was put to him that the removal of the side-tube (used to change the pressure in the lamp during the assembly process when completing the second end of the lamp) leaves behind a "pip". When asked how big the pip was, Mr Morris said: "I do not think there are set dimensions, but I would suggest it is probably less than a millimetre in most cases." Mr Hall relied specifically on the answer to the next question:

> "Q: Less then a millimetre. It is certainly not flush is it?

A: It can be flush if that is part of a specification, a customer has a tight spec, it can be made flush but that would be rare."

64. There was no evidence from either expert that the skilled person would understand that the reference in [0015] to "any form" of lamp was intended to mean that lamps assembled according to the method taught in the Patent would necessarily satisfy the passthrough requirements of *any* customer, so as to include the rare case of a customer demanding that there be no tolerance on the outer limit of the lamp.

65. The only support for this proposition is the above answer of Mr Morris given in cross-examination. I do not regard that as justifying the conclusion Mr Hall seeks to draw from it. The reason why the invention is appropriate for "any form" of light or discharge lamp is given in the same sentence of [0015], namely because it provides a mechanically strong and leak free seal. It has nothing to do with satisfying all passthrough requirements.

66. The rare case of a customer requiring tighter tolerances falls, in my view, within the exception that was built into the CGK: that there was an accepted tolerance of a few tenths of a millimetre, *except where a tighter tolerance was specified*. That is reinforced by the fact that, as was acknowledged by the experts, imposing tighter tolerances comes at a cost in terms of additional work on the part of the operators, which would cut across the stated benefit of simplicity and efficiency.

67. Mr Hall then submitted that, in light of Mr Huxley's evidence, Heraeus' argument wrongly cherry-picks from the CGK only those parts helpful to its case. He referred to Mr Huxley's report, where it is said that the lamp assembler would "aim for the seal OD to match the OD of the tube", and to a passage in the cross-examination of Mr Huxley where he again spoke of the "aim" of the lamp assembler to match the seal to the outer diameter of the tube as a "rule of thumb". Mr Huxley agreed with the proposition that if the lamp assembler "aims for a seal that is 0.2mm bigger, they are inevitably going to go over that fairly often", and that if they aim for the seal diameter that matches the outer diameter of the tube, the error rate is reduced, and that the reason for doing so would be to satisfy passthrough as often as possible.

68. Mr Hall submitted that it was "unequivocally made out" as part of the CGK, on this evidence, "that one should aim to match the seal size with the outer diameter of the tube". Nothing in this evidence contradicts, however, Mr Huxley's point (with which Mr Morris agreed) that it was CGK that tolerances of a few tenths of a millimetre were acceptable. The fact that it is usual for a lamp assembler to "aim" for a particular target says nothing about the viability of the product if the target is missed by a few tenths of a millimetre.

69. Mr Hall referred to the fact that in each of the drawings set out in the Patent, the bead is identified as being not bigger than the outer diameter of the tube. I do not, however, read much into this. The drawings are not to scale and, given that there would have been no technical difficulty in drawing the bead so that its diameter fell between the inner and outer diameters of the tube, it would be surprising if they had been drawn any differently. It does no more than reinforce, in my view, the point made by Mr Huxley, that the Patent teaches the lamp assemblers to *aim* for a bead that is precisely no smaller than the inside, and no bigger than the outside, diameter of the tube. It is not, however, of assistance in determining whether "not bigger than" was intended to denote a hard limit.

70. Mr Hall distinguished other cases (such as those referred to in *Actavis UK Ltd v Eli Lilly & Co* [2017] UKSC 48, at §35-36 and §55) in which numerical ranges or words

of degree have been considered (e.g. whether 10% encompasses 9.5% to 10.5%, or how vertical is vertical or how fixed is fixed?) on the basis that those involved abstract concepts. In contrast, he submitted, the Patent involves a physical thing, the tube, which has a precise measurement; a diameter that is fixed without any tolerance. Accordingly, an instruction to build up a bead to be no bigger than the diameter of the tube similarly denotes a fixed measurement without any tolerance. I do not accept this distinction. I do not see that there is any difference for the purposes of the point in issue in this case between an instruction to construct something to a diameter of, say, no bigger than 6mm, and an instruction to construct it to a diameter no bigger than the diameter of something else. In either case, the concept in issue is "no bigger than". Whether that denotes a hard, or fuzzy, limit is not determined by whether the thing by reference to which it is to be measured is an abstract measurement or the measurement of a physical thing.

71. In response to Heraeus' broader case (that not bigger than means not bigger such that it impairs the strength or utility of the seal) Mr Hall advanced two arguments. First, compliance with such a claimed feature would require a comparative test for "impairment" of which there was no CGK test. Second, it would amount impermissibly to reading the upper size limit out of the claim.

72. As to the first point, he cited *Generics (UK) Ltd v Yeda Research and Development Co Ltd* [2013] EWCA Civ 925, per Floyd LJ, at §78:

> "It is sometimes difficult to determine where the precise boundary of a claim lies. In such cases what matters is whether the skilled person knows what the test is he has to apply to determine infringement. The judge expressed this well in the following passage at [193]:
>
> > " . . . it is necessary to distinguish between claims that are difficult to construe or that have a "fuzzy boundary" (in the words of Lord Hoffmann in *Kirin-Amgen Inc v Hoechst Marion Roussel Ltd* [2004] UKHL 46, [2005] R.P.C. 9 at [126]) on the one hand from claims that are truly ambiguous on the other. It is regrettably common for claims to be difficult to construe, but the court will nevertheless strive to give such claims a sensible meaning having regard to the inventor's purpose. It is also common for claims to have a fuzzy boundary, because an integer of the claim involves some question of degree or an imprecise functional limitation. It is well established that is not itself objectionable. If a claim is truly ambiguous, so that it is unclear what is the correct test to determine whether or not a product or process infringes, however, then the claim is insufficient . . . "

73. Mr Huxley accepted that the Patent did not try to describe a test for assessing at what point the size of the bead would be such that it would impair the seal's strength or utility. In answer to the question how the skilled person would know how to test whether the bead was too big, Mr Huxley said he thought that they would follow the rule of thumb referred to above at §67..

74. Mr Huxley referred to "seal integrity" clearly being compromised if too big a bead was used. Mr Morris did not have sufficient experience of working with beads to comment on this. It was First Light's director, Mr Churchley, alone who explained why this was: if the bead becomes too large it starts to collapse under its own mass. As I have noted above, however, it was common ground that using beads that were a

few tenths of a millimetre oversized would not impair the integrity of the seal in this way.

75. In light of that evidence, Mr Pritchard submitted that the skilled person would have no difficulty in ascertaining when the bead was "too big", because it would be at the point that the seal started to collapse under its own weight. In my judgment, while it is not possible to define the precise measurement of a bead which is too big, on Heraeus' test the limit is nevertheless sufficiently clear from what actually happens during implementation to enable the skilled person to identify the outer limits of "not bigger than". This is a case, therefore (to adopt the dichotomy referred to in *Generics v Yeda*), of an imprecise functional limitation, rather than a truly ambiguous claim.

76. In support of his second contention – that Heraeus' broader test of materiality means reading out the upper size limit of the claim – Mr Hall submitted that Heraeus' argument was basically interpreting the integer as "do what you already know from your CGK", because it was CGK that if it was made too big it would collapse under its own weight. Accordingly, the words "not bigger than", on Heraeus' case are pointless and, since it is impermissible to ignore words which the patentee has chosen to include in the Patent, that cannot be the right interpretation. I do not accept this: the argument assumes that each and every part of a claim should not already be part of the CGK or prior art, but that is not so. If it were, then the same complaint could be made of other aspects of the claim – including the reference to the use of a sheath and a bead, each of which was part of the CGK in the GS10 Dome Method.

77. Mr Hall developed this argument as follows: if beads a little bigger than the external diameter of the tube are within the claim because they will work, then it follows that beads that are a little smaller than the inner diameter will also work, so that the bead size limits are merely arbitrary. The suggestion that beads that are a little smaller than the internal diameter would work is based on the fact that it was CGK that the tube could be flattened a little using just a flame (see above at §47.). The short answer to this, as Mr Pritchard submitted, is that the lower limit on the bead size undoubtedly has a technical purpose, and is not purely arbitrary. The purpose is to ensure that there is fusion between the bead and the *end* of the tube. Whether that is by reason of the fact that the bead is larger than the inner diameter of the tube all along, or only after the tube has been slightly flattened does not matter: there is a clear technical purpose.

78. In his written opening submissions, Mr Hall made two further, related points. First, the ordinary meaning of the words "no bigger than" is clear and unambiguous and to construe them as including 0.1mm to 0.3mm bigger would be inconsistent with the requirement to afford parties a reasonable degree of legal certainty. Second, it would be manifestly unfair to the patentee and to third parties to ignore the limitation: there are only three possibilities for bead size (larger than the external diameter, smaller than the internal diameter, or somewhere in between) and the patentee, by choosing the latter has ruled out the other two. There is in my view, however, no material uncertainty or unfairness in construing the words "no bigger than" as a fuzzy limit in the way Heraeus contends, given that – for the reasons developed above – it has no impact on the technical purpose of the limit in the context of the Patent as a whole.

79. Finally, Mr Hall relied on *Société Technique de Pulverisation v Emson Europe Ltd* [1993] R.P.C. 513 for the proposition that giving a patent a purposive construction does not mean that deliberate limitations can be treated as struck out if it does not make any difference to the inventive concept: "it may have some other purpose buried in the prior art and even if this is not discernible, the patentee may have had some reason of his own for introducing it" (per Hoffmann LJ at p.522). That is not,

however, Heraeus' argument. It does not seek to strike out the words "not bigger than", but merely to construe them. Nor – for the same reason – does Heraeus' argument seek to give the patentee "more protection than that which, objectively assessed, he indicated he wanted" (c.f. *Merck & Co v Generics* [2003] EWHC 2842 (Pat), per Laddie J at §47).

80. In agreement with Mr Pritchard, I conclude that – construed objectively – the protection sought in the Patent is not limited to a method in which beads are precisely no bigger than the outer diameter of the tube, but include variants in which the bead is not materially bigger than the outside diameter of the tube to an extent "which could have no material effect upon the way in which the invention worked" (per Lord Diplock in *Catnic Components Ltd v Hill & Smith Ltd* [1982] R.P.C. 183, at p.243). In this case, that means not bigger so that it impairs the strength or utility of the seal. As a matter of fact, that encompasses any bead made within CGK tolerances. If that is wrong, then alternatively the phrase is to be construed as not bigger by reference to CGK tolerances.

81. In reaching this conclusion, I keep in mind that it is a method patent, not a product patent. Mr Hall suggested that using oversized beads, per the Annex C method, did have a material effect on the way in which the method worked. It was less efficient than the method taught in the Patent as it required (at least potentially) the use of tooling to eliminate bulging on the side of the tube as a result of the use of the oversized bead, and it was one of the trumpeted benefits of the Patent that it avoided the need for tooling. I am satisfied, however, that the elimination of tooling referred to in the Patent is the tooling required to form the seal in the first place, as in the CGK GS10 Dome Method. It was tooling during the formation of the seal that introduced inefficiencies and potential weakness (as a result of the carbon tool contaminating the molten glass before it was formed in the seal). The tooling contemplated by Annex C is undertaken after the lamp has been assembled, in order to work down any bulging that has occurred as a result of using a bead that was at the upper end of CGK tolerance – such a bead having been chosen for no technical purpose other than to seek to incorporate a change from the Patent.

Infringement by equivalents

82. The parties are agreed that the question of infringement by equivalents is determined by reference to the three questions posed by Lord Neuberger in *Actavis UK Ltd v Eli Lilly and Co* [2017] UKSC 48, at §66.

> "(i) Notwithstanding that it is not within the literal meaning of the relevant claim(s) of the patent, does the variant achieve substantially the same result in substantially the same way as the invention, i.e. the inventive concept revealed by the patent?
>
> (ii) Would it be obvious to the person skilled in the art, reading the patent at the priority date, but knowing that the variant achieves substantially the same result as the invention, that it does so in substantially the same way as the invention?
>
> (iii) Would such a reader of the patent have concluded that the patentee nonetheless intended that strict compliance with the literal meaning of the relevant claim(s) of the patent was an essential requirement of the invention?"

83. I need deal only briefly with this aspect of the claim, first because it does not arise for determination in view of my conclusion on the purposive construction case and, second, because the parties were agreed that although the question raised by a case on infringement by equivalents is logically distinct from that raised when purposively construing a patent (*Actavis*, above, at §56), on the facts of this case there is no material difference.

84. Before I address the three *Actavis* questions, however, it is necessary to deal with a dispute as to the inventive concept of the Patent. This is the "clever bit" which solves the problem underlying the invention: *Actavis* (above) at §83.

85. Mr Hall submitted that the inventive concept is "about consistency, simplification, removal of manual tooling and de-skilling, which aims are enabled by the combined requirements of the direct seal and the bead size." For reasons similar to those that I have set out above in rejecting First Light's arguments on purposive construction, I consider that this confuses the claimed benefits of the Patent, which include consistency, simplification and automation, with the core of the invention. In my view the latter, in agreement with the submission of Mr Pritchard, resides in steps (3) and (4) of [0017] of the Patent. This is the core teaching which solves the problem underlying the invention: namely the weakness in the seal in the method forming the CGK.

(i) Does the variant achieve substantially the same result in substantially the same way?

86. Mr Hall accepted that the variant achieves substantially the same result, but contended that it did not do so in substantially the same way, because Annex C requires the use of an oversized bead which, if necessary, gives rise to further work in tooling the seal so that it matches the outer diameter of the tube.

87. As he acknowledged in his written closing submissions, his answer to the first *Actavis* question depended on him being right that the inventive concept includes the upper bead size limit for the purposes of "achieving consistency, reducing variability in the seal etc." I have rejected that contention above.

(ii) Would it be obvious to the Skilled Person that it does so?

88. It was common ground that, whatever the answer to the first *Actavis* question, the answer to the second question would be the same.

(iii) Would such a reader have concluded that the patentee nonetheless intended strict compliance with the literal meaning of the patent?

89. Again, both parties agreed that on the facts of this case, the third *Actavis* question is essentially the same as that raised by the purposive construction case.

90. Accordingly, for essentially the same reasons that I have set out above in relation to the purposive construction case, the infringement by equivalents case succeeds.

Literal Infringement

91. In view of my conclusions on the purposive construction case, it is also unnecessary to determine whether there was literal infringement, and I do so only in case the matter goes further.

92. As I have noted above, the literal infringement case is based on the contention that, while the Annex C process requires the lamp assemblers to use oversized beads, in fact – due to error not design – First Light's lamp assemblers have on occasion used beads that are no bigger than the outside diameter of the tube.

93. Heraeus has presented only one example of an allegedly infringing lamp: the F985-164 Sample. There were originally two sample lamps, but one was broken up in the course of experiments carried out at an earlier stage of this case.

94. Mr Pritchard submitted that Heraeus' case turns simply on whether the F985-164 Sample was in fact manufactured using a bead that was no bigger than the outer diameter of the tube. If so, he said, then infringement was established, and all questions relating to how often this might occur went only to the form of relief to be granted.

95. Mr Hall agreed that this is a necessary pre-condition of the case on literal infringement, but contended that this was not sufficient to establish the case: it would also be necessary for Heraeus to show that, on the balance of probabilities, when First Light's operatives purport to follow the Annex C method they fail to use oversized beads more than a *de minimis* number of times.

96. In *Napp Pharmaceutical Holdings v Dr Reddy's Laboratories (UK)* [2017] EWHC 1517 (Pat), a case which concerned patches for use in the treatment of pain, Arnold J held that the "de minimis" principle applied to patent claims. In answer to a submission that a defendant who sold 200 patches that fell within the claim would undoubtedly infringe, and that it made no difference if the 200 patches constituted a single hour's production out of a year's worth of production, he said (at §148):

> "I can only say that I disagree. It seems to me that most people, and specifically the skilled person, would be very surprised by the proposition that selling products only 0.01% of which fall within the claim constitutes patent infringement, particularly where the 0.01% are randomly distributed among the remainder. I consider that this is precisely the kind of situation covered by the de minimis principle."

97. I consider that the true position lies somewhere between the parties' submissions. Where (leaving aside the purposive construction case) the only basis on which it is alleged that infringement occurred was due to the inadvertent failure of First Light's employees to follow the Annex C process, there will have been no infringement unless this has occurred on a more than *de minimis* basis. Accordingly, it is not sufficient to establish infringement that the F985-164 Sample was made with a bead no bigger than the outer diameter of the tube: it must be shown that this was an example of something that happened on a more than *de minimis* basis. Equally, it is not enough to avoid a finding of infringement that the F985-164 Sample did not infringe the Patent, if it could be shown on the balance of probabilities that undersized beads were used on a more than *de minimis* number of other occasions.

98. For the reasons which follow, I am not satisfied either that the F985-164 Sample is an instance of literal infringement or that this occurred on a more than *de minimis* basis.

99. Heraeus, as it pointed out, faces inherent difficulties in establishing its case on literal infringement. In making the lamp, the GS10 bead – as a separate component – ceases to exist. Once the lamp is made, therefore, it is impossible to measure the bead that was used in its making. It might theoretically be possible to conduct experiments to reverse engineer the process so as to arrive at the bead size, but that has not been done

in this case. There are no contemporaneous records of the bead sizes actually used since, even if this was something that was recorded, any records were destroyed (innocently) before the start of these proceedings. None of these reasons for the lack of evidence can be blamed on First Light.

100. Heraeus' case is based on two strands. The first relates to what occurred at an inspection of First Light's Annex C process.

101. I heard evidence from the two employees of First Light who carried out the work at the inspection: Sarah Griffin, who carried out the lamp assembly and Grant Hinchliffe who made the beads. I also heard evidence from two directors of First Light, Martin Churchley (who is also the inventor of the Churchley patent) and Paul Walker, who observed the inspection, and from two employees of Heraeus who also attended the inspection: Ashley Foster and Carl Reeder. All of these witnesses gave truthful evidence with a view to assisting the Court.

102. During the inspection, Mr Hinchliffe made 40 beads. Ten were retained and the other 30 were then used by Ms Griffin in assembling 15 lamps.

103. Both Mr Hinchliffe and Ms Griffin referred to the unnatural and uncomfortable circumstances of the inspection. First Light stopped assembling lamps pursuant to the manual process under Annex C in about November 2020, so it was some years since either of them had carried out the manual process. Mr Hinchliffe practised making beads and sealing them to the lamp for about an hour a day for the two weeks prior to the inspection. At the inspection, however, he only made the beads. Ms Griffin undertook the sealing process, having had only a couple of days to practise something she had last done three years ago.

104. Neither of them considered that they did their best work, particularly as they were somewhat nervous having to work under the gaze of many onlookers. Mr Hinchliffe referred to his hands being "very shaky" as a result. He said that his error rate was greater than what he recalled from his time making the beads. He had been told that the purpose of the inspection was because of the argument raised in the proceedings about the diameter of the beads. He said however, and I accept his evidence, that he attempted to build beads to all aspects of the required specifications, not merely the bead diameter.

105. Heraeus contends that, although all of the beads made during the inspection were bigger than the outer diameter of the tube, a significant number were found to be smaller than the required width.

106. This contention is based primarily on evidence produced by Mr Walker in the form of a schedule of measurements taken of ten beads. There are three ways to measure the beads: using digital vernier callipers; using a "go/no-go" gauge, which allows only those beads that met specification to pass through; and using a microscope. The PPD states that the diameter of beads was measured using *either* callipers or a go/no-go gauge.

107. All the witnesses referred to the fact that measuring beads using callipers is a skilled process, and that it is likely that different people, certainly where they are not skilled in the process, will often arrive at different measurements for the width of a bead. There is a particular difficulty in measuring the width of beads, as Mr Huxley explained, because this involves a judgement about where the bead begins as it rises up from the sleeve.

108. The schedule exhibited by Mr Walker contains measurements taken by Mr Walker and an unknown person on behalf of Heraeus (each using callipers) and by microscope. The microscope measurements of bead widths are all within the specified range, but a significant proportion of the calliper measurements of the bead widths taken by Mr Walker and by Heraeus are smaller than the range, and there are material differences between the two sets of measurements.

109. Mr Walker is not skilled in using callipers. Although it is not known who carried out the measurements on behalf of Heraeus, it is not claimed that they were skilled in using the callipers.

110. Mr Hinchliffe, in contrast, is skilled in using callipers. His evidence was that he was focused during the inspection on ensuring that the beads he made were within specification and that he measured each one, rejecting those that did not make the grade. He was satisfied on the measurements he took that each of the beads that he made, and did not reject, was within specification both as to diameter and width. He accepted, with reference to the time he made beads when operating the manual process in and prior to 2020, that he is only human and so could have produced a bead that was outside width specifications which he did not correct.

111. Both Ms Griffin and Mr Hinchliffe recalled that when operating the manual process described in Annex C, they used beads that were bigger than the outer diameter of the tube. Ms Griffin said that she remembered that the bead was "always bigger" and that in any event "we made sure that the size of the bead matched the dimensional requirements on the drawing specification". Mr Hinchliffe referred to this as a "crucial process and that is the way we have always done it", and was something that he learned from his supervisor at the time he was trained.

112. There was some debate about whether the PPD was complete, because Mr Churchley's evidence was that the go/no-go gauge was only used from some point after the Annex C process had begun, whereas Mr Hinchliffe said that he always used the go/no-go gauge. It is unnecessary to resolve this since, on the face of the PPD, operatives used *either* callipers or the go/no-go gauge, so it is possible that callipers (the use of which Heraeus contends leads to errors) were used on a material number of occasions.

113. Heraeus contends, on the basis of what occurred at the inspection, that is likely that undersized beads were used in error – when the Annex C manual process was operated by First Light – on a more than *de minimis* number of occasions. The argument runs as follows: there were significant errors made in relation to the width of the beads at the inspection; that is likely to have been replicated to a similar extent in practice in the past; although all of the beads made during the inspection were bigger than the outer diameter of the tube, that was because Mr Hinchliffe knew that the purpose of the inspection was to test whether oversized beads were used in the Annex C process and he was therefore particularly focused on that aspect; in contrast, the operatives carrying out the Annex C process were not told that the specifications as to diameter were more important than those relating to width.

114. I do not accept this contention for the following reasons.

115. First, in circumstances where the width measurements were made by persons unskilled in the use of callipers, the measurements recorded in the schedule produced by Mr Walker provide only weak support for the proposition that the beads made during the inspection were in fact under-width.

116. Second, Mr Hinchliffe's evidence – which I accept as being honestly given – was that he measured all of the beads that he made on the day of the inspection, and passed only those that he was satisfied met the required specifications, both as to diameter and width. Mr Pritchard contended that First Light could have produced evidence of Mr Hinchliffe's measurements taken during the inspection but had not done so. They did, however, produce Mr Hinchliffe himself, who said that he measured the width of the beads, using callipers, to check they were within tolerance, and that he made more errors than he usually did, but that (as he confirmed in cross-examination) he discarded those made in error. I find that Mr Hinchliffe, with his much greater experience of using callipers, was more likely to have measured the beads accurately than either Mr Walker or Heraeus' representative whose measurements are recorded in Mr Walker's schedule.

117. Third, I do not accept that, even if mistakes were made during the inspection in relation to the width of beads, it can be inferred that errors would similarly have been made in relation to the diameter of the beads when operating the Annex C process. There are particular difficulties in using callipers to measure the width of beads (as explained above) which are not present when measuring the diameter. Moreover, the circumstances of the inspection were, for the reasons given by Mr Hinchliffe and Ms Griffin, unusual and unlikely to be representative of the way in which the lamps were manufactured in and before 2020.

118. I accept that Mr Hinchliffe and Ms Griffin were not the only ones who made beads and assembled lamps within First Light. I do not see any reason, however, for inferring, from the fact that First Light did not seek to call evidence from others involved in the process at the time, that those others would have been more likely than Mr Hinchliffe or Ms Griffin to have failed to comply with the specifications given to them at the time.

119. In the end, I do not think there is more to Heraeus' case on literal infringement than the obvious fact that, as compliance with the Annex C process depends upon the operatives complying with the instructions given to them, "mistakes do happen". There has been no attempt to provide any statistical basis for how often this is likely to have occurred. Not surprisingly, Mr Hinchliffe agreed with the proposition (which specifically related to measuring the width of beads) that he was human and therefore could make mistakes. This is an insufficient basis, in my judgment, for concluding that First Light makes lamps using beads that are no bigger than the outer diameter of the tube on any more than a *de minimis* basis.

120. This is sufficient to dispose of the literal infringement case since (as I have noted above) even if the F985-164 Sample was made with an undersized bead, that does no more than establish that this occurred on one occasion. I will nevertheless consider the second strand of Heraeus' case: that it was Mr Huxley's view that it is more likely than not that the F985-164 Sample was made with a bead that was no bigger than the outside diameter of the tube.

121. Mr Huxley's view was based on a visual comparison of the F985-164 Sample with examples of Heraeus' own lamps, and carrying out a "fingernail" test – i.e. running his finger over the lamp to see whether there is a smooth transition from the seal to the body and/or a dip in the surface and/or more subtle surface anomalies. His conclusions, at §209 of his report, are as follows:

> "In my view, the F985-164 Samples are materially identical to Heraeus NL7255 lamps, which I am told to assume have been made in

> accordance with the Patent, including using Small Beads. This is consistent with the F985-164 Samples having also been made using Small Beads, although I cannot exclude the possibility that Oversized Beads might have been used and that some alternative explanation exists for the similarity of the two sets of seals. I also note that the F985-164 Samples look physically closer in shape to the NL7255 lamps than they do to the vast majority of samples from the Inspection (the possible exception being the cathode of lamp 3 [pp. 39 of PGD03]). The differences in shape could be caused by several factors, but I believe the most likely is the reduced volume of GS10 in the bead which I attribute, in turn, to be most likely due to the use of a smaller bead diameter."

122. Since it is impossible to know from looking at the completed lamp, whether the bead used was bigger than the outer diameter of the tube, Mr Huxley's approach was based on his "by-eye" comparison of the *volume* of GS10 used in (1) the F985-164 Sample; (2) samples of Heraeus' lamps made in accordance with the Patent, and (3) the inspection samples. He considered that the volume of GS10 in the first two was comparable, and smaller than the amount used in the inspection samples. He said there could be various reasons for this, including the use of beads of a smaller diameter, or a smaller width or with a more "pointy" shape. Of these, since he considered it was easiest to achieve the first, harder to achieve the second, and even harder to achieve the third, the most likely explanation was that it was the former.

123. In cross-examination, Mr Huxley candidly accepted that the tests he carried out were subjective, "wholly unscientific" and inherently less reliable than a scientific method he had proposed, but which involved experiments which have not been adduced in evidence.

124. I do not doubt Mr Huxley's expertise or honesty. I am not satisfied, however, that his view supports the conclusion that on the balance of probabilities the bead used in making the F985-164 Sample was no bigger than the outer diameter of the tube. Mr Huxley was not aware of the diameter, width, profile or mass of the bead used in making the samples of Heraeus' lamps which he looked at for comparison. If a bead's diameter was the same as the outer diameter of the tube, then a bead that had a diameter of just 0.1mm bigger (and was thus non-infringing on this literal approach) would have had the same mass if its width was only a fraction of a millimetre narrower, or its profile was marginally different. The precise extent would depend on the profile of the bead which, as demonstrated in the diagrams within the Patent, could vary substantially.

125. The comparison between the F985-164 Sample and the lamps assembled at the inspection is subject to similar drawbacks. In addition, given the pressures under which Ms Griffin and Mr Hinchliffe were working at the inspection, and the lack of time they had to reacquaint themselves with the process after some years, I am not satisfied that the manner in which the beads were made and the lamps assembled on that day are sufficiently representative of the way in which lamps were made according to the Annex C process to enable much to be deduced from a "by-eye" comparison.

126. Mr Morris' agreement during his cross-examination that – all other things being equal – beads of a smaller diameter would be of smaller volume and give rise to less bulbous seals goes nowhere, precisely because it is an unsafe assumption that all other things were equal. The same applies, in my view, to Mr Huxley's additional point

about arc length, i.e. the distance between the tip of the two electrodes. In the eleven instances where the arc length of the inspection lamps was measured it was found to be greater than that specified in the PPD in all but two cases. Mr Huxley said that, assuming all other things were equal then that would support the view that a smaller bead had been used, because as the arc length increases for a given body length, the seals will be less bulbous. The problem is, however, that "all other things" includes (as was put to Mr Morris), in addition to the size and profile of the bead, the length of the electrodes and the position of the bead along the length of the electrode. The assumption that these were all equal is not a safe one to make.

127. There was some debate with the experts as to whether the appearance of lines on the seals indicated tooling (which might indicate an oversized bead leading to a bulbous seal). I did not find this of help either way, particularly as tooling is only one of three methods which is commonly used for flattening down a bulbous seal. The others are the use of a flame and – where the tolerance in the length of the lamp allows it – pulling back the stock of the lathe. Even if, therefore, the lines referred to in some of the lamps were not indicative of tooling, that did not rule out the possibility that there had been a bulbous seal that was flattened down in some other way.

128. For the above reasons, I am not persuaded that the F985-164 Sample was in fact made with a bead that was no bigger than the outer diameter of the tube on a strict interpretation of that concept. For completeness, Mr Huxley accepted that his view in relation to the F985-164 Sample says nothing about the likelihood of infringement on any other occasion.

Validity

129. First Light contends that the Patent is invalid because it did not involve an inventive step (as required by s.1(b) of the Patents Act 1977). By s.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…"

130. Section 2(2) provides:

> "The state of the art in the case of an invention shall be taken to comprise all matter (whether a product, a process, information about either, or anything else) which has at any time before the priority date of that invention been made available to the public (whether in the United Kingdom or elsewhere) by written or oral description, by use or in any other way."

131. First Light contends that the Patent involved no inventive step because the method disclosed by it was obvious having regard to two pre-existing patents: (1) US patent 4 481 443 ("Mathijssen") and (2) US patent 5 979 187 ("Churchley").

132. Obviousness falls to be assessed separately in relation to each of these pieces of prior art, there being no suggestion that the prior art may be "mosaiced", i.e. read together. While the test remains that set out in s.3, a useful approach is that formulated by Jacob LJ in *Pozzoli SpA v BDMO SA* [2007] EWCA Civ 558, at §23:

> "(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?”

133. The importance of putting knowledge of the invention to one side was stressed by Moulton LJ in *British Westinghouse Coy v Braulik* (1910) 27 R.P.C. 209, at p.230, quoted with approval by Lord Russell in *Non-Drip Measure Co Ltd v Strangers Ltd* (1943) 60 R.P.C. 134, at 142:

> “I view with suspicion arguments to the effect that a new combination, bringing with.it new and important consequences in the shape of practical machines, is not an invention, because, when it has once been established, it is easy to show how it might be arrived at by starting from something known, and it taking a series of apparently easy steps. This ex post facto analysis of invention is unfair to the inventors, and in my opinion it is not countenanced by English Patent Law.”

134. I have addressed the inventive concept above at §85..

Mathijssen

135. Mathijssen was published in 1984. It teaches a method of sealing the end of a “short-arc discharge lamp” by attaching a bead of sealing glass, attached via a thin sleeve of sealing glass to a tungsten rod, directly to the glass of the tube. Specifically, the method includes the following:

(1) The bead is built up to a diameter that approximates to the inside diameter of the tube.

(2) The rod is introduced (while rotating on a lathe) to the end of the tube, so that the bead sits part within and part outside the end of the tube.

(3) The end of the tube is heated by means of a flame and pressed inwards by the flame (the use of a tool at this stage being optional but not necessary) so as to make contact with the bead.

(4) Gas is then blown into the tube, causing “a gradual transition of the sealed parts.”

(5) The patent explains that the invention does not eliminate the stresses which arise due to the differences in coefficients of thermal expansion of the tungsten and the quartz, but that “as a result of the geometry chosen, in which the glass-shaped member is enclosed by the quartz glass of the neck-shaped lamp envelope portion, these are pressure stresses which are taken up by the quartz glass”. The “geometry” referred to is the curving inwards of the tube to fuse with the bead, and appears in the following figures in the patent:

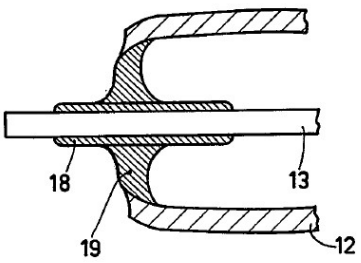


Fig.4

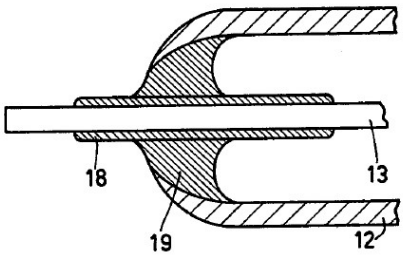


Fig.5

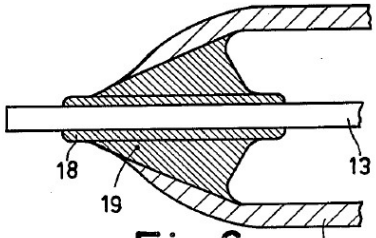


Fig.6

136. First Light's arguments relating to Mathijssen developed significantly over the course of the trial.

137. In his first report, Mr Morris said that the skilled person might have tried three obvious developments after reading Mathijssen. First, as the thickness of the larger diameter portion of the bead (i.e. longitudinal to the lamp) was not mentioned, it would have been interesting to conduct trials/investigations to look at varying the thickness. Second, the example in Mathijssen referred to the use of an envelope with a wall thickness of 2.5mm, and as the majority of flash lamps are made using 0.5mm or 1.0mm quartz in the seal area, the skilled person would have thought it worthwhile to investigate using the Mathijssen method with a wall thickness of 0.5mm or 1.0mm. Third, as Mathijssen referred to using different bead profiles, the skilled person would think it worth looking at a parallel sided-bead, as that would more closely match the inner form of the quartz body. He also said that, having seen the Patent, the third of those obvious developments would result in using a bead with a bigger diameter than the internal diameter of the end of the tube, but not bigger than the external diameter of the end of the tube. He accepted in cross-examination, however, that this conclusion was one reached only in hindsight, with the benefit of the Patent.

138. In cross-examination, Mr Morris agreed that:

(1) Mathijssen taught, specifically, that the problem created by the differences in coefficients of expansion of tungsten and quartz glass had been solved by the use of the geometry explained in the patent.

(2) The vast majority of GS used is on the inside of the tube.

(3) In order to get a bead sealed on the outer surface of the annulus in Mathijssen, it would be necessary to change the geometry, and in doing so, the skilled person would be discarding the central thrust of what Mathijssen is teaching.

(4) The skilled person would not "move away" from the geometry that is shown in Figs 4, 5 & 6, because there was no expectation that it would work. he accepted that throwing away that geometry would be "an act of hindsight".

139. In his reply report, Mr Morris had made reference to a passage in Mathijssen in which it compared testing which was carried out on the invention disclosed by that patent – which was tested at room temperature at 120 bar without any cracks occurring – and testing carried out on lamps constructed in the geometry of Figure 1 (that is, the existing prior art) "but without using a graded seal 7*a*", where it was said that a crack occurred at a pressure of 40 bar. Mr Morris said that this information would be "the key message that the Skilled Person would take from Mathijssen. They would learn that their prejudice against a direct seal was mistaken, and that they could simply adopt a direct seal in place of the indirect dome in their CGK method."

140. In cross-examination, Mr Morris acknowledged that he had made no reference to this in his first report, and agreed that was because it did not "leap out of the page" at him. He also acknowledged that in discussing – in his first report – the lack of obviousness over Mathijssen, he made no reference to this point, because it "simply did not leap out of the page and occur to [him]". Finally, he accepted (contrary to the assumption made in his reply report) that the skilled person looking at the relevant passage in Mathijssen would understand it to be referring to a form of *indirect* seal.

141. In closing, however, these points – other than that in relation to the bead size – were not pursued. Instead, in addition to the point that it would have been obvious to increase the bead size to arrive at the [0017] embodiment of the invention in the Patent, Mr Hall developed the case of obviousness over Mathijssen on two new bases: (1) following Mathijssen's primary teaching together with the CGK would lead the skilled person to the method described in [0018] of the Patent; and (2) there is a "no technical benefit" point in relation to the bead size integer of the Patent.

(1) The method described in [0018]

142. The essence of First Light's case on this point is that [0018] of the Patent describes a method which is almost indistinguishable from the method taught in Mathijssen. Mr Hall submitted that the only gap which needed filling to get from Mathijssen to the Patent is the fact that it is assembled while rotating and that, he said, was something that formed part of the CGK. Accordingly, the skilled person would regard it as obvious to fill the gap by use of rotation.

143. He submitted that [0018] is essentially the same as Mathijssen for the following reasons:

(1) The first sentence of [0018] reads: "In a further Example the end of the quartz glass tube is molten and softly pressed to a heated bead."

(2) That, in itself, is ambiguous: it might mean that the tube and the bead are brought together by the rod being inserted further into the tube, or that the tube is pressed down onto the bead. That ambiguity is resolved, however, by Fig 4 of the Patent (see above at §20.). In that diagram the electrode is positioned so that it, and the tungsten rod which carries it, cannot move further to the left. The diagram also shows the narrowed end of the tube touching the bead. Accordingly, since there is no room for further movement of the tungsten rod, it follows that the end of the tube must have been pressed *down* to meet the bead.

(3) Although the geometry of the end of the tube in Mathijssen is shown as a frusto-conical shape, whereas the end of the tube in Fig 4 narrows in a straight line, there is nothing in the Patent which excludes the geometry used in Mathijssen.

144. This is not a point that was pleaded by First Light. Nor is there any mention of it in the reports of either expert. Mr Huxley makes a passing reference to [0018] but, since he was not on notice of this possible interpretation of it, did not address it. It is not a point that Mr Morris dealt with at all. It was something that was only raised with Mr Huxley during cross-examination. The sole reference to it prior to the cross-examination of Mr Huxley was the following passage in Mr Hall's skeleton argument: "Indeed, Mathijssen's method may be on all fours with the example discussed in [0018] (subject to rotation, which the experts agree is CGK). The description of the sealing process at the top of column 4 [of Mathijssen] is conspicuously similar to the example discussed in [0018] of the Patent."

145. In these circumstances, Mr Pritchard objected that this was a point that it was not open to First Light to take, in reliance on *Liqwd Inc v L'Oreal (UK) Ltd* [2018] EWHC 1394 (Pat), per Birss J at §215:

> "Olaplex made submissions about the principles by which the Patents Court operates. I agree with them. Some are elementary but are worth restating anyway. I set them out here with minor modifications:
>
> (a) The critical points which are sought to be proven on each of the issues in the case need to be laid out in advance so that they can be properly addressed in evidence. Either in a Statement of Case, or (if the Statement of Case is broadly pleaded) in an expert's report served well in advance of trial.
>
> (b) It is not acceptable to keep a new critical point going to a central issue in the case for ambush in cross-examination. Such points are commonly thought of late in the day, but they should be disclosed as soon as the decision is taken to run them so the judge can decide how to deal with them having heard the submissions of the other side.
>
> (c) Where a new point of substance requiring investigation and technical analysis is thought of and intended to be run at trial, it is incumbent on the party who wishes to run it to give proper notice to the other party and not to seek to ambush an expert witness with the point at trial.
>
> (d) If a new point of this nature requires expert evidence to prove it (as this one), it is incumbent on the party running it to serve his own expert evidence in advance setting out what the point is and the technical reasons why it is considered to be correct, to give the other side an opportunity to consider it and file their own counter-evidence. It may even be incumbent to file a new Statement of Case.
>
> (e) A fortiori where (as here) the point may well have required research, experiment and historical evidence to deal with."

146. I agree that this is a point that ought to have been squarely raised prior to the trial. It is a "new critical point" (Mr Hall described it as a "very important" point) that raises the question whether the skilled person would have considered that [0018] was teaching a method that was fundamentally different from that in [0017] in that it required the end of the tube to be tooled down to fuse with the bead. The oblique reference in Mr Hall's skeleton to the fact that Mathijssen's method "may" be on all fours with [0018] of the Patent is far from a sufficient notification of this point and, in any event, there was nothing in Mr Morris' expert reports which supported the

contention that the skilled person would, in light of the CGK, have understood [0018] of the Patent in the way necessary for First Light's argument on this point to work. Mr Hall suggested that it was legitimate to raise this with Mr Huxley in cross-examination because Mr Huxley, in his first report, described his interpretation of [0018] of the Patent. Specifically, Mr Huxley said that the skilled person would understand [0018] as a variation, but one which depended on the steps in [0017] being carried out. That, however, ignores the fact that First Light did not adduce any evidence of its own, via Mr Morris, to suggest that the skilled person would understand [0018] to be teaching anything other than that which Mr Huxley said.

147. I nevertheless deal substantively with the point, which I reject for the following reasons. Mr Hall candidly accepted that the point could not be run if his interpretation of the first sentence of [0018] is wrong which, in my judgment, it is. The contention that [0018] requires the end of the tube to be tooled down to meet the bead rests wholly on the assertion that, because in Fig 4 the electrode is positioned so that it cannot move any further to the left, it follows that the tungsten rod cannot have been moved further into the tube after the ends had been tooled down. That, however, reads far too much into Fig 4. It is a schematic drawing only, not one intended to identify the precise positioning of any element, and certainly not the positioning of the electrode, which is not critical to any part of the method as described in the claim or the specification.

148. Mr Hall suggested that Mr Huxley's answers in cross-examination supported his interpretation of [0018], in particular where Mr Huxley agreed to the proposition that it was "an interpretation" of [0018] that it described what was happening in Mathijssen. That must be read, however, with Mr Huxley's answers earlier in his cross-examination, where he rejected Mr Hall's interpretation of [0018]: "I would say that the point that 18 is making is that before you start 17, you can make some modifications, be it with tooling or other, to the starting conditions for the tube. So you can modify the end of the tube before you start 17. I do not think it implies that you modify what has been described previously, i.e. your steps to make the seal, but you can do some pre-steps before you start that process."

149. In my judgment, [0018] of the Patent is describing an alternative method which involves bending the tube to a lower diameter *before* the bead is inserted into the end. That is consistent with the second sentence of [0018] which refers to the fact that pre-forming or tooling the tube is possible to create a different starting position. It is further supported by the fact that there is nothing in Claim 1 itself that refers to fusing the end of the tube with the bead by tooling down the former. On the contrary, Claim 1 refers only to inserting the heated bead into the anulus of the tube: see para (3), which mirrors sub-para (2) of [0017]. Finally, as Mr Pritchard submitted, one of the claimed advantages of the invention was that it dispensed with the need for tooling *in order to form the seal* (see [0020]), which is inconsistent with the interpretation of [0018] put forward by Mr Hall.

(2) No technical benefit

150. First Light's argument under this head is as follows:

(1) The skilled person would see four key events happening in the Patent: (i) fusion takes place to the internal surface of the quartz; (ii) fusion also takes place to the end of the tube; (iii) positive pressure is applied causing the sealing glass that has wetted on the inside of the tube to move back towards the end of the tube; and (iv) there is formed a smooth internal radius.

(2) Each of these four events is present in Mathijssen.

(3) Thus all that remains between Claim 1 of the Patent and Mathijssen is the lower bead size limit, but this serves no technical purpose, and is an arbitrary selection.

(4) Where, as here therefore, the only distinction between the prior art and the Patent is an arbitrary selection of bead size from the CGK which cannot be justified by some useful technical property, it makes no technical advance and is deemed obvious: see *Generics (UK) Ltd v Yeda Research and Development Co Ltd* [2013] EWCA Civ 925, per Floyd LJ at §49(iv):

> "a selection from the prior art which is purely arbitrary and cannot be justified by some useful technical property is likely to be held to be obvious because it does not make a real technical advance."

151. Mr Hall accepted in closing that this argument is run as a "squeeze" on [0018] of the Patent, on First Light's interpretation of that paragraph, where the end of the tube is pressed down to fuse to the bead. The short answer to this argument, therefore, is that it fails because I have rejected First Light's construction of [0018].

152. In my judgment, it fails in any event because I do not accept that the lower limit on the bead size serves no technical purpose. Its purpose is to ensure that the bead seals both to the inside and to the end of the tube.

153. Mr Hall submitted that Mr Huxley had agreed that there was no technical benefit in the bead size being bigger than the inside diameter of the tube, because he had accepted that if it was a *little smaller* then it was still possible that the quartz might fuse to it because of the flattening effect of the flame applied during the sealing process. I have addressed this part of Mr Huxley's evidence above: he accepted, in my view, only that it is possible that the application of heat to the tube could result in a slight contraction. Nowhere, however, did he resile from his view that it is a critical part of the method taught in the Patent that the bead should fuse both to the *end* and to the inside of the tube. That is the technical purpose of the lower limit on the bead size, even on the construction of [0018] advanced by First Light.

154. Moreover, I consider that this is a significant distinction from Mathijssen. Mr Hall submitted that sealing to the end of the tube was also present in Mathijssen, but I disagree. Each of Figs 4, 5, and 6 of Mathijssen, which indicate the geometry that is referred to in the patent as critical to its success, involves the end of the tube being tooled down in varying degrees. In Fig 4 it is tooled down the least, such that there remains an identifiable "end" to the walls of the tube. In that variation, sealing is shown as occurring only on the inside of the tube. In Figs 5 and 6, the tube is tooled down so that the end, in substance, disappears into a point. What is left, apart from that "point", is the inside and outside of the tube. While it is true – as Mr Hall elicited from Mr Huxley in cross-examination – that parts of the quartz glass that originally formed the end of the tube will have merged into what is now the inside of the tube, so that to some extent there is fusion between the GS10 and material which was originally part of the end, that is fundamentally different from the Patent, in which the end of the tube remains as such, and the bead is fused to it. In short, in Figs 4 and 5 of Mathijssen there is no sealing to the *end* of the tube because the end of the tube has disappeared.

155. While Mr Huxley also agreed in cross-examination that, in Fig 4 (or any variation in which an identifiable end to the tube remains) there may be some sealing glass which fuses to the end of the tube, that is merely incidental, not something which is taught as

a requirement of the method in Mathijssen. It does not serve any technical purpose in the invention disclosed in Mathijssen by which a direct seal between the bead and the quartz glass was achieved.

156. Mr Hall further submitted that the Patent does not teach *how much* GS10 should be fused to the end of the tube and if it was a necessary part of the invention that there should be a specific amount of GS10 fused to the end, then the Patent was insufficient. This was run as a further squeeze in relation to the obviousness case over Mathijssen, and not as an independent ground of invalidity. In my judgment, however, the requirement, sufficiently taught in the Patent, for there to be fusion of GS10 both on the inside and the end of the tube is significantly different from the possibility, in Mathijssen, that in those variations of the method where an identifiable end of the tube remains there is some incidental wetting of that end, and not an obvious step to take in light of Mathijssen.

(3) Obvious to use a bigger bead

157. First Light's third basis for contending that the Patent was obvious over Mathijssen applies to the method at [0017] of the Patent. Mr Hall submitted that the skilled person would see the same four events (referred to above at §150.(1)) in both Mathijssen and the Patent, and would know from their CGK that those same four events would produce a reliable direct seal irrespective of Mathijssen's geometry. If that were not so, the Patent would be insufficient because the following problems are not solved by the Patent:

(1) The need for the skilled person to deal with stresses in the seal;

(2) The high temperature needed to create a GS10 to quartz seal; and

(3) The difficulty that as a matter of fact sealing a GS10 bead directly to a quartz tube was not reliable where a tungsten rod was used. The Patent simply states that such a seal should be made, in which regard the Patent is no more enabling than Mathijssen.

158. It follows, submitted Mr Hall, that it would be obvious for the skilled person to use a bigger bead.

159. Mr Huxley gave two reasons in his report why it would not be obvious to the skilled person familiar with Mathijssen to use a bigger bead. Principally, it was because:

> "the skilled person would be abandoning the teaching of Mathijssen that stress is taken up by the geometry depicted in figures 4-6, where 'the glass bead-shaped member is enclosed by the quartz glass of the neck-shaped lamp envelope portion'. The Patent explicitly teaches that the ends of the tube need not be tooled. Instead, sealing glass is fused to the interior and exterior of the straight ends of the tube. As a result, the Skilled Person would understand that the approach which Mathijssen specifically teaches as being required to deal with seal stress would not be applicable."

160. Mr Hall pointed to the fact that Mr Huxley agreed in cross-examination that increasing the size of the bead, in Mathijssen, would reduce the need for tooling, and that it was CGK – in relation to the GS10 Dome Method, that there should be wetting of GS10 on the end of the tube. He suggested that Mr Huxley's response that the CGK to use a bead that sealed on the end in the GS10 Dome Method was not

"directly transferable" to Mathijssen was "puzzling". This, however, takes Mr Huxley's answers out of context: overall, he reiterated that the skilled person, starting with Mathijssen, would not consider using a bead sufficiently large to avoid the need to tool down the ends of the tube, because that would require the core teaching in Mathijssen to be abandoned.

161. Mr Morris essentially agreed with this analysis. In cross-examination, he was walked through the following steps (which I take from Heraeus' closing submissions), with which he agreed:

(1) The skilled person comes to Mathijssen with the CGK knowledge of the difficulties of thermal stress, and the GS Dome Method solution to those;

(2) The skilled person would therefore regard Mathijssen's particular solution to a direct seal problem as both interesting and surprising;

(3) Mathijssen teaches only one very particular solution to the direct seal problem – which is based in the geometry found in Figs 4, 5 and 6: it is not teaching that the general prejudice in the CGK against direct seals was wrong;

(4) To seal on the outer surface of the tube, as the Patent requires, would require the skilled person to discard the geometry of Mathijssen and its central teaching;

(5) If the skilled person did try to seal directly to the end of the tube, he would have no expectation of success;

(6) While the skilled person might remove a step from the process for reasons of simplification, he would not do so if the step was essential to the process and, in the case of Mathijssen, the geometry in Figs 4, 5 and 6 was essential to the process taught;

(7) If the skilled person used a bigger bead, therefore, he would have no expectation of success, because he could not predict whether or not the thermal stress would be managed.

162. Mr Hall criticised Mr Huxley for being wedded to the geometry in Mathijssen, in contrast to the position he took in relation to fig 4 of the Patent. There is nothing in the Patent, however, that indicates that the particular geometry of fig 4 is of importance. In contrast, Mathijssen expressly teaches that the pressure stresses are taken up by the quartz glass "as a result of the geometry chosen". He also criticised Mr Huxley for saying in cross-examination that the skilled person would not say, in relation to using a bigger bead, "of course it would succeed", when the test is a fair expectation of success. I have no doubt, however, that Mr Huxley is aware of the correct test – as his report makes clear – and that this was a lapse into loose language, not a concession that the skilled person would have had a fair expectation of success.

163. As Mr Hall submitted, the question of obviousness is for me, although I am guided in answering it by the assistance the experts (who, as noted above, were ultimately in agreement) can give as to the perspective of the skilled person. I am satisfied that the skilled person would regard Mathijssen as teaching only one specific solution to the problem of direct seals (as opposed to challenging the general prejudice against direct seals), and that the essence of the solution is to be found in the geometry adopted, which involves the curvature of the end of the quartz tube so as to envelope within it the bulk, at least, of the molten GS bead. I do not accept the premise of Mr Hall's submission, therefore, namely that the skilled person would think that the four

"events" upon which Mr Hall relies would produce a reliable direct seal irrespective of Mathijssen's geometry. Accordingly, I do not accept that the skilled person would think it obvious to discard the geometry of Mathijssen altogether by using a larger bead.

164. First Light does not advance an independent case on insufficiency – but relies on it only in support of its case on obviousness – and it is therefore unnecessary separately to address its contentions in that respect.

Churchley

165. Churchley was published in 1999. It is a variation, and intended improvement, upon the GS10 Dome Method. It starts by using a conventional GS dome, and then removing the GS10 until there is only a thin dome left, leaving approximately 5% of the amount of GS10 originally applied. The thin dome is then burst open and, through continued heating, the sealing glass melts back towards the ends of the quartz tube, leaving only a thin annulus left on the end of the tube. The following figures illustrate the process:

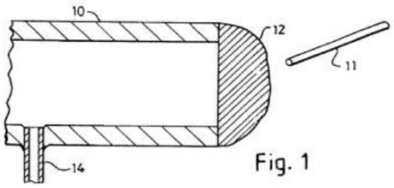


Fig. 1

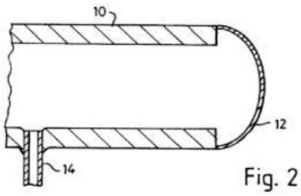


Fig. 2

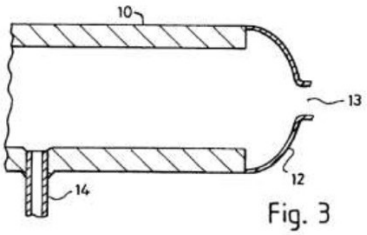


Fig. 3

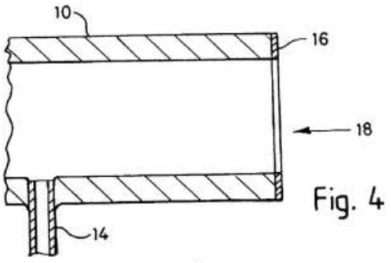


Fig. 4

166. Next, in place of the shaping of the GS10 dome in the GS10 Dome Method, the ends of the quartz tube are tooled down to form a frusto-conical shape, which is then brought into contact with the bead on the tungsten rod (assembled as per the GS10 Dome Method) and fused together to form a smooth internal concave surface:

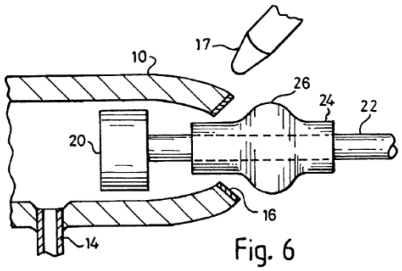


Fig. 6

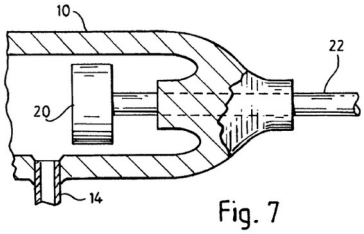


Fig. 7

167. It can be seen from this that Churchley is not a direct seal. First Light contend that it nevertheless satisfies all of the elements of Claim 1 of the Patent save that the disclosed seal is indirect, and that the skilled person would see, contrary to their CGK belief, that they could achieve Churchley's improved seal using much less GS10 than in the GS10 Dome Method, and that it would be obvious to keep reducing the amount of GS10 until it was done away with altogether.

168. Mr Huxley's evidence, in his report, was that there are two principal differences between Churchley and the Patent: first, the elimination of any GS10 annulus on the end of the quartz tube; second, changing the design of the seal so that the sealing glass fuses both with the exterior and the interior of the quartz tube. Neither, he thought, would be obvious to the skilled person.

First difference between Churchley and the Patent

169. As to the first difference, Mr Huxley considered that Churchley, contrary to suggesting it was obvious to do away with the GS10 annulus altogether, actually reinforced the need for an indirect seal. He said that the inclusion of several quite intricate steps (Figs 1-4 above) emphasises the importance Churchley appears to place on the integrity of the GS10-GS10 bond it teaches. He said that the skilled person would have understood:

> "… that the CGK approach was to use two layers of GS10 – one on the end of the tube and one in the form of the bead – to seal the electrodes in place in the types of lamp described in Churchley)… [and that] this was to allow the creation of a dome which was able to bear the stresses inherent in this kind of lamp and that b) the application of GS10 to the quartz tube first, before that GS10 is then fused to the GS10 of the bead, was a more feasible way of forming the seal. Abandoning the CGK approach of applying GS10 to the end of the tube would therefore require the Skilled Person to find a way of a) reliably fusing the GS10 of the bead bearing the electrode and feed-through to the quartz of the lamp and b) dealing with the stresses inherent in the lamp. On the latter point, whilst in Churchley the ends of the tube are tapered down (forming a stress-bearing dome), in the Patent the ends of the tube are straight: without the GS10 layer applied to the end of the tube, there would be no dome. These problems would, in my view, deter the Skilled Person from going down this route."

170. He said that there was no teaching in Churchley that suggested to the skilled person that the dome structure could be abandoned. In its absence, the skilled person would need to devise a different type of seal, which would require significant experimentation. In his view, including based on his own experience of trying to develop the Patent, the skilled person would have had only a limited expectation of success.

171. Mr Hall submitted that Churchley does not tell the skilled person that the point of the GS ring was to assist with bonding. I do not think it needed to: as already noted, it was CGK that fusing GS10 to the quartz, before the tungsten rod was introduced to the tube was a necessary step. He also submitted that Mr Huxley conceded in cross-examination that the GS annular ring was not performing the CGK function of the GS10 dome in Churchley. He relied on the following passage in his cross-examination:

> "Q. So the reason for having the indirect GS at all in the CGK method, which was to get the arms to deal with the stress, is not here anymore in Churchley?
>
> A. Yes.
>
> Q. It has been solved by a different process, yes?
>
> A. Yes, and I have said in my report that the dome part of that rather than -- well, parallel part is still there, it is just quartz, and the dome part is still there rather than being GS material, it is quartz with a GS annulus on the end.
>
> Q. The skilled person therefore can see that the GS annulus is not responsible for dealing with any stresses, right?
>
> A. No."

172. This must be seen, however, in the context of the passages from Mr Huxley's evidence which came before and after.

173. The following exchange occurred immediately before the passage relied on by Mr Hall:

> "Q. So the skilled person can now see when looking at Churchley that the problems they thought necessitated a GS Dome have been solved by Churchley without the GS Dome?
>
> A. Well … the GS Dome I would argue is sort of replaced by the quartz dome. So there is not a complete removal of the dome, merely a transition from GS-- a replacement of GS with quartz.
>
> Q. But the purpose of the dome was to get the arms to deal with the stress?
>
> A. The arms extend out and taper into ----
>
> Q. Yes.

A. It is that tapering part rather than the parallel part that I have argued is the dome part of the dome method."

174. The following exchange came after:

"Q. A further point both you and Mr. Morris make is that Churchley's process for removing 95% of the GS and getting to the annular ring is quite an involved one?

A. Yes.

Q. So reducing or removing that process would be attractive if it did not bring disadvantages or difficulties?

A. Correct.

Q. And given the skilled person can see that stresses are not being dealt with by this annular ring, they would not see any disadvantage or difficulty with removing it, would they?

A. I think they would still have that prejudice that the annulus on the end makes it easier to seal your quartz, to join your quartz to the bead because you have already done half of the work which is to fuse the GS10 to the quartz. Now, whether there is an obviousness to Churchley that you are having to heat it up again to temperatures in order to be able to manipulate the quartz, because it does teach to manipulate it, that is still part of their CGK but that makes this whole seal easier to do and therefore removing it adds a barrier to potential success.

Q. It is just in the CGK, as we discussed, the reason the skilled person was using GS at all on the quartz was to get the arms from the dome to bear the stress associated with the tungsten rod?

A. I also talk about and I do not exclude the joining of the quartz to the GS10. So that is the point of the heat sink tungsten is that they are doing that process at a time when it is easier to do and they have created a -- because I think if they did not create a bond between the quartz and the GS, then it would fail. They have to be able to do that in order for the arms to be properly bonded to the quartz, and doing so without the heat sink present makes it easier and therefore more likely to succeed."

175. Viewed as a whole, I consider that Mr Huxley maintained in his evidence in the witness box the two points that he made in his expert report: first, the benefit of the dome "arms" in the CGK (GS10 Dome Method) was replicated in Churchley, but instead of adding a GS10 dome this was done by forming the quartz glass of the tube itself into a dome shape; second, the retention of even a thin annulus of GS10 on the ends of the tube would be understood by the skilled person as being necessary in light of the CGK that in order to obtain a reliable fusion with quartz glass - given that the quartz glass must be heated to 1600C which is problematic if this is done directly to the bead attached to the tungsten rod.

176. Mr Morris, in his report, said that the skilled person would be interested in the reduction of the GS10 down to an annular ring, and that one of the obvious things to

try would be to reduce it more than the 95% taught in Churchley, for example by 96%, 97% and so on and that would have led to trying to remove *all* of the GS10 annular ring, because that would save time and could lead to potential savings, as GS10 is expensive. In cross-examination, however, he accepted: (1) there is a fundamental difference between trying to make the GS10 annular ring thinner – thus saving on cost by conserving more GS10 – and removing it altogether; (2) that is because of the important role the layer of GS10 played in fusion, given the different temperature required to fuse GS10 to quartz as opposed to fusing GS10 to tungsten; and (3) if the skilled person tried removing the GS10 annular ring altogether he would have no expectation of success.

177. On this point, Mr Hall relied however on a passage in Mr Morris' re-examination, when he was asked about the following step in the Churchley patent, which occurs after the quartz has been tooled down (to form the frusto-conical shape) and the bead has been brought into contact with the annulus of GS10:

> "(5) momentarily balancing the pressure between the inside and outside of the lamp tube after the bead has been fused to the annulus whilst using a carbon tool work the quartz tube down onto the bead and cause it and the annulus of the GS material to become more completely fused."

178. Mr Morris accepted that since this step involved tooling down the quartz glass it would take place at "the higher of the two temperatures" – compared to the lower temperature (around 1200C) required to fuse the GS10 annulus to the bead. Mr Hall submitted that this demonstrated that it would have been obvious to the skilled person that the GS10 annulus in the Churchley method was *not* necessary in order to aid with the fusion of the quartz tube to the GS10 bead. Accordingly, since the GS10 dome shape had also been removed in the Churchley method, the skilled person would see the step of removing the GS10 annulus altogether as obvious.

179. I do not accept this submission. This was a further point not foreshadowed in Mr Morris' expert report, but only brought out in re-examination. There was no evidence led as to the temperature required in order to perform step (5) (quoted above) in the Churchley patent, whether it was the same high temperature required in order to *melt* quartz glass so that it fused with GS10 glass to form a seal, and whether – given the relative proximity of the part of the quartz tube required to be heated so as to further manipulate it down in step (5) and the length of time that heat was required to be applied to it for this purpose – it gave rise to the problem arising from differentials in coefficients of expansion when quartz glass is fused with a GS10 bead attached to the tungsten rod. This was the point I consider that Mr Huxley was making – in the passage from his cross-examination set out above – when he acknowledged the fact that Churchley required the quartz to be heated up again to manipulate it, but nevertheless removing the GS10 annulus would have been understood as a barrier to success.

180. Accordingly, I prefer the conclusion, supported by both Mr Huxley and Mr Morris, that the skilled person would not have regarded removing the GS10 annulus in the Churchley method altogether as obvious.

Second difference between Churchley and the Patent

181. As to the second difference between Churchley and the Patent, namely that in the latter the sealing glass fuses both with the exterior and the interior of the quartz tube, Mr Huxley considered that this would involve several changes to the method taught in

Churchley, which would not have been obvious to the skilled person. In particular, the skilled person would have to:

> "(i) Decide to do away with the tooling down of the tube ends, and so with the dome shape present in Churchley and the CGK method;
>
> (ii) Compensate for the lack of tooling down of the tube ends by using a larger bead, big enough to seal over the end of the tube;
>
> (iii) Find an alternative way of coping with the stresses inherent in the lamp seal in the absence of the dome shape – in particular, relying on the internal coating of sealing glass and the smooth radius between the electrode/electrical feed through and the quartz tube."

182. The only point taken in closing argument on this aspect by Mr Hall was that the Churchley method would – or at least might – involve some wetting of GS10 on the *inside* of the tube, so that it would be obvious to the skilled person to try this. He relied on Mr Huxley's cross-examination where he appeared to accept this possibility. In my view, however, he did no more than accept that there might be some wetting on the inside of the tube, in the Churchley method, but that would be merely incidental (in the same way that he thought that any wetting on the *end* of the tube in the Mathijssen method, was incidental). It was no part of the method taught by Churchley to wet the inside of the tube. Moreover, such wetting would be directly with the quartz glass (requiring the higher temperature to melt the quartz) whereas the wetting on the end is GS10 to GS10. There was nothing in Churchley to overcome the skilled person's prejudice against such a direct seal.

183. A further point taken by Mr Morris, in his report, was that since Churchley shows a bead diameter substantially smaller than that of the internal diameter of the body of the tube, but almost as big as the external diameter of the tube once it was tooled down, the skilled person would investigate using a bigger bead so as to avoid tooling down the body of the tube. He said that it would have been ideal to take this to its extreme where the bead diameter approximately matched the tube diameter. He accepted in cross-examination, however, that this would involve abandoning the teaching in Churchley that tooling down the arms into a frusto-conical shape addressed the problem of stress, and that the skilled person would not have any expectation of success in so doing.

184. Accordingly, I reject the contention that the skilled person would regard the Patent as obvious over Churchley.

<u>Conclusion</u>

185. For the reasons set out above, my principal conclusions are as follows:

(1) The Annex C method of First Light infringes the Patent on a purposive construction of the Patent (and since the parties accept that there is no distinction between the Annex C method and the Annex D method, the latter also infringes the Patent on its purposive construction);

(2) The Patent is not invalid by reason of being obvious over either Mathijssen or Churchley.

186. In addition, although these points do not arise in light of my principal conclusions, I find that:

(1) The Annex C method, and thus the Annex D method, infringe the Patent on the basis of the doctrine of equivalents; but

(2) Neither the Annex C method nor the Annex D method involves the use of a bead that is no bigger than the outer diameter of the tube on more than a *de minimis* number of occasions, and so neither of them infringes the Patent on its literal construction.

187. I thank all Counsel and their instructing solicitors for the very high quality of presentation of this case throughout.