Intellectual Property Office

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18 September 2025

PATENTS ACT 1977

APPLICANT	Jinko Solar Co. Ltd.
ISSUE	Whether application GB2217428.8 complies with Section 1(1) of the Patents Act 1977 (as Amended)
HEARING OFFICER	Stephen Brown

DECISION

1 Patent application GB2217428.8, entitled “SOLAR MODULE”, was filed on 22 November 2022 in the name of Jinko Solar Co. Ltd. (‘The applicant’). It claims priority from an earlier Chinese application, 202210037575.5, filed on 13 January 2022. This priority document was published as CN115084301A. The application also has a co-pending EP application published as EP4213223A1.

2 There have been multiple rounds of correspondence between the applicant and the examiner. The most recent examination report, dated 20 March 2024, raised an inventive step objection stating that the examiner considered claim 1 to be a collocation of multiple inventions, each of which was obvious.

3 This examination report included a letter inviting the applicant to request a hearing and, in the event the applicants did not so do, stated that the examiner might pass the application to a Hearing Officer for a decision on the papers.

4 In the applicant’s most recent letter, dated 20 May 2024, amendments were filed which added features to claim 1 which had already been objected to on the grounds of obviousness. Thus, in a letter dated 21 June 2024, the examiner invited the applicant to a hearing.

5 As there was no such request from the applicants, the application was sent to me for a decision on the papers. Due to an Office error this did not occur until 25 June 2025.

The Application

6 The application relates a solar module which comprises multiple solar cells of a particular size, electrode lines which connect solar cells, busbars, contact pads and an encapsulation layer. Broadly speaking the application relates to balancing the electrical efficiency gained by using larger numbers of bus bars and wider electrode lines with the costs associated with using more material and the fact that larger components also occlude more light from reaching the solar cells.

7 The latest version of the claims was filed on 20 May 2024. Claim 1 is the only independent claim and it reads:

> *A solar module, comprising:*
>
> *solar cells, having a size of 182 mm×182 mm;*
>
> *wherein each of the solar cells has a front surface and a rear surface arranged opposite to each other, and comprises a semiconductor substrate and busbars located on the semiconductor substrate,*
>
> *wherein first electrode pads are provided at the busbars, and a number of the first electrode pads ranges from 6 to 12;*
>
> *wherein the solar module further comprises an electrode line,*
>
> *wherein the electrode line comprises an end connected to the first electrode pads of the busbars on the front surface of one solar cell of the solar cells, and another end connected to the first electrode pads of the busbars on the rear surface of another one solar sheet of the solar cells that is adjacent to the one solar sheet; and*
>
> *wherein a relation between a diameter of the electrode line and a number of the busbars is* $116.55x^2-92.03x+27.35<y<582.75x^2-425.59x+92.58$*, where x denotes the diameter in millimetres of the electrode line, and y denotes the number of the busbars; and*
>
> *the diameter of the electrode line is greater than or equal to 0.18 mm and less than or equal to 0.35 mm; and*
>
> *the semiconductor substrate of the solar cell is an N-type substrate, and the first encapsulation layer and/or the second encapsulation layer has an area density greater than or equal to 250 g/*m^2*and less than or equal to 500 g/m; or*
>
> *the semiconductor substrate of the solar cell is a P-type substrate, and the first encapsulation layer and/or the second encapsulation layer has an area density greater than or equal to 250 g/*m^2 *and less than or equal to 400 g/*m^2

8 As a matter of construction, it is noted that claim 1 includes the phrase “solar sheets”. This term only exists in the claims and where the description repeats the claims. Claim 1 defines that “front surface of one solar cell of the solar cells” and the “rear surface of another one solar sheet of the solar cells”. This phrasing indicates to me that the term “solar sheet” is an error and it most likely should have been referred to as “solar cell”. This is consistent with paragraph 0041 of the description, in which two solar *cells* are described as being connected by the electrode line. Consequently, for this decision the phrase “solar sheet” in claim 1, and elsewhere, will be read as “solar cell”.

9 I also note that the density of the encapsulation material is given in terms of “g/m^2”. Such units are unusual for most density measurements, but are normal for a film, tape or sheet.

The law

10 Section 1(1) of the Act reads:

> *A patent may be granted only for an invention in respect of which the following conditions are satisfied, that is to say*
> *(a) the invention is new;*
> *(b) it involves an inventive step;*
> *(c) it is capable of industrial application;*
> *(d) the grant of a patent for it is not excluded by subsections (2) and (3) or section 4A below; and references in this Act to a patentable invention shall be construed accordingly*

11 Sec. 3 of the Act goes on to say:

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

12 Sec. 2(2) of the Act states that:

> *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.*

13 The specific process to assess inventive step was set-out by the Court of Appeal in *Windsurfing*[1] in which the court formulated a four step process. This process was re-formulated by Jacob LJ in the Court of Appeal decision of *Pozzoli*[2] as follows:

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[1] *Windsurfing International Inc. v Tabur Marine (Great Britain) Ltd, [1985] RPC 59*
[2] *Pozzoli SPA v BDMO SA [2007] EWCA Civ 588*

(1)(a) Identify the notional "person skilled in the art"

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

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

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

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

14 However, with the current application, the examiner contends there are multiple inventions defined in claim 1. In SABAF[3] Lord Hoffman stated that:

..before you can apply s.3 and ask whether the invention involves an inventive step, you first have to decide what the invention is. In particular, you have to decide whether you are dealing with one invention or two or more inventions. Two inventions do not become one invention because they are included in the same hardware. A compact motor car may contain many inventions, each operating independently of each other but all designed to contribute to the overall goal of having a compact car. That does not make the car a single invention.

15 Lord Hoffmann also went on to reference passages from the EPO Guidelines for Substantive Examination as being useful in the assessment of collocations, namely that[4]:

The EPO guidelines say that 'the invention claimed must normally be considered as a whole'. But equally, one must not try to consider as a whole what are in fact two separate inventions. What the Guidelines do is to state the principle upon which you decide whether you are dealing with a single invention or not. If the two integers interact upon each other, if there is synergy between them, they constitute a single invention having a combined effect and one applies section 3 to the idea of combining them. If each integer performs its own proper function <u>independently</u> of any of the others', then each is for the purposes of section 3 a separate invention and it has to be applied to each one separately.

[3] SABAF SpA v MFI Furniture Centres Ltd [2005] RPC 10, House of Lords, page 215 paragraph 24-26

[4] SABAF SpA v MFI Furniture Centres Ltd [2005] RPC 10, House of Lords, page 216 paragraph 26

Analysis

Collocation

16 In paragraph 26 of his decision in SABAF[4], Lord Hoffmann gave the following guidance on how to establish interaction across various integers:

> *"If each integer performs its own proper function independently of any of the others, then each is for the purposes of s.3 a separate invention and it has to be applied to each one separately. That, in my opinion, is what Laddie J. meant by the law of collocation."*

17 To assess if there is a collocation within claim 1 it is first necessary to assess what integers there *could* be and then determine if there are interactions between those integers that might be considered synergistic.

18 However, claim 1 does not, at first sight, appear to define something that could easily be split into separate parts. The claim appears to define a fairly standard solar module with known components, each of which is only potentially differentiated from the prior art by their number or other specific parameters defining them.

19 For the sake of this analysis, though, I believe that the claim can be broken down into the following integers, each of which might be considered to perform their own task:

i. A solar module with at least two solar cells, each of *a specific size*, with front and rear surfaces, a substrate, and a plurality of busbars;

ii. A solar module with *a specific number* of first electrode pads;

iii. A solar module with an electrode line with *a specific diameter*, which is *based* on the number of busbars. The electrode line also has one end connected to the first electrode pads of busbars on the front surface of one solar cell and another end connected to the first electrode pads of the busbars on the rear surface of another solar cell;

iv. A solar module with an encapsulation layer with *a specific density*.

20 The EPO's technical board of Appeal[5] offered the following guidance when determining if two features display synergy:

"Two features interact synergistically if their functions are interrelated and lead to an additional effect that goes beyond the sum of the effects of each feature taken in isolation. It is not enough that the features solve the same technical problem or that their effects are of the same kind and add up to an increased but otherwise unchanged effect."

21 Firstly, it seems to me that the number of bus bars is dependent, in some way, on the size of the solar cells. If cell size is increased, the number of bus bars needs to increase too if a desired level of performance is to be maintained, as explained in

[5] EPO technical board of appeal T1054/05

paragraph [0037] of the description. While this paragraph explains that there are also complications associated with increasing the number of bus bars, I nonetheless can see a degree of synergy between integer (i) and the number of busbars in integer (iii), as defined above.

22 Next, I believe that it is self-evident that the number of electrode pads depends directly on the number of bus bars as it is their function to connect the bus bars to the electrode line. Thus, I can also see synergy between integers (ii) and (iii).

23 On page 4 of their letter dated 20 May 2024, the applicants argued that inventions (iii) and (iv), as defined above, also have an interrelationship such that they act synergistically. Namely, that reducing the diameter of the electrode line allows lower density encapsulation layers to be used but also leads to a reduction of the power carried by each electrode line thus requiring more electrode lines and more busbars. This seems plausible and as established in Human Genome Sciences[6] such plausibility only has to be in contrast to "speculation". It is my view that this assertion appears to be closer to plausible than pure speculation, and I therefore conclude that there is synergy between integers (iii) & (iv).

24 At this point, I will note that in the only citation found by the examiner which discloses a density of its encapsulation layer, DE 202021105469, the lower bounds for both the equivalent of the electrode line diameter (the "welding wire" in DE'469) and encapsulation material density ("adhesive film" in DE'469), are 0.25mm and 300g/m^2 respectively. This is higher than the lower bounds of the electrode line diameter and the encapsulation layer density in the current application (0.18mm and 250g/m^2 respectively), which appears to add credence to the agent's arguments.

25 Having concluded that each of the integers identified above interacts with at least one other integer with an effect that is different to an enhanced version of their normal actions, it follows that there is synergy across all of claim 1. Consequently, I decide that there is no collocation within claim 1 and that the claim should be considered as a single invention for the purpose of inventiveness.

Inventive Step

26 The examiner cites five citations in their pre-hearing report. Additionally, in the examination report dated 22 December 2023 the citations raised in the applicant's co-pending application EP4213223 were also alluded to but were not raised formally in the pre-hearing report.

27 Thus, the citations to be considered from the pre-hearing report are:

CN 106229356 A (LIANYUNANG);
DE 202021105469 U (ZHEIJIANG);
CN 113725307 A (SHANGHAI);
US 10164130 B2 (CHOI); and
US 9978899 B2 (KIM)

[6] Human Genome Sciences v Lilly [2011] UKSK page 38 paragraph 123

28 I will now apply the steps of the Windsurfing/Pozzoli[2] test. For ease of reference, I will repeat the steps here:

> *(1)(a) Identify the notional "person skilled in the art"*
>
> *(1)(b) Identify the relevant common general knowledge of that person;*
>
> *(2) Identify the inventive concept of the claim in question or if that cannot readily be done, construe it;*
>
> *(3) Identify what, if any, differences exist between the matter cited as forming part of the "state of the art" and the inventive concept of the claim or the claim as construed;*
>
> *(4) Viewed without any knowledge of the alleged invention as claimed, do those differences constitute steps which would have been obvious to the person skilled in the art or do they require any degree of invention?*

29 I consider steps 1a,1b and 2 to be common for all of the above cited documents and so will carry them out together before the assessing steps 3 and 4 for each document in turn.

30 I believe that a suitable skilled person is someone working in the design and manufacture of solar panels.

31 The skilled person's common general knowledge will thus include the common practices in making solar modules including the components used to make solar modules. The skilled person will also naturally be able to understand what the standard values for component parts are as a whole but not likely be able to change only one value in isolation of the others as that would require an understanding of where optimisations and efficiencies may lie and pursuing such optimisations would arguably require a degree of invention. The skilled person may depart from this kind of variation if there are directed reasons to do so.

32 I construe the inventive concept of the claim to be:

A solar module with at least two solar cells, *each 182 mm×182 mm*, with front and rear surfaces, a substrate, a plurality of busbars, *6 to 12 first electrode pads* provided at the busbars and an electrode line that has one end connected to the first electrode pads of busbars on the *front surface* of one solar cell and another end connected to the first electrode pads of the busbars on the *rear surface* of another solar cell. The diameter of the electrode line is *greater than or equal to 0.18 mm and less than or equal to 0.35 mm* and *dependent on the number of busbars*, according to the relationship given in claim 1. An encapsulation layer with *an area density greater than or equal to 250 g/m^{2}and less than or equal to 500 g/m^2* if the substrate is N-type substrate, *or* with *an area density greater than or equal to 250 g/m^{2}and less than or equal to 400 g/m^2* if the substrate is P-type substrate.

33 I will now consider each of the citations in turn.

34 CN 106229356 does not disclose the specific cell size, the ‘front to back’ connection of the electrode wire between two adjacent solar cells or the specific densities of the encapsulation layer. The adjacent cells in CN ‘356 appear to be connected ‘front layer to front layer’ and ‘rear layer to rear layer’ fashion. I thus conclude that CN ‘356 does not render claim 1 of the current application obvious.

35 DE 202021105469 likewise does not clearly disclose the required cell size or the ‘front to back’ electrode line connection. Indeed, there appears to be a complete omission of how adjacent cells are coupled together. I thus conclude that DE’469 also does not render claim 1 obvious.

36 CN 113725307 does not disclose a specific cell size. I can also see no disclosure of any electrode lines. The closest possible equivalents would appear to be the auxiliary gates 12 but these seem to have no explicit relationship to pads 2 (as shown in Figure 2) so I cannot say that these are the same thing. As a result, I conclude that CN’307 also does not render claim 1 obvious.

37 Next, US 10164130 B2 does not disclose the specific cell size, rather it discloses a smaller cell size of 156mm x 156mm (line 22 of column 6). Neither does it disclose the specific density of the encapsulation layer defined in claim 1. It also does not disclose the specified relationship between the diameter of the electrode line and the number of busbars. The closest it gets to this last feature is disclosing a different algebraic relationship between the diameter of the electrode line and the number of electrode lines (lines 29 to 45 of column 21). However, US’130 does disclose every other feature, either in generality, covered by a disclosed range or a plausible reading from a figure. I shall now go through these in detail:

38 Figure 16 of US’130 shows 12 electrode lines (referred to as “wiring members” or “IC”) and Figure 32 appears to disclose a first pad (Pd) associated with every electrode line, implying that if there are 12 electrode lines then there would be 12 first pads. Additionally, lines 39-41 of column 2 state that 10 to 18 wiring members connect two adjacent solar cells, implying the same number of first pads. Additionally, electrode lines may be circular (line 5 of column 15) and may have a width (i.e. diameter) of 0.24 mm to 0.53 mm (lines 39-41, column 2 again) which overlaps the range defined in claim 1. Finally, Figure 16b of US’130 (also lines 42-46 column 2) shows electrode lines that connect to the front side of one cell and rear side of an adjacent cell.

39 That the citation appears concerned with the shading effect created by the number and width of electrode lines suggests there is some overlap with the occlusion concerns in the current application. However, I can find no discussion in US’130 in relation to the occluding effect of the busbars (referred to as “first electrodes 140” in figure 16, and the associated description of US’130, i.e. column 10 onwards).

40 I note that while US’130 also refers to a ‘bus bar’ that item does not seems to relate to the same thing as the current application’s ‘bus bars’. The bus bars of the current application appear to match the characteristics of the ‘first electrodes 140’ in US’130, from their relative orientation to the IC component and their purpose.

41 Lastly, in common with the current application, US'130 discloses an encapsulation layer made from ethylene vinyl acetate (EVA). See components 60 and 70 in figure 2 and lines 10 to 22 of column 5. US'130 though is silent on the density of this layer. However, it does disclose that the substrate is either p-type or n-type (lines 5-15 of column 11).

42 The questions that need to be asked for step 4 of the Pozzoli[2] test with regards to this citation are thus:

1) Would the skilled person consider increasing the size of the cell size to 182mm x 182mm while maintaining everything else the same;

2) Would the number of busbars fall within the range defined by claim 1 in the context of a preferred value for the electrode line diameter and;

3) Would the skilled person use an encapsulation material with a density of 250 to 400g/m^2 and/or 250 to 500g/m^2

43 Starting with first question, there is a reasonable argument that varying the size of the cell is something the skilled person would consider doing as part of workshop modifications. Indeed US'130 discloses that the cell size is not set (lines 19-25 of column 6) and the discussion within US '130 seems agnostic as to cell size. It is principally concerned with the thickness and number of electrode lines, concerns around "shading" and the relative amount of non-solar cell material vs solar cell material. This would suggest the more likely direction of travel if a skilled person was to exercise routine modification is towards a larger cell size (i.e. increasing cell area to reduce shading effects), but would they naturally land on a 182mm x 182mm cell size? This, however, raises a further question. Namely, does the solar cell being exactly 182mm x 182mm contain any technical merit or is it merely an arbitrary selection?

44 In Dr Reddy's[7] it was stated that for a selection to be inventive it needs to demonstrate a hitherto unknown technical effect:

> *"The selection…must not be arbitrary but had to be justified by a hitherto unknown technical effect, which distinguished the [claimed invention]"*

45 There is nothing in the application as filed that suggests that 182mm x 182mm offers an unknown technical effect over cells of, for example, 184mm, 186mm, 188mm, or 190mm widths. Furthermore, where the applicants introduced the size of the cell as a feature, in the amendments filed with the letter dated 1st December 2023, there is no argument provided that the size has technical merit but only that it is supported by the description. Consequently, I do not consider that the specific size of the solar cell (i.e. 182mm x 182mm) has any technical merit and as a mere selection it cannot be considered to be a feature that requires inventiveness on the part of the skilled person.

46 I will now move on to consider the second question. Towards the end of US '130 (column 21 lines 50-54) a preferable set of values is given for both the thickness of

[7] Dr Reddy's Laboratories (UK) Ltd v Eli Lilly & Co Ltd [2010] RPC Page 223, H11

the electrode lines (0.34-0.36mm), and the number of electrode lines (9-24). Earlier in the discussion relating to US '130, I concluded the document disclosed (at least implicitly) that the number of first pads was equal to the number of electrode lines. Thus, if there are 12 electrode lines shown in Figure 16 then it implies there must be 12 first pads. That this value of 12 falls within the preferred range of 9-24 given in the text suggests that this is a reasonable interpretation and one the skilled person might well try. The thickness of the electrode lines, i.e. the component that performs the front to rear connection on adjacent cells, is half inside the range defined in claim 1 and half outside the range in claim 1.

47 Having relied on the accuracy of the drawings for possible numbers of first pads and electrode lines the skilled person would likely also do so regarding the number of busbars disclosed in figure 16 of US'130. In this figure the busbars are shown as the vertical members and there are 14 in number. This number of busbars is within the range defined by the equation in claim 1 if the electrode line diameter (x) is chosen to be 0.34mm. By my calculation, the range given in claim 1 is 9.5 to 14.1 busbars for an electrode line diameter of 0.34mm. By contrast though the range is 9.4 to 13.0 busbars if x is chosen to be 0.35mm, i.e. outside the disclosure of figure 16.

48 I thus conclude that the skilled person working the small range of values given for the preferred electrode line thickness and following the drawn example of Figure 16 in US'130 would assume a reasonably high probability of success and thereby make something that falls within the scope of the equation defined in claim 1. Does this render this feature of claim1 obvious? I am not wholly convinced that it does since there is no disclosure in US'130 that the number of busbars is related to electrode line thickness let alone of the specific relationship of claim 1. It just discloses an embodiment that falls within one end of the range. I will park this point for now though and move on to consider the third question.

49 The last question with regards to this citation is whether the skilled person would use an encapsulation material that falls within the range of densities defined in claim 1. As noted above, US'130 is silent on the density of its encapsulation layer. Indeed, of all the documents cited above only one discloses a density in the required range. DE'469 discloses an encapsulation layer with a density between 300 and 500 g/m^2. It also discloses electrode lines with diameters in the range 0.25 to 0.4mm.The fact that the midpoints of these ranges (400g/m^2 and 0.33mm, respectively) align with the values required by claim 1 of the current application and the electrode line diameter required by US'130 to satisfy the required bus-bar range, might suggest that the normal density for an EVA type encapsulation material for a 0.34mm electrode line could be 400g/m^2.

50 However, this is only the disclosure of a single document and therefore I cannot say that a 400g/m^2 encapsulation layer for a 0.34mm diameter electrode line is common general knowledge for the skilled person. As argued above, I also do not think that I can convincingly argue obviousness starting with DE'469. It simply has too many 'differences' missing. Also, there is nothing clearly linking the disclosure of US'130 to that of DE'469 and I must rightly be wary of mosaicing documents.

51 With these points in mind, in addition to my concerns around the second question, I cannot say with certainty that the all the differences between the disclosure of US'130 and the inventive concept of claim 1 of the current application constitute

steps which would have been obvious to the skilled person. I thus conclude that US'130 does not render claim 1 of the current application obvious.

52 Finally, US'899 discloses solar cells with 25 busbars (see figure 2). While this document does disclose electrode lines (reference numeral 125) with diameters between 0.3 and 0.5mm, this range does not allow 25 busbars when input into the equation in claim 1 of the current application. I thus conclude that US'899 also does not render claim 1 obvious.

53 I thus decide that the claims are novel and inventive over the cited prior art.

Conclusion

54 Having decided that the claims are novel and inventive the application is remitted back to the examiner for further processing.

Additional matters

55 The applicants have also filed a co-pending application EP4213223 A1 and the relevance of its citations CN212659550U, CN 213988902U and KR20190032584 A should be assessed by the examiner.

Appeal

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

STEPHEN BROWN

Patent Examination Group Head