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UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

Ex parte LEA DI CIOCCIO and YANN BEILLIARD

Appeal 2019-002352
Application 14/504,701
Technology Center 1700

Before MICHAEL P. COLAIANNI, JULIA HEANEY, and
BRIAN D. RANGE, *Administrative Patent Judges*.

COLAIANNI, *Administrative Patent Judge*.

DECISION ON APPEAL

Pursuant to 35 U.S.C. § 134(a), Appellant¹ appeals from the Examiner's decision to reject claims 1–18. We have jurisdiction under 35 U.S.C. § 6(b).

We AFFIRM IN PART.

Appellant's invention is directed to a method of assembly of two elements by direct bonding, the surface to be assembled of at least one of these elements comprising portions of metal and portions of dielectric

¹ We use the word "Appellant" to refer to "applicant" as defined in 37 C.F.R. § 1.42. Appellant identifies the real party in interest as Commissariat a L'Energie Atomique et aux Energies Alternatives. Appeal Br. 2.

material, the method can be used particularly for making microelectronic and nanoelectronic devices (Spec. 1:6–9; Claim 1).

Claim 1 is representative of the subject matter on appeal:

A method of assembly of a first element and a second element each having a back face and an assembly surface by direct bonding, at least the assembly surface of the first element comprising at least one first portion with at least one first metal part surrounded by at least one dielectric material, said first metal part having a free surface recessed from the dielectric material at said assembly surface, said method comprising:

a step A) to bring the two assembly surfaces into contact without application of pressure such that direct bonding is obtained between the assembly surfaces, said step taking place at at least one first temperature, said first and second assemblies forming a stack with a thickness, and

a step B) taking place after step A), said step B) comprising

B1) a step to hold the back faces of the first and the second elements in position so that they are immobilized only in a direction perpendicular to the assembly surfaces of the first element and the second element and held at a fixed distance between the stack thickness - 2 nm and the stack thickness + 2 nm,

B2) a step to apply a heat treatment to said stack at at least one second temperature which is higher than the first temperature, the back faces of the first and the second elements being still held in position at said fixed distance.

Appellant appeals the following rejections:

1. Claims 1–18 are rejected under 35 U.S.C. § 112(a) as failing to comply with the written description requirement.
2. Claims 1–18 are rejected under 35 U.S.C. § 112(b) as being indefinite for failing to particularly point out and distinctly claim the subject matter which the inventor regards as the invention.

3. Claims 1–10 and 12–18 are rejected under 35 U.S.C. § 103 as unpatentable over Sadaka (US 2012/0252189 A1, published Oct. 4, 2012) in view of Lombardi (US 2012/0187180 A1, published July 26, 2012) and Su (US 6,933,178, issued Aug. 23, 2005).
4. Claim 11 is rejected under 35 U.S.C. § 103 as unpatentable over Sadaka in view of Lombardi, Su, and Di Cioccio (US 2012/0100657 A1, published Apr. 26, 2012).

FINDINGS OF FACT & ANALYSIS

35 U.S.C. § 112(a)

The Examiner’s findings and conclusions regarding the rejection of claim 1 as failing to comply with the written description requirement are located on pages 2 to 3 of the Non-Final Action. The Examiner finds that the Specification lacks support for the claim limitation that requires the elements “are immobilized in only one direction perpendicular to the assembly surfaces” (Non-Final Act. 2). The Examiner finds that Appellant’s Figure 2C provides support for “restraining in the direction perpendicular to the assembly surfaces and not to the left [or] right” (Non-Final Act. 2–3). The Examiner finds that the Specification provides no evidence about any restraint or lack of restraint into or out of the page direction in Figure 2C (Non-Final Act. 3).

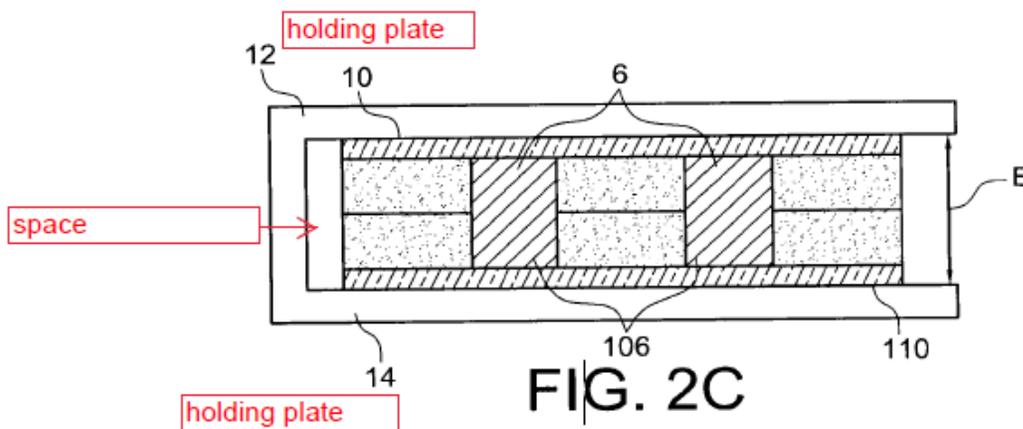
Appellant argues page 10, lines 10–22, page 11, lines 8–13, and Figures 2B, 2C, and 3 describe immobilizing the first and second elements only in a direction perpendicular to the assembly surfaces of the elements (Appeal Br. 4). Appellant contends that the Specification discloses that the

first and second elements are placed between two holding plates and the only function of the holding plates is to prevent the elements from separating from each other beyond a given clearance (Appeal Br. 4). Appellant contends that another embodiment places the stack between two pistons, which are activated only to hold the elements in contact with each other (Appeal Br. 4). Appellant contends that a person of ordinary skill in the art would understand that placing elements between holding plates or pistons whose only stated purpose is to prevent the elements from separating from each other would immobilize the elements only in the direction in which the plates/pistons face each other (i.e., perpendicular to the assembly surfaces of the elements) (Non-Final Act. 4).

The Examiner responds that the portions of the Specification cited by the Appellant do not discuss not allowing movement in a lateral direction (Ans. 3–4). The Examiner finds that the disclosure does not exclude an element from immobilizing the elements in the direction into and out of the paper or to the left and right parallel to the assembly direction (Ans. 4).

In assessing a written description rejection, the question to be answered is whether a person of ordinary skill in the art would have understood from the Specification that Appellant was in possession of the claimed invention. *Moba, B.V. v. Diamond Automation, Inc.*, 325 F.3d 1306, 1319 (Fed. Cir. 2003). In the present case, we find that the preponderance of the evidence favors Appellant’s argument of written descriptive support. We agree that based on the pages 10 and 11 disclosures, one of ordinary skill in the art would have recognized that Appellant possessed the use of only plates or pistons to hold the first and second element stack in a perpendicular direction (Figs. 2B, 2C, 3). Although the

figures do not show the structure of the holding plate or piston in plan view, Figure 3 shows that the pistons do not have walls around at least three edges of the pistons (i.e., there is no indication that the back edge is enclosed or has a restraining wall structure). In other words, there are no lateral restraints shown in the piston embodiment on at least three of the edges. The Figures 2B and 2C embodiments that use plates, not pistons, show a holding plate 12 that is formed in a U-shape, where one side is closed. However, Figures 2B and 2C show a space left between the closed end and the laminate. Figure 2C with annotations is reproduced below.



Appellant's Figure 2C shows the laminate inserted between two holding plates 12 and 14. In our view, Appellant has shown possession of immobilizing only in a direction perpendicular to the assembly surfaces of the first and second element. We reverse the Examiner's § 112(a) rejection for lack of written description.

35 U.S.C. §112(b)

The Examiner determines that the claim 1 requirement that the elements “are immobilized in only one direction perpendicular to the assembly surfaces ... and held at a fixed distance between the stack thickness -2nm and the stack thickness $+2\text{nm}$ ” is indefinite (Non-Final Act. 3). The Examiner determines that it is unclear how something can be immobilized when it can still move at least 2 nm (Non-Final Act. 3).

Appellant argues that a person of ordinary skill in the art would understand in light of the Specification at page 10 that “immobilized” refers to the laminate being held at a fixed distance E and the elements are prevented from separating from one another (Appeal Br. 7). Appellant contends that the ± 2 nm limitation may allow clearance for the stack to slide into position between the plates (Appeal Br. 7).

The Examiner responds that it is unclear how the recitation of $+2$ nm which allows 2 nm of space for the stack to move within would immobilize the stack (Ans. 4).

In assessing whether a claim is indefinite, we determine whether those skilled in the art would understand what is claimed when the claim is read in light of the Specification. *Orthokinetics, Inc. v. Safety Travel Chairs, Inc.*, 806 F.2d 1565, 1576 (Fed. Cir. 1986). In the present case, page 10 of the Specification describes that the stack of first and second elements is placed between two plates spaced apart by a distance E , within the range of $E \pm 2\text{nm}$. The stack is slid between the plates and the first and second elements are held in contact with each other but no force is applied to bring them together (Spec. 10:15–16). In light of the description in the Specification, we determine that preponderance of the evidence supports that one of

ordinary skill in the art would have understood that immobilizing the first and second elements means that the first and second elements are held between two plates or pistons at a fixed distance that ranges from $E \pm 2\text{nm}$ so that the two elements may be bonded together.

We reverse the Examiner's § 112(b) rejection.

35 U.S.C. §103

Appellant argues the following groups of claims: (1) claims 1–8 and 11–17, (2) claims 9 and 10, and (3) claim 18 (Appeal Br. 7–15). We select claim 1, claims 9 and 10, and claim 18, respectively, as representative of each grouping.

Claim 1

The Examiner's findings and conclusions regarding the § 103 rejection of claim 1 over Sadaka in view of Lombardi and Su are located on pages 4 to 5 of the Non-Final Action. The Examiner finds that Sadaka teaches the subject matter of claim 1, except for the step of holding the back faces of the first and second elements in position so that they are immobilized only in a direction perpendicular to the assembly surfaces of the first element and the second element and held at a fixed distance between the stack thickness $\pm 2\text{ nm}$ and the back faces are held in position at said fixed distance during the heating step (Non-Final Act. 4–5). The Examiner finds that Lombardi teaches a snug fitting, no space, fixture that has a lower coefficient of thermal expansion than the laminate it holds, so that upon heating the laminate is prevented from warping due to the upper and lower planar holding devices which are larger than the laminate (Non-Final Act.

5). The Examiner finds that Su teaches that only the top and bottom surfaces of a laminate of holding strip 10 and dies 11 are contacted to prevent warping and delamination (Non-Final Act. 5). The Examiner denominates the combined teachings of Lombardi and Su as the “Lombardi collective” (Non-Final Act. 5; Ans. 8). The Examiner concludes that it would have been obvious to incorporate the anti-warp concept of the Lombardi collective into Sadaka’s method and place Sadaka’s assembly between opposing surfaces of a fixture during the heating step in order to prevent warping/bending/delamination by keeping the stack immobilized (Non-Final Act. 5).

Appellant argues that the Examiner’s rejection is based upon an incomplete reading of Lombardi because Lombardi does not teach immobilizing only in one direction (Appeal Br. 8–9). Appellant contends that in addition to holding devices 205 and 210 that contact the stack in a perpendicular direction, Lombardi uses plates with stepped portions that immobilize the stack in the lateral direction (Appeal Br. 8–9). Appellant argues that Lombardi restrains movement in two directions, not only in the perpendicular direction (Appeal Br. 9). Appellant argues that the Examiner has not provided any reason why it would have been obvious to do away with Lombardi’s stepped structure that limits lateral expansion and warping (Appeal Br. 9).

Appellant argues that Su does not teach holding the back faces of the stack elements in position so that they are immobilized in a direction perpendicular to the assembly surfaces of the elements and held at a fixed distance (Appeal Br. 10). Appellant contends that Su uses a vacuum force to

move dies 11 and strip 10 toward the submold 14 and, thus, the back faces of dies 11 are not held so as to immobilize the stack (Appeal Br. 11).

Appellant contends that the combined teachings of Lombardi and Su would have suggested that pressure needs to be applied to prevent warping and bending (Appeal Br. 12). Appellant contends that the pressing required by Lombardi and Su is not the same as the “hold/contact” required by the claims (Appeal Br. 12). Appellant contends that it is unclear how the plates could press on the stack while keeping a fixed distance on the nanometer scale (Appeal Br. 12).

Although Lombardi teaches a stepped feature on the plate to control lateral expansion, the Examiner relies on Lombardi as teaching that it is known to restrain a laminate that is being bonded to avoid warping and bending of the laminate (Non-Final Act. 5). Lombardi teaches that the space 220 in fixture 200 is sized and configured so that there is no room (space) for laminate 106 to expand or contract in the X, Y, or Z directions (Lombardi ¶ 28). Lombardi teaches that the lateral constraint (i.e., the Z-restraint) can be controlled by controlling the size of the stepped portion (Lombardi ¶ 29). Stated differently, Lombardi recognizes that the amount of constraint includes complete constraint where there is no space for expansion and some modification to the stepped features to permit less Z-constraint as desired. Contrary to Appellant’s argument, Lombardi teaches modifying the stepped feature size to control the amount of Z-constraint. Based on Lombardi’s teachings, if little Z-constraint is desired, then a size of the stepped feature would have been sized to meet that requirement.

The Examiner relies upon Su for the teaching to use a vacuum to hold a laminate in a fixture, where the laminate does not touch the side walls, and

prevent warping in the laminate (Non-Final Act. 5). In other words, the combined teachings of Lombardi and Su would have suggested holding Sadaka's laminate structure so that the ends are spaced from the sides of the fixture so as to prevent warping and delamination in the device.

Although Su uses a vacuum to hold the dies 11 and strip 10 that does not mean that the vacuum moves the dies 11 and strip 10 toward submold 14. Su discloses that the negative pressure force (e.g., vacuum) causes the “dies 10 [sic 11] [to] securely abut the top surface 140 of the submold 14” (Su col. 4, ll. 52–53). In other words, the negative pressure force does not cause the dies 11 to move, but rather securely holds them in an abutting relationship with the submold 14. Su discloses that the top mold 130 “firmly clamps” the substrate strip 10 between the top mold 130 and bottom mold 131 (Su col. 4, ll. 40–42). Su's Figure 1C shows the aforementioned column 4 disclosure where no space is shown between the top mold 130, strip 10, dies 11, submold 14, and bottom mold 131 in the closed fixture 13. Su's Figure 1C only shows space between the sides of the bottom mold 131 and strip 10 and dies 11. Su further discloses that the attraction force (i.e., negative pressure force or vacuum) is sufficient to counteract thermal stresses produced in the substrate strip 10, thereby preventing warpage and delamination in the combined structure of substrate strip 10 and dies 11 (Su col. 4, ll. 49–56). Appellant's argument to the contrary is not persuasive.

Appellant's argument that the combined teachings of Su and Lombardi would have taught that applying pressure is required to prevent warping and bending does not show reversible error in the Examiner's rejection. Claim 1 requires a step A where two assembly surfaces are “in[] contact without application of pressure such that direct bonding is obtained

between the . . . first and second assemblies forming a stack.” The Specification describes this step A as requiring that the first and second elements of the stack are brought together to bond to one another by direct bonding (Spec. 9:20–30). The Specification describes that “application without pressure” means “the lack of any external pressure applied to the elements when they are brought into contact, contact being achieved by the weight of the top element alone” (Spec. 8:19–21). The Specification describes that “application without pressure” in the context of the flattening step means a pressure of less than 3 kN or even less than 1 kN (Spec. 8:21–23). Claim 1 recites step B that requires holding the back faces of the first and second elements in position so that they are immobilized only in a direction perpendicular to the assembly surfaces of the first and second elements and held at a fixed distance between the stack thickness ± 2 nm. Step B occurs after step A as recited in claim 1. Claim 1 does not specify that no pressure is applied during step B. As the Examiner finds, holding the stack elements so the thickness equals the stack thickness minus 2 nm would impart some pressure on the stack of elements (Ans. 8). Even if claim 1 were construed to require application without pressure during step B, that does not preclude applying a force of less than 3 kN to the first and second elements. The Specification includes an embodiment where pistons are used to hold the elements in contact (Spec. 11:8–13).

Appellant’s second part of this argument states that it is unclear how the plates could press on the stack while keeping a fixed distance on the nanometer scale (Appeal Br. 12). Su, however, shows that top mold 130 rests on top of bottom mold 131 and Su describes that mold 130 firmly clamps the strip 10 into place and the exhauster counteracts thermal stresses

(col. 4, ll. 40–42; 49–52). Su further shows that strip 10 rests on a ledge formed in bottom mold 131 (Fig. 1C). In other words, the negative pressure applied via external exhauster counters the thermal stresses while keeping dies and adhesively attached strip 10 abutting submold 14. Su’s “attractive force” does not move dies 11 and strip 10, but rather maintains a fixed, abutting relationship to counter the thermal stresses.

On this record, we affirm the Examiner’s § 103 rejection of claims 1–8 and 11–17 based upon the preponderance of the evidence.

Claims 9 and 10

Claim 9 depends from claim 1 and recites “said stack being curved, said method comprises a stack flattening step after step A) and before and/or during the heat treatment in order to eliminate said curvature.”

Appellant argues that the Examiner’s rejection is based on a conclusory obviousness statement that it would have been obvious to modify Sadaka as modified by Lombardi and Su to include a stack flattening step in which the force is less than 3 kN as recited in claims 9 and 10 (Appeal Br. 13). Appellant argues that the Examiner’s rejection is based upon common sense, but the Examiner provides no evidence to substantiate this finding (Appeal Br. 13; Reply Br. 9).

The Examiner finds that flattening an item before placing it inside something else is performed in everyday actions such as placing a paper in an envelope, placing money in a wallet, or putting a comic book into a protective sleeve (Non-Final Act. 8). The Examiner concludes that it would have been obvious to flatten the stack, if possible, before placing it into the fixture in order to be able to put the stack inside the fixture instead of

throwing the stack away (Non-Final Act. 8). The Examiner finds that it would have been less costly to flatten a curved stack instead of throwing the stack away (Non-Final Act. 8).

We note that Appellant does not specifically contests the Examiner's finding that it has been conventionally known to flatten an item before inserting the item into another item, such as, for example, a piece of paper before inserting the paper into an envelope. The examples provided by the Examiner in the rejection of claim 9 amount to official notice that it was known to flatten an item before placing that item in an enclosure. The Examiner determines that based upon this general understanding in the art, a person of ordinary skill in the art would have flattened a curved stack before inserting the stack into a fixture. Appellant contends that the examples provided by the Examiner amount to relying on common knowledge as a basis for the rejection (Reply Br. 9). We disagree. Appellant does not contest the Examiner's finding that it was known to flatten a piece of paper before placing into an envelope, flatten money before placing in a wallet, or flatten a comic book before sliding it into a sleeve.² As such, these findings of the Examiner become conclusive. *In re Ahlert*, 424 F.2d 1088, 1091 (CCPA 1970). Appellant also does not provide a persuasive argument why a person of skill in the art would not have combined the flattening of this known prior art (for example, flattening paper and money) with the teachings of the other cited references. Based upon the Examiner's uncontested findings and reasoning, we find that the preponderance of the

² We note that the Examiner's reliance on these findings extends back to the Non-Final Action dated August 10, 2016. Appellant had ample time to challenge these findings, but has not specifically done so.

evidence favors the Examiner's determination that flattening the stack before placing the stack into a fixture would have been obvious.

Regarding claim 10, the Examiner finds that the pressure applied would have been within the skill of the ordinary artisan since too much pressure would plastically deform or break the stack making the stack useless (Non-Final Act. 9). Appellant does not specifically challenge or otherwise show reversible error with this finding of the Examiner.

On this record, we affirm the Examiner's § 103 rejection of claims 9 and 10.

Claim 18

Claim 18 depends from claim 1 and recites "wherein the at least one second temperature is selected as a function of a distance of the recess if the surface of the first metal part from the dielectric material at the assembly surface at the beginning of the heat treatment."

Appellant argues that Sadaka discloses several annealing processes but does not indicate that the annealing temperature is selected based upon the size of the voids in the bond pads or the distance of the bond pad surface from the dielectric material surface (Appeal Br. 14). Appellant contends that Sadaka's purpose is not to eliminate voids by using the annealing steps (Appeal Br. 14). Appellant contends that the Examiner has not established that Sadaka inherently teaches the subject matter of claim 18 (Appeal Br. 15).

The Examiner finds that Sadaka's paragraphs 47–51, 66, 76, and 101–113 teach that a second temperature is a function of the distance of the surface of the first metal part from the dielectric material at the assembly

surface at the beginning of the heat treatment (Non-Final Act. 10; Ans. 9). The Examiner explains that Sadaka is concerned with the depth of the void and not the length since the expansion that Sadaka is concerned with is in the direction perpendicular to the bonding surfaces (Ans. 9).

Appellant counters that Sadaka does not describe assessing the size of the voids and basing any temperature on the assessed size thereof (Reply Br. 10). Appellant contends that Sadaka's teaching that some of the voids may be reduced in size or eliminated as a result of the annealing process is not commensurate with the step of affirmatively basing the annealing temperature on the size of the voids (Reply Br. 10). We agree.

The Examiner cites to various paragraphs in Sadaka, but the Examiner does not explain how the disclosure in those paragraphs teaches the subject matter of claim 18. We have reviewed those paragraphs in Sadaka cited by the Examiner. We do not find any explicit or implicit setting of the annealing temperature (i.e., second temperature) as a function of a distance of the recess of the surface of the first metal part from the dielectric material as recited in claim 18. The Examiner has not satisfied the initial burden of establishing a prima facie case of obviousness of claim 18. We reverse the Examiner's § 103 rejection of claim 18.

CONCLUSION

In summary:

Claims Rejected	35 U.S.C. §	Reference(s)/Basis	Affirmed	Reversed
1-18	112(a)	Written Description		1-18
1-18	112(b)	Indefiniteness		1-18
1-10, 12-18	103	Sadaka, Lombardi, Su	1-10, 12-17	18

Claims Rejected	35 U.S.C. §	Reference(s)/Basis	Affirmed	Reversed
11	103	Sadaka, Lombardi, Su, Di Cioccio	11	
Overall Outcome			1-17	18

No time period for taking any subsequent action in connection with this appeal may be extended under 37 C.F.R. § 1.136(a)(1)(iv).

AFFIRMED IN PART