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Bezeichnung der Erfindung: Laser welding method and apparatus
Title of invention:
Titre de l'invention :

Klassifikation / Classification / Classement : B23K 26/16

ENTSCHEIDUNG / DECISION

vom / of / du 9 November 1990

Anmelder / Applicant / Demandeur :

Patentinhaber / Proprietor of the patent /
Titulaire du brevet : Mitsubishi Denki Kabushiki Kaisha

Einsprechender / Opponent / Opposant : I. Siemens Aktiengesellschaft
II. Bayerische Motoren Werke AG

Stichwort / Headword / Référence :

EPÜ / EPC / CBE Articles 123, 54, 56

Schlagwort / Keyword / Mot clé : "Amendment (allowable)"
"Novelty (yes)"
"Inventive step (yes)"

Leitsatz / Headnote / Sommaire

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Case Number : T 792/89 - 3.2.4

D E C I S I O N
of the Technical Board of Appeal 3.2.4
of 9 November 1990

Appellant : (Opponent I)
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Decision under appeal :
Interlocutory decision of the Opposition Division of the European Patent Office dated 2 October 1989 and dispatched on 25 October 1989 concering maintenance of European Patent No. 157 913 in amended form.

Composition of the Board :

Chairman : C. Andries
Members : H. Seidenschwarz
O. Bossung

Summary of Facts and Submissions

I. European patent No. 157 913 concerning a laser welding method and apparatus was granted on 12 August 1987 in response to European patent application No. 84 113 975.1 filed on 19 November 1984.

II. Oppositions were filed against the European patent requesting it be revoked on the grounds of lack of both novelty and inventive step.

III. By interlocutory decision dated 2 October 1989 and dispatched on 25 October 1989, the Opposition Division maintained the patent as amended on the basis of Claim 1 filed with letter dated 14 July 1989 and of description, Claims 2 to 5 and drawings as granted.

IV. The Appellant (Opponent I) lodged an appeal against the decision on 18 December 1989, paying the appeal fee simultaniously and submitting the statement of Grounds on 1 March 1990.

V. Oral proceedings took place on 9 November 1990.

(i) The Respondent requested (main request) that the appeal be rejected and the patent be maintained in an amended form with the documents provided for by the decision under appeal with the proviso that the words "by further additional means (14)" be inserted in Claim 1, line 6, between the words "provided" and "between".

The independent Claims 1 and 5 read as follows:

Claim 1:

"A laser lap welding method in which materials (1, 2) to be welded are covered with coating material (4 to 7) having a lower melting point than the base metal thereof (1, 2) and a laser beam (3) is applied to said materials to weld the latter, characterised in that a predetermined air gap (16) is provided by further additional means (14) between the overlapped materials to be welded so as to form a path for discharging gas or vapour (8) formed by heating said coating material (4 to 7)."

Claim 5:

"A laser welding apparatus comprising a table (13) on which a first material (2) to be welded is placed, characterised by:
a spacer (14) having a predetermined thickness arranged in confrontation with said first material (2) placed on said table (13);

a first drive unit (17) for moving said spacer (14) towards and away from said table (13);
a clamper (15) for pressing through said spacer (14) a second material (1) to be welded placed on said spacer (14) in confrontation with said first material (2) to be welded;
a second drive unit (18) for pressing said clamper (15) through said second material (1) to be welded against said spacer (14); and
a laser beam welding unit for welding overlapping parts of said first (2) and second (1) materials to be welded."

The Respondent further filed an auxiliary request.

(ii) The Appellant and the party to the appeal proceedings as of right in accordance with Article 107 EPC (Opponent II), submitted the following objections to the subject-matter of the new Claim 1:

(a) In the application as filed and in the description of the patent in suit, only a spacer was disclosed as the means for producing a predetermined air gap between the overlapping materials to be welded. The addition of the expression "additional means" would also include means, permitting to maintain a gap during the welding, which are different from a "spacer". Such different means, however, were not mentioned in the application as filed. The European patent in suit on the basis of the new Claim 1 would, therefore, contravene Article 123(2) EPC.

(b) New Claim 1 did also not comply with Article 84 EPC, because the feature "by further additional means" was unclear with respect to the meaning of "means".

(c) The subject-matter of new Claim 1 lacked novelty having regard to document US-A-3 881 084 (D1). According to this document, a gap of 0.254 mm was provided between two overlapping sheets which were coated with a material having a lower melting point than the sheet and to be welded by a laser beam. A further additional means in the form of flux materials were located between the overlapping sheets, maintaining a gap between both sheets.

Although, in document (D1) nothing was said with respect to the purpose of the gap, the person skilled in the art would have known on the grounds of his general knowledge that the only purpose of said gap was to allow gases to escape. Furthermore, the particular intended use of said gap, namely "to form a path of discharging gas or vapour ...", was a non-distinctive characteristic, which should be disregarded for the assessment of novelty.

(d) Document US-A-4 386 728 (D2) would clearly disclose the basic technical teaching that a gap between materials to be welded was necessary independently of the materials being overlapped or in abutment. Having in mind this decisive suggestion, it was obvious for the person skilled in the art to combine the teaching of document D2 with the teaching of document D1 being the closest prior art document to come to a method according to new Claim 1. Therefore, the subject-matter of said claim did also not involve an inventive step (Article 56 EPC).

Hence, the Appellant and the party as of right (Article 107 EPC) requested that the decision under appeal be set aside and the patent be revoked.

Reasons for the Decision

1. The appeal is admissible.

2. **Main Request**

2.1 **Amendments**

Claim 1 comprises a combination of all features mentioned in Claim 1 as granted and features disclosed in the description.

2.1.1 From the description as granted it is clear that the laser welding method refers to a laser lap welding method for welding overlapping materials (cf. page 2, lines 4 and 5, 35 to 40, 42; page 3, line 35; Figure 2; and claim 5, line 58).

2.1.2 According to the description, the materials to be welded are held in such a manner so as to have a suitable air gap therebetween. It is left undecided to the person skilled in the art to provide those means he thinks suitable for that purpose (cf. page 2, lines 24 to 27; page 3, lines 33 and 34; the wording of the granted Claims 1 to 4). Only in the description of one way of carrying out the invention according to Rule 27(1)f) EPC, it is referred to a preferred embodiment of said invention (cf. page 2, lines 31, 32 and 35 to 41; Figure 2), i.e. the use of a spacer as an additional means separate from the materials to be welded.

Therefore, it is clear for a person skilled in the art, that the patent as a whole, unequivocally discloses all methods using any additional means which keeps the materials to be welded at a predetermined distance of each other.

Therefore, Claim 1 complies with Article 123(2) EPC.

2.1.3 Since the method according to Claim 1 has been limited to lap welding and to a specific method of forming the air gap (eliminating thereby the possibility of forming the gap by the two overlapping materials itself) the scope of Claim 1 has been restricted with respect to the granted Claim 1,so that Claim 1 also satisfies Article 123(3) EPC.

2.1.4 Claims 2 to 5, as well as the description and the drawings correspond to their granted versions, so that they satisfy Article 123 EPC.

2.2 Clarity

From the wording of the characterising portion of new Claim 1 it is clear that the predetermined distance between the overlapping materials does not depend on the quality and property of the surfaces themselves of the overlapping materials or their corresponding coating materials but solely on the further additional means, which are suitable to maintain said distance around the welding line.

Such an arrangement independent from the overlapping materials and their coating materials to be welded permits a free flow of the gas or vapour formed by heating the coating material along the welding line.

New Claim 1, therefore, also complies with Article 84 EPC.

2.3 Novelty

2.3.1 Document D1 discloses a welding method which employs substances for preventing the coating material of materials to be welded by a laser beam from undergoing rapid vaporisation during the welding operation. According

to the independent Claims 1 and 2, a deposit of flux material is placed between the overlapping materials. During the welding operation, the flux material is effective to form a compound with the coating material, which has a melting point substantially the same or higher than the base metal (cf. also "Summary of the Invention", column 1, lines 47 to 67).

Furthermore, according to aforementioned document "it was also found that a gap of no greater than 0.01 inch can be tolerated between the pieces of the workpiece to be welded with a burn-through configuration" (cf. column 5, lines 11 to 13 and Claim 14). No details with respect to the kind of providing and function of said gap are, however, mentioned in said document.

This document, therefore, clearly does not concern a method for welding overlapping materials which are coated only with a substance having a melting point lower than the base metal and which are held by further additional means (claim 1) to form the gap, let alone a spacer (claim 5) to form that gap.

2.3.2 None of the other documents cited in the proceedings before the European Patent Office discloses a laser lap welding method according to Claim 1 and a laser welding apparatus according to Claim 5. To give reasons in detail is unnecessary since novelty with respect to this state of the art was not disputed.

2.3.3 Hence, the subject-matter of the independent Claims 1 and 5 is novel within the meaning of Article 54 EPC.

2.4 Inventive step

2.4.1 According to the findings of the Board of Appeal, the closest prior art is the method which is mentioned in column 1, lines 4 to 28 of the document D1 as the background of the invention claimed in said document and which corresponds to the method indicated in the introductory part of the description of the patent in suit in the case where materials to be welded are coated members (page 2, lines 3 to 21).

In the known method, the high energy density beam such as provided by a laser vaporises a void into the material to be welded, the molten material surrounding the void held apart by the vapour pressure in the void. If the coating material, e.g. zinc, has a lower melting point than the base material, there is a sudden drastic vaporisation when the beam impinges the coating. As a result, the voids become irregular in configuration. Thus, during the welding operation, the molten metal cannot completely fill the voids and, therefore, many voids are liable to be formed in the solidified metal, which reduces the stability of the surrounding molten metal around the voids.

The technical problem to be solved by the invention is to provide a laser welding method for coated metal parts which permits to eliminate the above described difficulties, i.e. to avoid the voids formed in the solidified metal.

2.4.2 According to the teaching of the independent claims, this problem is solved by providing means (further additional means or spacer of a predetermined thickness) which holds the materials to be welded in such a manner that a gap is

provided between the materials in their overlapping zone which allow the vapour to escape freely and rapidly so that porosity due to welding is minimised.

2.4.3 From document D1 (column 1, lines 40 to 44), one prior art approach to solve the above-mentioned problem is known, which approach has included alloying a substance with the zinc coating to change the vapour pressure. But this has not been successful since discontinuities still appear within the weld zone.

Therefore, the proposed solution in said document is to locate a thin chemical film next to the trapped zinc with the property that as the material is heated by the laser beam, the film reacts with the zinc to form a compound with a melting point comparable to or higher than that of the material to be welded. When a film of iron oxide for example is placed between the overlapping materials to be welded, the iron oxide is reduced to iron and the zinc is oxidised to zinc oxide. The higher melting point results in a low vapour pressure from that compound. Lacking a driving force, weld splatter and porosity are substantially reduced (cf. column 3, line 61 to column 4, line 11).

It follows from the above that the teaching of document D1 is clearly to prevent the zinc coating from melting at a much lower temperature than the base materials and to prevent the high vapour pressure of the melting zinc from providing a driving force to eject the molten base material (cf. column 1, lines 54 to 60).

As far as the gap mentioned in said document is concerned, it can only be derived from the description that a gap of no greater than 0.254 mm can be tolerated between the materials to be welded with a laser beam. This indicates

clearly that a gap is not an advantage but a disadvantage in a laser lap welding method, which gap can only be tolerated up to a certain amount.

From Claim 14 depending on independent Claim 2 it is clear that the gap is related to the method of welding materials which uses a flux material. Since this flux material prevents the coating material from providing any driving force (cf. above paragraphs of this section), it is also clear that a predetermined gap as a path for discharging vapour has not been considered to be a further alternative to the solution as disclosed in document D1.

2.4.4 Document D2 concerns a method of hermetic sealing of abutment joints by welding with a laser beam. Such abutment joints formed by two elongate surfaces are attainable by press-fit, but even in a press-fit there is some air present in the joint. Such air together with any impurities that may be present on the surface of or in the materials to be welded and thus subject to gasification during welding create a problem in that the gas must escape from the melting area of the joint while such area is still in melted state. If the gas is trapped in the weld joint, gas pockets or blow-holes and porosity will defeat the intended hermetic seal (cf. column 2, lines 18 to 27).

According to a prior art document cited in document D2 (cf. column 2, line 32 to 43), it is a preferred practice in the submerged-arc-process to avoid press-fits in joints to be welded and to allow a gap of up to 0.794 mm. However, no further details with respect to the purpose of such a gap are mentioned.

If press-fits must be used, it is stated that one piece of the materials to be welded should be knurled to allow a path for gases to escape. Knurling is, however,

impractical for laser welding, because the whole purpose is to secure rapid, narrow band melting of the abutting surfaces. In other words, unless the surfaces at the joint are to a major extent in uninterrupted press-fit abutment, too wide a band of the adjoining materials must be brought into the melting state, causing undesirable heating involvement of the areas of the materials outside of the welding zone (cf. column 2, lines 43 to 64).

The solution for avoiding the aforementioned disadvantages in hermetic sealing of abutment joints, therefore, consists in a method of laser welding according to which narrow shallow vent grooves across one of the surfaces forming the abutment joint are provided at substantially spaced intervals while leaving between said vent grooves separating lengths of said one surface and each of which lengths extends between a pair of the grooves many times the groove width and substantially uninterrupted abutment joint contact of said surfaces along each of said lengths is effected. As the laser welding progresses continuously along the abutment joint the gases from this abutment joint are driven ahead of the welding point and escape from the vent grooves. Then, after venting at each of the vent grooves, such grooves are weldingly sealed (cf. column 3, lines 3 to 20; column 5, lines 34 to 47; Claim 1).

The person skilled in the art learns from document D2 that

- it is a preferred practice to avoid press-fits in joints to be welded by allowing a gap of up to 0.794 mm;

- a predetermined gap is disadvantageous to the materials to be welded by a laser beam, and

- grooves for venting gas are provided across one of the surfaces forming an abutment joint, while uninterrupted joint contact is left along the lengths of the surfaces between a pair of grooves.

This teaching, therefore, leads clearly away from the solution according to the invention in suit, namely to provide, by further additional means, a predetermined gap between the materials to be welded so as to form a path for discharging freely the gas or vapour formed during the welding operation.

Consequently, the person skilled in the art is not led to combine the teaching of document D2 with the prior art mentioned in document D1 as the background art of welding materials covered with coating material.

2.4.5 The Board of Appeal also considered the other available documents and found that their teachings depart from the teaching of Claim 1 far more than the teachings of the documents cited above. Therefore, these other documents are not prejudicial to the new Claim 1, either alone or in combination with the documents cited above.

2.4.6 The subject-matter of Claim 1, therefore, involves also a inventive step within the meaning of Article 56 EPC.

2.4.7 The inventive step of the subject-matter of independent Claim 5 was not contested during the oral proceedings by the Appellant and the party to the appeal proceedings as of right in accordance with Article 107 EPC.

In fact, after examination of all documents being introduced in the proceedings before the European Patent Office, the Board of Appeal is satisfied that none of them, would lead the person skilled in the art to construct a welding apparatus as defined in Claim 5 since

the realization of this apparatus is directly linked to the realization of the claimed method (providing a gap) and therefore the reasons put forward for the inventive step of the subject-matter of the independent method Claim 1 can analogously be applied for the inventive step of the subject-matter of the independent apparatus Claim 5.

2.5 In view of the above, the patent can be maintained with the independent Claims 1 and 5, together with the dependent Claims 2 to 4 concerning particular embodiments of the invention.

3. Under these circumstances, there is no need to consider the auxiliary request.

Order

For these reasons, it is decided that:

The case is remitted to the first instance with the order to maintain the European patent in an amended form with the documents provided for by the decision under appeal with the proviso that the words "by further additional means (14)" be inserted in Claim 1, line 6, between the words "provided" and "between".

The Registrar: The Chairman:

S. Fabiani

S. Fabiani C. Andries

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