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Datasheet for the decision of 6 November 2015

Case Number:	T 1022/12 - 3.2.07
Application Number:	04765533.7
Publication Number:	1664368
IPC:	C23C14/16, C23C14/02, C23C14/58, C23C10/02
Language of the proceedings:	EN

Title of invention:
A METHOD AND APPARATUS FOR THE PRODUCTION OF METAL COATED STEEL PRODUCTS

Patent Proprietor:
ArcelorMittal France

Opponents:
ThyssenKrupp Steel Europe AG
Corus Technology BV

Headword:

Relevant legal provisions:
EPC Art. 56

Keyword:
Inventive step - could-would approach

Decisions cited:

Catchword:

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Case Number: T 1022/12 - 3.2.07

D E C I S I O N
of Technical Board of Appeal 3.2.07
of 6 November 2015

Appellant: (Opponent I)	ThyssenKrupp Steel Europe AG Kaiser-Wilhelm-Strasse 100 47166 Duisburg (DE)
Representative:	Cohausz & Florack Patent- & Rechtsanwälte Partnerschaftsgesellschaft mbB Bleichstraße 14 40211 Düsseldorf (DE)
Respondent: (Patent Proprietor)	ArcelorMittal France 1à 5 Rue Luigi Cherubini 93200 Saint-Denis (FR)
Representative:	Pronovem Office Van Malderen Avenue Josse Goffin 158 1082 Bruxelles (BE)
Party as of right: (Opponent II)	Corus Technology BV Wenckebachstraat 1 1951 JZ Velsen-Noord (NL)
Representative:	Kruit, Jan Tata Steel Group Intellectual Property Services P.O. Box 10000 1970 CA IJmuiden (NL)
Decision under appeal:	**Decision of the Opposition Division of the European Patent Office posted on 22 February 2012 rejecting the opposition filed against European patent No. 1664368 pursuant to Article 101(2) EPC.**

Composition of the Board:

Chairman	G. Patton
Members:	H. Hahn
	I. Beckedorf

Summary of Facts and Submissions

I. The oppositions against European patent No. 1 664 368 were rejected, and the appellant (opponent I) filed an appeal against this decision. The appellant requested that the decision under appeal be set aside and that the patent be revoked in its entirety. As an auxiliary request it requested oral proceedings.

II. Claim 1 of the patent as granted reads as follows:

"1. A method for the production of metal coated steel products, comprising the steps of:
- providing a steel product with a metallic coating,
- adding an additional metallic element to said coating, followed by a step of
- subjecting said product to a thermal treatment, characterized in that:
- prior to the addition of said additional element, said product is subjected to a plasma treatment, for cleaning and activating the surface of said coating,
- said additional element is added through a physical vapour deposition technique,
- said thermal treatment is applied by directing high energy infra red radiation towards the outer surface of said coating, wherein the energy density of said infra red radiation is at least 400 kW/m^2."

III. In the present decision the following documents from the opposition proceedings are cited:

D1 = DE-C-19 527 515
D2 = DE-C-10 108 926
D3 = EP-A-1 201 321
D4 = WO-A-02/14573
D5 = JP-A-04 274 890

D6 = FR-A-2 655 058

IV. Two oppositions had been filed against the patent in its entirety under Article 100(a) EPC, for lack of inventive step.

The Opposition Division held that claim 1 of the single request involved an inventive step with respect to the closest prior art D1 when combined with the teaching of any of D2, D3, D4 or D5, or even D6 cited by the respondent. Therefore, the two oppositions were rejected.

V. With a communication annexed to the summons to oral proceedings the Board presented its preliminary opinion with respect to claims 1-10 of the patent as granted according to the main request and claims 1-9 of the auxiliary request of the respondent (patent proprietor) as filed with its reply to the statement of grounds of appeal.

It seemed to the Board that the subject-matter of claim 1 of the main and also of the auxiliary request was not rendered obvious for the person skilled in the art when starting from the teaching of the uncontested closest prior art D1 and considering the teachings of either D2 or D3.

It would then have to be discussed at the oral proceedings whether it would be obvious for the person skilled in the art when starting from the teaching of D1 to select infra red (NIR) heating instead of the commonly used induction heating or furnace heating.

VI. Neither the appellant nor the respondent submitted further arguments taking account of the Board's provisional opinion presented in its communication.

VII. With its letter dated 23 October 2015, filed by fax on the same date, opponent II submitted that it would not attend the scheduled oral proceedings. Opponent II had **not** made any substantive submission in the written proceedings.

VIII. Oral proceedings before the Board were held on 6 November 2015. Opponent II, as announced with its letter of 23 October 2015, did not attend the oral proceedings which in accordance with Rule 115(2) EPC and Rule 15(3) RPBA were continued in its absence. The single aspect discussed with both parties was inventive step for the subject-matter of claim 1 of the patent as granted in view of the teaching of D1 in the light of the teaching of any of documents D2 to D4 as well as the common general knowledge and practice of the person skilled in the art.

a) The appellant requested that the decision under appeal be set aside and that the patent be revoked.

b) The respondent requested that the appeal be dismissed or, in the alternative, that the decision under appeal be set aside and the patent maintained in amended form on the basis of the auxiliary request filed with letter of 8 November 2012.

At the end of the oral proceedings the Board announced its decision.

IX. The appellant argued, insofar as relevant for the present decision, essentially as follows:

D1 discloses a process for producing metal coated steel products wherein the steel product is coated with a metal layer onto which an additional metallic element is applied to produce a metal layer including said additional element by carrying out a diffusion and phase-building process involving heat treatment, and wherein said surface of the metal coating undergoes plasma treatment to clean and activate said surface before the addition of said additional metallic element, which is applied by a PVD process (see claim 1; column 3, lines 43 to 57; column 4, lines 16 to 26, lines 28 to 32, lines 34 to 42, and lines 54 to 63; column 4, line 66, to column 5, line 4).

D1 aims at providing an improved corrosion resistant steel product having a uniform and homogeneous outermost coating layer (see column 4, lines 37 to 42). In the product of D1 the diffusion and phase-building process is applied to and starts from an upper zone of the zinc layer which is opposite the steel sheet, i.e. heating from outside towards the outer surface. This is different from galvannealed products, where the diffusion process starts at the boundaries between the steel and the zinc coating layer and continues to the outer surface of the coating (see column 3, lines 48 to 57). To that extent the technical effect to be obtained through the heat treatment in D1 is identical with that of the patent in suit. However, D1 is silent on how said heat treatment has to be carried out. Therefore, the objective technical problem to be solved is to find a heat treatment which allows a fast and intense heating coming from the outside of the coating layer.

As acknowledged in the patent in suit, D3 teaches to quickly dry paint coatings using high-energy NIR radiation of at least 400 kW/m^2 (see paragraph [0028]). D2 uses the NIR radiation of at least 400 kW/m^2 for the heat treatment of near-surface metal layers without modification of the underlying layers (see paragraph [0014]).

The skilled person dealing with the coatings of D1, which may be further coated with e.g. paint, was aware of the processes of D3 and D2. Therefore, it is considered obvious that the skilled person when looking for a process to heat a thin layer from the outside would have applied the NIR radiation disclosed in D3 for the heat treatment of D1. The same argumentation is valid for a combination of D2 with D1. The success of such a combination was evident, since there were no technical obstacles to be overcome.

D4 discloses that the prior art according to D1 does not result in an excellent corrosion resistant product (see D4, page 6, first paragraph) and that the coating layer appears to be completely molten during the described alloying step (see page 13, lines 11 and 12 and lines 25 to 28). Therefore, it is concluded that induction heating would not result in a uniform/ homogeneous alloy layer when used for the heating step of the process of D1, and hence the skilled person would not think of applying induction heating in the process of D1. Therefore, the skilled person would consider the teaching of D2, i.e. he would use NIR for heating metal surfaces (see paragraph [0013]). Although D2 does not deal with (flat) sheet products it is clear to the skilled person, as proven by D3, that NIR heating is suitable for this purpose. Therefore, the application of NIR heating in the process of D1 is obvious to the skilled person in view of his common general knowledge.

X. The respondent argued, insofar as relevant for the present decision, essentially as follows:

The subject-matter of claim 1 as granted involves an inventive step with respect to the closest prior art, represented by document D1. The difference between the subject-matter of D1 and that of claim 1 as granted is the fact that claim 1 comprises the use of high-energy infra red (IR) radiation at an energy density of at least 400 kW/m^2, whereas D1 refers to an undefined "heat treatment".

The problem to be solved is, therefore, to find a suitable heat treatment applicable in the method of D1.

Contrary to the appellant's allegation, D1 does not disclose that the heating of the heat treatment is applied from the outside ("von Außen"). In the example described in D1, no information is given other than that the sheet is introduced into a process chamber in an inert atmosphere, where it undergoes the "heat treatment" at a temperature of ± 365°C, for about 4s, in a nitrogen atmosphere at 80kPa. In this context it needs to be considered that the magnesium layer is deposited by a PVD method, namely e-beam deposition, so that heating from the outside is apparently not necessary since the PVD-deposited magnesium layer is more prone to diffusion (compare in this context D4, page 13, lines 3 to 28, and the example, pages 15 and 16).

D1 does not provide sufficient information to conclude that it implicitly discloses a particular heat treatment step, e.g. induction or furnace heating. However, these were the heating methods commonly used at the time of D1. Consequently, D1 fails to disclose a higher temperature appearing first in the outermost layer of the zinc coating during the "heat treatment", as correctly acknowledged in paragraph II.6 of the impugned decision.

Furthermore, as proven by the induction heating according to the process of D4, a temperature profile in which the outermost layer would be first at a higher temperature for starting diffusion from the outside is not necessary.

The mere fact that said heat treatment induces the "controlled diffusion and phase building" from the outermost layer as stated in column 3, lines 48 to 52, of D1 does not imply that this requires a higher temperature appearing first in the outermost layer. Hence, the conclusion that such a profile is necessary for obtaining the interdiffused layer is incorrect on the basis of D1, at the priority date of the opposed patent.

In the grounds of appeal, the appellant did not insist on the implicit disclosure of a temperature profile in D1, but continued to point towards D2 as one document that would have led the skilled person towards the invention. D2 does describe the appearance of a temperature profile in a steel article under the influence of NIR at 400 kW/m^2 or more. However, given that such a temperature profile, or even a heating process taking place solely from the outside of the coated substrate, is neither explicitly nor implicitly described in D1, it is incorrect to conclude that D2 would have led the skilled person towards the invention, starting from D1.

Regardless of the above, and as stated in paragraph II. 14 of the impugned decision, D2 is limited to the heat treatment of metal parts, not metal sheets. Said metal parts are not coated with a metal coating. The influence of high-energy NIR on a PVD-deposited coating on a metal coated steel sheet could, therefore, not have been self-evident to the skilled person merely on the basis of the teaching of D2.

With regard to D3, the "thin layer" is not a metal coating, but a paint layer. The skilled person would surely have doubted the effectiveness of the technique as such, and of the energy range of 400 kW/m^2 or more, when applied to a zinc coating provided with a PVD-applied magnesium layer, for example. In any case, he would not have concluded on the basis of D3 alone that the technique in question is effective in obtaining an interdiffused Mg-Zn layer. The inventors were the first to discover the change in the reflectiveness of the zinc layer due to the additional magnesium layer (see patent in suit, paragraph [0023]), which is responsible for the fact that NIR can be used for heating.

Finally, reference is made to the Opposition Division's conclusion in paragraph II.5 of its decision that there might be a "slight difference between the teaching of D1 and the teaching of the patent in suit in that the patent in suit potentially allows the diffusion of the outermost metallic species also into an area between the steel sheet and the upper area of the metallic coating" (see end of page 9 of the contested decision). It is true that the scope of claim 1 comprises both the diffusion in a thin outer layer, as described in D1, and the diffusion potentially taking place throughout the metallic layer.

Nevertheless, the fact that the use of high-energy NIR at 400 kW/m^2 or more is capable of achieving diffusion throughout the coating underlines the inventive step of the patented method. In addition to solving the objective problem of finding a suitable heating method, the invention provides a method that allows the diffusion to take place over a higher thickness, whilst still preventing the interdiffusion of zinc and iron at the zinc-steel interface. Given that D1 explicitly advocates that diffusion must take place in a very thin outer layer (1 micron of a 15 micron coating in the example, column 5, lines 20 to 24), this result could not have been predicted on the basis of the available art. In other words, the invention not only defines a heat treatment that would have been suitable for use in D1, it also provides a heat treatment with additional capabilities other than those available or described in D1.

Concerning D4 it is remarked that the process disclosed therein serves the same purpose as D1, namely to improve corrosion resistance by diffusing an e-beam-deposited magnesium layer into a zinc layer applied on steel strip, by quickly heating the coated steel strip by induction heating. Consequently, the appellant's argument that it is unclear what D1 aims to achieve cannot hold. Furthermore, it is clear that the induction heating of the zinc-coated steel strip with the magnesium layer on top of said zinc layer does not result in a galvannealed steel strip.

Reasons for the Decision

1. *Inventive step (Article 56 EPC)*

1.1 The Board reviewed the impugned decision on the issue of inventive step and **no** fault could be found with the conclusion of the presence of inventive step as drawn by the Opposition Division in its decision, starting from the teaching of the uncontested closest prior art document D1 and - taking account of the "could-would approach" - considering the further teachings of D2 to D4 together with the common general knowledge and practice of the person skilled in the art. The reasoning is as follows.

1.2 D1 discloses a method for the manufacturing of corrosion-protected steel sheets, which includes the provision of a zinc-coated steel sheet followed by the vacuum deposition of one or more metals or metal alloys not comprising zinc and a heat treatment in an inert gas atmosphere (claim 1; column 3, lines 40 to 48, and column 4, lines 51 to 54). Prior to the vacuum deposition, the zinc-coated steel sheet is preheated and then subjected to a plasma treatment (claim 4; column 4, lines 27 to 32, and lines 59 to 66). The vacuum deposition is carried out by a physical deposition technique, such as e-beam evaporation (claim 2; column 4, lines 14 to 17; and line 66 to column 5, line 4) and the heat treatment is preferably in the range of from 300°C to 400°C (see claim 6). According to the example of D1, a 0.1 µm thick iron layer is deposited on the zinc-coated steel strip and the heat treatment is carried out in the heat treatment section ("Wärmebehandlungsstrecke") of a separate process chamber for a period of 4 seconds at a uniform and constant temperature of 365°C ± 5°C in a nitrogen atmosphere at 80kPa (see column 5, lines 4 to 10) in order to obtain a uniform surface layer (see column 4, lines 37 to 42, in combination with figure 3).

1.3 Contrary to the appellant's view, D1 does **not** disclose that the heat treatment for a controlled interdiffusion takes place from the outside ("von Außen") to the inside, **nor** does it provide sufficient information to conclude that it implicitly discloses a particular heat treatment method, e.g. induction or gas furnace heating.

1.3.1 The specific passage at column 3, lines 48 to 52, quoted by the appellant in this context - the steel sheet of D1 has an alloy layer (4) of restricted thickness only at the outer side of the zinc coating layer (5) opposite to the steel substrate (1) obtained by the diffusion process induced by the heat treatment step (see D1, figure 3) which product is compared with a galvannealed steel sheet in which the diffusion process starts at the boundary between the steel substrate surface and the zinc coating and then continues to the top surface of said coating - does **not** allow this conclusion to be arrived at.

1.3.2 It is part of the common general knowledge of the person skilled in the art - this was **not** contested by the appellant at the oral proceedings before the Board - that two heating methods, i.e. induction heating or gas heating, are commonly used for manufacturing galvannealed steel sheet.

Theoretically, the former might result in a temperature profile which has a higher temperature (for a very short period when entering the current induction zone) in the steel sheet substrate from which the heat thereby created is transferred very quickly into the zinc layer (see patent in suit paragraph [0005]), whereas the latter theoretically results in a contrary temperature profile with the higher temperature (also for a very short period) being created in the zinc layer from which the heat is then transferred to the steel sheet substrate. In practice, however, both mentioned heating methods produce galvannealed steel sheet, provided that the applied annealing temperature is high enough to cause alloying of the steel sheet and the zinc or zinc alloy layer.

The answer to the question whether or not a galvannealed strip will be formed is **not** based on the presence of a specific temperature profile of the steel sheet during the diffusion reaction, but only on a specific minimum value of the applied heat treatment temperature. This minimum temperature has to be high enough to cause the formation of intermetallic phases between the iron from the steel sheet substrate and the zinc of the zinc or zinc alloy coating layer. It is also part of the common general knowledge that in order to manufacture galvannealed steel sheet it is necessary for the zinc- or zinc-alloy-coated steel sheet to be annealed for some seconds at a temperature at least **above** the melting point of the zinc coating layer, e.g. at a temperature in the range of about 500-565°C. This annealing step in this temperature range induces said reaction between the iron of the steel sheet and the zinc coating whereby, through diffusion, a coating converted to layers of intermetallic zinc-iron compounds (which coating does not contain any free zinc) is formed.

From the above considerations it is apparent that a specific temperature profile is **not** necessary for producing galvannealed steel sheet.

Since the annealing temperature to be applied according to D1 is in the range of 300°C to 400°C, which is below the melting point of zinc of about 420°C, the skilled person does **not** expect that any galvannealing reaction will take place when using either induction heating or gas heating for the process according to D1.

1.3.3 The Board therefore considers that D1 fails to disclose a temperature profile with a higher temperature appearing just in the outermost layer of the zinc coating during the "heat treatment", as correctly remarked in the impugned decision (see the second paragraph of point II.6 of the reasons). The mere fact that the heat treatment of D1 induces the "controlled diffusion and phase building" from the outermost layer does **not** imply that it requires a higher temperature appearing first in the outermost layer.

1.3.4 This interpretation is additionally proven by D4 and its working example, which uses induction heating for the heat treatment of a magnesium layer on a zinc coating in order to manufacture a zinc-magnesium alloy layer, i.e. the process does **not** produce a galvannealed steel sheet since the applied heat treatment temperature of 396°C is too low (see pages 15 and 16). D4 describes in the context of figure 3 that the zinc-magnesium alloy formation starts at the outermost magnesium layer of the instantly heated steel strip and then - taking account of the essential process parameters - may continue throughout the entire zinc layer (see page 11, line 18, to page 12, line 12; pages

15 and 16; and description of figure 3 on page 13, second paragraph, to page 14, first paragraph).

Hence, it is proven that a temperature profile with the highest temperature at the outermost magnesium surface is **not** necessary for starting diffusion from the outermost layer (see point 1.3.2 above for the temperature profile of induction heating).

1.4 Therefore the method of claim 1 of the main request is distinguished from the method of D1 for the production of metal coated steel products having a two-layer metal coating in that the heat treatment step is applied by directing high-energy infra red radiation towards the outer surface of said coating, wherein the energy density of the infra red radiation is at least 400 kW/m^2. In this context it needs to be considered that claim 1 of the main request is restricted **neither** to a zinc coating applied by a specific method **nor** to magnesium as the alloying metallic element.

1.5 The technical effect of this type of heating is stated to be a speedy heating from the outside of the steel product which allows the magnesium diffusion into the zinc or aluminium coating to start more easily from the surface without affecting the interface between the steel substrate and the zinc or aluminium coating (see patent in suit, paragraph [0023]).

Furthermore, due to the application of this infra red heating in combination with the plasma treatment, the process of claim 1 is stated to be much more compact, i.e. it requires less physical space than prior-art processes, which allows it to be incorporated into existing metal coating production lines more easily (see patent in suit, paragraph [0025]).

1.6 In this context it needs to be considered that the process according to D1 is also considered to provide fast heating, namely a heat treatment period of 4 seconds at 365°C (see D1, column 5, lines 4 to 10). Furthermore, it can be added to an existing hot-dip production line (see column 5, lines 33 to 36) and the process results in a two-layer metal coating **without** affecting the interface between the steel substrate and the coating (see D1, figure 3), i.e. without producing galvannealed steel sheet. Finally, the induction heating furnace is also a compact one.

1.7 The objective technical problem starting from the teaching of D1 is thus defined as the provision of a heating method suitable for carrying out the process described in D1.

1.8 This technical problem is solved by the subject-matter of claim 1 of the patent as granted.

Contrary to the appellant's arguments this solution is not obvious for the following reasons.

1.9 The appellant argued that the person skilled in the art when starting from the teaching of D1 as the closest prior art and combining it with the teaching of D2 or D3 would arrive at the claimed subject-matter. These arguments cannot hold, for the following reasons.

1.9.1 First of all, the person skilled in the art knows from his common general knowledge that induction heating is perfectly suitable for carrying out the process of D1 (see point 1.3.2 above), since it is commonly used in the technical field of manufacturing corrosion-protected metal coated steel sheet such as galvannealed steel sheet. The skilled person knows how to control the energy in induction heating and/or to set the thickness of the coating in order to avoid galvannealing as in D1. This suitability is additionally proven by the disclosure of D4 (see point 1.3.4 above). Induction heating is considered to allow faster heating of the metal coated steel strip than gas heating. The person skilled in the art will therefore select induction heating from the two commonly used heating methods and thereby has no need to modify the used apparatus at all.

Therefore it is **not** considered to be obvious for the person skilled in the art to switch from induction heating to infra red heating.

1.9.2 This conclusion is further supported by the fact that in order to be heated efficiently by infra red radiation the metal coating layers must have a certain minimum absorptivity. However, zinc coating layers without the metal addition were apparently too reflective to be heated by infra red light (compare the patent in suit, paragraph [0023]).

The Board therefore considers that, although the person skilled in the art could have used infra red heating - since both D3 and D1 are silent on said absorptivity of metal coating layers, and the same holds true with respect to D2, which only mentions annealing and tempering of steel objects but not of metal coating layers on flat steel substrates - he would **not** have done so, since any advantages compared to induction heating are not apparent to him.

1.9.3 On the other hand it is likewise clear to the person skilled in the art that the commonly used gas heating, similarly to induction heating, could be used for the annealing treatment of D1. As already remarked in point 1.3.2 above, this type of furnace heating results at the start of the heat treatment in a temperature profile with the highest temperature being on the outermost surface of the metallic coating, e.g. a thin magnesium or iron layer on an underlying zinc coating layer, on the steel sheet.

Therefore, if the person skilled in the art for whatever reason were to select such a temperature profile - although not considered necessary for forming an alloy layer (see point 1.3.2 above) - he would have selected gas heating because thereby he would likewise have had no need to modify the used apparatus and would thereby also not arrive at the solution of the aforementioned technical problem according to claim 1 of the main request.

1.10 In the light of the above, the Board therefore considers that the subject-matter of claim 1 of the patent as granted involves an inventive step.

Order

For these reasons it is decided that:

The appeal is dismissed.

The Registrar: The Chairman:

G. Nachtigall G. Patton

Decision electronically authenticated