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INVENTOR(S) Pascal DRILLET, et al.

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FOR: COATED STEEL STRIPS, METHODS OF MAKING THE SAME, METHODS OF USING THE SAME, STAMPING BLANKS PREPARED FROM THE SAME, STAMPED PRODUCTS PREPARED FROM THE SAME, AND ARTICLES OF MANUFACTURE WHICH CONTAIN SUCH A STAMPED PRODUCT

FEE TRANSMITTAL

☐ No additional fee is required

☐ Small entity status of this application under 37 C.F.R. §1.9 and §1.27 is claimed.

☐ Track 1 Prioritized Examination

The Fee has been calculated as shown below:

FOR	NUMBER FILED	NUMBER EXTRA	RATE	CALCULATIONS
TOTAL CLAIMS	8 - 20 =	0	x $60 =	$0.00
INDEPENDENT CLAIMS	1 - 3 =	0	x $250 =	$0.00
UTILITY APPLICATION SIZE FEE	* - 100 = (* 46 x .75)	0 (each addtl. 50 sheets over 100)	x $310 =	$0.00
☐ MULTIPLE DEPENDENT CLAIMS (If applicable)			+ $450 =	$0.00
☐ LATE FILING OF DECLARATION			+ $130 =	$0.00
☐ NON-ELECTRONIC FILING FEE			+ $400 =	$0.00
■ FILING FEE ($380.00) ■ SEARCH FEE ($620.00) ■ EXAMINATION FEE ($250.00)			BASIC FEES	$1,250.00
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Submitted by: Andrew M. Ollis

Andrew M. Ollis
Registration No. 40,749

Customer Number
22850

Tel. (703) 413-3000
Fax. (703) 413-2220
(OSMMN 02/12)

Application Data Sheet

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Inventor Information

Applicant Authority Type::	Inventor
Primary Citizenship Country::	France
Status::	Full Capacity
Given Name::	Pascal
Family Name::	DRILLET
City of Residence::	Rozerieulles
Country of Residence::	France
Street of mailing address::	9 Chemin de Banauvignes
City of mailing address::	Rozerieulles
Country of mailing address::	France
Postal or Zip Code of mailing address::	57160

Applicant Authority Type::	Inventor
Primary Citizenship Country::	France
Status::	Full Capacity
Given Name::	Dominique

Family Name::	SPEHNER
City of Residence::	Balan
Country of Residence::	France
Street of mailing address::	8 rue de la Porte
City of mailing address::	Balan
Country of mailing address::	France
Postal or Zip Code of mailing address::	08200

Applicant Authority Type::	Inventor
Primary Citizenship Country::	France
Status::	Full Capacity
Given Name::	Ronald
Family Name::	KEFFERSTEIN
City of Residence::	Saint Mitre Les Ramparts
Country of Residence::	France
Street of mailing address::	2 rue des Rocaledes
City of mailing address::	Saint Mitre Les Ramparts
Country of mailing address::	France
Postal or Zip Code of mailing address::	13920

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Assignee Information

Assignee name::	ArcelorMittal France
Street of mailing address::	1-5 rue Luigi Cherubini
City of mailing address::	Saint Denis
Country of mailing address::	France
Postal or Zip Code of mailing address::	93200

COATED STEEL STRIPS, METHODS OF MAKING THE SAME, METHODS OF USING THE SAME, STAMPING BLANKS PREPARED FROM THE SAME, STAMPED PRODUCTS PREPARED FROM THE SAME, AND ARTICLES OF MANUFACTURE WHICH CONTAIN SUCH A STAMPED PRODUCT

FIELD OF THE INVENTION

The present invention relates to, among other things, coated steels, methods of making such coated steels, including hot dipping, methods of using such coated steels, stamping blanks prepared from coated steels, stamped products prepared from coated steels, and to various uses of the invention products such as in spot welding, etc.

Additional advantages and other features of the present invention will be set forth in part in the description that follows and in part will become apparent to those having ordinary skill in the art upon examination of the following or may be learned from the practice of the present invention. The advantages of the present invention may be realized and obtained as particularly pointed out in the appended claims. As will be realized, the present invention is capable of other and different embodiments, and its several details are capable of modifications in various obvious respects, all without departing from the present invention. The description is to be regarded as illustrative in nature, and not as restrictive.

BACKGROUND OF THE INVENTION

In recent years the use of pre-coated steels in hot-stamping processes for the shaping of parts has become important, especially in the automotive industry. Fabrication of such parts may include the following main steps:

- Pre-coating of a steel sheets, by hot dipping
- Trimming or cutting for obtaining blanks

- Heating the blanks in order to obtain alloying of the steel substrate with the pre-coating, as well as the austenitizing of the steel
- Hot forming followed by rapid cooling of the part in order to obtain predominantly martensitic structures

See for Example U.S. 6,296,805, incorporated herein by reference.

Thanks to an alloying of the pre-coating with the steel substrate, which has the effect of creating intermetallic alloys with high melting temperature, the blanks having such coating may be heated in a temperature range where austenitizing of the metallic substrate takes place, allowing further hardening by quenching.

Heat treatments of the blanks in view of the intermetallic alloying of the coating and austenitizing of the substrate are most frequently performed in furnaces, where blanks are traveling on rollers. The thermal cycles experienced by the blanks include first a heating phase whose rate is a function of parameters such as blank thickness, furnace temperature, traveling speed, and coating reflectivity. After this heating phase, thermal cycles generally include a holding phase, whose temperature is the regulation temperature of the furnace. Problems however are experienced with the furnace operation: the rollers may become fouled by metallic deposits which come from the pre-coating of the blanks. If these deposits are excessive, maintenance of the rollers has to be performed and productivity is decreased.

Parts obtained after heating and rapid cooling display very high mechanical resistance and may be used for structural applications, for example for automotive industry applications. These parts must be frequently welded with others and high weldability is required. This means that:

- The welding operation should be performable in a sufficiently wide operating range in order to guarantee that an eventual drift of the nominal welding parameters has no incidence on weld quality. For resistance welding, which is very common in the automotive industry, an operating welding range is defined by the combination of parameters: welding current intensity I and force F applied of the parts during welding being among the most important. A proper combination of these parameters helps to ensure that insufficient nugget diameter is

not obtained (caused by too low intensity or too low force) and that no weld expulsion occurs.

- The welding operation should also be performed in such a way that high mechanical resistance is obtained on the weld. This mechanical resistance may be evaluated by tests such as by shear-tensile tests or cross-tensile tests.

There remains a need for coated steels which may be conveniently used to prepare shaped parts by a stamping process. There also remains a need for coated steels which may be used to prepare shaped parts by a stamping process which are suitable for welding. There also remains a need for processes for preparing such coated steels and stamped parts.

SUMMARY OF THE INVENTION

The inventors have discovered that certain coated steels in which a base steel strip is at least partially coated (sometimes termed "pre-coated," this prefix indicating that a transformation of the nature of the pre-coating will take place during heat treatment before stamping) on at least one side with a coating of either aluminum or an aluminum alloy and in which the coating has a defined thickness and is preferably substantially uniform, are conveniently formed into shaped parts after heating by stamping and are conveniently welded. In addition, the inventors have discovered that the roller fouling problem described above generally arises from an insufficient degree of intermetallic alloying between the substrate and the metallic pre-coating. Furthermore, it was discovered that the location of the fouling of the rollers corresponds to zones of the blanks in contact with the rollers where the metallic pre-coating thickness locally exceeds the average thickness. While not bound by a particular theory, it is believed that if a pre-coating is locally too thick, intermetallic alloying is insufficient and the pre-coating melts, fouling the rollers. Thus, the inventors have discovered that the control of the homogeneity of the pre-coating thickness over the entire sheet within given tolerances is an important factor for obtaining the desired degree of intermetallic alloying, allowing one to improve the resistance to the subsequent melting of the coating during travel on rollers.

The inventors have also discovered that particularly good weldability of aluminized and hot stamped parts is associated with a special succession of coating layers on the parts, proceeding from steel substrate outwards.

The inventors have also discovered that a specific combination of transfer time between the heating furnace and the stamping die, the amount of deformation during stamping, the temperature of stamping, the cooling rate of the product during stamping, leads to the fabrication of a part with a fully homogeneous martensitic structure and that an increase in ductility or energy absorption of the parts after stamping is obtained by a reduction of sulfur below a critical value, these two benefits being obtained with or without the invention aluminum/aluminum alloy coating, and with other coatings.

OBJECTS OF THE INVENTION

Accordingly, and in view of the above, it is one object of the present invention to provide novel pre-coated steels strips which may be conveniently processed into stamping blanks.

It is another object of the present invention to provide novel pre-coated steels strips or sheets which may be conveniently formed into parts by stamping.

It is another object of the present invention to provide novel coated steels which may be conveniently formed into parts by hot stamping.

It is another object of the present invention to provide novel methods for making such a coated steel.

It is another object of the present invention to provide novel stamping blanks which are prepared from such a coated steel.

It is another object of the present invention to provide novel methods of making such stamping blanks.

It is another object of the present invention to provide novel stamped parts which are prepared from such a coated steel.

It is another object of the present invention to provide novel methods of making such stamped parts.

It is another object of the present invention to provide novel articles of manufacture, such as a motor vehicle, which contain such stamped parts.

It is another object of the present invention to provide novel stamped parts.

It is another object of the present invention to provide novel methods of making welded stamped parts.

It is another object of the present invention to provide novel articles of manufacture, such as a motor vehicle, which contain such welded stamped parts.

It is another object of the present invention to provide novel welded coated steels and welded stamping blanks.

It is another object of the present invention to provide novel methods of making such welded coated steels and welded stamping blanks.

These and other objects, which will become apparent during the following detailed description.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 illustrates a preferred embodiment of an invention coated part, after heat treatment and stamping. The succession of layers of the coating on the steel substrate is: (a) interdiffusion layer; (b) intermediate layer; (c) Intermetallic layer; and (d) superficial layer. This arrangement is particularly favorable for the further welding of the part.

Figure 2 illustrates a coating of a steel substrate after heat treatment and stamping which does not correspond to the invention. This succession of layers (interdiffusion layer and intermetallic layer) yields inferior results in resistance spot welding.

Figure 3 illustrates a microstructure of a steel part, hot stamped and cooled under conditions not according to the invention.

Figure 4 illustrates the microstructure of a steel part, hot stamped and cooled according to a preferred set of conditions according to the invention.

Figure 5 illustrates the influence of sulfur on the bending angle of parts after hot stamping.

Figure 6 illustrates the influence of sulfur on the initiation energy of fracture of parts after hot stamping.

Figure 7 shows conditions of furnace temperature as a function of the total dwell time in the furnace for sheets of total thicknesses of from 0.7-1.5 and 1.5-3 mm that provide particularly favorable coatings for welding.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

As noted above, the inventors' discovery that certain coated steels, in which a base steel is at least partially pre-coated on at least one side with a coating of either aluminum or an aluminum alloy and in which the pre-coating has a defined thickness and is substantially uniform, are conveniently formed into shaped parts by stamping, forms one basis for the invention.

In the context of the present invention, the terms first side (or side 1) and second side (or side 2) of the strip or sheet, etc., of base steel refer to the two large, opposite-facing, surfaces which have a surface area defined by the length and width of the strip of base steel. In contrast, the side edges of the strip of base steel are the two small, opposite-facing, surfaces which have a surface area defined by the length and thickness of the strip. The top and bottom edges of the strip of base steel are the two small, opposite-facing, surfaces which have a surface area defined by the width and thickness of the strip. In the following, t_p designates the thickness of the pre-coating, at any considered location on the sides 1 and 2 of a sheet or a blank. In particular, in the case of sheets coated on two sides 1 and 2, t_{p1} stands for the thickness on side 1, and t_{p2} for the thickness on side 2.

According to a highly preferred embodiment t_p is controlled in a precise range, expressed by (t_{pmin}, t_{pmax}), in order to improve the resistance to the fouling of the rollers. The thickness is preferably controlled, both in the longitudinal (or rolling) direction of the strip or sheet, as well in the transverse direction.

In relation to the problem of the fouling of rollers, the control of the pre-coating thickness on the side of the sheet or blank which is directly in contact with the rollers is especially important. Because different operations can follow the step of coating the steel sheet (for example hot-dip-coating which provides coated sides 1 and 2), it is preferable to carefully control the pre-coating on both sides of the sheet. For example, after any of coiling,

handling, cutting, punching, etc., sides 1 and 2 may be not readily identifiable. But when control of t_p is effected on the two sides of the sheet that has been coated (first side and second side) it is not necessary to track sides 1 and 2 as neither side will foul the roller. In addition, it is not necessary to trim the sheet in order to obtain a preferred smaller sheet having a more uniform homogeneity of pre-coating thickness, thus providing a sheet that is pre-coated by, e.g., hot-dipping. In other words, important benefits are obtained when one controls the pre-coating minimum and maximum thickness of the first side (t_{pmin1} , t_{pmax1}) and the pre-coating minimum and maximum thickness of the second side (t_{pmin2} , t_{pmax2}) of the subject steel sheet or blank.

Hot-dip coated steels are the preferred steels herein. However, regardless of the coating method, the pre-coating thickness on one or both sides of the sheet can be measured and monitored continuously on a coating line directly after the coating operation. This may be realized by devices known per se, such as thickness gages relying on X-Ray absorption. At every moment, the measurement of thickness at a given location may be performed for example on an area of a few hundreds of mm^2, this representing the dimension of the zone irradiated by X-Ray.

In a preferred embodiment, a plurality of such devices are positioned at different distances in the transverse direction of the strip in order to obtain a profile of the thickness of the pre-coating along the strip width.

The inventors have discovered that the resistance to the pollution or fouling of the rollers in the furnaces is improved when the minimum and maximum thickness respectively of at least one of the first side (t_{pmin1}, t_{pmax1}) and the second side (t_{pmin2}, t_{pmax2}) are respectively equal to 20 and 33 micrometers (a micrometer is the same as a micron and is a metric unit of length equal to one millionth of a meter). In other words, in a preferred embodiment, at every location on at least one face of the sheet or the blank, the thickness t_p of the pre-coating is preferably from 20 - 33 micrometers in thickness, including 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31 and 32 micrometers and all ranges and subranges therebetween, and including all numbers between each listed value as if written out in its entirety (e.g., 22.34 micrometers). For hot-dip coating, precise control of this range of pre-coating

thickness can be realized on an operating line for example using a system of nozzles blowing gas after coating, for example after exit of the strip or sheet from a bath, and by the flatness of the strip. Number, geometry and location of the nozzles, and flow rates are among the main parameters for a precise control of the thickness t_p. Given the present disclosure, one of ordinary skill in this art can control the pre-coating thickness as described herein without undue labor.

The invention refers to strips produced in industrial conditions, i.e. where control of pre-coating thickness is effective over a wide surface strip, i.e. with a length greater than 100m, and with a width greater than 600mm. In such a way, blanks cut or trimmed out these strips display very high homogeneity of pre-coating thickness, and the settings of the heating treatments in the furnace do not have to be changed for being adapted to eventual variations of this thickness.

While not bound by a particular theory of operation, the inventors believe that several of the benefits of the invention are related to this pre-coating thickness range, such as the following :

- For a pre-coating thickness less than 20 micrometers, the alloyed layer which is formed during the heating of the blank has an insufficient roughness. Thus, the adhesion of subsequent painting is low on this surface, and the corrosion resistance is decreased.

- If the pre-coating thickness is more than 33 micrometers at a given location on a sheet, the risk is that the difference of thickness between this location and some other locations where the pre-coating is thinner, becomes too important : The settings of the heating treatment in the furnace may be adapted to the thinner value of the pre-coating, but not to the thicker one. Thus, the alloying reaction forming the intermetallic alloy may take place to an insufficient degree since the mean diffusion distance of the elements in the pre-coating becomes significantly less than the local value of the pre-coating thickness. As a matter of results, alloying will become much more difficult in the external (or superficial) part, particularly in the case of high heating rate.

Thus, in a first embodiment, the present invention provides certain coated steel strips, which comprise a strip of base steel and a pre-coating of

aluminum or an aluminum alloy on at least a part of one side of the strip of the base steel. For many applications, the strip of base steel may comprise any type of steel which may be coated with either aluminum or an aluminum alloy. However, for certain applications, such as a structural part of an automobile, it is preferred that the strip of base steel comprise an ultra high strength steel (UHSS). In such cases, it is particularly preferred that the strip of base steel comprises a boron steel.

The inventors have also discovered that good welding results are achieved if the coating obtained on parts made out of blanks having undergone intermetallic alloying, austenitizing and hot stamping, displays distinctive features. It must be pointed out that this coating is different from the initial pre-coating, since the thermal treatment causes an alloying reaction with the steel substrate which modifies both the physico-chemical nature and the geometry of the pre-coating : in this regard, the inventors have discovered that particularly good weldability of aluminized and hot stamped parts is associated with the following succession of coating layers on the parts, proceeding from steel substrate outwards :

- (a) Interdiffusion layer,
- (b) Intermediate layer,
- (c) Intermetallic layer,
- (d) Superficial layer

See, e.g., Figure 1. In a preferred embodiment these layers are as follows:

- (a) Interdiffusion layer, preferably with medium hardness (e.g., HV50g between 290 and 410, HV50g designating the hardness measured under a load of 50 grams) In a preferred embodiment this layer has the following composition, by weight : 86-95%Fe, 4-10%Al, 0-5%Si
- (b) Intermediate layer (HV50g around 900 - 1000 e.g., +/- 10%))
  In a preferred embodiment this layer has the following composition, by weight : 39-47% Fe, 53-61%Al, 0-2%Si
- (c) Intermetallic layer, with hardness HV50g around 580-650, e.g., +/- 10%)
  In a preferred embodiment this layer has the following composition, by weight : 62-67%Fe, 30-34 %Al, 2-6%Si
- (d) Superficial layer (HV50g around 900 - 1000 e.g., +/- 10%))

In a preferred embodiment this layer has the following composition, by weight : 39-47% Fe, 53-61%Al, 0-2%

In a preferred embodiment the total thickness of layers (a) to (d) is greater than 30 micrometers.

In another preferred embodiment, the thickness of layer (a) is less than 15 micrometers, for example 14, 12, 10, 8, 6, 4, 2, or 1 micrometers, and all whole numbers, ranges and subranges therebetween, and including all numbers between each listed value as if written out in its entirety (e.g., 13.84 micrometers).

The inventors have discovered that high weldability is especially obtained when layers (c) and (d) are essentially continuous (i.e.: occupying at least 90% of the level corresponding to the considered layer) and when less than 10% of layer (c) is present at the extreme surface of the part. Without being bound by a theory, it is thought that this particular layer disposal, in particular layer (a) and layers (c) and (d) influence the resistivity of the coating both by their intrinsic characteristics and by the effect of roughness. Thus, current flow, heat generation at the surfaces, and nugget formation in the initial stage of spot welding are affected by this particular arrangement.

This favorable layer disposition is obtained for example when aluminum- or aluminum alloy pre-coated steel sheets, whose thickness range from, e.g., 0.7 to 3mm, are heated for 3 to 13 minutes (this dwell time includes the heating phase and the holding time) in a furnace heated to a temperature of 880 to 940°C. Other conditions leading to such favorable layer dispositions are found in Figure 7:

For sheets of total thicknesses greater or equal to 0.7mm, and less than or equal to 1.5mm, the preferred treatment conditions : (furnace temperature, total dwell time in the furnace) are illustrated in figure 7 by conditions lying within the limits of diagram "ABCD"

For sheets of total thicknesses greater than 1.5mm, and less than or equal to 3mm, the preferred treatment conditions : (furnace temperature, total dwell time in the furnace) are illustrated in figure 7 by diagram "EFGH" .

The heating rate V_c is comprised between 4 and 12°C/s for producing a favorable alloyed layer disposition. In this regard, this "heating rate" reflects

the temperature rise which is experienced by the pre-coated steel upon being located in the preheated furnace. V_c is defined as the mean heating rate between 20 and 700°C. The inventors have discovered that the control of V_c in this precise range is a key factor, because it controls directly the nature and the morphology of the alloyed layers which are formed. It is here underlined that the heating rate V_c is different from the mean heating rate, which is the heating rate between room temperature and furnace temperature. The rates of 6, 7, 8, 9, 10, and 11 °C/s are included as are all numbers, ranges and subranges therebetween, and including all numbers between each listed value as if written out in its entirety (e.g., 7.7 °C/s). In this regard, all of the conditions specified within Figure 7 are incorporated herein by reference thereto. Particularly preferred conditions are:

(for thicknesses of 0.7-1.5mm)

- 930°C, from 3 minutes up to 6 minutes;
- 880°C, from 4 minutes 30 seconds up to 13 minutes

(for thicknesses of 1.5 to 3 mm)

- 940°C, from 4 minutes up to 8 minutes;
- 900°C, from 6 minutes 30 seconds up to 13 minutes

A special advantage arises from pre-coatings whose thickness is comprised between 20 and 33 micrometers, since this thickness range yields favorable layer disposal, and since the homogeneity of the pre-coating thickness is associated to an homogeneity of the coating formed after alliation treatment.

Heated blanks are thereafter transferred to a die, hot stamped to obtain a part or product, and cooled at a rate of more than 30°C/s. The cooling rate is defined here as the mean rate between the exit of the heated blank from the furnace, down to 400°C.

The strip of base steel is coated with either aluminum or an aluminum alloy. Commercially pure aluminum is known in the art as Type 2 aluminum, while alloys of aluminum with 5 to 11 % by weight of silicon are known in the art as Type 1 aluminum. Silicon is present in order to prevent the formation of a thick iron-metallic intermetallic layer which reduces adherence and formability. Other alloying elements useful with aluminum herein include iron,

between 2.5 and 3% by weight, and calcium, between 15 and 30ppm by weight, including combinations of two or more thereof with aluminum.

A typical metal bath for an Al-Si coating generally contains in its basic composition by weight, from 8% to 11% silicon, from 2% to 4% iron, the remainder being aluminum or aluminum alloy, and impurities inherent in processing. Typical composition of Al-Si coating is: Al-9,3%Si-2,8%Fe. Invention coatings are not limited to these compositions, however.

The strip of base steel used herein may be any which can be coated by a conventional coating technique. For example, the strip of base steel may be any hot rolled strip, such as those prepared by hot rolling a steel slab (either with or without subsequent cold rolling). Typically, the strip of base steel will be stored and transported in the form of a coil both before and after the formation of the coating.

An example of a preferred steel for the strip of base steel is one having the following composition by weight:

0.10% < carbon < 0.5%
0.5% < manganese < 3%
0.1% < silicon < 1%
0.01% < chromium < 1%
titanium < 0.2%
aluminum < 0.1%
phosphorus < 0.1%
sulfur < 0.05%
0.0005% < boron < 0.010%,

the remainder comprising, consisting essentially of, or consisting of iron and impurities inherent in processing. Use of such a steel provides a very high mechanical resistance after thermal treatment and the aluminum-based coating provides a high resistance to corrosion.

Particularly preferably, the composition by weight of the steel in the strip of base steel is the following:

0.15% < carbon < 0.25%
0.8% < manganese < 1.8%
0.1% < silicon < 0.35%

0.01% < chromium < 0.5%
titanium < 0.1%
aluminum < 0.1%
phosphorus < 0.1%
sulfur < 0.05%
0.002% < boron < 0.005%,

the remainder comprising, consisting essentially of, or consisting of iron and impurities inherent in processing.

A preferred strip herein is 100 m long and 600mm wide. Preferred thicknesses are 0.7 to 3 mm.

Even more preferably, in the composition by weight of the sheet, the weight ratio of titanium content with respect to the nitrogen content is in excess of 3.42, believed to be a level at which the boron is no longer able to combine with the nitrogen.

An example of preferred commercially available steel for use in the strip of base steel is 22MnB5.

Chromium, manganese, boron and carbon may be added, in the composition of the steel according to the invention, for their effect on hardenability. In addition, carbon makes it possible to achieve high mechanical characteristics thanks to its effect on the hardness of the martensite.

Aluminum is introduced into the composition, to perform deoxidation in the liquid state and to protect the effectiveness of the boron.

Titanium, the ratio of the content of which with respect to the nitrogen content should be in excess of 3.42, is introduced for example in order to prevent combining of the boron with the nitrogen, the nitrogen being combined with titanium.

The alloying elements, Mn, Cr, B, make possible a hardenability allowing hardening in the stamping tools or the use of mild hardening fluids limiting deformation of the parts at the time of thermal treatment. In addition, the composition according to the invention is optimized from the point of view of weldability.

The steel in the sheet may undergo a treatment for globularization of sulfides performed with calcium, which has the effect of improving the fatigue resistance of the sheet.

As mentioned above, ultra-high-strength can be provided with the steel sheet coated and hot stamped according to the invention. This high level of strength is sometimes associated with a limited ductility. In applications requiring a higher ductility, in particular when an ability for bending is required from a part or a product, the inventors have discovered that increased ductility can be obtained if sulfur is particularly controlled: when the sulfur level of base steel is lower than or equal to 0.002% (20 ppm), the bending angle can be greater than 60° and enhanced ductility and tearing resistance are obtained on the parts having experienced heat treatment and stamping. Preferred levels include 20, 18, 15, 13, 10, 8, 5, 2, etc ppm sulfur. In fact, this benefit applies to steels in general, and is not limited to coated steels or to steels coated with Al or Al alloy coatings. While not bound by a particular theory, when analyzing causes of premature failure of some parts in bending operations, the inventors observed that failure initiated on sulfide inclusions. It is thus believed that decohesions between inclusions and the martensitic or bainito-martensitic matrix act as stress-concentration factors and trigger further crack propagation in the ductile mode.

The invention also concerns a process for producing a part starting from an invention coated sheet, then cut into a blank which, after shaping, the coating of the blank is subjected to an increase in temperature at a speed in excess of 4°C/second, but lower than 12°C/second. The heating rate V_c is defined as the mean rate between 20 and 700°C.

The invention also concerns the use of a hot-rolled steel sheet which then can be cold-rolled and coated, for structural and/or anti-intrusion or substructure parts for a land motor vehicle, such as, for example, a bumper bar, a door reinforcement, a wheel spoke, etc.

The sheet according to the invention described above can derive, by reason of its processing, from a hot-rolling mill, and possibly may be cold-rerolled again depending on the final thickness desired. It then is coated with an aluminum-based coating, for example by dipping in a bath containing, in

addition to the aluminum source/alloy, e.g., from 8% to 11% silicon and from 2% to 4% iron, the sheet having a high mechanical resistance after thermal treatment and a high resistance to corrosion, as well as a good capacity for painting and gluing.

The coating is preferably controlled as above, and has in particular the function of protecting the basic sheet against corrosion in various conditions. The thermal treatment applied at the time of a hot-forming process or after forming makes it possible to obtain high mechanical characteristics which can exceed 1500 MPa for mechanical resistance and 1200 MPa for yield stress. The final mechanical characteristics are adjustable and depend in particular on the martensite fraction of the structure, on the carbon content of the steel and on the thermal treatment. At the time of thermal treatment performed on a finished part or at the time of a hot-shaping process, the coating forms a layer having a substantial resistance to abrasion, wear, fatigue, shock, as well as a good resistance to corrosion and a good capacity for painting and gluing. The coating makes it possible to avoid different surface-preparation operations such as for steel sheets for thermal treatment not having any coating.

The steel sheet can be pre-coated by dipping, after pickling, in an aluminum bath containing for example only aluminum or either aluminum and from 8% to 11% silicon and 2% to 4% iron, or only from 2% to 4% iron, or even in an aluminum bath preferably containing from 9% to 10% silicon and 2% to 3.5% iron. The aluminum may be aluminum per se or an aluminum alloy.

In an example of implementation of a coating of the sheet by dipping in a metal bath containing an aluminum alloy comprising a proportion of approximately 90% aluminum, the coating layer comprises a first alloy layer in contact with the surface of the steel. This layer, directly in contact with the surface of the sheet, is highly alloyed with iron.

A second coating layer, on top of the first, contains approximately 90% aluminum and may contain silicon and a small amount of iron, depending on the composition of the bath.

The first alloy layer may crack when the sheet is submitted to high strains during cold forming operations of the manufacture of parts.

According to the invention, after the forming of the part, the coating is subjected to an increase in temperature at a speed in excess of 4°C /second. This rise in temperature makes possible a rapid remelting of the aluminum which fills in the cracks generated by the operation of shaping of the part.

At the time of thermal treatment, the base coating, of aluminum for example, is transformed into a layer alloyed with iron and comprising different phases depending on the thermal treatment and having a considerable hardness which may exceed 600 HV50 g.

Another advantage of the invention lies in the fact that the diffusion of the iron in the coating is initiated at high temperature. One thus will have a better cohesion between coating and steel in the sheet. In another form of the invention, the thermal treatment may be performed locally, in heavily deformed zones.

According to the invention, the sheet, in the delivery state in a coil or in a sheet, the thickness of which may range between 0.25 mm and 15 mm, has good forming properties and a good resistance to corrosion as well as a good capacity for painting or gluing. Preferably, the steel sheet or blank has a thickness less than 3 mm, since the cooling rates that may be achieved after quenching are high and help to obtain martensitic structures.

The steel sheet, a coated product, has a substantial resistance to corrosion in the delivery state, during forming and thermal treatments as well as during usage of the finished part.

The presence of the coating at the time of thermal treatment of the parts makes it possible to prevent any decarburization of the base metal as well as any oxidation. That is an undeniable advantage, in particular in the case of hot forming. Furthermore, heating of the treated part does not require a furnace having a controlled atmosphere to prevent a decarburization.

Thermal treatment of the metal in the sheet comprising heating at a temperature ranging between Ac1, starting temperature of austenitic transformation when heating, for example 750°C and 1200°C, in a furnace, for a period which depends on the temperature to be reached and the thickness of the blank. The composition is optimized so as to limit the grain growth at the time of thermal treatment. If the structure sought is completely

martensitic, the holding temperature should be in excess of Ac3, for example 840°C, temperature of complete austenitic transformation. The temperature holding should be followed by a cooling adjusted to the final structure sought.

Blanks are thereafter transferred from the furnace to a stamping press. When the elapsed time between the exit of the blanks from the furnace and the introduction in the stamping press is more 10 seconds, a partial transformation from austenite is susceptible to appear: if obtaining a full martensitic structure is desired, the transfer time between the exit of the furnace and stamping should be less than 10s.

The inventors have also discovered that the obtaining of a fully martensitic structure is linked to the amount of deformation in the hot forming operation: the amount of local deformation caused by hot forming is closely linked to the shape of the part or product and may exceed locally 40 or 50% in some particular regions. The inventors found that, when the local strain exceeds a critical value of 10%, the cooling rate must be sufficiently high in order to get a total martensitic transformation. Otherwise, bainitic transformation can take place at a significant amount instead of martensitic transformation. Thus, the risk is that heterogeneous structure appears on parts with complex shape where some locations are much more deformed than others. In this respect, the inventors put into evidence that, on the locations of the parts where the forming strain is higher than 10%, the cooling rate must be increased beyond 50°C/s in order to guarantee full martensitic transformation. The cooling rate is defined as the mean rate between the exit of the heated blank from the furnace, down to 400°C.

But one may also seek to obtain ferrito-bainitic or ferrito-martensitic structures, by a heating at a temperature ranging between Ac1, for example 750°C and Ac3, for example 840°C, followed by an appropriate cooling. According to the level of resistance to be achieved and the thermal treatment applied, one or several of these constituents is/are present in variable proportions.

The modulation of thermal treatment parameters makes it possible to achieve, with a given composition, different levels of hot and cold sheet

resistance according to the thickness sought. For the highest resistance levels, the structure is composed predominantly of martensite.

The steel is particularly suited to the production of structural and anti-intrusion parts.

The invention thus enables one to produce a hot- or cold-rolled steel sheet of a desired thickness, coated, and affording extensive forming possibilities and which, after thermal treatment performed on the finished part, makes it possible to obtain a mechanical resistance in excess of 1000 MPa, a substantial resistance to shocks, fatigue, abrasion and wear, while retaining a good resistance to corrosion as well as a good capacity for welding, painting and gluing.

The present invention will now be further described by way a certain exemplary embodiments which are not intended to be limiting.

EXAMPLES

Example 1 :

In a first example of implementation, a cold rolled steel sheet, 1.9 mm thick, containing by weight: 0.23 % carbon, 1.25% manganese, 0.017% phosphorus, 0.002% sulfur, 0.27% silicon, 0.062% aluminum, 0.021% copper, 0.019% nickel, 0.208% chromium, 0.005% nitrogen, 0.038% titanium, 0.004% boron, 0.003% calcium–has been pre-coated with an aluminum-based alloy with composition 9.3% silicon, 2.8% iron, the remainder being aluminum and unavoidable impurities. According to the conditions of fabrication, namely the settings of the blowing devices on the operating line, sheets of 120m long and 650mm wide with various thickness ranges were produced.

- Sheet A (according to the invention): The thickness t_{p1} and t_{p2} on each side of the sheet was controlled to be within the range (20-33) micrometers, at every location of the two faces of the sheet, both in the longitudinal (or rolling) direction and in the transversal direction. Measurement was performed continuously with thickness gages devices relying on X-Ray emission. At every moment, the spot of measurement of each gage was a circular zone of about 20mm radius. The sheets were afterwards cut into blanks of 1.2 x 0.5m² of overall dimensions.

- Sheet B (reference): On these sheets, the pre-coating thickness had a wider variability since the thickness t_{p1} and t_{p2} on the two sides of the sheet was comprised in the range (30-45) micrometers. Blanks cut out of these sheets exhibit the same pre-coating thickness.

The blanks were then submitted to heating in a furnace at T=920°C. Heating time was 3 min, with 4 mn holding time. The microstructure is then fully austenitic. Blanks were thereafter transferred from the furnace to a stamping press. When the elapsed time between the exit of the blanks from the furnace and the transfer in the stamping press is more 10 seconds, a partial transformation from austenite was susceptible to appear, thus reducing the mechanical resistance of the stamped part.

The blanks were directly cooled afterwards without hot stamping in order to appreciate the eventual remelting of the coating

On series A, no melting of the pre-coating was found. Intermetallic alloying between the pre-coating and the steel substrate occurred completely.

On series B, the pre-coating underwent mainly alloying, but some traces of remelting were found, particularly on the former thicker locations of the pre-coating. This partial remelting of the aluminium pre-coating contributes to the progressive fouling of the rollers in the furnace. The sheets according to the invention do not contribute to this progressive buildup on the rollers.

Example 2 :

i) Conditions according to the invention: In a second example of implementation, a cold rolled steel sheet, 1,2mm thick, 120m long and 650mm wide, with same composition and same pre-coating as in example 1, has been fabricated. The sheets were afterwards cut into blanks which were heated at 920°C for 6mn, this time including the heating phase and the holding time. Heating rate V_c between 20 and 700°C was 10°C/s. The blanks were finally hot stamped and quenched in order to obtain full martensitic structures.

The parts obtained after hot-stamping are covered by a coating, 40 micrometers thick, illustrated at figure 1, which has a four layer structure. Starting from the steel substrate, the layers are the following:

- (a) Interdiffusion layer or intermetallic layer, 17 micrometers thick. This layer is itself composed of two sub-layers. Hardness HV50g ranges from 295 to 407, and the mean composition is: 90%Fe, 7%Al, 3%Si.
- (b) Intermediate layer, appearing darker, 8 micrometers thick. This layer has a hardness of 940HV50g and a mean composition, by weight : 43%Fe, 57%Al, 1%Si.
- (c) Intermetallic layer appearing as a pale phase, 8 micrometers thick, displaying a hardness of 610HV50g, a mean composition of 65%Fe, 31%Al, 4%Si
- (d) Darker superficial layer, 7 micrometers thick, 950 HV50g, with a mean composition of 45%Fe, 54%Al, 1%Si

Layers (c) and (d) are quasi-continuous, i.e. occupying at least 90% of the level corresponding to the considered layer. In particular, layer (c) does not reach the extreme surface except very exceptionally. Anyway, this layer (c) occupies less than 10% of the extreme surface.

ii) Conditions of reference: On the other hand, blanks with the same base material and pre-coating parts were furnace-heated in different conditions: The blanks were heated to 950°C for 7 minutes, this time including the heating phase. Heating rate V_c was 11°C/s. These conditions correspond to a degree of alloying which is more important than in conditions (i)

- In this coating, the pale intermetallic layer (c), is not continuous and appears as to be scattered within the coating. About 50% of this layer is present at the extreme surface of the part. Moreover, the interdiffusion layer, 10 micrometers thick in contact with the steel substrate is thinner than in the previous case of figure 1.

Resistance spot welding was performed in the two situations i) and ii):

- (i): Coating with quasi-continuous layers (c) and (d), layer (c) occupying less than 10% of the extreme surface
- (ii) : Coating with mixed and discontinuous layers, layer (c) occupying more than 10% of the extreme surface

Resistance spot welding was performed by superposing two parts and joining them in the following conditions:

- Squeeze force and welding force : 4000 N
- Squeeze time: 50 periods
- Welding and holding time: 18 periods respectively

In each condition, the suitable intensity range was determined for obtaining:

- No sputter during welding
- Acceptable nugget size.

For the condition i), the weldability range, expressed in terms of current intensity, is 1,4kA. For the condition ii) the weldability range is extremely small.

Thus, it may be seen that the coating according to the invention, yields much more satisfactory results.

Example 3 :

In a third example of implementation, a cold rolled steel sheet of the example 1 was cut into blanks of 500x500mm² which were heated at 920°C, during 6mn, then hot stamped and cooled in tools, in such conditions that two different cooling rates were obtained :

- (A): Cooling rate: V_A= 30°C/s
- (B) : Cooling rate: V_B = 60°C/s

Due to the shape of he parts, different deformation levels ε were created during hot stamping. In particular, some zones largely strained display deformation levels higher than 30%.

- As illustrated on figure 3, metallographic observations reveal that when ε >10%, partial bainitic or ferritic transformation occurs on parts cooled with V_A= 30°C/s, mainly on former austenitic grain boundaries. On the other hand, the parts cooled with V_B= 60°C/s display fully martensitic microstructure as illustrated on figure 4. The latter structures display superior mechanic resistance and a great homogeneity in the case of mechanical solicitation.

Thus, even in products or parts where straining is larger than 10%, the application of cooling according to the invention guarantees a microstructural and mechanical homogeneity.

Example 4:

In a fourth example of implementation, steel castings containing different values of sulfur, were elaborated. These steels were further hot rolled, then cold rolled steel into sheets, 2,2mm thick. Sulfur content varies from 11ppm (0,0011%) to 59ppm (0,006%) in weight. Apart sulfur, the compositions of these different steel castings comprise in weight:

0,24% carbon, 1,17% manganese, 0,01% phosphorus, 0,25% silicon, 0,045% aluminum, 0,01% copper, 0,02% nickel, 0,2% chromium, 0,04% titanium, 0,003% boron, 0,002% calcium, the remainder being iron and unavoidable impurities.

These sheets were pre-coated with an aluminum-based alloy of composition comprising 9,3% silicon, 2.8% iron, the remainder being aluminum and unavoidable impurities.

The sheets were afterwards cut into blanks which were heated at 950°C for 5mn, then hot stamped and cooled in tools in order to obtain a full martensitic structure. Mechanical resistance exceeded 1450 MPa.

Specimens were extracted according to the transverse sense of rolling direction and submitted to a bending test with alternate bending modes. The inventors put into evidence that the critical bending angle (angle at fracture) is closely related to the sulfur content of the steel: when sulfur content is lower than 0,002%, the bending angle exceeds 60°, which indicates higher ductility and energy absorption.

Compact Tensile-Test type specimens were also extracted according to the transverse rolling direction in order to measure the resistance to tearing, i.e. the energy which is necessary for the initiation or propagation of an existing crack. The results, illustrated on figure 6, indicate that a initiation energy higher than 18 Joules is achieved when sulfur content is lower than 0,002% in weight.

As these qualities of high resistance, high energy absorption and weldability are required in automobile industry, the parts or products fabricated according to the invention will be used with profit for such applications.

While the above description is clear with regard to the understanding of the invention, the following terms as used in the following list of preferred embodiments and claims have the following noted meanings in order to avoid any confusion:

pre-coating – the material (Al or Al alloy) coated on or located on at least a portion of the strip or sheet, etc., of base steel to form a pre-coating/base composite, the composite not having been subjected to an alliation reaction between the coated Al or Al alloy material and base steel

alliation – a reaction between the pre-coating and base steel, to produce at least one intermediate layer different in composition from both the base steel and the pre-coating. The alliation reaction happens during the heat treatment immediately preceding hot stamping . The alliation reaction affects the total thickness of the pre-coating. In a highly preferred embodiment the alliation reaction forms the following layers: (a) interdiffusion, (b) intermediate, (c) intermetallic, and (d) superficial as described above;

pre-coated steel - the pre-coating/base composite, not having been subjected to an alliation reaction between the coated material and base steel;

coating – the pre-coating after having been subjected to an alliation reaction between the pre-coating and base steel. In a highly preferred embodiment the coating comprises layers (a) interdiffusion, (b) intermediate, (c) intermetallic, and (d) superficial described above;

coated steel or product - the pre-coated steel or product that has been subjected to an alliation reaction between the pre-coating and base steel. In a highly preferred embodiment the coated steel is a strip or sheet, etc., of base steel having thereon an invention coating comprising layers (a) interdiffusion, (b) intermediate, (c) intermetallic, and (d) superficial described above;

blank – a shape cut from a strip.

product – a stamped blank

Thus, the present invention provides, among other things, the following preferred embodiments:

1. A pre-coated steel strip, comprising:

(a) a strip of base steel having a length, a width, a first side, and a second side;

(b) said length of said strip of base steel being at least 100m and said width being at least 600mm, and

(c) an aluminum or an aluminum alloy pre-coating on at least part of one of said first and second sides of said strip of base steel, wherein

(i) the thickness t_p of the said pre-coating is from 20 - 33 micrometers at every location on at least one of said first and second sides.

2. A method for making a pre-coated steel strip according to embodiment 1 wherein the pre-coated steel strip has a thickness of not greater than 3 mm.

3. A process for making a hot stamped coated steel sheet product, comprising:

(A) heating an aluminum- or aluminum alloy pre-coated steel sheet in a furnace preheated to a temperature and during a time defined by diagram ABCD of figure 7 if thickness of said sheet is greater than or equal to 0.7mm and less than or equal to 1.5mm, and by diagram EFGH of figure 7 if thickness of said sheet is greater than 1.5mm and less than or equal to 3mm, at a heating rate V_c between 20 and 700°C comprised between 4 and 12°C/s, to obtain a heated blank;

(B) transferring said heated blank to a die; and

(C) stamping said heated blank in said die, to thereby obtain a hot stamped steel sheet product, and

wherein the said heated product is cooled at a rate of at least 30°C/s.

4. A process for making a hot stamped coated steel sheet product, comprising:

(A) providing a heated blank according to embodiment 3; and

(B) transferring said heated blank to a die; and

(C) stamping said heated blank in said die, to thereby obtain a hot stamped steel sheet product,
wherein the elapsed time between said heated blank exits said furnace and said stamping commences is not more than 10 seconds, and
wherein said heated blank is deformed by a quantity higher than 10% during said stamping and the said heated product is cooled at a rate of at least 50°C/s.

5. A process for making a hot stamped coated steel sheet product, comprising :
hot dip pre-coating a steel strip having a first side and a second side with aluminum or aluminum alloy to obtain a pre-coated steel strip, the pre-coating thickness on at least one of said first side and said second side of said strip having a thickness of from 20 to 33 µm at every location on at least one of said first and second sides of said strip;
cutting said pre-coated steel strip to obtain a sheet;
heating the sheet in a pre-heated furnace to obtain a heated blank in which the steel is austenitic;
transferring said heated blank to a die while maintaining said steel in the austenitic phase; and
stamping said heated blank in a die to obtain a hot stamped steel sheet product in which the steel microstructure is martensitic.

6. A hot stamped coated steel sheet product, which is prepared by a process comprising :
(A) providing a pre-coated strip according to embodiment 1, said strip being pre-coated with aluminum or aluminum alloy
(B) Cutting said pre-coated steel strip to a predetermined size and shape to obtain a sheet
(C) heating said steel sheet in a furnace preheated to a temperature and during a time defined by diagram ABCD of figure 7 if thickness of said product is greater than or equal to 0.7mm and less than or equal to 1.5mm, and by diagram EFGH of figure 7 if thickness of said product is

greater than 1.5mm and less than or equal to 3mm, to obtain a heated blank;

(D) transferring said heated blank to a die; and

(E) stamping said heated blank in said die, to thereby obtain a hot stamped steel sheet product,

wherein the elapsed time between said heated blank exits said furnace and said stamping commences is not more than 10 seconds, and

wherein said heated product cools at a rate higher than 30°C/s during said stamping.

7 A process for making a hot stamped coated steel sheet product, comprising:

(A) providing a heated blank according to embodiment 6

(B) transferring said heated blank to a die; and

(C) stamping said heated blank in said die, to thereby obtain a hot stamped steel sheet product,

wherein the elapsed time between said heated blank exits said furnace and said stamping commences is not more than 10 seconds, and

wherein said heated product cools at such a rate during said stamping that the steel microstructure is martensitic.

8. The pre-coated steel strip according to embodiment 1, wherein the base steel comprises the following components by weight based on total weight:

0.15%<carbon<0.5%

0.5%<manganese<3%

0.1%<silicon<0.5%

0.01%<chromium<1%

titanium<0.2%

aluminum<0.1%

phosphorus<0.1%

sulfur<0.05%

0.0005%<boron<0.08%,

and further comprises iron and impurities inherent in processing.

9 The pre-coated steel strip according to embodiment 8, wherein the base steel comprises the following components by weight based on total weight:

0.20%<carbon<0.5%
0.8%<manganese<1.5%
0.1%<silicon<0.35%
0.01%<chromium<1%
titanium<0.1%
aluminum<0.1%
phosphorus<0.05%
sulfur<0.03%
0.0005%<boron<0.01%,

and further comprises iron and impurities inherent in processing.

10 The pre-coated steel strip according to embodiment 8 or 9, wherein the base steel comprises 20 ppm or less of sulfur.

11. The pre-coated steel strip according to any of embodiments 8 to 10, wherein the ratio of titanium to nitrogen in the steel sheet in weight % is in excess of 3.42.

12. The pre-coated steel strip according to any of the embodiments 1 or 8 to 11, wherein the aluminum or aluminum alloy pre-coating comprises from 8% to 11% silicon by weight, from 2% to 4% iron by weight, the remainder being aluminum and impurities inherent in processing.

13. A coated steel stamped product, which comprises:
(a) a strip of base steel having a first side and a second side; and
(b) a coating on at least one of said first side of said strip of base steel and said second side of said strip of base steel,
wherein:,

(i) said coating results from the interdiffusion between said base steel, and aluminium or aluminium alloy pre-coating,
(ii) said coating comprises, proceeding from base steel outwards,
- (a) Interdiffusion layer
- (b) Intermediate layer
- (c) Intermetallic layer
- (d) Superficial layer

14. A coated steel stamped product according to embodiment 13, wherein said coating has a thickness greater than 30 micrometers

15. A coated steel stamped product according to embodiments 13 or 14, wherein said layer (a) has a thickness less than 15 micrometers

16. A coated steel stamped product according to any of the embodiments 13 to 15,
wherein the said layers (c) and (d) are occupying at least 90% of the level corresponding to the considered said layers and wherein less than 10% of layer (c) is present at the extreme surface of the product

17. A coated steel stamped product according to any of the embodiments 13 to 16, wherein the steel in the strip has a composition according to embodiment 8

18. A coated steel stamped product according to any of the embodiments 13 to 16, wherein the steel in the strip has a composition according to embodiment 9

19. A coated steel stamped product according to any of the embodiments 13 to 18, wherein the steel has a composition according to embodiment 10

20. A coated steel stamped product according to any of the embodiments 13 to 19, wherein the steel has a composition according to embodiment 11

21. A coated steel stamped product according to any of the embodiments 13 to 20, the aluminum or aluminum alloy pre-coating comprises from 8% to 11% silicon by weight, from 2% to 4% iron by weight, the remainder being aluminum and impurities inherent in processing.

22. A land motor vehicle comprising the heat treated coated steel product according to any of the embodiments 6, 13 to 21

23. A land motor vehicle comprising the heat treated coated steel product produced according to any of the embodiments 3, 4, 5, 7

The above written description of the invention provides a manner and process of making and using it such that any person skilled in this art is enabled to make and use the same, this enablement being provided in particular for the subject matter of the appended claims, which make up a part of the original description. As used above, the phrases "selected from the group consisting of," "chosen from," and the like include mixtures of the specified materials. Terms such as "contain(s)" and the like as used herein are open terms meaning 'including at least' unless otherwise specifically noted. All references, patents, applications, tests, standards, documents, publications, brochures, texts, articles, etc. mentioned herein are incorporated herein by reference. Where a numerical limit or range is stated, the endpoints are included. Also, all values and subranges within a numerical limit or range are specifically included as if explicitly written out. The above description is presented to enable a person skilled in the art to make and use the invention, and is provided in the context of a particular application and its requirements. Various modifications to the preferred embodiments will be readily apparent to those skilled in the art, and the generic principles defined herein may be applied to other embodiments and applications without departing from the spirit and scope of the invention. Thus, this invention is not intended to be limited to the embodiments shown, but is to be accorded the widest scope consistent with the principles and features disclosed herein.

CLAIMS

1. A pre-coated steel strip, comprising:

(a) a strip of base steel having a length, a width, a first side, and a second side;

(b) said length of said strip of base steel being at least 100m and said width being at least 600mm, and

(c) an aluminum or an aluminum alloy pre-coating on at least part of one of said first and second sides of said strip of base steel, wherein

(i) the thickness t_p of the said pre-coating is from 20 - 33 micrometers at every location on at least one of said first and second sides.

2. A method for making a pre-coated steel strip according to claim 1 wherein the pre-coated steel strip has a thickness of not greater than 3 mm.

3. A process for making a hot stamped coated steel sheet product, comprising:

(A) heating an aluminum- or aluminum alloy pre-coated steel sheet in a furnace preheated to a temperature and during a time defined by diagram ABCD of figure 7 if thickness of said sheet is greater than or equal to 0.7mm and less than or equal to 1.5mm, and by diagram EFGH of figure 7 if thickness of said sheet is greater than 1.5mm and less than or equal to 3mm, at a heating rate V_c between 20 and 700°C comprised between 4 and 12°C/s, to obtain a heated blank;

(B) transferring said heated blank to a die; and

(C) stamping said heated blank in said die, to thereby obtain a hot stamped steel sheet product, and

wherein the said heated product is cooled at a rate of at least 30°C/s.

4. A process for making a hot stamped coated steel sheet product, comprising:

(A) providing a heated blank according to claim 3; and

(B) transferring said heated blank to a die; and

(C) stamping said heated blank in said die, to thereby obtain a hot stamped steel sheet product,

wherein the elapsed time between said heated blank exits said furnace and said stamping commences is not more than 10 seconds, and

wherein said heated blank is deformed by a quantity higher than 10% during said stamping and the said heated product is cooled at a rate of at least 50°C/s.

5. A process for making a hot stamped coated steel sheet product, comprising :

hot dip pre-coating a steel strip having a first side and a second side with aluminum or aluminum alloy to obtain a pre-coated steel strip, the pre-coating thickness on at least one of said first side and said second side of said strip having a thickness of from 20 to 33 µm at every location on at least one of said first and second sides of said strip;

cutting said pre-coated steel strip to obtain a sheet;

heating the sheet in a pre-heated furnace to obtain a heated blank in which the steel is austenitic;

transferring said heated blank to a die while maintaining said steel in the austenitic phase; and

stamping said heated blank in a die to obtain a hot stamped steel sheet product in which the steel microstructure is martensitic.

6. A hot stamped coated steel sheet product, which is prepared by a process comprising :

(A) providing a pre-coated strip according to claim 1, said strip being pre-coated with aluminum or aluminum alloy

(B) Cutting said pre-coated steel strip to a predetermined size and shape to obtain a sheet

(C) heating said steel sheet in a furnace preheated to a temperature and during a time defined by diagram ABCD of figure 7 if thickness of said product is greater than or equal to 0.7mm and less than or equal to

1.5mm, and by diagram EFGH of figure 7 if thickness of said product is greater than 1.5mm and less than or equal to 3mm, to obtain a heated blank;

(D) transferring said heated blank to a die; and

(E) stamping said heated blank in said die, to thereby obtain a hot stamped steel sheet product,

wherein the elapsed time between said heated blank exits said furnace and said stamping commences is not more than 10 seconds, and

wherein said heated product cools at a rate higher than 30°C/s during said stamping.

7 A process for making a hot stamped coated steel sheet product, comprising:

(A) providing a heated blank according to claim 6

(B) transferring said heated blank to a die; and

(C) stamping said heated blank in said die, to thereby obtain a hot stamped steel sheet product,

wherein the elapsed time between said heated blank exits said furnace and said stamping commences is not more than 10 seconds, and

wherein said heated product cools at such a rate during said stamping that the steel microstructure is martensitic.

8. The pre-coated steel strip according to claim 1, wherein the base steel comprises the following components by weight based on total weight:

0.15%<carbon<0.5%

0.5%<manganese<3%

0.1%<silicon<0.5%

0.01%<chromium<1%

titanium<0.2%

aluminum<0.1%

phosphorus<0.1%

sulfur<0.05%

0.0005%<boron<0.08%,

and further comprises iron and impurities inherent in processing.

9 The pre-coated steel strip according to claim 8, wherein the base steel comprises the following components by weight based on total weight:

0.20%<carbon<0.5%
0.8%<manganese<1.5%
0.1%<silicon<0.35%
0.01%<chromium<1%
titanium<0.1%
aluminum<0.1%
phosphorus<0.05%
sulfur<0.03%
0.0005%<boron<0.01%,

and further comprises iron and impurities inherent in processing.

10 The pre-coated steel strip according to claim 8 or 9, wherein the base steel comprises 20 ppm or less of sulfur.

11. The pre-coated steel strip according to any of claims 8 to 10, wherein the ratio of titanium to nitrogen in the steel sheet in weight % is in excess of 3.42.

12. The pre-coated steel strip according to any of the claims 1 or 8 to 11, wherein the aluminum or aluminum alloy pre-coating comprises from 8% to 11% silicon by weight, from 2% to 4% iron by weight, the remainder being aluminum and impurities inherent in processing.

13. A coated steel stamped product, which comprises:
(a) a strip of base steel having a first side and a second side; and
(b) a coating on at least one of said first side of said strip of base steel and said second side of said strip of base steel,
wherein:,

(i) said coating results from the interdiffusion between said base steel, and aluminium or aluminium alloy pre-coating,
(ii) said coating comprises, proceeding from base steel outwards,
- (a) Interdiffusion layer
- (b) Intermediate layer
- (c) Intermetallic layer
- (d) Superficial layer

14. A coated steel stamped product according to claim 13, wherein said coating has a thickness greater than 30 micrometers

15. A coated steel stamped product according to claims 13 or 14, wherein said layer (a) has a thickness less than 15 micrometers

16. A coated steel stamped product according to any of the claims 13 to 15, wherein the said layers (c) and (d) are occupying at least 90% of the level corresponding to the considered said layers and wherein less than 10% of layer (c) is present at the extreme surface of the product

17. A coated steel stamped product according to any of the claims 13 to 16, wherein the steel in the strip has a composition according to claim 8

18. A coated steel stamped product according to any of the claims 13 to 16, wherein the steel in the strip has a composition according to claim 9

19. A coated steel stamped product according to any of the claims 13 to 18, wherein the steel has a composition according to claim 10

20. A coated steel stamped product according to any of the claims 13 to 19, wherein the steel has a composition according to claim 11

21. A coated steel stamped product according to any of the claims 13 to 20, the aluminum or aluminum alloy pre-coating comprises from 8% to 11%

silicon by weight, from 2% to 4% iron by weight, the remainder being aluminum and impurities inherent in processing.

22. A land motor vehicle comprising the heat treated coated steel product according to any of the claims 6, 13 to 21

23. A land motor vehicle comprising the heat treated coated steel product produced according to any of the claims 3, 4, 5, 7

(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

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(21) International Application Number:
PCT/IB2006/004019

(22) International Filing Date: 30 October 2006 (30.10.2006)

(25) Filing Language: English

(26) Publication Language: English

(71) Applicant *(for all designated States except US)*: **ARCELOR FRANCE** [FR/FR]; Arcelor Research Intellectual Property, 1-5 rue Luigi Cherubini, F-93212 Saint Denis (FR).

(72) Inventors; and

(75) Inventors/Applicants *(for US only)*: **DRILLET, Pascal** [FR/FR]; 9 chemin de Banauvignes, F-57160 Rozerieulles (FR). **SPEHNER, Dominique** [FR/FR]; 72 avenue Philippoteaux, F-08200 Sedan (FR). **KEFFERSTEIN, Ronald** [FR/FR]; Résidence La Brise-La Falaise n°2, F-13620 Carry Le Rouet (FR).

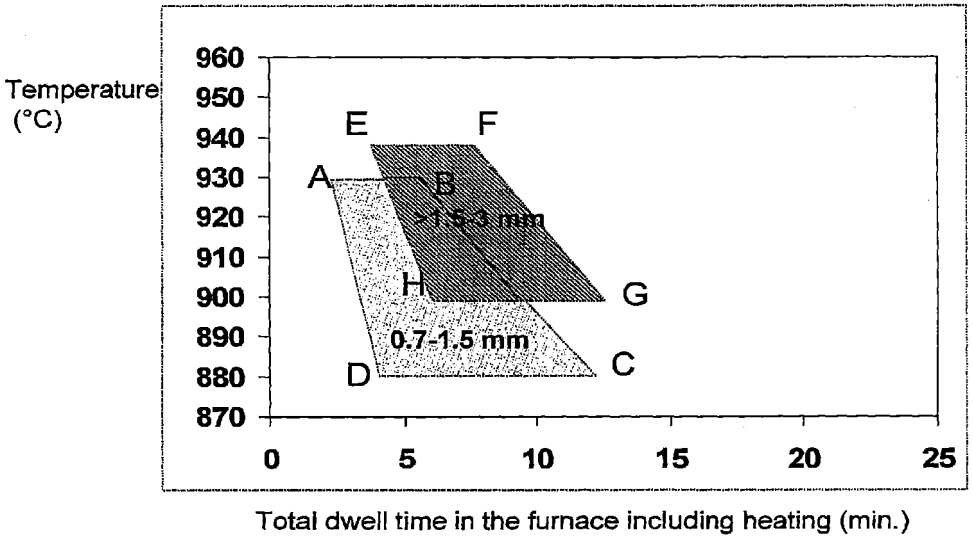
(74) Agent: **PLAISANT, Sophie**; Arcelor France, Arcelor Research Intellectual Property, 1-5 rue Luigi Cherubini, F-93200 Saint Denis (FR).

(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BW, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LV, LY, MA, MD, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RS, RU, SC, SD, SE, SG, SK, SL, SM, SV, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IS, IT, LT, LU, LV, MC, NL, PL, PT, RO, SE, SI, SK, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Published:
— *with international search report*

(54) Title: COATED STEEL STRIPS, METHODS OF MAKING THE SAME, METHODS OF USING THE SAME, STAMPING BLANKS PREPARED FROM THE SAME, STAMPED PRODUCTS PREPARED FROM THE SAME, AND ARTICLES OF MANUFACTURE WHICH CONTAIN SUCH A STAMPED PRODUCT



(57) Abstract: Coated steel having a well defined and uniform thickness is useful and advantageous for preparing products by hot stamping. Products prepared by hot stamping such a steel are particularly advantageous when subjected to a subsequent spot welding step.

WO 2008/053273 A1


(d) Superficial layer
(c) Al-rich Intermetallic layer
(b) Intermediate layer
(a) Interdiffusion layer
Steel substrate
EHT=15.00 kV
WD= 24 mm
Grand.= 500 X
10µm
Photo N°=5642
Détecteur= QBSD
10µm

Fig. 1

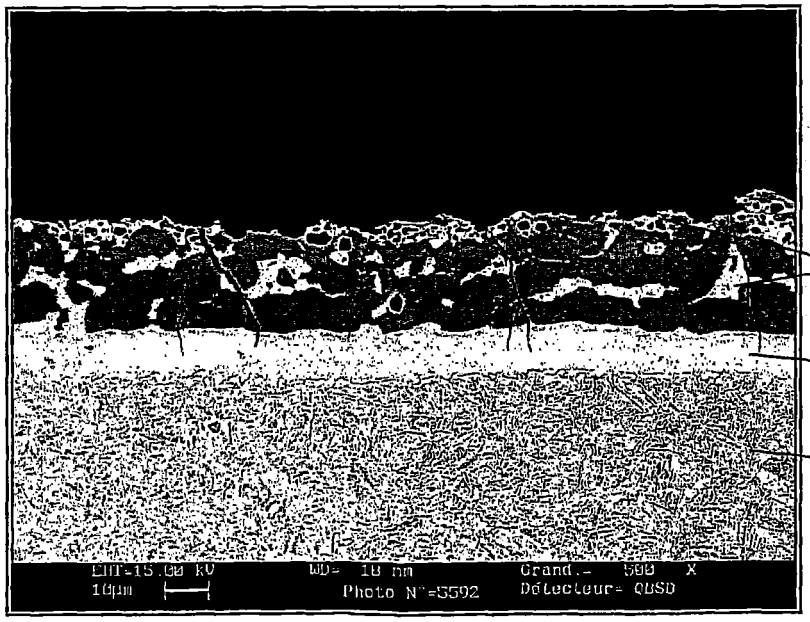

Al-rich Intermetallic layer
Interdiffusion layer
Steel substrate
EHT=15.00 kV
WD= 18 mm
Grand.= 500 X
10µm
Photo N°=5592
Détecteur= QUSD
10µm

Fig.2

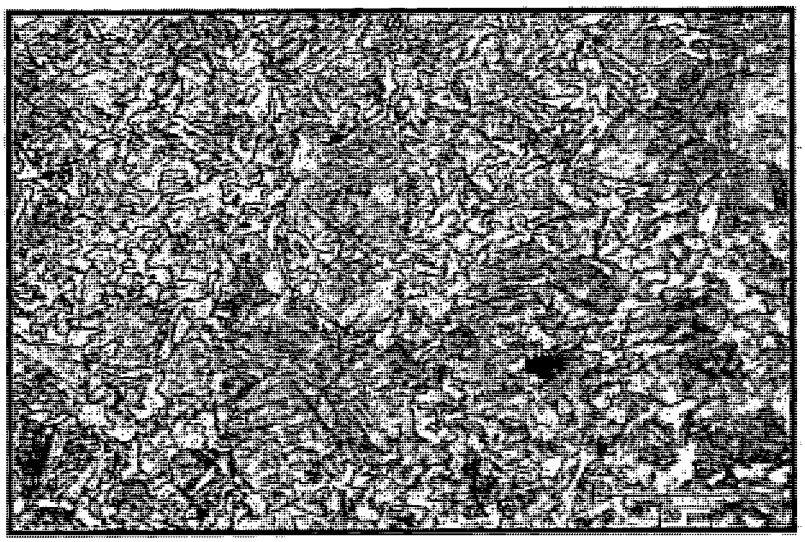


Fig. 3

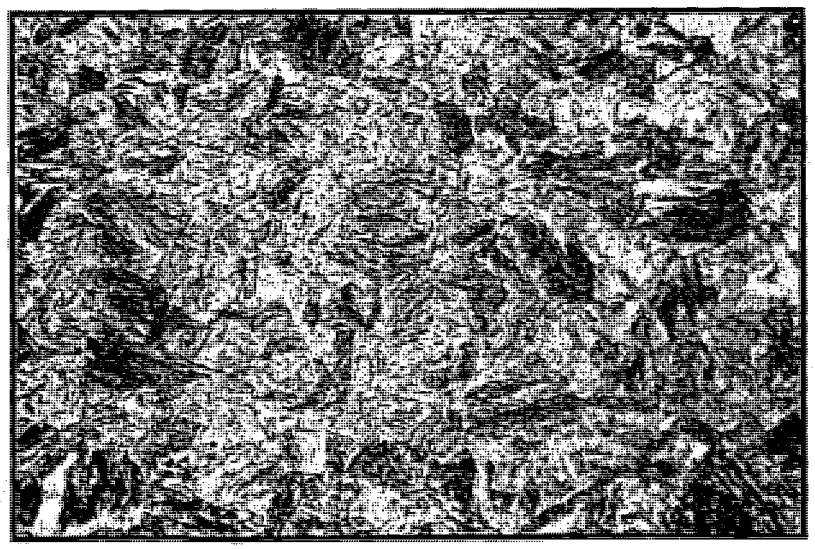


Fig. 4

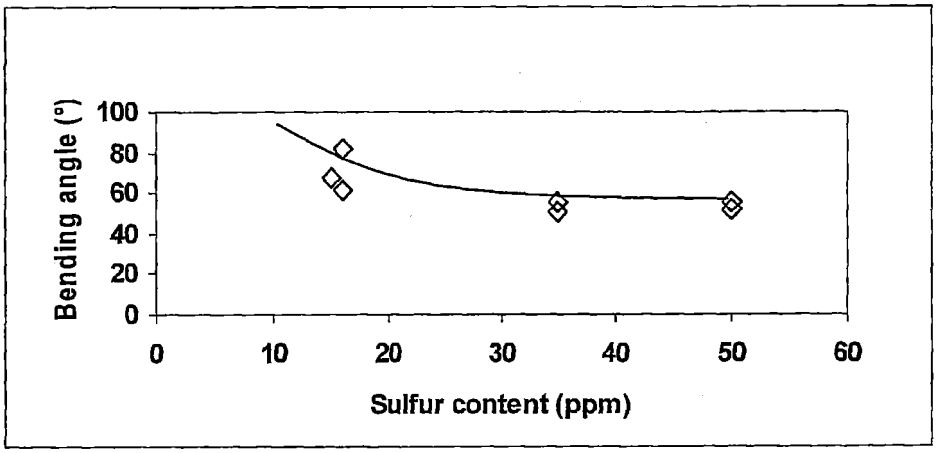

Bending angle (°)
100
80
60
40
20
0
0
10
20
30
40
50
60
Sulfur content (ppm)

Fig. 5

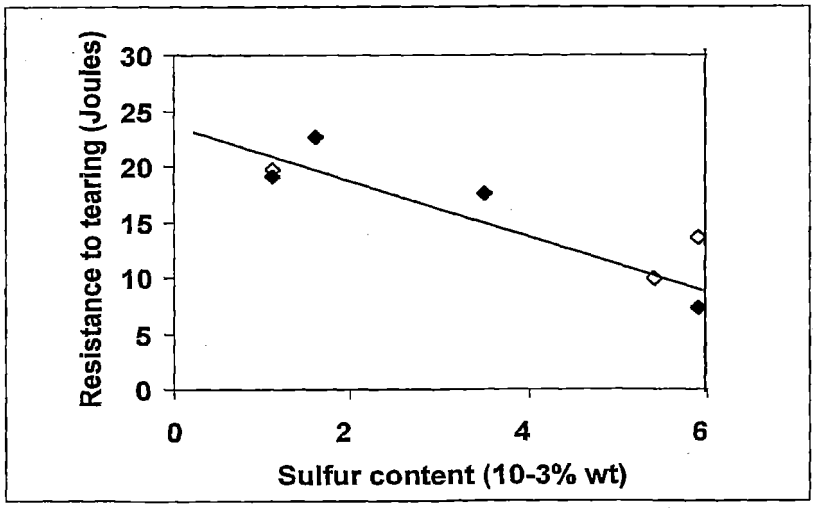

Resistance to tearing (Joules)
30
25
20
15
10
5
0
0
2
4
6
Sulfur content (10-3% wt)

Fig. 6

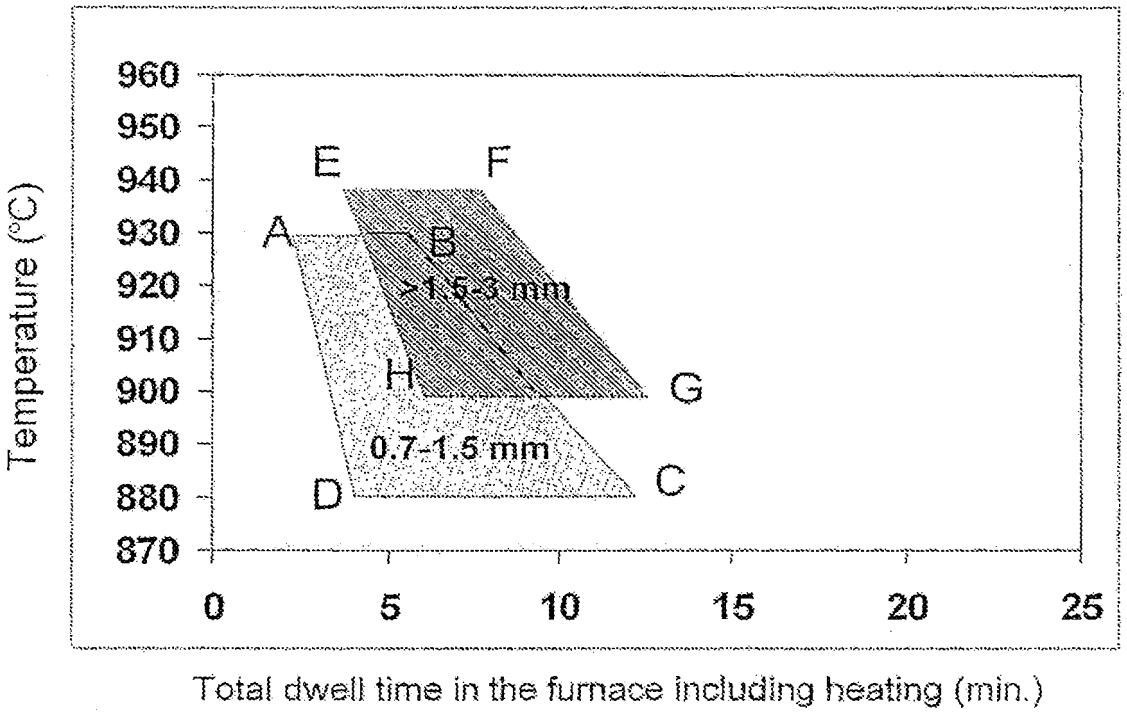

960
950
940
930
920
910
900
890
880
870
Temperature (°C)
0
5
10
15
20
25
Total dwell time in the furnace including heating (min.)
A
B
C
D
E
F
G
H
>1.5-3 mm
0.7-1.5 mm

Fig. 7

DOCKET NO: 404951US99DIV

IN THE UNITED STATES PATENT & TRADEMARK OFFICE

IN RE APPLICATION OF	:	
PASCAL DRILLET, ET AL.	:	ATTN: APPLICATION DIVISION
SERIAL NO: NEW U.S. APPLICATION	:	
FILED: HEREWITH	:	
FOR: COATED STEEL STRIPS, METHODS OF MAKING THE SAME, METHODS OF USING THE SAME, STAMPING BLANKS PREPARED FROM THE SAME, STAMPED PRODUCTS PREPARED FROM THE SAME, AND ARTICLES OF MANUFACTURE WHICH CONTAIN SUCH A STAMPED PRODUCT	:	

PRELIMINARY AMENDMENT

COMMISSIONER FOR PATENTS
ALEXANDRIA, VIRGINIA 22313

Commissioner:

Prior to examination on the merits, please amend the above-identified application as follows:

Amendments to the Specification begin on page 2 of this paper.

Amendments to the Claims are reflected in the listing of claims which begins on page 3 of this paper.

Remarks/Arguments begin on page 6 of this paper.

IN THE SPECIFICATION

Please insert this paragraph before the Title of The Invention at page 1, line 1, as follows:

This application is a divisional of U.S. Serial No. 12/447,777 filed March 18, 2011, allowed, which is a 371 application of PCT/IB06/04019 filed October 30, 2006. The contents of each of these applications are incorporated herein by reference in their entirety.

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IN THE CLAIMS

Please cancel Claims 1-23 and insert the following:

Claim 24 (New): A coated steel stamped product, which comprises:

(a) a strip of base steel having a first side and a second side; and

(b) a coating on at least one of said first side of said strip of base steel and said second side of said strip of base steel,

wherein:

(i) said coating results from the interdiffusion between said base steel, and aluminium or aluminium alloy pre-coating, and

(ii) wherein said coating comprises, proceeding from the base steel outwards:

(a) an Interdiffusion layer,

(b) an Intermediate layer,

(c) an Intermetallic layer, and

(d) a Superficial layer,

wherein said coating has a thickness greater than 30 micrometers and wherein said layer (a) has a thickness less than 15 micrometers.

Claim 25 (New): The coated steel stamped product according to claim 24, wherein the said layers (c) and (d) are quasi continuous by occupying at least 90 % of a level corresponding to each said layer and wherein less than 10 % of layer (c) is present at an extreme surface of the product.

Claim 26 (New): The coated steel stamped product according to claim 24, wherein the steel in the strip comprises the following components by weight based on total weight:

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0.15 %<carbon<0.5 %;

0.5 %<manganese<3 %;

0.1 %<silicon<0.5 %;

0.01 %<chromium<1 %;

titanium<0.2 %;

aluminum<0.1 %;

phosphorus<0.1 %;

sulfur<0.05 %;

0.0005 %<boron<0.08 %;

and further comprises iron and impurities inherent in processing.

Claim 27 (New): A coated steel stamped product according to claim 24, wherein the steel in the strip comprises the following components by weight based on total weight:

0.20 %<carbon<0.5 %;

0.8 %<manganese<1.5 %;

0.1 %<silicon<0.35 %;

0.01 %<chromium<1 %;

titanium<0.1 %;

aluminum<0.1 %;

phosphorus<0.05 %;

sulfur<0.03 %;

0.0005 %<boron<0.01 %;

and further comprises iron and impurities inherent in processing.

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Claim 28 (New): The coated steel stamped product according to claim 24, wherein the base steel comprises 20 ppm or less of sulfur.

Claim 29 (New): The coated steel stamped product according to claim 24, wherein the ratio of titanium to nitrogen in the base steel in weight % is in excess of 3.42.

Claim 30 (New): The coated steel stamped product according to claim 24, wherein the aluminum or aluminum alloy pre-coating comprises from 8 % to 11 % silicon by weight, from 2 % to 4 % iron by weight, the remainder being aluminum and impurities inherent in processing.

Claim 31 (New): A land motor vehicle comprising the heat treated coated steel product according to claim 24.

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REMARKS/ARGUMENTS

Favorable consideration of this application, as presently amended, is respectfully requested.

By the present preliminary amendment new dependent claims 1-23 are canceled and new claims 24-31 are presented for examination. Support for the new claims is found in at least the canceled claims 1-23. No new matter is believed to be added.

The present application is believed to be in condition for a full and thorough examination on the merits. An early and favorable consideration of the present application is hereby respectfully requested.

Respectfully Submitted,

OBLON, SPIVAK, McCLELLAND,
MAIER & NEUSTADT, L.L.P.

Andrew M. Ollis

Andrew M. Ollis
Attorney of Record
Registration No. 40,749

Customer Number
22850

Tel. (703) 413-3000
Fax. (703) 413-2220
(OSMMN 10/09)

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Page 50 of 624

Docket No. 341082US0PCT

Declaration, Power of Attorney and Petition

WE (I) the undersigned inventor(s), hereby declare(s) that:

My residence, post office address and citizenship are as stated below next to my name,

We (I) believe that we are (I am) the original, first and joint (sole) inventor(s) of the subject matter which is claimed and for which a patent is sought on the invention entitled

COATED STEEL STRIPS, METHODS OF MAKING THE SAME, METHODS OF USING THE SAME, STAMPING BLANKS PREPARED FROM THE SAME, STAMPED PRODUCTS PREPARED FROM THE SAME, AND ARTICLES OF MANUFACTURE WHICH CONTAIN SUCH A STAMPED PRODUCT

the specification of which

☐ is attached hereto.

☐ was filed on _____ as

Application Serial No. _____

and amended on _____.

☒ was filed as PCT international application

Number PCT/IB06/004019

on October 30, 2006,

and was amended under PCT Article 19

on _____ (if applicable).

We (I) hereby state that we (I) have reviewed and understand the contents of the above-identified specification, including the claims, as amended by any amendment referred to above.

We (I) acknowledge the duty to disclose information known to be material to the patentability of this application as defined in Section 1.56 of Title 37 Code of Federal Regulations, including for continuation-in-part applications, material information which became available between the filing date of the prior application and the national or PCT International filing date of the continuation-in-part application.

We (I) hereby claim foreign priority benefits under 35 U.S.C. §119(a)-(d) or §365(b) of any foreign application(s) for patent or inventor's certificate, or §365(a) of any PCT International application which designated at least one country other than the United States, listed below and have also identified below, by checking the box, any foreign application for patent or inventor's certificate, or PCT International application having a filing date before that of the application on which priority is claimed. Prior Foreign Application(s)

Application No.	Country	Day/Month/Year	Priority Claimed
_____	_____	_____	☐ Yes ☐ No
_____	_____	_____	☐ Yes ☐ No

We (I) hereby claim the benefit under Title 35, United States Code, §119(e) of any United States provisional application(s) listed below.

(Application Number)	(Filing Date)
(Application Number)	(Filing Date)

We (I) hereby claim the benefit under 35 U.S.C. §120 of any United States application(s), or under §365(c) of any PCT International application designating the United States, listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States or PCT International application in the manner provided by the first paragraph of 35 U.S.C. §112, I acknowledge the duty to disclose information which is material to patentability as defined in 37 CFR §1.56 which became available between the filing date of the prior application and the national or PCT International filing date of this application.

Application Serial No.	**Filing Date**	**Status (pending, patented, abandoned)**
PCT/IB06/04019	October 30, 2006	

And we (I) hereby appoint the following registered practitioner(s):

The Practitioners Associated With Customer Number

22850

as our (my) attorneys, with full powers of substitution and revocation, to prosecute this application and to transact all business in the Patent Office connected therewith; and we (I) hereby request that all correspondence regarding this application be sent to

The Address Associated With Customer Number

22850

We (I) declare that all statements made herein of our (my) own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issuing thereon.

Pascal DRILLET
NAME OF FIRST OR SOLE INVENTOR

Residence: Rozerieulles, France

Pascal DRILLET
Signature of Inventor

Citizen of: France

Mailing Address: 9 Chemin de Banauvignes,
Rozerieulles, France

Date 28th of April 09

ArcelorMittal Ex. 2017
Page 52 of 624

Dominique SPEHNER
NAME OF SECOND JOINT INVENTOR

Residence: Balan, France

Signature of Inventor

Citizen of: France

Mailing Address: 8 rue de la Porte, Balan, 08200, France

Date

Ronald KEFFERSTEIN
NAME OF THIRD JOINT INVENTOR

Residence: Saint Mitre Les Ramparts, France

Signature of Inventor

Citizen of: France

Mailing Address: 2 rue des Rocaledes, Saint Mitre Les Ramparts, 13920 France

Date

(OSMMN 09/2005)

ArcelorMittal Ex. 2017
Page 53 of 624

Docket No. 341082US0PCT

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_____	_____	_____	☐ Yes ☐ No

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Pascal DRILLET
NAME OF FIRST OR SOLE INVENTOR

Residence: Rozerieulles, France

Signature of Inventor

Citizen of: France

Mailing Address: 9 Chemin de Banauvignes, Rozerieulles, France

Date

ArcelorMittal Ex. 2017
Page 55 of 624

Dominique SPEHNER
NAME OF SECOND JOINT INVENTOR

Residence: Balan, France

Citizen of: France

Signature of Inventor
Dominique SPEHNER

Mailing Address: 8 rue de la Porte, Balan, 08200, France

Date 24/04/2009

Ronald KEFFERSTEIN
NAME OF THIRD JOINT INVENTOR

Residence: Saint Mitre Les Ramparts, France

Citizen of: France

Signature of Inventor

Mailing Address: 2 rue des Rocaledes, Saint Mitre Les Ramparts, 13920 France

Date

(OSMMN 09/2005)

ArcelorMittal Ex. 2017
Page 56 of 624

Docket No. 341082US0PCT

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_____	_____	_____	☐ Yes ☐ No
_____	_____	_____	☐ Yes ☐ No

ArcelorMittal Ex. 2017
Page 57 of 624

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Pascal DRILLET
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Rozerieulles, France

Date

ArcelorMittal Ex. 2017
Page 58 of 624

Dominique SPEHNER
NAME OF SECOND JOINT INVENTOR

Signature of Inventor

Date

Residence: Balan, France

Citizen of: France

Mailing Address: 8 rue de la Porte, Balan, 08200, France

Ronald KEFFERSTEIN
NAME OF THIRD JOINT INVENTOR

Signature of Inventor

15/03/2011
Date

Residence: Saint Mitre Les Ramparts, France

Citizen of: France

Mailing Address: 2 rue des Rocaledes, Saint Mitre Les Ramparts, 13920 France

(OSMMN 09/2005)

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Docket No. 404951US99DIV

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

IN RE APPLICATION OF:	Pascal DRILLET, et al.	
SERIAL NO:	New Application	GAU:
FILED:	Herewith	EXAMINER:
FOR:	COATED STEEL STRIPS, METHODS OF MAKING THE SAME, METHODS OF USING THE SAME, STAMPING BLANKS PREPARED FROM THE SAME, STAMPED PRODUCTS PREPARED FROM THE SAME, AND ARTICLES OF MANUFACTURE WHICH CONTAIN SUCH A STAMPED PRODUCT	

INFORMATION DISCLOSURE STATEMENT UNDER 37 CFR 1.97

COMMISSIONER FOR PATENTS
ALEXANDRIA, VIRGINIA 22313

Commissioner:

Applicant(s) wish to disclose the following information.

REFERENCES

- ■ The applicant(s) wish to make of record the reference(s) listed on the attached form PTO-1449 and/or accompanying documents from a corresponding foreign application. Copies of the listed reference(s) are attached, where required, as are either statements of relevancy or any readily available partial or full English translations of pertinent portions of any non-English language reference(s).
- ■ Credit card payment is being made online (if electronically filed), or is attached hereto (if paper filed), in the amount required under 37 CFR §1.17(p).

RELATED CASES

- ☐ Attached is a list of applicant's pending application(s), published application(s) or issued patent(s) which may be related to the present application. In accordance with the waiver of 37 CFR 1.98 dated September 21, 2004, copies of the cited pending applications are not provided. Cited published and/or issued patents, if any, are listed on the attached PTO form 1449.
- ☐ Credit card payment is being made online (if electronically filed), or is attached hereto (if paper filed), in the amount required under 37 CFR §1.17(p).

CERTIFICATION

- ☐ Each item of information contained in this information disclosure statement was first cited in any communication from a foreign patent office in a counterpart foreign application not more than three months prior to the filing of this statement.

- ☐ No item of information contained in this information disclosure statement was cited in a communication from a foreign patent office in a counterpart foreign application and, to the knowledge of the undersigned, having made reasonable inquiry, was known to any individual designated in 37 CFR §1.56(c) more than three months prior to the filing of this statement.

DEPOSIT ACCOUNT

- ■ Please charge any additional fees for the papers being filed herewith and for which no payment is enclosed herewith, or credit any overpayment to deposit account number **15-0030**.

Respectfully submitted,

OBLON, SPIVAK, McCLELLAND,
MAIER & NEUSTADT, L.L.P.

Andrew M. Ollis

Andrew M. Ollis
Registration No. 40,749

Customer Number
22850

Tel. (703) 413-3000
Fax. (703) 413-2220
(OSMMN 02/12)

Form PTO 1449 (Modified)	U.S. DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE	ATTY DOCKET NO.	SERIAL NO.
		404951US	New Application
LIST OF REFERENCES CITED BY APPLICANT		APPLICANT	
		Pascal DRILLET, et al.	
		FILING DATE	GROUP
		Herewith	

U.S. PATENT DOCUMENTS

EXAMINER INITIAL		DOCUMENT NUMBER	DATE	NAME	CLASS	SUB CLASS	FILING DATE IF APPROPRIATE
	AA	6 296 805	10-02--001	Jean-Pierre LAURENT, et al.			
	AB	2003 0152796	08-14-2003	Catherine CLANCY, et al.			
	AC	5 023 113	06-11-1991	Steven L. BOSTON, et al.			
	AD	7,137,201	11-21-2006	BRODT ET AL.			
	AE						
	AF						
	AG						
	AH						
	AI						
	AJ						
	AK						
	AL						
	AM						
	AN						

FOREIGN PATENT DOCUMENTS

		DOCUMENT NUMBER	DATE	COUNTRY	TRANSLATION YES	TRANSLATION NO
	AO	1 013 785	06/28/2000	EP		XXX
	AP	1 336 666	08/20/2003	EP (equivalent of US 2003 0152796)		XXX
	AQ	0 356 783	03/07/1990	EP (equivalent of US 5 023 113)		XXX
	AR	2 720 079	11/24/1995	FR		XXX
	AS	2 758 571	07/24/1998	FR		XXX
	AT	2006 097593	09/21/2006	WO (with English abstract)		XXX
	AU	1 297 906	07-06-1962	FR w (Attached English Abstract)		
	AV	1 380 666	01-14-2004	EP		

OTHER REFERENCES (Including Author, Title, Date, Pertinent Pages, etc.)

	AW	A technical specification by Ford (1992).
	AX	Aruna Bahadur et al., "Structural Studies of Hot Dip Aluminized Coatings on Mild Steel," Materials Transactions, JIM, Vol. 32, No. 11 (1991), pp. 1053-1061.
	AY	L. Vaissiere et al., "Development of Pre-Coated Boron Steel for Applications on PSA Peugeot Citroen and RENAULT Bodies in White," presented at the "International Body Engineering Conference," Paris, Society of Automotive Engineers, July 9-11, 2002.
	AZ	X. Bano, et al., "Heat Treated Boron Steels in the Automobile Industry," 39th MWSP Conf. Proc., ISS, Vol. XXXV, 1998.

☐ Additional References sheet(s) attached

Examiner	Date Considered

*Examiner: Initial if reference is considered, whether or not citation is in conformance with MPEP 609; Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

Form PTO 1449 (Modified)	U.S. DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE	ATTY DOCKET NO.	SERIAL NO.
		404951US	New Application
LIST OF REFERENCES CITED BY APPLICANT		APPLICANT	
		Pascal DRILLET, et al.	
		FILING DATE	GROUP
		Herewith	

U.S. PATENT DOCUMENTS

EXAMINER INITIAL		DOCUMENT NUMBER	DATE	NAME	CLASS	SUB CLASS	FILING DATE IF APPROPRIATE
	AA						
	AB						
	AC						
	AD						
	AE						
	AF						
	AG						
	AH						
	AI						
	AJ						
	AK						
	AL						
	AM						
	AN						

FOREIGN PATENT DOCUMENTS

		DOCUMENT NUMBER	DATE	COUNTRY	TRANSLATION YES	TRANSLATION NO
	AO	2 787 735	06-30-00	FR w/Attached English Abstract		
	AP					
	AQ					
	AR					
	AS					
	AT					
	AU					
	AV					

OTHER REFERENCES (Including Author, Title, Date, Pertinent Pages, etc.)

	AW	
	AX	
	AY	
	AZ	

☐ Additional References sheet(s) attached

Examiner	Date Considered

*Examiner: Initial if reference is considered, whether or not citation is in conformance with MPEP 609; Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

Electronic Patent Application Fee Transmittal

Application Number:	
Filing Date:	
Title of Invention:	COATED STEEL STRIPS, METHODS OF MAKING THE SAME, METHODS OF USING THE SAME, STAMPING BLANKS PREPARED FROM THE SAME, STAMPED PRODUCTS PREPARED FROM THE SAME, AND ARTICLES OF MANUFACTURE WHICH CONTAIN SUCH A STAMPED PRODUCT
First Named Inventor/Applicant Name:	Pascal DRILLET
Filer:	Andrew Michael Ollis/Adilia Wiggins
Attorney Docket Number:	

Filed as Large Entity

Utility under 35 USC 111(a) Filing Fees

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
Utility application filing	1011	1	380	380
Utility Search Fee	1111	1	620	620
Utility Examination Fee	1311	1	250	250
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Post-Allowance-and-Post-Issuance:				
Extension-of-Time:				
Miscellaneous:				
			Total in USD ($)	**1250**

Electronic Acknowledgement Receipt

EFS ID:	13758866
Application Number:	13621015
International Application Number:	
Confirmation Number:	6215
Title of Invention:	COATED STEEL STRIPS, METHODS OF MAKING THE SAME, METHODS OF USING THE SAME, STAMPING BLANKS PREPARED FROM THE SAME, STAMPED PRODUCTS PREPARED FROM THE SAME, AND ARTICLES OF MANUFACTURE WHICH CONTAIN SUCH A STAMPED PRODUCT
First Named Inventor/Applicant Name:	Pascal DRILLET
Customer Number:	22850
Filer:	Andrew Michael Ollis/Adilia Wiggins
Filer Authorized By:	Andrew Michael Ollis
Attorney Docket Number:	
Receipt Date:	15-SEP-2012
Filing Date:	
Time Stamp:	16:09:59
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	Credit Card
Payment was successfully received in RAM	$1250
RAM confirmation Number	11888
Deposit Account	
Authorized User	

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)

1		404951USDivAppln.pdf	2503038 dd17404c2c28a4a3ddbae27959eb4f1a27a91587	yes	62

Multipart Description/PDF files in .zip description		
Document Description	**Start**	**End**
Transmittal of New Application	1	1
Application Data Sheet	2	4
Specification	5	39
Abstract	40	40
Drawings-other than black and white line drawings	41	44
Oath or Declaration filed	45	53
Preliminary Amendment	54	54
Specification	55	55
Claims	56	58
Applicant Arguments/Remarks Made in an Amendment	59	59
Transmittal Letter	60	60
Information Disclosure Statement (IDS) Form (SB08)	61	62

Warnings:

Information:

2	Fee Worksheet (SB06)	fee-info.pdf	33037 ddb9e942e58fd964fb2f6bedd537a3e29543fb89	no	2

Warnings:

Information:

Total Files Size (in bytes):	2536075

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

SCORE Placeholder Sheet for IFW Content

Application Number: 13621015 Document Date: 09/15/2012

The presence of this form in the IFW record indicates that the following document type was received in electronic format on the date identified above. This content is stored in the SCORE database.

- Drawing

Since this was an electronic submission, there is no physical artifact folder, no artifact folder is recorded in PALM, and no paper documents or physical media exist. The TIFF images in the IFW record were created from the original documents that are stored in SCORE.

To access the documents in the SCORE database, refer to instructions developed by SIRA.

At the time of document entry (noted above):

- Examiners may access SCORE content via the eDAN interface.
- Other USPTO employees can bookmark the current SCORE URL (http://es/ScoreAccessWeb/).
- External customers may access SCORE content via the Public and Private PAIR interfaces.

Form Revision Date: February 8, 2006

ArcelorMittal Ex. 2017
Page 68 of 624

PATENT APPLICATION FEE DETERMINATION RECORD

Substitute for Form PTO-875

Application or Docket Number: 13/621,015

APPLICATION AS FILED - PART I

FOR	(Column 1) NUMBER FILED	(Column 2) NUMBER EXTRA	SMALL ENTITY RATE($)	SMALL ENTITY FEE($)	OR	OTHER THAN SMALL ENTITY RATE($)	OTHER THAN SMALL ENTITY FEE($)
BASIC FEE (37 CFR 1.16(a), (b), or (c))	N/A	N/A	N/A			N/A	380
SEARCH FEE (37 CFR 1.16(k), (i), or (m))	N/A	N/A	N/A			N/A	620
EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))	N/A	N/A	N/A			N/A	250
TOTAL CLAIMS (37 CFR 1.16(i))	8 minus 20 =	*			OR	x 60 =	0.00
INDEPENDENT CLAIMS (37 CFR 1.16(h))	1 minus 3 =	*				x 250 =	0.00
APPLICATION SIZE FEE (37 CFR 1.16(s))	If the specification and drawings exceed 100 sheets of paper, the application size fee due is $310 ($155 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).						0.00
MULTIPLE DEPENDENT CLAIM PRESENT (37 CFR 1.16(j))							0.00
* If the difference in column 1 is less than zero, enter "0" in column 2.			TOTAL			TOTAL	1250

APPLICATION AS AMENDED - PART II

		(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	SMALL ENTITY RATE($)	SMALL ENTITY ADDITIONAL FEE($)	OR	OTHER THAN SMALL ENTITY RATE($)	OTHER THAN SMALL ENTITY ADDITIONAL FEE($)
AMENDMENT A	Total (37 CFR 1.16(i))	*	Minus	**	=	x =		OR	x =	
	Independent (37 CFR 1.16(h))	*	Minus	***	=	x =		OR	x =	
	Application Size Fee (37 CFR 1.16(s))									
	FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							OR		
						TOTAL ADD'L FEE		OR	TOTAL ADD'L FEE	

		(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	RATE($)	ADDITIONAL FEE($)		RATE($)	ADDITIONAL FEE($)
AMENDMENT B	Total (37 CFR 1.16(i))	*	Minus	**	=	x =		OR	x =	
	Independent (37 CFR 1.16(h))	*	Minus	***	=	x =		OR	x =	
	Application Size Fee (37 CFR 1.16(s))									
	FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							OR		
						TOTAL ADD'L FEE		OR	TOTAL ADD'L FEE	

* If the entry in column 1 is less than the entry in column 2, write "0" in column 3.
** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20".
*** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3".
The "Highest Number Previously Paid For" (Total or Independent) is the highest found in the appropriate box in column 1.

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NUMBER	FILING or 371(c) DATE	GRP ART UNIT	FIL FEE REC'D	ATTY.DOCKET.NO	TOT CLAIMS	IND CLAIMS
13/621,015	09/15/2012	2827	1250	404951US99DIV	8	1

CONFIRMATION NO. 6215

22850
OBLON, SPIVAK, MCCLELLAND MAIER & NEUSTADT, L.L.P.
1940 DUKE STREET
ALEXANDRIA, VA 22314

FILING RECEIPT

OC000000056862428

Date Mailed: 10/03/2012

Receipt is acknowledged of this non-provisional patent application. The application will be taken up for examination in due course. Applicant will be notified as to the results of the examination. Any correspondence concerning the application must include the following identification information: the U.S. APPLICATION NUMBER, FILING DATE, NAME OF APPLICANT, and TITLE OF INVENTION. Fees transmitted by check or draft are subject to collection. Please verify the accuracy of the data presented on this receipt. **If an error is noted on this Filing Receipt, please submit a written request for a Filing Receipt Correction. Please provide a copy of this Filing Receipt with the changes noted thereon. If you received a "Notice to File Missing Parts" for this application, please submit any corrections to this Filing Receipt with your reply to the Notice. When the USPTO processes the reply to the Notice, the USPTO will generate another Filing Receipt incorporating the requested corrections**

Inventor(s)

Pascal DRILLET, Rozerieulles, FRANCE;
Dominique Spehner, Balan, FRANCE;
Ronald Kefferstein, Saint Mitre Les Ramparts, FRANCE;

Applicant(s)

Pascal DRILLET, Rozerieulles, FRANCE;
Dominique Spehner, Balan, FRANCE;
Ronald Kefferstein, Saint Mitre Les Ramparts, FRANCE;

Assignment For Published Patent Application

ArcelorMittal France, Saint Denis, FRANCE

Power of Attorney: The patent practitioners associated with Customer Number 22850

Domestic Priority data as claimed by applicant

This application is a DIV of 12/447,777 03/18/2011
which is a 371 of PCT/IB06/04019 10/30/2006

Foreign Applications (You may be eligible to benefit from the **Patent Prosecution Highway** program at the USPTO. Please see http://www.uspto.gov for more information.)

If Required, Foreign Filing License Granted: 10/01/2012
The country code and number of your priority application, to be used for filing abroad under the Paris Convention, is **US 13/621,015**
Projected Publication Date: To Be Determined - pending completion of Corrected Papers
Non-Publication Request: No
Early Publication Request: No

Title

COATED STEEL STRIPS, METHODS OF MAKING THE SAME, METHODS OF USING THE SAME, STAMPING BLANKS PREPARED FROM THE SAME, STAMPED PRODUCTS PREPARED FROM THE SAME, AND ARTICLES OF MANUFACTURE WHICH CONTAIN SUCH A STAMPED PRODUCT

Preliminary Class

365

PROTECTING YOUR INVENTION OUTSIDE THE UNITED STATES

Since the rights granted by a U.S. patent extend only throughout the territory of the United States and have no effect in a foreign country, an inventor who wishes patent protection in another country must apply for a patent in a specific country or in regional patent offices. Applicants may wish to consider the filing of an international application under the Patent Cooperation Treaty (PCT). An international (PCT) application generally has the same effect as a regular national patent application in each PCT-member country. The PCT process **simplifies** the filing of patent applications on the same invention in member countries, but **does not result** in a grant of "an international patent" and does not eliminate the need of applicants to file additional documents and fees in countries where patent protection is desired.

Almost every country has its own patent law, and a person desiring a patent in a particular country must make an application for patent in that country in accordance with its particular laws. Since the laws of many countries differ in various respects from the patent law of the United States, applicants are advised to seek guidance from specific foreign countries to ensure that patent rights are not lost prematurely.

Applicants also are advised that in the case of inventions made in the United States, the Director of the USPTO must issue a license before applicants can apply for a patent in a foreign country. The filing of a U.S. patent application serves as a request for a foreign filing license. The application's filing receipt contains further information and guidance as to the status of applicant's license for foreign filing.

Applicants may wish to consult the USPTO booklet, "General Information Concerning Patents" (specifically, the section entitled "Treaties and Foreign Patents") for more information on timeframes and deadlines for filing foreign patent applications. The guide is available either by contacting the USPTO Contact Center at 800-786-9199, or it can be viewed on the USPTO website at http://www.uspto.gov/web/offices/pac/doc/general/index.html.

For information on preventing theft of your intellectual property (patents, trademarks and copyrights), you may wish to consult the U.S. Government website, http://www.stopfakes.gov. Part of a Department of Commerce initiative, this website includes self-help "toolkits" giving innovators guidance on how to protect intellectual property in specific countries such as China, Korea and Mexico. For questions regarding patent enforcement issues, applicants may call the U.S. Government hotline at 1-866-999-HALT (1-866-999-4158).

LICENSE FOR FOREIGN FILING UNDER

Title 35, United States Code, Section 184

Title 37, Code of Federal Regulations, 5.11 & 5.15

GRANTED

The applicant has been granted a license under 35 U.S.C. 184, if the phrase "IF REQUIRED, FOREIGN FILING LICENSE GRANTED" followed by a date appears on this form. Such licenses are issued in all applications where the conditions for issuance of a license have been met, regardless of whether or not a license may be required as set forth in 37 CFR 5.15. The scope and limitations of this license are set forth in 37 CFR 5.15(a) unless an earlier license has been issued under 37 CFR 5.15(b). The license is subject to revocation upon written notification. The date indicated is the effective date of the license, unless an earlier license of similar scope has been granted under 37 CFR 5.13 or 5.14.

This license is to be retained by the licensee and may be used at any time on or after the effective date thereof unless it is revoked. This license is automatically transferred to any related applications(s) filed under 37 CFR 1.53(d). This license is not retroactive.

The grant of a license does not in any way lessen the responsibility of a licensee for the security of the subject matter as imposed by any Government contract or the provisions of existing laws relating to espionage and the national security or the export of technical data. Licensees should apprise themselves of current regulations especially with respect to certain countries, of other agencies, particularly the Office of Defense Trade Controls, Department of State (with respect to Arms, Munitions and Implements of War (22 CFR 121-128)); the Bureau of Industry and Security, Department of Commerce (15 CFR parts 730-774); the Office of Foreign AssetsControl, Department of Treasury (31 CFR Parts 500+) and the Department of Energy.

NOT GRANTED

No license under 35 U.S.C. 184 has been granted at this time, if the phrase "IF REQUIRED, FOREIGN FILING LICENSE GRANTED" DOES NOT appear on this form. Applicant may still petition for a license under 37 CFR 5.12, if a license is desired before the expiration of 6 months from the filing date of the application. If 6 months has lapsed from the filing date of this application and the licensee has not received any indication of a secrecy order under 35 U.S.C. 181, the licensee may foreign file the application pursuant to 37 CFR 5.15(b).

SelectUSA

The United States represents the largest, most dynamic marketplace in the world and is an unparalleled location for business investment, innovation and commercialization of new technologies. The USA offers tremendous resources and advantages for those who invest and manufacture goods here. Through SelectUSA, our nation works to encourage, facilitate, and accelerate business investment. To learn more about why the USA is the best country in the world to develop technology, manufacture products, and grow your business, visit SelectUSA.gov.

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
13/621,015	09/15/2012	Pascal DRILLET	404951US99DIV

CONFIRMATION NO. 6215

22850
OBLON, SPIVAK, MCCLELLAND MAIER & NEUSTADT, L.L.P.
1940 DUKE STREET
ALEXANDRIA, VA 22314

FORMALITIES LETTER

OC000000056862429

Date Mailed: 10/03/2012

NOTICE TO FILE CORRECTED APPLICATION PAPERS

Filing Date Granted

An application number and filing date have been accorded to this application. The application is informal since it does not comply with the regulations for the reason(s) indicated below. Applicant is given TWO MONTHS from the date of this Notice within which to correct the informalities indicated below. Extensions of time may be obtained by filing a petition accompanied by the extension fee under the provisions of 37 CFR 1.136(a).

The required item(s) identified below must be timely submitted to avoid abandonment:

- A substitute specification in compliance with 37 CFR 1.52, 1.121(b)(3), and 1.125, is required. The substitute specification must be submitted with markings and be accompanied by a clean version (without markings) as set forth in 37 CFR 1.125(c) and a statement that the substitute specification contains no new matter (see 37 CFR 1.125(b)). The specification, claims, and/or abstract page(s) submitted is not acceptable and cannot be scanned or properly stored because:
  - The claims and/or abstract contain drawings or flow diagrams on pages **39**. Drawings or flow diagrams are not permitted to be contained in the claims or abstract. See 37 CFR 1.58(a). Drawings and flow diagrams must be submitted separately in accordance with 37 CFR 1.84.

    If the drawings or flow diagrams are contained in the claims, applicant must file:
    (1) an amendment to the claims in compliance with 37 CFR 1.121 (deleting the drawings or flow diagrams); and
    (2) new drawings in compliance with 37 CFR 1.84 and 1.121(d) (if applicant wants to include the drawings or flow diagrams in the application).

    If the drawings or flow diagrams are contained in the abstract, applicant must file:
    (1) a replacement abstract commencing on a separate sheet in compliance with 37 CFR 1.72(b) and 1.121 (deleting the drawings or flow diagrams); and
    (2) new drawings in compliance with 37 CFR 1.84 and 1.121(d) (if applicant wants to include the drawings or flow diagrams in the application).

Applicant is cautioned that correction of the above items may cause the specification and drawings page count to exceed 100 pages. If the specification and drawings exceed 100 pages, applicant will need to submit the required application size fee.

Replies should be mailed to:

Mail Stop Missing Parts
Commissioner for Patents
P.O. Box 1450
Alexandria VA 22313-1450

Registered users of EFS-Web may alternatively submit their reply to this notice via EFS-Web.
https://sportal.uspto.gov/authenticate/AuthenticateUserLocalEPF.html

For more information about EFS-Web please call the USPTO Electronic Business Center at **1-866-217-9197** or visit our website at http://www.uspto.gov/ebc.

If you are not using EFS-Web to submit your reply, you must include a copy of this notice.

/smunpanthovong/

Office of Data Management, Application Assistance Unit (571) 272-4000, or (571) 272-4200, or 1-888-786-0101

OBLON
SPIVAK

ATTORNEYS AT LAW

Docket No.: 404951US99DIV

COMMISSIONER FOR PATENTS
ALEXANDRIA, VIRGINIA 22313

RE: Application Serial No.: 13/621,015
Applicants: Pascal DRILLET, et al.
Filing Date: September 15, 2012
For: COATED STEEL STRIPS, METHODS OF MAKING THE SAME, METHODS OF USING THE SAME, STAMPING BLANKS PREPARED FROM THE SAME, STAMPED PRODUCTS PREPARED FROM THE SAME, AND ARTICLES OF MANUFACTURE WHICH CONTAIN SUCH A STAMPED PRODUCT
Group Art Unit: 2827
Examiner:

Commissioner:

Attached hereto for filing are the following papers:

RESPONSE REGARDING SUBSTITUTE SPECIFICATION
SUBSTITUTE SPECIFICATION

Credit card payment is being made online (if electronically filed), or is attached hereto (if paper filed), in the amount of **-0-** to cover any required fees. In the event any variance exists between the amount enclosed and the Patent Office charges for filing the above-noted documents, including any fees required under 37 C.F.R. 1.136 for any necessary Extension of Time to make the filing of the attached documents timely, please charge or credit the difference to our Deposit Account No. **15-0030**. Further, if these papers are not considered timely filed, then a petition is hereby made under 37 C.F.R. 1.136 for the necessary extension of time.

Respectfully submitted,

OBLON, SPIVAK, McCLELLAND,
MAIER & NEUSTADT, L.L.P.

Andrew M. Ollis

Andrew M. Ollis
Registration No. 40,749

Customer Number
22850
(703) 413-3000 (phone)
(703) 413-2220 (fax)
(OSMMN 02/12)

DOCKET NO.: 404951US99DIV/amw

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

IN RE APPLICATION OF: GROUP: 2827

Pascal DRILLET, et al.

SERIAL NO: 13/621,015 EXAMINER:

FILED: September 15, 2012

FOR: COATED STEEL STRIPS, METHODS OF MAKING THE SAME, METHODS OF USING THE SAME, STAMPING BLANKS PREPARED FROM THE SAME, STAMPED PRODUCTS PREPARED FROM THE SAME, AND ARTICLES OF MANUFACTURE WHICH CONTAIN SUCH A STAMPED PRODUCT

RESPONSE REGARDING SUBSTITUTE SPECIFICATION

COMMISSIONER FOR PATENTS
ALEXANDRIA, VIRGINIA 22313

SIR:

In response to the Notice to File Corrected Application Papers dated October 3, 2012, Applicants respectfully request that the previously submitted Abstract be deleted in its entirety. A Substitute Specification is submitted herewith. The drawings as described in the specification were submitted upon filing of the application. Therefore no further drawings are necessary.

No new matter has been added.

In light of the foregoing, this application is deemed to be in proper condition for examination and such favorable action is earnestly solicited.

Respectfully Submitted,

OBLON, SPIVAK, McCLELLAND,
MAIER & NEUSTADT, L.L.P.

Andrew M. Ollis

Andrew M. Ollis
Registration No. 40,749

Customer Number
22850

Tel. (703) 413-3000
Fax. (703) 413-2220
(OSMMN 05/03)

COATED STEEL STRIPS, METHODS OF MAKING THE SAME, METHODS OF USING THE SAME, STAMPING BLANKS PREPARED FROM THE SAME, STAMPED PRODUCTS PREPARED FROM THE SAME, AND ARTICLES OF MANUFACTURE WHICH CONTAIN SUCH A STAMPED PRODUCT

FIELD OF THE INVENTION

The present invention relates to, among other things, coated steels, methods of making such coated steels, including hot dipping, methods of using such coated steels, stamping blanks prepared from coated steels, stamped products prepared from coated steels, and to various uses of the invention products such as in spot welding, etc.

Additional advantages and other features of the present invention will be set forth in part in the description that follows and in part will become apparent to those having ordinary skill in the art upon examination of the following or may be learned from the practice of the present invention. The advantages of the present invention may be realized and obtained as particularly pointed out in the appended claims. As will be realized, the present invention is capable of other and different embodiments, and its several details are capable of modifications in various obvious respects, all without departing from the present invention. The description is to be regarded as illustrative in nature, and not as restrictive.

BACKGROUND OF THE INVENTION

In recent years the use of pre-coated steels in hot-stamping processes for the shaping of parts has become important, especially in the automotive industry. Fabrication of such parts may include the following main steps:

- Pre-coating of a steel sheets, by hot dipping
- Trimming or cutting for obtaining blanks

- Heating the blanks in order to obtain alloying of the steel substrate with the pre-coating, as well as the austenitizing of the steel
- Hot forming followed by rapid cooling of the part in order to obtain predominantly martensitic structures

See for Example U.S. 6,296,805, incorporated herein by reference.

Thanks to an alloying of the pre-coating with the steel substrate, which has the effect of creating intermetallic alloys with high melting temperature, the blanks having such coating may be heated in a temperature range where austenitizing of the metallic substrate takes place, allowing further hardening by quenching.

Heat treatments of the blanks in view of the intermetallic alloying of the coating and austenitizing of the substrate are most frequently performed in furnaces, where blanks are traveling on rollers. The thermal cycles experienced by the blanks include first a heating phase whose rate is a function of parameters such as blank thickness, furnace temperature, traveling speed, and coating reflectivity. After this heating phase, thermal cycles generally include a holding phase, whose temperature is the regulation temperature of the furnace. Problems however are experienced with the furnace operation: the rollers may become fouled by metallic deposits which come from the pre-coating of the blanks. If these deposits are excessive, maintenance of the rollers has to be performed and productivity is decreased.

Parts obtained after heating and rapid cooling display very high mechanical resistance and may be used for structural applications, for example for automotive industry applications. These parts must be frequently welded with others and high weldability is required. This means that:

- The welding operation should be performable in a sufficiently wide operating range in order to guarantee that an eventual drift of the nominal welding parameters has no incidence on weld quality. For resistance welding, which is very common in the automotive industry, an operating welding range is defined by the combination of parameters: welding current intensity I and force F applied of the parts during welding being among the most important. A proper combination of these parameters helps to ensure that insufficient nugget diameter is

not obtained (caused by too low intensity or too low force) and that no weld expulsion occurs.

- The welding operation should also be performed in such a way that high mechanical resistance is obtained on the weld. This mechanical resistance may be evaluated by tests such as by shear-tensile tests or cross-tensile tests.

There remains a need for coated steels which may be conveniently used to prepare shaped parts by a stamping process. There also remains a need for coated steels which may be used to prepare shaped parts by a stamping process which are suitable for welding. There also remains a need for processes for preparing such coated steels and stamped parts.

SUMMARY OF THE INVENTION

The inventors have discovered that certain coated steels in which a base steel strip is at least partially coated (sometimes termed "pre-coated," this prefix indicating that a transformation of the nature of the pre-coating will take place during heat treatment before stamping) on at least one side with a coating of either aluminum or an aluminum alloy and in which the coating has a defined thickness and is preferably substantially uniform, are conveniently formed into shaped parts after heating by stamping and are conveniently welded. In addition, the inventors have discovered that the roller fouling problem described above generally arises from an insufficient degree of intermetallic alloying between the substrate and the metallic pre-coating. Furthermore, it was discovered that the location of the fouling of the rollers corresponds to zones of the blanks in contact with the rollers where the metallic pre-coating thickness locally exceeds the average thickness. While not bound by a particular theory, it is believed that if a pre-coating is locally too thick, intermetallic alloying is insufficient and the pre-coating melts, fouling the rollers. Thus, the inventors have discovered that the control of the homogeneity of the pre-coating thickness over the entire sheet within given tolerances is an important factor for obtaining the desired degree of intermetallic alloying, allowing one to improve the resistance to the subsequent melting of the coating during travel on rollers.

The inventors have also discovered that particularly good weldability of aluminized and hot stamped parts is associated with a special succession of coating layers on the parts, proceeding from steel substrate outwards.

The inventors have also discovered that a specific combination of transfer time between the heating furnace and the stamping die, the amount of deformation during stamping, the temperature of stamping, the cooling rate of the product during stamping, leads to the fabrication of a part with a fully homogeneous martensitic structure and that an increase in ductility or energy absorption of the parts after stamping is obtained by a reduction of sulfur below a critical value, these two benefits being obtained with or without the invention aluminum/aluminum alloy coating, and with other coatings.

OBJECTS OF THE INVENTION

Accordingly, and in view of the above, it is one object of the present invention to provide novel pre-coated steels strips which may be conveniently processed into stamping blanks.

It is another object of the present invention to provide novel pre-coated steels strips or sheets which may be conveniently formed into parts by stamping.

It is another object of the present invention to provide novel coated steels which may be conveniently formed into parts by hot stamping.

It is another object of the present invention to provide novel methods for making such a coated steel.

It is another object of the present invention to provide novel stamping blanks which are prepared from such a coated steel.

It is another object of the present invention to provide novel methods of making such stamping blanks.

It is another object of the present invention to provide novel stamped parts which are prepared from such a coated steel.

It is another object of the present invention to provide novel methods of making such stamped parts.

It is another object of the present invention to provide novel articles of manufacture, such as a motor vehicle, which contain such stamped parts.

It is another object of the present invention to provide novel stamped parts.

It is another object of the present invention to provide novel methods of making welded stamped parts.

It is another object of the present invention to provide novel articles of manufacture, such as a motor vehicle, which contain such welded stamped parts.

It is another object of the present invention to provide novel welded coated steels and welded stamping blanks.

It is another object of the present invention to provide novel methods of making such welded coated steels and welded stamping blanks.

These and other objects, which will become apparent during the following detailed description.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 illustrates a preferred embodiment of an invention coated part, after heat treatment and stamping. The succession of layers of the coating on the steel substrate is: (a) interdiffusion layer; (b) intermediate layer; (c) Intermetallic layer; and (d) superficial layer. This arrangement is particularly favorable for the further welding of the part.

Figure 2 illustrates a coating of a steel substrate after heat treatment and stamping which does not correspond to the invention. This succession of layers (interdiffusion layer and intermetallic layer) yields inferior results in resistance spot welding.

Figure 3 illustrates a microstructure of a steel part, hot stamped and cooled under conditions not according to the invention.

Figure 4 illustrates the microstructure of a steel part, hot stamped and cooled according to a preferred set of conditions according to the invention.

Figure 5 illustrates the influence of sulfur on the bending angle of parts after hot stamping.

Figure 6 illustrates the influence of sulfur on the initiation energy of fracture of parts after hot stamping.

Figure 7 shows conditions of furnace temperature as a function of the total dwell time in the furnace for sheets of total thicknesses of from 0.7-1.5 and 1.5-3 mm that provide particularly favorable coatings for welding.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

As noted above, the inventors' discovery that certain coated steels, in which a base steel is at least partially pre-coated on at least one side with a coating of either aluminum or an aluminum alloy and in which the pre-coating has a defined thickness and is substantially uniform, are conveniently formed into shaped parts by stamping, forms one basis for the invention.

In the context of the present invention, the terms first side (or side 1) and second side (or side 2) of the strip or sheet, etc., of base steel refer to the two large, opposite-facing, surfaces which have a surface area defined by the length and width of the strip of base steel. In contrast, the side edges of the strip of base steel are the two small, opposite-facing, surfaces which have a surface area defined by the length and thickness of the strip. The top and bottom edges of the strip of base steel are the two small, opposite-facing, surfaces which have a surface area defined by the width and thickness of the strip. In the following, t_p designates the thickness of the pre-coating, at any considered location on the sides 1 and 2 of a sheet or a blank. In particular, in the case of sheets coated on two sides 1 and 2, t_{p1} stands for the thickness on side 1, and t_{p2} for the thickness on side 2.

According to a highly preferred embodiment t_p is controlled in a precise range, expressed by (t_{pmin}, t_{pmax}), in order to improve the resistance to the fouling of the rollers. The thickness is preferably controlled, both in the longitudinal (or rolling) direction of the strip or sheet, as well in the transverse direction.

In relation to the problem of the fouling of rollers, the control of the pre-coating thickness on the side of the sheet or blank which is directly in contact with the rollers is especially important. Because different operations can follow the step of coating the steel sheet (for example hot-dip-coating which provides coated sides 1 and 2), it is preferable to carefully control the pre-coating on both sides of the sheet. For example, after any of coiling,

handling, cutting, punching, etc., sides 1 and 2 may be not readily identifiable. But when control of t_p is effected on the two sides of the sheet that has been coated (first side and second side) it is not necessary to track sides 1 and 2 as neither side will foul the roller. In addition, it is not necessary to trim the sheet in order to obtain a preferred smaller sheet having a more uniform homogeneity of pre-coating thickness, thus providing a sheet that is pre-coated by, e.g., hot-dipping. In other words, important benefits are obtained when one controls the pre-coating minimum and maximum thickness of the first side (t_{pmin1} , t_{pmax1}) and the pre-coating minimum and maximum thickness of the second side (t_{pmin2} , t_{pmax2}) of the subject steel sheet or blank.

Hot-dip coated steels are the preferred steels herein. However, regardless of the coating method, the pre-coating thickness on one or both sides of the sheet can be measured and monitored continuously on a coating line directly after the coating operation. This may be realized by devices known per se, such as thickness gages relying on X-Ray absorption. At every moment, the measurement of thickness at a given location may be performed for example on an area of a few hundreds of mm^2, this representing the dimension of the zone irradiated by X-Ray.

In a preferred embodiment, a plurality of such devices are positioned at different distances in the transverse direction of the strip in order to obtain a profile of the thickness of the pre-coating along the strip width.

The inventors have discovered that the resistance to the pollution or fouling of the rollers in the furnaces is improved when the minimum and maximum thickness respectively of at least one of the first side (t_{pmin1}, t_{pmax1}) and the second side (t_{pmin2}, t_{pmax2}) are respectively equal to 20 and 33 micrometers (a micrometer is the same as a micron and is a metric unit of length equal to one millionth of a meter). In other words, in a preferred embodiment, at every location on at least one face of the sheet or the blank, the thickness t_p of the pre-coating is preferably from 20 - 33 micrometers in thickness, including 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31 and 32 micrometers and all ranges and subranges therebetween, and including all numbers between each listed value as if written out in its entirety (e.g., 22.34 micrometers). For hot-dip coating, precise control of this range of pre-coating

thickness can be realized on an operating line for example using a system of nozzles blowing gas after coating, for example after exit of the strip or sheet from a bath, and by the flatness of the strip. Number, geometry and location of the nozzles, and flow rates are among the main parameters for a precise control of the thickness t_p. Given the present disclosure, one of ordinary skill in this art can control the pre-coating thickness as described herein without undue labor.

The invention refers to strips produced in industrial conditions, i.e. where control of pre-coating thickness is effective over a wide surface strip, i.e. with a length greater than 100m, and with a width greater than 600mm. In such a way, blanks cut or trimmed out these strips display very high homogeneity of pre-coating thickness, and the settings of the heating treatments in the furnace do not have to be changed for being adapted to eventual variations of this thickness.

While not bound by a particular theory of operation, the inventors believe that several of the benefits of the invention are related to this pre-coating thickness range, such as the following :

- For a pre-coating thickness less than 20 micrometers, the alloyed layer which is formed during the heating of the blank has an insufficient roughness. Thus, the adhesion of subsequent painting is low on this surface, and the corrosion resistance is decreased.

- If the pre-coating thickness is more than 33 micrometers at a given location on a sheet, the risk is that the difference of thickness between this location and some other locations where the pre-coating is thinner, becomes too important : The settings of the heating treatment in the furnace may be adapted to the thinner value of the pre-coating, but not to the thicker one. Thus, the alloying reaction forming the intermetallic alloy may take place to an insufficient degree since the mean diffusion distance of the elements in the pre-coating becomes significantly less than the local value of the pre-coating thickness. As a matter of results, alloying will become much more difficult in the external (or superficial) part, particularly in the case of high heating rate.

Thus, in a first embodiment, the present invention provides certain coated steel strips, which comprise a strip of base steel and a pre-coating of

aluminum or an aluminum alloy on at least a part of one side of the strip of the base steel. For many applications, the strip of base steel may comprise any type of steel which may be coated with either aluminum or an aluminum alloy. However, for certain applications, such as a structural part of an automobile, it is preferred that the strip of base steel comprise an ultra high strength steel (UHSS). In such cases, it is particularly preferred that the strip of base steel comprises a boron steel.

The inventors have also discovered that good welding results are achieved if the coating obtained on parts made out of blanks having undergone intermetallic alloying, austenitizing and hot stamping, displays distinctive features. It must be pointed out that this coating is different from the initial pre-coating, since the thermal treatment causes an alloying reaction with the steel substrate which modifies both the physico-chemical nature and the geometry of the pre-coating : in this regard, the inventors have discovered that particularly good weldability of aluminized and hot stamped parts is associated with the following succession of coating layers on the parts, proceeding from steel substrate outwards :

- (a) Interdiffusion layer,
- (b) Intermediate layer,
- (c) Intermetallic layer,
- (d) Superficial layer

See, e.g., Figure 1. In a preferred embodiment these layers are as follows:

- (a) Interdiffusion layer, preferably with medium hardness (e.g., HV50g between 290 and 410, HV50g designating the hardness measured under a load of 50 grams) In a preferred embodiment this layer has the following composition, by weight : 86-95%Fe, 4-10%Al, 0-5%Si
- (b) Intermediate layer (HV50g around 900 - 1000 e.g., +/- 10%))
  In a preferred embodiment this layer has the following composition, by weight : 39-47% Fe, 53-61%Al, 0-2%Si
- (c) Intermetallic layer, with hardness HV50g around 580-650, e.g., +/- 10%)
  In a preferred embodiment this layer has the following composition, by weight : 62-67%Fe, 30-34 %Al, 2-6%Si
- (d) Superficial layer (HV50g around 900 - 1000 e.g., +/- 10%))

In a preferred embodiment this layer has the following composition, by weight : 39-47% Fe, 53-61%Al, 0-2%

In a preferred embodiment the total thickness of layers (a) to (d) is greater than 30 micrometers.

In another preferred embodiment, the thickness of layer (a) is less than 15 micrometers, for example 14, 12, 10, 8, 6, 4, 2, or 1 micrometers, and all whole numbers, ranges and subranges therebetween, and including all numbers between each listed value as if written out in its entirety (e.g., 13.84 micrometers).

The inventors have discovered that high weldability is especially obtained when layers (c) and (d) are essentially continuous (i.e.: occupying at least 90% of the level corresponding to the considered layer) and when less than 10% of layer (c) is present at the extreme surface of the part. Without being bound by a theory, it is thought that this particular layer disposal, in particular layer (a) and layers (c) and (d) influence the resistivity of the coating both by their intrinsic characteristics and by the effect of roughness. Thus, current flow, heat generation at the surfaces, and nugget formation in the initial stage of spot welding are affected by this particular arrangement.

This favorable layer disposition is obtained for example when aluminum- or aluminum alloy pre-coated steel sheets, whose thickness range from, e.g., 0.7 to 3mm, are heated for 3 to 13 minutes (this dwell time includes the heating phase and the holding time) in a furnace heated to a temperature of 880 to 940°C. Other conditions leading to such favorable layer dispositions are found in Figure 7:

For sheets of total thicknesses greater or equal to 0.7mm, and less than or equal to 1.5mm, the preferred treatment conditions : (furnace temperature, total dwell time in the furnace) are illustrated in figure 7 by conditions lying within the limits of diagram "ABCD"

For sheets of total thicknesses greater than 1.5mm, and less than or equal to 3mm, the preferred treatment conditions : (furnace temperature, total dwell time in the furnace) are illustrated in figure 7 by diagram "EFGH" .

The heating rate V_c is comprised between 4 and 12°C/s for producing a favorable alloyed layer disposition. In this regard, this "heating rate" reflects

the temperature rise which is experienced by the pre-coated steel upon being located in the preheated furnace. V_c is defined as the mean heating rate between 20 and 700°C. The inventors have discovered that the control of V_c in this precise range is a key factor, because it controls directly the nature and the morphology of the alloyed layers which are formed. It is here underlined that the heating rate V_c is different from the mean heating rate, which is the heating rate between room temperature and furnace temperature. The rates of 6, 7, 8, 9, 10, and 11 °C/s are included as are all numbers, ranges and subranges therebetween, and including all numbers between each listed value as if written out in its entirety (e.g., 7.7 °C/s). In this regard, all of the conditions specified within Figure 7 are incorporated herein by reference thereto. Particularly preferred conditions are:

(for thicknesses of 0.7-1.5mm)

- 930°C, from 3 minutes up to 6 minutes;
- 880°C, from 4 minutes 30 seconds up to 13 minutes

(for thicknesses of 1.5 to 3 mm)

- 940°C, from 4 minutes up to 8 minutes;
- 900°C, from 6 minutes 30 seconds up to 13 minutes

A special advantage arises from pre-coatings whose thickness is comprised between 20 and 33 micrometers, since this thickness range yields favorable layer disposal, and since the homogeneity of the pre-coating thickness is associated to an homogeneity of the coating formed after alliation treatment.

Heated blanks are thereafter transferred to a die, hot stamped to obtain a part or product, and cooled at a rate of more than 30°C/s. The cooling rate is defined here as the mean rate between the exit of the heated blank from the furnace, down to 400°C.

The strip of base steel is coated with either aluminum or an aluminum alloy. Commercially pure aluminum is known in the art as Type 2 aluminum, while alloys of aluminum with 5 to 11 % by weight of silicon are known in the art as Type 1 aluminum. Silicon is present in order to prevent the formation of a thick iron-metallic intermetallic layer which reduces adherence and formability. Other alloying elements useful with aluminum herein include iron,

between 2.5 and 3% by weight, and calcium, between 15 and 30ppm by weight, including combinations of two or more thereof with aluminum.

A typical metal bath for an Al-Si coating generally contains in its basic composition by weight, from 8% to 11% silicon, from 2% to 4% iron, the remainder being aluminum or aluminum alloy, and impurities inherent in processing. Typical composition of Al-Si coating is: Al-9,3%Si-2,8%Fe. Invention coatings are not limited to these compositions, however.

The strip of base steel used herein may be any which can be coated by a conventional coating technique. For example, the strip of base steel may be any hot rolled strip, such as those prepared by hot rolling a steel slab (either with or without subsequent cold rolling). Typically, the strip of base steel will be stored and transported in the form of a coil both before and after the formation of the coating.

An example of a preferred steel for the strip of base steel is one having the following composition by weight:

0.10% < carbon < 0.5%
0.5% < manganese < 3%
0.1% < silicon < 1%
0.01% < chromium < 1%
titanium < 0.2%
aluminum < 0.1%
phosphorus < 0.1%
sulfur < 0.05%
0.0005% < boron < 0.010%,

the remainder comprising, consisting essentially of, or consisting of iron and impurities inherent in processing. Use of such a steel provides a very high mechanical resistance after thermal treatment and the aluminum-based coating provides a high resistance to corrosion.

Particularly preferably, the composition by weight of the steel in the strip of base steel is the following:

0.15% < carbon < 0.25%
0.8% < manganese < 1.8%
0.1% < silicon < 0.35%

0.01% < chromium < 0.5%
titanium < 0.1%
aluminum < 0.1%
phosphorus < 0.1%
sulfur < 0.05%
0.002% < boron < 0.005%,

the remainder comprising, consisting essentially of, or consisting of iron and impurities inherent in processing.

A preferred strip herein is 100 m long and 600mm wide. Preferred thicknesses are 0.7 to 3 mm.

Even more preferably, in the composition by weight of the sheet, the weight ratio of titanium content with respect to the nitrogen content is in excess of 3.42, believed to be a level at which the boron is no longer able to combine with the nitrogen.

An example of preferred commercially available steel for use in the strip of base steel is 22MnB5.

Chromium, manganese, boron and carbon may be added, in the composition of the steel according to the invention, for their effect on hardenability. In addition, carbon makes it possible to achieve high mechanical characteristics thanks to its effect on the hardness of the martensite.

Aluminum is introduced into the composition, to perform deoxidation in the liquid state and to protect the effectiveness of the boron.

Titanium, the ratio of the content of which with respect to the nitrogen content should be in excess of 3.42, is introduced for example in order to prevent combining of the boron with the nitrogen, the nitrogen being combined with titanium.

The alloying elements, Mn, Cr, B, make possible a hardenability allowing hardening in the stamping tools or the use of mild hardening fluids limiting deformation of the parts at the time of thermal treatment. In addition, the composition according to the invention is optimized from the point of view of weldability.

The steel in the sheet may undergo a treatment for globularization of sulfides performed with calcium, which has the effect of improving the fatigue resistance of the sheet.

As mentioned above, ultra-high-strength can be provided with the steel sheet coated and hot stamped according to the invention. This high level of strength is sometimes associated with a limited ductility. In applications requiring a higher ductility, in particular when an ability for bending is required from a part or a product, the inventors have discovered that increased ductility can be obtained if sulfur is particularly controlled: when the sulfur level of base steel is lower than or equal to 0.002% (20 ppm), the bending angle can be greater than 60° and enhanced ductility and tearing resistance are obtained on the parts having experienced heat treatment and stamping. Preferred levels include 20, 18, 15, 13, 10, 8, 5, 2, etc ppm sulfur. In fact, this benefit applies to steels in general, and is not limited to coated steels or to steels coated with Al or Al alloy coatings. While not bound by a particular theory, when analyzing causes of premature failure of some parts in bending operations, the inventors observed that failure initiated on sulfide inclusions. It is thus believed that decohesions between inclusions and the martensitic or bainito-martensitic matrix act as stress-concentration factors and trigger further crack propagation in the ductile mode.

The invention also concerns a process for producing a part starting from an invention coated sheet, then cut into a blank which, after shaping, the coating of the blank is subjected to an increase in temperature at a speed in excess of 4°C/second, but lower than 12°C/second. The heating rate V_c is defined as the mean rate between 20 and 700°C.

The invention also concerns the use of a hot-rolled steel sheet which then can be cold-rolled and coated, for structural and/or anti-intrusion or substructure parts for a land motor vehicle, such as, for example, a bumper bar, a door reinforcement, a wheel spoke, etc.

The sheet according to the invention described above can derive, by reason of its processing, from a hot-rolling mill, and possibly may be cold-rerolled again depending on the final thickness desired. It then is coated with an aluminum-based coating, for example by dipping in a bath containing, in

addition to the aluminum source/alloy, e.g., from 8% to 11% silicon and from 2% to 4% iron, the sheet having a high mechanical resistance after thermal treatment and a high resistance to corrosion, as well as a good capacity for painting and gluing.

The coating is preferably controlled as above, and has in particular the function of protecting the basic sheet against corrosion in various conditions. The thermal treatment applied at the time of a hot-forming process or after forming makes it possible to obtain high mechanical characteristics which can exceed 1500 MPa for mechanical resistance and 1200 MPa for yield stress. The final mechanical characteristics are adjustable and depend in particular on the martensite fraction of the structure, on the carbon content of the steel and on the thermal treatment. At the time of thermal treatment performed on a finished part or at the time of a hot-shaping process, the coating forms a layer having a substantial resistance to abrasion, wear, fatigue, shock, as well as a good resistance to corrosion and a good capacity for painting and gluing. The coating makes it possible to avoid different surface-preparation operations such as for steel sheets for thermal treatment not having any coating.

The steel sheet can be pre-coated by dipping, after pickling, in an aluminum bath containing for example only aluminum or either aluminum and from 8% to 11% silicon and 2% to 4% iron, or only from 2% to 4% iron, or even in an aluminum bath preferably containing from 9% to 10% silicon and 2% to 3.5% iron. The aluminum may be aluminum per se or an aluminum alloy.

In an example of implementation of a coating of the sheet by dipping in a metal bath containing an aluminum alloy comprising a proportion of approximately 90% aluminum, the coating layer comprises a first alloy layer in contact with the surface of the steel. This layer, directly in contact with the surface of the sheet, is highly alloyed with iron.

A second coating layer, on top of the first, contains approximately 90% aluminum and may contain silicon and a small amount of iron, depending on the composition of the bath.

The first alloy layer may crack when the sheet is submitted to high strains during cold forming operations of the manufacture of parts.

According to the invention, after the forming of the part, the coating is subjected to an increase in temperature at a speed in excess of 4°C /second. This rise in temperature makes possible a rapid remelting of the aluminum which fills in the cracks generated by the operation of shaping of the part.

At the time of thermal treatment, the base coating, of aluminum for example, is transformed into a layer alloyed with iron and comprising different phases depending on the thermal treatment and having a considerable hardness which may exceed 600 HV50 g.

Another advantage of the invention lies in the fact that the diffusion of the iron in the coating is initiated at high temperature. One thus will have a better cohesion between coating and steel in the sheet. In another form of the invention, the thermal treatment may be performed locally, in heavily deformed zones.

According to the invention, the sheet, in the delivery state in a coil or in a sheet, the thickness of which may range between 0.25 mm and 15 mm, has good forming properties and a good resistance to corrosion as well as a good capacity for painting or gluing. Preferably, the steel sheet or blank has a thickness less than 3 mm, since the cooling rates that may be achieved after quenching are high and help to obtain martensitic structures.

The steel sheet, a coated product, has a substantial resistance to corrosion in the delivery state, during forming and thermal treatments as well as during usage of the finished part.

The presence of the coating at the time of thermal treatment of the parts makes it possible to prevent any decarburization of the base metal as well as any oxidation. That is an undeniable advantage, in particular in the case of hot forming. Furthermore, heating of the treated part does not require a furnace having a controlled atmosphere to prevent a decarburization.

Thermal treatment of the metal in the sheet comprising heating at a temperature ranging between Ac1, starting temperature of austenitic transformation when heating, for example 750°C and 1200°C, in a furnace, for a period which depends on the temperature to be reached and the thickness of the blank. The composition is optimized so as to limit the grain growth at the time of thermal treatment. If the structure sought is completely

martensitic, the holding temperature should be in excess of Ac3, for example 840°C, temperature of complete austenitic transformation. The temperature holding should be followed by a cooling adjusted to the final structure sought.

Blanks are thereafter transferred from the furnace to a stamping press. When the elapsed time between the exit of the blanks from the furnace and the introduction in the stamping press is more 10 seconds, a partial transformation from austenite is susceptible to appear: if obtaining a full martensitic structure is desired, the transfer time between the exit of the furnace and stamping should be less than 10s.

The inventors have also discovered that the obtaining of a fully martensitic structure is linked to the amount of deformation in the hot forming operation: the amount of local deformation caused by hot forming is closely linked to the shape of the part or product and may exceed locally 40 or 50% in some particular regions. The inventors found that, when the local strain exceeds a critical value of 10%, the cooling rate must be sufficiently high in order to get a total martensitic transformation. Otherwise, bainitic transformation can take place at a significant amount instead of martensitic transformation. Thus, the risk is that heterogeneous structure appears on parts with complex shape where some locations are much more deformed than others. In this respect, the inventors put into evidence that, on the locations of the parts where the forming strain is higher than 10%, the cooling rate must be increased beyond 50°C/s in order to guarantee full martensitic transformation. The cooling rate is defined as the mean rate between the exit of the heated blank from the furnace, down to 400°C.

But one may also seek to obtain ferrito-bainitic or ferrito-martensitic structures, by a heating at a temperature ranging between Ac1, for example 750°C and Ac3, for example 840°C, followed by an appropriate cooling. According to the level of resistance to be achieved and the thermal treatment applied, one or several of these constituents is/are present in variable proportions.

The modulation of thermal treatment parameters makes it possible to achieve, with a given composition, different levels of hot and cold sheet

resistance according to the thickness sought. For the highest resistance levels, the structure is composed predominantly of martensite.

The steel is particularly suited to the production of structural and anti-intrusion parts.

The invention thus enables one to produce a hot- or cold-rolled steel sheet of a desired thickness, coated, and affording extensive forming possibilities and which, after thermal treatment performed on the finished part, makes it possible to obtain a mechanical resistance in excess of 1000 MPa, a substantial resistance to shocks, fatigue, abrasion and wear, while retaining a good resistance to corrosion as well as a good capacity for welding, painting and gluing.

The present invention will now be further described by way a certain exemplary embodiments which are not intended to be limiting.

EXAMPLES

Example 1 :

In a first example of implementation, a cold rolled steel sheet, 1.9 mm thick, containing by weight: 0.23 % carbon, 1.25% manganese, 0.017% phosphorus, 0.002% sulfur, 0.27% silicon, 0.062% aluminum, 0.021% copper, 0.019% nickel, 0.208% chromium, 0.005% nitrogen, 0.038% titanium, 0.004% boron, 0.003% calcium–has been pre-coated with an aluminum-based alloy with composition 9.3% silicon, 2.8% iron, the remainder being aluminum and unavoidable impurities. According to the conditions of fabrication, namely the settings of the blowing devices on the operating line, sheets of 120m long and 650mm wide with various thickness ranges were produced.

- Sheet A (according to the invention): The thickness t_{p1} and t_{p2} on each side of the sheet was controlled to be within the range (20-33) micrometers, at every location of the two faces of the sheet, both in the longitudinal (or rolling) direction and in the transversal direction. Measurement was performed continuously with thickness gages devices relying on X-Ray emission. At every moment, the spot of measurement of each gage was a circular zone of about 20mm radius. The sheets were afterwards cut into blanks of 1.2 x 0.5m² of overall dimensions.

- Sheet B (reference): On these sheets, the pre-coating thickness had a wider variability since the thickness t_{p1} and t_{p2} on the two sides of the sheet was comprised in the range (30-45) micrometers. Blanks cut out of these sheets exhibit the same pre-coating thickness.

The blanks were then submitted to heating in a furnace at T=920°C. Heating time was 3 min, with 4 mn holding time. The microstructure is then fully austenitic. Blanks were thereafter transferred from the furnace to a stamping press. When the elapsed time between the exit of the blanks from the furnace and the transfer in the stamping press is more 10 seconds, a partial transformation from austenite was susceptible to appear, thus reducing the mechanical resistance of the stamped part.

The blanks were directly cooled afterwards without hot stamping in order to appreciate the eventual remelting of the coating

On series A, no melting of the pre-coating was found. Intermetallic alloying between the pre-coating and the steel substrate occurred completely.

On series B, the pre-coating underwent mainly alloying, but some traces of remelting were found, particularly on the former thicker locations of the pre-coating. This partial remelting of the aluminium pre-coating contributes to the progressive fouling of the rollers in the furnace. The sheets according to the invention do not contribute to this progressive buildup on the rollers.

Example 2 :

i) Conditions according to the invention: In a second example of implementation, a cold rolled steel sheet, 1,2mm thick, 120m long and 650mm wide, with same composition and same pre-coating as in example 1, has been fabricated. The sheets were afterwards cut into blanks which were heated at 920°C for 6mn, this time including the heating phase and the holding time. Heating rate V_c between 20 and 700°C was 10°C/s. The blanks were finally hot stamped and quenched in order to obtain full martensitic structures.

The parts obtained after hot-stamping are covered by a coating, 40 micrometers thick, illustrated at figure 1, which has a four layer structure. Starting from the steel substrate, the layers are the following:

- (a) Interdiffusion layer or intermetallic layer, 17 micrometers thick. This layer is itself composed of two sub-layers. Hardness HV50g ranges from 295 to 407, and the mean composition is: 90%Fe, 7%Al, 3%Si.
- (b) Intermediate layer, appearing darker, 8 micrometers thick. This layer has a hardness of 940HV50g and a mean composition, by weight : 43%Fe, 57%Al, 1%Si.
- (c) Intermetallic layer appearing as a pale phase, 8 micrometers thick, displaying a hardness of 610HV50g, a mean composition of 65%Fe, 31%Al, 4%Si
- (d) Darker superficial layer, 7 micrometers thick, 950 HV50g, with a mean composition of 45%Fe, 54%Al, 1%Si

Layers (c) and (d) are quasi-continuous, i.e. occupying at least 90% of the level corresponding to the considered layer. In particular, layer (c) does not reach the extreme surface except very exceptionally. Anyway, this layer (c) occupies less than 10% of the extreme surface.

ii) Conditions of reference: On the other hand, blanks with the same base material and pre-coating parts were furnace-heated in different conditions: The blanks were heated to 950°C for 7 minutes, this time including the heating phase. Heating rate V_c was 11°C/s. These conditions correspond to a degree of alloying which is more important than in conditions (i)

- In this coating, the pale intermetallic layer (c), is not continuous and appears as to be scattered within the coating. About 50% of this layer is present at the extreme surface of the part. Moreover, the interdiffusion layer, 10 micrometers thick in contact with the steel substrate is thinner than in the previous case of figure 1.

Resistance spot welding was performed in the two situations i) and ii):

- (i): Coating with quasi-continuous layers (c) and (d), layer (c) occupying less than 10% of the extreme surface
- (ii) : Coating with mixed and discontinuous layers, layer (c) occupying more than 10% of the extreme surface

Resistance spot welding was performed by superposing two parts and joining them in the following conditions:

- Squeeze force and welding force : 4000 N
- Squeeze time: 50 periods
- Welding and holding time: 18 periods respectively

In each condition, the suitable intensity range was determined for obtaining:

- No sputter during welding
- Acceptable nugget size.

For the condition i), the weldability range, expressed in terms of current intensity, is 1,4kA. For the condition ii) the weldability range is extremely small.

Thus, it may be seen that the coating according to the invention, yields much more satisfactory results.

Example 3 :

In a third example of implementation, a cold rolled steel sheet of the example 1 was cut into blanks of 500x500mm² which were heated at 920°C, during 6mn, then hot stamped and cooled in tools, in such conditions that two different cooling rates were obtained :

- (A): Cooling rate: V_A= 30°C/s
- (B) : Cooling rate: V_B = 60°C/s

Due to the shape of he parts, different deformation levels ε were created during hot stamping. In particular, some zones largely strained display deformation levels higher than 30%.

- As illustrated on figure 3, metallographic observations reveal that when ε >10%, partial bainitic or ferritic transformation occurs on parts cooled with V_A= 30°C/s, mainly on former austenitic grain boundaries. On the other hand, the parts cooled with V_B= 60°C/s display fully martensitic microstructure as illustrated on figure 4. The latter structures display superior mechanic resistance and a great homogeneity in the case of mechanical solicitation.

Thus, even in products or parts where straining is larger than 10%, the application of cooling according to the invention guarantees a microstructural and mechanical homogeneity.

Example 4:

In a fourth example of implementation, steel castings containing different values of sulfur, were elaborated. These steels were further hot rolled, then cold rolled steel into sheets, 2,2mm thick. Sulfur content varies from 11ppm (0,0011%) to 59ppm (0,006%) in weight. Apart sulfur, the compositions of these different steel castings comprise in weight:

0,24% carbon, 1,17% manganese, 0,01% phosphorus, 0,25% silicon, 0,045% aluminum, 0,01% copper, 0,02% nickel, 0,2% chromium, 0,04% titanium, 0,003% boron, 0,002% calcium, the remainder being iron and unavoidable impurities.

These sheets were pre-coated with an aluminum-based alloy of composition comprising 9,3% silicon, 2.8% iron, the remainder being aluminum and unavoidable impurities.

The sheets were afterwards cut into blanks which were heated at 950°C for 5mn, then hot stamped and cooled in tools in order to obtain a full martensitic structure. Mechanical resistance exceeded 1450 MPa.

Specimens were extracted according to the transverse sense of rolling direction and submitted to a bending test with alternate bending modes. The inventors put into evidence that the critical bending angle (angle at fracture) is closely related to the sulfur content of the steel: when sulfur content is lower than 0,002%, the bending angle exceeds 60°, which indicates higher ductility and energy absorption.

Compact Tensile-Test type specimens were also extracted according to the transverse rolling direction in order to measure the resistance to tearing, i.e. the energy which is necessary for the initiation or propagation of an existing crack. The results, illustrated on figure 6, indicate that a initiation energy higher than 18 Joules is achieved when sulfur content is lower than 0,002% in weight.

As these qualities of high resistance, high energy absorption and weldability are required in automobile industry, the parts or products fabricated according to the invention will be used with profit for such applications.

While the above description is clear with regard to the understanding of the invention, the following terms as used in the following list of preferred embodiments and claims have the following noted meanings in order to avoid any confusion:

pre-coating – the material (Al or Al alloy) coated on or located on at least a portion of the strip or sheet, etc., of base steel to form a pre-coating/base composite, the composite not having been subjected to an alliation reaction between the coated Al or Al alloy material and base steel

alliation – a reaction between the pre-coating and base steel, to produce at least one intermediate layer different in composition from both the base steel and the pre-coating. The alliation reaction happens during the heat treatment immediately preceding hot stamping . The alliation reaction affects the total thickness of the pre-coating. In a highly preferred embodiment the alliation reaction forms the following layers: (a) interdiffusion, (b) intermediate, (c) intermetallic, and (d) superficial as described above;

pre-coated steel - the pre-coating/base composite, not having been subjected to an alliation reaction between the coated material and base steel;

coating – the pre-coating after having been subjected to an alliation reaction between the pre-coating and base steel. In a highly preferred embodiment the coating comprises layers (a) interdiffusion, (b) intermediate, (c) intermetallic, and (d) superficial described above;

coated steel or product - the pre-coated steel or product that has been subjected to an alliation reaction between the pre-coating and base steel. In a highly preferred embodiment the coated steel is a strip or sheet, etc., of base steel having thereon an invention coating comprising layers (a) interdiffusion, (b) intermediate, (c) intermetallic, and (d) superficial described above;

blank – a shape cut from a strip.

product – a stamped blank

Thus, the present invention provides, among other things, the following preferred embodiments:

ABSTRACT

Coated steel having a well defined and uniform thickness is useful and advantageous for preparing products by hot stamping. Products prepared by hot stamping such a steel are particularly advantageous when subjected to a subsequent spot welding step.

COATED STEEL STRIPS, METHODS OF MAKING THE SAME, METHODS OF USING THE SAME, STAMPING BLANKS PREPARED FROM THE SAME, STAMPED PRODUCTS PREPARED FROM THE SAME, AND ARTICLES OF MANUFACTURE WHICH CONTAIN SUCH A STAMPED PRODUCT

FIELD OF THE INVENTION

The present invention relates to, among other things, coated steels, methods of making such coated steels, including hot dipping, methods of using such coated steels, stamping blanks prepared from coated steels, stamped products prepared from coated steels, and to various uses of the invention products such as in spot welding, etc.

Additional advantages and other features of the present invention will be set forth in part in the description that follows and in part will become apparent to those having ordinary skill in the art upon examination of the following or may be learned from the practice of the present invention. The advantages of the present invention may be realized and obtained as particularly pointed out in the appended claims. As will be realized, the present invention is capable of other and different embodiments, and its several details are capable of modifications in various obvious respects, all without departing from the present invention. The description is to be regarded as illustrative in nature, and not as restrictive.

BACKGROUND OF THE INVENTION

In recent years the use of pre-coated steels in hot-stamping processes for the shaping of parts has become important, especially in the automotive industry. Fabrication of such parts may include the following main steps:

- Pre-coating of a steel sheets, by hot dipping
- Trimming or cutting for obtaining blanks

- Heating the blanks in order to obtain alloying of the steel substrate with the pre-coating, as well as the austenitizing of the steel
- Hot forming followed by rapid cooling of the part in order to obtain predominantly martensitic structures

See for Example U.S. 6,296,805, incorporated herein by reference.

Thanks to an alloying of the pre-coating with the steel substrate, which has the effect of creating intermetallic alloys with high melting temperature, the blanks having such coating may be heated in a temperature range where austenitizing of the metallic substrate takes place, allowing further hardening by quenching.

Heat treatments of the blanks in view of the intermetallic alloying of the coating and austenitizing of the substrate are most frequently performed in furnaces, where blanks are traveling on rollers. The thermal cycles experienced by the blanks include first a heating phase whose rate is a function of parameters such as blank thickness, furnace temperature, traveling speed, and coating reflectivity. After this heating phase, thermal cycles generally include a holding phase, whose temperature is the regulation temperature of the furnace. Problems however are experienced with the furnace operation: the rollers may become fouled by metallic deposits which come from the pre-coating of the blanks. If these deposits are excessive, maintenance of the rollers has to be performed and productivity is decreased.

Parts obtained after heating and rapid cooling display very high mechanical resistance and may be used for structural applications, for example for automotive industry applications. These parts must be frequently welded with others and high weldability is required. This means that:

- The welding operation should be performable in a sufficiently wide operating range in order to guarantee that an eventual drift of the nominal welding parameters has no incidence on weld quality. For resistance welding, which is very common in the automotive industry, an operating welding range is defined by the combination of parameters: welding current intensity I and force F applied of the parts during welding being among the most important. A proper combination of these parameters helps to ensure that insufficient nugget diameter is

not obtained (caused by too low intensity or too low force) and that no weld expulsion occurs.

- The welding operation should also be performed in such a way that high mechanical resistance is obtained on the weld. This mechanical resistance may be evaluated by tests such as by shear-tensile tests or cross-tensile tests.

There remains a need for coated steels which may be conveniently used to prepare shaped parts by a stamping process. There also remains a need for coated steels which may be used to prepare shaped parts by a stamping process which are suitable for welding. There also remains a need for processes for preparing such coated steels and stamped parts.

SUMMARY OF THE INVENTION

The inventors have discovered that certain coated steels in which a base steel strip is at least partially coated (sometimes termed "pre-coated," this prefix indicating that a transformation of the nature of the pre-coating will take place during heat treatment before stamping) on at least one side with a coating of either aluminum or an aluminum alloy and in which the coating has a defined thickness and is preferably substantially uniform, are conveniently formed into shaped parts after heating by stamping and are conveniently welded. In addition, the inventors have discovered that the roller fouling problem described above generally arises from an insufficient degree of intermetallic alloying between the substrate and the metallic pre-coating. Furthermore, it was discovered that the location of the fouling of the rollers corresponds to zones of the blanks in contact with the rollers where the metallic pre-coating thickness locally exceeds the average thickness. While not bound by a particular theory, it is believed that if a pre-coating is locally too thick, intermetallic alloying is insufficient and the pre-coating melts, fouling the rollers. Thus, the inventors have discovered that the control of the homogeneity of the pre-coating thickness over the entire sheet within given tolerances is an important factor for obtaining the desired degree of intermetallic alloying, allowing one to improve the resistance to the subsequent melting of the coating during travel on rollers.

The inventors have also discovered that particularly good weldability of aluminized and hot stamped parts is associated with a special succession of coating layers on the parts, proceeding from steel substrate outwards.

The inventors have also discovered that a specific combination of transfer time between the heating furnace and the stamping die, the amount of deformation during stamping, the temperature of stamping, the cooling rate of the product during stamping, leads to the fabrication of a part with a fully homogeneous martensitic structure and that an increase in ductility or energy absorption of the parts after stamping is obtained by a reduction of sulfur below a critical value, these two benefits being obtained with or without the invention aluminum/aluminum alloy coating, and with other coatings.

OBJECTS OF THE INVENTION

Accordingly, and in view of the above, it is one object of the present invention to provide novel pre-coated steels strips which may be conveniently processed into stamping blanks.

It is another object of the present invention to provide novel pre-coated steels strips or sheets which may be conveniently formed into parts by stamping.

It is another object of the present invention to provide novel coated steels which may be conveniently formed into parts by hot stamping.

It is another object of the present invention to provide novel methods for making such a coated steel.

It is another object of the present invention to provide novel stamping blanks which are prepared from such a coated steel.

It is another object of the present invention to provide novel methods of making such stamping blanks.

It is another object of the present invention to provide novel stamped parts which are prepared from such a coated steel.

It is another object of the present invention to provide novel methods of making such stamped parts.

It is another object of the present invention to provide novel articles of manufacture, such as a motor vehicle, which contain such stamped parts.

It is another object of the present invention to provide novel stamped parts.

It is another object of the present invention to provide novel methods of making welded stamped parts.

It is another object of the present invention to provide novel articles of manufacture, such as a motor vehicle, which contain such welded stamped parts.

It is another object of the present invention to provide novel welded coated steels and welded stamping blanks.

It is another object of the present invention to provide novel methods of making such welded coated steels and welded stamping blanks.

These and other objects, which will become apparent during the following detailed description.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 illustrates a preferred embodiment of an invention coated part, after heat treatment and stamping. The succession of layers of the coating on the steel substrate is: (a) interdiffusion layer; (b) intermediate layer; (c) Intermetallic layer; and (d) superficial layer. This arrangement is particularly favorable for the further welding of the part.

Figure 2 illustrates a coating of a steel substrate after heat treatment and stamping which does not correspond to the invention. This succession of layers (interdiffusion layer and intermetallic layer) yields inferior results in resistance spot welding.

Figure 3 illustrates a microstructure of a steel part, hot stamped and cooled under conditions not according to the invention.

Figure 4 illustrates the microstructure of a steel part, hot stamped and cooled according to a preferred set of conditions according to the invention.

Figure 5 illustrates the influence of sulfur on the bending angle of parts after hot stamping.

Figure 6 illustrates the influence of sulfur on the initiation energy of fracture of parts after hot stamping.

Figure 7 shows conditions of furnace temperature as a function of the total dwell time in the furnace for sheets of total thicknesses of from 0.7-1.5 and 1.5-3 mm that provide particularly favorable coatings for welding.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

As noted above, the inventors' discovery that certain coated steels, in which a base steel is at least partially pre-coated on at least one side with a coating of either aluminum or an aluminum alloy and in which the pre-coating has a defined thickness and is substantially uniform, are conveniently formed into shaped parts by stamping, forms one basis for the invention.

In the context of the present invention, the terms first side (or side 1) and second side (or side 2) of the strip or sheet, etc., of base steel refer to the two large, opposite-facing, surfaces which have a surface area defined by the length and width of the strip of base steel. In contrast, the side edges of the strip of base steel are the two small, opposite-facing, surfaces which have a surface area defined by the length and thickness of the strip. The top and bottom edges of the strip of base steel are the two small, opposite-facing, surfaces which have a surface area defined by the width and thickness of the strip. In the following, t_p designates the thickness of the pre-coating, at any considered location on the sides 1 and 2 of a sheet or a blank. In particular, in the case of sheets coated on two sides 1 and 2, t_{p1} stands for the thickness on side 1, and t_{p2} for the thickness on side 2.

According to a highly preferred embodiment t_p is controlled in a precise range, expressed by (t_{pmin}, t_{pmax}), in order to improve the resistance to the fouling of the rollers. The thickness is preferably controlled, both in the longitudinal (or rolling) direction of the strip or sheet, as well in the transverse direction.

In relation to the problem of the fouling of rollers, the control of the pre-coating thickness on the side of the sheet or blank which is directly in contact with the rollers is especially important. Because different operations can follow the step of coating the steel sheet (for example hot-dip-coating which provides coated sides 1 and 2), it is preferable to carefully control the pre-coating on both sides of the sheet. For example, after any of coiling,

handling, cutting, punching, etc., sides 1 and 2 may be not readily identifiable. But when control of t_p is effected on the two sides of the sheet that has been coated (first side and second side) it is not necessary to track sides 1 and 2 as neither side will foul the roller. In addition, it is not necessary to trim the sheet in order to obtain a preferred smaller sheet having a more uniform homogeneity of pre-coating thickness, thus providing a sheet that is pre-coated by, e.g., hot-dipping. In other words, important benefits are obtained when one controls the pre-coating minimum and maximum thickness of the first side (t_{pmin1} , t_{pmax1}) and the pre-coating minimum and maximum thickness of the second side (t_{pmin2} , t_{pmax2}) of the subject steel sheet or blank.

Hot-dip coated steels are the preferred steels herein. However, regardless of the coating method, the pre-coating thickness on one or both sides of the sheet can be measured and monitored continuously on a coating line directly after the coating operation. This may be realized by devices known per se, such as thickness gages relying on X-Ray absorption. At every moment, the measurement of thickness at a given location may be performed for example on an area of a few hundreds of mm^2, this representing the dimension of the zone irradiated by X-Ray.

In a preferred embodiment, a plurality of such devices are positioned at different distances in the transverse direction of the strip in order to obtain a profile of the thickness of the pre-coating along the strip width.

The inventors have discovered that the resistance to the pollution or fouling of the rollers in the furnaces is improved when the minimum and maximum thickness respectively of at least one of the first side (t_{pmin1}, t_{pmax1}) and the second side (t_{pmin2}, t_{pmax2}) are respectively equal to 20 and 33 micrometers (a micrometer is the same as a micron and is a metric unit of length equal to one millionth of a meter). In other words, in a preferred embodiment, at every location on at least one face of the sheet or the blank, the thickness t_p of the pre-coating is preferably from 20 - 33 micrometers in thickness, including 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31 and 32 micrometers and all ranges and subranges therebetween, and including all numbers between each listed value as if written out in its entirety (e.g., 22.34 micrometers). For hot-dip coating, precise control of this range of pre-coating

thickness can be realized on an operating line for example using a system of nozzles blowing gas after coating, for example after exit of the strip or sheet from a bath, and by the flatness of the strip. Number, geometry and location of the nozzles, and flow rates are among the main parameters for a precise control of the thickness t_p. Given the present disclosure, one of ordinary skill in this art can control the pre-coating thickness as described herein without undue labor.

The invention refers to strips produced in industrial conditions, i.e. where control of pre-coating thickness is effective over a wide surface strip, i.e. with a length greater than 100m, and with a width greater than 600mm. In such a way, blanks cut or trimmed out these strips display very high homogeneity of pre-coating thickness, and the settings of the heating treatments in the furnace do not have to be changed for being adapted to eventual variations of this thickness.

While not bound by a particular theory of operation, the inventors believe that several of the benefits of the invention are related to this pre-coating thickness range, such as the following :

- For a pre-coating thickness less than 20 micrometers, the alloyed layer which is formed during the heating of the blank has an insufficient roughness. Thus, the adhesion of subsequent painting is low on this surface, and the corrosion resistance is decreased.

- If the pre-coating thickness is more than 33 micrometers at a given location on a sheet, the risk is that the difference of thickness between this location and some other locations where the pre-coating is thinner, becomes too important : The settings of the heating treatment in the furnace may be adapted to the thinner value of the pre-coating, but not to the thicker one. Thus, the alloying reaction forming the intermetallic alloy may take place to an insufficient degree since the mean diffusion distance of the elements in the pre-coating becomes significantly less than the local value of the pre-coating thickness. As a matter of results, alloying will become much more difficult in the external (or superficial) part, particularly in the case of high heating rate.

Thus, in a first embodiment, the present invention provides certain coated steel strips, which comprise a strip of base steel and a pre-coating of

aluminum or an aluminum alloy on at least a part of one side of the strip of the base steel. For many applications, the strip of base steel may comprise any type of steel which may be coated with either aluminum or an aluminum alloy. However, for certain applications, such as a structural part of an automobile, it is preferred that the strip of base steel comprise an ultra high strength steel (UHSS). In such cases, it is particularly preferred that the strip of base steel comprises a boron steel.

The inventors have also discovered that good welding results are achieved if the coating obtained on parts made out of blanks having undergone intermetallic alloying, austenitizing and hot stamping, displays distinctive features. It must be pointed out that this coating is different from the initial pre-coating, since the thermal treatment causes an alloying reaction with the steel substrate which modifies both the physico-chemical nature and the geometry of the pre-coating : in this regard, the inventors have discovered that particularly good weldability of aluminized and hot stamped parts is associated with the following succession of coating layers on the parts, proceeding from steel substrate outwards :

- (a) Interdiffusion layer,
- (b) Intermediate layer,
- (c) Intermetallic layer,
- (d) Superficial layer

See, e.g., Figure 1. In a preferred embodiment these layers are as follows:

- (a) Interdiffusion layer, preferably with medium hardness (e.g., HV50g between 290 and 410, HV50g designating the hardness measured under a load of 50 grams) In a preferred embodiment this layer has the following composition, by weight : 86-95%Fe, 4-10%Al, 0-5%Si
- (b) Intermediate layer (HV50g around 900 - 1000 e.g., +/- 10%))
  In a preferred embodiment this layer has the following composition, by weight : 39-47% Fe, 53-61%Al, 0-2%Si
- (c) Intermetallic layer, with hardness HV50g around 580-650, e.g., +/- 10%)
  In a preferred embodiment this layer has the following composition, by weight : 62-67%Fe, 30-34 %Al, 2-6%Si
- (d) Superficial layer (HV50g around 900 - 1000 e.g., +/- 10%))

In a preferred embodiment this layer has the following composition, by weight : 39-47% Fe, 53-61%Al, 0-2%

In a preferred embodiment the total thickness of layers (a) to (d) is greater than 30 micrometers.

In another preferred embodiment, the thickness of layer (a) is less than 15 micrometers, for example 14, 12, 10, 8, 6, 4, 2, or 1 micrometers, and all whole numbers, ranges and subranges therebetween, and including all numbers between each listed value as if written out in its entirety (e.g., 13.84 micrometers).

The inventors have discovered that high weldability is especially obtained when layers (c) and (d) are essentially continuous (i.e.: occupying at least 90% of the level corresponding to the considered layer) and when less than 10% of layer (c) is present at the extreme surface of the part. Without being bound by a theory, it is thought that this particular layer disposal, in particular layer (a) and layers (c) and (d) influence the resistivity of the coating both by their intrinsic characteristics and by the effect of roughness. Thus, current flow, heat generation at the surfaces, and nugget formation in the initial stage of spot welding are affected by this particular arrangement.

This favorable layer disposition is obtained for example when aluminum- or aluminum alloy pre-coated steel sheets, whose thickness range from, e.g., 0.7 to 3mm, are heated for 3 to 13 minutes (this dwell time includes the heating phase and the holding time) in a furnace heated to a temperature of 880 to 940°C. Other conditions leading to such favorable layer dispositions are found in Figure 7:

For sheets of total thicknesses greater or equal to 0.7mm, and less than or equal to 1.5mm, the preferred treatment conditions : (furnace temperature, total dwell time in the furnace) are illustrated in figure 7 by conditions lying within the limits of diagram "ABCD"

For sheets of total thicknesses greater than 1.5mm, and less than or equal to 3mm, the preferred treatment conditions : (furnace temperature, total dwell time in the furnace) are illustrated in figure 7 by diagram "EFGH" .

The heating rate V_c is comprised between 4 and 12°C/s for producing a favorable alloyed layer disposition. In this regard, this "heating rate" reflects

the temperature rise which is experienced by the pre-coated steel upon being located in the preheated furnace. V_c is defined as the mean heating rate between 20 and 700°C. The inventors have discovered that the control of V_c in this precise range is a key factor, because it controls directly the nature and the morphology of the alloyed layers which are formed. It is here underlined that the heating rate V_c is different from the mean heating rate, which is the heating rate between room temperature and furnace temperature. The rates of 6, 7, 8, 9, 10, and 11 °C/s are included as are all numbers, ranges and subranges therebetween, and including all numbers between each listed value as if written out in its entirety (e.g., 7.7 °C/s). In this regard, all of the conditions specified within Figure 7 are incorporated herein by reference thereto. Particularly preferred conditions are:

(for thicknesses of 0.7-1.5mm)

- 930°C, from 3 minutes up to 6 minutes;
- 880°C, from 4 minutes 30 seconds up to 13 minutes

(for thicknesses of 1.5 to 3 mm)

- 940°C, from 4 minutes up to 8 minutes;
- 900°C, from 6 minutes 30 seconds up to 13 minutes

A special advantage arises from pre-coatings whose thickness is comprised between 20 and 33 micrometers, since this thickness range yields favorable layer disposal, and since the homogeneity of the pre-coating thickness is associated to an homogeneity of the coating formed after alliation treatment.

Heated blanks are thereafter transferred to a die, hot stamped to obtain a part or product, and cooled at a rate of more than 30°C/s. The cooling rate is defined here as the mean rate between the exit of the heated blank from the furnace, down to 400°C.

The strip of base steel is coated with either aluminum or an aluminum alloy. Commercially pure aluminum is known in the art as Type 2 aluminum, while alloys of aluminum with 5 to 11 % by weight of silicon are known in the art as Type 1 aluminum. Silicon is present in order to prevent the formation of a thick iron-metallic intermetallic layer which reduces adherence and formability. Other alloying elements useful with aluminum herein include iron,

between 2.5 and 3% by weight, and calcium, between 15 and 30ppm by weight, including combinations of two or more thereof with aluminum.

A typical metal bath for an Al-Si coating generally contains in its basic composition by weight, from 8% to 11% silicon, from 2% to 4% iron, the remainder being aluminum or aluminum alloy, and impurities inherent in processing. Typical composition of Al-Si coating is: Al-9,3%Si-2,8%Fe. Invention coatings are not limited to these compositions, however.

The strip of base steel used herein may be any which can be coated by a conventional coating technique. For example, the strip of base steel may be any hot rolled strip, such as those prepared by hot rolling a steel slab (either with or without subsequent cold rolling). Typically, the strip of base steel will be stored and transported in the form of a coil both before and after the formation of the coating.

An example of a preferred steel for the strip of base steel is one having the following composition by weight:

0.10% < carbon < 0.5%
0.5% < manganese < 3%
0.1% < silicon < 1%
0.01% < chromium < 1%
titanium < 0.2%
aluminum < 0.1%
phosphorus < 0.1%
sulfur < 0.05%
0.0005% < boron < 0.010%,

the remainder comprising, consisting essentially of, or consisting of iron and impurities inherent in processing. Use of such a steel provides a very high mechanical resistance after thermal treatment and the aluminum-based coating provides a high resistance to corrosion.

Particularly preferably, the composition by weight of the steel in the strip of base steel is the following:

0.15% < carbon < 0.25%
0.8% < manganese < 1.8%
0.1% < silicon < 0.35%

0.01% < chromium < 0.5%
titanium < 0.1%
aluminum < 0.1%
phosphorus < 0.1%
sulfur < 0.05%
0.002% < boron < 0.005%,

the remainder comprising, consisting essentially of, or consisting of iron and impurities inherent in processing.

A preferred strip herein is 100 m long and 600mm wide. Preferred thicknesses are 0.7 to 3 mm.

Even more preferably, in the composition by weight of the sheet, the weight ratio of titanium content with respect to the nitrogen content is in excess of 3.42, believed to be a level at which the boron is no longer able to combine with the nitrogen.

An example of preferred commercially available steel for use in the strip of base steel is 22MnB5.

Chromium, manganese, boron and carbon may be added, in the composition of the steel according to the invention, for their effect on hardenability. In addition, carbon makes it possible to achieve high mechanical characteristics thanks to its effect on the hardness of the martensite.

Aluminum is introduced into the composition, to perform deoxidation in the liquid state and to protect the effectiveness of the boron.

Titanium, the ratio of the content of which with respect to the nitrogen content should be in excess of 3.42, is introduced for example in order to prevent combining of the boron with the nitrogen, the nitrogen being combined with titanium.

The alloying elements, Mn, Cr, B, make possible a hardenability allowing hardening in the stamping tools or the use of mild hardening fluids limiting deformation of the parts at the time of thermal treatment. In addition, the composition according to the invention is optimized from the point of view of weldability.

The steel in the sheet may undergo a treatment for globularization of sulfides performed with calcium, which has the effect of improving the fatigue resistance of the sheet.

As mentioned above, ultra-high-strength can be provided with the steel sheet coated and hot stamped according to the invention. This high level of strength is sometimes associated with a limited ductility. In applications requiring a higher ductility, in particular when an ability for bending is required from a part or a product, the inventors have discovered that increased ductility can be obtained if sulfur is particularly controlled: when the sulfur level of base steel is lower than or equal to 0.002% (20 ppm), the bending angle can be greater than 60° and enhanced ductility and tearing resistance are obtained on the parts having experienced heat treatment and stamping. Preferred levels include 20, 18, 15, 13, 10, 8, 5, 2, etc ppm sulfur. In fact, this benefit applies to steels in general, and is not limited to coated steels or to steels coated with Al or Al alloy coatings. While not bound by a particular theory, when analyzing causes of premature failure of some parts in bending operations, the inventors observed that failure initiated on sulfide inclusions. It is thus believed that decohesions between inclusions and the martensitic or bainito-martensitic matrix act as stress-concentration factors and trigger further crack propagation in the ductile mode.

The invention also concerns a process for producing a part starting from an invention coated sheet, then cut into a blank which, after shaping, the coating of the blank is subjected to an increase in temperature at a speed in excess of 4°C/second, but lower than 12°C/second. The heating rate V_c is defined as the mean rate between 20 and 700°C.

The invention also concerns the use of a hot-rolled steel sheet which then can be cold-rolled and coated, for structural and/or anti-intrusion or substructure parts for a land motor vehicle, such as, for example, a bumper bar, a door reinforcement, a wheel spoke, etc.

The sheet according to the invention described above can derive, by reason of its processing, from a hot-rolling mill, and possibly may be cold-rerolled again depending on the final thickness desired. It then is coated with an aluminum-based coating, for example by dipping in a bath containing, in

addition to the aluminum source/alloy, e.g., from 8% to 11% silicon and from 2% to 4% iron, the sheet having a high mechanical resistance after thermal treatment and a high resistance to corrosion, as well as a good capacity for painting and gluing.

The coating is preferably controlled as above, and has in particular the function of protecting the basic sheet against corrosion in various conditions. The thermal treatment applied at the time of a hot-forming process or after forming makes it possible to obtain high mechanical characteristics which can exceed 1500 MPa for mechanical resistance and 1200 MPa for yield stress. The final mechanical characteristics are adjustable and depend in particular on the martensite fraction of the structure, on the carbon content of the steel and on the thermal treatment. At the time of thermal treatment performed on a finished part or at the time of a hot-shaping process, the coating forms a layer having a substantial resistance to abrasion, wear, fatigue, shock, as well as a good resistance to corrosion and a good capacity for painting and gluing. The coating makes it possible to avoid different surface-preparation operations such as for steel sheets for thermal treatment not having any coating.

The steel sheet can be pre-coated by dipping, after pickling, in an aluminum bath containing for example only aluminum or either aluminum and from 8% to 11% silicon and 2% to 4% iron, or only from 2% to 4% iron, or even in an aluminum bath preferably containing from 9% to 10% silicon and 2% to 3.5% iron. The aluminum may be aluminum per se or an aluminum alloy.

In an example of implementation of a coating of the sheet by dipping in a metal bath containing an aluminum alloy comprising a proportion of approximately 90% aluminum, the coating layer comprises a first alloy layer in contact with the surface of the steel. This layer, directly in contact with the surface of the sheet, is highly alloyed with iron.

A second coating layer, on top of the first, contains approximately 90% aluminum and may contain silicon and a small amount of iron, depending on the composition of the bath.

The first alloy layer may crack when the sheet is submitted to high strains during cold forming operations of the manufacture of parts.

According to the invention, after the forming of the part, the coating is subjected to an increase in temperature at a speed in excess of 4°C /second. This rise in temperature makes possible a rapid remelting of the aluminum which fills in the cracks generated by the operation of shaping of the part.

At the time of thermal treatment, the base coating, of aluminum for example, is transformed into a layer alloyed with iron and comprising different phases depending on the thermal treatment and having a considerable hardness which may exceed 600 HV50 g.

Another advantage of the invention lies in the fact that the diffusion of the iron in the coating is initiated at high temperature. One thus will have a better cohesion between coating and steel in the sheet. In another form of the invention, the thermal treatment may be performed locally, in heavily deformed zones.

According to the invention, the sheet, in the delivery state in a coil or in a sheet, the thickness of which may range between 0.25 mm and 15 mm, has good forming properties and a good resistance to corrosion as well as a good capacity for painting or gluing. Preferably, the steel sheet or blank has a thickness less than 3 mm, since the cooling rates that may be achieved after quenching are high and help to obtain martensitic structures.

The steel sheet, a coated product, has a substantial resistance to corrosion in the delivery state, during forming and thermal treatments as well as during usage of the finished part.

The presence of the coating at the time of thermal treatment of the parts makes it possible to prevent any decarburization of the base metal as well as any oxidation. That is an undeniable advantage, in particular in the case of hot forming. Furthermore, heating of the treated part does not require a furnace having a controlled atmosphere to prevent a decarburization.

Thermal treatment of the metal in the sheet comprising heating at a temperature ranging between Ac1, starting temperature of austenitic transformation when heating, for example 750°C and 1200°C, in a furnace, for a period which depends on the temperature to be reached and the thickness of the blank. The composition is optimized so as to limit the grain growth at the time of thermal treatment. If the structure sought is completely

martensitic, the holding temperature should be in excess of Ac3, for example 840°C, temperature of complete austenitic transformation. The temperature holding should be followed by a cooling adjusted to the final structure sought.

Blanks are thereafter transferred from the furnace to a stamping press. When the elapsed time between the exit of the blanks from the furnace and the introduction in the stamping press is more 10 seconds, a partial transformation from austenite is susceptible to appear: if obtaining a full martensitic structure is desired, the transfer time between the exit of the furnace and stamping should be less than 10s.

The inventors have also discovered that the obtaining of a fully martensitic structure is linked to the amount of deformation in the hot forming operation: the amount of local deformation caused by hot forming is closely linked to the shape of the part or product and may exceed locally 40 or 50% in some particular regions. The inventors found that, when the local strain exceeds a critical value of 10%, the cooling rate must be sufficiently high in order to get a total martensitic transformation. Otherwise, bainitic transformation can take place at a significant amount instead of martensitic transformation. Thus, the risk is that heterogeneous structure appears on parts with complex shape where some locations are much more deformed than others. In this respect, the inventors put into evidence that, on the locations of the parts where the forming strain is higher than 10%, the cooling rate must be increased beyond 50°C/s in order to guarantee full martensitic transformation. The cooling rate is defined as the mean rate between the exit of the heated blank from the furnace, down to 400°C.

But one may also seek to obtain ferrito-bainitic or ferrito-martensitic structures, by a heating at a temperature ranging between Ac1, for example 750°C and Ac3, for example 840°C, followed by an appropriate cooling. According to the level of resistance to be achieved and the thermal treatment applied, one or several of these constituents is/are present in variable proportions.

The modulation of thermal treatment parameters makes it possible to achieve, with a given composition, different levels of hot and cold sheet

resistance according to the thickness sought. For the highest resistance levels, the structure is composed predominantly of martensite.

The steel is particularly suited to the production of structural and anti-intrusion parts.

The invention thus enables one to produce a hot- or cold-rolled steel sheet of a desired thickness, coated, and affording extensive forming possibilities and which, after thermal treatment performed on the finished part, makes it possible to obtain a mechanical resistance in excess of 1000 MPa, a substantial resistance to shocks, fatigue, abrasion and wear, while retaining a good resistance to corrosion as well as a good capacity for welding, painting and gluing.

The present invention will now be further described by way a certain exemplary embodiments which are not intended to be limiting.

EXAMPLES

Example 1 :

In a first example of implementation, a cold rolled steel sheet, 1.9 mm thick, containing by weight: 0.23 % carbon, 1.25% manganese, 0.017% phosphorus, 0.002% sulfur, 0.27% silicon, 0.062% aluminum, 0.021% copper, 0.019% nickel, 0.208% chromium, 0.005% nitrogen, 0.038% titanium, 0.004% boron, 0.003% calcium–has been pre-coated with an aluminum-based alloy with composition 9.3% silicon, 2.8% iron, the remainder being aluminum and unavoidable impurities. According to the conditions of fabrication, namely the settings of the blowing devices on the operating line, sheets of 120m long and 650mm wide with various thickness ranges were produced.

- Sheet A (according to the invention): The thickness t_{p1} and t_{p2} on each side of the sheet was controlled to be within the range (20-33) micrometers, at every location of the two faces of the sheet, both in the longitudinal (or rolling) direction and in the transversal direction. Measurement was performed continuously with thickness gages devices relying on X-Ray emission. At every moment, the spot of measurement of each gage was a circular zone of about 20mm radius. The sheets were afterwards cut into blanks of 1.2 x 0.5m² of overall dimensions.

- Sheet B (reference): On these sheets, the pre-coating thickness had a wider variability since the thickness t_{p1} and t_{p2} on the two sides of the sheet was comprised in the range (30-45) micrometers. Blanks cut out of these sheets exhibit the same pre-coating thickness.

The blanks were then submitted to heating in a furnace at T=920°C. Heating time was 3 min, with 4 mn holding time. The microstructure is then fully austenitic. Blanks were thereafter transferred from the furnace to a stamping press. When the elapsed time between the exit of the blanks from the furnace and the transfer in the stamping press is more 10 seconds, a partial transformation from austenite was susceptible to appear, thus reducing the mechanical resistance of the stamped part.

The blanks were directly cooled afterwards without hot stamping in order to appreciate the eventual remelting of the coating

On series A, no melting of the pre-coating was found. Intermetallic alloying between the pre-coating and the steel substrate occurred completely.

On series B, the pre-coating underwent mainly alloying, but some traces of remelting were found, particularly on the former thicker locations of the pre-coating. This partial remelting of the aluminium pre-coating contributes to the progressive fouling of the rollers in the furnace. The sheets according to the invention do not contribute to this progressive buildup on the rollers.

Example 2 :

i) Conditions according to the invention: In a second example of implementation, a cold rolled steel sheet, 1,2mm thick, 120m long and 650mm wide, with same composition and same pre-coating as in example 1, has been fabricated. The sheets were afterwards cut into blanks which were heated at 920°C for 6mn, this time including the heating phase and the holding time. Heating rate V_c between 20 and 700°C was 10°C/s. The blanks were finally hot stamped and quenched in order to obtain full martensitic structures.

The parts obtained after hot-stamping are covered by a coating, 40 micrometers thick, illustrated at figure 1, which has a four layer structure. Starting from the steel substrate, the layers are the following:

- (a) Interdiffusion layer or intermetallic layer, 17 micrometers thick. This layer is itself composed of two sub-layers. Hardness HV50g ranges from 295 to 407, and the mean composition is: 90%Fe, 7%Al, 3%Si.
- (b) Intermediate layer, appearing darker, 8 micrometers thick. This layer has a hardness of 940HV50g and a mean composition, by weight : 43%Fe, 57%Al, 1%Si.
- (c) Intermetallic layer appearing as a pale phase, 8 micrometers thick, displaying a hardness of 610HV50g, a mean composition of 65%Fe, 31%Al, 4%Si
- (d) Darker superficial layer, 7 micrometers thick, 950 HV50g, with a mean composition of 45%Fe, 54%Al, 1%Si

Layers (c) and (d) are quasi-continuous, i.e. occupying at least 90% of the level corresponding to the considered layer. In particular, layer (c) does not reach the extreme surface except very exceptionally. Anyway, this layer (c) occupies less than 10% of the extreme surface.

ii) Conditions of reference: On the other hand, blanks with the same base material and pre-coating parts were furnace-heated in different conditions: The blanks were heated to 950°C for 7 minutes, this time including the heating phase. Heating rate V_c was 11°C/s. These conditions correspond to a degree of alloying which is more important than in conditions (i)

- In this coating, the pale intermetallic layer (c), is not continuous and appears as to be scattered within the coating. About 50% of this layer is present at the extreme surface of the part. Moreover, the interdiffusion layer, 10 micrometers thick in contact with the steel substrate is thinner than in the previous case of figure 1.

Resistance spot welding was performed in the two situations i) and ii):

- (i): Coating with quasi-continuous layers (c) and (d), layer (c) occupying less than 10% of the extreme surface
- (ii) : Coating with mixed and discontinuous layers, layer (c) occupying more than 10% of the extreme surface

Resistance spot welding was performed by superposing two parts and joining them in the following conditions:

- Squeeze force and welding force : 4000 N
- Squeeze time: 50 periods
- Welding and holding time: 18 periods respectively

In each condition, the suitable intensity range was determined for obtaining:

- No sputter during welding
- Acceptable nugget size.

For the condition i), the weldability range, expressed in terms of current intensity, is 1,4kA. For the condition ii) the weldability range is extremely small.

Thus, it may be seen that the coating according to the invention, yields much more satisfactory results.

Example 3 :

In a third example of implementation, a cold rolled steel sheet of the example 1 was cut into blanks of 500x500mm² which were heated at 920°C, during 6mn, then hot stamped and cooled in tools, in such conditions that two different cooling rates were obtained :

- (A): Cooling rate: V_A= 30°C/s
- (B) : Cooling rate: V_B = 60°C/s

Due to the shape of he parts, different deformation levels ε were created during hot stamping. In particular, some zones largely strained display deformation levels higher than 30%.

- As illustrated on figure 3, metallographic observations reveal that when ε >10%, partial bainitic or ferritic transformation occurs on parts cooled with V_A= 30°C/s, mainly on former austenitic grain boundaries. On the other hand, the parts cooled with V_B= 60°C/s display fully martensitic microstructure as illustrated on figure 4. The latter structures display superior mechanic resistance and a great homogeneity in the case of mechanical solicitation.

Thus, even in products or parts where straining is larger than 10%, the application of cooling according to the invention guarantees a microstructural and mechanical homogeneity.

Example 4:

In a fourth example of implementation, steel castings containing different values of sulfur, were elaborated. These steels were further hot rolled, then cold rolled steel into sheets, 2,2mm thick. Sulfur content varies from 11ppm (0,0011%) to 59ppm (0,006%) in weight. Apart sulfur, the compositions of these different steel castings comprise in weight:

0,24% carbon, 1,17% manganese, 0,01% phosphorus, 0,25% silicon, 0,045% aluminum, 0,01% copper, 0,02% nickel, 0,2% chromium, 0,04% titanium, 0,003% boron, 0,002% calcium, the remainder being iron and unavoidable impurities.

These sheets were pre-coated with an aluminum-based alloy of composition comprising 9,3% silicon, 2.8% iron, the remainder being aluminum and unavoidable impurities.

The sheets were afterwards cut into blanks which were heated at 950°C for 5mn, then hot stamped and cooled in tools in order to obtain a full martensitic structure. Mechanical resistance exceeded 1450 MPa.

Specimens were extracted according to the transverse sense of rolling direction and submitted to a bending test with alternate bending modes. The inventors put into evidence that the critical bending angle (angle at fracture) is closely related to the sulfur content of the steel: when sulfur content is lower than 0,002%, the bending angle exceeds 60°, which indicates higher ductility and energy absorption.

Compact Tensile-Test type specimens were also extracted according to the transverse rolling direction in order to measure the resistance to tearing, i.e. the energy which is necessary for the initiation or propagation of an existing crack. The results, illustrated on figure 6, indicate that a initiation energy higher than 18 Joules is achieved when sulfur content is lower than 0,002% in weight.

As these qualities of high resistance, high energy absorption and weldability are required in automobile industry, the parts or products fabricated according to the invention will be used with profit for such applications.

While the above description is clear with regard to the understanding of the invention, the following terms as used in the following list of preferred embodiments and claims have the following noted meanings in order to avoid any confusion:

pre-coating – the material (Al or Al alloy) coated on or located on at least a portion of the strip or sheet, etc., of base steel to form a pre-coating/base composite, the composite not having been subjected to an alliation reaction between the coated Al or Al alloy material and base steel

alliation – a reaction between the pre-coating and base steel, to produce at least one intermediate layer different in composition from both the base steel and the pre-coating. The alliation reaction happens during the heat treatment immediately preceding hot stamping . The alliation reaction affects the total thickness of the pre-coating. In a highly preferred embodiment the alliation reaction forms the following layers: (a) interdiffusion, (b) intermediate, (c) intermetallic, and (d) superficial as described above;

pre-coated steel - the pre-coating/base composite, not having been subjected to an alliation reaction between the coated material and base steel;

coating – the pre-coating after having been subjected to an alliation reaction between the pre-coating and base steel. In a highly preferred embodiment the coating comprises layers (a) interdiffusion, (b) intermediate, (c) intermetallic, and (d) superficial described above;

coated steel or product - the pre-coated steel or product that has been subjected to an alliation reaction between the pre-coating and base steel. In a highly preferred embodiment the coated steel is a strip or sheet, etc., of base steel having thereon an invention coating comprising layers (a) interdiffusion, (b) intermediate, (c) intermetallic, and (d) superficial described above;

blank – a shape cut from a strip.

product – a stamped blank

Thus, the present invention provides, among other things, the following preferred embodiments:

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(71) Applicant *(for all designated States except US)*: **ARCELOR FRANCE** [FR/FR]; Arcelor Research Intellectual Property, 1-5 rue Luigi Cherubini, F-93212 Saint Denis (FR).

(72) Inventors; and

(75) Inventors/Applicants *(for US only)*: **DRILLET, Pascal** [FR/FR], 9 chemin de Banauvignes, F-57160 Rozerieulles (FR). **SPEHNER, Dominique** [FR/FR], 72 avenue Philippoteaux, F-08200 Sedan (FR). **KEFFERSTEIN, Ronald** [FR/FR], Résidence La Brise-La Falaise n°2, F-13620 Carry Le Rouet (FR).

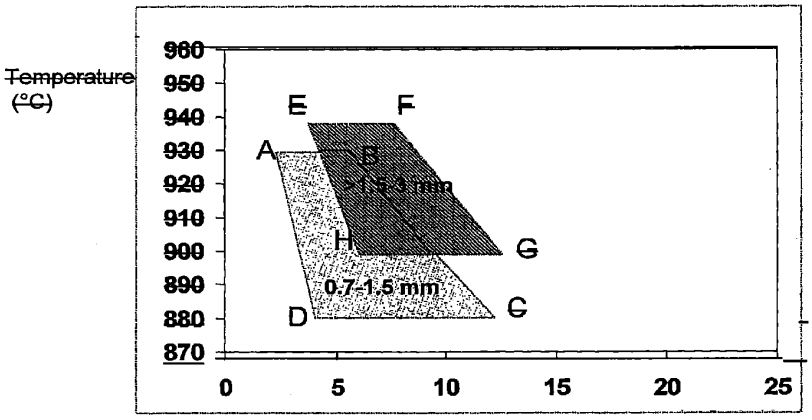
(74) Agent: **PLAISANT, Sophie**; Arcelor France, Arcelor Research Intellectual Property, 1-5 rue Luigi Cherubini, F-93200 Saint Denis (FR).

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(57) Abstract: Coated steel having a well defined and uniform thickness is useful and advantageous for preparing products by hot stamping. Products prepared by hot stamping such a steel are particularly advantageous when subjected to a subsequent spot welding step.

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OBLON, SPIVAK, MCCLELLAND MAIER & NEUSTADT, L.L.P.
1940 DUKE STREET
ALEXANDRIA, VA 22314

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Inventor(s)

Pascal DRILLET, Rozerieulles, FRANCE;
Dominique Spehner, Balan, FRANCE;
Ronald Kefferstein, Saint Mitre Les Ramparts, FRANCE;

Applicant(s)

Pascal DRILLET, Rozerieulles, FRANCE;
Dominique Spehner, Balan, FRANCE;
Ronald Kefferstein, Saint Mitre Les Ramparts, FRANCE;

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If Required, Foreign Filing License Granted: 10/01/2012
The country code and number of your priority application, to be used for filing abroad under the Paris Convention, is **US 13/621,015**
Projected Publication Date: 01/31/2013
Non-Publication Request: No
Early Publication Request: No

Title

COATED STEEL STRIPS, METHODS OF MAKING THE SAME, METHODS OF USING THE SAME, STAMPING BLANKS PREPARED FROM THE SAME, STAMPED PRODUCTS PREPARED FROM THE SAME, AND ARTICLES OF MANUFACTURE WHICH CONTAIN SUCH A STAMPED PRODUCT

Preliminary Class

365

PROTECTING YOUR INVENTION OUTSIDE THE UNITED STATES

Since the rights granted by a U.S. patent extend only throughout the territory of the United States and have no effect in a foreign country, an inventor who wishes patent protection in another country must apply for a patent in a specific country or in regional patent offices. Applicants may wish to consider the filing of an international application under the Patent Cooperation Treaty (PCT). An international (PCT) application generally has the same effect as a regular national patent application in each PCT-member country. The PCT process **simplifies** the filing of patent applications on the same invention in member countries, but **does not result** in a grant of "an international patent" and does not eliminate the need of applicants to file additional documents and fees in countries where patent protection is desired.

Almost every country has its own patent law, and a person desiring a patent in a particular country must make an application for patent in that country in accordance with its particular laws. Since the laws of many countries differ in various respects from the patent law of the United States, applicants are advised to seek guidance from specific foreign countries to ensure that patent rights are not lost prematurely.

Applicants also are advised that in the case of inventions made in the United States, the Director of the USPTO must issue a license before applicants can apply for a patent in a foreign country. The filing of a U.S. patent application serves as a request for a foreign filing license. The application's filing receipt contains further information and guidance as to the status of applicant's license for foreign filing.

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Title 35, United States Code, Section 184

Title 37, Code of Federal Regulations, 5.11 & 5.15

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PATENT APPLICATION FEE DETERMINATION RECORD

Substitute for Form PTO-875

Application or Docket Number: 13/621,015

APPLICATION AS FILED - PART I

FOR	(Column 1) NUMBER FILED	(Column 2) NUMBER EXTRA	SMALL ENTITY RATE($)	SMALL ENTITY FEE($)	OR	OTHER THAN SMALL ENTITY RATE($)	OTHER THAN SMALL ENTITY FEE($)
BASIC FEE (37 CFR 1.16(a), (b), or (c))	N/A	N/A	N/A			N/A	390
SEARCH FEE (37 CFR 1.16(k), (i), or (m))	N/A	N/A	N/A			N/A	620
EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))	N/A	N/A	N/A			N/A	250
TOTAL CLAIMS (37 CFR 1.16(i))	8 minus 20 =	*			OR	x 62 =	0.00
INDEPENDENT CLAIMS (37 CFR 1.16(h))	1 minus 3 =	*				x 250 =	0.00
APPLICATION SIZE FEE (37 CFR 1.16(s))	If the specification and drawings exceed 100 sheets of paper, the application size fee due is $310 ($155 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).						0.00
MULTIPLE DEPENDENT CLAIM PRESENT (37 CFR 1.16(j))							0.00
* If the difference in column 1 is less than zero, enter "0" in column 2.			TOTAL			TOTAL	1260

APPLICATION AS AMENDED - PART II

		(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	SMALL ENTITY RATE($)	SMALL ENTITY ADDITIONAL FEE($)	OR	OTHER THAN SMALL ENTITY RATE($)	OTHER THAN SMALL ENTITY ADDITIONAL FEE($)
AMENDMENT A	Total (37 CFR 1.16(i))	*	Minus	**	=	x =		OR	x =	
	Independent (37 CFR 1.16(h))	*	Minus	***	=	x =		OR	x =	
	Application Size Fee (37 CFR 1.16(s))									
	FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							OR		
						TOTAL ADD'L FEE		OR	TOTAL ADD'L FEE	

		(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	SMALL ENTITY RATE($)	SMALL ENTITY ADDITIONAL FEE($)	OR	OTHER THAN SMALL ENTITY RATE($)	OTHER THAN SMALL ENTITY ADDITIONAL FEE($)
AMENDMENT B	Total (37 CFR 1.16(i))	*	Minus	**	=	x =		OR	x =	
	Independent (37 CFR 1.16(h))	*	Minus	***	=	x =		OR	x =	
	Application Size Fee (37 CFR 1.16(s))									
	FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							OR		
						TOTAL ADD'L FEE		OR	TOTAL ADD'L FEE	

* If the entry in column 1 is less than the entry in column 2, write "0" in column 3.

** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20".

*** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3".

The "Highest Number Previously Paid For" (Total or Independent) is the highest found in the appropriate box in column 1.

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APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
13/621,015	09/15/2012	Pascal DRILLET	404951US99DIV/amw

CONFIRMATION NO. 6215

22850
OBLON, SPIVAK, MCCLELLAND MAIER & NEUSTADT, L.L.P.
1940 DUKE STREET
ALEXANDRIA, VA 22314

PUBLICATION NOTICE



Title:COATED STEEL STRIPS, METHODS OF MAKING THE SAME, METHODS OF USING THE SAME, STAMPING BLANKS PREPARED FROM THE SAME, STAMPED PRODUCTS PREPARED FROM THE SAME, AND ARTICLES OF MANUFACTURE WHICH CONTAIN SUCH A STAMPED PRODUCT

Publication No.US-2013-0029172-A1
Publication Date:01/31/2013

NOTICE OF PUBLICATION OF APPLICATION

The above-identified application will be electronically published as a patent application publication pursuant to 37 CFR 1.211, et seq. The patent application publication number and publication date are set forth above.

The publication may be accessed through the USPTO's publically available Searchable Databases via the Internet at www.uspto.gov. The direct link to access the publication is currently http://www.uspto.gov/patft/.

The publication process established by the Office does not provide for mailing a copy of the publication to applicant. A copy of the publication may be obtained from the Office upon payment of the appropriate fee set forth in 37 CFR 1.19(a)(1). Orders for copies of patent application publications are handled by the USPTO's Office of Public Records. The Office of Public Records can be reached by telephone at (703) 308-9726 or (800) 972-6382, by facsimile at (703) 305-8759, by mail addressed to the United States Patent and Trademark Office, Office of Public Records, Alexandria, VA 22313-1450 or via the Internet.

In addition, information on the status of the application, including the mailing date of Office actions and the dates of receipt of correspondence filed in the Office, may also be accessed via the Internet through the Patent Electronic Business Center at www.uspto.gov using the public side of the Patent Application Information and Retrieval (PAIR) system. The direct link to access this status information is currently http://pair.uspto.gov/. Prior to publication, such status information is confidential and may only be obtained by applicant using the private side of PAIR.

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Office of Data Managment, Application Assistance Unit (571) 272-4000, or (571) 272-4200, or 1-888-786-0101

PLUS Search Results for S/N 13621015, Searched Mon Feb 25 12:32:18 EST 2013

The Patent Linguistics Utility System (PLUS) is a USPTO automated search system for U.S. Patents from 1971 to the present PLUS is a query-by-example search system which produces a list of patents that are most closely related linguistically to the application searched. This search was prepared by the staff of the Scientific and Technical Information Center, SIRA.

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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
13/621,015	09/15/2012	Pascal DRILLET	404951US99DIV/amw	6215

22850 7590 03/15/2013

OBLON, SPIVAK, MCCLELLAND MAIER & NEUSTADT, L.L.P.
1940 DUKE STREET
ALEXANDRIA, VA 22314

EXAMINER	
SCHLEIS, DANIEL J	
ART UNIT	PAPER NUMBER
1784	

NOTIFICATION DATE	DELIVERY MODE
03/15/2013	ELECTRONIC

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Notice of the Office communication was sent electronically on above-indicated "Notification Date" to the following e-mail address(es):

patentdocket@oblon.com
oblonpat@oblon.com
jgardner@oblon.com

Office Action Summary	Application No.	Applicant(s)	
	13/621,015	DRILLET ET AL.	
	Examiner	Art Unit	
	DANIEL J. SCHLEIS	1784	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE *3* MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *15 September 2012*.

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ An election was made by the applicant in response to a restriction requirement set forth during the interview on _____; the restriction requirement and election have been incorporated into this action.

4)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

5)☒ Claim(s) *24-31* is/are pending in the application.

5a) Of the above claim(s) _____ is/are withdrawn from consideration.

6)☐ Claim(s) _____ is/are allowed.

7)☒ Claim(s) *24-31* is/are rejected.

8)☐ Claim(s) _____ is/are objected to.

9)☐ Claim(s) _____ are subject to restriction and/or election requirement.

* If any claims have been determined allowable, you may be eligible to benefit from the **Patent Prosecution Highway** program at a participating intellectual property office for the corresponding application. For more information, please see http://www.uspto.gov/patents/init_events/pph/index.jsp or send an inquiry to PPHfeedback@uspto.gov.

Application Papers

10)☐ The specification is objected to by the Examiner.

11)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)

2) ☒ Information Disclosure Statement(s) (PTO/SB/08) Paper No(s)/Mail Date *09/15/12*.

3) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____ .

4) ☐ Other: _____.

DETAILED ACTION

Information Disclosure Statement

The information disclosure statement (IDS) submitted on 15 September 2012 was considered by the examiner.

Claim Rejections - 35 USC § 102 / § 103

The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

> A person shall be entitled to a patent unless –
>
> (b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of application for patent in the United States.

The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

The factual inquiries set forth in *Graham* v. *John Deere Co.*, 383 U.S. 1, 148 USPQ 459 (1966), that are applied for establishing a background for determining obviousness under 35 U.S.C. 103(a) are summarized as follows:

1. Determining the scope and contents of the prior art.
2. Ascertaining the differences between the prior art and the claims at issue.
3. Resolving the level of ordinary skill in the pertinent art.
4. Considering objective evidence present in the application indicating obviousness or nonobviousness.

This application currently names joint inventors. In considering patentability of the claims under 35 U.S.C. 103(a), the examiner presumes that the subject matter of the various

claims was commonly owned at the time any inventions covered therein were made absent any evidence to the contrary. Applicant is advised of the obligation under 37 CFR 1.56 to point out the inventor and invention dates of each claim that was not commonly owned at the time a later invention was made in order for the examiner to consider the applicability of 35 U.S.C. 103(c) and potential 35 U.S.C. 102(e), (f) or (g) prior art under 35 U.S.C. 103(a).

Claims 24-31 are rejected under 35 U.S.C. 102(b) as anticipated by or, in the alternative, under 35 U.S.C. 103(a) as obvious over U.S. Patent Number 6,296,805 (Laurent).

In regards to independent claim 24 and dependent claim 25, Laurent is directed to a coated, hot- and cold-rolled steel sheet comprising a very high resistance after thermal treatment. [1:6-8] The sheet is provided with an aluminum-based coating, for example by dipping in a bath containing, in addition, from 8% to 11% silicon, from 2% to 4% iron, the sheet having a high mechanical resistance after thermal treatment and a high resistance to corrosion, as well as a good capacity for painting and gluing. [2:37-45] The aluminum-based layer is provided in a thickness of about 20 microns. [3:38-44]

Diffusion of the iron in the coating will be initiated at high temperature, thus there will be better cohesion between the coating and steel in the sheet. [3:26-37] After the shaping of a casting the coating is subjected to an increase in temperature to an excess of 5° C/second. [3:26-29]

Thermal treatment of the metal sheet consists in a heating at a temperature between Ac1, starting temperature of austenitic formation, for example 750° C and 1200° C, in a furnace, for a period which depends on the temperature to be reached and the thickness of the casting sheet.

[3:61-65] For a completely martensitic structure, and for steel having the composition of the example, the speed of cooling should be in excess of the critical speed of hardening, which is 27° C / second for an austenitizing at 900° C for five minutes, wherein the sheet has a thickness of approximately 1 mm. [4:4-9]

This process appears to be identical or substantially identical to the process set forth in the specification of the instant application, which produces the claimed product. The instant application sets forth that the aluminum hot-dip coating is precisely controlled to fall within a range equal to 20 and 33 microns. [¶43 of corresponding 2013/0029172] The favorable layer disposition is obtained when aluminum- or aluminum alloy pre-coated steel sheets, whose thickness range from, e.g. 07 to 3 mm, are heated for 3 to 13 minutes in a furnace heated to a temperature of 880 to 940° C. [¶58] The heating rate is between 4 and 12° C/second for producing a favorable alloyed layer disposition. [¶59]

It appears that the thickness of the aluminum hot-dip coating, the thickness of the steel sheet, the time and temperature of the heating within the furnace, and the heating rates in Laurent are identical or substantially identical to those set forth in the specification of the instant application. Applicant teaches that the heating rate and temperature lead to the favorable layer disposition. [See ¶58 and ¶59]

Where the claimed and prior art products are identical or substantially identical, or are produced by identical or substantially identical processes, the Office can require an applicant to prove that the prior art products do not necessarily or inherently possess the characteristics of the claimed product. Whether the rejection is based on "inherency" under 35 USC 102, on "prima

facie obviousness" under 35 USC 103, jointly or alternatively, the burden of proof is the same, and its fairness is evidenced by the Office's inability to manufacture products or to obtain and compare prior art products.

Consequently, absent a showing to the contrary, it appears that the properties of the product in the prior art necessarily or inherently possesses the characteristics of the claimed product, including the presence of the four claimed layers, the resulting thickness of the overall coating and its respective layers, and the quasi-continuous nature of the layers.

As to claim 26, Laurent teaches a steel sheet with the following composition:

0.15% < carbon < 0.5%
0.5% < manganese < 3%
0.1% < silicon < 0.5%
0.01% < chromium<1%
titanium < 0.2%
aluminum < 0.1%
phosphorus < 0.1%
sulfur < 0.05%
0.0005% < boron < 0.08%,
the remainder being iron and impurities inherent in processing.

[1:47-64]

As to claim 27, Laurent teaches a preferred steel sheet with the following composition:

0.20% < carbon < 0.5%
0.8% < manganese < 1.5%
0.1% < silicon < 0.35%
0.01% < chromium < 1%
titanium < 0.1%
aluminum < 0.1%
phosphorus < 0.05%
sulfur < 0.03%
0.0005% < boron < 0.01%,
the remainder being iron and impurities inherent in processing.

[1:65-2:10]

As to claim 28, Laurent teaches that the sulfur content of the preferred embodiment has a sulfur content of less than 0.03%. [1:65-2:10] This range taught by Laurent overlaps the claimed range.

As to claim 29, Laurent teaches in the preferred embodiment that the titanium content with respect to the nitrogen content is in excess of 3.42. [2:11-14]

As to claim 30, Laurent teaches that the steel sheet is coated by dipping in an aluminum bath containing 8% to 11% silicon and 2% to 4% iron. [3:9-14]

As to claim 31, this claim is an intended use claim. Laurent specifically teaches using the hot-rolled steel sheet for structural and/or anti-intrusion or substructure castings for a land motor vehicle. [2:30-34]

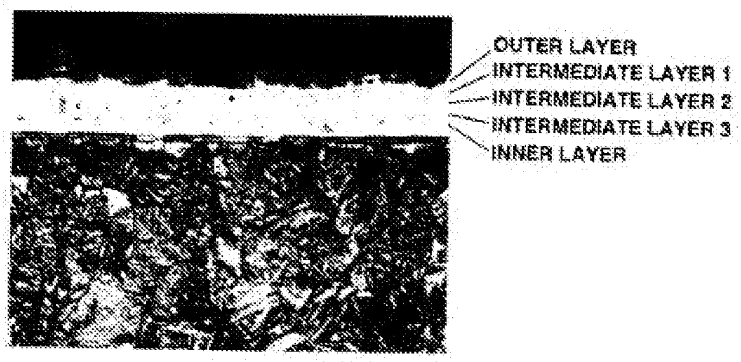
Claims 24, 25, and 31 are rejected under 35 U.S.C. 102(b) as anticipated by or, in the alternative, under 35 U.S.C. 103(a) as obvious over U.S. Patent Application Publication 2004/0009366 (Takagi)

In regards to independent claim 24 and dependent claim 25, Takagi relates to an aluminum-coated structural member. [¶1] A multi-layer structure including a hard outermost layer is advantageous for maintaining good contact with a welding gun in spot welding even under great pressure for high tension material. [¶24]

A hot-dip aluminum-coated steel sheet is formed by immersing a strip continuously in a bath of molten aluminum. [¶13] Takagi teaches that the thickness of this aluminum coating layer is between 10 and 20 microns. [¶35] The coated steel sheet is heated at a rate of 1 to 10°

C/second to a temperature within the range of 900 to 950° C, and it is held at that temperature for holding time of 2 to 8 minutes. [¶26] Takagi specifically teaches a sheet thickness of the steel being 1.4 mm. [¶33] This method provides for a coating as set forth in figure 2A, which is reproduced below.

FIG.2A



This process appears to be identical or substantially identical to the process set forth in the specification of the instant application, which produces the claimed product. The instant application sets forth that the aluminum hot-dip coating is precisely controlled to fall within a range equal to 20 and 33 microns. [¶43 of corresponding 2013/0029172] The favorable layer disposition is obtained when aluminum- or aluminum alloy pre-coated steel sheets, whose thickness range from, e.g. 07 to 3 mm, are heated for 3 to 13 minutes in a furnace heated to a temperature of 880 to 940° C. [¶58] The heating rate is between 4 and 12° C/second for producing a favorable alloyed layer disposition. [¶59]

Consequently, absent a showing to the contrary, it appears that the properties of the product in the prior art necessarily or inherently possesses the characteristics of the claimed

product, including the presence of the four claimed layers, the resulting thickness of the overall coating and its respective layers, and the quasi-continuous nature of the layers.

Pertaining to claim 31, Takagi teaches that the aluminum-coated structure member can be used as a structural member for a motor vehicle. [¶1]

Claim Rejections - 35 USC § 103

Claims 26-28 are rejected under 35 U.S.C. 103(a) as being unpatentable over Takagi as applied to claim 24 above, and further in view of the Ford Engineering Specification, Specification Number WSP-MIA322-A1, dated 1992-03-31 (Hereinafter "the Ford Engineering Specification," submitted in IDS).

In regards to claims 26 and 27, as set forth above in regards to claim 24, Takagi sets forth a steel sheet that is covered with an aluminum dip coating and subjected to heat treatment in order to obtain a multilayered structure. While Takagi teaches that the steel is used as a structural component of a motor vehicle, it does not explicitly set forth the claimed composition.

In the same field of endeavor of motor vehicle components, the Ford Engineering Specification sets forth requirements for material used in door intrusion beams where a high strength to weight ratio is required. [Section 2] The composition of the material must fall within the range:

C	0.20-0.25
Mn	1.00 – 1.30
P	0.03 max
S	0.025 max
Si	0.20 – 0.35
Cr	0.15 – 0.25

B 0.0015 – 0.005

[Section 3.2] All materials supplied to this specification must be equivalent in all characteristics to the material upon which approval was originally granted. [Section 3.4]

It would have been obvious to one of ordinary skill in the art at the time of the invention to have used the composition set forth in the Ford Engineering Specification as the steel sheet of the product of Takagi. One of ordinary skill in the art at the time of the invention would have been motivated by the desire and expectation of a simple substitution of one known element for another to obtain predictable results, including using a known composition which is known for its high strength to weight ratio. Further, as shown by the Ford Engineering Specification, such composition is recognized in the field for its use as a structural member of a motor vehicle.

As to claim 28, the ratio of sulfur in the composition set forth in the Ford Specification overlaps the claimed range.

Conclusion

Any inquiry concerning this communication or earlier communications from the examiner should be directed to DANIEL J. SCHLEIS whose telephone number is (571)270-5636. The examiner can normally be reached on Monday through Friday between the hours of 9:00 AM and 4:30 PM EST.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Jennifer McNeil can be reached on (571) 272-1540. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

/D. J. S./
Examiner, Art Unit 1784

/Jennifer C McNeil/
Supervisory Patent Examiner, Art Unit 1784

Notice of References Cited	Application/Control No. 13/621,015	Applicant(s)/Patent Under Reexamination DRILLET ET AL.	
	Examiner DANIEL J. SCHLEIS	Art Unit 1784	Page 1 of 1

U.S. PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Name	Classification
*	A	US-2004/0009366	01-2004	Takagi et al.	428/653
	B	US-			
	C	US-			
	D	US-			
	E	US-			
	F	US-			
	G	US-			
	H	US-			
	I	US-			
	J	US-			
	K	US-			
	L	US-			
	M	US-			

FOREIGN PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Country	Name	Classification
	N					
	O					
	P					
	Q					
	R					
	S					
	T					

NON-PATENT DOCUMENTS

*		Include as applicable: Author, Title Date, Publisher, Edition or Volume, Pertinent Pages)
	U	
	V	
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*A copy of this reference is not being furnished with this Office action. (See MPEP § 707.05(a).)
Dates in MM-YYYY format are publication dates. Classifications may be US or foreign.

Search Notes	Application/Control No.	Applicant(s)/Patent Under Reexamination
	13621015	DRILLET ET AL.
	Examiner	Art Unit
	DANIEL J SCHLEIS	1784

CPC- SEARCHED		
Symbol	Date	Examiner

CPC COMBINATION SETS - SEARCHED		
Symbol	Date	Examiner

US CLASSIFICATION SEARCHED			
Class	Subclass	Date	Examiner

SEARCH NOTES		
Search Notes	Date	Examiner
Inventor Name Search	03/13	Schleis
PLUS Patent Search	03/13	Schleis
Non-Patent Literature Search - Google Scholar, Knovel, Science Direct	03/13	Schleis
EAST Text Search - See Search History	03/13	Schleis

INTERFERENCE SEARCH			
US Class/ CPC Symbol	US Subclass / CPC Group	Date	Examiner

Form PTO 1449 (Modified)	U.S. DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE	ATTY DOCKET NO. 404951US	SERIAL NO. 13/621,015 ~~New Application~~
LIST OF REFERENCES CITED BY APPLICANT		APPLICANT Pascal DRILLET, et al.	
		FILING DATE ~~Herewith~~ 09/15/12	GROUP 1784

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EXAMINER INITIAL		DOCUMENT NUMBER	DATE	NAME	CLASS	SUB CLASS	FILING DATE IF APPROPRIATE
	AA	6 296 805	10-02--001	Jean-Pierre LAURENT, et al.			
	AB	2003 0152796	08-14-2003	Catherine CLANCY, et al.			
	AC	5 023 113	06-11-1991	Steven L. BOSTON, et al.			
	AD	7,137,201	11-21-2006	BRODT ET AL.			
	AE						
	AF						
	AG						
	AH						
	AI						
	AJ						
	AK						
	AL						
	AM						
	AN						

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		DOCUMENT NUMBER	DATE	COUNTRY	TRANSLATION YES	TRANSLATION NO
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	AP	1 336 666	08/20/2003	EP (equivalent of US 2003 0152796)		XXX
	AQ	0 356 783	03/07/1990	EP (equivalent of US 5 023 113)		XXX
	AR	2 720 079	11/24/1995	FR		XXX
	AS	2 758 571	07/24/1998	FR		XXX
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	AX	Aruna Bahadur et al., "Structural Studies of Hot Dip Aluminized Coatings on Mild Steel," Materials Transactions, JIM, Vol. 32, No. 11 (1991), pp. 1053-1061.
	AY	L. Vaissiere et al., "Development of Pre-Coated Boron Steel for Applications on PSA Peugeot Citroen and RENAULT Bodies in White," presented at the "International Body Engineering Conference," Paris, Society of Automotive Engineers, July 9-11, 2002.
	AZ	X. Bano, et al., "Heat Treated Boron Steels in the Automobile Industry," 39th MWSP Conf. Proc., ISS, Vol. XXXV, 1998.

☐ Additional References sheet(s) attached

Examiner	Date Considered

*Examiner: Initial if reference is considered, whether or not citation is in conformance with MPEP 609; Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /D.J.S.

Form PTO 1449 (Modified)	U.S. DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE	ATTY DOCKET NO.	SERIAL NO.
		404951US	New Application
LIST OF REFERENCES CITED BY APPLICANT		APPLICANT	
		Pascal DRILLET, et al.	
		FILING DATE	GROUP
		Herewith	

U.S. PATENT DOCUMENTS

EXAMINER INITIAL		DOCUMENT NUMBER	DATE	NAME	CLASS	SUB CLASS	FILING DATE IF APPROPRIATE
	AA						
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	AH						
	AI						
	AJ						
	AK						
	AL						
	AM						
	AN						

FOREIGN PATENT DOCUMENTS

		DOCUMENT NUMBER	DATE	COUNTRY	TRANSLATION YES	TRANSLATION NO
	AO	2 787 735	06-30-00	FR w/Attached English Abstract		
	AP					
	AQ					
	AR					
	AS					
	AT					
	AU					
	AV					

OTHER REFERENCES (Including Author, Title, Date, Pertinent Pages, etc.)

	AW	
	AX	
	AY	
	AZ	☐ Additional References sheet(s) attached

Examiner	/Daniel J. Schleis/	Date Considered	02/26/2013

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CONFIRMATION NO. 6215

SERIAL NUMBER	FILING or 371(c) DATE	CLASS	GROUP ART UNIT	ATTORNEY DOCKET NO.
13/621,015	09/15/2012 RULE	428	1784	404951US99DIV/amw

APPLICANTS

Pascal DRILLET, Rozerieulles, FRANCE;
Dominique Spehner, Balan, FRANCE;
Ronald Kefferstein, Saint Mitre Les Ramparts, FRANCE;

**** CONTINUING DATA ***************************

This application is a DIV of 12/447,777 03/18/2011 PAT 8,307,680
which is a 371 of PCT/IB06/04019 10/30/2006

**** FOREIGN APPLICATIONS ***************************

**** IF REQUIRED, FOREIGN FILING LICENSE GRANTED ****

10/01/2012

Foreign Priority claimed	35 USC 119(a-d) conditions met	Verified and Acknowledged	Met after Allowance	STATE OR COUNTRY	SHEETS DRAWINGS	TOTAL CLAIMS	INDEPENDENT CLAIMS
☐ Yes ☑ No	☐ Yes ☑ No	/DANIEL J SCHLEIS/ Examiner's Signature	☐ Initials	FRANCE	4	8	1

ADDRESS

OBLON, SPIVAK, MCCLELLAND MAIER & NEUSTADT, L.L.P.
1940 DUKE STREET
ALEXANDRIA, VA 22314
UNITED STATES

TITLE

COATED STEEL STRIPS, METHODS OF MAKING THE SAME, METHODS OF USING THE SAME, STAMPING BLANKS PREPARED FROM THE SAME, STAMPED PRODUCTS PREPARED FROM THE SAME, AND ARTICLES OF MANUFACTURE WHICH CONTAIN SUCH A STAMPED PRODUCT

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EAST Search History

EAST Search History (Prior Art)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
S1	13	((PASCAL) near2 (DRILLET)).INV.	US-PGPUB; USPAT; USOCR	OR	ON	2013/02/26 09:51
S2	8	((DOMINIQUE) near2 (SPEHNER)).INV.	US-PGPUB; USPAT; USOCR	OR	ON	2013/02/26 09:51
S3	11	((RONALD) near2 (KEFFERSTEIN)).INV.	US-PGPUB; USPAT; USOCR	OR	ON	2013/02/26 09:51
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S5	9	("20030152796" | "3240269" | "5023113" | "6296805" | "6815087" | "7137201" | "7217331" | "7503116").PN. OR ("8307680").URPN.	US-PGPUB; USPAT; USOCR	OR	ON	2013/02/26 09:51
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S7	9	("4891274" | "5133815" | "5178688" | "5656102").PN. OR ("6296805").URPN.	US-PGPUB; USPAT; USOCR	OR	ON	2013/02/26 10:37
S8	4	("3214820" | "6197132" | "6296805").PN. OR ("7708843").URPN.	US-PGPUB; USPAT; USOCR	OR	ON	2013/02/26 10:40
S9	16	("20010042393" | "20070082214" | "20070163685" | "20090242086" | "20090308499" | "20110006491" | "20110165436" | "4546051" | "6017643" | "6093498" | "6296805" | "6298905" | "6564604" | "6815087" | "7137201" | "7867344").PN. OR ("8066829").URPN.	US-PGPUB; USPAT; USOCR	OR	ON	2013/02/26 10:40
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S12	10	("3632453" | "3664293" | "4751957" | "4891274" | "5518772" | "5529816").PN. OR ("6017643").URPN.	US-PGPUB; USPAT; USOCR	OR	ON	2013/02/26 10:47
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		("8066829") or ("8307680") or ("20110006491") or ("20110165436") or ("20110214475") or ("20120064362") or ("20130029172") or ("6564604") or ("20010042393") or ("20120118437") or ("4846986") or ("20120085467") or ("20080261058") or ("4601766") or ("5248528") or ("5456953") or ("5568914") or ("5830290") or ("20040118482") or ("5287983") or ("4880481") or ("4344342") or ("4963400") or ("4999241") or ("5342672") or ("5792180") or ("6070444") or ("4353765") or ("5982073") or ("6129790") or ("6165595") or ("3798406") or ("4033918") or ("4311755") or ("4488862") or ("4508755") or ("4514264") or ("4525177") or ("4551085") or ("4554765") or ("4585519") or ("4842887") or ("4994517") or ("5273369") or ("5389452") or ("5538576") or ("5542978") or ("5639510") or ("5697715") or ("5729616") or ("5801128") or ("5837314") or ("5869160") or ("6020026") or ("6019923") or ("6251514") or ("6258425") or ("6262513") or ("6309748") or ("6340397") or ("6342108") or ("20020014181") or ("20090025836") or ("20090048127") or ("4374168") or ("4309951") or ("5810332") or ("5795661") or ("8349098") or ("20020160235") or ("20020166606") or ("20100294400") or ("20110056594") or ("20110056594") or ("20120085466") or ("5981089") or ("6197125") or ("4793867") or ("4941930") or ("4980241") or ("5238506") or ("5405427") or ("5939144") or ("6090873") or ("6241393") or ("3859239") or ("3850684") or ("3850647") or ("4316751") or ("4347085") or ("4401719") or ("4402994") or ("4533606") or ("4592958") or ("4867853") or ("5232619") or ("5242506") or ("5290362") or ("5332776") or ("5466280") or ("5608028") or ("5643474") or ("5700551") or ("5743536") or ("5783622") or ("5786098") or ("5851659") or ("5863640") or ("5890852") or ("5955201") or ("6001494") or ("6042949") or ("6083613") or ("6194088") or ("6197436") or ("6284059") or ("6329456") or ("6410626") or ("7533713") or ("8025965") or ("8025965") or ("20030150308") or ("20040129346") or ("20040216860") or ("20070209555") or ("20080090093") or ("20100175794") or ("20110300407") or ("20100199872") or ("4793218") or ("5584845") or ("5759304") or ("6463779") or ("7703820") or ("7926180") or ("7926180") or ("20070045384") or ("20070051434") or ("20090058111") or ("20100187291")).PN. or (("20110247467") or ("4384011") or ("5960930") or ("6120604") or ("4863650") or ("4926792") or ("4942061") or ("4035528") or ("4342418") or ("4355059")	PGPUB; USPAT; USOCR			10:54	

		or ("4490129") or ("4611610") or ("4818570") or ("4925213") or ("5300362") or ("5728474") or ("5809628") or ("5820954") or ("6037053") or ("6132864") or ("6403192") or ("8042484") or ("20080000417") or ("20080305358") or ("20090220815") or ("20120074106") or ("20120152410") or ("4486172") or ("4537588") or ("4844327") or ("4925518") or ("7955413") or ("4283225") or ("4302515") or ("4314661") or ("4316572") or ("4358325") or ("4480016") or ("4801072") or ("4853047") or ("5018259") or ("5271318") or ("5533423") or ("5622674") or ("5660443") or ("5926516") or ("6554919") or ("6986536") or ("RE40736") or ("7955413") or ("20010049956") or ("20050285416") or ("20050285417") or ("20080257110") or ("20090173129") or ("20110266724") or ("20120120561") or ("4251549")).PN.				
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S15	0	("2012/0085467").URPN.	USPAT	OR	ON	2013/02/26 10:55
S16	0	("2011/0214475").URPN.	USPAT	OR	ON	2013/02/26 10:55
S17	1	("2011/0165436").URPN.	USPAT	OR	ON	2013/02/26 10:56
S18	1	("2011/0006491").URPN.	USPAT	OR	ON	2013/02/26 10:56
S19	8085	((428/601,600,602,653) or (420/104,120,121,126) or (148/531,535,534,537,635,653) or (72/364,342.1,47) or (280/1)).CCLS.	US-PGPUB; USPAT; USOCR	OR	OFF	2013/02/26 11:01
S20	2517	S19 and (steel ferrous) same (aluminum aluminium al)	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2013/02/26 11:02
S21	304	S20 and (interdiffusion intermediate intermetallic superficial) near3 layer	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2013/02/26 11:03
S22	14	("20020068189" | "20020104876" | "20030012977" | "20030207769" | "20040028939" | "3195991" | "4957822" | "4973523" | "5112416" | "5362574" | "5384205" | "5470666" | "7074496").PN. OR ("8053087").URPN.	US-PGPUB; USPAT; USOCR	OR	ON	2013/02/26 12:13
S23	8085	((428/601,600,602,653) or (420/104,120,121,126) or (148/531,535,534,537,635,653) or (72/364,342.1,47) or (280/1)).CCLS.	US-PGPUB; USPAT; USOCR	OR	OFF	2013/02/26 12:33
S24	286	S23 and (carbon c) same (manganese Mn) same (Silicon si) same (Chromium Cr) same (titanium ti) same (aluminum al)	US-PGPUB; USPAT;	OR	ON	2013/02/26 12:33

		same (Phosphorus P) same (Sulfur Sulphur S) same (Boron B)	USOCR; EPO; JPO; DERWENT			
S25	59	S24 and (aluminum aluminium al) near5 (pre-coat$4 precoat$4 layer coat$5)	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2013/02/26 12:35
S26	0	("2010/0294400").URPN.	USPAT	OR	ON	2013/02/26 12:36
S27	2	("2001/0001049").URPN.	USPAT	OR	ON	2013/02/26 12:40

EAST Search History (Interference)

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SIGNATURE of Assignee of Record

The individual whose signature and title is supplied below is authorized to act on behalf of the assignee

Signature		Date	21/03/2013
Name	Sophie PLAISANT	Telephone	+ 33 1 71 92 00 25
Title	Head of Central Patent Team, Corporate Officer		

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STATEMENT UNDER 37 CFR 3.73(b)

Applicant/Patent Owner: ARCELORMITTAL FRANCE

Application No./Patent No.: 13621015 Filed/Issue Date: 09/15/2012

Titled: COATED STEEL STRIPS, METHODS OF MAKING THE SAME, METHODS OF USING THE SAME, STAMPING BLANKS PREPARED FROM THE SAME, STAMPED PRODUCTS PREPARED FROM THE SAME, AND ARTICLES OF MANUFACTURE WHICH CONTAIN SUCH A STAMPED PRODUCT

ARCELORMITTAL FRANCE , a corporation

(Name of Assignee) (Type of Assignee, e.g., corporation, partnership, university, government agency, etc.

states that it is:

1. [X] the assignee of the entire right, title, and interest in;

2. [ ] an assignee of less than the entire right, title, and interest in
(The extent (by percentage) of its ownership interest is _____ %); or

3. [ ] the assignee of an undivided interest in the entirety of (a complete assignment from one of the joint inventors was made)

the patent application/patent identified above, by virtue of either:

A. [X] An assignment from the inventor(s) of the patent application/patent identified above. The assignment was recorded in the United States Patent and Trademark Office at Reel 026004, Frame 0196, or for which a copy therefore is attached.

OR

B. [ ] A chain of title from the inventor(s), of the patent application/patent identified above, to the current assignee as follows:

1. From: _____ To: _____

The document was recorded in the United States Patent and Trademark Office at

Reel _____, Frame _____, or for which a copy thereof is attached.

2. From: _____ To: _____

The document was recorded in the United States Patent and Trademark Office at

Reel _____, Frame _____, or for which a copy thereof is attached.

3. From: _____ To: _____

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Reel _____, Frame _____, or for which a copy thereof is attached.

[ ] Additional documents in the chain of title are listed on a supplemental sheet(s).

[ ] As required by 37 CFR 3.73(b)(1)(i), the documentary evidence of the chain of title from the original owner to the assignee was, or concurrently is being, submitted for recordation pursuant to 37 CFR 3.11.

[NOTE: A separate copy (*i.e.*, a true copy of the original assignment document(s)) must be submitted to Assignment Division in accordance with 37 CFR Part 3, to record the assignment in the records of the USPTO. See MPEP 302.08]

The undersigned (whose title is supplied below) is authorized to act on behalf of the assignee.

/William C. Gehris/ 04/03/2013

Signature Date

William C. Gehris Reg. No. 38,156

Printed or Typed Name Title

This collection of information is required by 37 CFR 3.73(b). The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

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The **Privacy Act of 1974** (**P.L. 93-579)** requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether disclosure of these records is required by the Freedom of Information Act.
2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.
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4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).
5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.
6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).
7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (*i.e.*, GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.
8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspection or an issued patent.
9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

Electronic Acknowledgement Receipt

EFS ID:	15426604
Application Number:	13621015
International Application Number:	
Confirmation Number:	6215
Title of Invention:	COATED STEEL STRIPS, METHODS OF MAKING THE SAME, METHODS OF USING THE SAME, STAMPING BLANKS PREPARED FROM THE SAME, STAMPED PRODUCTS PREPARED FROM THE SAME, AND ARTICLES OF MANUFACTURE WHICH CONTAIN SUCH A STAMPED PRODUCT
First Named Inventor/Applicant Name:	Pascal DRILLET
Customer Number:	22850
Filer:	William C. Gehris/Daniel Hummel
Filer Authorized By:	William C. Gehris
Attorney Docket Number:	404951US99DIV/amw
Receipt Date:	03-APR-2013
Filing Date:	15-SEP-2012
Time Stamp:	17:50:31
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Power of Attorney	7041007DIVsignedSB80ARCELORMITTALFRANCE21mar13.pdf	77305 0dbe3fd7f9151ad6847a1e98ed36970ea3cff095	no	1
Warnings:					
Information:					

2	Assignee showing of ownership per 37 CFR 3.73.	7041007DIV13621015SB963apr13.pdf	423494 3c410ed5f43dff19037c4818de578fbd20fec638	no	2

Warnings:	
Information:	
Total Files Size (in bytes):	500799

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111
If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371
If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office
If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
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APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
13/621,015	09/15/2012	Pascal DRILLET	404951US99DIV/amw

CONFIRMATION NO. 6215

23280
Davidson, Davidson & Kappel, LLC
485 7th Avenue
14th Floor
New York, NY 10018

POA ACCEPTANCE LETTER

OC000000060365392

Date Mailed: 04/15/2013

NOTICE OF ACCEPTANCE OF POWER OF ATTORNEY

This is in response to the Power of Attorney filed 04/03/2013.

The Power of Attorney in this application is accepted. Correspondence in this application will be mailed to the above address as provided by 37 CFR 1.33.

/ttkim/

Office of Data Management, Application Assistance Unit (571) 272-4000, or (571) 272-4200, or 1-888-786-0101

UNITED STATES PATENT AND TRADEMARK OFFICE

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APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
13/621,015	09/15/2012	Pascal DRILLET	404951US99DIV/amw

CONFIRMATION NO. 6215

22850
OBLON, SPIVAK, MCCLELLAND MAIER & NEUSTADT, L.L.P.
1940 DUKE STREET
ALEXANDRIA, VA 22314

POWER OF ATTORNEY NOTICE

OC000000060365357

Date Mailed: 04/15/2013

NOTICE REGARDING CHANGE OF POWER OF ATTORNEY

This is in response to the Power of Attorney filed 04/03/2013.

- The Power of Attorney to you in this application has been revoked by the assignee who has intervened as provided by 37 CFR 3.71. Future correspondence will be mailed to the new address of record(37 CFR 1.33).

/ttkim/

Office of Data Management, Application Assistance Unit (571) 272-4000, or (571) 272-4200, or 1-888-786-0101

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant:	DRILLET	Application No.:	13/621,015
Filing Date:	September 15, 2012	Confirmation No.:	6215
Examiner:	Schleis	Attorney Docket:	704.1007DIV
Art Unit:	1784	Customer No.:	23280

Title: **COATED STEEL STRIPS, METHODS OF MAKING THE SAME, METHODS OF USING THE SAME, STAMPING BLANKS PREPARED FROM THE SAME, STAMPED PRODUCTS PREPARED FROM THE SAME, AND ARTICLES OF MANUFACTURE WHICH CONTAIN SUCH A STAMPED PRODUCT**

Submitted electronically via EFS-WEB
Mail Stop: AMENDMENT
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

August 15, 2013

RESPONSE TO OFFICE ACTION

S i r:

In response to the Office Action dated March 15, 2013, please reconsider the above-identified patent application based on the following:

IN THE CLAIMS:

The following listing of claims will replace all prior versions and listings of claims in the application.

Listing of Claims:

Claim 24 (currently amended): A coated steel stamped product, which comprises:

(a) a strip of base steel having a first side and a second side; and

(b) a coating on at least one of said first side of said strip of base steel and said second side of said strip of base steel,

wherein:

(i) said coating results from the interdiffusion between said base steel, and ~~aluminium~~ aluminum or ~~aluminium~~ aluminum alloy pre-coating, and

(ii) wherein said coating comprises, proceeding from the base steel outwards:

(a) an Interdiffusion layer,

(b) an Intermediate layer,

(c) an Intermetallic layer, and

(d) a Superficial layer,

wherein said coating has a thickness greater than 30 micrometers and wherein said layer (a) has a thickness less than 15 micrometers.

Claim 25 (previously presented): The coated steel stamped product according to claim 24, wherein the said layers (c) and (d) are quasi continuous by occupying at least 90 % of a level corresponding to each said layer and wherein less than 10 % of layer (c) is present at an extreme surface of the product.

Claim 26 (previously presented): The coated steel stamped product according to claim 24, wherein the steel in the strip comprises the following components by weight based on total weight:

0.15 %<carbon<0.5 %;

0.5 %<manganese<3 %;

0.1 %<silicon<0.5 %;

0.01 %<chromium<1%;

titanium<0.2 %;

aluminum<0.1 %;

phosphorus<0.1 %;

sulfur<0.05 %;

0.0005 %<boron<0.08 %;

and further comprises iron and impurities inherent in processing.

Claim 27 (previously presented): A coated steel stamped product according to claim 24, wherein the steel in the strip comprises the following components by weight based on total weight:

0.20 %<carbon<0.5 %;

0.8 %<manganese<1.5 %;

0.1 %<silicon<0.35 %;

0.01 %<chromium<1 %;

titanium<0.1 %;

aluminum<0.1 %;

phosphorus<0.05 %;

sulfur<0.03 %;

0.0005 %<boron<0.01 %;

and further comprises iron and impurities inherent in processing.

Claim 28 (previously presented): The coated steel stamped product according to claim 24, wherein the base steel comprises 20 ppm or less of sulfur.

Claim 29 (previously presented): The coated steel stamped product according to claim 24, wherein the ratio of titanium to nitrogen in the base steel in weight % is in excess of 3.42.

Claim 30 (previously presented): The coated steel stamped product according to claim 24, wherein the aluminum or aluminum alloy pre-coating comprises from 8 % to 11 % silicon by weight, from 2 % to 4 % iron by weight, the remainder being aluminum and impurities inherent in processing.

Claim 31 (previously presented): A land motor vehicle comprising the heat treated coated steel product according to claim 24.

Claim 32 (new): The coated steel stamped product according to claim 24, wherein the product is hot formed with a strain higher than 10% and cooled with a cooling rate higher than 50° C/s.

Claim 33 (new): The coated steel stamped product according to claim 24, wherein the product includes a full martensitic structure.

Claim 34 (new): The coated steel stamped product according to claim 24, wherein said layer (a) has a thickness less than 10 micrometers.

REMARKS/ARGUMENTS

Claims 24 to 31 were rejected under 35 §102(b) as anticipated by or, in the alternative, under 35 U.S.C. §103(a) as obvious over Laurent, U.S. Patent No. 6,296,805. Claims 24, 25 and 31 were rejected under 35 §102(b) as anticipated by or, in the alternative, under 35 U.S.C. §103(a) as obvious over Takagi, U.S. Publication No. 2004/0009366. Claims 26 to 28 were rejected under 35 U.S.C. §103(a) as obvious over Takagi in view of Ford Engineering Specification, Specification Number WSP-MIA322-A1.

Claim 24 is hereby amended for grammatical reasons. Claims 32 to 34 are hereby presented. Support for new claims 32 to 34 in, for example, paragraphs [0112] and [0127].

Reconsideration of the application in view of the foregoing amendments and following remarks is respectfully requested.

Rejections under 35 U.S.C. §§102(b) and 103(a)

Claims 24 to 31 were rejected under 35 §102(b) as anticipated by or, in the alternative, under 35 U.S.C. §103(a) as obvious over Laurent, U.S. Patent No. 6,296,805.

Claim 24 recites "[a] coated steel stamped product, which comprises:

(a) a strip of base steel having a first side and a second side; and

(b) a coating on at least one of said first side of said strip of base steel and said second side of said strip of base steel,

wherein:

(i) said coating results from the interdiffusion between said base steel, and aluminum or aluminum alloy pre-coating, and

(ii) wherein said coating comprises, proceeding from the base steel outwards:

(a) an Interdiffusion layer,

(b) an Intermediate layer,

(c) an Intermetallic layer, and

(d) a Superficial layer,

wherein said coating has a thickness greater than 30 micrometers and wherein said layer (a) has a thickness less than 15 micrometers."

Laurent does not show or disclose "said coating has a thickness greater than 30 micrometers and wherein said layer (a) has a thickness less than 15 micrometers" as recited in claim 24, thus Laurent does not anticipate or obviate claim 24.

With regard to inherency, the fact that a certain result or characteristic ***may occur*** or be present in the prior art ***is not sufficient*** to establish the inherency of that result or characteristic. *In re Rijckaert*, 9 F.3d 1531, 1534, 28 USPQ2d 1955, 1957 (Fed. Cir. 1993) (reversed rejection because inherency was based on what would result due to optimization of conditions, not what was ***necessarily present*** in the prior art); (emphasis added). To establish inherency, the extrinsic evidence must make clear that the missing descriptive matter ***is necessarily present*** in the thing described in the reference, and that it would be so recognized by persons of ordinary skill. Inherency, however, may not be established by probabilities or possibilities. The mere fact that a certain thing ***may result*** from a given set of circumstances is not sufficient. *In re Robertson*, 169 F.3d 743, 745, 49 USPQ2d 1949, 1950-51 (Fed. Cir. 1999). Furthermore, in relying upon the theory of inherency, the examiner must ***provide a basis in fact and/or technical reasoning*** to reasonably support the determination that the allegedly inherent characteristic necessarily flows from the teachings of the applied prior art. *Ex parte Levy,* 17 USPQ2d 1461, 1464 (Bd. Pat. App. & Inter. 1990).

When determining whether a claim is obvious, an examiner must make "a searching comparison of the claimed invention – *including all its limitations* – with the teaching of the prior art." *In re Ochiai*, 71 F.3d 1565, 1572 (Fed. Cir. 1995) (emphasis added). Thus, "obviousness requires a suggestion of all limitations in a claim." *CFMT, Inc. v. Yieldup Intern. Corp.*, 349 F.3d 1333, 1342 (Fed. Cir. 2003) (*citing In re Royka*, 490 F.2d 981, 985 (CCPA 1974)). Moreover, as the Supreme Court recently stated, "***there must be some articulated reasoning*** with some rational underpinning to support the legal conclusion of obviousness." *KSR Int'l v. Teleflex Inc.*, 127 S. Ct. 1727, 1741 (2007) (quoting In re Kahn, 441 F.3d 977, 988 (Fed. Cir. 2006) (emphasis added)).

The Office Action asserts on Pages 4 and 5 that:

> This process appears to be identical or substantially identical to the process set forth in the specification of the instant application, which produces the claimed product. The instant application sets forth that the aluminum hot-dip coating is precisely controlled to fall within a range equal to 20 and 33 microns. [¶43 of corresponding 2013/0029172] The favorable layer disposition is obtained when aluminum or aluminum alloy pre-coated steel sheets, whose thickness range from, e.g. 07 to 3 mm, are heated for 3 to 13 mins in a furnace heated to a temperature of 880 to 940°C. [¶58] The heating rate is between 4 and 12°C/second for producing a favorable alloyed layer disposition. [¶59]
>
> It appears that the thickness of the aluminum hot-dip coating, the thickness of the steel sheet, the time and temperature of the heating within the furnace, and the heating rates in Laurent are identical or substantially identical to those set forth in the specification of the instant application. Applicant teaches that the heating rate and temperature lead to the favorable layer disposition.
>
> ...
>
> Consequently, absent a showing to the contrary, it appears that the properties of the product in the prior art necessarily or inherently possesses the characteristics of the claimed product, including the presence of the four claimed layers, the resulting thickness of the overall coating and its respective layers, and the quasi-continuous nature of the layers.

Applicants respectfully submit that process limitations disclosed in Laurent do not necessarily or inherently include a coating having "a ***thickness greater than 30 micrometers***" and in particular "said layer (a) has ***a thickness less than 15 micrometers***" as recited in claim 24. The Examiner's statements about the properties Laurent "appears" to include and that Laurent includes both thicknesses are completely conclusory and amount to an impermissible hindsight reconstruction. See MPEP 2142; *KSR Int'l Co. v. Teleflex Inc.*, 383 127 S. Ct. 1727, 1740-41 (2007) ("[R]ejections on obviousness cannot be sustained with mere conclusory statements; instead, there must be some articulated reasoning with some rational underpinning to support the legal conclusion of obviousness."); MPEP 2145; *In re Fine*, 837 F.2d 1071, 1075, 5 U.S.P.Q.2D (BNA) 1596 (Fed. Cir. 1988) ("[C]annot use hindsight reconstruction to pick and choose among isolated disclosures in the prior art to deprecate the claimed invention."). There is ***simply no reason or rationale*** provided by the Office Action or in Laurent to show or disclose that Laurent includes both thicknesses, either inherently or necessarily. Thus, the Office Action has failed to

meet the burden of a proper anticipation rejection and has failed to establish a *prima facie* case of obviousness and.

Contrary to the Examiner's assertion, the heating rates are not identical. As disclosed in Laurent "the coating is subjected to an increase in temperature at a speed in excess of 5°C/second which may exceed 600°C/second. This rise in temperature makes possible a rapid remelting of the aluminum which fills in the cracks generated by the operation of shaping of the casting." See col. 3, lines 26 to 31. Whereas, Applicants' instant specification states "heating rate V_c is comprised between 4 and 12°C/s for producing a favorable alloyed layer disposition... The inventors have discovered that the control of V_c in this precise range is a key factor, because it controls directly the nature and the morphology of the alloyed layers which are formed." Laurent does not disclose an increase in temperature from 4 to 5°C/second and Laurent does not show or disclose the advantages provided by the inventors of the instant application in maintaining the heating rate at or below 12 °C/second. In fact, Laurent desires and discloses heating rates in excess of 600°C/second to provide the rapid remelting of aluminum. Thus, there is no basis for asserting that the claimed interdiffusion layer would result.

The Examiner's assertions are also based on the present specification and a desire to meet the claim language and are not based on the disclosure of Laurent. ("'Any judgement on obviousness is in a sense necessarily a reconstruction based on hindsight reasoning, but so long as it takes into account only knowledge which was within the level of ordinary skill in the art at the time the claimed invention was made and ***does not include knowledge gleaned only from applicant's disclosure***, such a reconstruction is proper'" (MPEP § 2145(X)(A), quoting *In re McLaughlin*, 443 F.2d 1392, 1395 (CCPA 1971), (emphasis added). Laurent discloses a thickness of the sheet, "the sheet, in the delivery state in a coil or in sheeting, the thickness of which may range between 0.25 mm and 15 mm." See col. 3, lines 44 to 48. Laurent also discloses coating the sheet with "an aluminum-based layer ***about 20μm in thickness***." See col. 3, lines 42 and 43. Thus, Laurent does not show or disclose the thickness of a coating being "***greater than 30 micrometer***s" or that a "layer (a) has a thickness less than 15 micrometers" as recited in claim 24 and there is simply no reason to assume Laurent includes these features. It seems if Applicants' claims recited different thicknesses entirely, the Examiner would still rely

on the same conclusory statements instead of relying on the actual disclosure of Laurent for support of the rejection.

Applicants respectfully submit that the one who bears the ***initial burden*** of presenting a prima facie case of unpatentability is the ***Examiner***. *In re Oetiker*, 977 F.2d 1443, 1445 (Fed. Cir. 1992). The allocation of burdens requires that ***the USPTO produce the factual basis*** for its rejection of an application under 35 U.S.C. § 102. *In re Piasecki*, 745 F.2d 1468, 1472 (Fed. Cir. 1984) (citing *In re Warner*, 379 F.2d 1011, 1016 (CCPA 1967)). The Office Action has not provided Applicants with any rationale or factual basis to support the 102/103 rejections set forth. As a result, the Office Action has failed to establish a prima facie case of obviousness and anticipation. Thus, the Office Action is erroneously shifting the burden of the rejection to the Applicants to demonstrate that Laurent does not show the features recited in claim 24.

Furthermore, as presented above, Laurent discloses coating the sheet with "an aluminum-based layer ***about 20μm in thickness***." See col. 3, lines 42 and 43. There is simply no reason why one of ordinary skill in the art would increase the thickness of this aluminum based coating by 150% and the Office Action has failed to provide Applicants with such rationale or factual basis.

Thus, there is simply no reason or rationale to assume that the sheet disclosed in Laurent includes both a coating that is "greater than 30 micrometers" thick and an interdiffusion layer that "has a thickness less than 15 micrometers" as recited in claim 24.

Withdrawal of the rejections to claims 24 to 31 under 35 U.S.C. §§102(b) and 103(a) is respectfully requested.

Claims 24, 25 and 31 were rejected under 35 §102(b) as anticipated by or, in the alternative, under 35 U.S.C. §103(a) as obvious over Takagi, U.S. Publication No. 2004/0009366.

Takagi does not show or teach "a ***thickness greater than 30 micrometers***" and in particular "said layer (a) has ***a thickness less than 15 micrometers***" as recited in claim 24.

As admitted in the Office Action on page 6, Takagi discloses that a thickness of the aluminum coating is from 10 to 20 micrometers. "Thickness of aluminum coating layer: 10~20 μm." See Takagi, paragraph [0035]. Thus, Takagi specifically discloses an aluminum coating that is less than and not "***greater than 30 micrometers***" as recited in claim 24. For this reason alone, Takagi does not show or disclose each and every limitation recited in claim 24.

Contrary to the Examiner's assertion on page 7, Takagi discloses particular ranges and the limitations associated with those ranges, specifically concerning the heating rate and time. For example, when the aluminum coated member in Takagi is heated at a rate in excess of 10°C/second, the aluminum coating may be subject to local melting, which is undesirable in Takagi. See paragraph [0026]. Thus, Takagi does not show or teach an identical heating rate, between 4 and 12°C/s, as disclosed in the instant specification.

Further, "when the time for holding at the raised temperature is longer than 8 minutes, the oxidation of coating layer proceeds, and undesired influence is exerted on the adhesiveness of the coating film by electro deposition." See paragraph [0026]. Thus, Takagi does not show or teach an identical heating time including, from 8 to 13 minutes, as disclosed in the instant specification. As a result, there is no basis for asserting that the claimed interdiffusion layer, interdiffusion layer thickness and coating thickness would result.

Withdrawal of the rejections to claims 24, 25 and 31 under 35 U.S.C. §§102(b) and 103(a) is respectfully requested.

Claims 26 to 28 were rejected under 35 U.S.C. §103(a) as obvious over Takagi in view of Ford Engineering Specification, Specification Number WSP-MIA322-A1.

Claims 26 to 28 depend, directly, from claim 24. Ford Engineering Specification does not disclose the limitations not present in Takagi discussed above with respect to claim 24. Since Takagi in view of Ford Engineering Specification does not show or teach each of the

limitations recited in claim 24, withdrawal of the rejections under 35 U.S.C. §103(a) to claims for these same reasons is respectfully requested.

CONCLUSION

The present application is respectfully submitted as being in condition for allowance and applicants respectfully request such action.

Respectfully submitted,
DAVIDSON, DAVIDSON & KAPPEL, LLC

By: /William C. Gehris/
William C. Gehris
(Reg. No. 38,156)

Davidson, Davidson & Kappel, LLC
485 Seventh Avenue
New York, New York 10018
(212) 736-1940

Electronic Patent Application Fee Transmittal

Application Number:	13621015
Filing Date:	15-Sep-2012
Title of Invention:	COATED STEEL STRIPS, METHODS OF MAKING THE SAME, METHODS OF USING THE SAME, STAMPING BLANKS PREPARED FROM THE SAME, STAMPED PRODUCTS PREPARED FROM THE SAME, AND ARTICLES OF MANUFACTURE WHICH CONTAIN SUCH A STAMPED PRODUCT
First Named Inventor/Applicant Name:	Pascal DRILLET
Filer:	Jennifer Lauren O'Connell
Attorney Docket Number:	704.1007DIV

Filed as Large Entity

Utility under 35 USC 111(a) Filing Fees

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				
Extension-of-Time:				
Extension - 2 months with $0 paid	1252	1	600	600

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Miscellaneous:				
		Total in USD ($)		**600**

Electronic Acknowledgement Receipt

EFS ID:	16604846
Application Number:	13621015
International Application Number:	
Confirmation Number:	6215
Title of Invention:	COATED STEEL STRIPS, METHODS OF MAKING THE SAME, METHODS OF USING THE SAME, STAMPING BLANKS PREPARED FROM THE SAME, STAMPED PRODUCTS PREPARED FROM THE SAME, AND ARTICLES OF MANUFACTURE WHICH CONTAIN SUCH A STAMPED PRODUCT
First Named Inventor/Applicant Name:	Pascal DRILLET
Customer Number:	23280
Filer:	Jennifer Lauren O'Connell
Filer Authorized By:	
Attorney Docket Number:	704.1007DIV
Receipt Date:	15-AUG-2013
Filing Date:	15-SEP-2012
Time Stamp:	17:47:57
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	Deposit Account
Payment was successfully received in RAM	$600
RAM confirmation Number	4863
Deposit Account	500552
Authorized User	

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)

1	Extension of Time	PetExtTime.pdf	189249 65940e403880d0df74189f502e2fade6d3c73392	no	2
Warnings:					
Information:					
2	Amendment/Req. Reconsideration-After Non-Final Reject	ResOA15aug13.pdf	170292 7926523ba1672d536bceb6a66cd652cfde390b62	no	11
Warnings:					
Information:					
3	Fee Worksheet (SB06)	fee-info.pdf	30804 2d3e44a6f327c66a22515f0c950d7ab3ebc55e3e	no	2
Warnings:					
Information:					
		Total Files Size (in bytes):	390345		

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<u>New Applications Under 35 U.S.C. 111</u>
If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

<u>National Stage of an International Application under 35 U.S.C. 371</u>
If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

<u>New International Application Filed with the USPTO as a Receiving Office</u>
If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

PTO/SB/22 (03-13)
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PETITION FOR EXTENSION OF TIME UNDER 37 CFR 1.136(a)	Docket Number (Optional) 704.1007DIV
Application Number 13/621,015	Filed September 15, 2012
For Coated Steel Strips, Methods of Making the Same	
Art Unit 1784	Examiner Schleis

This is a request under the provisions of 37 CFR 1.136(a) to extend the period for filing a reply in the above-identified application.

The requested extension and fee are as follows (check time period desired and enter the appropriate fee below):

	Fee	Small Entity Fee	Micro Entity Fee	
☐ One month (37 CFR 1.17(a)(1))	$200	$100	$50	$
☑ Two months (37 CFR 1.17(a)(2))	$600	$300	$150	$ 600
☐ Three months (37 CFR 1.17(a)(3))	$1,400	$700	$350	$
☐ Four months (37 CFR 1.17(a)(4))	$2,200	$1,100	$550	$
☐ Five months (37 CFR 1.17(a)(5))	$3,000	$1,500	$750	$

☐ Applicant asserts small entity status. See 37 CFR 1.27.

☐ Applicant certifies micro entity status. See 37 CFR 1.29.
Form PTO/SB/15A or B or equivalent must either be enclosed or have been submitted previously.

☐ A check in the amount of the fee is enclosed.

☐ Payment by credit card. Form PTO-2038 is attached.

☑ The Director has already been authorized to charge fees in this application to a Deposit Account.

☑ The Director is hereby authorized to charge any fees which may be required, or credit any overpayment, to Deposit Account Number 50-0552.

☑ Payment made via EFS-Web.

WARNING: Information on this form may become public. Credit card information should not be included on this form. Provide credit card information and authorization on PTO-2038.

I am the

☐ applicant/inventor.

☐ assignee of record of the entire interest. See 37 CFR 3.71. 37 CFR 3.73(b) statement is enclosed (Form PTO/SB/96).

☑ attorney or agent of record. Registration number 57,392.

☐ attorney or agent acting under 37 CFR 1.34. Registration number _____.

/Jennifer L. O'Connell/	August 15, 2013
Signature	Date
Jennifer L. O'Connell	(212) 736-1940
Typed or printed name	Telephone Number

NOTE: This form must be signed in accordance with 37 CFR 1.33. See 37 CFR 1.4 for signature requirements and certifications. Submit multiple forms if more than one signature is required, see below*.

☐ * Total of _____ forms are submitted.

This collection of information is required by 37 CFR 1.136(a). The information is required to obtain or retain a benefit by the public, which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 6 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

Privacy Act Statement

The **Privacy Act of 1974 (P.L. 93-579)** requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether disclosure of these records is required by the Freedom of Information Act.
2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.
3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.
4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).
5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.
6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).
7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (*i.e.*, GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.
8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspection or an issued patent.
9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

PTO/SB/22 (03-13)
Approved for use through 3/31/2013. OMB 0651-0031
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/Jennifer L. O'Connell/	August 15, 2013
Signature	Date
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PTO/SB/06 (09-11)
Approved for use through 1/31/2014. OMB 0651-0032
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PATENT APPLICATION FEE DETERMINATION RECORD Substitute for Form PTO-875	Application or Docket Number 13/621,015	Filing Date 09/15/2012	☐ To be Mailed

ENTITY: ☒ LARGE ☐ SMALL ☐ MICRO

APPLICATION AS FILED – PART I

FOR	(Column 1) NUMBER FILED	(Column 2) NUMBER EXTRA	RATE ($)	FEE ($)
☐ BASIC FEE (37 CFR 1.16(a), (b), or (c))	N/A	N/A	N/A	
☐ SEARCH FEE (37 CFR 1.16(k), (i), or (m))	N/A	N/A	N/A	
☐ EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))	N/A	N/A	N/A	
TOTAL CLAIMS (37 CFR 1.16(i))	minus 20 =	*	X $ =	
INDEPENDENT CLAIMS (37 CFR 1.16(h))	minus 3 =	*	X $ =	
☐ APPLICATION SIZE FEE (37 CFR 1.16(s))	If the specification and drawings exceed 100 sheets of paper, the application size fee due is $310 ($155 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).			
☐ MULTIPLE DEPENDENT CLAIM PRESENT (37 CFR 1.16(j))				
* If the difference in column 1 is less than zero, enter "0" in column 2.			TOTAL	

APPLICATION AS AMENDED – PART II

AMENDMENT	08/15/2013	(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	RATE ($)	ADDITIONAL FEE ($)
	Total (37 CFR 1.16(i))	* 11	Minus	** 20	= 0	X $80 =	0
	Independent (37 CFR 1.16(h))	* 1	Minus	***3	= 0	X $420 =	0
	☐ Application Size Fee (37 CFR 1.16(s))						
	☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))						
						TOTAL ADD'L FEE	0

AMENDMENT		(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	RATE ($)	ADDITIONAL FEE ($)
	Total (37 CFR 1.16(i))	*	Minus	**	=	X $ =	
	Independent (37 CFR 1.16(h))	*	Minus	***	=	X $ =	
	☐ Application Size Fee (37 CFR 1.16(s))						
	☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))						
						TOTAL ADD'L FEE	

* If the entry in column 1 is less than the entry in column 2, write "0" in column 3.
** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20".
*** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3".
The "Highest Number Previously Paid For" (Total or Independent) is the highest number found in the appropriate box in column 1.

LIE
/BRENDA TURNER/

This collection of information is required by 37 CFR 1.16. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

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www.uspto.gov

23280 e 2013-08-19

Davidson, Davidson & Kappel, LLC
485 7th Avenue
14th Floor
New York, NY 10018

Paper No.

Application No.:	**13/621,015**	**Date Mailed:**	**2013-08-19**
First Named Inventor:	DRILLET, Pascal,	Examiner:	SCHLEIS, DANIEL J
Attorney Docket No.:	704.1007DIV	Art Unit:	1784
Confirmation No.:	6215	Filing Date:	2012-09-15

Please find attached an Office communication concerning this application or proceeding.

Commissioner for Patents

PTO-90c (Rev.08-06)

Notice of Non-Compliant Amendment (37 CFR 1.121)	Application No. 13/621,015	Applicant(s) DRILLET ET AL.
		Art Unit 3998

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

The amendment document filed on *15 August, 2013* is considered non-compliant because it has failed to meet the requirements of 37 CFR 1.121 or 1.4. In order for the amendment document to be compliant, correction of the following item(s) is required.

THE FOLLOWING MARKED (X) ITEM(S) CAUSE THE AMENDMENT DOCUMENT TO BE NON-COMPLIANT:

- ☐ 1. Amendments to the specification:
  - ☐ A. Amended paragraph(s) do not include markings.
  - ☐ B. New paragraph(s) should not be underlined.
  - ☐ C. Other _____.
- ☐ 2. Abstract:
  - ☐ A. Not presented on a separate sheet. 37 CFR 1.72.
  - ☐ B. Other _____.
- ☐ 3. Amendments to the drawings:
  - ☐ A. The drawings are not properly identified in the top margin as "Replacement Sheet," "New Sheet," or "Annotated Sheet" as required by 37 CFR 1.121(d).
  - ☐ B. The practice of submitting proposed drawing correction has been eliminated. Replacement drawings showing amended figures, without markings, in compliance with 37 CFR 1.84 are required.
  - ☐ C. Other _____.
- ☒ 4. Amendments to the claims:
  - ☒ A. A complete listing of all of the claims is not present.
  - ☐ B. The listing of claims does not include the text of all pending claims (including withdrawn claims)
  - ☐ C. Each claim has not been provided with the proper status identifier, and as such, the individual status of each claim cannot be identified. Note: the status of every claim must be indicated after its claim number by using one of the following status identifiers: (Original), (Currently amended), (Canceled), (Previously presented), (New), (Not entered), (Withdrawn) and (Withdrawn-currently amended).
  - ☒ D. The claims of this amendment paper have not been presented in ascending numerical order.
  - ☒ E. Other: *See Continuation Sheet*.
- ☐ 5. Other (e.g., the amendment is unsigned or not signed in accordance with 37 CFR 1.4): For further explanation of the amendment format required by 37 CFR 1.121, see MPEP § 714.

TIME PERIODS FOR FILING A REPLY TO THIS NOTICE:

1. Applicant is given **no new time period if the non-compliant amendment is an** after-final amendment or an amendment filed after allowance, or a drawing submission (only) If applicant wishes to resubmit the non-compliant after-final amendment with corrections, the **entire corrected amendment** must be resubmitted.

2. Applicant is given **one month**, or thirty (30) days, whichever is longer, from the mail date of this notice to supply the correction, if the non-compliant amendment is one of the following: a preliminary amendment, a non-final amendment (including a submission for a request for continued examination (RCE) under 37 CFR 1.114), a supplemental amendment filed within a suspension period under 37 CFR 1.103(a) or (c), and an amendment filed in response to a Quayle action. If any of above boxes 1 to 4 are checked, the correction required is only the corrected section of the non-compliant amendment in compliance with 37 CFR 1.121.

   Extensions of time are available under 37 CFR 1.136(a) only if the non-compliant amendment is a non-final amendment or an amendment filed in response to a *Quayle* action.
   Failure to timely respond to this notice will result in:
   Abandonment of the application if the non-compliant amendment is a non-final amendment or an amendment filed in response to a *Quayle* action; or
   Non-entry of the amendment if the non-compliant amendment is a preliminary amendment or supplemental amendment.

Legal Instruments Examiner (LIE), if applicable /BRENDA TURNER/ Telephone No: (571)272-3614

Continuation of 4. Other: All claims including claims 1-23 must be in the claims listing.

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant:	DRILLET	Application No.:	13/621,015
Filing Date:	September 15, 2012	Confirmation No.:	6215
Examiner:	Schleis	Attorney Docket:	704.1007DIV
Art Unit:	1784	Customer No.:	23280

Title: **COATED STEEL STRIPS, METHODS OF MAKING THE SAME, METHODS OF USING THE SAME, STAMPING BLANKS PREPARED FROM THE SAME, STAMPED PRODUCTS PREPARED FROM THE SAME, AND ARTICLES OF MANUFACTURE WHICH CONTAIN SUCH A STAMPED PRODUCT**

Submitted electronically via EFS-WEB
Mail Stop: AMENDMENT
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

September 5, 2013

RESPONSE TO NOTICE OF NON-COMPLIANT AMENDMENT

S i r:

In response to the Notice of Non-Compliant Amendment dated August 19, 2013, please reconsider the above-identified patent application based on the following:

IN THE CLAIMS:

The following listing of claims will replace all prior versions and listings of claims in the application.

Listing of Claims:

Claims 1 to 23 (canceled).

Claim 24 (currently amended): A coated steel stamped product, which comprises:

(a) a strip of base steel having a first side and a second side; and

(b) a coating on at least one of said first side of said strip of base steel and said second side of said strip of base steel,

wherein:

(i) said coating results from the interdiffusion between said base steel, and ~~aluminium~~ aluminum or ~~aluminium~~ aluminum alloy pre-coating, and

(ii) wherein said coating comprises, proceeding from the base steel outwards:

(a) an Interdiffusion layer,

(b) an Intermediate layer,

(c) an Intermetallic layer, and

(d) a Superficial layer,

wherein said coating has a thickness greater than 30 micrometers and wherein said layer (a) has a thickness less than 15 micrometers.

Claim 25 (previously presented): The coated steel stamped product according to claim 24, wherein the said layers (c) and (d) are quasi continuous by occupying at least 90 % of a level corresponding to each said layer and wherein less than 10 % of layer (c) is present at an extreme surface of the product.

Claim 26 (previously presented): The coated steel stamped product according to claim 24, wherein the steel in the strip comprises the following components by weight based on total weight:

0.15 %<carbon<0.5 %;

0.5 %<manganese<3 %;

0.1 %<silicon<0.5 %;

0.01 %<chromium<1%;

titanium<0.2 %;

aluminum<0.1 %;

phosphorus<0.1 %;

sulfur<0.05 %;

0.0005 %<boron<0.08 %;

and further comprises iron and impurities inherent in processing.

Claim 27 (previously presented): A coated steel stamped product according to claim 24, wherein the steel in the strip comprises the following components by weight based on total weight:

0.20 %<carbon<0.5 %;

0.8 %<manganese<1.5 %;

0.1 %<silicon<0.35 %;

0.01 %<chromium<1 %;

titanium<0.1 %;

aluminum<0.1 %;

phosphorus<0.05 %;

sulfur<0.03 %;

0.0005 %<boron<0.01 %;

and further comprises iron and impurities inherent in processing.

Claim 28 (previously presented): The coated steel stamped product according to claim 24, wherein the base steel comprises 20 ppm or less of sulfur.

Claim 29 (previously presented): The coated steel stamped product according to claim 24, wherein the ratio of titanium to nitrogen in the base steel in weight % is in excess of 3.42.

Claim 30 (previously presented): The coated steel stamped product according to claim 24, wherein the aluminum or aluminum alloy pre-coating comprises from 8 % to 11 % silicon by

weight, from 2 % to 4 % iron by weight, the remainder being aluminum and impurities inherent in processing.

Claim 31 (previously presented): A land motor vehicle comprising the heat treated coated steel product according to claim 24.

Claim 32 (new): The coated steel stamped product according to claim 24, wherein the product is hot formed with a strain higher than 10% and cooled with a cooling rate higher than 50° C/s.

Claim 33 (new): The coated steel stamped product according to claim 24, wherein the product includes a full martensitic structure.

Claim 34 (new): The coated steel stamped product according to claim 24, wherein said layer (a) has a thickness less than 10 micrometers.

REMARKS/ARGUMENTS

Claims 24 to 31 were rejected under 35 §102(b) as anticipated by or, in the alternative, under 35 U.S.C. §103(a) as obvious over Laurent, U.S. Patent No. 6,296,805. Claims 24, 25 and 31 were rejected under 35 §102(b) as anticipated by or, in the alternative, under 35 U.S.C. §103(a) as obvious over Takagi, U.S. Publication No. 2004/0009366. Claims 26 to 28 were rejected under 35 U.S.C. §103(a) as obvious over Takagi in view of Ford Engineering Specification, Specification Number WSP-MIA322-A1.

Claim 24 is hereby amended for grammatical reasons. Claims 32 to 34 are hereby presented. Support for new claims 32 to 34 in, for example, paragraphs [0112] and [0127].

Reconsideration of the application in view of the foregoing amendments and following remarks is respectfully requested.

Rejections under 35 U.S.C. §§102(b) and 103(a)

Claims 24 to 31 were rejected under 35 §102(b) as anticipated by or, in the alternative, under 35 U.S.C. §103(a) as obvious over Laurent, U.S. Patent No. 6,296,805.

Claim 24 recites "[a] coated steel stamped product, which comprises:

(a) a strip of base steel having a first side and a second side; and

(b) a coating on at least one of said first side of said strip of base steel and said second side of said strip of base steel,

wherein:

(i) said coating results from the interdiffusion between said base steel, and aluminum or aluminum alloy pre-coating, and

(ii) wherein said coating comprises, proceeding from the base steel outwards:

(a) an Interdiffusion layer,

(b) an Intermediate layer,

(c) an Intermetallic layer, and

(d) a Superficial layer,

wherein said coating has a thickness greater than 30 micrometers and wherein said layer (a) has a thickness less than 15 micrometers."

Laurent does not show or disclose "said coating has a thickness greater than 30 micrometers and wherein said layer (a) has a thickness less than 15 micrometers" as recited in claim 24, thus Laurent does not anticipate or obviate claim 24.

With regard to inherency, the fact that a certain result or characteristic ***may occur*** or be present in the prior art ***is not sufficient*** to establish the inherency of that result or characteristic. *In re Rijckaert*, 9 F.3d 1531, 1534, 28 USPQ2d 1955, 1957 (Fed. Cir. 1993) (reversed rejection because inherency was based on what would result due to optimization of conditions, not what was ***necessarily present*** in the prior art); (emphasis added). To establish inherency, the extrinsic evidence must make clear that the missing descriptive matter ***is necessarily present*** in the thing described in the reference, and that it would be so recognized by persons of ordinary skill. Inherency, however, may not be established by probabilities or possibilities. The mere fact that a certain thing ***may result*** from a given set of circumstances is not sufficient. *In re Robertson*, 169 F.3d 743, 745, 49 USPQ2d 1949, 1950-51 (Fed. Cir. 1999). Furthermore, in relying upon the theory of inherency, the examiner must ***provide a basis in fact and/or technical reasoning*** to reasonably support the determination that the allegedly inherent characteristic necessarily flows from the teachings of the applied prior art. *Ex parte Levy,* 17 USPQ2d 1461, 1464 (Bd. Pat. App. & Inter. 1990).

When determining whether a claim is obvious, an examiner must make "a searching comparison of the claimed invention – *including all its limitations* – with the teaching of the prior art." *In re Ochiai*, 71 F.3d 1565, 1572 (Fed. Cir. 1995) (emphasis added). Thus, "obviousness requires a suggestion of all limitations in a claim." *CFMT, Inc. v. Yieldup Intern. Corp.*, 349 F.3d 1333, 1342 (Fed. Cir. 2003) (*citing In re Royka*, 490 F.2d 981, 985 (CCPA 1974)). Moreover, as the Supreme Court recently stated, "***there must be some articulated reasoning*** with some rational underpinning to support the legal conclusion of obviousness." *KSR Int'l v. Teleflex Inc.*, 127 S. Ct. 1727, 1741 (2007) (quoting In re Kahn, 441 F.3d 977, 988 (Fed. Cir. 2006) (emphasis added)).

The Office Action asserts on Pages 4 and 5 that:

> This process appears to be identical or substantially identical to the process set forth in the specification of the instant application, which produces the claimed product. The instant application sets forth that the aluminum hot-dip coating is precisely controlled to fall within a range equal to 20 and 33 microns. [¶43 of corresponding 2013/0029172] The favorable layer disposition is obtained when aluminum or aluminum alloy pre-coated steel sheets, whose thickness range from, e.g. 07 to 3 mm, are heated for 3 to 13 mins in a furnace heated to a temperature of 880 to 940°C. [¶58] The heating rate is between 4 and 12°C/second for producing a favorable alloyed layer disposition. [¶59]
>
> It appears that the thickness of the aluminum hot-dip coating, the thickness of the steel sheet, the time and temperature of the heating within the furnace, and the heating rates in Laurent are identical or substantially identical to those set forth in the specification of the instant application. Applicant teaches that the heating rate and temperature lead to the favorable layer disposition.
>
> ...
>
> Consequently, absent a showing to the contrary, it appears that the properties of the product in the prior art necessarily or inherently possesses the characteristics of the claimed product, including the presence of the four claimed layers, the resulting thickness of the overall coating and its respective layers, and the quasi-continuous nature of the layers.

Applicants respectfully submit that process limitations disclosed in Laurent do not necessarily or inherently include a coating having "a ***thickness greater than 30 micrometers***" and in particular "said layer (a) has ***a thickness less than 15 micrometers***" as recited in claim 24. The Examiner's statements about the properties Laurent "appears" to include and that Laurent includes both thicknesses are completely conclusory and amount to an impermissible hindsight reconstruction. See MPEP 2142; *KSR Int'l Co. v. Teleflex Inc.*, 383 127 S. Ct. 1727, 1740-41 (2007) ("[R]ejections on obviousness cannot be sustained with mere conclusory statements; instead, there must be some articulated reasoning with some rational underpinning to support the legal conclusion of obviousness."); MPEP 2145; *In re Fine*, 837 F.2d 1071, 1075, 5 U.S.P.Q.2D (BNA) 1596 (Fed. Cir. 1988) ("[C]annot use hindsight reconstruction to pick and choose among isolated disclosures in the prior art to deprecate the claimed invention."). There is ***simply no reason or rationale*** provided by the Office Action or in Laurent to show or disclose that Laurent includes both thicknesses, either inherently or necessarily. Thus, the Office Action has failed to

meet the burden of a proper anticipation rejection and has failed to establish a *prima facie* case of obviousness and.

Contrary to the Examiner's assertion, the heating rates are not identical. As disclosed in Laurent "the coating is subjected to an increase in temperature at a speed in excess of 5°C/second which may exceed 600°C/second. This rise in temperature makes possible a rapid remelting of the aluminum which fills in the cracks generated by the operation of shaping of the casting." See col. 3, lines 26 to 31. Whereas, Applicants' instant specification states "heating rate V_c is comprised between 4 and 12°C/s for producing a favorable alloyed layer disposition... The inventors have discovered that the control of V_c in this precise range is a key factor, because it controls directly the nature and the morphology of the alloyed layers which are formed." Laurent does not disclose an increase in temperature from 4 to 5°C/second and Laurent does not show or disclose the advantages provided by the inventors of the instant application in maintaining the heating rate at or below 12 °C/second. In fact, Laurent desires and discloses heating rates in excess of 600°C/second to provide the rapid remelting of aluminum. Thus, there is no basis for asserting that the claimed interdiffusion layer would result.

The Examiner's assertions are also based on the present specification and a desire to meet the claim language and are not based on the disclosure of Laurent. ("'Any judgement on obviousness is in a sense necessarily a reconstruction based on hindsight reasoning, but so long as it takes into account only knowledge which was within the level of ordinary skill in the art at the time the claimed invention was made and ***does not include knowledge gleaned only from applicant's disclosure***, such a reconstruction is proper'" (MPEP § 2145(X)(A), quoting *In re McLaughlin*, 443 F.2d 1392, 1395 (CCPA 1971), (emphasis added). Laurent discloses a thickness of the sheet, "the sheet, in the delivery state in a coil or in sheeting, the thickness of which may range between 0.25 mm and 15 mm." See col. 3, lines 44 to 48. Laurent also discloses coating the sheet with "an aluminum-based layer ***about 20μm in thickness***." See col. 3, lines 42 and 43. Thus, Laurent does not show or disclose the thickness of a coating being "***greater than 30 micrometer***s" or that a "layer (a) has a thickness less than 15 micrometers" as recited in claim 24 and there is simply no reason to assume Laurent includes these features. It seems if Applicants' claims recited different thicknesses entirely, the Examiner would still rely

on the same conclusory statements instead of relying on the actual disclosure of Laurent for support of the rejection.

Applicants respectfully submit that the one who bears the ***initial burden*** of presenting a prima facie case of unpatentability is the ***Examiner***. *In re Oetiker*, 977 F.2d 1443, 1445 (Fed. Cir. 1992). The allocation of burdens requires that ***the USPTO produce the factual basis*** for its rejection of an application under 35 U.S.C. § 102. *In re Piasecki*, 745 F.2d 1468, 1472 (Fed. Cir. 1984) (citing *In re Warner*, 379 F.2d 1011, 1016 (CCPA 1967)). The Office Action has not provided Applicants with any rationale or factual basis to support the 102/103 rejections set forth. As a result, the Office Action has failed to establish a prima facie case of obviousness and anticipation. Thus, the Office Action is erroneously shifting the burden of the rejection to the Applicants to demonstrate that Laurent does not show the features recited in claim 24.

Furthermore, as presented above, Laurent discloses coating the sheet with "an aluminum-based layer ***about 20μm in thickness***." See col. 3, lines 42 and 43. There is simply no reason why one of ordinary skill in the art would increase the thickness of this aluminum based coating by 150% and the Office Action has failed to provide Applicants with such rationale or factual basis.

Thus, there is simply no reason or rationale to assume that the sheet disclosed in Laurent includes both a coating that is "greater than 30 micrometers" thick and an interdiffusion layer that "has a thickness less than 15 micrometers" as recited in claim 24.

Withdrawal of the rejections to claims 24 to 31 under 35 U.S.C. §§102(b) and 103(a) is respectfully requested.

Claims 24, 25 and 31 were rejected under 35 §102(b) as anticipated by or, in the alternative, under 35 U.S.C. §103(a) as obvious over Takagi, U.S. Publication No. 2004/0009366.

Takagi does not show or teach "a ***thickness greater than 30 micrometers***" and in particular "said layer (a) has ***a thickness less than 15 micrometers***" as recited in claim 24.

As admitted in the Office Action on page 6, Takagi discloses that a thickness of the aluminum coating is from 10 to 20 micrometers. "Thickness of aluminum coating layer: 10~20 μm." See Takagi, paragraph [0035]. Thus, Takagi specifically discloses an aluminum coating that is less than and not "***greater than 30 micrometers***" as recited in claim 24. For this reason alone, Takagi does not show or disclose each and every limitation recited in claim 24.

Contrary to the Examiner's assertion on page 7, Takagi discloses particular ranges and the limitations associated with those ranges, specifically concerning the heating rate and time. For example, when the aluminum coated member in Takagi is heated at a rate in excess of 10°C/second, the aluminum coating may be subject to local melting, which is undesirable in Takagi. See paragraph [0026]. Thus, Takagi does not show or teach an identical heating rate, between 4 and 12°C/s, as disclosed in the instant specification.

Further, "when the time for holding at the raised temperature is longer than 8 minutes, the oxidation of coating layer proceeds, and undesired influence is exerted on the adhesiveness of the coating film by electro deposition." See paragraph [0026]. Thus, Takagi does not show or teach an identical heating time including, from 8 to 13 minutes, as disclosed in the instant specification. As a result, there is no basis for asserting that the claimed interdiffusion layer, interdiffusion layer thickness and coating thickness would result.

Withdrawal of the rejections to claims 24, 25 and 31 under 35 U.S.C. §§102(b) and 103(a) is respectfully requested.

Claims 26 to 28 were rejected under 35 U.S.C. §103(a) as obvious over Takagi in view of Ford Engineering Specification, Specification Number WSP-MIA322-A1.

Claims 26 to 28 depend, directly, from claim 24. Ford Engineering Specification does not disclose the limitations not present in Takagi discussed above with respect to claim 24. Since Takagi in view of Ford Engineering Specification does not show or teach each of the

limitations recited in claim 24, withdrawal of the rejections under 35 U.S.C. §103(a) to claims for these same reasons is respectfully requested.

CONCLUSION

The present application is respectfully submitted as being in condition for allowance and applicants respectfully request such action.

Respectfully submitted,
DAVIDSON, DAVIDSON & KAPPEL, LLC

By: /William C. Gehris/
William C. Gehris
(Reg. No. 38,156)

Davidson, Davidson & Kappel, LLC
485 Seventh Avenue
New York, New York 10018
(212) 736-1940

Electronic Acknowledgement Receipt

EFS ID:	16770389
Application Number:	13621015
International Application Number:	
Confirmation Number:	6215
Title of Invention:	COATED STEEL STRIPS, METHODS OF MAKING THE SAME, METHODS OF USING THE SAME, STAMPING BLANKS PREPARED FROM THE SAME, STAMPED PRODUCTS PREPARED FROM THE SAME, AND ARTICLES OF MANUFACTURE WHICH CONTAIN SUCH A STAMPED PRODUCT
First Named Inventor/Applicant Name:	Pascal DRILLET
Customer Number:	23280
Filer:	Jennifer Lauren O'Connell
Filer Authorized By:	
Attorney Docket Number:	704.1007DIV
Receipt Date:	05-SEP-2013
Filing Date:	15-SEP-2012
Time Stamp:	13:18:16
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Supplemental Response or Supplemental Amendment	ResNCA5sept13.pdf	171740 17fc6fc94c463292c6c426784ccaaaf88229c6fa	no	11

Warnings:	
Information:	

Total Files Size (in bytes):	171740

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New Applications Under 35 U.S.C. 111
If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371
If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office
If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
13/621,015	09/15/2012	Pascal DRILLET	704.1007DIV	6215

23280 7590 09/25/2013

Davidson, Davidson & Kappel, LLC
485 7th Avenue
14th Floor
New York, NY 10018

EXAMINER	
SCHLEIS, DANIEL J	
ART UNIT	PAPER NUMBER
1784	
MAIL DATE	DELIVERY MODE
09/25/2013	PAPER

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Office Action Summary	Application No. 13/621,015	Applicant(s) DRILLET ET AL.	
	Examiner DANIEL J. SCHLEIS	Art Unit 1784	AIA (First Inventor to File) Status No

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE *3* MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *09/05/2013*.

☐ A declaration(s)/affidavit(s) under **37 CFR 1.130(b)** was/were filed on _____.

2a)☒ This action is **FINAL**. 2b)☐ This action is non-final.

3)☐ An election was made by the applicant in response to a restriction requirement set forth during the interview on _____; the restriction requirement and election have been incorporated into this action.

4)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

5)☒ Claim(s) *24-34* is/are pending in the application.

5a) Of the above claim(s) _____ is/are withdrawn from consideration.

6)☐ Claim(s) _____ is/are allowed.

7)☒ Claim(s) *24-34* is/are rejected.

8)☐ Claim(s) _____ is/are objected to.

9)☐ Claim(s) _____ are subject to restriction and/or election requirement.

* If any claims have been determined allowable, you may be eligible to benefit from the **Patent Prosecution Highway** program at a participating intellectual property office for the corresponding application. For more information, please see http://www.uspto.gov/patents/init_events/pph/index.jsp or send an inquiry to PPHfeedback@uspto.gov.

Application Papers

10)☐ The specification is objected to by the Examiner.

11)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

Certified copies:

a)☐ All b)☐ Some * c)☐ None of the:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☐ Notice of References Cited (PTO-892)

2) ☐ Information Disclosure Statement(s) (PTO/SB/08) Paper No(s)/Mail Date _____.

3) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____ .

4) ☐ Other: _____.

DETAILED ACTION

Notice of Pre-AIA or AIA Status

The present application is being examined under the pre-AIA first to invent provisions.

Claim Rejections - 35 USC § 102 / § 103

The text of those sections of Title 35, U.S. Code not included in this action can be found in a prior Office action.

Claims 24-31, 33, and 34 are rejected under 35 U.S.C. 102(b) as anticipated by or, in the alternative, under 35 U.S.C. 103(a) as obvious over U.S. Patent Number 6,296,805 (Laurent).

In regards to independent claim 24 and dependent claims 25, 33, and 34, Laurent is directed to a coated, hot- and cold-rolled steel sheet comprising a very high resistance after thermal treatment. [1:6-8] The sheet is provided with an aluminum-based coating, for example by dipping in a bath containing, in addition, from 8% to 11% silicon, from 2% to 4% iron, the sheet having a high mechanical resistance after thermal treatment and a high resistance to corrosion, as well as a good capacity for painting and gluing. [2:37-45] The aluminum-based layer is provided in a thickness of about 20 microns. [3:38-44]

Diffusion of the iron in the coating will be initiated at high temperature, thus there will be better cohesion between the coating and steel in the sheet. [3:26-37] After the shaping of a

casting the coating is subjected to an increase in temperature to an excess of 5° C/second. [3:26-29]

Thermal treatment of the metal sheet consists in a heating at a temperature between Ac1, starting temperature of austenitic formation, for example 750° C and 1200° C, in a furnace, for a period which depends on the temperature to be reached and the thickness of the casting sheet. [3:61-65] For a completely martensitic structure, and for steel having the composition of the example, the speed of cooling should be in excess of the critical speed of hardening, which is 27° C / second for an austenitizing at 900° C for five minutes, wherein the sheet has a thickness of approximately 1 mm. [4:4-9]

This process appears to be identical or substantially identical to the process set forth in the specification of the instant application, which produces the claimed product. The instant application sets forth that the aluminum hot-dip coating is precisely controlled to fall within a range equal to 20 and 33 microns. [¶43 of corresponding 2013/0029172] The favorable layer disposition is obtained when aluminum- or aluminum alloy pre-coated steel sheets, whose thickness range from, e.g. 07 to 3 mm, are heated for 3 to 13 minutes in a furnace heated to a temperature of 880 to 940° C. [¶58] The heating rate is between 4 and 12° C/second for producing a favorable alloyed layer disposition. [¶59]

It appears that the thickness of the aluminum hot-dip coating, the thickness of the steel sheet, the time and temperature of the heating within the furnace, and the heating rates in Laurent are identical or substantially identical to those set forth in the specification of the instant

application. Applicant teaches that the heating rate and temperature lead to the favorable layer disposition. [See ¶58 and ¶59]

Where the claimed and prior art products are identical or substantially identical, or are produced by identical or substantially identical processes, the Office can require an applicant to prove that the prior art products do not necessarily or inherently possess the characteristics of the claimed product. Whether the rejection is based on "inherency" under 35 USC 102, on "prima facie obviousness" under 35 USC 103, jointly or alternatively, the burden of proof is the same, and its fairness is evidenced by the Office's inability to manufacture products or to obtain and compare prior art products.

Consequently, absent a showing to the contrary, it appears that the properties of the product in the prior art necessarily or inherently possesses the characteristics of the claimed product, including the presence of the four claimed layers, the resulting thickness of the overall coating and its respective layers, and the quasi-continuous nature of the layers.

As to claim 26, Laurent teaches a steel sheet with the following composition:

0.15% < carbon < 0.5%
0.5% < manganese < 3%
0.1% < silicon < 0.5%
0.01% < chromium<1%
titanium < 0.2%
aluminum < 0.1%
phosphorus < 0.1%
sulfur < 0.05%
0.0005% < boron < 0.08%,
the remainder being iron and impurities inherent in processing.

[1:47-64]

As to claim 27, Laurent teaches a preferred steel sheet with the following composition:

0.20% < carbon < 0.5%
0.8% < manganese < 1.5%
0.1% < silicon < 0.35%
0.01% < chromium < 1%
titanium < 0.1%
aluminum < 0.1%
phosphorus < 0.05%
sulfur < 0.03%
0.0005% < boron < 0.01%,
the remainder being iron and impurities inherent in processing.

[1:65-2:10]

As to claim 28, Laurent teaches that the sulfur content of the preferred embodiment has a sulfur content of less than 0.03%. [1:65-2:10] This range taught by Laurent overlaps the claimed range.

As to claim 29, Laurent teaches in the preferred embodiment that the titanium content with respect to the nitrogen content is in excess of 3.42. [2:11-14]

As to claim 30, Laurent teaches that the steel sheet is coated by dipping in an aluminum bath containing 8% to 11% silicon and 2% to 4% iron. [3:9-14]

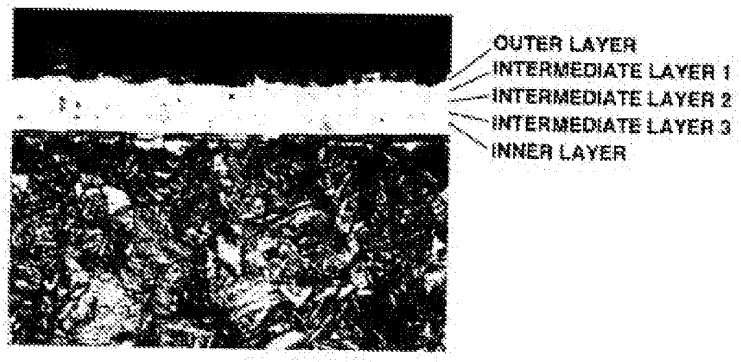
As to claim 31, this claim is an intended use claim. Laurent specifically teaches using the hot-rolled steel sheet for structural and/or anti-intrusion or substructure castings for a land motor vehicle. [2:30-34]

Claims 24, 25, 31, 33, and 34 are rejected under 35 U.S.C. 102(b) as anticipated by or, in the alternative, under 35 U.S.C. 103(a) as obvious over U.S. Patent Application Publication 2004/0009366 (Takagi).

In regards to independent claim 24 and dependent claim 25 and 34, Takagi relates to an aluminum-coated structural member. [¶1] A multi-layer structure including a hard outermost layer is advantageous for maintaining good contact with a welding gun in spot welding even under great pressure for high tension material. [¶24]

A hot-dip aluminum-coated steel sheet is formed by immersing a strip continuously in a bath of molten aluminum. [¶13] Takagi teaches that the thickness of this aluminum coating layer is between 10 and 20 microns. [¶35] The coated steel sheet is heated at a rate of 1 to 10° C/second to a temperature within the range of 900 to 950° C, and it is held at that temperature for holding time of 2 to 8 minutes. [¶26] Takagi specifically teaches a sheet thickness of the steel being 1.4 mm. [¶33] This method provides for a coating as set forth in figure 2A, which is reproduced below.

FIG.2A



This process appears to be identical or substantially identical to the process set forth in the specification of the instant application, which produces the claimed product. The instant application sets forth that the aluminum hot-dip coating is precisely controlled to fall within a

range equal to 20 and 33 microns. [¶43 of corresponding 2013/0029172] The favorable layer disposition is obtained when aluminum- or aluminum alloy pre-coated steel sheets, whose thickness range from, e.g. 07 to 3 mm, are heated for 3 to 13 minutes in a furnace heated to a temperature of 880 to 940° C. [¶58] The heating rate is between 4 and 12° C/second for producing a favorable alloyed layer disposition. [¶59]

Consequently, absent a showing to the contrary, it appears that the properties of the product in the prior art necessarily or inherently possesses the characteristics of the claimed product, including the presence of the four claimed layers, the resulting thickness of the overall coating and its respective layers, and the quasi-continuous nature of the layers.

Pertaining to claim 31, Takagi teaches that the aluminum-coated structure member can be used as a structural member for a motor vehicle. [¶1]

Pertaining to claim 33, Takagi teaches cooling at a rate of 20 to 100° C/second after a forming operation. [¶28] Takagi teaches that this rapid cooling promotes martensitic transformation. [¶28] This cooling rate overlaps the range that produces the claimed product. Consequently, absent a showing to the contrary, it appears that the properties of the product in the prior art necessarily or inherently possesses the characteristics of the claimed product.

Claim Rejections - 35 USC § 103

Claim 32 is rejected under pre-AIA 35 U.S.C. 103(a) as being unpatentable over Takagi.

The amount of strain present within the product is dependent upon the art and the type of product produced. Takagi is directed to structural members used for motor vehicles. [¶1] Similarly, the product of the instant application is directed to structural parts of an automobile. [See ¶10 of corresponding 2013/0029172] There is no patentable distinction for strain ratios for these types of products. Additionally, it is within the purview of one of ordinary skill in the art at the time of the invention to form a product more than others based on the desired part being produced, therefore it would be expected that the strain ratios would likewise overlap.

Claims 26-28 are rejected under 35 U.S.C. 103(a) as being unpatentable over Takagi as applied to claim 24 above, and further in view of the Ford Engineering Specification, Specification Number WSP-MIA322-A1, dated 1992-03-31 (Hereinafter "the Ford Engineering Specification," submitted in IDS).

In regards to claims 26 and 27, as set forth above in regards to claim 24, Takagi sets forth a steel sheet that is covered with an aluminum dip coating and subjected to heat treatment in order to obtain a multilayered structure. While Takagi teaches that the steel is used as a structural component of a motor vehicle, it does not explicitly set forth the claimed composition.

In the same field of endeavor of motor vehicle components, the Ford Engineering Specification sets forth requirements for material used in door intrusion beams where a high strength to weight ratio is required. [Section 2] The composition of the material must fall within the range:

C	0.20-0.25
Mn	1.00 – 1.30
P	0.03 max
S	0.025 max

Si	0.20 – 0.35
Cr	0.15 – 0.25
B	0.0015 – 0.005

[Section 3.2] All materials supplied to this specification must be equivalent in all characteristics to the material upon which approval was originally granted. [Section 3.4]

It would have been obvious to one of ordinary skill in the art at the time of the invention to have used the composition set forth in the Ford Engineering Specification as the steel sheet of the product of Takagi. One of ordinary skill in the art at the time of the invention would have been motivated by the desire and expectation of a simple substitution of one known element for another to obtain predictable results, including using a known composition which is known for its high strength to weight ratio. Further, as shown by the Ford Engineering Specification, such composition is recognized in the field for its use as a structural member of a motor vehicle.

As to claim 28, the ratio of sulfur in the composition set forth in the Ford Specification overlaps the claimed range.

Response to Arguments

Applicant's arguments filed 5 September 2013 have been fully considered but they are not persuasive.

Applicant argues that Laurent does not show or disclose the coating having a thickness greater than 30 micrometers and wherein the layer (a) has a thickness less than 15 micrometers as recited in claim 24. Applicant argues that the process limitations in Laurent do not necessarily or inherently include the claimed thicknesses. Applicant asserts that the Examiner's statements about the properties of Laurent and that Laurent includes both thicknesses are completely

conclusory and amount to an impermissible hindsight reconstruction. Applicant asserts that "[t]here is simply no reason or rationale provided by the Office Action or in Laurent to show or disclose that Laurent includes both thicknesses, either inherently or necessarily." Applicant asserts that the heating ranges taught in Laurent are not identical those in the instant application. Applicant asserts that the Office Action was based on the present specification and a desire to meet the claim language and are not based on the disclosure of Laurent.

Further, applicant asserts that Laurent discloses coating the sheet with an aluminum-based layer about 20 microns in thickness, and therefore does not show or disclose a thickness of a coating being greater than 30 microns or a layer (a) having a thickness less than 15 microns. Applicant alleges that since Laurent discloses coating the sheet with an aluminum-based layer about 20 microns in thickness that there is simply no reason why one of ordinary skill in the art would increase this aluminum based coating by 150% and that the Office Action has failed to provide Applicants with such rational or factual basis.

These arguments are not found persuasive.

As set forth above and in the previous Office Action, the process of Laurent appears to be identical or substantially identical to the process set forth in the instant application, which produces the claimed product.

The instant application sets forth that the product is produced by providing an aluminum hot-dip coating that is precisely controlled to fall within a range equal to 20 and 33 microns. [¶43 of corresponding 2013/0029172] The favorable layer disposition is obtained when aluminum or aluminum alloy pre-coated steel sheets, whose thicknesses range from, for example, 0.7 to 3 mm, are heated for 3 to 13 minutes in a furnace heated to a temperature of 880

to 940° C. [¶58] The heating rate is between 4 and 12° C for producing a favorable alloyed layer disposition. [¶59]

Likewise, Laurent teaches providing an aluminum-based layer in a thickness of about 20 microns. [3:38-44] The coating is subjected to an increase in temperature in excess of 5° C/second. [3:26-29] The thermal treatment of the metal sheet consists in a heating at a temperature within the range of 750 to 1200°C. [3:61-65]

The thickness of the aluminum hot-dip coating, the thickness of the steel sheet, the time and temperature of the heating within the furnace, and the heating rates in Laurent are identical or substantially identical to those set forth in the specification of the instant application. The ranges and values for these parameters overlap those used to produce the claimed product. In particular, the thickness of the coating prior to heat treatment, rate of the heat treatment, the range of the temperature, and the thickness of the steel sheet are either identical or substantially identical. Applicant has not provided any evidence in the record rebutting the position that the product produced by Laurent would not necessarily or inherently possess the characteristics of the claimed product under either inherency under 35 U.S.C. 102 or on prima facie obviousness under 35 U.S.C. 103, jointly or alternatively.

It is additionally noted that the about 20 microns and the 20 to 33 microns discussed in the specification of the instant application are not referring to the thicknesses of the claimed product, but rather are the pre-coat thickness prior to the heat treatment. Therefore, it is improper to compare the thickness of this coating with the claimed coating produced after the heat treatment.

Applicant argues that Takagi discloses an aluminum coating that is less than and not greater than 30 micrometers. Applicant also asserts that Takagi does not show or teach the heating rate of between 4 and 12°C/second as disclosed in the instant application. Applicant also asserts that Takagi does not show or teach a heating time from 8 to 13 minutes as disclosed in the instant application. These arguments are not found persuasive.

It is initially noted that the about 20 microns and the 20 to 33 microns discussed in the specification of the instant application are not referring to the thicknesses of the claimed product, but rather are the pre-coat thickness prior to the heat treatment. Therefore, it is improper to compare the thickness of this coating with the claimed coating produced after the heat treatment.

Takagi further clearly discloses a heating rate in the range of 1 to 10°C. Paragraph 26 of Takagi sets forth:

> An aluminum-coated structural member having an Al—Si—Fe alloy layer on the surface as mentioned above can be obtained by the following process. First, a heat resisting hot-dip aluminum-coated steel sheet containing Si in a coating layer is heated at a rate of 1-10° C./sec to a temperature in the temperature range of 900-950° C., and held at that raised temperature for a holding time (or duration) of 2-8 minutes. In this case, the aluminum coating could melt locally when the hot-dip aluminum-coated steel sheet is heated at a heating rate faster than 10° C./sec to a temperature higher than 900° C. The coating layer could oxidize when the heating rate is slower than 1° C./sec. The progress of austenitizing in the steel base material is too slow to obtain a sufficient strength as a structural member when the raised temperature at which the specimen is held is lower than 900° C. When the raised temperature is higher than 950° C., the undesired oxidation of the coating layer proceeds, and the diffusion of Fe proceeds too much up to the surface of the coating layer. When the time for holding at the raised temperature is shorter than 2 minutes, then the formation of Al—Si—Fe alloy layer becomes insufficient. When the time for holding at the raised temperature is longer than 8 minutes, the oxidation of coating layer proceeds, and undesired influence is

> exerted on the adhesiveness of the coating film by electro deposition. [¶26]

Additionally, the instant application sets forth that the favorable layer disposition is obtained when aluminum or aluminum alloy pre-coated steel sheets, whose thicknesses range from, for example, 0.7 to 3 mm, are heated for 3 to 13 minutes in a furnace heated to a temperature of 880 to 940° C. [¶58] The specification of the instant application explicitly sets forth this 3 to 13 minute range. [¶58] Therefore, since these ranges clearly substantially overlap, it would be expected that the resulting products would not be patentably distinct.

Applicant has not provided any evidence in the record rebutting the position that the product produced by Takagi would not necessarily or inherently possess the characteristics of the claimed product under either inherency under 35 U.S.C. 102 or on prima facie obviousness under 35 U.S.C. 103, jointly or alternatively.

Conclusion

THIS ACTION IS MADE FINAL. Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event,

however, will the statutory period for reply expire later than SIX MONTHS from the mailing date of this final action.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to DANIEL J. SCHLEIS whose telephone number is (571)270-5636. The examiner can normally be reached on Monday through Friday between the hours of 9:00 AM and 4:30 PM EST.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Mark Ruthkosky can be reached on (571) 272-1291. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

/DANIEL J SCHLEIS/
Examiner, Art Unit 1784

/Mark Ruthkosky/
Supervisory Patent Examiner, Art Unit 1785

EAST Search History

EAST Search History (Prior Art)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
S1	13	((PASCAL) near2 (DRILLET)).INV.	US-PGPUB; USPAT; USOCR	OR	ON	2013/02/26 09:51
S2	8	((DOMINIQUE) near2 (SPEHNER)).INV.	US-PGPUB; USPAT; USOCR	OR	ON	2013/02/26 09:51
S3	11	((RONALD) near2 (KEFFERSTEIN)).INV.	US-PGPUB; USPAT; USOCR	OR	ON	2013/02/26 09:51
S4	0	("2013/0029172").URPN.	USPAT	OR	ON	2013/02/26 09:51
S5	9	("20030152796" | "3240269" | "5023113" | "6296805" | "6815087" | "7137201" | "7217331" | "7503116").PN. OR ("8307680").URPN.	US-PGPUB; USPAT; USOCR	OR	ON	2013/02/26 09:51
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S9	16	("20010042393" | "20070082214" | "20070163685" | "20090242086" | "20090308499" | "20110006491" | "20110165436" | "4546051" | "6017643" | "6093498" | "6296805" | "6298905" | "6564604" | "6815087" | "7137201" | "7867344").PN. OR ("8066829").URPN.	US-PGPUB; USPAT; USOCR	OR	ON	2013/02/26 10:40
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		("8066829") or ("8307680") or ("20110006491") or ("20110165436") or ("20110214475") or ("20120064362") or ("20130029172") or ("6564604") or ("20010042393") or ("20120118437") or ("4846986") or ("20120085467") or ("20080261058") or ("4601766") or ("5248528") or ("5456953") or ("5568914") or ("5830290") or ("20040118482") or ("5287983") or ("4880481") or ("4344342") or ("4963400") or ("4999241") or ("5342672") or ("5792180") or ("6070444") or ("4353765") or ("5982073") or ("6129790") or ("6165595") or ("3798406") or ("4033918") or ("4311755") or ("4488862") or ("4508755") or ("4514264") or ("4525177") or ("4551085") or ("4554765") or ("4585519") or ("4842887") or ("4994517") or ("5273369") or ("5389452") or ("5538576") or ("5542978") or ("5639510") or ("5697715") or ("5729616") or ("5801128") or ("5837314") or ("5869160") or ("6020026") or ("6019923") or ("6251514") or ("6258425") or ("6262513") or ("6309748") or ("6340397") or ("6342108") or ("20020014181") or ("20090025836") or ("20090048127") or ("4374168") or ("4309951") or ("5810332") or ("5795661") or ("8349098") or ("20020160235") or ("20020166606") or ("20100294400") or ("20110056594") or ("20110056594") or ("20120085466") or ("5981089") or ("6197125") or ("4793867") or ("4941930") or ("4980241") or ("5238506") or ("5405427") or ("5939144") or ("6090873") or ("6241393") or ("3859239") or ("3850684") or ("3850647") or ("4316751") or ("4347085") or ("4401719") or ("4402994") or ("4533606") or ("4592958") or ("4867853") or ("5232619") or ("5242506") or ("5290362") or ("5332776") or ("5466280") or ("5608028") or ("5643474") or ("5700551") or ("5743536") or ("5783622") or ("5786098") or ("5851659") or ("5863640") or ("5890852") or ("5955201") or ("6001494") or ("6042949") or ("6083613") or ("6194088") or ("6197436") or ("6284059") or ("6329456") or ("6410626") or ("7533713") or ("8025965") or ("8025965") or ("20030150308") or ("20040129346") or ("20040216860") or ("20070209555") or ("20080090093") or ("20100175794") or ("20110300407") or ("20100199872") or ("4793218") or ("5584845") or ("5759304") or ("6463779") or ("7703820") or ("7926180") or ("7926180") or ("20070045384") or ("20070051434") or ("20090058111") or ("20100187291")).PN. or (("20110247467") or ("4384011") or ("5960930") or ("6120604") or ("4863650") or ("4926792") or ("4942061") or ("4035528") or ("4342418") or ("4355059")	PGPUB; USPAT; USOCR			10:54	

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S14	0	("2012/0085466").URPN.	USPAT	OR	ON	2013/02/26 10:55
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S21	304	S20 and (interdiffusion intermediate intermetallic superficial) near3 layer	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2013/02/26 11:03
S22	14	("20020068189" | "20020104876" | "20030012977" | "20030207769" | "20040028939" | "3195991" | "4957822" | "4973523" | "5112416" | "5362574" | "5384205" | "5470666" | "7074496").PN. OR ("8053087").URPN.	US-PGPUB; USPAT; USOCR	OR	ON	2013/02/26 12:13
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S24	286	S23 and (carbon c) same (manganese Mn) same (Silicon si) same (Chromium Cr) same (titanium ti) same (aluminum al)	US-PGPUB; USPAT;	OR	ON	2013/02/26 12:33

		same (Phosphorus P) same (Sulfur Sulphur S) same (Boron B)	USOCR; EPO; JPO; DERWENT			
S25	59	S24 and (aluminum aluminium al) near5 (pre-coat$4 precoat$4 layer coat$5)	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2013/02/26 12:35
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S27	2	("2001/0001049").URPN.	USPAT	OR	ON	2013/02/26 12:40
S28	8224	((428/601,600,602,653) or (420/104,120,121,126) or (148/531,535,534,537,635,653) or (72/364,342.1,47) or (280/1)).CCLS.	US-PGPUB; USPAT; USOCR	OR	OFF	2013/09/19 16:58
S29	456	S28 and (interdiffusion intermediate intermetallic superficial) near3 layer	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2013/09/19 16:58
S30	4	S29 and (strain near3 ratio)	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2013/09/19 16:59
S31	36	S28 and (strain near3 ratio)	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2013/09/19 16:59
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S36	0	("2009/0252641").URPN.	USPAT	OR	ON	2013/09/19 17:00
S37	4	("4985196" | "4990545" | "5139832" | "6084849").PN. OR ("7060140").URPN.	US-PGPUB; USPAT; USOCR	OR	ON	2013/09/19 17:00
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EAST Search History (Interference)

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9/19/2013 5:02:13 PM
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Page 216 of 624

Search Notes	Application/Control No.	Applicant(s)/Patent Under Reexamination
	13621015	DRILLET ET AL.
	Examiner	Art Unit
	DANIEL J SCHLEIS	1784

CPC- SEARCHED		
Symbol	Date	Examiner

CPC COMBINATION SETS - SEARCHED		
Symbol	Date	Examiner

US CLASSIFICATION SEARCHED			
Class	Subclass	Date	Examiner

SEARCH NOTES		
Search Notes	Date	Examiner
Inventor Name Search	03/13	Schleis
PLUS Patent Search	03/13	Schleis
Non-Patent Literature Search - Google Scholar, Knovel, Science Direct	03/13	Schleis
EAST Text Search - See Search History	03/13	Schleis
Non-Patent Literature Search - Google Scholar, Knovel, Science Direct (Updated)	09/13	Schleis
EAST Text Search - See Search History (Updated)	09/13	Schleis
Discussed Application with Primary Examiner John Zimmerman	09/13	Schleis

INTERFERENCE SEARCH			
US Class/ CPC Symbol	US Subclass / CPC Group	Date	Examiner

PTO/SB/31 (09-12)
Approved for use through 01/31/2013. OMB 0651-0031
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

NOTICE OF APPEAL FROM THE EXAMINER TO THE PATENT TRIAL AND APPEAL BOARD

Docket Number (Optional): 704.1007DIV

I hereby certify that this correspondence is being facsimile transmitted to the USPTO EFS-Web transmitted to the USPTO, or or deposited with the United States Postal Service with sufficient postage as first class mail in an envelope addressed to "Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450" [37 CFR 1.8(a)]

on _____

Signature _____

Typed or printed name _____

In re Application of: DRILLET

Application Number	Filed
13/621,015	September 25, 2013

For: Coated Steel Strips...

Art Unit	Examiner
1784	Schleis

Applicant hereby **appeals** to the Patent Trial and Appeal Board from the last decision of the examiner.

The fee for this Notice of Appeal is (37 CFR 41.20(b)(1)) $ 800

☐ Applicant claims small entity status. See 37 CFR 1.27. Therefore, the fee shown above is reduced by half, and the resulting fee is: $ _____

☐ A check in the amount of the fee is enclosed.

☐ Payment by credit card. Form PTO-2038 is attached.

☑ The Director has already been authorized to charge fees in this application to a Deposit Account.

☑ The Director is hereby authorized to charge any fees which may be required, or credit any overpayment to Deposit Account No. 50-0552 .

☑ A petition for an extension of time under 37 CFR 1.136(a) (PTO/SB/22) is enclosed.

WARNING: Information on this form may become public. Credit card information should not be included on this form. Provide credit card information and authorization on PTO-2038.

I am the

☐ applicant/inventor.

☐ assignee of record of the entire interest. See 37 CFR 3.71. Statement under 37 CFR 3.73(b) is enclosed. (Form PTO/SB/96)

☑ attorney or agent of record. Registration number 57,392.

☐ attorney or agent acting under 37 CFR 1.34. Registration number if acting under 37 CFR 1.34. _____

/Jennifer L. O'Connell/
Signature

Jennifer L. O'Connell
Typed or printed name

(212) 736-1940
Telephone number

March 19, 2014
Date

NOTE: Signatures of all the inventors or assignees of record of the entire interest or their representative(s) are required. Submit multiple forms if more than one signature is required, see below*.

☐ *Total of _____ forms are submitted.

This collection of information is required by 37 CFR 41.31. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11, 1.14 and 41.6. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

Privacy Act Statement

The **Privacy Act of 1974 (P.L. 93-579)** requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether disclosure of these records is required by the Freedom of Information Act.
2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.
3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.
4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).
5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.
6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).
7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (*i.e.*, GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.
8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspection or an issued patent.
9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

Electronic Patent Application Fee Transmittal

Application Number:	13621015
Filing Date:	15-Sep-2012
Title of Invention:	COATED STEEL STRIPS, METHODS OF MAKING THE SAME, METHODS OF USING THE SAME, STAMPING BLANKS PREPARED FROM THE SAME, STAMPED PRODUCTS PREPARED FROM THE SAME, AND ARTICLES OF MANUFACTURE WHICH CONTAIN SUCH A STAMPED PRODUCT
First Named Inventor/Applicant Name:	Pascal DRILLET
Filer:	Jennifer Lauren O'Connell
Attorney Docket Number:	704.1007DIV

Filed as Large Entity

Utility under 35 USC 111(a) Filing Fees

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				
Notice of Appeal	1401	1	800	800
Post-Allowance-and-Post-Issuance:				
Extension-of-Time:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Extension - 3 months with $0 paid	1253	1	1400	1400
Miscellaneous:				
		Total in USD ($)		**2200**

Electronic Acknowledgement Receipt

EFS ID:	18526336
Application Number:	13621015
International Application Number:	
Confirmation Number:	6215
Title of Invention:	COATED STEEL STRIPS, METHODS OF MAKING THE SAME, METHODS OF USING THE SAME, STAMPING BLANKS PREPARED FROM THE SAME, STAMPED PRODUCTS PREPARED FROM THE SAME, AND ARTICLES OF MANUFACTURE WHICH CONTAIN SUCH A STAMPED PRODUCT
First Named Inventor/Applicant Name:	Pascal DRILLET
Customer Number:	23280
Filer:	Jennifer Lauren O'Connell
Filer Authorized By:	
Attorney Docket Number:	704.1007DIV
Receipt Date:	19-MAR-2014
Filing Date:	15-SEP-2012
Time Stamp:	18:22:47
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	Deposit Account
Payment was successfully received in RAM	$2200
RAM confirmation Number	5057
Deposit Account	500552
Authorized User	

The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows:

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Charge any Additional Fees required under 37 C.F.R. Section 1.20 (Post Issuance fees)

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File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Extension of Time	PetExtTime19march14.pdf	189257 d4b4381eed8d8c4afd5b24d84e10855c4b482c9e	no	2
Warnings:					
Information:					
2	Notice of Appeal Filed	NoticeAppeal19march14.pdf	215680 677d6a68a592181d6024bfde95c213b91ec7fca7	no	2
Warnings:					
Information:					
3	Fee Worksheet (SB06)	fee-info.pdf	32566 8fd6a38690d4346f3cd96fc250e31a92a8648f4e	no	2
Warnings:					
Information:					
		Total Files Size (in bytes):	437503		

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New Applications Under 35 U.S.C. 111
If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371
If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office
If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

PTO/SB/22 (03-13)
Approved for use through 3/31/2013. OMB 0651-0031
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

PETITION FOR EXTENSION OF TIME UNDER 37 CFR 1.136(a)	Docket Number (Optional) 704.1007DIV
Application Number 13/621,015	Filed September 15, 2012
For Coated Steel Strips, Methods of Making the Same	
Art Unit 1784	Examiner Schleis

This is a request under the provisions of 37 CFR 1.136(a) to extend the period for filing a reply in the above-identified application.

The requested extension and fee are as follows (check time period desired and enter the appropriate fee below):

	Fee	Small Entity Fee	Micro Entity Fee	
☐ One month (37 CFR 1.17(a)(1))	$200	$100	$50	$
☐ Two months (37 CFR 1.17(a)(2))	$600	$300	$150	$
☑ Three months (37 CFR 1.17(a)(3))	$1,400	$700	$350	$ 1400
☐ Four months (37 CFR 1.17(a)(4))	$2,200	$1,100	$550	$
☐ Five months (37 CFR 1.17(a)(5))	$3,000	$1,500	$750	$

☐ Applicant asserts small entity status. See 37 CFR 1.27.

☐ Applicant certifies micro entity status. See 37 CFR 1.29.
Form PTO/SB/15A or B or equivalent must either be enclosed or have been submitted previously.

☐ A check in the amount of the fee is enclosed.

☐ Payment by credit card. Form PTO-2038 is attached.

☑ The Director has already been authorized to charge fees in this application to a Deposit Account.

☑ The Director is hereby authorized to charge any fees which may be required, or credit any overpayment, to Deposit Account Number 50-0552.

☑ Payment made via EFS-Web.

WARNING: Information on this form may become public. Credit card information should not be included on this form. Provide credit card information and authorization on PTO-2038.

I am the

☐ applicant/inventor.

☐ assignee of record of the entire interest. See 37 CFR 3.71. 37 CFR 3.73(b) statement is enclosed (Form PTO/SB/96).

☑ attorney or agent of record. Registration number 57,392.

☐ attorney or agent acting under 37 CFR 1.34. Registration number _____.

/Jennifer L. O'Connell/	March 19, 2014
Signature	Date
Jennifer L. O'Connell	(212) 736-1940
Typed or printed name	Telephone Number

NOTE: This form must be signed in accordance with 37 CFR 1.33. See 37 CFR 1.4 for signature requirements and certifications. Submit multiple forms if more than one signature is required, see below*.

☐ * Total of _____ forms are submitted.

This collection of information is required by 37 CFR 1.136(a). The information is required to obtain or retain a benefit by the public, which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 6 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

Privacy Act Statement

The **Privacy Act of 1974 (P.L. 93-579)** requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether disclosure of these records is required by the Freedom of Information Act.
2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.
3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.
4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).
5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.
6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).
7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (*i.e.*, GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.
8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspection or an issued patent.
9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

Electronic Patent Application Fee Transmittal

Application Number:	13621015
Filing Date:	15-Sep-2012
Title of Invention:	COATED STEEL STRIPS, METHODS OF MAKING THE SAME, METHODS OF USING THE SAME, STAMPING BLANKS PREPARED FROM THE SAME, STAMPED PRODUCTS PREPARED FROM THE SAME, AND ARTICLES OF MANUFACTURE WHICH CONTAIN SUCH A STAMPED PRODUCT
First Named Inventor/Applicant Name:	Pascal DRILLET
Filer:	Jennifer Lauren O'Connell
Attorney Docket Number:	704.1007DIV

Filed as Large Entity

Utility under 35 USC 111(a) Filing Fees

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				
Extension-of-Time:				
Extension - 5 months with $0 paid	1255	1	3000	3000

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Miscellaneous:				
		Total in USD ($)		**3000**

Electronic Acknowledgement Receipt

EFS ID:	20466877
Application Number:	13621015
International Application Number:	
Confirmation Number:	6215
Title of Invention:	COATED STEEL STRIPS, METHODS OF MAKING THE SAME, METHODS OF USING THE SAME, STAMPING BLANKS PREPARED FROM THE SAME, STAMPED PRODUCTS PREPARED FROM THE SAME, AND ARTICLES OF MANUFACTURE WHICH CONTAIN SUCH A STAMPED PRODUCT
First Named Inventor/Applicant Name:	Pascal DRILLET
Customer Number:	23280
Filer:	Jennifer Lauren O'Connell
Filer Authorized By:	
Attorney Docket Number:	704.1007DIV
Receipt Date:	20-OCT-2014
Filing Date:	15-SEP-2012
Time Stamp:	18:48:24
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	Deposit Account
Payment was successfully received in RAM	$3000
RAM confirmation Number	5875
Deposit Account	500552
Authorized User	

The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows:

Charge any Additional Fees required under 37 C.F.R. Section 1.16 (National application filing, search, and examination fees)

Charge any Additional Fees required under 37 C.F.R. Section 1.17 (Patent application and reexamination processing fees)

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Charge any Additional Fees required under 37 C.F.R. Section 1.21 (Miscellaneous fees and charges)

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Fee Worksheet (SB06)	fee-info.pdf	30688 5f93e01e4c639a29731acfe34671b912f9470772	no	2

Warnings:

Information:

Total Files Size (in bytes):	30688

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE
BEFORE THE BOARD OF PATENT APPEALS AND INTERFERENCES

Applicant:	**DRILLET et al.**	Application No.:	13/621,015
Filing Date:	September 15, 2012	Confirmation No.:	6215
Examiner:	Schleis	Attorney Docket:	704.1007DIV
Art Unit:	1784	Customer No.:	23280

Title: **COATED STEEL STRIPS, METHODS OF MAKING THE SAME, METHODS OF USING THE SAME, STAMPING BLANKS PREPARED FROM THE SAME, STAMPED PRODUCTS PREPARED FROM THE SAME, AND ARTICLES OF MANUFACTURE WHICH CONTAIN SUCH A STAMPED PRODUCT**

Submitted electronically via EFS-Web
Mail Stop: APPEAL BRIEF – PATENTS
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

October 20, 2014

APPELLANTS' BRIEF UNDER 37 C.F.R. §41.37

Sir:

Appellants submit this brief for the consideration of the Board of Patent Appeals and Interferences (the "Board") in support of their appeal of the Final Rejection dated September 25, 2013 in this application.

I. REAL PARTY IN INTEREST

The real party in interest is ArcelorMittal France, a corporation having a place of business in Saint Denis, France, and the assignee of the entire right, title and interest in the above-identified patent application. The invention was assigned to ArcelorMittal France by an assignment originating from the inventors in the parent application, U.S. Application No. 12/447,777 which issued as U.S. Patent No. 8,307,680 on November 13, 2012. The most recent assignment was recorded on March 23, 2011 at reel 026004, frame 0196.

II. RELATED APPEALS AND INTERFERENCES

Appellants, their legal representatives and assignee are not aware of any appeal, interference or judicial proceeding that directly affects, will be directly affected by, or will have a bearing on the Board's decision in this appeal.

III. STATUS OF CLAIMS

Claims 24 to 34 are pending. Claims 1 to 23 were canceled without prejudice. Claims 24 to 34 were finally rejected as per the Final Office Action dated September 25, 2013. The rejection to claims 24 to 34 thus is appealed. A copy of appealed claims 24 to 34 is attached hereto as Appendix A.

IV. STATUS OF AMENDMENTS AFTER FINAL

No amendments were made after the Final Office Action. A Notice of Appeal was filed electronically via EFS-Web and on March 19, 2014.

V. SUMMARY OF THE CLAIMED SUBJECT MATTER

A. Independent Claim 24

A coated steel stamped product, which comprises (a) a strip of base steel having a first side and a second side (e.g. side 1, side 2 described on page 6, lines 11 to 14 and shown in Fig. 1); and (b) a coating on at least one of said first side of said strip of base steel and said second

side of said strip of base steel (e.g. coating described on page 9, lines 8 to 21), wherein: (i) said coating results from the interdiffusion between said base steel, and aluminum or aluminum alloy pre-coating (e.g. see page 9, lines 8 to 21), and (ii) wherein said coating comprises, proceeding from the base steel outwards: (a) an Interdiffusion layer (e.g. interdiffusion layer shown in Fig. 1 and described at page 9, lines 21 to 26), (b) an Intermediate layer (e.g. intermediate layer shown in Fig. 1 and described at page 9, lines 27 to 28), (c) an Intermetallic layer (e.g. Al-rich intermetallic layer shown in Fig. 1 and described at page 9, lines 30 to 32), and (d) a Superficial layer (e.g. superficial layer shown in Fig. 1 and described at page 9 line 34 to page 10, line 2), wherein said coating has a thickness greater than 30 micrometers (e.g. layers (a) to (d) shown in Fig. 1 and described at page 10, lines 3 and 4) and wherein said layer (a) has a thickness less than 15 micrometers (e.g. interdiffusion layer shown in Fig. 1 and described at page 10, lines 5 to 9).

VI. GROUNDS OF REJECTION TO BE REVIEWED ON APPEAL

Claims 24 to 31, 33 and 34 were rejected under 35 U.S.C. §102(b) as anticipated by or, in the alternative, under 35 U.S.C. §103(a) as obvious over Laurent, U.S. Patent No. 6,296,805. Claims 24, 25, 31, 33 and 34 were rejected under 35 U.S.C. §102(b) as anticipated by or, in the alternative, under 35 U.S.C. §103(a) as obvious over Takagi, U.S. Publication No. 2004/0009366. Claim 32 was rejected under 35 U.S.C. §103(a) as obvious over Takagi. Claims 26 to 28 were rejected under 35 U.S.C. §103(a) as obvious over Takagi in view of Ford Engineering Specification, Specification Number WSP-MIA322-A1.

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Page 232 of 624

VII. ARGUMENTS

A. Rejections under 35 U.S.C. §102(b) and 35 U.S.C. §103(a)

i. Claims 24 to 31, 33 and 34: Argued Together

1. Laurent

Claims 24 to 31, 33 and 34 were rejected under 35 U.S.C. §102(b) as anticipated by or, in the alternative, under 35 U.S.C. §103(a) as obvious over Laurent, U.S. Patent No. 6,296,805.

> Claim 24 recites "[a] coated steel stamped product, which comprises:
> (a) a strip of base steel having a first side and a second side; and
> (b) a coating on at least one of said first side of said strip of base steel and said second side of said strip of base steel,
> wherein:
> (i) said coating results from the interdiffusion between said base steel, and aluminum or aluminum alloy pre-coating, and
> (ii) wherein said coating comprises, proceeding from the base steel outwards:
> (a) an Interdiffusion layer,
> (b) an Intermediate layer,
> (c) an Intermetallic layer, and
> (d) a Superficial layer,
> wherein said coating has a thickness greater than 30 micrometers and wherein said layer (a) has a thickness less than 15 micrometers."

Laurent does not show or disclose "said coating has a thickness greater than 30 micrometers and wherein said layer (a) has a thickness less than 15 micrometers" as recited in claim 24, thus Laurent does not anticipate or obviate claim 24.

With regard to inherency, the fact that a certain result or characteristic ***may occur*** or be present in the prior art ***is not sufficient*** to establish the inherency of that result or characteristic. *In re Rijckaert*, 9 F.3d 1531, 1534, 28 USPQ2d 1955, 1957 (Fed. Cir. 1993) (reversed rejection because inherency was based on what would result due to optimization of conditions, not what was ***necessarily present*** in the prior art); (emphasis added). To establish inherency, the extrinsic evidence must make clear that the missing descriptive matter ***is necessarily present*** in the thing described in the reference, and that it would be so recognized by persons of ordinary skill. Inherency, however, may not be established by probabilities or possibilities. The mere fact that a

certain thing ***may result*** from a given set of circumstances is not sufficient. *In re Robertson*, 169 F.3d 743, 745, 49 USPQ2d 1949, 1950-51 (Fed. Cir. 1999). Furthermore, in relying upon the theory of inherency, the examiner must ***provide a basis in fact and/or technical reasoning*** to reasonably support the determination that the allegedly inherent characteristic necessarily flows from the teachings of the applied prior art. *Ex parte Levy,* 17 USPQ2d 1461, 1464 (Bd. Pat. App. & Inter. 1990).

When determining whether a claim is obvious, an examiner must make "a searching comparison of the claimed invention – *including all its limitations* – with the teaching of the prior art." *In re Ochiai*, 71 F.3d 1565, 1572 (Fed. Cir. 1995) (emphasis added). Thus, "obviousness requires a suggestion of all limitations in a claim." *CFMT, Inc. v. Yieldup Intern. Corp.*, 349 F.3d 1333, 1342 (Fed. Cir. 2003) (*citing In re Royka*, 490 F.2d 981, 985 (CCPA 1974)). Moreover, as the Supreme Court recently stated, "***there must be some articulated reasoning*** with some rational underpinning to support the legal conclusion of obviousness." *KSR Int'l v. Teleflex Inc.*, 127 S. Ct. 1727, 1741 (2007) (quoting In re Kahn, 441 F.3d 977, 988 (Fed. Cir. 2006) (emphasis added)).

The Final Office Action asserts on Pages 3 and 4 that:

> This process appears to be identical or substantially identical to the process set forth in the specification of the instant application, which produces the claimed product. The instant application sets forth that the aluminum hot-dip coating is precisely controlled to fall within a range equal to 20 and 33 microns. [¶43 of corresponding 2013/0029172] The favorable layer disposition is obtained when aluminum or aluminum alloy pre-coated steel sheets, whose thickness range from, e.g. 07 to 3 mm, are heated for 3 to 13 mins in a furnace heated to a temperature of 880 to 940°C. [¶58] The heating rate is between 4 and 12°C/second for producing a favorable alloyed layer disposition. [¶59]
>
> It appears that the thickness of the aluminum hot-dip coating, the thickness of the steel sheet, the time and temperature of the heating within the furnace, and the heating rates in Laurent are identical or substantially identical to those set forth in the specification of the instant application. Applicant teaches that the heating rate and temperature lead to the favorable layer disposition.
>
> ...
>
> Consequently, absent a showing to the contrary, it appears that the properties of the product in the prior art necessarily or inherently possesses the

characteristics of the claimed product, including the presence of the four claimed layers, the resulting thickness of the overall coating and its respective layers, and the quasi-continuous nature of the layers.

Applicants respectfully submit that process limitations disclosed in Laurent do not necessarily or inherently include a coating having "a ***thickness greater than 30 micrometers***" and in particular "said layer (a) has ***a thickness less than 15 micrometers***" as recited in claim 24. The Examiner's statements about the properties Laurent "appears" to include and that Laurent includes both thicknesses are completely conclusory and amount to an impermissible hindsight reconstruction. See MPEP 2142; *KSR Int'l Co. v. Teleflex Inc.*, 383 127 S. Ct. 1727, 1740-41 (2007) ("[R]ejections on obviousness cannot be sustained with mere conclusory statements; instead, there must be some articulated reasoning with some rational underpinning to support the legal conclusion of obviousness."); MPEP 2145; *In re Fine*, 837 F.2d 1071, 1075, 5 U.S.P.Q.2D (BNA) 1596 (Fed. Cir. 1988) ("[C]annot use hindsight reconstruction to pick and choose among isolated disclosures in the prior art to deprecate the claimed invention."). There is ***simply no reason or rationale*** provided by the Office Action or in Laurent to show or disclose that Laurent includes both thicknesses, either inherently or necessarily. Thus, the Office Action has failed to meet the burden of a proper anticipation rejection and has failed to establish a *prima facie* case of obviousness.

For this reason alone, the rejections to claims 24 to 31, 33 and 34 should be reversed.

Also, a *prima facie* case of obviousness may be rebutted by showing that the art, in any material respect, teaches away from the claimed invention. *In re Geisler,* 116 F.3d 1465, 1471, 43 USPQ2d 1362, 1366 (Fed. Cir. 1997).

Laurent specifically discloses a coating having **two layers**. "The coating layer comprises **a first alloy layer** in contact with the surface of the steel. This layer, directly in contact with the surface of the sheet, is highly alloyed with iron. A **second coating layer**, on top of the first, contains approximately 90% aluminum and may contain silicon and a small amount of iron, depending upon the composition of the bath." See col. 3, lines 17 to 23.

In contrast, claim 1 recites **four layers**: "an Interdiffusion layer, (b) an Intermediate layer, (c) an Intermetallic layer, and (d) a Superficial layer." Thus, the Examiner's assertions that

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Laurent "necessarily or inherently possesses the characteristics of the claimed product, including the presence of the four claimed layers, the resulting thickness of the overall coating and its respective layers, and the quasi-continuous nature of the layers" are without merit and unfounded. Laurent discloses a first alloy layer and a second coating layer. **Laurent does not disclose a coating having four layers**.

Thus, the Examiners assertions that "properties of the product in the prior art necessarily or inherently possesses the characteristics of the claimed product, including the presence of the four claimed layers" is in error because Laurent discloses a coating including only two layers and thus teaches away from a coating which "inherently possesses" four layers.

Contrary to the Examiner's assertion, the heating rates are not identical. Laurent desires and discloses heating rates **in excess of 600°C/second** to provide the rapid **remelting** of aluminum. As disclosed in Laurent "the coating is subjected to an increase in temperature at a speed in excess of 5° C/second which may exceed 600° C/second. This rise in temperature makes possible a **rapid remelting** of the aluminum which fills in the cracks generated by the operation of shaping of the casting." See col. 3, lines 26 to 31.

On the contrary, as disclosed in the Applicants' specification, the rapid remelting of aluminum is not acceptable because it is this remelting of aluminum that causes fouling of the rollers in the furnace. See paragraphs [0009] and [0121]. As stated in Applicants' specification at paragraph [0121]:

> On [sheet] A, no melting of the pre-coating was found. Intermetallic alloying between the pre-coating and the steel substrate occurred completely.
>
> On [sheet] B, the pre-coating underwent mainly alloying, but some traces of remelting were found, particularly on the former thicker locations of the pre-coating. This partial remelting of the aluminium pre-coating contributes to the progressive fouling of the rollers in the furnace. The sheets according to the invention do not contribute to this progressive buildup on the rollers.

Sheet A is according to the instant invention, sheet B is a reference sheet. As described above, the remelt occurring in sheet B, as in Laurent, is not in accordance with Applicants' invention.

Applicants' instant specification states "heating rate V_c is comprised between **4 and 12°C/s** for producing a favorable **alloyed layer** disposition... The inventors have discovered that the control of V_c in this **precise range** is a key factor, because it controls directly the nature and the morphology of the alloyed layers which are formed." As disclosed in the instant publication at paragraph [0121], in "series A, **no melting** of the pre-coating was found. **Intermetallic alloying** between the precoating and the steel substrate **occurred completely**." The disclosure of Laurent fails to show an increase in temperature from 4 to 5°C/second and does not show or disclose the advantages provided by the inventors of the instant application in maintaining the **heating rate at or below 12 °C/second** in order to provide the intermetallic alloying of the precoating and steel substrate.

Again, one of ordinary skill in the art would be lead away from the present invention in view of Laurent because Laurent desires and discloses rapidly remelting the aluminum of the second coating layer to fill in cracks in the first alloy layer. Thus, there is no basis for asserting that the claimed interdiffusion layer would result necessarily or inherently in Laurent or in view of the teachings of Laurent.

The Examiner's assertions are also based on the present specification and a desire to meet the claim language and are not based on the disclosure of Laurent. ("'Any judgement on obviousness is in a sense necessarily a reconstruction based on hindsight reasoning, but so long as it takes into account only knowledge which was within the level of ordinary skill in the art at the time the claimed invention was made and ***does not include knowledge gleaned only from applicant's disclosure***, such a reconstruction is proper'" (MPEP § 2145(X)(A), quoting *In re McLaughlin*, 443 F.2d 1392, 1395 (CCPA 1971), (emphasis added).

Furthermore, Laurent discloses a thickness of the sheet, "the sheet, in the delivery state in a coil or in sheeting, the thickness of which may range between 0.25 mm and 15 mm." See col. 3, lines 44 to 48. Laurent also discloses coating the sheet with "an aluminum-based layer ***about 20μm in thickness***." See col. 3, lines 42 and 43. Thus, Laurent does not show or disclose the thickness of a coating being "***greater than 30 micrometer***s" or that a "layer (a) has a thickness less than 15 micrometers" as recited in claim 24 and there is simply no reason to assume Laurent includes these features. It seems if Applicants' claims recited different thicknesses entirely, the

Examiner would still rely on the same conclusory statements instead of relying on the actual disclosure of Laurent for support of the rejection.

Applicants respectfully submit that the one who bears the ***initial burden*** of presenting a prima facie case of unpatentability is the ***Examiner***. *In re Oetiker*, 977 F.2d 1443, 1445 (Fed. Cir. 1992). The allocation of burdens requires that ***the USPTO produce the factual basis*** for its rejection of an application under 35 U.S.C. § 102. *In re Piasecki*, 745 F.2d 1468, 1472 (Fed. Cir. 1984) (citing *In re Warner*, 379 F.2d 1011, 1016 (CCPA 1967)). The Final Office Action has not provided Applicants with any rationale or factual basis to support the 102/103 rejections set forth. As a result, the Final Office Action has failed to establish a prima facie case of obviousness and anticipation. Thus, the Final Office Action is erroneously shifting the burden of the rejection to the Applicants to demonstrate that Laurent does not show the features recited in claim 24.

Even furthermore, as presented above, Laurent discloses coating the sheet with "an aluminum-based layer ***about 20μm in thickness***." See col. 3, lines 42 and 43. There is simply no reason why one of ordinary skill in the art would increase the thickness of this aluminum based coating by 150% and the Final Office Action has failed to provide Applicants with such rationale or factual basis.

Thus, the process disclosed in Laurent is not identical to the Applicants' instant specification and there is simply no reason or rationale to assume that the sheet disclosed in Laurent includes both a coating that is "greater than 30 micrometers" thick and an interdiffusion layer that "has a thickness less than 15 micrometers" as recited in claim 24.

Based on the foregoing, reversal of the rejections under 35 U.S.C. §§102(b) and 103(a) to independent claim 24 and claims 25 to 31, 33 and 34 depending therefrom is respectfully requested.

ii. Claims 24, 25, 31, 33 and 34: Argued Together

1. Takagi

Claims 24, 25 and 31 were rejected under 35 §102(b) as anticipated by or, in the alternative, under 35 U.S.C. §103(a) as obvious over Takagi, U.S. Publication No. 2004/0009366.

Takagi does not show or teach "a ***thickness greater than 30 micrometers***" and in particular "said layer (a) has ***a thickness less than 15 micrometers***" as recited in claim 24.

As admitted in the Final Office Action on page 5, Takagi discloses that a thickness of the aluminum coating is from 10 to 20 micrometers. "Thickness of aluminum coating layer: 10~20 μm." See Takagi, paragraph [0035]. Thus, Takagi specifically discloses an aluminum coating that is less than and not "***greater than 30 micrometers***" as recited in claim 24. For this reason alone, Takagi does not show or disclose each and every limitation recited in claim 24.

Contrary to the Examiner's assertion on page 7, Takagi discloses particular ranges and the limitations associated with those ranges, specifically concerning the heating rate and time. For example, when the aluminum coated member in Takagi is heated at a rate in excess of 10°C/second, the aluminum coating may be subject to local melting, which is undesirable in Takagi. See paragraph [0026]. Thus, Takagi does not show or teach an identical heating rate, between 4 and 12°C/s, as disclosed in the instant specification.

In addition, "when the time for holding at the raised temperature is longer than 8 minutes, the oxidation of coating layer proceeds, and undesired influence is exerted on the adhesiveness of the coating film by electro deposition." See paragraph [0026]. Thus, Takagi does not show or teach an identical heating time including, from 8 to 13 minutes, as disclosed in the instant specification. As a result, there is no basis for asserting that the claimed interdiffusion layer, interdiffusion layer thickness and coating thickness would result.

Thus, the process disclosed in Takagi is not identical to the Applicants' instant specification and there is simply no reason or rationale to assume that the sheet disclosed in

Takagi includes both a coating that is "greater than 30 micrometers" thick and an interdiffusion layer that "has a thickness less than 15 micrometers" as recited in claim 24.

Based on the foregoing, reversal of the rejections under 35 U.S.C. §§102(b) and 103(a) to independent claim 24 and claims 25, 31, 33 and 34 depending therefrom is respectfully requested.

iii. Claim 32: Argued separately

Claim 32 is rejected under 35 U.S.C. §103(a) as obvious over Takagi.

Claim 32 depends, directly, from claim 24. Takagi does not disclose the limitations discussed above with respect to claim 24. Since Takagi does not show or teach each of the limitations recited in claim 24, reversal of the rejection under 35 U.S.C. §103(a) to claim 32 for these same reasons is respectfully requested.

iv. Claims 26 to 28: Argued together

Claims 26 to 28 were rejected under 35 U.S.C. §103(a) as obvious over Takagi in view of Ford Engineering Specification, Specification Number WSP-MIA322-A1.

Claims 26 to 28 depend, directly, from claim 24. Ford Engineering Specification does not disclose the limitations not present in Takagi discussed above with respect to claim 24. Since Takagi in view of Ford Engineering Specification does not show or teach each of the limitations recited in claim 24, reversal of the rejections under 35 U.S.C. §103(a) to claims 26 to 28 for these same reasons is respectfully requested.

VIII. CONCLUSION

It is respectfully submitted that the application is in condition for allowance. Favorable consideration of this appeal brief is respectfully requested.

Respectfully submitted,
DAVIDSON, DAVIDSON & KAPPEL, LLC

By: /Jennifer L. O'Connell/
Jennifer L. O'Connell
(Reg. No. 57,392)

DAVIDSON, DAVIDSON & KAPPEL, LLC
485 Seventh Avenue, 14th Floor
New York, NY 10018
Tel: (212) 736-1940
Fax: (212) 736-2427

APPENDIX A

CLAIMS 24 to 34 of
U.S. APPLICATION NO. 13/621,015

Claim 24 (previously presented): A coated steel stamped product, which comprises:

(a) a strip of base steel having a first side and a second side; and

(b) a coating on at least one of said first side of said strip of base steel and said second side of said strip of base steel,

wherein:

(i) said coating results from the interdiffusion between said base steel, and aluminum or aluminum alloy pre-coating, and

(ii) wherein said coating comprises, proceeding from the base steel outwards:

(a) an Interdiffusion layer,

(b) an Intermediate layer,

(c) an Intermetallic layer, and

(d) a Superficial layer,

wherein said coating has a thickness greater than 30 micrometers and wherein said layer (a) has a thickness less than 15 micrometers.

Claim 25 (previously presented): The coated steel stamped product according to claim 24, wherein the said layers (c) and (d) are quasi continuous by occupying at least 90 % of a level corresponding to each said layer and wherein less than 10 % of layer (c) is present at an extreme surface of the product.

Claim 26 (previously presented): The coated steel stamped product according to claim 24, wherein the steel in the strip comprises the following components by weight based on total weight:

0.15 %<carbon<0.5 %;

0.5 %<manganese<3 %;

0.1 %<silicon<0.5 %;

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0.01 %<chromium<1%;

titanium<0.2 %;

aluminum<0.1 %;

phosphorus<0.1 %;

sulfur<0.05 %;

0.0005 %<boron<0.08 %;

and further comprises iron and impurities inherent in processing.

Claim 27 (previously presented): A coated steel stamped product according to claim 24, wherein the steel in the strip comprises the following components by weight based on total weight:

0.20 %<carbon<0.5 %;

0.8 %<manganese<1.5 %;

0.1 %<silicon<0.35 %;

0.01 %<chromium<1 %;

titanium<0.1 %;

aluminum<0.1 %;

phosphorus<0.05 %;

sulfur<0.03 %;

0.0005 %<boron<0.01 %;

and further comprises iron and impurities inherent in processing.

Claim 28 (previously presented): The coated steel stamped product according to claim 24, wherein the base steel comprises 20 ppm or less of sulfur.

Claim 29 (previously presented): The coated steel stamped product according to claim 24, wherein the ratio of titanium to nitrogen in the base steel in weight % is in excess of 3.42.

Claim 30 (previously presented): The coated steel stamped product according to claim 24, wherein the aluminum or aluminum alloy pre-coating comprises from 8 % to 11 % silicon by

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weight, from 2 % to 4 % iron by weight, the remainder being aluminum and impurities inherent in processing.

Claim 31 (previously presented): A land motor vehicle comprising the heat treated coated steel product according to claim 24.

Claim 32 (previously presented): The coated steel stamped product according to claim 24, wherein the product is hot formed with a strain higher than 10% and cooled with a cooling rate higher than 50° C/s.

Claim 33 (previously presented): The coated steel stamped product according to claim 24, wherein the product includes a full martensitic structure.

Claim 34 (previously presented): The coated steel stamped product according to claim 24, wherein said layer (a) has a thickness less than 10 micrometers.

APPENDIX B

Evidence Appendix under 37 C.F.R. §41.37 (c) (ix):

No evidence pursuant to 37 C.F.R. §§1.130, 1.131 or 1.132 and relied upon in the appeal has been submitted by appellants or entered by the examiner.

APPENDIX C

Related proceedings appendix under 37 C.F.R. §41.37 (c) (x):

As stated in "2. RELATED APPEALS AND INTERFERENCES" of this appeal brief, appellants, their legal representatives, and assignee are not aware of any appeal or interference that directly affects, will be directly affected by, or will have a bearing on the Board=s decision in this appeal.

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Electronic Acknowledgement Receipt

EFS ID:	20466900
Application Number:	13621015
International Application Number:	
Confirmation Number:	6215
Title of Invention:	COATED STEEL STRIPS, METHODS OF MAKING THE SAME, METHODS OF USING THE SAME, STAMPING BLANKS PREPARED FROM THE SAME, STAMPED PRODUCTS PREPARED FROM THE SAME, AND ARTICLES OF MANUFACTURE WHICH CONTAIN SUCH A STAMPED PRODUCT
First Named Inventor/Applicant Name:	Pascal DRILLET
Customer Number:	23280
Filer:	Jennifer Lauren O'Connell
Filer Authorized By:	
Attorney Docket Number:	704.1007DIV
Receipt Date:	20-OCT-2014
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Application Type:	Utility under 35 USC 111(a)

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Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Appeal Brief Filed	AppealBrief19oct14.pdf	215435 8e30badcf125802e4feaecb07bfd7d5ff01ed402	no	17

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New International Application Filed with the USPTO as a Receiving Office
If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
13/621,015	09/15/2012	Pascal DRILLET	704.1007DIV	6215

23280 7590 01/28/2015

Davidson, Davidson & Kappel, LLC
485 7th Avenue
14th Floor
New York, NY 10018

EXAMINER	
SCHLEIS, DANIEL J	

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1784	

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01/28/2015	PAPER

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

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BEFORE THE PATENT TRIAL AND APPEAL BOARD

Application Number: 13/621,015
Filing Date: September 15, 2012
Appellant(s): Drillet, Pascal, et al

Jennifer L. O'Connell
Reg. No. 57,392
For Appellant

EXAMINER'S ANSWER

This is in response to the appeal brief filed 20 October 2014.

(1) Grounds of Rejection to be Reviewed on Appeal

Every ground of rejection set forth in the Office action dated 25 September 2013 from which the appeal is taken is being maintained by the examiner except for the grounds of rejection (if any) listed under the subheading "WITHDRAWN REJECTIONS." New grounds of rejection (if any) are provided under the subheading "NEW GROUNDS OF REJECTION."

The following ground(s) of rejection are applicable to the appealed claims.

Claim Rejections - 35 USC § 102 / § 103

The text of those sections of Title 35, U.S. Code not included in this action can be found in a prior Office action.

Claims 24-31, 33, and 34 are rejected under 35 U.S.C. 102(b) as anticipated by or, in the alternative, under 35 U.S.C. 103(a) as obvious over U.S. Patent Number 6,296,805 (Laurent).

In regards to independent claim 24 and dependent claims 25, 33, and 34, Laurent is directed to a coated, hot- and cold-rolled steel sheet comprising a very high resistance after thermal treatment. [1:6-8] The sheet is provided with an aluminum-based coating, for example by dipping in a bath containing, in addition, from 8% to 11% silicon, from 2% to 4% iron, the sheet having a high mechanical resistance after thermal treatment and a high resistance to corrosion, as well as a good capacity for painting and gluing. [2:37-45] The aluminum-based layer is provided in a thickness of about 20 microns. [3:38-44]

Diffusion of the iron in the coating will be initiated at high temperature, thus there will be better cohesion between the coating and steel in the sheet. [3:26-37] After the shaping of a

casting the coating is subjected to an increase in temperature to an excess of 5° C/second. [3:26-29]

Thermal treatment of the metal sheet consists in a heating at a temperature between Ac1, starting temperature of austenitic formation, for example 750° C and 1200° C, in a furnace, for a period which depends on the temperature to be reached and the thickness of the casting sheet. [3:61-65] For a completely martensitic structure, and for steel having the composition of the example, the speed of cooling should be in excess of the critical speed of hardening, which is 27° C / second for an austenitizing at 900° C for five minutes, wherein the sheet has a thickness of approximately 1 mm. [4:4-9]

This process appears to be identical or substantially identical to the process set forth in the specification of the instant application, which produces the claimed product. The instant application sets forth that the aluminum hot-dip coating is precisely controlled to fall within a range equal to 20 and 33 microns. [¶43 of corresponding 2013/0029172] The favorable layer disposition is obtained when aluminum- or aluminum alloy pre-coated steel sheets, whose thickness range from, e.g. 07 to 3 mm, are heated for 3 to 13 minutes in a furnace heated to a temperature of 880 to 940° C. [¶58] The heating rate is between 4 and 12° C/second for producing a favorable alloyed layer disposition. [¶59]

It appears that the thickness of the aluminum hot-dip coating, the thickness of the steel sheet, the time and temperature of the heating within the furnace, and the heating rates in Laurent are identical or substantially identical to those set forth in the specification of the instant

application. Applicant teaches that the heating rate and temperature lead to the favorable layer disposition. [See ¶58 and ¶59]

Where the claimed and prior art products are identical or substantially identical, or are produced by identical or substantially identical processes, the Office can require an applicant to prove that the prior art products do not necessarily or inherently possess the characteristics of the claimed product. Whether the rejection is based on "inherency" under 35 USC 102, on "prima facie obviousness" under 35 USC 103, jointly or alternatively, the burden of proof is the same, and its fairness is evidenced by the Office's inability to manufacture products or to obtain and compare prior art products.

Consequently, absent a showing to the contrary, it appears that the properties of the product in the prior art necessarily or inherently possesses the characteristics of the claimed product, including the presence of the four claimed layers, the resulting thickness of the overall coating and its respective layers, and the quasi-continuous nature of the layers.

As to claim 26, Laurent teaches a steel sheet with the following composition:

0.15% < carbon < 0.5%
0.5% < manganese < 3%
0.1% < silicon < 0.5%
0.01% < chromium<1%
titanium < 0.2%
aluminum < 0.1%
phosphorus < 0.1%
sulfur < 0.05%
0.0005% < boron < 0.08%,
the remainder being iron and impurities inherent in processing.

[1:47-64]

As to claim 27, Laurent teaches a preferred steel sheet with the following composition:

0.20% < carbon < 0.5%
0.8% < manganese < 1.5%
0.1% < silicon < 0.35%
0.01% < chromium < 1%
titanium < 0.1%
aluminum < 0.1%
phosphorus < 0.05%
sulfur < 0.03%
0.0005% < boron < 0.01%,
the remainder being iron and impurities inherent in processing.

[1:65-2:10]

As to claim 28, Laurent teaches that the sulfur content of the preferred embodiment has a sulfur content of less than 0.03%. [1:65-2:10] This range taught by Laurent overlaps the claimed range.

As to claim 29, Laurent teaches in the preferred embodiment that the titanium content with respect to the nitrogen content is in excess of 3.42. [2:11-14]

As to claim 30, Laurent teaches that the steel sheet is coated by dipping in an aluminum bath containing 8% to 11% silicon and 2% to 4% iron. [3:9-14]

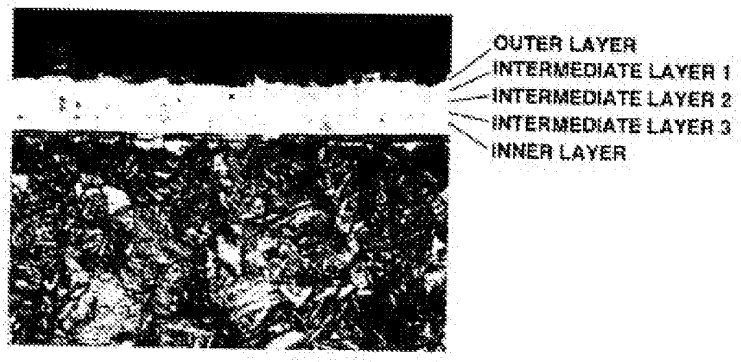
As to claim 31, this claim is an intended use claim. Laurent specifically teaches using the hot-rolled steel sheet for structural and/or anti-intrusion or substructure castings for a land motor vehicle. [2:30-34]

Claims 24, 25, 31, 33, and 34 are rejected under 35 U.S.C. 102(b) as anticipated by or, in the alternative, under 35 U.S.C. 103(a) as obvious over U.S. Patent Application Publication 2004/0009366 (Takagi).

In regards to independent claim 24 and dependent claim 25 and 34, Takagi relates to an aluminum-coated structural member. [¶1] A multi-layer structure including a hard outermost layer is advantageous for maintaining good contact with a welding gun in spot welding even under great pressure for high tension material. [¶24]

A hot-dip aluminum-coated steel sheet is formed by immersing a strip continuously in a bath of molten aluminum. [¶13] Takagi teaches that the thickness of this aluminum coating layer is between 10 and 20 microns. [¶35] The coated steel sheet is heated at a rate of 1 to 10° C/second to a temperature within the range of 900 to 950° C, and it is held at that temperature for holding time of 2 to 8 minutes. [¶26] Takagi specifically teaches a sheet thickness of the steel being 1.4 mm. [¶33] This method provides for a coating as set forth in figure 2A, which is reproduced below.

FIG.2A



This process appears to be identical or substantially identical to the process set forth in the specification of the instant application, which produces the claimed product. The instant application sets forth that the aluminum hot-dip coating is precisely controlled to fall within a

range equal to 20 and 33 microns. [¶43 of corresponding 2013/0029172] The favorable layer disposition is obtained when aluminum- or aluminum alloy pre-coated steel sheets, whose thickness range from, e.g. 07 to 3 mm, are heated for 3 to 13 minutes in a furnace heated to a temperature of 880 to 940° C. [¶58] The heating rate is between 4 and 12° C/second for producing a favorable alloyed layer disposition. [¶59]

Consequently, absent a showing to the contrary, it appears that the properties of the product in the prior art necessarily or inherently possesses the characteristics of the claimed product, including the presence of the four claimed layers, the resulting thickness of the overall coating and its respective layers, and the quasi-continuous nature of the layers.

Pertaining to claim 31, Takagi teaches that the aluminum-coated structure member can be used as a structural member for a motor vehicle. [¶1]

Pertaining to claim 33, Takagi teaches cooling at a rate of 20 to 100° C/second after a forming operation. [¶28] Takagi teaches that this rapid cooling promotes martensitic transformation. [¶28] This cooling rate overlaps the range that produces the claimed product. Consequently, absent a showing to the contrary, it appears that the properties of the product in the prior art necessarily or inherently possesses the characteristics of the claimed product.

Claim Rejections - 35 USC § 103

Claim 32 is rejected under pre-AIA 35 U.S.C. 103(a) as being unpatentable over Takagi.

The amount of strain present within the product is dependent upon the art and the type of product produced. Takagi is directed to structural members used for motor vehicles. [¶1] Similarly, the product of the instant application is directed to structural parts of an automobile. [See ¶10 of corresponding 2013/0029172] There is no patentable distinction for strain ratios for these types of products. Additionally, it is within the purview of one of ordinary skill in the art at the time of the invention to form a product more than others based on the desired part being produced, therefore it would be expected that the strain ratios would likewise overlap.

Claims 26-28 are rejected under 35 U.S.C. 103(a) as being unpatentable over Takagi as applied to claim 24 above, and further in view of the Ford Engineering Specification, Specification Number WSP-MIA322-A1, dated 1992-03-31 (Hereinafter "the Ford Engineering Specification," submitted in IDS).

In regards to claims 26 and 27, as set forth above in regards to claim 24, Takagi sets forth a steel sheet that is covered with an aluminum dip coating and subjected to heat treatment in order to obtain a multilayered structure. While Takagi teaches that the steel is used as a structural component of a motor vehicle, it does not explicitly set forth the claimed composition.

In the same field of endeavor of motor vehicle components, the Ford Engineering Specification sets forth requirements for material used in door intrusion beams where a high strength to weight ratio is required. [Section 2] The composition of the material must fall within the range:

C	0.20-0.25
Mn	1.00 – 1.30
P	0.03 max
S	0.025 max

Si	0.20 – 0.35
Cr	0.15 – 0.25
B	0.0015 – 0.005

[Section 3.2] All materials supplied to this specification must be equivalent in all characteristics to the material upon which approval was originally granted. [Section 3.4]

It would have been obvious to one of ordinary skill in the art at the time of the invention to have used the composition set forth in the Ford Engineering Specification as the steel sheet of the product of Takagi. One of ordinary skill in the art at the time of the invention would have been motivated by the desire and expectation of a simple substitution of one known element for another to obtain predictable results, including using a known composition which is known for its high strength to weight ratio. Further, as shown by the Ford Engineering Specification, such composition is recognized in the field for its use as a structural member of a motor vehicle.

As to claim 28, the ratio of sulfur in the composition set forth in the Ford Specification overlaps the claimed range.

(2) Response to Argument

Appellant argues that the Examiner has failed to establish a basis in fact and/or technical reasoning to reasonably support the determination that the allegedly inherent characteristics claimed necessarily flows from the teachings of the applied prior art. Appellant further asserts that the Examiner has failed to articulate reasoning with some rational underpinning to support the legal conclusion of obviousness. Appellant asserts that Laurent does not necessarily or inherently include a coating having a thickness greater than 30 micrometers and in particular that layer (a) has a thickness less than 15 micrometers. Appellant asserts that there "is simply no reason or rationale provided by the Office Action or in Laurent to show or disclose that Laurent includes both thicknesses, either inherently or necessarily."

Appellant also argues that Laurent specifically discloses a coating having two layers. Appellant points to the claims to show that the claim recites four layers being present. Appellant asserts that Laurent does not disclose a coating having four layers. Appellant contends that Laurent therefore teaches away from the claimed layers.

The Examiner respectfully disagrees.

Where the claimed and prior art products are identical or substantially identical, or are produced by identical or substantially identical processes, a *prima facie* case of either anticipation or obviousness has been established. [MPEP 2112.01] Where the PTO shows a sound basis for believing that the products of the applicant and the prior art are the same, the applicant has the burden of showing that they are not. [MPEP 2112.01] Therefore, the *prima facie* case can be rebutted by evidence showing that the prior art products do not necessarily possess the characteristics of the claimed product. [MPEP 2112.01]

As set forth above and in the previous Office Action, Laurent and the claimed products appear to have been produced by identical or substantially identical process.

The instant application sets forth that the product is produced by providing an aluminum hot-dip coating that is precisely controlled to fall within a range equal to 20 and 33 microns. [Specification, Page 7, Line 22-Page 8, Line 7] The favorable layer disposition is obtained when aluminum or aluminum alloy pre-coated steel sheets, whose thicknesses range from, for example, 0.7 to 3 mm, are heated for 3 to 13 minutes in a furnace heated to a temperature of 880 to 940° C. [Specification, Page 10, Line 10-Page 11, Line 12] The heating rate is between 4 and 12° C for producing a favorable alloyed layer disposition. [Specification, Page 10, Line 10-Page 11, Line 12]

Likewise, Laurent teaches providing an aluminum-based layer in a thickness of about 20 microns. [3:38-44] The coating is subjected to an increase in temperature in excess of 5° C/second. [3:26-29] The thermal treatment of the metal sheet consists in a heating at a temperature within the range of 750 to 1200°C. [3:61-65]

It appears that the thickness of the aluminum hot-dip coating, the thickness of the steel sheet, the time and temperature of the heating within the furnace, and the heating rates in Laurent are identical or substantially identical to those set forth in the specification of the instant application. Applicant teaches that the heating rate and temperature lead to the favorable layer disposition. [Specification, Page 10, Line 10-Page 11, Line 12] It is the Examiner's position that absent a showing of evidence to the contrary, it appears that the properties of the product of the prior art, including the respective layers and their thicknesses, would necessarily or inherently possess the characteristics of the claimed product. Therefore, even if Laurent does not

recognize the presence of the four claimed layers, they would still necessarily possess these layers.

Appellant has failed to set forth any evidence in the record rebutting this position.

Appellant submitted mere arguments of counsel that the process of Laurent would result in a product that would not inherently or necessarily possess the claimed properties. For example, Appellant's counsel asserts that the Laurent fails to teach the claimed heating rate. Appellant asserts that this would not result in the claimed properties.

The Examiner respectfully disagrees.

Laurent sets forth that the coating is subjected to an increase in temperature in excess of 5° C/second. [3:26-29] This overlaps with the heating rate set forth in the instant application utilized for producing the claimed product, viz. a heating rate between 4 and 12° C. [Specification, Page 10, Line 10-Page 11, Line 12] Clearly, these ranges overlap. Therefore, Laurent teaches a range that includes the claimed heating rate. Therefore, the product would be expected to have the same or substantially similar properties.

Appellant asserts that the Examiner's assertions are based on the present specification and a desire to meet the claim language and are not based on the disclosure of Laurent. Applicant asserts that the Examiner's rationale does not take into account only knowledge that was used within the level of ordinary skill in the art at the time of the claimed invention was made and does not include knowledge gleaned only from applicant's disclosure.

The Examiner respectfully disagrees.

Laurent sets forth an identical or substantially identical process. Accordingly, it would have been well within the knowledge of one of ordinary skill in the art at the time of the invention to have followed the process parameters set forth in Laurent to obtain the claimed product.

Appellant asserts that Laurent discloses a sheet with an aluminum-based layer about 20 microns in thickness and therefore Laurent does not show or disclose the coating having a thickness greater than 30 micrometers or a layer (a) having a thickness less than 15 micrometers.

The Examiner respectfully disagrees.

The instant application sets forth providing an aluminum hot-dip coating that falls within the range of 20 to 33 microns. [Specification, Page 7, Line 22-Page 8, Line 7] This thickness corresponds to the pre-coat that is subsequently subjected to a heat-treatment process. [Specification, Page 7, Line 22-Page 8, Line 7] Therefore, it appears that the thickness of the coating within this range would result in the claimed coating thickness in the final product after it has been subjected to the heat treatment process.

Likewise, Laurent teaches providing an aluminum-based layer in a thickness of about 20 microns. [3:38-44] Since the aluminum hot-dip coating of Laurent falls within the acceptable range set forth in the instant application in order to produce the claimed thickness and product, it would be expected that the final product would also have a thickness falling within the claimed range.

Appellant has failed to set forth any evidence in the record rebutting this position.

Appellant argues that Takagi does not show or teach a thickness greater than 30 micrometers and in particular layer (a) having a thickness less than 15 micrometers. Appellant asserts that Takagi does not disclose particular ranges and the limitations associated with those ranges, specifically concerning the heating rate and time. The Appellant further asserts that Takagi fails to teach the heating time.

The Examiner respectfully disagrees.

The instant application sets forth providing an aluminum hot-dip coating that falls within the range of 20 to 33 microns. [Specification, Page 7, Line 22-Page 8, Line 7] This thickness corresponds to the pre-coat that is subsequently subjected to a heat-treatment process. [Specification, Page 7, Line 22-Page 8, Line 7] Therefore, it appears that the thickness of the coating within this range would result in the claimed coating thickness in the final product after it has been subjected to the heat treatment process.

Likewise, Takagi teaches that the thickness of this aluminum coating layer is between 10 and 20 microns. [¶35] Since the aluminum hot-dip coating of Takagi overlaps the acceptable range set forth in the instant application in order to produce the claimed thickness and product, it would be expected that the final product would also have a thickness falling within the claimed range.

Takagi further clearly discloses a heating rate in the range of 1 to 10°C. Paragraph 26 of Takagi sets forth:

> An aluminum-coated structural member having an Al—Si—Fe alloy layer on the surface as mentioned above can be obtained by the following process. First, a heat resisting hot-dip aluminum-coated steel sheet containing Si in a coating layer is heated at a rate of 1-10° C./sec to a temperature in the temperature range of 900-950° C., and held at that raised temperature for a holding time (or

> duration) of 2-8 minutes. In this case, the aluminum coating could melt locally when the hot-dip aluminum-coated steel sheet is heated at a heating rate faster than 10° C./sec to a temperature higher than 900° C. The coating layer could oxidize when the heating rate is slower than 1° C./sec. The progress of austenitizing in the steel base material is too slow to obtain a sufficient strength as a structural member when the raised temperature at which the specimen is held is lower than 900° C. When the raised temperature is higher than 950° C., the undesired oxidation of the coating layer proceeds, and the diffusion of Fe proceeds too much up to the surface of the coating layer. When the time for holding at the raised temperature is shorter than 2 minutes, then the formation of Al—Si—Fe alloy layer becomes insufficient. When the time for holding at the raised temperature is longer than 8 minutes, the oxidation of coating layer proceeds, and undesired influence is exerted on the adhesiveness of the coating film by electro deposition. [¶26]

Appellant has failed to provide any evidence in the record rebutting the Examiner's position.

For the above reasons, it is believed that the rejections should be sustained.

Respectfully submitted,

/DANIEL J SCHLEIS/
Examiner, Art Unit 1784

Conferees:

/HUMERA SHEIKH/

Supervisory Patent Examiner, Art Unit 1784

/Callie Shosho/

Supervisory Patent Examiner, Art Unit 1787

Requirement to pay appeal forwarding fee. In order to avoid dismissal of the instant appeal in any application or ex parte reexamination proceeding, 37 CFR 41.45 requires payment of an appeal forwarding fee within the time permitted by 37 CFR 41.45(a), unless appellant had timely paid the fee for filing a brief required by 37 CFR 41.20(b) in effect on March 18, 2013.

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE
BEFORE THE BOARD OF PATENT APPEALS AND INTERFERENCES

Re:	Application of:	DRILLET
	Application No.:	13/621,015
	Filed:	September 15, 2012
	Art Unit:	1784
	Examiner:	Schleis
	Attorney Docket No.:	704.1007DIV
	Title:	**COATED STEEL STRIPS, METHODS OF MAKING THE SAME, METHODS OF USING THE SAME, STAMPING BLANKS PREPARED FROM THE SAME, STAMPED PRODUCTS PREPARED FROM THE SAME, AND ARTICLES OF MANUFACTURE WHICH CONTAIN SUCH A STAMPED PRODUCT**

Submitted electronically via EFS-Web
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Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

March 26, 2015

APPELLANTS' REPLY BRIEF UNDER 37 C.F.R. §41.41

Sir:

Appellants submit this Reply Brief for consideration of the Board of Patent Appeals and Interferences (the "Board") in response to the Examiner's Answer dated January 28, 2015 and in support of their appeal of the Final Rejection dated September 25, 2013. Appellants respectfully reassert each of the arguments asserted in Appellants' Brief dated October 20, and provides herein only a rebuttal of several of the arguments raised in the Examiner's Answer. The Appeal Forwarding fees will be paid concurrently with this submission via EFS-Web. If any additional fees are required at this time, the Assistant Commissioner is authorized to charge payment of the same to Deposit Account No. 50-0552.

ARGUMENTS

The following additional remarks are submitted for consideration by the Board under 37 CFR §41.41.

A. Rejections under 35 U.S.C. §§102(b) and 103(a)

Claims 24 to 31, 33 and 34 were rejected under 35 U.S.C. §102(b) as anticipated by or, in the alternative, under 35 U.S.C. §103(a) as obvious over Laurent, U.S. Patent No. 6,296,805. Claims 24, 25, 31, 33 and 34 were rejected under 35 U.S.C. §102(b) as anticipated by or, in the alternative, under 35 U.S.C. §103(a) as obvious over Takagi, U.S. Publication No. 2004/0009366. Claim 32 was rejected under 35 U.S.C. §103(a) as obvious over Takagi. Claims 26 to 28 were rejected under 35 U.S.C. §103(a) as obvious over Takagi in view of Ford Engineering Specification, Specification Number WSP-MIA322-A1.

In addition to the arguments previously submitted, Applicants respectfully submit the following arguments for consideration by the Board.

The Examiner arguments are based on the assertion at page 10 of the Examiner's Answer and elsewhere that "[w]here the claimed and prior art products are identical or substantially identical, or are produced by identical or substantially identical processes, a prima facie case of either anticipation or obviousness has been established. [MPEP 2112.01]." On Page 11, the Examiner asserts that "[a]s set forth above and in the previous Office Action, Laurent and the claimed products **appear to have been** produced by identical or substantially identical process." (Emphasis added).

The Examiner states at page 3 to page 4: "It appears that the thickness of the hot-dip coating, the thickness of the steel sheet, the time and temperature of the heating within the furnace, and the heating rates in Laurent are identical or substantially identical to those set forth in the specification of the instant application. Applicant teaches that the heating rate and temperature lead to favorable layer disposition" citing to [0058] and [0059] of the publication of the present application at US 2013/0029172.

This assertion is simply wrong and contradicted by both Laurent itself and the present specification at [0043]. Laurent teaches an aluminum-based layer about 20 microns in thickness, well below the presently claimed range. See col. 3, lines 38 to 43 of Laurent. The present specification teaches at [0043]:

> For hot-dip coating, precise control of this range of pre-coating thickness can be realized on an operating line for example using a system of nozzles blowing gas after coating, for example after exit of the strip or sheet from a bath, and by the flatness of the strip. Number, geometry and location of the nozzles, and flow rates are among the main parameters for a precise control of the thickness t_p. Given the present disclosure, one of ordinary skill in this art can control the pre-coating thickness as described herein without undue labor.

Laurent teaches nothing of this control, and even if somehow it did it would teach it to be less than the claimed range. ***It is not the heating rate and temperature alone that control layer thickness, and in fact the present specification clearly teaches that other factors control the layer thickness.***

And even if somehow Laurent taught this control, then Laurent would teach away from the claimed range, which is much higher. There is absolutely no basis for an anticipation or obviousness rejection, and clearly the "thickness of the hot-dip coating" in Laurent is ***not*** the same as one that would lead to the present invention as claimed.

Applicants also respectfully submit that the Examiner cites a rule of law which requires the claimed and prior art products **to be** identical or substantially identical or **to be** produced by identical or substantially identically processes to establish a prima facie case of anticipation or obviousness. Then the Examiner relies on an "**appearance**" of identicalness to form his rejection instead of relying upon actual teachings in Laurant that affirmatively show an identical product or process. Applicants respectfully submit that Laurent does not show an identical product or process or a substantially identical product or process for the reasons previously set forth during prosecution and as discussed above. There is for example no basis for the assertion that "the thickness of the hot-dip coating" appears to be the same as the claimed range. The Examiner seems to ignore the claim language. The Examiner cannot rely on what he believes

Laurant appears to teach and can rely only on what Laurant actually discloses to meet the standard for a prima facie case of anticipation or obviousness. Thus, the Examiner has failed to provide Applicants with a prima face case of anticipation or obviousness. As a result, Applicants do not have to overcome a prima facie case of anticipation or obviousness.

The same faulty analysis has occurred with Takagi which also does not teach the claimed range or any identical process which would result in the present claimed invention.

Based on the foregoing, reversal of the rejection to claims 24 to 34 under 35 U.S.C. §103(a) is respectfully requested.

CONCLUSION

It is respectfully submitted that the application is in condition for allowance. Favorable consideration of this Reply Brief is respectfully requested.

Respectfully submitted,

DAVIDSON, DAVIDSON & KAPPEL, LLC

By: /Jennifer L. O'Connell/
Jennifer L. O'Connell
(Reg. No. 57,392)

DAVIDSON, DAVIDSON & KAPPEL, LLC
485 Seventh Avenue, 14th Floor
New York, NY 10018
Tel: (212) 736-1940
Fax: (212) 736-2427

Electronic Acknowledgement Receipt

EFS ID:	21887304
Application Number:	13621015
International Application Number:	
Confirmation Number:	6215
Title of Invention:	COATED STEEL STRIPS, METHODS OF MAKING THE SAME, METHODS OF USING THE SAME, STAMPING BLANKS PREPARED FROM THE SAME, STAMPED PRODUCTS PREPARED FROM THE SAME, AND ARTICLES OF MANUFACTURE WHICH CONTAIN SUCH A STAMPED PRODUCT
First Named Inventor/Applicant Name:	Pascal DRILLET
Customer Number:	23280
Filer:	Jennifer Lauren O'Connell
Filer Authorized By:	
Attorney Docket Number:	704.1007DIV
Receipt Date:	26-MAR-2015
Filing Date:	15-SEP-2012
Time Stamp:	15:05:36
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Reply Brief Filed	ReplyBrief_24march15ff.pdf	18533 7752075173e93ec4103508d5b17cb83b0a75750e	no	4
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Electronic Patent Application Fee Transmittal

Application Number:	13621015
Filing Date:	15-Sep-2012
Title of Invention:	COATED STEEL STRIPS, METHODS OF MAKING THE SAME, METHODS OF USING THE SAME, STAMPING BLANKS PREPARED FROM THE SAME, STAMPED PRODUCTS PREPARED FROM THE SAME, AND ARTICLES OF MANUFACTURE WHICH CONTAIN SUCH A STAMPED PRODUCT
First Named Inventor/Applicant Name:	Pascal DRILLET
Filer:	Jennifer Lauren O'Connell
Attorney Docket Number:	704.1007DIV

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Filing Fees for Utility under 35 USC 111(a)

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				
Appeal Forwarding Fee	1413	1	2000	2000
Post-Allowance-and-Post-Issuance:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Extension-of-Time:				
Miscellaneous:				
		Total in USD ($)		**2000**

Electronic Acknowledgement Receipt	
EFS ID:	21892102
Application Number:	13621015
International Application Number:	
Confirmation Number:	6215
Title of Invention:	COATED STEEL STRIPS, METHODS OF MAKING THE SAME, METHODS OF USING THE SAME, STAMPING BLANKS PREPARED FROM THE SAME, STAMPED PRODUCTS PREPARED FROM THE SAME, AND ARTICLES OF MANUFACTURE WHICH CONTAIN SUCH A STAMPED PRODUCT
First Named Inventor/Applicant Name:	Pascal DRILLET
Customer Number:	23280
Filer:	Jennifer Lauren O'Connell
Filer Authorized By:	
Attorney Docket Number:	704.1007DIV
Receipt Date:	26-MAR-2015
Filing Date:	15-SEP-2012
Time Stamp:	17:37:54
Application Type:	Utility under 35 USC 111(a)

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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
13/621,015	09/15/2012	Pascal DRILLET	704.1007DIV	6215

23280 7590 04/08/2015

Davidson, Davidson & Kappel, LLC
485 7th Avenue
14th Floor
New York, NY 10018

EXAMINER	
SCHLEIS, DANIEL J	

ART UNIT	PAPER NUMBER
1784	

MAIL DATE	DELIVERY MODE
04/08/2015	PAPER

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The time period for reply, if any, is set in the attached communication.

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DAVIDSON, DAVIDSON & KAPPEL, LLC
485 7TH AVENUE
14TH FLOOR
NEW YORK, NY 10018

Appeal No: 2015-004912
Application: 13/621,015
Appellant: Pascal DRILLET et al.

Patent Trial and Appeal Board Docketing Notice

Application 13/621,015 was received from the Technology Center at the Board on April 06, 2015 and has been assigned Appeal No: 2015-004912.

In all future communications regarding this appeal, please include both the application number and the appeal number.

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INFORMATION DISCLOSURE STATEMENT BY APPLICANT (**Not for submission under 37 CFR 1.99**)		
	Application Number	13621015
	Filing Date	2012-09-15
	First Named Inventor	Drillet
	Art Unit	1784
	Examiner Name	Schleis
	Attorney Docket Number	631.1028DIV

U.S.PATENTS Remove

Examiner Initial*	Cite No	Patent Number	Kind Code[1]	Issue Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1	6296805	B1	2001-10-02	Laurent et al.	
	2	7559998	B2	2009-07-14	Nishibata et al.	
	3	6815087	B2	2004-11-09	Takagi et al.	

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	1	1829813	CN	A	2006-09-06		See U.S. '998	☐

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	Application Number	13621015
	Filing Date	2012-09-15
	First Named Inventor	Drillet
	Art Unit	1784
	Examiner Name	Schleis
	Attorney Docket Number	631.1028DIV

	2	1531604	CN	A	2004-09-22		See WO '073	☐
	3	1472068	CN	A	2004-02-04		See U.S. '087	☐
	4	02/103073	WO	A2	2002-12-27		Published in English	☐

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	1	Properties of Aluminum-coated Steels for Hot-forming. Suehiro et al. Nippon Steel Technical Report, No. 88, July 2003, pages 15 to 20	☐
	2	Investigation of the thermo-mechanical properties of hot stamping steels. Merklein et al. Journal of Materials Processing Technology, Vol. 177/1-3 2006.	☐
	3	Basic Study on Hot Stamping of Ultrahigh-strength Steel, Dissertation for Degree of Master of Tongji University, Zhiyao Tan, July 2006. (Ref 9)	☐
	4	Analysis and Application of Axle Housing Hot Stamping Process, Qingyu Zhao, Forgining Machinery, published in March 2002. (Ref 6)	☐

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	Application Number	13621015
	Filing Date	2012-09-15
	First Named Inventor	Drillet
	Art Unit	1784
	Examiner Name	Schleis
	Attorney Docket Number	631.1028DIV

[1] See Kind Codes of USPTO Patent Documents at www.USPTO.GOV or MPEP 901.04. [2] Enter office that issued the document, by the two-letter code (WIPO Standard ST.3). [3] For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document. [4] Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST.16 if possible. [5] Applicant is to place a check mark here if English language translation is attached.

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	Application Number	13621015
	Filing Date	2012-09-15
	First Named Inventor	Drillet
	Art Unit	1784
	Examiner Name	Schleis
	Attorney Docket Number	631.1028DIV

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Please see 37 CFR 1.97 and 1.98 to make the appropriate selection(s):

☒ That each item of information contained in the information disclosure statement was first cited in any communication from a foreign patent office in a counterpart foreign application not more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(1).

OR

☐ That no item of information contained in the information disclosure statement was cited in a communication from a foreign patent office in a counterpart foreign application, and, to the knowledge of the person signing the certification after making reasonable inquiry, no item of information contained in the information disclosure statement was known to any individual designated in 37 CFR 1.56(c) more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(2).

☐ See attached certification statement.

☒ The fee set forth in 37 CFR 1.17 (p) has been submitted herewith.

☐ A certification statement is not submitted herewith.

SIGNATURE

A signature of the applicant or representative is required in accordance with CFR 1.33, 10.18. Please see CFR 1.4(d) for the form of the signature.

Signature	/Jennifer L. O'Connell/	Date (YYYY-MM-DD)	2015-05-28
Name/Print	Jennifer L. O'Connell	Registration Number	57,392

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1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C. 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether the Freedom of Information Act requires disclosure of these record s.

2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.

3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.

4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).

5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.

6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).

7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.

8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspections or an issued patent.

9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

附件 2

[19] 中华人民共和国国家知识产权局

[12] 发明专利申请公开说明书

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[32] 2001. 8. 9 [33] JP [31] 241633/2001
[32] 2001. 8.31 [33] JP [31] 264727/2001
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[71] 申请人 新日本制铁株式会社
地址 日本东京

[72] 发明人 末广正芳 真木纯 布田雅裕
宫腰寿拓 高田良久 江口晴彦
伊崎辉明 楠见和久

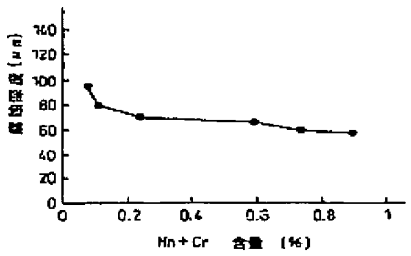
[74] 专利代理机构 永新专利商标代理有限公司
代理人 于 辉

权利要求书 3 页 说明书 44 页 附图 7 页

[54] 发明名称 镀有铝合金体系的高强度钢板以及具有优异的耐热性和喷漆后耐腐蚀性的高强度汽车零件

[57] 摘要

本发明提供了一种用于制备高强度汽车部件(具体地说，一种需要高强度的零件，例如汽车的底盘组件)的热压方法。更具体地说，本发明提供了一种适用于高温成型(热成型)的镀铝钢板或镀铝－锌钢板，其中在高温成型之后获得高强度，本发明还提供了这种钢板的制备方法。另外，本发明提供了一种热浸镀铝钢板，它抑制了在压制成型期间电镀层的合金化反应并具有漂亮的外观，本发明还提供了一种具有优异的喷漆后耐腐蚀性的热压用的镀有铝－体系的钢板。具体地说，本发明是一种具有优异的耐热性和优异的喷漆后耐腐蚀性的高强度的镀有铝体系的钢板，其特征在于在该钢板的表面上具有 Fe－Al－体系镀层，以质量计，该镀层中含有总量大于 0.1%的 Mn 和 Cr，以质量计，该钢板含有 C：0.05－0.7%、Si：0.05－1%、Mn：0.5－3%、P：不大于 0.1%、S：不大于 0.1%和 Al：不大于 0.2%，此外还含有一种或多种选自以下的元素：Ti：0.01－0.8%、Cr：不大于 3%和 Mo：不大于 1%，以便满足以下表达式 1：Ti＋0.5×Mn＋Cr＋0.5×Mo＞0.4…1。



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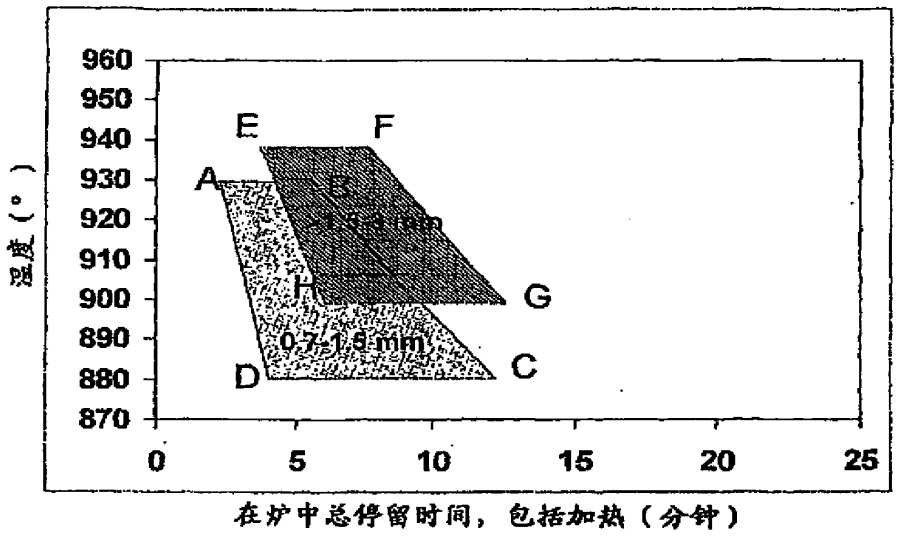


图 7

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1、一种具有优异的耐热性和喷漆后耐腐蚀性的高强度的镀有铝合金体系的钢板，其特征在于在该钢板的表面上具有 Fe-Al-体系镀层，该镀层中含有总量大于 0.1%的 Mn 和 Cr。

2、一种具有优异的耐热性和喷漆后耐腐蚀性的高强度的镀有铝合金体系的钢板，其特征在于在该钢板的表面上具有 Fe-A1-体系镀层，以质量计，该镀层中含有总量大于 0.1%的 Mn 和 Cr，以质量计，该钢板含有 C：0.05-0.7%、Si：0.05-1%、Mn：0.5-3%、P：不高于 0.1%、S：不高于 0.1%和 Al：不高于 0.2%，此外还含有一种或多种选自以下的元素：Ti：0.01-0.8%、Cr：不高于 3% 和 Mo：不高于 1%，以便满足以下表达式 1：

$$Ti + 0.5\times Mn + Cr + 0.5\times Mo > 0.4 \quad \ldots 1$$

3、如权利要求 2 的具有优异的耐热性和喷漆后耐腐蚀性的高强度的镀有铝合金体系的钢板，其特征在于，以质量计，该钢还含有一种或多种选自以下的元素：N：不高于 0.1%、Nb：不高于 0.1%、V：不高于 0.1%、Ni：不高于 1%、Cu：不高于 1%、B：0.0003-0.03%、Sn：不高于 0.1%和 Sb：不高于 0.1%。

4、如权利要求 1 的具有优异的耐热性和喷漆后耐腐蚀性的高强度的镀有铝合金体系的钢板，其特征在于，以质量计，该钢含有：C：0.15-0.55%、Si：不高于 0.5%、Mn：0.2-3%、P：不高于 0.1%、S：不高于 0.04%、Al：0.01-0.1%和 N：不高于 0.01%，并且还含有一种或多种选自以下的元素：B：0.0002-0.0050%、Ti：0.01-0.8%、Cr：不高于 2%、Mo：不高于 1%、Ni：不高于 1%、Cu：不高于 0.5%和 Sn：不高于 0.2%。

5、如权利要求 1-4 任一项的具有优异的耐热性和喷漆后耐腐蚀性的高强度的镀有铝合金体系的钢板，其特征在于所述 Fe-Al-体系镀

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层还含有 1-20%的 Si。

6、如权利要求 1-5 任一项的用于高强度汽车部件的镀有铝合金体系的钢板，其特征在于 Fe-Al-体系镀层中的 Al 浓度不高于 35 重量%。

7、如权利要求 1-6 任一项的具有优异的耐热性和喷漆后耐腐蚀性的高强度的镀有铝合金体系的钢板，其特征在于所述 Fe-Al-体系镀层还含有 Zn：1-50%和 Mg：0.1-10%中的一种或两种。

8、如权利要求 1-7 任一项的具有优异的耐热性和喷漆后耐腐蚀性的高强度的镀有铝合金体系的钢板，其特征在于所述 Fe-Al-体系镀层的厚度是 3-35 μm。

9、一种用于高强度汽车部件的镀有铝合金体系的钢板，其特征在于其具有：钢板表面上的主要由 Fe-Al 组成的镀层；在该镀层下面的厚度从不小于 2 μm 至不高于钢板厚度的十分之一的铁氧体层；和在该铁氧体层下面的主要由马氏体组成的基底钢。

10、如权利要求 9 的用于高强度汽车部件的镀有铝合金体系的钢板，其特征在于钢板表面上的铝合金体系镀层和金属间化合物层下面的铁氧体层中含有 Si。

11、如权利要求 9 或 10 的用于高强度汽车部件的镀有铝合金体系的钢板，其特征在于所述铁氧体相的硬度不高于 200。

12、一种压制成型的高强度汽车零件，其至少一部分是由如权利要求 1-11 任一项的钢制成的。

13、如权利要求 12 的高强度汽车零件，其特征在于在其表面的至少一部分上具有厚度为 1-200 μm 的镀膜。

14、一种高强度汽车部件的热轧方法，其中，在采用热压方法制备该汽车部件时，所用钢板是用主要由 Al 组成的金属电镀含有不小于 0.05 重量%的 C 作为钢组分的钢而制得的，该部件是在比以下 A、B、C 和 D 条件的时间更长的加热条件下加热之后通过压制成型形成

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的，并且该部件的至少一部分在不低于 10℃/秒的冷却速率下冷却：

A (800℃, 13 分钟)、B (900℃, 6 分钟)、C (1,050℃, 1.5 分钟)、D (1,200℃, 0.3 分钟)。

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镀有铝合金体系的高强度钢板以及具有优异的耐热性和喷漆后耐腐蚀性的高强度汽车零件

技术领域

本发明涉及一种镀有铝合金体系的钢板，其适用于通过高温压制生产的需要强度的部件（例如汽车零件的结构部件）以及所述钢板的制备方法，具体地说，本发明涉及一种需要高强度的部件（如汽车等的底盘组件）以及用于制备这种部件的钢材。

背景技术

为了减轻汽车重量(源自全球环境问题)，要求用于汽车的钢板具有尽可能高的强度。然而，一般说来，提高钢板强度的同时，伸长率和 r-值降低，因此成型性受损。因此需要一种同时具有高强度、高成型性和形状固定性的钢板。

解决该问题的一种方法是一种通过将残留奥氏体转变成马氏体而制备的 TRIP (相变感生塑性)钢，并且最近 TRIP 钢的使用越来越多。然而，尽管可以使用 TRIP 钢制备成型性优异的 1,000 MPa 级高强度钢板，但是难以保证更高强度的钢板的良好的成型性，例如，强度不低于 1,500 MPa 的超高强度钢板。而且，通过该工艺难以解决形状固定性的问题。

为了解决这些问题，有一种温压工艺，它是一种最近才引起注意的工艺，是另一种协调高强度和高成型性的方式。日本未审专利公开号 2000-234153 公开了一种在加热的同时形成钢板并利用成型期间产生的热量来增加强度的工艺。该工艺的目的在于通过适当控制钢中的组分，在铁氧体的温度范围内加热该钢板，并在该温度范围内利用沉

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淀强化来增加强度。

在日本未审专利公开号 2000-87183 中提出了一种高强度钢板，其中在成型温度下的屈服强度降至远远低于室温下的屈服强度，旨在提高压制成型的精确度。然而，通过该工艺获得的强度可能有一定的限制。

作为一种克服该缺陷的工艺，在文献(SAE, 2001-01-0078)中公开了一种工艺，它是将钢板加热至形成奥氏体单相的温度范围，然后在压制成型期间将其冷却。

该工艺通过将钢板在不低于800℃的高温下成形来获得所需物料性能，这样做解决了高强度钢板的成型问题，并且在成型之后冷却时将其淬火。然而，由于该工艺涉及在大气中加热，因此在钢板表面上产生氧化物并且需要在下面的过程中除去这些氧化物。在上述文献(SAE, 2001-01-0078)中还公开了一种抑制加热期间的这种氧化的镀铝工艺。

另外，可以采用如下方式来获得高强度：在室温下形成钢板之后，通过将部分钢板快速加热和快速冷却来进行淬火。在这种情况下，通过局部加热钢板，可以仅提高需要高强度的这部分的强度。日本未审专利公开号 2000-83640 公开了这样一种工艺并为此使用碳含量在0.15-0.5%的钢板。

在上述现有技术中公开了一种热成型工艺和一种将镀铝钢板用于热成型的工艺。然而，在这些现有技术中，当将钢板加热至不低于800℃的高温时，在短时间内 Fe 扩散至表面并且铝镀层变成金属间化合物，本文后面称之为“铝合金体系镀层”。由于这种铝合金体系镀层非常硬且脆，有时它产生裂缝并以粉状剥离，因此喷漆后耐腐蚀性受损受到关注。即使不产生裂缝，在喷漆后耐腐蚀性方面存在镀铝钢板比其它表面处理过的钢板(例如，热浸镀锌钢板或热浸电退火(galvannealed)钢板)差的情形。更具体地说，在高温成型之后评价喷

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漆后耐腐蚀性，并且当有划痕（例如以交叉形状切割的划痕）时，基底钢的腐蚀易于从这部分沿深度方向蔓延，并且其延伸速度比牺牲防腐蚀型的热浸镀锌或热浸电退火钢板要快。

而且，也存在剥落的镀层堆积在模具上，并在压制期间产生疤痕的可能性。这是由于，尽管所述电镀层可以经受热成型的加工，但是实际上难以对整个零件进行热加工，并且存在所述电镀层易于在加工延迟并且温度降低的部分剥离的问题。这里的另一个问题是，当温度降低时，淬火使得基底钢形成主要由马氏体组成的硬结构，因此应力趋于逐渐升高。

发明概述

本发明人为了解决上述问题进行了彻底的研究，并发现可以通过在高温成型后的钢板表面上施加含有 Mn 和 Cr 总量大于 0.1%的 Fe-Al-体系来制备具有优异的喷漆后耐腐蚀性的涂镀钢板(plated steel sheet)。经过热成型和局部快速加热之后的铝-体系镀层全部转化成铝合金体系镀层，并且该化合物非常脆，因此在加工期间易于产生裂缝。本发明定义的镀有铝体系的钢板是指镀层中 Al 和 Fe 含量至少为 70%的涂镀钢板。而且，由于该镀层具有比基底钢板高的电势，因此基底钢的腐蚀从裂缝开始，并且喷漆后耐腐蚀性趋于降低。为了避免喷漆后耐腐蚀性的降低，将 Mn 加入到所述铝合金体系镀层中是非常有效的。尽管 Mn 的功能还不清楚，但是据说 Mn 起通过控制合金层的电势使 Fe-Al-体系镀层的电势接近基底钢板的电势的作用，并且除了该功能之外，Mn 还可以控制在磷酸盐处理(喷漆前的预处理)中磷酸盐结晶的形状。

通过将 C、Si、Mn、P、S 和 Al 指定为基底钢组分，并加入 Ti、Cr 和 Mo(其加入是有效的)，以便满足以下等式 1：

$$Ti + 0.5\times Mn + Cr + 0.5\times Mo > 0.4 \quad \ldots 1$$

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从而可以获得极其优异的耐热性，尤其是加工之后的耐热性。

估计是这些元素加速了 Al 和 Fe 之间的扩散，并且这样以来即使在镀层中产生裂缝时，Fe 和 Al 之间的反应在裂缝的周围进行，因此几乎不曝露基底钢。

而且，本发明人还获悉通过加入 N、Nb、V、Ni、Cu、B、Sn 和 Sb 作为钢组分，可以获得更优异的喷漆后耐腐蚀性。

与此同时，合金化处理之后的电镀层含有 Si 也是有益的，并且加入 Zn、Mg 等可以获得更好的耐腐蚀性。为了抑制合金层中的裂缝，合金层中的 Al 含量不大于 35%是重要的。而且，从喷漆后耐腐蚀性的角度来看，Fe-Al-体系合金层的理想厚度是 3-35 μm。

而且，为了克服上述问题，本发明人详细研究了合金化处理之后影响镀有铝体系的钢板的可加工性的因素，并获得以下知识。即，由于铝合金体系镀层和基底钢都硬，因此内部应力增加，但是，由于在铝合金体系镀层和基底钢之间存在软层，因此使应力减弱，故剥落耐性显著提高。所述软层由铁氧体相组成，并且估计所述软层不小于 1 μm 的事实防止了合金层中的裂缝蔓延至基底钢。

此外，为了克服上述问题，本发明人详细研究了合金化处理之后影响镀有铝体系的钢板的可加工性的因素，并获得以下知识。即，通过使加热条件最佳化可以防止电镀层剥落。其原因还不清楚，但是估计是在加热条件镀层被合金化，相结构发生复杂变化，并且出现保证可加工性的合适的相结构。本发明的要点如下：

(1) 一种具有优异的喷漆后耐腐蚀性的高强度的镀有铝合金体系的钢板，其特征在于在该钢板的表面上具有 Fe-Al-体系镀层，该镀层中含有总量大于 0.1%的 Mn 和 Cr。

(2) 一种具有优异的耐热性和喷漆后耐腐蚀性的高强度的镀有铝合金体系的钢板，其特征在于在该钢板的表面上具有 Fe-Al-体系镀层，以质量计，该镀层中含有总量大于 0.1%的 Mn 和 Cr，以质量计，

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该钢板含有 C：0.05-0.7%、Si：0.05-1%、Mn：0.5-3%、P：不高于 0.1%、S：不高于 0.1%和 Al：不高于 0.2%，此外还含有一种或多种选自以下的元素：Ti：0.01-0.8%、Cr：不高于 3% 和 Mo：不高于 1%，以便满足以下等式 1：

$$Ti + 0.5\times Mn + Cr + 0.5\times Mo > 0.4 \quad \ldots 1$$

(3) 如第(2)项的具有优异的耐热性和喷漆后耐腐蚀性的高强度的镀有铝合金体系的钢板，其特征在于该钢还含有(以质量计)一种或多种选自以下的元素：N：不高于 0.1%、Nb：不高于 0.1%、V：不高于 0.1%、Ni：不高于 1%、Cu：不高于 1%、B：0.0003-0.03%、Sn：不高于 0.1%和 Sb：不高于 0.1%。

(4) 如第(1)项的具有优异的耐热性和喷漆后耐腐蚀性的高强度的镀有铝合金体系的钢板，其特征在于该钢含有(以质量计)：C：0.15-0.55%、Si：不高于 0.5%、Mn：0.2-3%、P：不高于 0.1%、S：不高于 0.04%、Al：0.01-0.1%和 N：不高于 0.01%，并且还含有一种或多种选自以下的元素：B：0.0002-0.0050%、Ti：0.01-0.8%、Cr：不高于 2%、Mo：不高于 1%、Ni：不高于 1%、Cu：不高于 0.5%和 Sn：不高于 0.2%。

(5) 如第(1)-(4)项任一的具有优异的耐热性和喷漆后耐腐蚀性的高强度的镀有铝合金体系的钢板，其特征在于所述 Fe-Al-体系镀层还含有 1-20%的 Si。

(6) 如第(1)-(5)项任一的用于高强度汽车部件的镀有铝合金体系的钢板，其特征在于所述 Fe-Al-体系镀层中的 Al 浓度不高于 35 重量%。

(7) 如第(1)-(6)项任一的具有优异的耐热性和喷漆后耐腐蚀性的高强度的镀有铝合金体系的钢板，其特征在于所述 Fe-Al-体系镀层还含有 Zn：1-50%和 Mg：0.1-10%中的一种或两种。

(8) 如第(1)-(7)项任一的具有优异的耐热性和喷漆后耐腐蚀性的

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高强度的镀有铝合金体系的钢板，其特征在于所述 Fe-Al-体系镀层的厚度是 3-35 μm。

(9) 一种用于高强度汽车部件的镀有铝合金体系的钢板，其特征在于具有：在钢板的表面上主要由 Fe-Al 组成的镀层；在该镀层下面的厚度从不小于 2 μm 至不大于钢板厚度的十分之一的铁氧体层；和在该铁氧体层下面主要由马氏体组成的基底钢。

(10) 如第(9)项的用于高强度汽车部件的镀有铝合金体系的钢板，其特征在于钢板表面上的铝合金体系镀层和金属间化合物层下面的铁氧体层含有 Si。

(11) 如第(9)或(10)项的用于高强度汽车部件的镀有铝合金体系的钢板，其特征在于铁氧体相的硬度不高于 200。

(12) 一种高强度汽车零件，其是通过将由如第(1)-(11)项任一的钢组成的至少一部分压制成型而形成的。

(13) 如第(12)项的高强度汽车零件，其特征在于在其表面的至少一部分上具有厚度为 1-200 μm 的镀膜。

(14) 一种高强度汽车部件的热成型方法，其中，在采用热成型方法制备该汽车部件时，所用钢板是通过在含有不小于 0.05 重量%的 C 的钢上电镀以 Al 为主要组成的金属而制得的，该部件是在比以下条件 A、B、C 和 D 的时间更长的加热条件下加热之后通过压制成型而形成的，并且所述部件的至少一部分在不低于 10℃/秒的冷却速率下冷却：

A (800℃, 13 分钟)、B (900℃, 6 分钟)、C (1,050℃, 1.5 分钟)、D (1,200℃, 0.3 分钟)。

附图简述

图 1 是显示铝合金体系镀层中 Mn 和 Cr 的总量对喷漆后耐腐蚀性的影响的图。

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图 2 是显示 Ni、Cu 和 Sn 的加入量与裸露耐腐蚀性之间的关系的图。

图 3 是显示 Ni、Cu 和 Sn 的加入量与喷漆后耐腐蚀性之间的关系的图。

图 4 是显示 Cr 和 Mo 的加入量与裸露耐腐蚀性之间的关系的图。

图 5 是显示 Cr 和 Mo 的加入量与喷漆后耐腐蚀性之间的关系的图。

图 6 是 950℃的温度下 Fe-Al-Si-体系的三相图。

图 7 是显示通过光学显微镜拍摄的本发明结构的一个实例的照片(反向散射电子图象)。

图 8 是显示外层厚度与电镀层的可加工性之间的关系的图。

图 9 是显示通过光学显微镜拍摄的本发明金属结构的一个实例的照片(反向散射电子图象)。

图 10 是显示通过将本发明的钢板成形而获得的形状的图。

图 11 是显示了本发明的加热时间与加热温度之间的关系的图。

实施本发明的最佳方式

实施方式 1

下面解释用于本发明的钢板的化学组成。

C：本发明的钢板在成型之后具有不低于 1,000 MPa 的高强度，其是通过在高温压制之后快速冷却并由此将其结构转化成主要由马氏体组成的结构而获得的。在这种意义下，C 含量不小于 0.05%是理想的，并且为了稳定地获得高强度，该含量不小于 0.1%更理想。另一方面，即使 C 含量增加至不小于 0.7%，其强度饱和并且也趋于产生焊接裂缝，因此其上限定在 0.7%。

Si：由于 Si 含量太低使得疲劳特性受损，因此其加入量不小于

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0.05%是理想的。然而，在再结晶退火期间 Si 在钢板表面上形成稳定氧化物薄膜并阻碍镀铝性能。为此，Si 的上限定在 1%。

Mn：Mn 是公知的强化钢板可硬化性的元素。同样，Mn 也是防止由 S(是一种不可避免的杂质)引起的热脆化所需的元素。为此，其加入量不小于 0.5%是优选的。而且，Mn 还强化镀铝之后的耐热性。然而，由于 Mn 加入量超过 3%使得淬火之后的抗冲性能受损，因此该值确定为其上限。

Ti：Ti 对铝镀层的耐热性影响最大。在超过 900℃的温度范围内使用钢板的情况下，正如本发明的情形，从耐热性的角度优选加入 Ti，并且其加入量不小于 0.01%对获得该效果是理想的。然而，由于 Ti 与 C 形成 TiC，降低了赋予强度的 C 的量，因此必需相应于 Ti 的加入量增加 C 的量。而且，Ti 的影响在约 0.8%的量时达到饱和，因此该值确定为其上限。

Cr：与 Mn 和 Ti 类似，Cr 有利于提高镀铝之后的耐热性。然而，Mn 通过在钢板的表面上形成稳定的氧化物而使镀铝性能受损，其方式与 Si 相同。而且，Cr 是一种相对昂贵的元素，因此在加入它时其上限定在 3%。

Mo：与 Mn、Ti 和 Cr 相似，Mo 也有利于提高镀铝之后的耐热性，并且其加入是理想的。然而，由于 Mo 是一种相对昂贵的元素，并且其效果会饱和，因此其上限定在 1%。

在本发明中，优选加入提高镀铝之后的耐热性的元素，诸如 Ti、Mn、Cr 和 Mo，其方式满足以下表达式：

$Ti+0.5\times Mn+Cr+0.5\times Mo > 0.4$，

具体地说，Ti 和 Cr 具有在加热期间防止镀层剥落的效果。而且，Mn 可以相对大量地加入并且对耐热性非常有利。

本发明还将 P、S 和 Al 加入到钢中。然而，由于 P 和 Al 损害钢的延展性和疲劳强度，并且 S 使其韧性受损，因此对它们每一个确定

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了一个上限。此外，偶尔需要时可以在钢中含有 Ni、Nb、V、N、Cu、B、Sn 和 Sb 中的一种或多种。Ni 和 Cu 对钢的耐腐蚀性有利，并且 B 提高可硬化性。

在许多情况下，钢板是在将铝镀层合金化之后，然后喷漆才使用的。在这些情况下，喷漆后耐腐蚀性受铝合金体系镀层中 Mn 和 Cr 的量的影响。当这些元素的量不小于 0.1%时，获得良好的喷漆后耐腐蚀性。作为加入 Mn 和 Cr 的方法，有钢组分扩散法和将它们加入到镀浴中的方法，并且只要其加入量不小于 0.1%，这两种方法任意一种都可以获得该效果。已知 1-5 个相可以共存于一个铝合金体系镀层中，这取决于电镀的沉积量、钢组成、加热条件等。由于在表面附近的相的影响特别大，因此在分析它们时，优选通过在距离表面 5 μm 深度内的区域的横截面上的约 5 个部分使用诸如 EPMA 定量分析等的手段来测定它们，并计算其平均值，从而进行判断。正如后面所述，在热浸镀铝的情形下，通常加入 Si，此时，Si 也含在铝合金体系镀层内。其量是约 1-20%，并且 1-5 相的铝合金体系镀层中的 Si 的量可以有很大的变化。尽管 1-5 相的 Fe-Al-体系镀层可以具有不同的组成，诸如 Fe-Al-Si-体系铝合金体系镀层、Fe_2Al_5、$FeAl_3$、Fe_3Al、FeAl、溶解 Al 的铁氧体，等等，在任意这些组成中，只要 Mn 和 Cr 的总量不小于 0.1%，便可以获得稳定的喷漆后耐腐蚀性。至于存在许多相时应分析哪一相，由于已知 Mn 和 Cr 有利于提高喷漆后耐腐蚀性，并且腐蚀现象是一种宏观现象，因此本发明人认为：即使存在多个相，通过在随机的约 5 个部分分析它们，并计算其平均值，可以获得常规信息，并且这样做，可以进行判断。而且，为了观察加热之后的结构的横截面，规定横截面用 2-3%的 nitral 蚀刻。这是由于不蚀刻的话，不能观察到基底金属和溶解 Al 的铁氧体之间的界面。

镀铝的沉积量影响耐腐蚀性、可焊性、可加工性等等。如果沉积量太小，喷漆后耐腐蚀性不足，而如果太大，可焊性和可加工性受损。

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至于可加工性，它是由于在加热之后的压制期间脆的铝合金体系镀层趋于剥离。

镀铝方法没有特别的限制，并且可以使用热浸镀法、电镀法、真空沉积法、在金属外覆以另一金属的方法等等。目前工业上最广泛使用的方法是热浸镀法，并且经常将 Al-10%Si 用于镀浴中，其中含有 Fe 作为不可避免的杂质。除了这些之外，已经报道了加入 Cr 和 Mn 提高喷漆后耐腐蚀性。作为其它添加元素，推荐有 Mg、Ti、Zn、Sb、Sn、Cu、Ni、Co、In、Bi、混合稀土等，并且只要电镀层主要由 Al 组成，那么可以使用这些元素。

本发明没有特别定义镀铝的预处理和后处理。作为电镀预处理，推荐预电镀 Ni、Cu、Cr 或 Fe 等，并且这些中任意的都可以采用。作为电镀后处理，推荐有铬酸盐处理、树脂镀层处理等等，旨在主要防止生锈和光滑，但是由于有机树脂受热时消失，因此它不是优选的。至于铬酸盐处理，考虑目前对六价铬的管制，优选含有三价铬的处理薄膜，例如电解铬酸盐等等。可以使用无机体系铬酸盐处理以外的其它后处理。也可以预先使用氧化铝、二氧化硅、MoS_2 等的处理，旨在光滑。

实施方式 2

下面将描述本发明的实施方式 2 中调节钢组份的理由。

N 是一种不可避免包含的元素并且在不加入 B 时要特别添加的，但是，当加入 B 并且其量过大时，必需增加 Ti 的加入量。结果，存在的问题是最终产生的 TiN 量增加并且发生热裂缝，并且成本也增加。因此，其上限定在 0.1%。

加入 B 是为了提高压制成型期间或之后冷却时的可硬化性，并且为了获得该效果，其加入必需不小于 0.0002%。然而，当其加入量过大时，存在热裂缝的问题并且该效果饱和。因此，其上限定在

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0.03%。

Ni、Cu 和 Sn 具有在高温加热之后的压制成型期间通过改变高温加热期间合金化铝镀层的状态来改变表面裂缝状态的效果，并且由于它们导致成型产品的喷漆后耐腐蚀性提高因此是重要的。至于这些元素，由通过测定 Ni、Cu 和 Sn 的加入量获得的图 2 和 3 所示的结果，和实验室试验中高温成型之后样品的裸露耐腐蚀性和喷漆后耐腐蚀性，本发明人发现，为了获得上述效果，不得不加入 Ni、Cu 和 Sn，以便它们可以满足等式 3。这里，采用在实施例中所示的条件下测定的方法，使用取自在高温成型之后进行加工的部分的样品来评价其裸露耐腐蚀性和喷漆后耐腐蚀性。

$$(Ni+0.5\times Cu+3\times Sn)\geq 0.012 \quad \ldots 3$$

至于 Ni、Cu 和 Sn 中的每一种，加入过量的 Ni 使得这些效果饱和并且使成本增加，Cu 和 Sn 具有产生表面裂缝的问题，因此每一元素的上限分别定在 1.0%、1% 和 0.2%。

本发明的钢板的制备条件没有特别的规定，但是下面将解释优选的制备条件。

将具有上述组份的钢铸造，并将所得热平板，直接或者在加热之后，或者将冷却并再加热的平板，热轧。这里，几乎不能识别直接轧制热平板和再加热之后轧制之间钢的性能的差异。而且，再加热温度不特定，但是考虑到生产率，优选将其调节在 1,000-1,300℃的范围内。

至于热轧，可以采用常规热轧法或者将平板彼此相连并在精轧时轧制的连续热轧法。考虑到生产率和钢板厚度的精确度，优选控制热轧时的抛光温度不低于 Ar3 转化温度。

采用常规方法进行热轧之后的冷却。在这种情况下，从生产率的角度，优选将该冷却温度控制在不低于 550℃。另一方面，如果冷却温度太高，酸渍能力受损，因此优选将该冷却温度控制在不高于 750℃。

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就酸渍处理或冷轧处理而言，可以使用常规方法，并且就接下来的镀铝处理或接下来的镀铝-锌处理而言，也可以使用常规方法。即，在镀铝处理的情况下，镀浴中 Si 浓度为 5-12%是合适的，而在镀铝-锌处理中，镀浴中 Zn 浓度为 40-50%是合适的。

这里，至于电镀处理中的气氛，可以使用具有非氧化炉的连续电镀设备或者没有非氧化炉的连续电镀设备进行电镀，只要保持常规条件。因此，在生产本发明的产品时不需要特别的控制，并且因此生产率不受到干扰。

在上面的生产条件下，在电镀之前没有对钢板表面进行金属预电镀，但是即使使用 Ni 预电镀、Fe 预电镀或其它金属预电镀以提高电镀性能时，也不会产生特定的问题。

而且，即使当 Mg 和 Zn 包括在铝镀层或者 Mg 包括在铝-锌电镀层时，不会产生特定的问题并且可以制得具有类似性能的钢板。

实施方式 3

下面首先解释在实施方式 3 中按照本发明调节钢组份的理由。

C 元素的加入使冷却之后的结构由马氏体构成，并且确保材料质量，并且要求其加入量不小于 0.15%以保证强度不低于 1,200 MPa。另一方面，如果加入量过大，几乎不能保证抗冲击变形的强度，因此其上限定在 0.55%。

Si 是一种溶质强化元素，并且可以相对低的成本增加钢板的强度。然而，如果其加入过量，那么电镀性能将受损，因此其上限定在 0.5%。

Mn 加入是为了保证在广泛的冷却速率范围下的冷却后强度。

当 C 量大但是 Mn 的加入量小时，在常规冷却速率的范围(该范围可以在压制成型期间获得)内不能获得马氏体结构，因此其强度几乎不能得到保证。在钢板厚度为 1.4 mm 的情况下，本文引证的冷却

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速率的范围不高于 500℃/秒。为了展示这种功能，要求其加入量不小于 0.2%。另一方面，如果 Mn 量太大，不仅成本增加，而且该效果饱和。因此，其上限定在 3%。

S 是一种不可避免地包含并且引起可加工性受损的元素。因此，需要尽可能地降低其量。通过使其量降低至不高于 0.04%，消除了可加工性的问题，并且因此确定其含量不高于 0.04%。

P 是一种溶质强化元素，并且可以相对低的成本增加钢板的强度。然而，如果其加入量增加太大，那么在热轧或冷轧期间因脆化产生裂缝，并且因此其上限定在 0.1%。

Al 用作脱氧剂，并为了展示这种效果，要求钢中 Al 含量不小于 0.005%。另一方面，其加入量超过 0.1%使得氧化物-体系包含物增加，并引起表面质量降低的问题，因此其上限定在 0.10%。

Cr 和 Mo 具有在高温加热之后的压制成型期间通过改变高温加热期间合金化铝镀层的状态来改变表面裂缝的状态的作用，并且由于它们导致成型产品的喷漆后耐腐蚀性提高因此是重要的。对于这些元素，由通过测定 Cr 和 Mo 的加入量获得的图 2 和 3 所示的结果，和实验室试验中高温成型之后样品的裸露耐腐蚀性和喷漆后耐腐蚀性，本发明人发现不得不加入 Cr 和 Mo。这里，采用在实施例中所示的条件下测定的方法，使用取自高温成型后经过加工的部分的样品来评价其裸露耐腐蚀性和喷漆后耐腐蚀性。

对于 Cr 和 Mo 中的每一种，加入过量的 Cr 导致性能问题和成本增加，并且过量的 Mo 使得这些效果饱和并且使成本增加。因此每一元素的上限分别定在 2.0%和 1.0%。

对其它组份没有特别的规定。不可避免地包括 Ni，并且如果其量在常规范围内，不会产生问题。

本发明的钢板的制备条件没有特别的规定，但是下面将解释优选的制备条件。

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将具有上述组份的钢铸造，并将所得热平板，直接或者在加热之后，或者将冷却并再加热的平板，热轧。这里，几乎不能识别直接轧制热平板和再加热之后轧制之间钢的性能的差异。而且，再加热温度不特定，但是考虑生产率，优选将其调节在 1,000-1,300℃的范围内。

至于热轧，可以采用常规热轧法或者将平板彼此相连并在精轧时轧制的连续热轧法。考虑生产率和钢板厚度的精确度，优选控制热轧时的抛光温度不低于 Ar3 转化温度。

采用常规方法进行热轧之后的冷却。在这种情况下，从生产率的角度考虑，优选将该冷却温度控制在不低于 550℃。另一方面，如果冷却温度太高，酸渍能力受损，因此优选将该冷却温度控制在不高于 750℃。

就酸渍处理或冷轧处理而言，可以使用常规方法，并且就接下来的镀铝处理或接下来的镀铝-锌处理而言，也可以使用常规方法。即，在镀铝处理的情况下，镀浴中 Si 浓度为 5-12%是合适的，并且在镀铝-锌处理中，镀浴中 Zn 浓度为 40-50%是合适的。

这里，对电镀处理中的气氛，可以使用具有非氧化炉的连续电镀设备或者没有非氧化炉的连续电镀设备进行电镀，只要保持常规条件。因此，在生产本发明的产品时不需要特别的控制，并且因此生产率不受到干扰。

在上面的生产条件下，在电镀之前没有对钢板表面进行金属预电镀，但是即使使用 Ni 预电镀、Fe 预电镀或其它金属预电镀以提高电镀性能时，也不会产生特定的问题。

而且，即使当 Mg 和 Zn 包括在铝镀层或者 Mg 包括在铝-锌电镀层时，不会产生特定的问题并且可以制得具有类似性能的钢板。

实施方式 4

通过加热铝镀层并由此将其转变成合金层，即 Fe-Al-体系镀层，

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并且还通过将 Al 量控制在不大于 35%，并由此将 Fe-Al-体系镀层转变成 Fe+Fe_3Al(其中溶解有 Al 和 Si)，这样与那些含有 Fe+Fe_3Al 之外的其它相的电镀层相比，在经受加工的部分获得更优异的可加工性和耐腐蚀性。

C：本发明的钢板在成型之后具有不低于 1,000 MPa 的高强度，其是通过热轧之后快速冷却并由此将其结构转化成主要由马氏体组成的结构而获得的。为了这样做，C 含量必需不小于 0.05%。另一方面，即使 C 含量增加至不小于 0.7%，该强度饱和并且也趋于产生焊接裂缝，因此其上限定在 0.7%。

除 C 之外的钢组份没有特别限制，但是推荐诸如 Si、Mn、P、Al、N、Cr、Mo、Ti、Nb、B、Ni、Cu、V、Sn、Sb 等的元素作为加入元素或者不可避免的杂质元素。这些元素可以在偶尔需要时加入。实例是：Mn 和 B 在可硬化性方面有效；Cr、Ti 和 Mo 在铝镀层的耐热性方面有效；并且 Ni 和 Cu 提高耐腐蚀性。其加入的理想范围是：Mn：0.5-3%、Si：不高于 1%、P：不高于 0.1%、S：不高于 0.1%、Al：不高于 0.1%、N：不高于 0.01%、Cr：不高于 2%、Mo：不高于 0.5%、Ti：不高于 0.5%、Nb：不高于 0.1%、B：不高于 0.05%、Ni：不高于 1%、Cu：不高于 1%、V：不高于 0.1%、Sn：不高于 0.1%和 Sb：不高于 0.1%。

如上所述，镀铝的沉积量越小，越容易形成 Fe+Fe_3Al 区域。在这种意义下，两面的沉积量不大于 120 g/m^2 是理想的。

镀铝方法没有特别的限制，并且可以使用热浸镀法、电镀法、真空沉积法、在金属外覆以另一金属的方法等等。目前工业上最广泛使用的方法是热浸镀法，并且经常将 Al-10%Si 用于镀浴中，其中含有 Fe 作为不可避免的杂质。在这种情况下，在加热之后 Si 进入合金层并且 Si 量可以随相结构而变化。然而，Fe+Fe_3Al 区域中的 Si 量不大于 15%，并因此将该值确定为 Si 的上限。作为其它添加元素，推荐

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有 Mn、Cr、Mg、Ti、Zn、Sb、Sn、Cu、Ni、Co、In、Bi、混合稀土等，并且只要电镀层主要由 Al 组成，那么可以使用这些元素。加入 Zn 和 Mg 能够有效地防止红锈产生。然而，加入过量的这些元素(其蒸汽压力高)使得产生含有 Zn 和 Mg 的烟雾和在表面上产生粉状物质，等等。因此，Zn 的加入量不小于 60%并且 Mg 的加入量不小于 10%是不理想的。

本发明没有特别定义镀铝的预处理和后处理。作为电镀预处理，推荐预电镀 Ni、Cu、Cr 或 Fe 等，并且这些中任意的都可以采用。作为电镀后处理，推荐有铬酸盐处理、树脂镀层处理等等，旨在主要防止生锈和光滑，但是由于有机树脂受热时消失，因此它不是优选的。至于铬酸盐处理，考虑目前对六价铬的管制，优选含有三价铬的处理薄膜，例如电解铬酸盐等等。也可以使用无机体系铬酸盐处理以外的其它后处理。还可以预先使用氧化铝、二氧化硅、MoS_2 等的处理，旨在光滑。

实施方式 5

在实施方式 5 中，将解释对铝-体系镀层的组成的限制。本文所述的铝-体系镀层是指一种还未加热并因此还未合金化的镀层。

Si：Si 能够有效地降低镀铝-体系的合金层(一种由在镀层和钢板之间的界面上形成的金属间化合物构成的层)的厚度。而且，通过加入 Mg，与 Si 复合形成 Mg_2Si，有效地提高了耐腐蚀性。为了享有这些效果，其加入量不小于 1%是有效的。过量加入 Si 使得熔点升高，并且当 Si 单相在镀层上结晶时，它使得耐腐蚀性受损。因此，其上限定在 15%。

Mg：已知 Mg 能够有效地提高耐腐蚀性，特别是在盐破坏环境下。特别是通过形成 Mg_2Si，释放到环境中的效率增加并且耐腐蚀性提高。为了保证耐腐蚀性，Mg 的加入量不小于 0.5%。由于过量加入

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使得镀浴的表面产生剧烈氧化并使镀浴的熔点升高，因此将其加入量定在不大于 10%。为了抑制镀浴表面的氧化．加入少量 Ca (不大于 0.5%)是有效的，并且可以加入大致这一量的 Ca。

Zn：Zn 具有比 Al 或钢更低的电势，并且具有抑制基底钢腐蚀的功能。当 Zn 加入量不小于 1%时这些效果开始出现，并且当 Zn 量是 20-60%时获得最佳性能。然而，加入量超过 60%时，耐腐蚀性大大受损。因此，Zn 量的下限和其上限分别定在 1% 和 60%。

当实际使用本发明的镀有铝-体系的钢板制备一零件时，在压制之后用模具快速冷却零件来进行淬火，因此该结构主要由马氏体构成。为了保证部件足够的强度，测定马氏体的百分比不小于 60%体积。本文中，马氏体的百分比是通过抛光和蚀刻样品，之后用光学显微镜观察并使用图象分析计算得出的。

实施方式 6

下面描述在实施方式 6 中调节钢板的组份等的原因。

本发明的钢板在通过铝镀层合金化形成的金属间化合物层和主要由马氏体组成的基底钢之间具有一厚度从不小于 2 μm 至不大于钢板厚度的十分之一的软铁氧体层。通常，约 1-10%的 Al 存在于铁氧体层中。除了 Al 之外，该铁氧体相也可以含有 Si。其厚度限制在不小于 1 μm。其原因在于，如果该软铁氧体层的厚度不大于上面的厚度，那么不能充分获得该镀层的剥落耐性。另一方面，由于该层软，如果太厚的话，整个钢板的强度受损。为此，确定其上限不大于钢板厚度的十分之一。通常，经常通过热浸镀法制得一镀铝钢板，并且在这种情况下，在钢板和镀层之间的界面上的铝合金体系镀层(称作“合金层”)趋于生长。如果该层生长过度，那么钢板的可加工性受损，并且，因此在加入约 10%的 Si 的镀浴中制得该镀铝钢板。在本发明中，由于是在整个镀层受热合金化之后趁热加工镀铝钢板，不需要在

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镀浴中加入 Si，但是即使加入 Si 也没有特别的问题。

在本发明中，根据维氏硬度，优选铁氧体层的硬度不高于 200。如上所述，该层起着防止硬合金层在加工期间剥离的作用。为此，优选该层是软的。然而，当该层含有溶质强化元素如 Al、Si 等时，它比常规铁氧体层硬。

接下来，描述与本发明有关的其它组份。首先，关于钢组份，由于本发明旨在获得常规 TRIP 钢不能获得的高强度区域，并通过淬火增强强度，理想的 C 量不小于 0.05%，优选不小于 0.1%。至于钢中的其它元素，通常使用 Si、Mn、Ti、B、Cr、Mo、Al、P、S、N 等元素。Si 在疲劳特性方面有效，Mn 和 B 有利于提高可硬化性。Ti、Si、Cr、Mo 和 Al 是在镀铝之后提高耐热性的元素。

至于铝镀层的构造，如上所述，铝镀层主要由 Al 组成并且可以含有 Si。作为其它加入元素，推荐有 Cr、Mg、Ti、Sb、Sn、Zn 等，并且只要该镀层主要由 Al 组成，那么它们都可使用。然而，Zn 的沸点低，并且当过量使用时，在加热期间 Zn 在其表面上产生锌粉，这样在压制期间引起磨损。因此，其加入量不小于 60%是不理想的。

在铝合金体系镀层中产生的组分有 $FeAl_3$、Fe_2Al_5、Fe_3Al、Fe_2Al_5Si 等。这些相趋于以层状方式形成多层结构，但是这些相的结构并不特别规则。当其组成主要由 Al 和 Fe 构成，并且将 Si 加入到铝镀浴中时，其含有约 5-10%的 Si。这些元素在所有组成中占不小于 90%。而且，可以保留有少量未合金化的 Al，但是只要其量小，它不影响镀铝钢板的性能。

用光学显微镜测定铁氧体层的厚度。通过将横截面抛光，并且之后用约 2%的 nital 蚀刻它，清楚地观察到铁氧体层的厚度。然而，存在一种几乎不能观察到金属间化合物层的边界的情况，在这种情况下，另外采用 EPMA 分析。这样，由 Fe 和 Al 之间的放射强度的差异可以容易地鉴定铁氧体层。它是通过测定约 5 个随机部分的厚度并

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计算其平均值进行铁氧体层的厚度的测定来确定的。而且，基底钢由主要由马氏体组成的结构组成，并且例如可以通过用苦味酸酒精溶液蚀刻并用光学显微镜观察到该结构。

图 7 显示了本发明的结构的实例。在其界面处识别到两层，并且根据 EPMA 定量分析的结果，下层是厚度为约 5 μm 的铁氧体层。在本文的图 7 中，标号 1 显示该层由 Al：26.85%、Si：9.83%、Fe：59.92%组成；标号 2 显示组成为 Al：49.54%、Si：3.11%、Fe：44.89%；标号 3 显示组成为 Al：30.75%、Si：8.88%、Fe：56.91%；标号 4 显示组成为 Al：9.59%、Si：2.92%、Fe：84.02%。

最后，对于涂镀钢板的加热和冷却条件，对加热和冷却方法没有特别的限制。为了获得硬化结构，事实上冷却速率大大影响它，并且冷却速率不低于约 30℃/秒是理想的。这取决于钢组份，并且对于具有良好的可硬化性的钢，主要由马氏体组成的理想结构甚至可以在约 10℃/秒的冷却速率下获得，或者在另一情况下，要求冷却速率不低于 100℃/秒，这取决于钢等级。为了获得所需厚度的铁氧体层，需要使加热条件最佳化。

实施方式 7

下面描述在实施方式 7 中调节钢板组成等的理由。

本发明是一种在成型之后具有不低于约 1,000 Mpa 的高强度的高强度钢板，并且其是在经受热轧或局部快速加热之后，通过快速冷却将其淬火而获得的钢板，这样做，将其转变成主要由马氏体组成的结构。因此，测定基底钢的硬度不低于 250。该硬度是根据维氏硬度测定的。为了获得该硬度，C 量为 0.05%是理想的。至于钢中的其它元素，没有特别的限制，但是经常使用元素 Si、Mn、Ti、B、Cr、Mo、Al、P、S、N 等。Si 在疲劳特性方面有效，Mn 和 B 有利于提高可硬化性。Ti、Si、Cr、Mo 和 Al 是在镀铝之后提高耐热性的元素。

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而且，本发明钢板在基底钢的表面上有一主要由 Al 和 Fe 组成的铝合金体系镀层，并且该铝合金体系镀层的厚度限制在 3-35 μm，优选 3-18 μm。如上所述，这一限制是在考虑到可焊性、喷漆后耐腐蚀性和耐热性之间的平衡才确定的。即，当层厚小于 3 μm 时，不能获得足够的喷漆后耐腐蚀性和耐热性。特别是在铝镀层中不加 Si 的情况下，耐热性受损明显。通过可点焊性确定其厚度的上限。当电镀厚度不大于 35 μm 时，可以获得与镀锌钢板相同的可点焊性(电极寿命)；并且当电镀厚度不大于 18 μm 时，可以获得与热浸合金化镀锌钢板相同的可点焊性。可以将 $FeAl_3$、Fe_2Al_5、Fe_3Al、Fe_2Al_8Si 等形成为合金层。而且，在合金化层和基底钢之间的界面处可以经常地识别含有 Al 的铁氧体层的形成。

通常，在镀铝钢板中，Fe-Al-体系合金化层趋于生长并破坏可加工性。因此，经常发生加入 Si 以抑制合金层生长并提高可加工性。在热轧的情况下，由于钢板是在铝镀层受热并合金化至其表面之后趁热加工的，因此不是特别需要加入 Si。然而，事实上也可以加入 Si。在对部分钢板进行快速加热的情况下，由于在室温下进行加工，因此 Si 的加入必不可少。推荐 Cr、Mg、Ti、Sb、Sn、Zn 等作为铝镀层中的其它加入元素，并且只要该镀层主要由 Al 组成，那么这些元素都可以使用。然而，Zn 的沸点低，并且当过量使用时，在加热期间 Zn 在其表面上产生锌粉，这样在压制期间引起磨损。因此，其加入量不小于 60%是不理想的。

本发明没有特别定义电镀的预处理和后处理，以及压制期间钢板的加热方法及其冷却方法。作为电镀后处理，推荐有铬酸盐处理、树脂镀层处理等等，旨在主要防止生锈和光滑，然而，至于铬酸盐处理，考虑目前对六价铬的管制，优选含有三价铬的处理薄膜，例如电解铬酸盐等等。可以使用树脂镀层处理通常可以有效地提高成型性，并且在成型之后将一部分钢板快速加热时特别有效。当钢板受热然后成型

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时，树脂薄膜分解，因此没有影响。

对镀铝钢板的制备方法也没有规定。可以使用常规制钢条件和热轧条件。经常通过热浸镀法进行镀铝，但是方法并不限于此，可以使用在无水溶剂中电镀、蒸汽沉积处理等。作为电镀之前的预处理推荐有 Ni 预电镀等，并且可以采用它。

加热或冷却钢板的方法也没有特别的规定。可以采用一种加热装置如电加热、在炉中加热、高频加热等。在这些装置中，高频加热适合快速对部分钢板进行加热。

实施方式 8

下面描述在实施方式 8 中调节钢板组份等的理由。

如上所述，本发明是一种通过加热之后趁热形成镀铝钢板，之后将其立即冷却，并由此将其淬火以保证所需强度的工艺，并要求钢板的组份赋予该钢板优异的可硬化性。为了满足该要求，要求 C 量不小于 0.05%，优选不小于 0.1%。至于钢中的其它元素，经常使用元素 Si、Mn、Ti、B、Cr、Mo、Al、P、S、N 等。Si 在疲劳特性方面有效，Mn 和 B 有利于提高可硬化性。Ti、Si、Cr、Mo 和 Al 是在镀铝之后提高耐热性的元素。

加热之后在表面上可以产生铝合金体系镀层组分有 $FeAl_3$、Fe_2Al_5、Fe_3Al、Fe_2Al_5Si 等。这些相趋于以层状方式形成多层结构，但是这些相的结构并不特别规则。当其组成主要由 Al 和 Fe 构成，并且将 Si 加入到铝镀浴中时，其中含有约 5-10%的 Si。这些元素在所有组成中占不小于 90%。而且，在镀层受热转变成铝合金体系镀层至其表面之后，才将镀铝钢板经受压制加工。这是由于，当 Al 大量留在表面上时，可焊性和喷漆后耐腐蚀性受损。

至于本发明的加热和冷却条件，对加热和冷却方法没有特别的限制。可以使用任意一种加热方式，例如在大气炉中加热、感应加热、

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电加热等。此时的加热速率也没有限制。加热速率事实上大大取决于钢板的厚度和形状。新近获悉，在炉中停留时间越长，在接下来的成型期间的镀层附着性越好。加热温度大致在 800-1,200℃的范围内，优选 900-1,000℃，并且重要的是保持钢板在该温度范围内持续约几分钟。然而，停留时间取决于温度，并且确定该停留时间必需长于以下四个条件的时间：A (800℃、13 分钟)、B (900℃、6 分钟)、C (1,050℃、1.5 分钟)和 D (1,200℃、0.3 分钟)。

然而，较长的停留时间使得压制成型时的生产率受损。通过在 950℃下加热 5-8 分钟可以获得实际上足够的镀层附着性，这一条件是作为折衷点而确定的。硬化结构实际上大大受到冷却速率的影响，并且为了获得所述硬化结构，要求冷却速率不低于 10℃/秒。这取决于钢组份，并且在为具有良好可硬化性的钢板的情况下，即使在约 10℃/秒的冷却速率下也可以获得主要由马氏体组成的所需结构，或者在另一情况下，根据钢等级要求冷却速率为约 30℃/秒。

接下来，以实施例为基础详细解释本发明。

实施例 1

对作为物料的酸渍钢板(厚 1.8 mm)和冷轧钢板(厚 1.2 mm)(具有表 1 所示的钢组成并通过常规热轧和冷轧法制得)施加热浸镀铝。表 1 中的第 1、3、5、7 和 9 号是冷轧钢板，其它的是热轧钢板。在热浸镀铝时，使用非氧化炉还原炉型的管线，在浸镀之后采用气体擦去法(gas wiping method)将电镀的沉积量调整至每面 40 g/m^2，并且在此之后，将钢板冷却并经受零锌花(zero-spangle)处理。此时的镀浴组成是 Al-10%Si-2%Fe。镀浴中的 Fe 是电镀设备和镀浴中的钢板不可避免地提供的组份。镀层外观良好，没有未电镀缺陷等。评价由此制得的热浸镀铝钢板的可硬化性和耐热性。评价方法示于下。

作为实际的合金化的方法，将镀铝钢板在 950℃下加热 30 分钟，

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之后冷却，同时在氮气环境下将其插入由钢制成的模具之间。冷却速率是 100℃/秒。肉眼评价钢板镀层的剥落。另外，施加 100 g 载荷下测定钢板横截面的维氏硬度。之后，将钢板经受常用于镀铝的化学处理，并镀锌，涂布厚度为 20 μm 的阳离子电沉积漆(Nippon Paint Co., Ltd.; powernix 110)，烘焙，并在切出十字形状之后经受 20 天的喷盐试验(JIS-Z2371)，并测定十字形切割部分的腐蚀深度。这里，十字形切割的深度是约 50 μm。因此，由记录值减去 50 μm 得到的值是真正的腐蚀深度。而且，为了获得 Fe-Al 金属间化合物中的 Mn 和 Cr 的浓度，淬火之后，在从表面到 5 μm 深的区域的横截面的 5 个经抛光的部分，使用 EPMA 通过定量分析一样品来测定 Mn 和 Cr 的量。评价结果示于表 2。

耐热性的评价标准

O：没有剥落

Δ：从边缘部分剥落

X：产生剥落

喷漆后耐腐蚀性的评价标准

O：腐蚀深度不大于 80 μm

X：腐蚀深度大于 80 μm

(每一值包括十字形切割的深度。)

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表 1

编号	化学组成(质量%)											
	C	Si	Mn	P	S	Al	N	Ti	Cr	Mo	B	Ti*
1	0.23	0.12	1.21	0.02	0.009	0.03	0.004	0.02	0.13	-	0.002	0.76
2	0.21	0.20	0.81	0.02	0.007	0.05	0.004	0.22	0.20	-	-	0.83
3	0.17	0.15	1.24	0.01	0.008	0.03	0.003	0.01	1.10	-	0.0008	1.73
4	0.42	0.7	2.41	0.01	0.009	0.01	0.003	0.66	0.21	-	0.001	2.08
5	0.23	0.31	1.54	0.02	0.007	0.05	0.003	0.02	0.44	-	0.002	1.23
6	0.25	0.18	1.22	0.01	0.01	0.04	0.003	0.02	0.66	0.20	0.005	1.29
7	0.24	0.2	0.41	0.01	0.02	0.05	0.004	0.09	0.10	0.15	0.01	0.47
8	0.2	0.2	2.43	0.01	0.01	0.04	0.003	0.09	0.21	-	0.0008	1.52
9	0.03	0.1	1.4	0.02	0.01	0.03	0.004	0.25	0.15	-	0.0003	1.1
10	0.23	0.12	0.3	0.01	0.008	0.05	0.003	0.03	0.23	-	-	0.41
11	0.24	0.10	0.51	0.01	0.008	0.03	0.004	0.05	0.03	-	0.0022	0.34

注 1) Ti*：Ti + 0.5Mn + Cr + 0.5Mo

表 2

编号	Mn + Cr 量	耐热性	维氏硬度	喷漆后耐腐蚀性
1	0.4	O	515	O
2	0.22	O	480	O
3	0.96	O	405	O
4	0.85	O	766	O
5	0.30	O	511	O
6	0.30	O	548	O
7	0.15	O	539	O
8	0.78	O	466	O
9	0.44	O	200	O
10	0.19	O	311	O
11	0.21	Δ	522	O

当 C 量过低时，如第 9 个钢板，其强度降低。一般说来，通过将维氏硬度乘以 3 得到接近材料强度的值(MPa)，并且在这种情况下，获得最多仅仅 600 Mpa 级别的强度。当对淬火有效的元素（例如 Mn、B 等）的加入量小时，如第 10 号钢板，即使 C 量大也不能获得淬火效果，并且该强度在一定程度上趋于受损。而且，在 Ti*：Ti + 0.5×Mn

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+ Cr + 0.5×Mo 的值小的情况下，如第 11 号钢板，加热之后镀层剥离并且耐热性在一定程度上趋于受损。在第 1-8 号钢板中，其中这些元素在钢中的加入量得到适当控制，强度、耐热性和喷漆后耐腐蚀性都显示出良好的结果。

接下来，表 1 中本实施例的第 7 号钢板在主要含有 Al-10%Si-2%Fe 并且其中加入 Mn 和 Cr 的镀浴中电镀。电镀的沉积量是每一面 60 g/m^2，并且获得良好的电镀外观。在加热之后将钢板用模具在 900℃下淬火 2 分钟。冷却速率是约 100℃/秒。此时镀浴中的 Mn 和 Cr 的量和评价结果示于表 3。当金属间化合物中的 Mn 和 Cr 的量小时，如第 1 号钢板，喷漆后耐腐蚀性差，但是随着镀浴中 Mn 和 Cr 的加入量增加，其耐腐蚀性提高。此时金属间化合物内 Mn 和 Cr 的量与喷漆后耐腐蚀性的关系示于图 3。应理解的是喷漆后耐腐蚀性随 Mn 和 Cr 的量增加而提高。

表 3

编号	镀浴中元素的量(%)		金属间化合物内元素的量(%)		喷漆后耐腐蚀性
	Mn	Cr	Mn	Cr	
1	0	0	0.08	0	X
2	0.1	0	0.11	0	O
3	0.2	0	0.24	0	O
4	0.4	0.05	0.51	0.08	O
5	0.6	0	0.73	0	O
6	0.8	0.1	0.75	0.14	O

实施例 2

将表 4 中所示具有不同化学组成的钢铸造，再次加热至 1,050-1,250℃的温度，之后热轧、酸渍、冷轧、退火、经受电镀处理(镀铝或者镀铝-锌：镀"Galvalium ®")，之后以 0.8%的收缩率(reduction rate)经受回火轧。而且，作为整个合金化过程，将这些钢板加热至

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900-1,000℃的温度，在该温度下保持 5 分钟，之后用室温的模具进行压制成型，然后调查其性能。对物料性能的测定是通过从轧制时快速冷却的部分切取样品，并对其施加抗拉试验来进行的。该试验是按照 JIS-Z2201 将样品切割成 5 个试验片，并按照 JIS-Z2241 中所述的测定方法进行的。评价结果示于表 5。

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表4

钢号	C	Si	Mn	S	P	Al	Ti	N	Ni	Cu	B	Sn	Ti−3.42*N
1	0.22	0.20	1.05	0.020	0.020	0.025	0.020	0.0024	0.02	0.02	0.0030	—	0.012
2	0.21	0.15	0.94	0.018	0.023	0.024	0.022	0.0035	0.25	0.10	0.0027	—	0.010
3	0.22	0.15	0.94	0.018	0.023	0.024	0.022	0.0025	0.01	0.01	0.0027	0.01	0.013
4	0.16	0.48	1.70	0.009	0.015	0.021	0.017	0.0025	0.80	0.02	0.0002	—	0.008
5	0.35	0.05	1.00	0.015	0.012	0.030	0.020	0.0028	0.01	0.01	0.0020	—	0.010
6	0.53	0.10	1.10	0.010	0.020	0.026	0.200	0.0021	0.02	0.01	0.0010	0.05	0.193
7	0.53	0.10	0.30	0.010	0.020	0.030	0.020	0.0020	0.90	0.02	0.0047	—	0.013
8	0.22	0.20	1.00	0.002	0.015	0.035	0.005	0.0034	0.02	0.02	0.0005	—	-0.007
9	0.21	0.20	1.10	0.022	0.021	0.028	0.020	0.0026	0.00	0.02	0.0020	—	0.011
10	0.22	0.20	2.00	0.010	0.010	0.030	0.020	0.0033	0.01	0.01	—	—	0.009
11	0.35	0.15	2.10	0.012	0.013	0.023	0.018	0.0028	0.05	0.01	—	0.01	0.008
12	0.24	0.20	2.50	0.008	0.009	0.035	0.026	0.0035	0.02	0.01	—	—	0.014

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表 5

钢号	冷却温度(℃)	退火温度(℃)	电镀类型	成型之前的TS (Mpa)	成型之前的加热温度(℃)	YP (MPa)	TS (MPa)	裸露耐腐蚀性	喷漆后耐腐蚀性
1	630	780	镀铝	560	950	1250	1580	O	O
	610	775	镀Galvalium	550	950	1255	1600	O	O
2	680	760	镀铝	550	950	1220	1610	O	O
	650	780	镀Galvalium	558	950	1210	1590	O	O
3	620	730	镀铝	570	950	1280	1550	O	O
	630	730	镀Galvalium	564	950	1270	1540	O	O
4	650	830	镀铝	500	980	1110	1310	O	O
	660	840	镀Galvalium	508	980	1100	1320	O	O
5	630	770	镀铝	603	950	1480	1830	O	O
	640	770	镀Galvalium	605	950	1490	1820	O	O
6	650	775	镀铝	654	940	1610	1990	O	O
	660	780	镀Galvalium	660	940	1620	1980	O	O
7	650	760	镀铝	780	910	1850	2100	O	O
	650	760	镀Galvalium	774	910	1820	2120	O	O
8	650	790	镀铝	553	950	750	980	O	O
9	630	800	镀铝	558	950	1210	1540	X	O
10	640	780	镀铝	554	950	1240	1580	O	O
	630	775	镀Galvalium	550	950	1230	1575	O	O
11	650	760	镀铝	572	950	1200	1510	O	O
	650	760	镀Galvalium	563	950	1205	1520	O	O
12	620	730	镀铝	595	950	1270	1560	O	O
	630	730	镀Galvalium	598	950	1275	1570	O	O

从压制成型期间经过加工的部分切取样品，并评价作为高温成型之后的表面性能的裸露耐腐蚀性和喷漆后耐腐蚀性。通过使样品经受湿罐试验(相对湿度：95%，温度：40℃)持续 3 天来评价裸露耐腐蚀性；在样品上切出十字形切痕，然后通过使样品经受持续 30 天的喷盐试验(JIS-Z2134)来评价喷漆后耐腐蚀性。采用阳离子电沉积漆作为这种情况下的喷漆，并且喷漆厚度是 15 μm。从其外观判断其裸露耐

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腐蚀性，并使用标记 O 或 X 来标记，其评价标准是：X 代表发生红锈，O 代表没有红锈。同样，从其外观判断喷漆后耐腐蚀性，并使用标记 O、Δ或 X 来标记，其评价标准是：O 代表起凸不大于 2 mm，Δ代表起凸大于 2 mm 但不大于 4 mm，并且 X 代表起凸大于 4 mm。第 1-7 号钢是组份在本发明所述范围内的钢，并且在本发明所述范围内的条件下生产的所有钢板在高温成型之后可以保证高强度，而且，在裸露耐腐蚀性和喷漆后耐腐蚀性方面都没有问题。这里，在第 7 号钢的情况下，还显示了在这些条件(退火温度得自本发明所述的范围)下制得的钢板的结果，并且，在这种情况下，由于钢板强度太高，因此没有评价这些性能。在第 8 和 9 号钢的情况下，钢板组成偏离本发明所述的范围内。结果，在第 8 号钢的情况下，高温成型之后的强度(为本发明的一个目标)低，并且在为第 9 号钢的情况下，无法保证裸露耐腐蚀性和喷漆后耐腐蚀性。

实施例 3

将表 6 中所示具有不同化学组成的钢铸造，再次加热至 1,050-1,250℃的温度，之后热轧、酸渍、冷轧、退火、经受电镀处理(镀铝或者镀铝-锌)，之后以 0.8%的收缩率经受回火轧。而且，作为整个合金化过程，将这些钢板加热至 900-1,000℃的温度，在该温度下保持 5 分钟，之后用室温的模具进行压制成型，然后调查其性能。对物料性能的测定是通过从轧制时快速冷却的部分切取样品，并对其施加抗拉试验进行的。该试验是按照 JIS-Z2201 将样品切割成 5 个试验片并按照 JIS-Z2241 中所述的测定方法进行的。评价结果示于表 7。

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表6

钢号	C	Si	Mn	S	P	Al	N	Cr	Mo	Cr+7×Mo	注
1	0.16	0.20	0.72	0.006	0.020	0.035	0.0025	1.00	0.18	2.260	本发明实施例
2	0.21	0.21	0.68	0.008	0.018	0.032	0.0030	0.95	0.15	2.000	本发明实施例
3	0.50	0.25	0.75	0.006	0.020	0.026	0.0028	0.98	0.17	2.170	本发明实施例
4	0.23	0.20	1.50	0.010	0.015	0.030	0.0030	0.32	0.00	0.320	本发明实施例
5	0.22	0.45	2.20	0.009	0.010	0.038	0.0035	0.00	0.05	0.350	本发明实施例
6	0.23	0.15	0.30	0.008	0.012	0.032	0.0026	1.90	0.00	1.900	本发明实施例
7	0.21	0.20	0.50	0.008	0.010	0.033	0.0028	0.00	0.80	5.600	本发明实施例
8	0.22	0.21	0.65	0.006	0.015	0.032	0.0030	0.10	0.02	0.240	本发明实施例
9	0.22	0.20	0.70	0.008	0.014	0.025	0.0025	0.25	0.00	0.250	本发明实施例
10	0.21	0.18	0.45	0.010	0.012	0.028	0.0025	0.00	0.03	0.210	对比实施例

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表 7

钢编号	冷却温度(℃)	退火温度(℃)	电镀类型	成型之前的TS (MPa)	成型之前的加热温度(℃)	YP (MPa)	TS (Mpa)	裸露耐腐蚀性	喷漆后耐腐蚀性	注
1	630	780	镀铝	565	980	1080	1280	O	O	本发明实施例
	620	780	镀铝-锌	560	980	1090	1270	O	O	本发明实施例
2	650	770	镀铝	605	950	1290	1560	O	O	本发明实施例
	650	765	镀铝-锌	600	950	1285	1580	O	O	本发明实施例
3	635	740	镀铝	725	930	1705	1890	O	O	本发明实施例
	630	750	镀铝-锌	750	930	1700	1900	O	O	本发明实施例
4	645	775	镀铝	500	950	1390	1610	O	O	本发明实施例
	650	780	镀铝-锌	508	950	1400	1600	O	O	本发明实施例
5	630	770	镀铝	603	950	1300	1550	O	O	本发明实施例
	630	770	镀铝-锌	605	950	1320	1555	O	O	本发明实施例
6	650	770	镀铝	654	950	1390	1620	O	O	本发明实施例
	640	760	镀铝-锌	660	950	1380	1620	O	O	本发明实施例
7	640	770	镀铝	780	950	1320	1510	O	O	本发明实施例
	650	760	镀铝-锌	774	950	1325	1520	O	O	本发明实施例
8	630	765	镀铝	553	950	1320	1580	O	O	本发明实施例
	635	760	镀铝-锌	555	950	1310	1570	O	O	本发明实施例
9	640	770	镀铝	558	950	1340	1575	O	O	本发明实施例
	645	770	镀铝-锌	562	950	1350	1585	O	O	本发明实施例
10	630	765	镀铝	554	950	1350	1595	X	X	对比实施例
	640	760	镀铝-锌	550	950	1330	1530	X	X	对比实施例

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从压制成型期间经受加工的部分切取样品，并在高温成型之后评价作为表面性能的裸露耐腐蚀性和喷漆后耐腐蚀性。通过使样品经受持续 3 天的湿罐试验(相对湿度：95%，温度：40℃)来评价裸露耐腐蚀性；在样品上切出十字形切痕，然后通过使样品经受持续 30 天的喷盐试验(JIS-Z2134)来评价喷漆后耐腐蚀性。采用阳离子电沉积漆作为这种情况下的喷漆，并且喷漆厚度是 15 μm。从其外观判断其裸露耐腐蚀性，使用标记 O 或 X 标记，其评价标准是：X 代表发生红锈，O 代表没有红锈。同样，从其外观判断喷漆后耐腐蚀性，使用标记 O、Δ或 X 标记，其评价标准是：O 代表起凸不大于 2 mm，Δ代表起凸大于 2 mm 但不大于 4 mm，并且 X 代表起凸大于 4 mm。第 1-9 号钢是组份在本发明所述范围内的钢，并且在本发明所述范围内的条件下生产的所有钢板在高温成型之后可以保证高强度，而且，在裸露耐腐蚀性和喷漆后耐腐蚀性方面都没有问题。在第 10 号钢的情况下，钢板组成偏离本发明所述的范围，并因此无法保证裸露耐腐蚀性和喷漆后耐腐蚀性。

实施例 4

对作为物料的酸渍钢板(厚 1.8 mm)和冷轧钢板(厚 1.2 mm)(具有表 8 所示的钢组成并通过常规热轧和冷轧法制得)施加热浸镀铝。表 8 中的第 1、3、5 和 7 号是冷轧钢板，其它的是热轧钢板。在热浸镀铝时，使用非氧化炉还原炉型的管线，在电镀之后通过气体擦去法将电镀的沉积量调整至两个面都是 80 g/m^2，并且在此之后，将钢板冷却并经受零锌花处理。此时的镀浴组成是 Al-10%Si-2%Fe。镀浴中的 Fe 是电镀设备和镀浴中的钢板不可避免地提供的组份。电镀外观良好，没有未电镀缺陷等。性能示于表 9。

评价由此制得的热浸镀铝钢板的可硬化性和可加工性。可加工性是通过如下评价的：作为实际合金化的方法，将镀铝钢板在大气中

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950℃下加热 10 分钟，之后冷却，同时将其插入由钢制成的模具之间(冷却速率：约 30℃/秒)，将其冷却至室温，之后使其经受冲击试验。而且，施加 100 g 载荷下测定钢板横截面的维氏硬度。

可加工性的评价标准

O：没有剥落

Δ：产生裂缝

X：产生粉状剥落

表 8

编号	化学组成 (重量%)										
	C	Si	Mn	P	S	Al	N	Ti	Cr	Mo	B
1	0.23	0.12	1.21	0.02	0.009	0.03	0.004	0.02	0.13	-	0.002
2	0.21	0.20	0.81	0.02	0.007	0.05	0.004	0.22	0.20	-	-
3	0.17	0.15	1.24	0.01	0.008	0.03	0.003	0.01	1.10	-	0.0008
4	0.23	0.31	1.54	0.02	0.007	0.05	0.003	0.02	0.44	-	0.002
5	0.25	0.18	1.22	0.01	0.01	0.04	0.003	0.02	0.66	0.20	0.005
6	0.24	0.2	0.95	0.01	0.02	0.05	0.004	0.09	0.5	0.15	0.01
7	0.2	0.2	2.43	0.01	0.01	0.04	0.003	0.09	0.21	-	0.0008
8	0.04	0.1	1.4	0.02	0.01	0.03	0.004	0.25	0.15	-	0.0003

表 9

编号	可加工性	Fe-Al 镀层中的 Al 量(%)	维氏硬度
1	O	15	515
2	O	15	480
3	O	15	405
4	O	15	511
5	O	15	548
6	O	15	539
7	O	15	466
8	O	15	209

当 C 量相对低时，如第 8 号钢中的，其强度也相对低。一般说

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来，通过将维氏硬度乘以 3 得到接近材料拉伸强度的值(MPa)，并且在这种情况下，获得最多仅仅 600 Mpa 级别的强度。在为第 1-7 号钢的情况下，强度和可加工性都显示良好的结果。使用 EPMA 定量分析这种情况下 Fe-Al 镀层中 Al 的量，并且该值是约 15%。这里，该值是通过在从表面到 10 μm 深的范围内分析淬火后样品横截面的 5 个部分并将该分析数据平均获得的。

接下来，表 8 中本实施例的第 1 号钢板用主要由 Al-10%Si-2%Fe 组成的金属电镀，并且电镀的沉积量是每一面都在 60 g/m^2 到 200 g/m^2 之间。将由此获得的样品在大气中 950℃下加热，同时改变停留时间，用冲击试验评价其可加工性，并通过实施例 4 的第 1 项中所述的方法测定 Fe-Al 镀层中 Al 的量。如表 10 中所示，其可加工性取决于 Fe-Al 镀层中 Al 的量，并且当 Al 的量不大于 35%时，获得良好的可加工性。而且，Fe-Al 镀层中 Al 的量取决于沉积量和停留时间，并且可以理解为沉积量越小并且停留时间越长，扩散进行越充分，并且 Fe-Al 镀层中 Al 的量越少。

表 10

编号	沉积量(g/m^2)	停留时间	Fe-Al 镀层中 Al 的量(%)	可加工性
1	60	0	36	Δ
2	60	1	29	O
3	60	2	17	O
4	80	0	38	X
5	80	1	35	Δ
6	80	2	20	O
7	120	2	42	X
8	120	4	36	X
9	120	6	15	O
10	200	5	44	X
11	200	10	38	X
12	200	15	377	X

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实施例 5

对作为物料的酸渍钢板(厚 1.8 mm)和冷轧钢板(厚 1.2 mm)(具有表 11 所示的钢组成并通过常规热轧和冷轧法制得)施加热浸镀 Al-Si-Mg。表 11 中的 A、C、E 和 G 号是冷轧钢板，其它的是热轧钢板。在热浸镀铝时，使用非氧化炉还原炉型的管线，在电镀之后通过气体擦去法将电镀的沉积量调整至每面 40 g/m^2，并且在此之后，将钢板冷却并经受零锌花处理。此时的镀浴组成是 Al-8%Si-6%Mg-1%Fe-0.1%Ca。镀浴中的 Fe 是电镀设备和镀浴中的钢板不可避免地提供的组份。电镀外观显示闪烁图案并且良好，没有未电镀缺陷等。这种情况下的制备条件示于表 12。

评价由此制得的热浸镀钢板的可硬化性和耐腐蚀性。下面描述评价方法。作为实际合金化方法，将该热浸镀钢板经受 5%拉伸应力，然后在 950℃下加热 5 分钟，之后冷却，同时将其插入钢板之间。冷却速率是约 30℃/秒。肉眼观察冷却之后的样品以评价其耐热性。然后，通过使样品经受持续 3 天的湿罐试验(相对湿度：95%，温度：40℃)来评价裸露耐腐蚀性；在样品上切出十字形切痕，然后通过使样品经受持续 30 天的喷盐试验(JIS-Z2134)来评价喷漆后耐腐蚀性。采用阳离子电沉积漆作为这种情况下的喷漆并且喷漆厚度是 15 μm。而且，通过施加 100 g 载荷测定钢板的维氏硬度。

耐热性的评价标准

O：良好

Δ：在表面上产生裂缝状图案

X：产生红垢(red scales)

裸露耐腐蚀性的评价标准

O：良好

Δ：产生红锈

喷漆后耐腐蚀性的评价标准

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◎ ：油漆起凸不大于 1 mm

O：油漆起凸不大于 2 mm

Δ：油漆起凸 2-4 mm

X：油漆起凸大于 4 mm

表 11

钢号	C	Si	Mn	P	S	Al	N	Ti	Cr	Mo	Ni	B
A	0.21	0.20	0.81	0.02	0.007	0.05	0.004	0.05	0.20	-	-	0.0005
B	0.17	0.15	1.24	0.01	0.008	0.03	0.003	0.15	1.10	-	-	0.0008
C	0.42	0.7	2.41	0.01	0.009	0.01	0.003	0.46	0.21	-	-	0.001
D	0.23	0.31	1.54	0.02	0.007	0.4	0.003	0.24	0.44	-	-	0.002
E	0.25	0.18	1.22	0.01	0.01	0.04	0.003	0.003	0.66	0.20	-	0.005
F	0.24	0.2	0.95	0.01	0.02	0.05	0.004	0.001	-	0.15	0.33	0.01
G	0.08	0.1	1.4	0.02	0.01	0.03	0.004	0.25	0.15	-		0.0003
H	0.24	0.10	0.31	0.01	0.008	0.03	0.004	0.21	0.03	-		0.0001

表 12

编号	所用钢编号	裸露耐腐蚀性	喷漆后耐腐蚀性	维氏硬度
1	A	O	O	485 (O)
2	B	O	O	401 (O)
3	C	O	O	769 (O)
4	D	O	O	509 (O)
5	E	O	O	544 (O)
6	F	O	O	540 (O)
7	G	O	O	289 (X)
8	H	O	O	301 (X)

当 C 量太小时，如第 7 号钢板中的，不能获得足够的强度。一般说来，通过将维氏硬度乘以 3 得到接近材料强度的值(MPa)，并且在这种情况下，获得最多仅仅 800 Mpa 级别的强度。当对淬火有效的元素如 Mn、B 等的量小时，如第 8 号钢板，即使 C 量大也不能获得

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淬火效果。在为第 1-6 号钢板的情况下，其中这些钢中加入的元素量适当控制，在为 Mn-B-体系或 Mo-Cr-Ni-体系的情况下，强度和耐腐蚀性都显示良好的结果。

然后，使用表 11 中的钢 E，随着热浸镀管线的镀浴组成的变化来研究镀层组成与涂镀钢板性能之间的关系。镀层组成与镀后的性能之间的关系汇总于表 13。这里，每一种情况下的维氏硬度在 470-510 的范围内。

在为第 8 号钢板(属于 Mg-Zn-体系)的情况下，耐腐蚀性差。另一方面，第 4-7 号钢板(属于 Si-Mg-体系)显示优异的耐腐蚀性。同样，第 1-3 号钢板(属于 Si-Mg-Zn-体系)显示优异的耐腐蚀性。

表 13

编号	镀层的组成(质量%)				裸露耐腐蚀性	喷漆后耐腐蚀性
	Si	Mg	Zn	Ca		
1	2	3	40	0.1	O	◎
2	5	7	20	0.1	O	◎
3	8	6	10	-	O	◎
4	12	8	-	0.1	O	◎
5	8	6	-	0.1	O	◎
6	6	3	-	-	O	◎
7	9	0.5	-	-	O	◎
8	-	1	3	-	X	X

实施例 6

对作为物料的冷轧钢板(厚 1.2 mm)(具有表 14 所示的钢组成并通过常规热轧和冷轧法制得)施加热浸镀铝。在热浸镀铝时，使用非氧化炉还原炉型的管线，在电镀之后通过气体擦去法将电镀的沉积量调整至每一面都是 60 g/m^2，并且在此之后，将钢板冷却并经受零闪烁处理。此时的镀浴组成是 Al-10%Si-2%Fe。镀浴中的 Fe 是电镀设备和镀浴中的钢板不可避免地提供的组份。电镀外观良好，没有未电镀

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缺陷等。将由此制得的镀铝钢板加热至950℃，并以实际合金化方法评价空气冷却期间镀层的可加工性(剥落耐性)。

此时，通过改变加热时间和加热方式改变铁氧体层的厚度。通过冲击试验进行加工，随着冷却期间加工温度的变化肉眼判断剥落状态，并且在不发生镀层剥落的最低温度下评价镀层的可加工性。这里，在为该钢的情况下，即使在10℃/秒的冷却速率下可硬化性依然良好，并且即使在空气冷却的情况下仍获得主要由马氏体组成的结构。图8显示了中间铁氧体层的厚度与这种情况下可以获得良好加工的最低温度之间的关系。

如图8所示，应理解，当铁氧体层的厚度不小于2 μm，优选不小于4 μm时，镀层的剥落耐性提高。当铁氧体层的厚度是约0.5 μm时，即使在800℃下加工也观察到镀层的粉状剥落。而且，作为实际合金化方法，镀层的可加工性取决于电镀的沉积量。尽管铁氧体层的厚度是2 μm，当每一面的沉积量是30 g/m^{2}时，获得良好加工的最低温度是约500℃。而且，通过用光学显微镜观察和接下来的图象分析来分析此时基底钢的结构，并且在所有情况下不小于80%的结构由马氏体组成。

表14

C	Si	Mn	P	S	Al	N	Ti	Cr	Mo	B
0.36	0.21	0.65	0.02	0.006	0.027	0.003	0.002	1.01	0.16	0.0001

实施例7

对作为物料的酸渍钢板(厚1.8 mm)和冷轧钢板(厚1.2 mm)(具有表15所示的钢组成并通过常规热轧和冷轧法制得)施加热浸镀铝。表15中的第1、3和5号是冷轧钢板，其它的是热轧钢板。在热浸镀铝时，使用非氧化炉还原炉型的管线，在电镀之后通过气体擦去法将电

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镀的沉积量调整至每个面都是 60 g/m^2，并且在此之后，将钢板冷却并经受零闪烁处理。此时的镀浴组成是 Al-10%Si-2%Fe。电镀外观良好，没有未电镀缺陷等。作为实际合金化方法，将由此制得的热浸镀铝钢板加热至 950℃，通过水冷模具冷却，在温度达到约 600℃时经受压制成型。肉眼判断在经过弯曲加工的部分的电镀层的剥落状态，所有钢板都没有观察到电镀层剥落。此时，铁氧体层的厚度是 10-20 μm，并且在所有基底钢中的马氏体百分比不小于 80%。这里，冷却速率是约 150℃/秒。

表 15

编号	C	Si	Mn	P	S	Al	N	Ti	Cr	Mo	B
1	0.22	0.20	0.94	0.02	0.007	0.025	0.003	0.22	0.05	0.002	0.0017
2	0.16	0.17	0.69	0.02	0.007	0.037	0.004	0.002	0.98	0.17	0.0001
3	0.20	0.20	0.67	0.02	0.006	0.033	0.003	0.002	0.96	0.17	0.0002
4	0.22	0.15	0.88	0.03	0.007	0.022	0.004	0.55	0.12	0.01	0.0005
5	0.25	0.55	0.72	0.02	0.009	0.025	0.003	0.31	0.58	0.12	0.0020

实施例 8

对作为物料的冷轧钢板(厚 1.2 mm)(具有表 16 所示的钢组成并通过常规热轧和冷轧法制得)施加热浸镀铝。在热浸镀铝时，使用非氧化炉还原炉型的管线，在电镀之后通过气体擦去法将电镀的沉积量调整至每一面都是 30-80 g/m^2，并且在此之后，将钢板冷却并经受零闪烁处理。此时的镀浴组成是 Al-10%Si-2%Fe。镀浴中的 Fe 是电镀设备和镀浴中的钢板不可避免地提供的组份。电镀外观良好，没有未电镀缺陷等。评价由此制得的镀铝钢板的淬火之后的硬度、金属间化合物的厚度、可焊性、耐热性和喷漆后耐腐蚀性。作为实际合金化方法，通过将钢板在大气中 950℃下加热 0.5-20 分钟进行淬火，之后在平板状态下用模具将该钢板压制并将其冷却。此时，冷却速度是约 300℃/

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US006296805B1

(12) **United States Patent**
Laurent et al.

(10) **Patent No.: US 6,296,805 B1**
(45) **Date of Patent: Oct. 2, 2001**

021

(54) **COATED HOT- AND COLD-ROLLED STEEL SHEET COMPRISING A VERY HIGH RESISTANCE AFTER THERMAL TREATMENT**

(75) Inventors: **Jean-Pierre Laurent**, Istres; **Jean-Paul Hennechart**, Floing; **Dominique Spehner**, Sedan; **Jacques Devroc**, Salon de Provence, all of (FR)

(73) Assignee: **Sollac**, Puteaux (FR)

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(58) **Field of Search** 428/653, 939; 420/104; 148/537, 531

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Primary Examiner—Deborah Jones
Assistant Examiner—Jason Savage
(74) *Attorney, Agent, or Firm*—Oblon, Spivak, McClelland, Maier & Neustadt, P.C.

(57) **ABSTRACT**

Hot-rolled steel sheet which then can be cold-rolled, coated, the steel in the sheet having the following composition by weight:

0.15%<carbon<0.5%
0.5%<manganese<3%
0.1%<silicon<0.5%
0.01%<chromium<1%
titanium<0.2%
aluminum<0.1%
phosphorus<0.1%
sulfur<0.05%
0.0005%<boron<0.08%, the remainder being iron and impurities inherent in processing, the sheet ensuring a very high mechanical resistance after thermal treatment and the aluminum-based coating ensuring a high resistance to corrosion.

16 Claims, No Drawings

FW000001076261

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COATED HOT- AND COLD-ROLLED STEEL SHEET COMPRISING A VERY HIGH RESISTANCE AFTER THERMAL TREATMENT

The invention relates to a coated, hot- and cold-rolled steel sheet comprising a very high resistance after thermal treatment.

In this technical area, the proposed solutions involving an increase in the mechanical characteristics are accomplished to the detriment of shaping properties. There is a solution consisting in separating the shaping properties and those required for use. The characteristics required for use are obtained through a thermal treatment subsequent to or concomitant with shaping. In this case, the proposed sheets are not delivered coated because of problems of holding power of the coating at the time of thermal treatment. Coating therefore is performed on finished castings, which requires a careful cleaning of the surfaces and the hollowed portions. In addition, the thermal treatment must be performed under a controlled atmosphere in order to prevent any decarbonization and oxidation of the metal in the sheet. Steel sheets for thermal treatment do not have any precoating which requires post-treatments of scouring, pickling and coating.

At the time of continuous coating of flat hot- and cold-rolled products, preliminary annealing and cooling preceding or following the zinc- or aluminum-based coating operation, are used only to bring the sheet to a temperature close to that of the bath or to restore the mechanical properties of the sheet degraded at the time of cold-rolling. These thermal cycles are chosen in terms of the composition of the steel so that no allotropic transformation takes place at the time of the thermal cycle, the objective being to obtain mechanical characteristics similar to those measured on the steel sheet delivered uncoated.

The purpose of the invention is to produce a hot- or cold-rolled steel sheet of a desired thickness, coated, and affording extensive shaping possibilities and which, after thermal treatment performed on the finished casting, makes it possible to obtain a mechanical resistance in excess of 1000 MPa, a substantial resistance to shocks, fatigue, abrasion and wear, while retaining a good resistance to corrosion as well as a good capacity for painting and gluing. It also is possible to carry out hot-shaping with hardening in the tool making it possible to obtain the same properties.

The subject of the invention is a hot-rolled steel sheet, which then can be cold-rolled, coated, the steel in the sheet having the following composition by weight:

0.15%<carbon<0.5%

0.5%<manganese<3%

0.1% silicon<0.5%

0.01%<chromium<1%

titanium<0.2%

aluminum<0.1%

phosphorus<0.01%

sulfur<0.05%

0.0005%<boron<0.08%, the remainder being iron and impurities inherent in processing, the sheet ensuring a very high mechanical resistance after thermal treatment and the aluminum-based coating ensuring a high resistance to corrosion.

The other characteristics of the invention are:

the composition by weight of the sheet preferably is the following:

0.20%<carbon<0.5%

0.8%<manganese<1.5%

0.1% silicon<0.35%

0.01%<chromium<1%

titanium<0.1%

aluminum<0.1%

phosphorus<0.05%

sulfur<0.03%

0.0005%<boron<0.01%, the remainder being iron and impurities inherent in processing.

in the composition by weight of the sheet, the titanium content with respect to the nitrogen content is in excess of 3.42, the boron no longer being able to be combined with the nitrogen.

the metal bath for the coating contains in its basic composition by weight, from 9% to 10% silicon, from 2% to 3.5% iron, the remainder being aluminum.

the metal bath for the coating contains in its basic composition by weight, from 2% to 4% iron, the remainder being aluminum.

The invention also concerns a process for producing a casting starting from the coated sheet in which, after shaping, the coating of the casting is subjected to an increase in temperature at a speed in excess of 5° C./second, which may exceed 600° C./second.

A further characteristic of the process is:

the coating and the casting are heated to a temperature in excess of 750° C.

The invention also concerns the use of the hot-rolled steel sheet which then can be cold-rolled and coated, for structural and/or anti-intrusion or substructure castings for a land motor vehicle, such as, for example, a bumper bar, a door reinforcement, a wheel spoke.

The description which follows will make the invention clearly understood.

The sheet according to the invention which derives, by reason of its processing, from a hot-rolling mill, possibly may be cold-rerolled again depending on the final thickness desired. It then is coated with an aluminum-based coating, for example by dipping in a bath containing, in addition, from 8% to 11% silicon, from 2% to 4% iron, the sheet having a high mechanical resistance after thermal treatment and a high resistance to corrosion, as well as a good capacity for painting and gluing.

The coating has in particular the function of protecting the basic sheet against hot as well as cold corrosion. The mechanical characteristics in the delivery state of the sheet according to the invention allow a great variety of shaping, in particular a deep stamping. The thermal treatment applied at the time of a hot-shaping process or after shaping makes it possible to obtain high mechanical characteristics which may exceed 1500 MPa for mechanical resistance and 1200 MPa for the limit of elasticity. The final mechanical characteristics are adjustable and depend on the carbon content of the steel and on the thermal treatment.

At the time of thermal treatment performed on a finished casting or at the time of a hot-shaping process, the coating forms a layer having a substantial resistance to abrasion, wear, fatigue, shock, as well as a good resistance to corrosion and a good capacity for painting and gluing.

According to the invention, the steel the weight composition of which is the following:

0.15%<carbon<0.5%

0.5%<manganese<3%

0.1%<silicon<0.5%

0.01%<chromium<1%

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titanium<0.2%

aluminum<0.1%

phosphorus<0.1%

sulfur<0.05%

0.0005%<boron<0.08%, the remainder being iron and impurities inherent in processing, is processed in the form of a hot-rolled and possibly cold-rolled sheet to obtain the desired thickness. The steel sheet then is coated by dipping, after pickling, in an aluminum bath containing either from 8% to 11% silicon and 2% to 4% iron, or from 2% to 4% iron, or even in an aluminum bath preferably containing from 9% to 10% silicon and 2% to 3.5% iron.

In an example of implementation of a coating of the sheet by dipping in a metal bath containing an aluminum alloy comprising a proportion of approximately 90% aluminum, the coating layer comprises a first alloy layer in contact with the surface of the steel. This layer, directly in contact with the surface of the sheet, is highly alloyed with iron.

A second coating layer, on top of the first, contains approximately 90% aluminum and may contain silicon and a small amount of iron, depending on the composition of the bath.

The first alloy layer may crack when the sheet is shaped for the manufacture of castings.

According to the invention, after the shaping of the casting, the coating is subjected to an increase in temperature at a speed in excess of 5° C./second, which may exceed 600° C./second. This rise in temperature makes possible a rapid remelting of the aluminum which fills in the cracks generated by the operation of shaping of the casting.

Another advantage of the invention lies in the fact that the diffusion of the iron in the coating will be initiated at high temperature. One thus will have a better cohesion between coating and steel in the sheet. In another form of the invention, the thermal treatment may be performed locally, in heavily deformed zones.

In an example of implementation, the steel sheet according to the invention containing 0.21% carbon, 1.14% manganese, 0.020% phosphorus, 0.0038% sulfur, 0.25% silicon, 0.040% aluminum, 0.009% copper, 0.020% nickel, 0.18% chromium, 0.0040% nitrogen, 0.032% titanium, 0.003% boron, 0.0050% calcium is coated with an aluminum-based layer about 20 μm in thickness.

According to the invention the sheet, in the delivery state in a coil or in sheeting, the thickness of which may range between 0.25 mm and 15 mm, has good shaping properties and a good resistance to corrosion as well as a good capacity for painting or gluing.

The sheet, a coated siderurgic product, has a substantial resistance to corrosion in the delivery state, during shaping and thermal treatments as well as during usage of the finished casting. After thermal treatment, a substantial mechanical resistance, which may exceed 1500 MPa, is obtained. The presence of the coating at the time of thermal treatment of the castings makes it possible to prevent any decarbonization of the base metal as well as any oxidation. That is an undeniable advantage, in particular in the case of hot-shaping. Furthermore, heating of the treated casting does not require a furnace having a controlled atmosphere to prevent a decarbonization.

Thermal treatment of the metal in the sheet consists in a heating at a temperature ranging between Ac1, starting temperature of austenitic transformation, for example 750° C. and 1200° C., in a furnace, for a period which depends on the temperature to be reached and the thickness of the casting sheet. The composition is optimized so as to limit the enlargement of the grains at the time of thermal treatment. If the structure sought is completely martensitic, the holding temperature should be in excess of Ac3, for example 840° C., ending temperature of austenitic formation. The temperature holding should be followed by a cooling adjusted to the final structure sought. For a completely martensitic structure and for a steel having the composition of the example, the speed of cooling should be in excess of the critical speed of hardening which is 27° C./s for an austenitizing at 900° C. for 5 min., the sheet having a thickness of approximately 1 mm.

It also is possible to obtain in particular ferrito-bainitic or ferrito-martensitic structures, by a heating at a temperature ranging between Ac1, for example 750° C. and Ac3, for example 840° C., followed by an appropriate cooling. According to the level of resistance to be achieved and the thermal treatment applied, one or several of these phases is/are present in variable proportions. For the highest resistance levels, the structure is composed predominantly of martensite.

Chromium, manganese, boron and carbon are added, in the composition of the steel according to the invention, for their effect on hardenability. In addition, carbon makes it possible to achieve high mechanical characteristics thanks to its effect on the hardness of the martensite.

Aluminum is introduced into the composition in order to trap oxygen and to protect the effectiveness of the boron.

Titanium, the ratio of the content of which with respect to the nitrogen content should be in excess of 3.42, is introduced in order to prevent combining of the boron with the nitrogen, the nitrogen being combined with titanium.

The alloying elements, Mn, Cr, B, make possible a hardenability allowing hardening in the stampers or the use of mild hardening fluids limiting deformation of the castings at the time of thermal treatment. In addition, the composition according to the invention is optimized from the point of view of weldability.

The steel in the sheet may undergo a treatment for globularization of sulfides performed with calcium, which has the effect of improving the fatigue resistance of the sheet.

The steel is particularly suited to the production of structural and anti-intrusion castings.

The proposed coating makes it possible to avoid different surface-preparation operations such as for steel sheets for thermal treatment not having any coating.

The modulation of thermal treatment parameters makes it possible to achieve, with a given composition, different levels of hot and cold sheet resistance according to the thickness sought.

At the time of thermal treatment, the base coating, of aluminum for example, is transformed into a layer alloyed with iron and comprising different phases depending on the thermal treatment and having a considerable hardness which may exceed 600 HV100 g.

Table 2 presents an example of maximal resistance of the steel sheet according to the invention after thermal treatment.

Thermal treatment	Rm (MPa)
850° C./5 min.	1695
900° C./5 min.	1675
950° C./5 min.	1665

What is claimed is:

1. A hot-rolled coated steel sheet comprising a hot-rolled steel sheet coated with an aluminum or aluminum alloy coating, wherein the steel in the sheet comprises the following composition by weight:

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0.15%<carbon<0.5%

0.5%<manganese<3%

0.1%<silicon<0.5%

0.01%<chromium<1%

titanium<0.2%

aluminum<0.1%

phosphorus<0.1%

sulfur<0.05%

0.0005%<boron<0.08%, the remainder being iron and impurities inherent in processing, and the steel sheet has a very high mechanical resistance after thermal treatment and the aluminum or aluminum alloy coating provides a high resistance to corrosion of the steel sheet.

2. The coated steel sheet according to claim 1, wherein the composition by weight of the sheet further comprises the following:

0.20%<carbon<0.5%

0.8%<manganese<1.5%

0.1%<silicon<0.35%

0.01%<chromium<1%

titanium<0.1%

aluminum<0.1%

phosphorus<0.05%

sulfur<0.03%

0.0005%<boron<0.01%, the remainder being iron and impurities inherent in processing.

3. A heat treated coated steel sheet prepared by subjecting the coated steel sheet according to claim 2, to an increase in temperature at a speed in excess of 600° C./second.

4. A process for producing a casting comprising

shaping the coated steel sheet of claim 2,

subjecting the shaped coated steel sheet to an increase in temperature at a speed in excess of 5° C./sec.

5. The coated steel sheet according to claim 1, wherein the ratio of titanium to nitrogen in the steel sheet in weight % is in excess of 3.42.

6. A process for producing a casting comprising

shaping the coated steel sheet of claim 5,

subjecting the shaped coated steel sheet to an increase in temperature at a speed in excess of 5° C./sec.

7. The coated steel sheet according to claim 1, wherein the aluminum or aluminum alloy coating comprises from 9% to 10% silicon by weight, from 2% to 3.5% iron by weight, the remainder being aluminum.

8. A process for producing a casting comprising

shaping the coated steel sheet of claim 7,

subjecting the shaped coated steel sheet to an increase in temperature at a speed in excess of 5° C./sec.

9. The coated steel sheet according to claim 1, wherein the coating comprises from 2% to 4% iron by weight, the remainder being aluminum.

10. A process for producing a casting comprising

shaping the coated steel sheet of claim 9,

subjecting the shaped coated steel sheet to an increase in temperature at a speed in excess of 5° C./sec.

11. A process for producing a casting comprising

shaping the coated steel sheet of claim 1,

subjecting the shaped coated steel sheet to an increase in temperature at a speed in excess of 5° C./second.

12. The process according to claim 11, wherein the casting is heated to a temperature in excess of 750° C.

13. A heat treated coated steel sheet prepared by subjecting the coated steel sheet according to claim 1 to an increase in temperature at a speed in excess of 600° C./second.

14. A land motor vehicle comprising the heat treated coated steel of claim 13.

15. A land motor vehicle comprising the coated steel sheet of claim 1.

16. A heat treated coated steel sheet prepared by subjecting the coated steel sheet according to claim 1 to a temperature in excess of 750° C.

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附件 5

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[71] 申请人 日产自动车株式会社
地址 日本神奈川县
[72] 发明人 高木洁 中西荣三郎 吉田智行
[74] 专利代理机构 中国国际贸易促进委员会专利商标事务所
代理人 蔡胜有

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[54] 发明名称 镀铝结构件和生产方法

[57] 摘要

一种镀铝结构件，包含一个形成于钢基体层上的 Al－Si－Fe 合金层。该合金层包括一个硬度小于或等于钢基体层硬度的软质区域，该软质区域从钢基体层表面向合金层表面延伸大于或等于合金层厚度的50%的深度范围。该 Al－Si－Fe 合金层具有小于或等于 500mg/dm² 的氧化物重量。



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1、一种镀铝结构件，包括：

一个钢基体层；和

一个形成于钢基体层表面上的Al-Si-Fe合金层，该合金层包含一个从钢基体层表面向合金层表面延伸的，硬度小于或等于钢基体层的硬度、且厚度大于或等于合金层厚度的50％的软质区域，该Al-Si-Fe合金层具有小于或等于500mg/dm^{2}的氧化物重量。

2、如权利要求1所述的镀铝结构件，其中，Al-Si-Fe合金层具有包含一个与钢基体层相邻的内层、和一个形成合金层表面的外层的多层结构。

3、如权利要求2所述的镀铝结构件，其中，该内层为多层结构中最软的层。

4、如权利要求2所述的镀铝结构件，其中，该内层包含85－95％的Fe，并且内层的Hv硬度比合金层的平均硬度软20％或更多。

5、如权利要求2所述的镀铝结构件，其中，Al-Si-Fe合金层的多层结构进一步包括一个包含25－40％Al的中间层，且该中间层的硬度比钢基体层低。

6、如权利要求2所述的镀铝结构件，其中，Al-Si-Fe合金层的多层结构进一步包括多个中间层，至少一个中间层包含25－40％Al，并且硬度低于钢基体层。

7、如权利要求2所述的镀铝结构件，其中，Al-Si-Fe合金层的外层比钢基体层硬。

8、如权利要求2所述的镀铝结构件，其中，外层包含35－50％的Fe。

9、一种镀铝结构件，包括：

一个钢基体层；和

一个形成于钢基体层表面上的Al-Si-Fe合金层，该Al-Si-Fe合金层具有多层结构，所述多层结构包括一个与钢基体相邻的内层，一个形

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成合金层表面的外层，以及一个形成于内层和外层之间的中间层，所述内层包含85－95％的Fe，所述中间层包含25－40％的Al，且所述的外层的硬度比钢基体层大。

10、一种镀铝结构件的生产方法，包括：

以1～10℃/sec范围内的加热速率加热热浸镀铝钢板；

将该热浸镀铝钢板在900～950℃的温度范围内升高的温度下保持2～8分钟；

以5～15℃/sec范围内的冷却速率将该热浸镀铝钢板冷却至700～800℃的温度范围内的温度；

在700～800℃的温度范围内将该热浸镀铝钢板成型成预定形状；和

以20－100℃/sec范围内的冷却速率将形成预定形状的热浸镀铝钢板从700－800℃的温度范围内迅速冷却至低于或等于300℃的较低温度。

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镀铝结构件和生产方法

发明背景

本发明涉及一种镀铝结构件及其生产方法。更具体地说，本发明涉及一种通过对镀铝钢板进行热处理和成型加工、并且用Al-Si-Fe合金的合金层进行镀覆以提高成型性、可焊接性和抗腐蚀性的镀铝结构件、例如用于汽车的结构件。

日本专利申请公开No.2000-204463公开了一种热浸镀铝钢板，这种钢板由于其氧化膜而具有优异的抗腐蚀性，并且由于不含有例如铅等重金属而对于环境的影响较小，从这一角度看，这种钢板可以用于汽车的油箱、消音器、隔热板等。

发明概述

包含在热浸镀铝钢板中的在与钢基体交界处的硬质Al-Fe合金层在成型性方面或多或少都存在一些问题。进而，该合金层在成型加工中易于开裂，并且因此有时需要进行其它的处理以便确保足够的抗腐蚀性。由于镀铝层的熔点低并且单一的铝表面层的热传导性不充分，所以焊接性能是另一个问题。因此，热浸镀铝钢板在应用上受到限制。

本发明的一个目的是提供一种在抗腐蚀性、成型性能和焊接性能上具有优点、并且在汽车领域具有更广泛应用的镀铝结构件和生产方法。

根据本发明的一个方案，一种镀铝结构件包括：一个钢基体层；和一个形成于钢基体层的表面上的Al-Si-Fe合金层，该合金层包含一个从钢基体层的表面向合金层表面延伸的，硬度小于或等于钢基体层的硬度、且厚度大于或等于合金层厚度的50％的软质区域，该Al-Si-Fe合金层具有小于或等于500mg/dm^{2}的氧化物重量。

根据本发明的另一个方案，一种镀铝结构件的生产方法包括：以在1～10℃/sec的范围内的加热速率加热热浸镀铝钢板的第一方法要

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素；和使热浸镀铝钢板在900～950℃的温度范围内的升高的温度下保持2～8分钟的第二方法要素；以在5－15℃/sec范围内的冷却速率将热浸镀铝钢板冷却至700～800℃的温度范围内的温度的第三方法要素；在700～800℃的温度范围内将该热浸镀铝钢板成型成预定形状的第四方法要素；以及以20～100℃/sec范围内的冷却速率将形成预定形状的热浸镀铝钢板从700～800℃的温度范围内迅速冷却至低于或等于300℃的较低温度的第五方法要素。

附图简要说明

图1是表示在根据本发明实施方案的测试1中使用的试样的形状和尺寸的透视图，用以对成型性能进行评价。

图2A是表示测试1的实例No.1中的一个结构件中的镀层的微观结构的照片。

图2B是表示测试1中的实例No.2中的一个结构件中的镀层的微观结构的照片。

图3是表示本发明实施方案中的结构件点焊中的连续焊点性能与普通的热浸镀铝钢板相比较的图解。

图4是表示实施方案中的测试1的结果的表1。

图5是表示实施方案中的测试3的结果的表2。

发明的详细说明

通常，热浸镀铝钢板是通过将带材连续浸入熔融铝的槽中。根据镀覆金属的成分，热浸镀铝钢板被大致分成两类。其中一种采用纯铝作为镀覆金属（用于抗大气腐蚀性能），另一种采用除了Al之外还包含Si的Al-Si合金作为镀覆金属（用于耐热性能）。根据本发明的一个实施例，采用包含Si添加剂（大约3～11％的Si）的耐热镀覆钢板。

向镀层中添加Si，用以抑制镀铝工艺过程中在钢和镀层之间界面的硬质Al-Fe合金层的生长，并且因此用于提高Al镀层的附着力和抗腐蚀性。在这种热浸镀铝钢板中，在Al镀层和钢基体层之间的交界中形成Al-Si-Fe合金层。

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当在特定条件下，对这种类型的热浸镀铝钢板进行热处理时，Al-Si-Fe层会生长并全面扩展直到到达表面为止．图2A表示在镀铝钢板的一个例子中的剖面结构，该镀铝钢板包含由于热处理而生长至表面的这种Al-Si-Fe层．

在由于热处理而使Al-Si-Fe生长的过程中，Al镀层的钢基体层之间的相互扩散产生各种Al-Si-Fe三元金属间化合物、例如αFeAlSi相（alpha FeAlSi）、βFeAlSi相（beta FeAlSi）和γFeAlSi相（gamma FeAlSi）．通过热处理形成的Al-Si-Fe合金层具有由这些金属间化合物构成的层状结构，并且在可成型性能、抗腐蚀性和焊接性能方面具有优点．

当Al-Si-Fe合金层的硬度超过钢基体的硬度时，由于削弱了涂层的可塑性，并且增加了镀层中开裂的可能性，Al-Si-Fe合金层对钢板在成型工艺中的成型性能和抗腐蚀性产生不利影响．因此，在本实施例中，在钢和镀层之间的交界处或附近，形成具有比钢基体的硬度低的不太硬的或软质层．该软质层可以防止在任何情况下产生的裂纹从表面向钢基板更深地延伸．在本实施例中，该软质层的厚度等于或大于合金镀层总厚度的50％．从位于或接近与钢基体的交界的位置处延伸至或超过镀层深度的中间处的厚的软质层，有效地用于防止裂纹的发展并保证足够的抗腐蚀性．

以氧化物形式包含在镀覆合金层中的氧，在电解沉积过程中导致产生气孔，因此如果氧的量增加，则使镀层和沉积薄膜之间的附着力削弱．因此，使氧化物的质量或氧化物的重量等于或小于500mg/dm^2．在本说明书中，如后面所述，"氧化物重量"被定义为，在950℃下进行热处理之后的试样质量和在热处理之前的试样质量之间的质量差．

层状结构的形成机理并不完全清楚．目前，本发明的发明人等假设：（1）将试样保持在升高的温度下将导致Fe的扩散，并且在镀层中产生Fe和Si的浓度梯度．（2）在这种情况下，促使镀层合金相转变成由各个深度处的成分确定的稳定化合物相，从而在不同的深度区域中形成不同的化合物层．（3）因此，通过控制加热升高的温度和在该升

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高的温度下的保持时间，改变了Fe的扩散量并且改变了转变成稳定化合物的程度.

由于Fe从钢基体层的扩散，与钢基体层相邻的该Al-Si-Fe合金层被软化，并且与钢的附着更为紧密，并因此更容易成型．具体地，Fe含量的优选范围是85～95%．当Fe含量在这一范围内时，与钢基体接触的软质层的硬度等于或小于镀层平均硬度的80%（300～400Hv）．当Fe的含量小于85%时，由Fe的扩散产生的上述良好效果不够充分．当Fe的含量大于95%时，Fe的扩散过度，并且使Al的含量太低，无法获得在多层结构中的最外层中的抗腐蚀性．在本说明书中，除非另有说明，否则百分比%用于表示"质量%"（质量百分比）.

通过热处理和Fe从钢基体的扩散，使Al-Si-Fe合金层软化．然而，Fe的过度扩散将使Al的含量降低到抗腐蚀性所需的水平以下．从抗腐蚀性的角度考虑，为了保持最低限度的Al含量，并且为了形成比钢基体材料更软的层，至少在三层或更多层的多层结构中的一层中，优选将Al的含量设定在25～40%的范围内．当Al含量小于25%时，抗腐蚀性不足．当Al含量为40%或更大时，软质层的成型变得困难，并且与钢基体的附着力变差.

在包含三层或更多组成或成分不同的次级层的多层结构的情况下，在与钢基体层相邻的最内层和形成镀层表面的最外层之间存在一个或多个中间层．优选地，该中间层或至少一个中间层含有25～40% Al.

通过从钢基体材料扩散而来的Fe与铝镀层的合金化，提高了焊接性能．合金化的Al-Si-Fe镀层的熔点高于通过热浸镀形成的Al镀层，从而可以在低电流条件下进行焊接．进而，在点焊时防止镀覆金属与焊接电极的附着，有利地改善了连续点焊的状况.

通过将Al-Si-Fe镀层全部合金化成多层结构、例如具有含有不同合金组成的五个层的五层结构，改善了热稳定性．包含硬质最外层的多层结构的优点是，即使在用于高张力材料的很大的压力下，仍可以在点焊中保持与焊枪的良好接触.

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当Fe的含量随着铝镀层和从金属基体扩散而来的Fe之间的合金化过程而增加时，镀层的热传导率减小，并且可以以低电流进行焊接。通过使镀层表面或最外层中的Fe的浓度在35－50％的范围内，可以将可焊接性能和抗腐蚀性结合起来。通过形成具有多层结构的Al-Si-Fe层，或者通过形成具有Fe含量的浓度梯度的Al-Si-Fe层，可以形成具有在这一范围内的表面Fe浓度的镀层。当最外层的Fe的浓度小于35％时，焊接性能的改善不充分。当最外层中的Fe浓度大于50％时，Al含量相对减小并且抗腐蚀性下降。

通过下述工艺，可以获得如上面所述、在表面上具有Al-Si-Fe合金层的镀铝结构件。首先，将镀层中含有Si的耐热热浸镀铝钢板以1－10℃/sec的速率加热至900－950℃的温度范围内的一个温度下，并且在该升高的温度下保持2－8分钟的保持时间(或持续时间)。在这种情况下，当热浸镀铝钢板被以比10℃/sec快的加热速率加热至高于900℃的温度时，铝镀层会产生局部熔融。当加热速率低于1℃/sec时，该镀层会被氧化。当试样保持的升高温度低于900℃时，钢基体材料中的奥氏体化过程太慢，无法获得作为结构件的足够强度。当升高的温度大于950℃时，镀层产生不希望出现的氧化作用，并且Fe的扩散过度以至到达镀层的表面。当在升高的温度下保持的时间短于2分钟时，Al-Si-Fe合金层的形成变得不充分。当在升高的温度下保持的时间比8分钟长时，镀层产生氧化，并且对电解沉积镀膜的粘附产生不利影响。

在保持在上述温度范围内的热处理之后，将钢板从加热炉送至成型压力机。在输送过程中，开始冷却。在这种情况下，热处理之后的冷却速率需要在5－15℃/sec的范围内，以便在预定的温度下进行成型加工并从预定的温度快速冷却。当冷却速率低于5℃/sec时，镀层的氧化变得显著。对于比15℃/sec更高的速率冷却，需要进行强制冷却。

制成所需形状的成型操作是在700－800℃的温度范围下开始的。在成型操作之后，将成型的板材从700－800℃以20－100℃/sec的速率，迅速冷却到低于或等于300℃的温度。通过这种迅速冷却，使钢基体材料冷却，同时保持通过热处理形成的Al-Si-Fe合金层，并且获得所需形

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状的镀铝结构件．热处理的上述条件对于钢基体材料的淬火硬化也是足够的，所以对于增强材料强度是有效的．由于需要再加热并且加速了镀层的氧化，所以不需要在高于800℃下开始成型操作．当在低于700℃的温度下开始成型操作时，对于马氏体转变而言的淬火温度太低．当成型操作之后的冷却速率低于20℃/sec时，向马氏体的转变不充分，并且Fe的扩散过度．当成型操作之后的冷却速率比100℃/sec块时，由于需要改善生产设备中的冷却系统所以成本易于显著增加．快速冷却至小于或等于300℃的温度有效的防止留下铁素体相、并且促进马氏体转变的充分进行．

下面对实施方案的实际例子进行说明．

（测试1）在下述条件下生产镀铝或铝化结构件，并且对成型性能、抗腐蚀性和焊接性能进行研究．

［待测试的热浸镀铝钢板］

用于镀覆的原料板材成分：0.22%C、0.22%Si、1.0%Mn、0.015%P、0.007%S．

板材厚度：1.4mm．

铝镀层中的Si浓度：5%．

铝镀层的厚度：10～20μm．

［测试过程］从上述热浸镀铝钢板上切下一个宽度160mm、长度160mm的平板，在下述条件下进行热处理，并且成图1中所示的形状．然后，对合金镀层的成分、硬度、成型性能、抗腐蚀性和焊接性能进行研究．

<热处理条件>

加热速率：	8℃/sec
加热温度：	900～950℃
保持时间：	2～10min
首次冷却速率：	7℃/sec
成型开始温度：	720℃
快速冷却开始温度：	720℃

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二次冷却速率: 30℃/sec

冷却结束的温度: 100℃

[测试结果]表1表示出了测试的结果。在表1中的所有情况下，镀层中最软的层是与钢基体材料的钢基体层相邻的层。表1包括：一个生产条件列，该列被分为升高的温度列和保持时间列；一个镀层结构和成分（%）列，该列被分为组分和硬度列、内层（INNER）列、第一中间层（INTER1）列、第二中间层（INTER2）列、第三中间层（INTER3）列和外层（OUTER）列；一个钢基体材料的硬度（Hv）列；一个镀层的硬度（Hv）列，该列被分为最软层列、平均列、和较基体材料软化的范围（%）的列；一个氧化物重量（mg/dm^2）列；一个成型性能列；一个抗腐蚀性列；和一个焊接性能列。

<成型性能>成型操作之后，在Al-Si-Fe合金层中检查裂纹。没有到达钢基体层裂纹的测试试样被评价为合适，并且标为圆圈。具有一条或多条到达钢基体层裂纹的试样被评价为不合适，并且标为叉。除了No.2结构件之外，试样均表现出良好成型性能，No.2结构件镀覆过硬的镀层，该镀层的平均硬度比钢基体材料的硬度大，并且该镀层在延伸至大于合金层厚度的50%的整个深度范围的区域中的硬度都更大。作为一个典型的例子，图2A表示没有裂纹的No.1结构件中的镀层的微观结构，并且图2B表示产生开裂的No.2结构件中的镀层微观结构。

<抗腐蚀性>对所生产的结构件进行由JIS Z2371确定的盐雾腐蚀试验（SST），以评价每个结构件的抗腐蚀性。结果，No.3结构件表现出较差的抗腐蚀性，在No.3结构件中，由于在升高的温度下保持的时间过长所以Fe的扩散过度，并且因此在最外层中的铝含量太低。

<焊接性能>在下述条件下对所生产的结构件进行连续的点焊。当连续焊点的数目增加时，通常熔核直径会减小并且焊接强度倾向于降低。因而，在下述焊接条件下进行点焊，直到焊点数目达到比JIS Z3140中的A级判断标准小的数目为止。根据连续焊点的数目确定焊接性能。由于NO.3结构件的连续焊点的数目为大约500。在判断标准的水平之下，所以No.3结构件被判断为不合适并且用X标出。对于除了No.3结构

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件之外的结构件，焊点数目最高达到3000，达到满足判断标准的水平，并且在该点结束点焊。因此，除No.3试样之外结构件用圆圈标为合适。因此，测试的结果表示当热处理的保持时间太长并且Fe的扩散使镀层软化时，如No.3试样那样，焊接能力下降。该No.3试样的抗腐蚀性和焊接性能均较差。然而，No.3试样的成型性能良好。因此，No.3试样仍适合于一些应用。

[焊接条件]

基体材料: 镀铝钢板(厚1.2mm)和具有440MPa抗拉强度的类型的GA材料(厚2.0mm)

压力:	5.98kN
预压:	50Hz
上升:	3Hz
通电:	9kA ×18Hz
保持:	21Hz

(测试2)通过采用以与测试1的试样No.1相同的方式进行热处理的热浸镀铝钢板，和作为比较例的不进行热处理的热浸镀铝钢板对在下述条件下进行连续点焊的特征进行比较。图3表示对于实施例,试样和比较试样的测试2的结果。不进行热处理的热浸镀铝钢板的试样表现出大约500点，而根据本发明的例子的试样表现出3000点或更多。

(测试条件)

基体材料: 镀铝钢板(1.2t)和具有440MPa的抗拉强度的GA材料(2.0t)

压力:	610kgf
预压:	50cyc
上升:	3cyc
通电:	9kA ×18cyc
保持:	21cyc

(测试3)将热浸镀铝钢板在950℃下保持不同长度的时间，以形成Al-Si-Fe合金层，并且在合金层上进行电解沉积镀覆。然后，对试样

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进行检测，以考察合金层中的氧化物重量和涂覆性能(paintability)之间的关系。结果表示在表2中。在此，氧化物重量被定义为在加热之前通过化学平衡进行质量测量的结果和加热之后质量测量的结果之间的质量差。

从表2可知，当氧化物重量大于500mg/dm^{2}时，在沉积镀膜中产生的气孔变得明显。在受到气孔损害的试样中，镀膜的粘附力不充分，并且通过电解沉积涂覆不能充分提高抗腐蚀性。

在根据本发明实施方案的镀铝结构件中，钢基体或基体层上的Al-Si-Fe合金层防止在钢基体和镀层之间形成硬质层，并且取而代之地在深度方向上形成范围很宽的较软区域。而且，该合金层的氧化物重量低。因此，本实施方案可以提高成型性能和涂覆性能，并且通过平衡Al含量和Fe含量，同时获得抗腐蚀性和焊接性能。

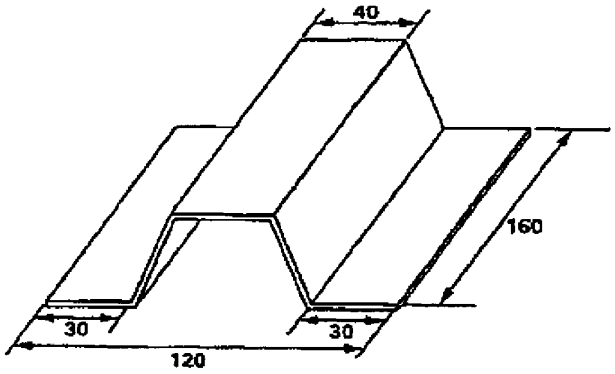
在根据本发明实施方案的生产方法中，对镀覆有包含Si的热浸铝镀层的钢板进行热处理，形成所需形状，并且迅速冷却。因此，该生产方法可以提高抗腐蚀性、涂覆性能、焊接性能和成型性能。

本申请以2002年7月11日申请的日本专利申请No.2002－202770为基础。该日本专利申请No.2002-202770的全部内容在此被引入作为参考。

尽管上面通过参考本发明的特定实施方案已经对本发明进行了说明，但是本发明不限于上述实施方案。根据上述技术，本领域技术人员可以对上述实施方案作出各种改进和改变。本发明的范围参照下面的权利要求进行限定。

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图1



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图2A

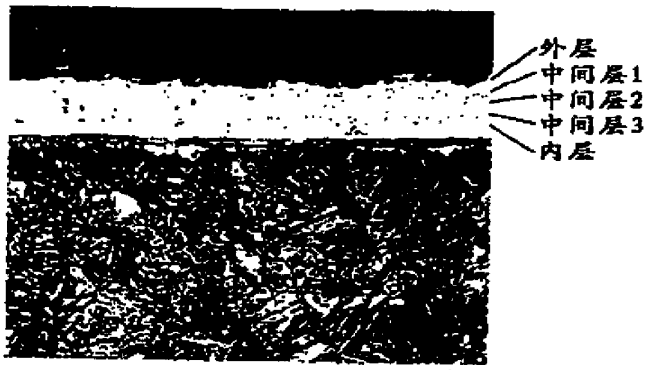
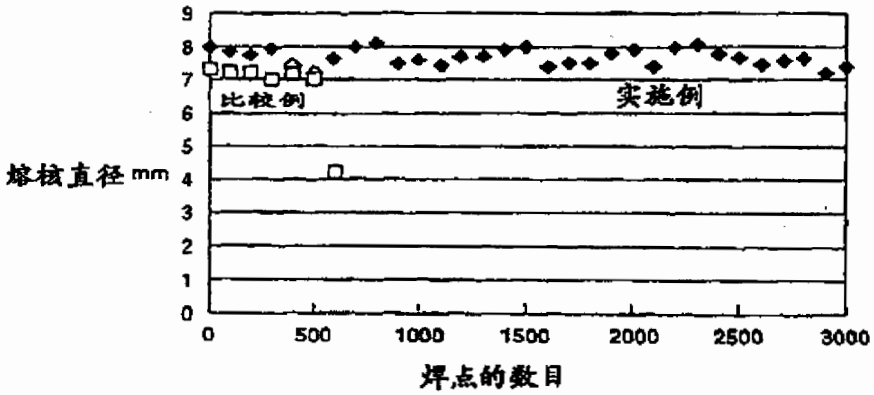


图2B



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图3



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图4

表1

No.	生产		镀层结构和成份（%）						钢基体硬度	镀层硬度（Hv）			氧化物重量	成形性能	抗腐蚀性	焊接性能
	升高的温度 (°C)	保持时间 (min.)	组份和硬度	INNER	INTER 1	INTER 2	INTER 3	OUTER	(Hv)	最软	平均	软化范围 (%)	(mg/dm²)			
1	920	3	Al	7.7	31.0	48.4	31.6	54.8	450	310	415	51	300	○	○	○
			Si	2.0	3.9	1.2	5.7	0.8								
			Fe	89.6	65.9	50.1	62.0	44.5								
			Hv	310	360	750	700	800								
2	900	2	Al	27.2	40.4	31.6	—	54.9	415	380	455	22	275	×	○	○
			Si	4.1	1.2	5.7		0.8								
			Fe	67.2	50.1	61.9		44.1								
			Hv	380	760	720	—	810								
3	930	10	Al	9.4	—	—	—	11.6	400	305	385	78	550	○	×	×
			Si	1.3				1.8								
			Fe	88.4				85.7								
			Hv	305	—	—	—	410								
4	950	5	Al	6.0	27.8	51.9	30.4	47.4	440	280	400	59	385	○	○	○
			Si	1.5	4.3	0.6	5.3	2.2								
			Fe	90.7	66.7	46.8	63.1	49.8								
			Hv	280	340	720	690	800								
5	900	4	Al	3.2	54.5	33.4	—	54.5	440	300	410	56	335	○	○	○
			Si	0.4	2.5	15.3		6.8								
			Fe	94.3	42.7	51.4		38.4								
			Hv	300	740	700	—	810								

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图5

表2

加热温度 (℃)	保持时间 (min.)	氧化物重量 (mg/dm²)	附着力	
			气孔	横切测试
950	3	290	无	○
	5	385	无	○
	10	540	有	×
	15	690	有	×
	20	760	有	×
	25	790	有	×
	30	805	有	×

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[71] 申请人 住友金属工业株式会社
地址 日本大阪府
共同申请人 丰田自动车株式会社
丰田铁工株式会社
[72] 发明人 西畑敏伸 中田匡浩 须藤俊太郎
尾林彰 市川正信
[74] 专利代理机构 中科专利商标代理有限责任公司
代理人 李香兰

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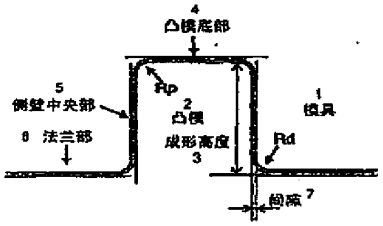
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[54] 发明名称

热成形法与热成形构件

[57] 摘要

从高强度钢板，通过热冲压而制作兼具稳定的强度和韧性的热冲压构件。在热冲压时的冷却过程中，以临界冷却速度以上冷却至 Ms 点，从 Ms 点至 200℃的温度范围的冷却速度为 25～150℃/s。热冲压构件的维氏硬度为，低于(最高淬火硬度－10)，且在(最高淬火硬度－100)以上。



1－模具　5－侧壁中央部
2－凸模　6－法兰
3－成形高度　7－间隙
4－凸模底部

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1、一种热成形法，其特征在于，是对本质上具有如下钢组成的钢板，加热至 Ac_3 点以上并保持后，进行对最终制品形状的成形的方法，所述钢板，以质量%计，含有 C：0.15～0.45%、Mn：0.5～3.0%、Cr：0.1～0.5%、Ti：0.01～0.1%、B：0.0002～0.004%、Si：0.5%以下、P：0.05%以下、S：0.05%以下、Al：1%以下、N：0.01%以下；并且还含有 Ni：2%以下、Cu：1%以下、Mo：1%以下、V：1%以下、以及 Nb：1%以下的 1 种或 2 种以上；剩余部为 Fe 和不可避免的杂质，在成形中或者从成形后的成形温度的冷却之时，到达成形构件的 Ms 点的冷却速度在临界冷却速度以上，并且，以从 Ms 点到 200℃的平均冷却速度为 25～150℃/s 冷却而进行淬火处理。

2、根据权利要求 1 记载的热成形方法，其特征在于，所述成形采用冲压成形用金属模具而进行。

3、根据权利要求 1 或 2 记载的热成形法，其特征在于，所述成形在采用冲压成形用金属模具成形后，在金属模具间注入水而进行冷却。

4、一种热成形构件，其特征在于，由本质上具有如下的钢组成的钢板而构成，所述钢板，以质量%计，含有 C：0.15～0.45%、Mn：0.5～3.0%、Cr：0.1～0.5%、Ti：0.01～0.1%、B：0.0002～0.004%、Si:0.5%以下、P：0.05%以下、S：0.05%以下、Al:1%以下、N：0.01%以下；还含有 Ni：2%以下、Cu：1%以下、Mo：1%以下、V：1%以下、以及 Nb：1%以下的 1 种或 2 种以上；剩余部为 Fe 和不可避免的杂质，其热成形后的硬度，以维氏硬度计，低于最高淬火硬度-10，并且在最高淬火硬度-100 以上。

5、根据权利要求 4 记载的热成形构件，其特征在于，所述热成形为热冲压成形。

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热成形法与热成形构件

技术领域

本发明涉及以汽车的车身结构部件、行走部分部件等为首要的机械结构部件等的热成形构件，及其制造所使用的热成形方法。若进一步详述，则本发明涉及热冲压构件与为此的热冲压方法。

以下，以热冲压成形为例对本发明进行说明，但是本发明也可以适用于辊轧成形、锻造等的压力成形以外的热成形。

背景技术

近年来，为了汽车的轻量化，而寻求例如拉伸强度在 590MPa 以上的钢材的高强度化，以削减使用重量的努力在进行着。在汽车广泛使用的薄钢板中，在如此的倾向之下，随着钢板强度的增加，冲压成形性降低，制造复杂的形状变得困难。具体地说，即随着强度增加而延展性降低，会发生在加工度高的部位产生破断，回弹和壁翘曲变大，尺寸精度劣化这样的问题。

因此，高强度、特别是拉伸强度在 780MPa 级以上钢板的情况，不容易作为利用冷加工方法的冲压成形而制造部件。如果不是冲压成形而利用辊轧成形，虽然可以进行上述的高强度钢板的加工，但是辊轧成形只能适用于在纵长方向具有同样的剖面的部件，限定了能够适用的制品的形状。

另一方面，如英国专利第 1490535 号所公开，在冲压成形加热的钢板的热冲压法中，因为在高温加热钢板，钢板的材质软化而变为高延展性，所以在加热状态下可以尺寸精度良好地成形复杂的形状。此外，将钢板加热至奥氏体区域温度，通过在金属模具内急冷的金属模具冷却，能够同时完成马氏体相变的钢板的高强度化，即淬火。

不过，在热冲压法的金属模具冷却中，构件的淬火硬度，在 2%C 材的情况下 Hv400～490 很不充分，而且存在构件中的硬度偏差非常大这样的

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问题。

在 Advanced Materials & Processes、Vol.146、No.6、12/94、p.16 中，介绍了由瑞典的 plunger 公司开发的热压机技术，记载了从 980℃进行模具淬火(die quench)（金属模具内急冷）。金属模具温度，因为没有与加热相关的记载，所以推定为常温～数十℃。

在特開平 8-269615 号中，所公示的急速淬火用热轧钢板由以下成分构成：含有 C：0.18～0.30%、Si：0.01～1.0%、Mn：0.2～1.5%、P：0.03%以下、S：0.02%以下、sol.Al:0.08%以下、Cr：0.1～0.5%、B：0.0006～0.0040%、N：0.01%以下；在此情况下，还含有 Cu：0.5%以下、Ni：0.3%以下、Ti：0.01～0.05%中的至少一种；剩余部为铁。此钢板，在冷加工之后，由高频淬火而使之高强度化。

发明内容

本发明提供一种，通过热成形法能够从高强度钢板制造出兼具稳定的强度与韧性的热成形构件，及制作其的热成形法。

更具体地说，本发明提供以汽车的车身结构部件、行走部分部件等为首要的机械结构部件等的热成形构件，和其制造所使用的热冲压方法。

根据本发明，成形后的冷却时，例如在金属模具冷却时，通过将 Ms 点（从奥氏体到马氏体开始生成的温度）以下的温度区域的平均冷却速度控制在一定范围内，而能够通过热成形制造兼具稳定的强度和韧性的热成形构件。

在 1 形态中，本发明涉及一种热成形方法，将本质上具有如下钢组成的钢板，加热至 Ac_3 点以上并保持后，进行对最终制品形状的成形，所述钢板，以质量%计，含有 C：0.15～0.45%、Mn：0.5～3.0%、Cr：0.1～0.5%、Ti：0.01～0.1%、B：0.0002～0.004%、Si：0.5%以下、P：0.05%以下、S：0.05%以下、Al：1%以下、N：0.01%以下；并且还含有 Ni：2%以下、Cu：1%以下、Mo：1%以下、V：1%以下、以及 Nb：1%以下的 1 种或 2 种以上；剩余部为 Fe 和不可避免的杂质。根据本发明，在成形中或者从成形后的成形温度的冷却之时，到达成形构件的 Ms 点的冷却速度在临界冷却速度以上，并且，以从 Ms 点到 200℃的平均冷却速度为 25～150℃/s，进行冷

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却，淬火处理。并且，在本发明中，临界冷却速度为上部临界冷却速度的意思。

在其他的形态中，本发明涉及由具有上述钢组成的钢板而构成的热成形构件。此热成形构件，热成形后的硬度，以维氏硬度低于（最高淬火硬度-10），并且在（最高淬火硬度-100 以上）。

在本发明的最佳形态中，热成形是采用冲压成形用金属模具而进行的热冲压成形。

根据本发明能够制作兼具稳定的强度与韧性的热冲压构件。因此，本发明大大地有助于作为高强度钢板的冲压成形构件的用途的扩大。

附图说明

图 1 是帽成形法的模式的说明图。

图 2 是表示临界冷却速度的测定用试验片的形状的模式图。

具体实施方式

在本发明中采用所述的钢组成和成形条件的理由如下。在本发明中，表示钢组成，即钢的化学组成的“%”是表示“质量%”。

1. 基材钢板的组成

C：0.15～0.45%

碳（C），是提高钢板的淬火性，且在淬火后，主要决定强度的非常重要的元素。此外，是降低 Ac_3 点，促进淬火处理温度的低温化的元素。不过，C 含量低于 0.15%此效果不充分，另一方面，若 C 含量超过 0.45%，则淬火部的韧性劣化显著。优选 C 含量的下限为 0.16%，上限为 0.35%。

Mn：0.5～3.0%

锰（Mn），是提高钢板的淬火性，且在淬火后对用于稳定确保强度非常有效果的元素。此外，是降低 Ac_3 点，促进淬火处理温度的低温化的元素。不过，Mn 含量低于 0.5%此效果不充分，另一方面，若 Mn 含量超过 3.0%则此效果饱和，此外会导致淬火部的韧性劣化。优选 Mn 含量为 0.8～2.0%。

Cr：0.1～0.5%

铬（Cr），是提高钢板的淬火性，且在淬火后，对用于稳定确保强度

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有效果的元素。不过，Cr 含量低于 0.1%此效果不充分，另一方面，若 Cr 含量超过 0.5%则此效果饱和，只会导致成本增长。优选 Cr 含量为 0.15～0.30%。

Ti：0.01～0.1%

钛（Ti），是提高钢板的淬火性，且在淬火后，对用于稳定确保强度有效果的元素。此外，还具有使淬火部的韧性提高的效果。不过，Ti 含量低于 0.01%此效果不充分，另一方面，若 Ti 含量超过 0.1%则此效果饱和，只会导致成本增长。优选 Ti 含量为 0.015～0.03%。

B：0.0002～0.004%

硼（B），是提高钢板的淬火性，且在淬火后，进一步提高强度的稳定确保效果的重要的元素。不过，B 含量低于 0.0002%此效果不充分，另一方面，若 B 含量超过 0.004%则此效果饱和，且导致成本增加。优选 B 含量为 0.0005～0.0025%。

Si：0.5%以下；P：0.05%以下；S：0.05%以下；Al：1%以下；N：0.01%以下

这些元素，任一个均能提高钢板的淬火性，且具有提高淬火后的强度的稳定化的效果。不过，若其含量超过上述的各自的上限，则此效果饱和，反而导致成本增加。

Ni：2%以下；Cu：1%以下；Mo：1%以下；V：1%以下；Nb：1%以下的 1 种或 2 种以上

这些元素，因为也是提高钢板的淬火性，且在淬火后，对强度的稳定确保有效果的元素，所以使之含有 1 种或 2 种以上。不过，超过各自的上限值而使之含有其效果也很小，且因为徒然导致成本增加，所以各合金元素的含量设在上述的范围。

在本发明使用的钢板中，在成形之前的加热之时，加热至奥氏体温度区域，因为使奥氏体相变发生，在加热前的室温的机械的性质不重要，所以对加热前的金属组织没有特别的限制。因此，作为基材钢板，使用热轧钢板、冷轧钢板、镀层钢板的任意一种都可以，对其制造方法没有特别限定。作为镀层钢板，以镀铝系钢板（即镀铝和镀铝合金钢板）与镀锌系钢板（即镀锌和镀锌合金钢板）为例示。镀层钢板，可以用电镀钢板，也可

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以用熔融镀钢板。并且，也可以使用合金化熔融镀锌钢板。

2. 加热条件和保持时间

在热冲压时的金属模具冷却中，为了对成形构件、即热冲压构件进行成形后的淬火处理，所以首先将基材钢板加热到奥氏体温度区域，需要使基材钢板形成一次奥氏体相。为此，加热至 Ac_3 点以上，并在此温度在通常的条件下保持 1 分钟以上。保持时间的上限没有特别地设定，但考虑到实际的生产上的效率，优选保持时间的上限为 10 分钟左右。

3. 热冲压时的冷却速度

热冲压中（金属模具内）或热冲压后（脱模后）的冷却速度，在热冲压构件中是用于得到稳定的强度和韧性，具有非常重要作用的参数。

为了赋予热冲压构件稳定的强度和韧性，将热冲压后的组织不完全形成马氏体组织，而形成自动回火马氏体组织十分重要。为了成为此自动回火马氏体组织，在热冲压或热冲压后的冷却阶段，以临界冷却速度以上而冷却至 Ms 点，使扩散相变不会发生，且从 Ms 点到 200℃的温度范围，以平均冷却速度 25～150℃/s 这样缓慢的冷却速度进行冷却。通过如此的冷却，由于马氏体相变在发生的同时被回火，所以得到强度的偏差很少，且能够得到韧性优异的马氏体组织。从 Ms 点到 200℃的优选平均冷却速度为 30～120℃/s。

4. 在热冲压法中的成形方法

作为在热冲压法中的成形的形态，有弯曲加工、拉深成形、张出成形、扩孔成形、法兰成形等。并且，如果具有在与成形同时或紧接其后冷却钢板的机构，则本发明也适用于冲压成形以外的成形法，例如辊轧成形。

5. 热冲压构件

通过所述的热冲压法所制作的构件，形成强度的偏差很少，且具有韧性优异的回火马氏体组织的构件。并且，所得到的强度，由于作为回火马氏体组织的强度，若换言之以硬度（Hv），则比（最高淬火硬度-10）更低，但是，因为没有过度回火，所以具有（最高淬火硬度-100）以上的硬度。Hv 的值若比（最高淬火硬度-10）高则韧性降低，若比（最高淬火硬度-100）低则强度降低。优选 Hv 的值为（最高淬火硬度-20）以下，（最高淬火硬度-80）以上。

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在此，所谓的“最高淬火硬度”，是在加热到 900℃的盐浴中将此材料保持 10 分钟之后，实施水冷处理时所能得到的硬度。

6. 热冲压成形时的冷却方法

通常，因为钢制金属模具被保持在常温或数十℃左右的温度，所以在热冲压成形之时，由此钢金属模具完成冲压成形构件的冷却。因此可知，为了使冷却速度变化，可以改变金属模具的尺寸而使热容量变化。

并且，改变金属模具的材质为不同种类的金属（例如铜等）也能够使冷却速度变化。在金属模具尺寸、材质都没有改变时，采用水冷型的金属模具而改变其时的冷却水量，由此也能够改变冷却速度。在此情况下，例如，采用切割了数处预制槽的金属模具，通过在冲压中让水流经于槽而改变冷却速度，或在冲压成形中途抬起冲压机，在其间让水流动也能够改变冲压成形构件的冷却速度。

因此，在 Ms 点的前后使冷却速度变化的方法被认为是如下方法。

（1）在紧接 Ms 点到达之后，移动热容量的不同的金属模具或室温状态的金属模具，而改变冷却速度。

（2）水冷金属模具的情况，在紧接 Ms 点到达之后，使在金属模具中流动的水量变化，而改变冷却速度。

（3）在紧接 Ms 点到达之后，让水在金属模具与构件之间流动，以使此水量变化，而改变冷却速度。

实施例

以下的实施例虽然用以例示本发明，但是本发明并不受到由此的任何限制。

在本例中，以具有表 1 所示的组成的钢板（板厚：1.0mm）作为基材钢板。此钢板，是在实验室熔炼的钢胚通过热轧、冷轧而制造的钢板。此外在钢号 No.2 中，采用镀覆模拟装置如同实施熔融镀锌（每一面的 Zn 附着量为 60g/m^2），此后，进行合金化处理（镀膜中的 Fe 含量为 15 质量%）。

将此钢板切割为 40W×60L（mm）的尺寸，在大气气氛的加热炉内，进行 900℃×5 分钟的加热之后，从加热炉取出，紧接其后，用平板的钢制金属模具，进行热冲压成形。在钢种 No.2 中，进行使冷却条件变化的热冲压成形（试验 No.2、5、6）。

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对所得到的热冲压构件，进行维氏硬度测定（荷重 9.8N，测定次数：5）。并且在钢板贴装热电偶，也进行冲压成形后的冷却速度的测定。在冷却速度中，主要是改变金属模具尺寸而使冷却速度变化。

并且，在试验 No. 2 中，钢板温度到达 Ms 点，紧接其后在金属模具间注入水以调节冷却速度。

在最高淬火硬度中，将在加热到 900℃的盐浴中将此材料保持 10 分钟之后，实施水冷处理时所能得到的硬度作为最高淬火硬度。

将所得到的结果，与以下面的方法而测定的各钢号的 Ac_3 点、Ms 点、和临界冷却速度一起，由表 2 集中表示。

从热轧钢板切割直径 3.0mm、长 10mm 的圆柱试验片（图 2），在大气中以 10℃/s 的升温速度加热至 950℃，在此温度保持 2 分钟之后，以各种的冷却速度冷却到室温。此时的加热，通过测定冷却中的试验片的热膨胀变化，而测定 Ac_3 点、Ms 点。并且，对所得到的试验片进行了维氏硬度测定（荷重 49N，测定次数：5）和组织观察，由其结果估算临界冷却速度。

表 1

钢号 No.	化学组成（质量%，剩余部：实质上为 Fe）														
	C	Si	Mn	P	S	Cu	Ni	Cr	Mo	V	Ti	Nb	Al	B	N
1	0.16	0.02	1.36	0.019	0.004	0.01	0.01	0.19	—	0.01	0.03	—	0.06	0.0013	0.008
2	0.21	0.25	1.20	0.008	0.002	0.01	0.02	0.20	—	0.01	0.02	0.01	0.05	0.0007	0.005
3	0.33	0.11	1.53	0.001	0.001	—	—	0.20	—	—	0.02	—	0.04	0.0015	0.001
4	0.42	0.11	1.51	0.001	0.001	—	—	0.20	0.01	—	0.02	—	0.04	0.0014	0.001

表 2

试验 No.	钢号 No.	Ac3 点 (℃)	Ms 点 (℃)	临界冷却速度 (℃/s)	至 Ms 点的实测冷却速度 (℃/s)	M 点～200℃的平均冷却速度 (℃/s)	热冲压后的硬度 (HV)	最高淬火硬度 (HV)	金属模具尺寸 (t×W×Lmm)	备考
1	1	860	450	25	60	40	418	461	50×400×400	发明例
2	2	823	410	17	60	100	451	501	50×400×400*1	
3	3	823	390	10	60	40	560	652	50×400×400	
4	1	785	370	10	60	30	683	750	50×400×400	
5	2	823	410	17	60	22*2	390	501	50×50×400	比较例
6	2	823	410	17	60	200*2	500	501	50×50×400*2	

*1 紧接 Ms 点之后向金属模具间注入水

*2 紧接 Ms 点之后上升冲压机，立即将试验片投入水槽

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*3 本发明的范围外的条件

在作为本发明例的试验 No. 1～4 中，因为从 Ms 点至 200℃的平均冷却速度适当，所以得到的硬度比（最高淬火硬度-10）更低，并且比（最高淬火硬度-100）更高。

作为比较例的试验 No. 5，以临界冷却速度以上进行冷却，但因为从 Ms 点至 200℃的平均冷却速度缓慢，所以无法得到充分的硬度。并且，还有作为比较例的试验 No. 6，因为从 Ms 点至 200℃的平均冷却速度过快，所以变得过硬。在此，“过硬”意味着，不是硬度的绝对值高，而是接近最高淬火硬度。

在作为本发明例的试验 No. 2 的钢板中，在大气气氛的加热炉内进行 900℃×5 分钟的加热，从加热炉取出，进行帽型的热冲压成形（坯料尺寸：1.0t×80W×320L（mm））。

由图 1 表示此时的帽成形法的模式图。采用的热冲压条件为成形高度 70mm；Rd（锻模肩部 R）8mm；Rp（凸模肩部 R）8mm；间隙 1.0mm；折皱压力 12.7kN。

并且，在热冲压成形品的凸模底部、侧壁中央部、法兰部中，进行维氏硬度测定（荷重 9.8N，测定次数：5）。此外，在各部位贴装热电偶，测定其各部位的冷却速度。结果由表 3 集中表示。

表 3

	Ms 点～200℃的平均冷却速度（℃/s）	热冲压后的硬度（HV）
凸模底部	55	460
侧壁中央部	100	471
法兰部	120	480

因为在各部位，从 Ms 点至 200℃的平均冷却速度适当，所以能够得到良好的硬度。并且可知在相同的构件中的硬度的偏差也小。

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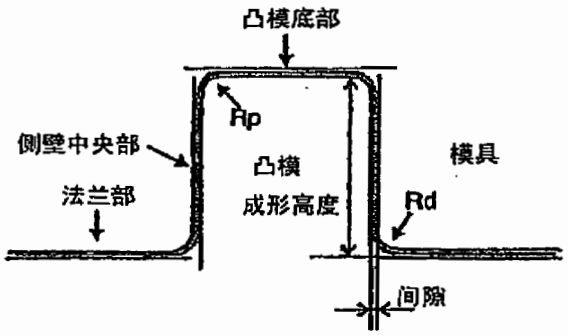


图 1

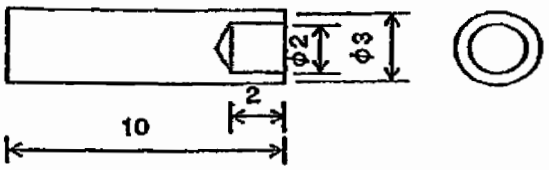


图 2

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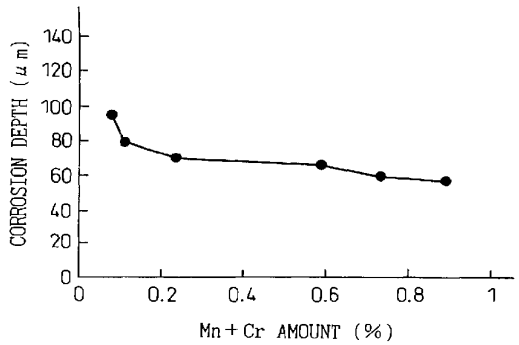
(71) Applicant *(for all designated States except US)*: **NIPPON STEEL CORPORATION** [JP/JP]; 6-3, Otemachi 2-chome, Chiyoda-ku, Tokyo 100-8071 (JP).

(72) Inventors; and

(75) Inventors/Applicants *(for US only)*: **SUEHIRO, Masayoshi** [JP/JP]; C/O NIPPON STEEL CORPORATION, YAWATA WORKS, 1-1, Tobihata-cho, Tobata-ku, Kitakyushu-shi, Fukuoka 804-8501 (JP). **MAKI, Jun** [JP/JP]; C/O NIPPON STEEL CORPORATION, YAWATA WORKS, 1-1, Tobihata-cho, Tobata-ku, Kitakyushu-shi, Fukuoka 804-8501 (JP). **FUDA, Masahiro** [JP/JP]; C/O NIPPON STEEL CORPORATION, Technical Development Bureau, 20-1, Shintomi, Futtsu-shi, Chiba 293-8511 (JP). **MIYAKOSHI, Toshihiro** [JP/JP]; C/O NIPPON STEEL CORPORATION, YAWATA WORKS, 1-1, Tobihata-cho, Tobata-ku, Kitakyushu-shi, Fukuoka 804-8501 (JP). **TAKADA, Yoshihisa** [JP/JP]; C/O NIPPON STEEL CORPORATION, YAWATA WORKS, 1-1, Tobihata-cho, Tobata-ku, Kitakyushu-shi, Fukuoka 804-8501 (JP). **EGUCHI, Haruhiko** [JP/JP]; C/O NIPPON STEEL CORPORATION, YAWATA WORKS, 1-1, Tobihata-cho, Tobata-ku, Kitakyushu-shi, Fukuoka 804-8501 (JP). **IZAKI, Teruaki** [JP/JP]; C/O NIPPON

[Continued on next page]

(54) Title: HIGH-STRENGTH ALLOYED ALUMINUM-SYSTEM PLATED STEEL SHEET AND HIGH-STRENGTH AUTOMOTIVE PART EXCELLENT IN HEAT RESISTANCE AND AFTER-PAINTING CORROSION RESISTANCE



(57) Abstract: The present invention provides a hot press method used for producing a high-strength member for an automobile and, in particular, a part which requires high-strength, such as an undercarriage component of an automobile. More specifically, the present invention provides an aluminum plated steel sheet or an aluminum-zinc plated steel sheet suitable for high temperature forming (hot forming) wherein high strength is obtained after high temperature forming, and a method of producing the same. Also, the present invention provides a hot dip aluminum plated steel sheet which suppresses the alloying reaction of a plated layer during press forming and has beautiful appearance, and an aluminum-system plated steel sheet for hot press having excellent after-painting corrosion resistance. Concretely, the present invention is a high-strength aluminum-system plated steel sheet excellent in heat resistance and after-painting corrosion resistance, characterized by having an Fe-Al-system coating containing, in mass, Mn and Cr of more than 0.1% in total on the surface of the steel containing, in mass, C: 0.05 to 0.7%, Si: 0.05 to 1%, Mn: 0.5 to 3%, P: not more than 0.1%, S: not more than 0.1% and Al: not more than 0.2%, and, in addition, one or more element(s) selected from among Ti: 0.01 to 0.8%, Cr: not more than 3% and Mo: not more than 1%, so as to satisfy the following expression (1): $Ti + 0.5xMn + Cr + 0.5xMo > 0.4$ ... 1

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STEEL CORPORATION, YAWATA WORKS, 1-1, Tobihata-cho, Tobata-ku, Kitakyushu-shi, Fukuoka 804-8501 (JP). **KUSUMI, Kazuhisa** [JP/JP]; C/O NIPPON STEEL CORPORATION, YAWATA WORKS, 1-1, Tobihata-cho, Tobata-ku, Kitakyushu-shi, Fukuoka 804-8501 (JP).

(74) Agents: ISHIDA, Takashi et al.; A. AOKI, ISHIDA & ASSOCIATES, Toranomon 37 Mori Bldg., 5-1, Toranomon 3-chome, Minato-ku, Tokyo 105-8423 (JP).

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DESCRIPTION

HIGH-STRENGTH ALLOYED ALUMINUM-SYSTEM PLATED STEEL SHEET AND HIGH-STRENGTH AUTOMOTIVE PART EXCELLENT IN HEAT RESISTANCE AND AFTER-PAINTING CORROSION RESISTANCE

Technical Field

The present invention relates to an alloyed aluminum-system plated steel sheet suitable for a member, which is produced by a high-temperature press and requires strength, as represented by a structural member for an automotive part, and a method of producing the same and, in particular, to a member which requires high strength such as an undercarriage component of an automobile or the like, and a steel material used for producing the same.

Background Art

For pursuing the weight reduction of an automobile, originating from global environmental problems, a steel sheet used for an automobile is required to have the highest possible strength. However, in general, when the strengthening of a steel sheet is enhanced, elongation and an r-value are lowered and thus formability is deteriorated. Therefore, a steel sheet is desired to have high-strength, high formability and shape fixability simultaneously.

One solution to the problem is a TRIP (Transformation Induced Plasticity) steel produced by using the martensite transformation of retained austenite and the application of a TRIP steel is increasing recently. However, though it is possible to produce a 1,000 MPa class high-strength steel sheet excellent in formability using a TRIP steel, it is difficult to secure good formability in a higher-strength steel sheet, for example, an ultra-high-strength steel sheet having a

strength of not lower than 1,500 MPa. Moreover, it is difficult to solve the problem of the shape fixability by that technology.

To cope with the problems, there is a warm press technology which is a technology attracting attention recently as another means which reconciles high-strength and high formability. A technology of increasing strength by forming a steel sheet while warm and making use of the heat generated during the forming is disclosed in Japanese Unexamined Patent Publication No. 2000-234153. This technology aims at increasing strength by controlling components in a steel appropriately, heating the steel sheet in the temperature range of ferrite and making use of the precipitation strengthening in the temperature range.

In Japanese Unexamined Patent Publication No. 2000-87183, proposed is a high-strength steel sheet wherein the yield strength at a temperature during forming is decreased far lower than the yield strength at the room temperature, aiming at improving the accuracy of press forming. However, there may be a limitation in the strength obtained by this technology.

As a technology which overcomes this drawback, a technology of heating a steel sheet to the temperature range where austenite single phase is formed and then cooling it during press forming is disclosed in the literature (SAE, 2001-01-0078).

This is a technology of obtaining desired material properties by forming a steel sheet in the state of heating it to a high temperature of not lower than 800°C, by so doing, solving the forming problem of a high-strength steel sheet, and then quenching it in the cooling after forming. However, as the technology involves heating in the atmosphere, oxides are generated on the surface of a steel sheet and it is required to remove the oxides in a downstream process. A technology of applying aluminum plating for suppressing the

oxidation during heating is also disclosed in the aforementioned literature (SAE, 2001-01-0078).

As another means, a means of obtaining high strength by, after forming a steel sheet at the room temperature, heating rapidly and cooling rapidly a part of the steel sheet and thus quenching it can be adopted. In this case, by heating the steel sheet locally, it is possible to enhance the strength of only the portion where high strength is required. Japanese Unexamined Patent Publication No. 2000-83640 discloses such a technology and a steel sheet containing carbon at 0.15 to 0.5% is used therefor.

A hot forming technology and a technology of applying an aluminum plated steel sheet in the hot forming are disclosed in the aforementioned prior arts. However, in the prior arts, when a steel sheet is heated to a high temperature of not lower than 800°C, Fe diffuses up to the surface for a short period of time and an aluminum plated layer changes to an intermetallic compound, hereinafter called "alloyed aluminum-system plated layer". Since the alloyed aluminum-system plated layer is very hard and brittle, sometimes it generates cracks and peels off in the state of powder, and therefore the deterioration of corrosion resistance after painting has been a concern. Even when cracks are not generated, there have been cases where an aluminum plated steel sheet is inferior to another surface treated steel sheet, for example, a hot-dip galvanized steel sheet or a hot-dip galvannealed steel sheet, in after-painting corrosion resistance. More specifically, after-painting corrosion resistance is evaluated after a forming at a high temperature and, when scratches, such as cutting in a cross shape, are provided, the corrosion of the base steel has been apt to propagate from the portion in the direction of the depth and to advance more than the case of a hot-dip galvanized or hot-dip galvannealed steel sheet of a sacrificial corrosion prevention type.

Further, there also is the possibility that the exfoliated plated layer piles up on dies and causes flaws during pressing. This is because, though the plated layer can withstand the working of a hot forming, it is practically difficult to work the whole part while it is hot and there is the problem of the plated layer being apt to peel off at the portion where the working has been delayed and the temperature has dropped. Another problem here is that, when the temperature drops, the base steel constitutes a hard structure mainly composed of martensite as a result of quenching, and therefore the stress is apt to escalate.

Disclosure of the Invention

The present inventors conducted a basic study for solving the aforementioned problems, and found that a plated steel sheet excellent in after-painting corrosion resistance could be produced by applying an Fe-Al-system coating containing Mn and Cr of more than 0.1% in total on the surface of a steel sheet after a high temperature forming. An aluminum-system plated layer after being subjected to a hot forming and being rapidly heated locally is transformed into an alloyed aluminum-system plated layer up to its surface, and the compound is very brittle and thus tends to generate cracks during working. The aluminum-system plated steel sheet defined in the present invention means a plated steel sheet having a plated layer composed of Al and Fe content of at least 70%. Further, since the layer has a nobler electric potential than the base steel sheet, the corrosion of the base steel is initiated starting from the cracks and after-painting corrosion resistance is apt to deteriorate. For avoiding the deterioration of the after-painting corrosion resistance, Mn addition to the alloyed aluminum-system plated layer is very effective. Though the function of Mn is not clarified yet, it is said that Mn plays the roll of bringing the electric

potential of an Fe-Al-system plated layer close to that of the steel sheet by controlling the electric potential of the alloy layer, and, in addition to the function, there is also the possibility that Mn controls also the shape of phosphate crystals in a phosphating treatment which is a pre-painting treatment.

Extremely excellent heat resistance, in particular, heat resistance after working, can be obtained by specifying the amounts of C, Si, Mn, P, S and Al as base steel components and by adding Ti, Cr and Mo, which addition was effective, so as to satisfy the following equation 1:

$$Ti + 0.5\times Mn + Cr + 0.5\times Mo > 0.4 \quad \ldots 1$$

It is estimated that those elements accelerate the diffusion between Al and Fe, and, by so doing, even when cracks are generated in a plated layer, the reaction between Fe and Al proceeds from the circumference of the cracks and therefore the base steel is hardly exposed.

Further, the present inventors also obtained the knowledge that, by adding N, Nb, V, Ni, Cu, B, Sn and Sb as steel components, further excellent after-painting corrosion resistance could be obtained.

In the meantime, it is advantageous for a plated layer after alloying treatment to contain Si further, and furthermore, better corrosion resistance is obtained by adding Zn, Mg, etc. It is important that Al content in an alloy layer is not more than 35% in view of suppressing cracks in the alloy layer. Further, it is desirable that the thickness of an Fe-Al-system alloy layer is 3 to 35 μm from the viewpoint of after-painting corrosion resistance.

Further, for overcoming the above-mentioned problems, the present inventors studied in detail the factors influencing the workability of an aluminum-system plated steel sheet after alloying treatment, and obtained

the following knowledge. That is, since both an alloyed aluminum-system plated layer and a base steel are hard, the internal stress increases, but, since a soft layer exists between the alloyed aluminum-system plated layer and the base steel, the stress is mitigated and therefore exfoliation resistance is improved markedly. The soft layer is composed of a ferrite phase, and it is estimated that the fact that the thickness of the soft layer is not less than 1 μm prevents the cracks in the alloyed layer propagating up to the base steel.

In addition, for overcoming the above-mentioned problems, the present inventors studied in detail the factors influencing the workability of an aluminum-system plated steel sheet after alloying treatment, and obtained the following knowledge. That is, it is possible to prevent the exfoliation of a plated layer by optimizing the heating conditions. The reason is not clear but it is estimated that a plated layer is alloyed according to heating conditions, the phase structure changes complicatedly, and there is an appropriate phase structure for securing workability. The gist of the present invention is as follows:

(1) A high-strength alloyed aluminum-system plated steel sheet excellent in after-painting corrosion resistance, characterized by having an Fe-Al-system coating containing Mn and Cr of more than 0.1% in total on the surface of the steel sheet.

(2) A high-strength alloyed aluminum-system plated steel sheet excellent in heat resistance and after-painting corrosion resistance, characterized by having an Fe-Al-system coating containing, in mass, Mn and Cr of more than 0.1% in total on the surface of the steel containing, in mass, C: 0.05 to 0.7%, Si: 0.05 to 1%, Mn: 0.5 to 3%, P: not more than 0.1%, S: not more than 0.1% and Al: not more than 0.2%, and, in addition, one or more element(s) selected from among Ti: 0.01 to 0.8%, Cr: not

more than 3% and Mo: not more than 1%, so as to satisfy the following equation 1:

$$Ti + 0.5 \times Mn + Cr + 0.5 \times Mo > 0.4 \quad \ldots 1$$

(3) A high-strength alloyed aluminum-system plated steel sheet excellent in heat resistance and after-painting corrosion resistance according to the item (2), characterized in that the steel further contains, in mass, one or more element(s) selected from among N: not more than 0.1%, Nb: not more than 0.1%, V: not more than 0.1%, Ni: not more than 1%, Cu: not more than 1%, B: 0.0003 to 0.03%, Sn: not more than 0.1% and Sb: not more than 0.1%.

(4) A high-strength alloyed aluminum-system plated steel sheet excellent in heat resistance and after-painting corrosion resistance according to the item (1), characterized in that the steel contains, in mass, C: 0.15 to 0.55%, Si: not more than 0.5%, Mn: 0.2 to 3%, P: not more than 0.1%, S: not more than 0.04%, Al: 0.01 to 0.1% and N: not more than 0.01%, and also one or more element(s) selected from among B: 0.0002 to 0.0050%, Ti: 0.01 to 0.8%, Cr: not more than 2%, Mo: not more than 1%, Ni: not more than 1%, Cu: not more than 0.5% and Sn: not more than 0.2%.

(5) A high-strength alloyed aluminum-system plated steel sheet excellent in heat resistance and after-painting corrosion resistance according to any one of the items (1) to (4), characterized in that the Fe-Al-system coating further contains Si of 1 to 20%.

(6) An alloyed aluminum-system plated steel sheet for high-strength automotive members according to any one of the items (1) to (5), characterized in that Al concentration in the Fe-Al-system coating layer is not more than 35% in weight.

(7) A high-strength alloyed aluminum-system plated steel sheet excellent in heat resistance and after-painting corrosion resistance according to any one of the items (1) to (6), characterized in that the Fe-Al-system coating further contains either one or both of Zn: 1 to 50% and Mg: 0.1 to 10%.

(8) An alloyed high-strength aluminum-system plated steel sheet excellent in heat resistance and after-painting corrosion resistance according to any one of the items (1) to (7), characterized in that the thickness of the Fe-Al-system coating layer is 3 to 35 μm.

(9) An alloyed aluminum-system plated steel sheet for high-strength automotive members, characterized by having: a coating layer mainly composed of Fe-Al on the surface of the steel sheet; a ferrite layer having a thickness from not less than 2 μm to not more than one tenth of the steel sheet thickness at the underside of the coating layer; and the base steel mainly composed of martensite at the underside of the ferrite layer.

(10) An alloyed aluminum-system plated steel sheet for high-strength automotive members according to the item (9), characterized in that the alloyed aluminum-system plated layer on the surface of the steel sheet and the ferrite layer at the underside of the intermetallic compound layer contain Si.

(11) An alloyed aluminum-system plated steel sheet for high-strength automotive members according to the item (9) or (10), characterized in that the hardness of the ferrite phase is not higher than 200.

(12) A high-strength automotive part formed by press

forming, at least a portion of which is composed of a steel according to any one of the items (1) to (11).

(13) A high-strength automotive part according to the item (12), characterized by having a coated film 1 to 200 μm in thickness on at least a part of the surface.

(14) A hot forming method for a high-strength automotive member, wherein, when the automotive member is produced by a hot forming using a steel sheet produced by plating a steel containing C of not less than 0.05% in weight as a steel component with a metal mainly composed of Al, the member is formed by press forming after heated on the heating condition of the longer time period side than the following regions, A, B, C and D, and at least a part of the member is cooled at a cooling rate of not lower than 10°C/sec.:

A (800°C, 13 min.), B (900°C, 6 min.), C (1,050°C, 1.5 min.), D (1,200°C, 0.3 min.).

Brief Description of the Drawings

Fig. 1 is a graph showing the influence of the total amount of Mn and Cr in an alloyed aluminum-system plated layer on after-painting corrosion resistance.

Fig. 2 is a graph showing the relation between the addition amount of Ni, Cu and Sn and bare corrosion resistance.

Fig. 3 is a graph showing the relation between the addition amount of Ni, Cu and Sn and after-painting corrosion resistance.

Fig. 4 is a graph showing the relation between the addition amount of Cr and Mo and bare corrosion resistance.

Fig. 5 is a graph showing the relation between the addition amount of Cr and Mo and after-painting corrosion resistance.

Fig. 6 is the Fe-Al-Si-system ternary phase diagram

at the temperature of 950°C.

Fig. 7 is a photograph (back scattered election image) showing an example of structures according to the present invention, taken by an optical microscope.

Fig. 8 is a graph showing the relation between the thickness of an outer layer and the workability of a plated layer.

Fig. 9 is a photograph (back scattered electron image) showing an example of metallic structures according to the present invention, taken by a microscope.

Fig. 10 is a view showing a shape obtained by forming a steel sheet according to the present invention.

Fig. 11 is a graph showing the relation between a heating time and a heating temperature according to the present invention.

Best Mode for Carrying out the Invention

Embodiment 1

Chemical compositions of steel sheets used in the present invention will be explained hereunder.

C: A steel sheet according to the present invention has a high-strength of not lower than 1,000 MPa after forming and is obtained by rapidly cooling it after a high temperature press and thus transforming the structure thereof into a structure mainly composed of martensite. In that sense, a C content of not less than 0.05% is desirable, and, for obtaining a high-strength stably, the content of not less than 0.1% is more desirable. On the other hand, even though C content is increased to not less than 0.7%, the strength is saturated and also weld cracking tends to be generated, and therefore the upper limit is set at 0.7%.

Si: Since too low an Si content causes fatigue property to deteriorate, the addition amount of not less than 0.05% is desirable. However, Si is also an element which forms a stable oxide film on the surface of a steel

sheet during recrystallizing annealing and hinders aluminum plating properties. For that reason, the upper limit of Si is set at 1%.

Mn: Mn is well known as an element which enhances the hardenability of a steel sheet. Also, Mn is an element which is necessary for preventing hot embrittlement caused by S which is an unavoidable impurity. For that reason, the addition amount of not less than 0.5% is preferable. Further, Mn also enhances heat resistance after aluminum plating. However, since Mn addition amount exceeding 3% causes the impact property after quenching to deteriorate, the value is determined to be the upper limit.

Ti: Ti affects the heat resistance of an aluminum plated layer most. In the case where a steel sheet is used in such a temperature range as exceeding 900°C, as is the case of the present invention, Ti addition is preferable from the viewpoint of heat resistance, and an addition amount of not less than 0.01% is desirable for achieving the effect. However, since Ti forms TiC with C and decreases the amount of C which contributes to strength, it is necessary to increase C amount corresponding to the Ti addition amount. Further, the effect of Ti is saturated in the amount of about 0.8%, and therefore this value is determined to be the upper limit.

Cr: Cr, like Mn and Ti, contribute to the improvement of the heat resistance after aluminum plating. However, Mn deteriorates aluminum plating properties by forming a stable oxide film on the surface of a steel sheet, in the same way as Si. Further, Cr is a relatively expensive element, and therefore the upper limit is set at 3% when it is added.

Mo: Mo, like Mn, Ti and Cr, also contributes to the improvement of the heat resistance after aluminum plating and its addition is desirable. However, since Mo is a relatively expensive element and the effect is saturated,

the upper limit is set at 1%.

In the present invention, it is preferable to add the elements which improve the heat resistance after aluminum plating, such as Ti, Mn, Cr and Mo, in a manner of satisfying the following expression:

$$Ti+0.5\times Mn+Cr+0.5\times Mo > 0.4.$$

In particular, Ti and Cr have an effect against the exfoliation of a plated layer during heating. Further, Mn may be added relatively abundantly and greatly contributes to heat resistance.

The present invention prescribes that P, S and Al are further added in a steel. However, since P and Al deteriorate the ductility and fatigue strength of a steel and S deteriorates toughness thereof, an upper limit is determined for each of them. In addition, one or more of Ni, Nb, V, N, Cu, B, Sn and Sb can be contained in a steel as occasion demands. Ni and Cu contribute to the corrosion resistance of a steel and B improves hardenability.

On many occasions, a steel sheet is used after an aluminum plated layer is alloyed and then it is painted. On those occasions, after-painting corrosion resistance is affected by the amounts of Mn and Cr in an alloyed aluminum-system plated layer. When the amount of these elements is not less than 0.1%, good after-painting corrosion resistance is obtained. As the methods of adding Mn and Cr, there are a method of diffusing steel components and a method of adding them in a plating bath, and either of the methods can achieve the effect as long as the addition amount is not less than 0.1%. It is known that one to five phases can coexist in an alloyed aluminum-system plated layer depending on the deposit amount of plating, the steel composition, the heating conditions and the like. Since the influence of phases in the vicinity of a surface is particularly large, when analyzing them, it is preferable to judge by measuring them at about 5 portions on a cross-section in the region

within 5 μm in depth from the surface using a means such as the EPMA quantitative analysis or the like, and by calculating the average thereof. As is stated later, in case of hot dip aluminum plating, it is common to add Si and, at that time, Si is further contained in the alloyed aluminum-system plated layer. The amount is about 1 to 20% and the Si amount in the alloyed aluminum-system plated layer of one to five phases may vary considerably. Though an Fe-Al-system coating of one to five phases can have various compositions, such as an Fe-Al-Si-system alloyed aluminum-system plated layer, Fe_2Al_5, $FeAl_3$, Fe_3Al, FeAl, Al dissolved ferrite, or the like, in any of the compositions, stable after-painting corrosion resistance can be obtained as long as the total amount of Mn and Cr is not less than 0.1%. With regard to which phase should be analyzed when a plurality of phases exist, since the knowledge that Mn and Cr contribute to the improvement of after-painting corrosion resistance was obtained and the corrosion phenomenon is a macroscopic phenomenon, the present inventors think that; general information can be obtained by analyzing them at about 5 portions at random, even when a plurality of phases exist, and calculating the average thereof and, by so doing, the judgement can be made. Further, it is prescribed that a cross-section is etched with nitral of 2 to 3% for observing the cross-section of a structure after heating. This is because the interface between a base metal and Al dissolved ferrite, which is formed particularly when the heating time is longer, cannot be observed without etching.

The deposit amount of aluminum plating affects corrosion resistance, weldability, workability and the like. If the deposit amount is too small, after-painting corrosion resistance is insufficient, and if it is too large, weldability and workability deteriorate. With regard to workability, it is because a brittle alloyed aluminum-system plated layer tends to peel off during the

press after heating.

A method of aluminum plating is not specifically restricted, and the hot dip plating method, the electroplating method, the vacuum deposition method, the clad method or the like can be employed. The method most widely employed industrially at present is the hot dip plating method, and usually Al-10%Si is frequently used in a plating bath and Fe is contained therein as an unavoidable impurity. It was already described before that, in addition to those, the addition of Cr and Mn improves after-painting corrosion resistance. As other additional elements, Mg, Ti, Zn, Sb, Sn, Cu, Ni, Co, In, Bi, misch metal, etc. are nominated, and those elements may be applied as long as the plated layer is mainly composed of Al.

The present invention does not specifically define a pre-treatment and a post-treatment of aluminum plating. As a plating pre-treatment, a pre-plating of Ni, Cu, Cr, or Fe, or the like is nominated, and any of those can be adopted. As a plating post-treatment, a chromate treatment, a resin coating treatment or the like is nominated aiming at primary rust prevention and lubricity, but an organic resin is not preferable because it disappears when heated. With regard to a chromate treatment, considering the recent regulation against hexavalent chrome, a treatment film containing trivalent chrome, such as electrolytic chromate or the like, is preferable. Another post-treatment other than an inorganic-system chromate treatment can be applied. It is also possible to apply a treatment of alumina, silica, MoS_2 or the like, beforehand, aiming at lubricity.

Embodiment 2

The reason why the steel components are regulated in Embodiment 2 according to the present invention will be described hereunder.

N is an element unavoidably included and is not

specifically prescribed when B is not added, but, when B is added and the amount is excessively large, the addition amount of Ti must be increased. As a result, there is a problem that the amount of resultantly generated TiN increases and hot cracking occurs, and that costs increase also. Therefore, the upper limit is set at 0.1%.

B is added for enhancing hardenability at cooling during or after press forming, and, for achieving the effect, the addition of not less than 0.0002% is necessary. However, when the addition amount is excessive, there is a problem of hot cracking and the effect is saturated. Therefore, the upper limit is set at 0.03%.

Ni, Cu and Sn have the effect of changing the state of surface cracking during press forming after high temperature heating by changing the state of alloying an aluminum plated layer during the high temperature heating, and are important since they lead to an improvement of after-painting corrosion resistance of a formed product. With regard to those elements, from the results shown in Figs. 2 and 3 which were obtained by measuring the addition amounts of Ni, Cu and Sn, and bare corrosion resistance and after-painting corrosion resistance of the samples after high temperature forming in a laboratory test, the present inventors found that, for obtaining above-mentioned effects, Ni, Cu and Sn had to be added so that they might satisfy the equation 3. Here, the bare corrosion resistance and the after-painting corrosion resistance were evaluated by the method examined under the conditions shown in Example, using samples taken from the portions to which working was applied after high temperature forming.

$$(Ni+0.5\times Cu+3\times Sn) \geqq 0.012 \quad \ldots \quad 3$$

With regard to each of Ni, Cu and Sn, an excessive addition of Ni makes the effects saturated and causes a

cost increase, Cu and Sn have the problem of generating surface cracking and, therefore, the upper limit of each element is set at 1.0%, 1% and 0.2%, respectively.

The production conditions of a steel sheet according to the present invention is not specifically prescribed, but preferable production conditions will be explained hereunder.

A steel having components as described above was cast, and the obtained hot slab, directly or after heated, or the slab once cooled and reheated, was hot-rolled. Here, the difference in the properties of the steel between the direct rolling of the hot slab and the rolling after reheating is scarcely recognized. Further, the reheating temperature is not specified, but it is preferable to regulate it in the range from 1,000 to 1,300°C, taking productivity into consideration.

With regard to hot-rolling, either a regular hot-rolling process or a continuous hot-rolling process wherein slabs are connected with each other and rolled at the finish rolling can be adopted. It is preferable to control the finishing temperature at the hot-rolling to not lower than Ar3 transformation temperature taking the productivity and the accuracy of the sheet thickness into consideration.

The cooling after hot-rolling is carried out by a usual method. In that case, it is preferable to control the coiling temperature to not lower than 550°C from the viewpoint of productivity. On the other hand, if the coiling temperature is too high, pickling capability deteriorates, and therefore it is preferable to control the coiling temperature to not higher than 750°C.

For a pickling process or a cold-rolling process, a usual method may be employed, and, for a subsequent aluminum plating process or a subsequent aluminum-zinc plating process, a usual method may be employed too. That is, in case of an aluminum plating process, Si concentration of 5 to 12% in a plating bath is

appropriate, and, in case of an aluminum-zinc plating process, Zn concentration of 40 to 50% in a plating bath is appropriate.

Here, with regard to the atmosphere in a plating process, plating can be carried out using either a continuous plating equipment having a non-oxidizing furnace or a continuous plating equipment not having a non-oxidizing furnace as long as usual conditions are preserved. Therefore, no specific control is required in the production of a product according to the present invention and thus the productivity is not hindered.

In the above production conditions, metal pre-plating is not applied to the surface of a steel sheet before plating, but no specific problem arises even when Ni pre-plating, Fe pre-plating, or another metal pre-plating which improves plating properties is employed.

Further, even when Mg and Zn are included in an aluminum plated layer or Mg is included in an aluminum-zinc plated layer, no specific problem occurs and a steel sheet having similar properties can be produced.

Embodiment 3

Firstly, the reason why the steel components are regulated in Embodiment 3 according to the present invention will be described hereunder.

C is an element which is added for making a structure after cooling composed of martensite and securing material quality, and the addition amount of not less than 0.15% is required for securing a strength of not lower than 1,200 MPa. On the other hand, if the addition amount is excessive, the strength against impact deformation is hardly secured and, therefore, the upper limit is set at 0.55%.

Si is a solute strengthening element and can increase the strength of a steel sheet at a relatively low cost. However, if it is added excessively, plating properties are deteriorated, and therefore the upper

limit is set at 0.5%.

Mn is added for making it possible to secure the strength after cooling in a wide range of cooling rates.

When the C amount is large but the addition amount of Mn is small, a martensite structure cannot be obtained in a usual range of cooling rate, which range can be obtained during press forming, and therefore the strength is hardly secured. The range of cooling rates cited here is not higher than 500°C/sec. in the case of the sheet thickness of 1.4 mm. To demonstrate such function, the addition amount of not less than 0.2% is required. On the other hand, if the Mn amount is too large, not only the cost increases but also the effect is saturated. Therefore, the upper limit is set at 3%.

S is an element which is included unavoidably and causes the deterioration of workability. Therefore, it is necessary to decrease the amount as much as possible. By decreasing the amount to not more than 0.04%, the problem of the workability is eliminated and therefore the range is determined to be not more than 0.04%.

P is a solute strengthening element and can increase the strength of a steel sheet at a relatively low cost. However, if the addition amount increases too much, cracks are generated during hot-rolling or cold-rolling caused by the embrittlement, and therefore the upper limit is set at 0.1%.

Al is used as a deoxidizing agent and, for demonstrating the effect, an Al content of not less than 0.005% in a steel is required. On the other hand, the addition amount exceeding 0.1% causes the increase of oxide-system inclusions and a problem of the deterioration of surface quality, and therefore the upper limit is set at 0.10%.

Cr and Mo have the effect of changing the state of surface cracking during press forming after a high temperature heating by changing the state of alloying an aluminum plated layer during the high temperature

heating, and are important since they lead to the improvement of after-painting corrosion resistance of a formed product. With regard to those elements, from the results shown in Figs. 2 and 3, which were obtained by measuring the addition amounts of Cr and Mo, and bare corrosion resistance and after-painting corrosion resistance of the samples after high temperature forming in a laboratory test, the present inventors found that Cr and Mo had to be added. Here, the bare corrosion resistance and the after-painting corrosion resistance were evaluated by the method examined under the conditions shown in Example, using samples taken from the portions to which working was applied after high temperature forming.

With regard to each of Cr and Mo, an excessive addition of Cr causes problems in plating properties and cost increase and Mo makes the effects saturated and causes cost increase. Therefore, the upper limit of each element is set at 2.0% and 1.0%, respectively.

Other components are not specifically prescribed. Ni is included unavoidably, and, if the amount is within the usual range, no problem arises.

The production conditions of a steel sheet according to the present invention are not specifically prescribed, but preferable production conditions will be explained hereunder.

A steel having components as described above was cast, and the obtained hot slab, directly or after being heated, or the slab once cooled and reheated, was hot-rolled. Here, the difference in the properties of the steel between the direct rolling of the hot slab and the rolling after reheating is scarcely recognized. Further, the reheating temperature is not specified, but it is preferable to regulate it in the range from 1,000 to 1,300°C taking the productivity into consideration.

With regard to hot-rolling, either a regular hot-rolling process or a continuous hot-rolling process

wherein slabs are connected with each other and rolled at the finish rolling can be adopted. It is preferable to control the finishing temperature at the hot-rolling to not lower than Ar3 transformation temperature taking the productivity and the accuracy of the sheet thickness into consideration.

The cooling after hot-rolling is carried out by a usual method. In that case, it is preferable to control the coiling temperature to not lower than 550°C from the viewpoint of productivity. On the other hand, if the coiling temperature is too high, pickling capability deteriorates, and therefore it is preferable to control the coiling temperature to not higher than 750°C.

For a pickling process or a cold-rolling process, a usual method may be employed, and, for a subsequent aluminum plating process or a subsequent aluminum-zinc plating process, a usual method may be employed too. That is, in case of an aluminum plating process, Si concentration of 5 to 12% in a plating bath is appropriate and, in case of an aluminum-zinc plating process, Zn concentration of 40 to 50% in a plating bath is appropriate.

Here, with regard to the atmosphere in a plating process, plating can be carried out using either a continuous plating equipment having a non-oxidizing furnace or a continuous plating equipment not having a non-oxidizing furnace as long as usual conditions are preserved. Therefore, no specific control is required in the production of a product according to the present invention and thus the productivity is not hindered.

In the above production conditions, metal pre-plating is not applied to the surface of a steel sheet before plating, but no specific problem arises even when Ni pre-plating, Fe pre-plating, or another metal pre-plating which improves plating properties is employed. Further, even when Mg and Zn are included in an aluminum plated layer or Mg is included in an aluminum-zinc plated

layer, no specific problem occurs and a steel sheet having similar properties can be produced.

Embodiment 4

By heating an aluminum plated layer and thus converting it into an alloy layer, namely an Fe-Al-system coating layer, and also by controlling the Al amount to not more than 35% and thus converting the Fe-Al-system coating layer into $Fe+Fe_3Al$ wherein Al and Si are dissolved, obtained are far more excellent workability and corrosion resistance at a portion which is subjected to working than those of a plated layer which contains other phases than $Fe+Fe_3Al$.

C: A steel sheet according to the present invention has a high-strength of not lower than 1,000 MPa after forming and is obtained by rapidly cooling it after a hot press and thus transforming the structure thereof into a structure mainly composed of martensite. To do so, a C content of not less than 0.05% is necessary. On the other hand, even though the C content is increased to not less than 0.7%, the strength is saturated and also weld cracking tends to be generated, and therefore the upper limit is set at 0.7%.

Steel components except C are not specifically prescribed, but elements such as Si, Mn, P, Al, N, Cr, Mo, Ti, Nb, B, Ni, Cu, V, Sn, Sb, etc., are nominated as addition elements or unavoidable impurity elements. Those elements may be added as occasion demands. Examples are: Mn and B are effective in hardenability; Cr, Ti and Mo are effective in the heat resistance of an aluminum plated layer; and Ni and Cu improve corrosion resistance. The desirable ranges of their addition are Mn: 0.5 to 3%, Si: not more than 1%, P: not more than 0.1%, S: not more than 0.1%, Al: not more than 0.1%, N: not more than 0.01%, Cr: not more than 2%, Mo: not more than 0.5%, Ti: not more than 0.5%, Nb: not more than 0.1%, B: not more than 0.05%, Ni: not more than 1%, Cu:

not more than 1%, V: not more than 0.1%, Sn: not more than 0.1% and Sb: not more than 0.1%.

As stated above, the smaller the deposit amount of aluminum plating is, the more easily an $Fe+Fe_3Al$ region is formed. In that sense, it is desirable that the deposit amount is not more than 120 g/m^2 per both sides.

A method of aluminum plating is not specifically restricted, and the hot dip plating method, the electroplating method, the vacuum deposition method, the clad method or the like can be employed. The method most widely employed industrially at present is the hot dip plating method, and usually Al-10%Si is frequently used in a plating bath and Fe is contained therein as an unavoidable impurity. In this case, Si enters into an alloy layer after heating and the Si amount may vary depending on the phase structure. However, the Si amount in the $Fe+Fe_3Al$ region is not more than 15% and therefore the value is determined to be the upper limit of Si. As other additional elements, Mn, Cr, Mg, Ti, Zn, Sb, Sn, Cu, Ni, Co, In, Bi, misch metal, etc. are nominated, and those elements may be applied as long as the plated layer is mainly composed of Al. The addition of Zn and Mg is effective in making red rust hardly generated. However, the excessive addition of those elements, whose vapor pressures are high, causes the generation of fumes containing Zn and Mg, the generation of powdery substances on the surface caused by Zn and Mg, and the like. Therefore, a Zn addition of not less than 60% and a Mg addition of not less than 10% are not desirable.

The present invention does not specifically define a pre-treatment and a post-treatment of aluminum plating. As a plating pre-treatment, a pre-plating of Ni, Cu, Cr, or Fe, or the like is nominated, and any of these can be adopted. As a plating post-treatment, a chromate treatment, a resin coating treatment or the like is nominated aiming at primary rust prevention and lubricity, but an organic resin is not preferable because

it disappears when heated. With regard to a chromate treatment, considering the recent regulation against hexavalent chrome, a treatment film containing trivalent chrome, such as electrolytic chromate or the like, is preferable. Another post-treatment other than an inorganic-system chromate treatment can be applied. It is also possible to apply a treatment of alumina, silica, MoS_2 or the like beforehand aiming at lubricity.

Embodiment 5

In Embodiment 5, the restriction of the composition of an aluminum-system plated layer will be explained. The aluminum-system plated layer cited here means a plated layer which is not heated yet and thus not alloyed yet.

Si: Si is effective in decreasing the thickness of an alloy layer (a layer composed of an intermetallic compound formed at an interface between a plated layer and a steel sheet) of aluminum-system plating. Further, Si forms Mg_2Si by adding Mg complexly and is effective in improving corrosion resistance. To enjoy the effects, the addition of not less than 1% is effective. An excessive addition of Si causes the rise of a melting point and, when Si single phase crystallizes at the plated layer, it causes the deterioration of corrosion resistance. Therefore, the upper limit is set at 15%.

Mg: It is known that Mg is effective in improving corrosion resistance particularly under a salt damage environment. By forming Mg_2Si particularly, a emission efficiency into an environment is increased and corrosion resistance is improved. For securing corrosion resistance, a Mg amount of not less than 0.5% is added. Since an excessive addition causes fierce oxidation at the surface of a plating bath and a rise in the melting point of the plating bath, the addition amount is determined to be not more than 10%. For suppressing the oxidation of the surface of a plating bath, the addition

of a small amount of Ca (not more than 0.5%) is effective, and about this amount of Ca may be added.

Zn: Zn has an electric potential more basic than that of Al or steel and a function of suppressing the corrosion of a base steel. The effects begin to appear when Zn addition amount is not less than 1% and the best properties are obtained when Zn amount is 20 to 60%. However, with the addition amount exceeding 60%, corrosion resistance is rather deteriorated. Therefore, the lower limit and the upper limit of Zn amount are set at 1% and 60%, respectively.

When a part is practically produced using an aluminum-system plated steel sheet according to the present invention, quenching is carried out by rapidly cooling the part with the dies after press, and thus the structure is mainly composed of martensite. For securing a sufficient strength as a member, the percentage of martensite is determined to be not less than 60% in volume. Here, the percentage of martensite is calculated by polishing and etching a specimen and, after that, observing it with an optical microscope and using image analysis.

Embodiment 6

The reason why the components of a steel sheet and the like are regulated in Embodiment 6 will be described hereunder.

A steel sheet according to the present invention has a soft ferrite layer having a thickness from not less than 2 μm to not more than one tenth of a steel sheet thickness at the interface between an intermetallic compound layer formed by alloying an aluminum plated layer and a base steel mainly composed of martensite. Usually, Al of about 1 to 10% exists in the ferrite layer. The ferrite phase can also contain Si, in addition to Al. The thickness is limited to not less

than 1 μm. The reason is that, if the thickness of the soft ferrite layer is not more than the above thickness, the exfoliation resistance of the plated layer is not sufficiently obtained. On the other hand, this layer is soft and, if it is too thick, the strength of the whole steel sheet is deteriorated. For that reason, the upper limit is determined to be not more than one tenth of the steel sheet thickness. Usually, an aluminum plated steel sheet is often produced by the hot dip plating method, and, in this case, an alloyed aluminum-system plated layer (called "alloy layer") at the interface between the steel sheet and the plated layer tends to grow. If the layer grows excessively, the workability of the steel sheet is deteriorated and, therefore, the aluminum plated steel sheet is produced in a plating bath wherein Si of about 10% is added. In the present invention, as an aluminum plated steel sheet is worked in the hot after the whole plated layer is alloyed by heating, Si is not necessarily required to be added in the plating bath, but there is no specific problem even when Si is added.

In the present invention, it is desirable that the hardness of a ferrite layer is not higher than 200 in terms of Vickers hardness. As stated above, the layer plays a role of preventing a hard alloy layer from peeling off during working. For that reason, it is preferable that the layer is soft. However, as the layer contains solute strengthening elements such as Al, Si, etc., it is harder than a usual ferrite layer.

Next, other components related to the present invention will be described hereunder. Firstly, with regard to steel components, as the present invention aims at a high-strength region which cannot be obtained with a regular TRIP steel or the like and the enhancement of strength by quenching, it is desirable that C amount is not less than 0.05%, preferably not less than 0.1%. With regard to other elements in a steel, the elements of Si, Mn, Ti, B, Cr, Mo, Al, P, S, N, etc. are used usually.

Si is effective in fatigue property, and Mn and B contribute to the improvement of hardenability. Ti, Si, Cr, Mo and Al are elements which improve heat resistance after aluminum plating.

With regard to the construction of an aluminum plated layer, an aluminum plated layer is mainly composed of Al and may contain Si as stated above. As other addition elements, Cr, Mg, Ti, Sb, Sn, Zn, etc. are nominated, and those are applicable as long as the plated layer is mainly composed of Al. However, Zn has a low boiling point and, when added excessively, Zn generates zinc powder on the surface during heating and that causes galling during pressing. Therefore, the addition amount of not less than 60% is not desirable.

$FeAl_3$, Fe_2Al_5, Fe_3Al, Fe_2Al_8Si, etc. are generated as an element of the alloyed aluminum-system plated layer. Those phases tend to form a multi-layered structure in a laminar manner, but the structures of the phases are not specifically regulated. When the composition is mainly composed of Al and Fe, and Si is added in an aluminum plating bath, Si of about 5 to 10% is contained. Those elements account for not less than 90% of the composition in total. Further, a small amount of not-alloyed Al may remain, but it does not affect the properties of an aluminum plated steel sheet as long as the amount is small.

The thickness of a ferrite layer is measured with an optical microscope. The thickness of a ferrite layer is clearly observed by polishing a cross-section and, after that, etching it with nital at about 2%. However, there is a case where the boundary with an intermetallic compound layer is hardly observed, and, in that case, EPMA analysis is additionally adopted. By so doing, a ferrite layer can easily be identified from the difference between the radiation strength of Fe and that of Al. It is determined that the measurement of the thickness of a ferrite layer is carried out by measuring

the thickness at about 5 portions at random and calculating the average value. Further, a base steel consists of a structure mainly composed of martensite, and the structure can be observed, for example, by etching it with picral and using an optical microscope.

Fig. 7 shows an example of structures according to the present invention. Two layers are recognized at the interface, and, as a result of quantitative analysis with an EPMA, the lower layer is a ferrite layer about 5 μm in thickness. Here, in Fig. 7, the reference numeral 1 shows the layer composed of Al: 26.85%, Si: 9.83%, Fe: 59.92%; the reference numeral 2 the layer composed of Al: 49.54%, Si: 3.11%, Fe: 44.89%; the reference numeral 3 the layer composed of Al: 30.75%, Si: 8.88%, Fe: 56.91%; and the reference numeral 4 the layer composed of Al: 9.59%, Si: 2.92%, Fe: 84.02%.

Finally, with regard to the heating and cooling conditions of a plated steel sheet, a method of heating and cooling is not specifically defined. For obtaining a hardened structure, a cooling rate affects it largely as a matter of course, and a cooling rate of not lower than about 30°C/sec. is desirable. This depends on steel components, and, in case of a steel having good hardenability, a desired structure mainly composed of martensite can be obtained even at a cooling rate of about 10°C/sec., or, in another case, a cooling rate of not lower than 100°C/sec. is required depending on a steel grade. For obtaining a desired thickness of a ferrite layer, the optimization of heating conditions is required.

Embodiment 7

The reason why the components of a steel sheet and the like are regulated in Embodiment 7 will be described hereunder.

The present invention is a high-strength steel sheet having a high-strength of not lower than about 1,000 MPa

after forming, and is the steel sheet obtained by rapidly cooling it after it is subjected to hot press or partial rapid heating, thus quenching it and, by so doing, transforming it into a structure mainly composed of martensite. Therefore, the hardness of a base steel is determined to be not lower than 250. The hardness is measured in terms of Vickers hardness. For obtaining the hardness, a C amount of 0.05% is desirable. With regard to other elements in a steel, no specific restriction is determined, but the elements of Si, Mn, Ti, B, Cr, Mo, Al, P, S, N, etc. are used usually. Si is effective in fatigue property, and Mn and B contribute to the improvement of hardenability. Ti, Si, Cr, Mo and Al are elements which improve heat resistance after aluminum plating.

Further, in the present invention, a steel sheet has an alloyed aluminum-system plated layer mainly composed of Al and Fe on the surface of the base steel and the thickness of the alloyed aluminum-system plated layer is limited to 3 to 35 μm, preferably 3 to 18 μm. The restriction is determined considering the balance among weldability, after-painting corrosion resistance and heat resistance, as described above. That is, when the thickness of a layer is less than 3 μm, sufficient after-painting corrosion resistance and heat resistance cannot be obtained. In case of not adding Si to an aluminum plated layer in particular, the deterioration of heat resistance is remarkable. The upper limit of the thickness is determined by spot weldability. A spot weldability (electrode life) identical with a galvanized steel sheet can be obtained when the plating thickness is not more than 35 μm, and a spot weldability identical with a hot dip alloyed zinc-coated steel sheet can be obtained when the plating thickness is not more than 18 μm. $FeAl_3$, Fe_2Al_5, Fe_3Al, Fe_2Al_8Si, etc. can be formed as alloyed layers. Further, the formation of a ferrite

layer containing Al is recognized very often at the interface between the alloyed layer and the base steel.

Usually, in an aluminum plated steel sheet, an Fe-Al-system ally layer tends to grow and deteriorate workability. Therefore, it often happens that Si is added for suppressing the growth of the alloy layer and improving workability. In case of hot press, since a steel sheet is worked in the hot after the aluminum plated layer is heated and alloyed up to the surface, Si is not particularly required to be added. However, Si may be added as a matter of course. In case of rapidly heating a part of a steel sheet, since working is applied at the room temperature, Si addition is indispensable. Cr, Mg, Ti, Sb, Sn, Zn, etc. are nominated as other addition elements in an aluminum plated layer, and those elements are applicable as long as the plated layer is mainly composed of Al. However, Zn has a low boiling point and, when added excessively, Zn generates zinc powder on the surface during heating and that causes galling during press. Therefore, the addition amount of not less than 60% is not desirable.

The present invention does not specifically define a pre-treatment and a post-treatment of plating, a heating method of a steel sheet during pressing and a cooling method thereof. As a plating post-treatment, a chromate treatment, a resin coating treatment or the like is nominated aiming at primary rust prevention and lubricity. However, with regard to a chromate treatment, considering the recent regulation against hexavalent chrome, a treatment film containing trivalent chrome, such as electrolytic chromate or the like, is preferable. A resin coating treatment is effective in improving formability in general and it is particularly effective when a part of a steel sheet is rapidly heated after forming. When a steel sheet is heated and then formed, a resin film is decomposed and therefore has no effect.

A method of producing an aluminum plated steel sheet

is not prescribed either. Regular steelmaking conditions and hot-rolling conditions may be applied. An aluminum plating is carried out by the hot dip plating method usually, but a method is not limited to it and an electroplating in nonaqueous solvent, a vapor deposition treatment or the like can be used. As a pre-treatment before plating, Ni pre-plating or the like is nominated, and it can be adopted.

A method of heating or cooling a steel sheet is not particularly prescribed either. A heating means such as electric heating, heating in a furnace, high-frequency heating or the like may be adopted. Among those means, high-frequency heating is appropriate for rapidly heating a part of a steel sheet.

Embodiment 8

The reason why the components of a steel sheet and the like are regulated in Embodiment 8 will be described hereunder.

As stated above, the present invention is a technology which secures a desired strength by forming an aluminum plated steel sheet while hot after heating it, cooling it immediately after that, and thus quenching it, and the components of the steel sheet are required to grant excellent hardenability to the steel sheet. To meet the requirement, a C amount of not less than 0.05%, preferably not less than 0.1%, is required. With regard to other elements in a steel, the elements of Si, Mn, Ti, B, Cr, Mo, Al, P, S, N, etc. are used as usual. Si is effective in fatigue property, and Mn and B contribute to the improvement of hardenability. Ti, Si, Cr, Mo and Al are elements which improve heat resistance after aluminum plating.

An element of an alloyed aluminum-system plated layer, such as $FeAl_3$, Fe_2Al_5, Fe_3Al, Fe_2Al_8Si, etc. can be generated on a surface after heating. Those phases tend to form a multi-layered structure in a laminar manner,

but the structures of the phases are not specifically regulated. When the composition is mainly composed of Al and Fe and, Si is added in an aluminum plating bath, Si of about 5 to 10% is contained. Those elements account for not less than 90% of the composition in total. Further, it is determined that an aluminum plated steel sheet is subjected to press working after the plated layer is transformed into an alloyed aluminum-system plated layer up to the surface by heating. This is because, when Al remains abundantly on the surface, weldability and after-painting corrosion resistance are deteriorated.

With regard to the heating and cooling conditions in the present invention, a method of heating and that of cooling are not particularly restricted. Any one of heating in an atmospheric furnace, induction heating, electric heating or the like may be used. A heating rate at this time is not restricted either. The heating rate largely depends on the thickness and shape of a steel sheet as a matter of course. New knowledge was obtained that, the longer the retention time in a furnace was, the better the plating adhesiveness during subsequent forming was. The heating temperature is in the range roughly from 800 to 1,200°C, preferably 900 to 1,000°C, and it is important to retain a steel sheet within this temperature range for about several minutes. However, the retention time depends on temperature, and it is determined that the retention time must be longer than the four points of A (800°C, 13 min.), B (900°C, 6 min.), C (1,050°C, 1.5 min.) and D (1,200°C, 0.3 min.).

However, a longer retention time causes the deterioration of the productivity in press forming. A practically sufficient plating adhesiveness can be obtained by a heating at 950°C for 5 to 8 min., which condition is determined as a point of compromise. A hardened structure is largely affected by a cooling rate as a matter of course, and, to obtain the hardened

structure, a cooling rate of not lower than 10°C/sec. is required. This depends on steel components, and, in case of a steel sheet having good hardenability, a desired structure mainly composed of martensite can be obtained even at a cooling rate of about 10°C/sec., or, in another case, a cooling rate of about 30°C/sec. is required depending on the steel grade.

Next, the present invention will hereunder be explained in detail based on Examples.

Example 1

Hot dip aluminum plating was applied to pickled steel sheets (1.8 mm in thickness) and cold-rolled steel sheets (1.2 mm in thickness) as the materials, having steel compositions shown in Table 1 and being produced through regular hot-rolling and cold-rolling processes. Nos. 1, 3, 5, 7 and 9 in Table 1 are cold-rolled steel sheets, and the rests are hot-rolled steel sheets. In the hot dip aluminum plating, a line of non-oxidizing furnace-reducing furnace type was used, a deposit amount of plating was adjusted to 40 g/m^2 per one side by the gas wiping method after plating, and, after that, the steel sheets were cooled and subjected to a zero-spangle treatment. The plating bath composition at the time was Al-10%Si-2%Fe. Fe in the bath is a component unavoidably supplied by the plating apparatus and the steel sheets in the bath. The plating appearance was good without having non-plating defects or the like. The hardenability and heat resistance of the hot dip aluminum plated steel sheets thus produced were evaluated. The evaluation methods are shown below.

As substantial alloying process, an aluminum plated steel sheet was heated at 950°C for 30 minutes and thereafter cooled while inserted between dies made of steel under a nitrogen atmosphere. The cooling rate was 100°C/sec. The exfoliation of a plated later of a steel sheet was evaluated visually. Further, Vickers hardness

at the cross-section of a steel sheet was measured imposing a load of 100 g. Thereafter, a steel sheet was subjected to a chemical treatment which was commonly used for aluminum plating, a steel sheet and zinc plating, coated with a cationic electrodeposition paint (Nippon Paint Co., Ltd.; powernix 110) in the thickness of 20 μm, baked, and subjected to a salt spray test (JIS-Z2371) for 20 days after being cut in a cross shape, and the corrosion depth from the portion cut in a cross shape was measured. Here, the depth of the cut in a cross shape was about 50 μm. Therefore, a value obtained by subtracting 50 μm from a recorded value is a true corrosion depth. Further, for obtaining the concentrations of Mn and Cr in an Fe-Al intermetallic compound, the amounts of Mn and Cr were measured by quantitatively analyzing a specimen after quenched at 5 portions in a cross-section after polished in the region from the surface to the depth of 5 μm, using an EPMA. The evaluation results are shown in Table 2.

Evaluation criteria of heat resistance

○: No exfoliation

△: Partial exfoliation from edges

×: Exfoliation generated

Evaluation criteria of after-painting corrosion resistance

○: Corrosion depth not more than 80 μm

×: Corrosion depth more than 80 μm

(Each value includes the depth of a cut in a cross shape.)

[Tables 1 and 2]

Table 1

No.	Chemical composition (mass%)											
	C	Si	Mn	P	S	Al	N	Ti	Cr	Mo	B	Ti*
1	0.23	0.12	1.21	0.02	0.009	0.03	0.004	0.02	0.13	-	0.002	0.76
2	0.21	0.20	0.81	0.02	0.007	0.05	0.004	0.22	0.20	-	-	0.83
3	0.17	0.15	1.24	0.01	0.008	0.03	0.003	0.01	1.10	-	0.0008	1.73
4	0.42	0.7	2.41	0.01	0.009	0.01	0.003	0.66	0.21	-	0.001	2.08
5	0.23	0.31	1.54	0.02	0.007	0.05	0.003	0.02	0.44	-	0.002	1.23
6	0.25	0.18	1.22	0.01	0.01	0.04	0.003	0.02	0.66	0.20	0.005	1.29
7	0.24	0.2	0.41	0.01	0.02	0.05	0.004	0.09	0.10	0.15	0.01	0.47
8	0.2	0.2	2.43	0.01	0.01	0.04	0.003	0.09	0.21	-	0.0008	1.52
9	0.03	0.1	1.4	0.02	0.01	0.03	0.004	0.25	0.15	-	0.0003	1.1
10	0.23	0.12	0.3	0.01	0.008	0.05	0.003	0.03	0.23	-	-	0.41
11	0.24	0.10	0.51	0.01	0.008	0.03	0.004	0.05	0.03	-	0.0022	0.34

Note 1) Ti*: Ti + 0.5Mn + Cr + 0.5Mo

Table 2

No.	Mn + Cr amount	Heat resistance	Vickers hardness	After-painting corrosion resistance
1	0.4	○	515	○
2	0.22	○	480	○
3	0.96	○	405	○
4	0.85	○	766	○
5	0.30	○	511	○
6	0.30	○	548	○
7	0.15	○	539	○
8	0.78	○	466	○
9	0.44	○	200	○
10	0.19	○	311	○
11	0.21	△	522	○

When the C amount is excessively low as in the No. 9 steel sheet, the strength lowers. In general, a value close to material strength (MPa) is obtained by multiply a Vickers hardness by 3, and, in this case, a strength of only 600 MPa class at the most is obtained. When the addition amounts of the elements effective in quenching, such as Mn, B, etc., are small like No. 10 steel sheet, quenching effect is not obtained even though the C amount is large and the strength tends to decrease to some

extent. Further, in the case where the value of Ti*: Ti + 0.5xMn + Cr + 0.5xMo is low like No. 11 steel sheet, the plated layer peels off after heating and the heat resistance tends to deteriorate to some extent. In case of Nos. 1 to 8 steel sheets wherein the addition amounts of the elements in the steels are properly controlled, all of strength, heat resistance and after-painting corrosion resistance show good results.

Next, No. 7 steel sheet of this Example in Table 1 was plated in a plating bath which mainly contained Al-10%Si-2%Fe and in which Mn and Cr were added. The deposit amount of the plating was 60 g/m^2 per one side, and good plating appearance was obtained. The steel sheet was quenched with dies after heated at 900°C for 2 minutes. The cooling rate was about 100°C/sec. The amounts of Mn and Cr in the bath at this time and the evaluation results are shown in Table 3. When the amounts of Mn and Cr in the intermetallic compound are small like No 1 steel sheet, after-painting corrosion resistance is inferior, but the corrosion resistance improves with the increase of the addition amounts of Mn and Cr in the plating bath. The relation between the amounts of Mn and Cr in the intermetallic compound and the after-painting corrosion resistance at this time are shown in Fig. 3. It is understood that the after-painting corrosion resistance improves with the increase of the amounts of Mn and Cr.

[Table 3]

Table 3

No.	Amount of element in bath (%)		Amount of element in intermetallic compound (%)		After-painting corrosion resistance
	Mn	Cr	Mn	Cr	
1	0	0	0.08	0	×
2	0.1	0	0.11	0	○
3	0.2	0	0.24	0	○
4	0.4	0.05	0.51	0.08	○
5	0.6	0	0.73	0	○
6	0.8	0.1	0.75	0.14	○

Example 2

The steels having various chemical compositions as shown in Table 4 were cast, heated again to a temperature of 1,050 to 1,250°C, thereafter hot-rolled, pickled, cold-rolled, annealed, subjected to a plating treatment (aluminum plating or aluminum-zinc plating: "Galvalium®" plating), and thereafter subjected to temper rolling at the reduction rate of 0.8%. Further, as alloying process, these steel sheets were heated to a temperature of 900 to 1,000°C, retained for 5 minutes at the temperature, thereafter subjected to press forming with dies of the room temperature, and then subjected to the investigation on the properties. The investigation on material properties was carried out by cutting out the specimens from the portions which were rapidly cooled at the press and applying a tensile test thereto. The test was carried out by cutting the specimens into No. 5 test pieces according to JIS-Z2201 and following the test method described in JIS-Z2241. The evaluation results are shown in Table 5.

[Tables 4 and 5]

Table 4

Steel No.	C	Si	Mn	S	P	Al	Ti	N	Ni	Cu	B	Sn	Ti-3.42*N
1	0.22	0.20	1.05	0.020	0.020	0.025	0.020	0.0024	0.02	0.02	0.0030	-	0.012
2	0.21	0.15	0.94	0.018	0.023	0.024	0.022	0.0035	0.25	0.10	0.0027	-	0.010
3	0.22	0.15	0.94	0.018	0.023	0.024	0.022	0.0025	0.01	0.01	0.0027	0.01	0.013
4	0.16	0.48	1.70	0.009	0.015	0.021	0.017	0.0025	0.80	0.02	0.0002	-	0.008
5	0.35	0.05	1.00	0.015	0.012	0.030	0.020	0.0028	0.01	0.01	0.0020	-	0.010
6	0.53	0.10	1.10	0.010	0.020	0.026	0.200	0.0021	0.02	0.01	0.0010	0.05	0.193
7	0.53	0.10	0.30	0.010	0.020	0.030	0.020	0.0020	0.90	0.02	0.0047	-	0.013
8	0.22	0.20	1.00	0.002	0.015	0.035	0.005	0.0034	0.02	0.02	0.0005	-	-0.007
9	0.21	0.20	1.10	0.022	0.021	0.028	0.020	0.0026	0.00	0.02	0.0020	-	0.011
10	0.22	0.20	2.00	0.010	0.010	0.030	0.020	0.0033	0.01	0.01	-	-	0.009
11	0.35	0.15	2.10	0.012	0.013	0.023	0.018	0.0028	0.05	0.01	-	0.01	0.008
12	0.24	0.20	2.50	0.008	0.009	0.035	0.026	0.0035	0.02	0.01	-	-	0.014

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Table 5

Steel No.	Coiling temperature (°C)	Annealing temperature (°C)	Kind of plating	TS before forming (Mpa)	Heating temperature before forming (°C)	YP (MPa)	TS (MPa)	Bare corrosion resistance	After-painting corrosion resistance
1	630	780	Aluminum plating	560	950	1250	1580	○	○
	610	775	Galvalium plating	550	950	1255	1600	○	○
2	680	760	Aluminum plating	550	950	1220	1610	○	○
	650	780	Galvalium plating	558	950	1210	1590	○	○
3	620	730	Aluminum plating	570	950	1280	1550	○	○
	630	730	Galvalium plating	564	950	1270	1540	○	○
4	650	830	Aluminum plating	500	980	1110	1310	○	○
	660	840	Galvalium plating	508	980	1100	1320	○	○
5	630	770	Aluminum plating	603	950	1480	1830	○	○
	640	770	Galvalium plating	605	950	1490	1820	○	○
6	650	775	Aluminum plating	654	940	1610	1990	○	○
	660	780	Galvalium plating	660	940	1620	1980	○	○
7	650	760	Aluminum plating	780	910	1850	2100	○	○
	650	760	Galvalium plating	774	910	1820	2120	○	○
8	650	790	Aluminum plating	553	950	750	980	○	○
9	630	800	Aluminum plating	558	950	1210	1540	×	○
10	640	780	Aluminum plating	554	950	1240	1580	○	○
	630	775	Galvalium plating	550	950	1230	1575	○	○
11	650	760	Aluminum plating	572	950	1200	1510	○	○
	650	760	Galvalium plating	563	950	1205	1520	○	○
12	620	730	Aluminum plating	595	950	1270	1560	○	○
	630	730	Galvalium plating	598	950	1275	1570	○	○

Specimens were cut out from the portions which underwent working during press forming and bare corrosion resistance and after-painting corrosion resistance were evaluated as the surface properties after high temperature forming. The bare corrosion resistance was evaluated by subjecting the specimens to a moisture tank test (relative humidity: 95%, temperature: 40°C) for 3 days, and the after-painting corrosion resistance was evaluated by subjecting the specimens to a salt spray test (JIS-Z2134) for 30 days after the specimens were cut in a cross shape. A cationic electrodeposition paint was adopted as the painting in this case and the painting thickness was 15 μm. The bare corrosion resistance was judged from the appearance using a mark ○ or ×, and the evaluation criteria were: × for the occurrence of red rust and ○ for no red rust. Likewise, the after-painting corrosion resistance was judged from the appearance using a mark ○, △ or ×, and the evaluation criteria were: ○ for blistering of not more than 2 mm, △ for blistering from more than 2 mm to not more than 4 mm, and × for blistering of more than 4 mm. Nos. 1 to 7 steels are the steels having the components within the range specified in the present invention, and all steel sheets produced on the conditions within the range specified in the present invention can secure high strength after high temperature forming and, moreover, have no problem with respect to both the bare corrosion resistance and the after-painting corrosion resistance. Here, in case of No. 7 steel, the results of the steel sheet produced on the conditions where the annealing temperature deviates from the range specified in the present invention is also shown, and, in this case, as the strength of the steel sheet is too high, the evaluation of the properties is not carried out thereafter. In case of Nos. 8 and 9 steels, the steel

compositions deviate from the range specified in the present invention. As a result, in case of No. 8 steel, the strength after high temperature forming, which is one of the targets of the present invention, is low, and, in the case of No. 9 steel, the bare corrosion resistance and the after-painting corrosion resistance are not secured.

Example 3

The steels having various chemical compositions as shown in Table 6 were cast, heated again to a temperature of 1,050 to 1,250°C, thereafter hot-rolled, pickled, cold-rolled, annealed, subjected to a plating treatment (aluminum plating or aluminum-zinc plating), and thereafter subjected to temper rolling at the reduction rate of 0.8%. Further, as substantial alloying process, these steel sheets were heated to a temperature of 900 to 1,000°C, retained for 5 minutes at this temperature, thereafter subjected to press forming with dies of the room temperature, and then subjected to the investigation on the properties. The investigation on material properties was carried out by cutting out specimens from the portions which were rapidly cooled at the press and applying a tensile test thereto. The test was carried out by cutting the specimens into No. 5 test pieces according to JIS-Z2201 and following the test method described in JIS-Z2241. The evaluation results are shown in Table 7.

[Tables 6 and 7]

Table 6

Steel No.	C	Si	Mn	S	P	Al	N	Cr	Mo	Cr+7×Mo	Remarks
1	0.16	0.20	0.72	0.006	0.020	0.035	0.0025	1.00	0.18	2.260	Invented example
2	0.21	0.21	0.68	0.008	0.018	0.032	0.0030	0.95	0.15	2.000	Invented example
3	0.50	0.25	0.75	0.006	0.020	0.026	0.0028	0.98	0.17	2.170	Invented example
4	0.23	0.20	1.50	0.010	0.015	0.030	0.0030	0.32	0.00	0.320	Invented example
5	0.22	0.45	2.20	0.009	0.010	0.038	0.0035	0.00	0.05	0.350	Invented example
6	0.23	0.15	0.30	0.008	0.012	0.032	0.0026	1.90	0.00	1.900	Invented example
7	0.21	0.20	0.50	0.008	0.010	0.033	0.0028	0.00	0.80	5.600	Invented example
8	0.22	0.21	0.65	0.006	0.015	0.032	0.0030	0.10	0.02	0.240	Invented example
9	0.22	0.20	0.70	0.008	0.014	0.025	0.0025	0.25	0.00	0.250	Invented example
10	0.21	0.18	0.45	0.010	0.012	0.028	0.0025	0.00	0.03	0.210	Comparative example

Table 7

Steel No.	Coiling temperature (°C)	Annealing temperature (°C)	Kind of plating	TS before forming (Mpa)	Heating temperature before forming (°C)	YP (MPa)	TS (MPa)	Bare corrosion resistance	After-painting corrosion resistance	Remarks
1	630	780	Aluminum plating	565	980	1080	1280	○	○	Invented example
	620	780	Aluminum-zinc plating	560	980	1090	1270	○	○	Invented example
2	650	770	Aluminum plating	605	950	1290	1560	○	○	Invented example
	650	765	Aluminum-zinc plating	600	950	1285	1580	○	○	Invented example
3	635	740	Aluminum plating	725	930	1705	1890	○	○	Invented example
	630	750	Aluminum-zinc plating	750	930	1700	1900	○	○	Invented example
4	645	775	Aluminum plating	500	950	1390	1610	○	○	Invented example
	650	780	Aluminum-zinc plating	508	950	1400	1600	○	○	Invented example
5	630	770	Aluminum plating	603	950	1300	1550	○	○	Invented example
	630	770	Aluminum-zinc plating	605	950	1320	1555	○	○	Invented example
6	650	770	Aluminum plating	654	950	1390	1620	○	○	Invented example
	640	760	Aluminum-zinc plating	660	950	1380	1620	○	○	Invented example
7	640	770	Aluminum plating	780	950	1320	1510	○	○	Invented example
	650	760	Aluminum-zinc plating	774	950	1325	1520	○	○	Invented example
8	630	765	Aluminum plating	553	950	1320	1580	○	○	Invented example
	635	760	Aluminum-zinc plating	555	950	1310	1570	○	○	Invented example
9	640	770	Aluminum plating	558	950	1340	1575	○	○	Invented example
	645	770	Aluminum-zinc plating	562	950	1350	1585	○	○	Invented example
10	630	765	Aluminum plating	554	950	1350	1595	×	×	Comparative example
	640	760	Aluminum-zinc plating	550	950	1330	1530	×	×	Comparative example

Specimens were cut out from the portions which underwent working during press forming and bare corrosion resistance and after-painting corrosion resistance were evaluated as the surface properties after high temperature forming. The bare corrosion resistance was evaluated by subjecting the specimens to a moisture tank test (relative humidity: 95%, temperature: 40°C) for 3 days, and the after-painting corrosion resistance was evaluated by subjecting the specimens to a salt spray test (JIS-Z2134) for 30 days after the specimens were cut in a cross shape. A cationic electrodeposition paint was adopted as the painting in this case and the painting thickness was 15 μm. The bare corrosion resistance was judged from the appearance using a mark ○ or ×, and the evaluation criteria were: × for the occurrence of red rust and ○ for no red rust. Likewise, the after-painting corrosion resistance was judged from the appearance using a mark ○, △ or ×, and the evaluation criteria were: ○ for blistering of not more than 2 mm, △ for blistering from more than 2 mm to not more than 4 mm, and × for blistering of more than 4 mm. Nos. 1 to 9 steels are the steels having the components within the range specified in the present invention, and all steel sheets produced on the conditions within the range specified in the present invention can secure high strength after high temperature forming, and moreover have no problem with respect to both the bare corrosion resistance and the after-painting corrosion resistance. In case of the No. 10 steel, the steel composition deviates from the range specified in the present invention and therefore the bare corrosion resistance and the after-painting corrosion resistance are not secured.

Example 4

Hot dip aluminum plating was applied to pickled steel sheets (1.8 mm in thickness) and cold-rolled steel

sheets (1.2 mm in thickness) as the materials having steel compositions shown in Table 8 and being produced through regular hot-rolling and cold-rolling processes. Nos. 1, 3, 5 and 7 in Table 8 are cold-rolled steel sheets, and the rest are hot-rolled steel sheets. In the hot dip aluminum plating, a line of non-oxidizing furnace-reducing furnace type was used, a deposit amount of plating was adjusted to 80 g/m^2 per both sides by the gas wiping method after plating, and, after that, the steel sheets were cooled and subjected to a zero-spangle treatment. The plating bath composition at the time was Al-10%Si-2%Fe. Fe in the bath is a component unavoidably supplied from the plating apparatus and the steel sheets in the bath. Plating appearance was good without having non-plating defects or the like. The properties are shown in Table 9.

The hardenability and workability of the hot dip aluminum plated steel sheets thus produced were evaluated. The workability was evaluated by heating an aluminum plated steel sheet at 950°C for 10 minutes under the atmosphere, as substantial alloying process, thereafter cooling it while inserting it between dies made of steel (cooling rate: about 30°C/sec.), cooling it to the room temperature, and thereafter subjecting it to an impact test. Further, Vickers hardness at the cross-section of a steel sheet was measured by imposing a load of 100 g.

Evaluation criteria of workability

○: No exfoliation

△: Cracks generated

×: Powdery exfoliation generated

[Tables 8 and 9]

Table 8

No.	Chemical composition (wt%)										
	C	Si	Mn	P	S	Al	N	Ti	Cr	Mo	B
1	0.23	0.12	1.21	0.02	0.009	0.03	0.004	0.02	0.13	-	0.002
2	0.21	0.20	0.81	0.02	0.007	0.05	0.004	0.22	0.20	-	-
3	0.17	0.15	1.24	0.01	0.008	0.03	0.003	0.01	1.10	-	0.0008
4	0.23	0.31	1.54	0.02	0.007	0.05	0.003	0.02	0.44	-	0.002
5	0.25	0.18	1.22	0.01	0.01	0.04	0.003	0.02	0.66	0.20	0.005
6	0.24	0.2	0.95	0.01	0.02	0.05	0.004	0.09	0.5	0.15	0.01
7	0.2	0.2	2.43	0.01	0.01	0.04	0.003	0.09	0.21	-	0.0008
8	0.04	0.1	1.4	0.02	0.01	0.03	0.004	0.25	0.15	-	0.0003

Table 9

No.	Workability	Al amount in Fe-Al coating (%)	Vickers hardness
1	O	15	515
2	O	15	480
3	O	15	405
4	O	15	511
5	O	15	548
6	O	15	539
7	O	15	466
8	O	15	209

When the C amount is rather low as in the No. 8 steel, the strength is rather low. In general, a value close to the tensile strength (MPa) of a material is obtained by multiplying a Vickers hardness by 3, and, in this case, a strength of only 600 MPa class at the most is obtained. In case of Nos. 1 to 7 steels, both strength and workability show good results. The Al amount in the Fe-Al coating layer in this case is quantitatively analyzed using an EPMA, and the value is around 15%. Here, the value is obtained by analyzing 5 portions in a cross-section of a specimen after quenching in the range from the surface to the depth of 10 μm and averaging the analysis data.

Next, No. 1 steel sheet of this Example in Table 8 was plated with a metal mainly composed of Al-10%Si-2%Fe and the deposit amount of the plating was varied from 60

to 200 g/m^2 per both sides. The samples thus obtained were heated at 950°C under the atmosphere with the retention time being changed, the workability was evaluated with an impact test, and the Al amount in the Fe-Al coating layer was measured by the method described in the item 1 of Example 4. As shown in Table 10, the workability depends on the Al amount in the Fe-Al coating layer, and, when the Al amount is not more than 35%, good workability is obtained. Further, the Al amount in the Fe-Al coating layer depends on the deposit amount and the retention time, and it can be understood that, the smaller the deposit amount is and the longer the retention time is, the more the diffusion proceeds and the smaller the Al amount in the Fe-Al coating layer is.

[Table 10]

Table 10

No.	Deposit amount (g/m^2)	Retention time	Al amount in Fe-Al coating (%)	Workability
1	60	0	36	△
2	60	1	29	○
3	60	2	17	○
4	80	0	38	×
5	80	1	35	△
6	80	2	20	○
7	120	2	42	×
8	120	4	36	×
9	120	6	15	○
10	200	5	44	×
11	200	10	38	×
12	200	15	377	×

Example 5

Hot dip Al-Si-Mg plating was applied to pickled steel sheets (1.8 mm in thickness) and cold-rolled steel sheets (1.2 mm in thickness) as the materials, having steel compositions shown in Table 11 and being produced through regular hot-rolling and cold-rolling processes.

A, C, E and G in Table 11 are cold-rolled steel sheets, and the rest are hot-rolled steel sheets. In the hot dip plating, a line of non-oxidizing furnace-reducing furnace type was used, a deposit amount of plating was adjusted to 40 g/m^2 per one side by the gas wiping method after plating, and, after that, the steel sheets were cooled and subjected to a zero-spangle treatment. The plating bath composition at the time was Al-8%Si-6%Mg-1%Fe-0.1%Ca. Fe in the bath is a component unavoidably supplied from the plating apparatus and the steel sheets in the bath. Plating appearance showed a spangle pattern and was good without having non-plating defects or the like. The production conditions in this case are shown in Table 12.

The hardenability and corrosion resistance of the hot dip plated steel sheets thus produced were evaluated. The evaluation methods are described below. The hot dip plated steel sheets were subjected to 5% tensile stress, then heated at 950°C for 5 minutes, and, as substantial alloying process, thereafter cooled while inserted between steel sheets. The cooling rate was about 30°C/sec. The heat resistance was evaluated by visually observing the specimens after cooling. Then, the bare corrosion resistance was evaluated by subjecting the specimens to a moisture tank test (relative humidity: 95%, temperature: 40°C) for 3 days, and the after-painting corrosion resistance was evaluated by subjecting the specimens to a salt spray test (JIS-Z2134) for 30 days after the specimens were cut in a cross shape. A cationic electrodeposition paint was adopted as the painting in this case and the painting thickness was 15 μm. Further, the Vickers hardness of a steel sheet was measured by imposing a load of 100 g.

Evaluation criteria of heat resistance

○: Good

△: Crack-shaped patterns generated on the

surface

×: Red scales generated

Evaluation criteria of bare corrosion resistance

○: Good

△: Red rust generated

Evaluation criteria of after-painting corrosion resistance

◎: Paint blister not more than 1 mm

○: Paint blister not more than 2 mm

△: Paint blister 2 to 4 mm

×: Paint blister more than 4 mm

[Tables 11 and 12]

Table 11

Steel code	C	Si	Mn	P	S	Al	N	Ti	Cr	Mo	Ni	B
A	0.21	0.20	0.81	0.02	0.007	0.05	0.004	0.05	0.20	-	-	0.0005
B	0.17	0.15	1.24	0.01	0.008	0.03	0.003	0.15	1.10	-	-	0.0008
C	0.42	0.7	2.41	0.01	0.009	0.01	0.003	0.46	0.21	-	-	0.001
D	0.23	0.31	1.54	0.02	0.007	0.4	0.003	0.24	0.44	-	-	0.002
E	0.25	0.18	1.22	0.01	0.01	0.04	0.003	0.003	0.66	0.20	-	0.005
F	0.24	0.2	0.95	0.01	0.02	0.05	0.004	0.001	-	0.15	0.33	0.01
G	0.08	0.1	1.4	0.02	0.01	0.03	0.004	0.25	0.15	-		0.0003
H	0.24	0.10	0.31	0.01	0.008	0.03	0.004	0.21	0.03	-		0.0001

Table 12

No.	Code of applied steel	Bare corrosion resistance	After-painting corrosion resistance	Vickers hardness
1	A	○	○	485 (○)
2	B	○	○	401 (○)
3	C	○	○	769 (○)
4	D	○	○	509 (○)
5	E	○	○	544 (○)
6	F	○	○	540 (○)
7	G	○	○	289 (×)
8	H	○	○	301 (×)

When the C amount is too small as in the No. 7 steel sheet, sufficient strength is not obtained. In general,

a value close to material strength (MPa) is obtained by multiplying a Vickers hardness by 3, and, in this case, a strength of only 800 MPa class at the most is obtained. Further, when the amounts of the elements effective in quenching, such as Mn, B, etc., are small as in No. 8 steel sheet, the quenching effect is not obtained even though the C amount is large. In case of Nos. 1 to 6 steel sheets wherein the addition amounts of the elements in the steels are properly controlled, both strength and corrosion resistance show good results in either the case of the Mn-B-system or the Mo-Cr-Ni-system.

Then, using steel E in Table 11, the relation between the plating compositions and the properties of the plated steel sheets was investigated with the compositions in the plating bath of the hot dip plating line being varied. The relation between the compositions of the plated layers and the properties thereof after plating is summarized in Table 13. Here, the Vickers hardness was in the range from 470 to 510 in each case.

In case of a No. 8 steel sheet, which is of Mg-Zn-system, corrosion resistance is poor. On the other hand, Nos. 4 to 7 steel sheets, which are of Si-Mg-system, show excellent corrosion resistance. Likewise, Nos. 1 to 3 steel sheets, which are of Si-Mg-Zn-system, show excellent corrosion resistance.

[Table 13]

Table 13

No.	Composition of plated layer (mass %)				Bare corrosion resistance	After-painting corrosion resistance
	Si	Mg	Zn	Ca		
1	2	3	40	0.1	○	◎
2	5	7	20	0.1	○	◎
3	8	6	10	-	○	◎
4	12	8	-	0.1	○	◎
5	8	6	-	0.1	○	◎
6	6	3	-	-	○	◎
7	9	0.5	-	-	○	◎
8	-	1	3	-	×	×

Example 6

Hot dip aluminum plating was applied to cold-rolled steel sheets (1.2 mm in thickness) as the materials, having a steel composition shown in Table 14 and being produced through regular hot-rolling and cold-rolling processes. In the hot dip aluminum plating, a line of non-oxidizing furnace-reducing furnace type was used, a deposit amount of plating was adjusted to 60 g/m^2 per one side by the gas wiping method after plating, and, after that, the steel sheets were cooled and subjected to a zero-spangle treatment. The plating bath composition at the time was Al-10%Si-2%Fe. Fe in the bath is a component unavoidably supplied from the plating apparatus and the steel sheets in the bath. The plating appearance was good without having non-plating defects or the like. The aluminum plated steel sheets thus produced were heated to 950°C, and, as substantial alloying process, the workability (exfoliation resistance) of the plated layers during air-cooling was evaluated.

At this time, the thickness of the ferrite layers was varied by varying the heating times and heating patterns. Working was applied by an impact test, the exfoliation state was visually judged with the working temperature being varied during cooling, and the workability of the plated layers was evaluated at the

lowest temperature where the exfoliation of a plated layer did not occur. Here, in case of this steel, the hardenability was good even at the cooling rate of 10°C/sec. and a structure mainly composed of martensite was obtained even in case of air-cooling. The relation between the thickness of the intermediate ferrite layer and the lowest temperature where good working can be obtained in this case is shown in Fig. 8.

As shown in Fig. 8, it is understood that, when the thickness of a ferrite layer is not less than 2 μm, preferably not less than 4 μm, the exfoliation resistance of a plated layer improves. When the thickness of a ferrite layer is about 0.5 μm, powdery exfoliation of a plated layer is observed even in the case of the working at 800°C. Further, as substantial alloying process, the workability of a plated layer depends on the deposit amount of plating. Even though the thickness of a ferrite layer is 2 μm, when the deposit amount is 30 g/m^2 per one side, the lowest temperature where good working is obtained is about 500°C. Further, the structure of the base steel at the time was analyzed by the observation with an optical microscope and the subsequent image analysis, and not less than 80% of the structure was composed of martensite under all conditions.

[Table 14]

Table 14

C	Si	Mn	P	S	Al	N	Ti	Cr	Mo	B
0.36	0.21	0.65	0.02	0.006	0.027	0.003	0.002	1.01	0.16	0.0001

Example 7

Hot dip aluminum plating was applied to pickled steel sheets (1.8 mm in thickness) and cold-rolled steel sheets (1.2 mm in thickness) as the materials, having steel compositions shown in Table 15 and being produced through regular hot-rolling and cold-rolling processes.

Nos. 1, 3 and 5 in Table 15 are cold-rolled steel sheets, and the rests are hot-rolled steel sheets. In the hot dip aluminum plating, a line of non-oxidizing furnace-reducing furnace type was used, a deposit amount of plating was adjusted to 60 g/m^2 per one side by the gas wiping method after plating, and, after that, the steel sheets were cooled and subjected to a zero-spangle treatment. The plating bath composition at the time was Al-10%Si-2%Fe. Plating appearance was good without having non-plating defects or the like. The hot dip aluminum plated steel sheets thus produced were heated to 950°C, and, as substantial alloying process, thereafter subjected to press forming at the time when the temperature reached about 600°C while cooled by water-cooled dies. The exfoliation state of a plated layer at the portion to which bending working was applied was visually judged and the exfoliation of a plated layer was not observed for all steel sheets. At the time, the thickness of the ferrite layers was 10 to 20 μm, and the martensite percentage in all base steels was not less than 80%. Here, the cooling rate was about 150°C/sec.

[Table 15]

Table 15

No.	C	Si	Mn	P	S	Al	N	Ti	Cr	Mo	B
1	0.22	0.20	0.94	0.02	0.007	0.025	0.003	0.22	0.05	0.002	0.0017
2	0.16	0.17	0.69	0.02	0.007	0.037	0.004	0.002	0.98	0.17	0.0001
3	0.20	0.20	0.67	0.02	0.006	0.033	0.003	0.002	0.96	0.17	0.0002
4	0.22	0.15	0.88	0.03	0.007	0.022	0.004	0.55	0.12	0.01	0.0005
5	0.25	0.55	0.72	0.02	0.009	0.025	0.003	0.31	0.58	0.12	0.0020

Example 8

Hot dip aluminum plating was applied to cold-rolled steel sheets (1.2 mm in thickness) as the materials, having a steel composition shown in Table 16 and being produced through regular hot-rolling and cold-rolling processes. In the hot dip aluminum plating, a line of non-oxidizing furnace-reducing furnace type was used, the

deposit amounts of plating were adjusted to 30 to 80 g/m^2 per one side by the gas wiping method after plating, and, after that, the steel sheets were cooled and subjected to a zero-spangle treatment. The plating bath composition at the time was Al-10%Si-2%Fe. Fe in the bath is a component unavoidably supplied from the plating apparatus and the steel sheets in the bath. Plating appearance was good without having non-plating defects or the like. The hardness after quenching, the thickness of the intermetallic compounds, weldability, heat resistance and after-painting corrosion resistance of the aluminum plated steel sheets thus produced were evaluated. The quenching was applied by heating a steel sheet at 950°C for 0.5 to 20 minutes in the atmosphere, and, as substantial alloying process, thereafter pressing the steel sheet in the state of a plane sheet with dies and cooling it. At the time, the cooling rate was about 300°C/sec. By so doing, quenched steel sheets having alloy layers different in thickness and alloyed up to the surface were obtained by changing the deposit amounts and heating times. Here, the appearance of all steel sheets was almost homogenous. The evaluation methods and the evaluation criteria of the properties are shown below.

[Table 16]

Table 16

Number	C	Si	Mn	P	S	Al	N	Ti	Cr	Mo	B
1	0.22	0.20	0.94	0.02	0.007	0.025	0.003	0.22	0.05	0.002	0.0017

[Hardness]

Vickers hardness was measured at the center portion in the cross-section of a steel sheet by imposing a load of 100 g.

[Thickness of intermetallic compound]

The thickness of an intermetallic compound was measured by observing the cross-section of a steel sheet using a microscope, then etching it with 2% nitral, and

thereafter analyzing the structure using an EPMA. An example of the analysis is shown in Fig. 9. The reference numeral 1 shows the layer composed of Al: 26.85%, Si: 9.83%, Fe: 59.92%; the reference numeral 2 the layer composed of Al: 49.54%, Si: 3.11%, Fe: 44.87%; the reference numeral 3 the layer composed of Al: 30.75%, Si: 8.88%, Fe: 56.91%; and the reference numeral 4 the layer composed of Al: 9.59%, Si: 2.92%, Fe: 84.02%.

[Weldability]

Spot weldability was evaluated on the following conditions:

Electrode; Dome electrode made of alumina dispersed copper and having an electrode tip of 6ϕ-40R,

Pressure; 600 kgf,

Welding current; 10 kA,

Welding time; 12 cycles (60 Hz).

Evaluation criteria

○: Consecutive spot welding of more than 2,000 cycles

△: Consecutive spot welding of 1,200 to 2,000 cycles

×: Consecutive spot welding of less than 1,200 cycles

[After-painting corrosion resistance]

A steel sheet was subjected to a chemical treatment for about 2 minutes in a chemical treatment liquid, which was commonly used for aluminum plating a steel sheet and zinc plating, then coated with a cationic electrodeposition paint of 20 μm in thickness, baked at 140°C for 20 minutes, and thereafter subjected to a salt spray test for 20 days after cut in a cross shape, and the after-painting corrosion resistance was judged by the corrosion depth at the portion cut in a cross shape. Here, the depth of the cut in a cross shape with a cutter was about 50 μm. Therefore, a value obtained by subtracting 50 μm from a measured value is a true

corrosion depth.

The evaluation results are summarized in Table 17.

Evaluation criteria

○: Corrosion depth not more than 80 μm

×: Corrosion depth more than 80 μm

[Table 17]

Table 17

No.	Thickness of alloy layer (μm)	Hardness of base material (Hv)	Spot weldability	After-painting corrosion resistance
1	2	397	○	×
2	5	395	○	○
3	10	399	○	○
4	17	401	○	○
5	25	398	△	○
6	32	399	△	○
7	38	397	×	○

As shown in Table 17, when the thickness of an alloy layer is small, the steel sheet tends to be excellent in spot weldability but to be inferior in after-painting corrosion resistance. When the thickness is too thin like No. 1 steel sheet, the steel sheet is inferior in after-painting corrosion resistance, and when the thickness is too heavy like No. 7 steel sheet, the steel sheet is inferior in spot weldability. In case of Nos. 5 and 6 steel sheets too, the steel sheets tend to be inferior in spot weldability. Therefore, when spot weldability is regarded as important, it is desirable to make the thickness of an alloy layer rather thin.

Example 9

Steel sheets made of the steels shown in Table 18 were plated with a metal mainly composed of Al-10%Si-2%Fe, and good plating appearance was obtained. The thickness of the alloyed layers after quenched on the same conditions as the item 1 of Example 7 was measured

and the values were within the range from 8 to 15 μm. With respect to those steel sheets, the same evaluation items as the item 1 of Example 7 were evaluated. As a result, all of the steel sheets obtained the evaluation results which correspond to the evaluation rank ○ of Example 1, and showed good weldability and good after-painting corrosion resistance.

[Table 18]

Table 18

No.	C	Si	Mn	P	S	Al	N	Ti	Cr	Mo	B
1	0.22	0.20	0.94	0.02	0.007	0.025	0.003	0.22	0.05	0.002	0.0017
2	0.16	0.17	0.69	0.02	0.007	0.037	0.004	0.002	0.98	0.17	0.0001
3	0.20	0.20	0.67	0.02	0.006	0.033	0.003	0.002	0.96	0.17	0.0002
4	0.36	0.21	0.65	0.02	0.006	0.027	0.003	0.002	1.01	0.16	0.0001
5	0.22	0.15	0.88	0.03	0.007	0.022	0.004	0.55	0.12	0.01	0.0005
6	0.25	0.55	0.72	0.02	0.009	0.052	0.003	0.31	0.58	0.12	0.0020
7	0.23	0.18	0.21	0.03	0.007	0.025	0.003	0.27	0.03	0.01	0.0022

Example 10

Hot dip aluminum plating was applied to cold-rolled steel sheets (1.2 mm in thickness) as the materials having a steel composition shown in Table 19 and being produced through regular hot-rolling and cold-rolling processes. In the hot dip aluminum plating, a line of non-oxidizing furnace-reducing furnace type was used, a deposit amount of plating was adjusted to 60 g/m^2 per one side by the gas wiping method after plating, and, after that, the steel sheets were cooled and subjected to a zero-spangle treatment. The plating bath composition at the time was Al-10%Si-2%Fe. Fe in the bath is a component unavoidably supplied from the plating apparatus and the steel sheets in the bath. The plating appearance was good without having non-plating defects or the like. The hot dip aluminum plated steel sheets thus produced were heated in the atmosphere, then retained at various temperatures, and formed into the shape shown in Fig. 10. At the time, the steel sheets were cooled with water-

cooled dies. The heating rate was about 5 to 10°C/sec., and the cooling rate was, though it varied with the portions, about 100°C/sec. at a portion where cooling rate was high and about 20°C/sec. at a portion where cooling rate was low. The workability (exfoliation resistance) of a plated layer at the time was evaluated. The exfoliation of the plated layers was formed in a shape of streak or in a shape of spot on the compressed surface. The relation between the heating conditions and the state of the exfoliation of the plated layers is shown in Table 20. Further, the heating conditions according to the present invention are shown in Fig. 11.

[Tables 19 and 20]

Table 19

C	Si	Mn	P	S	Al	N	Ti	Cr	Mo	B
0.24	0.21	0.95	0.02	0.006	0.027	0.003	0.002	1.01	0.16	0.0018

Table 20

No.	Heating temperature (°C)	Heating time (min.)	Adhesiveness
1	800	20	△
2	850	15	○
3	900	13	○
4	950	8	○
5	1000	6	○
6	1050	4	○
7	1100	2	○
8	900	5	×
9	1000	2	×

Evaluation criteria of adhesiveness

○: No exfoliation of plated layer

△: Cracks generated partially in plated layer

×: Exfoliation of plated layer generated

As shown in Table 20, the adhesiveness is not regarded yet as perfect even after heating for 20 minutes when the temperature is as low as 800°C as substantial

alloying process. When a heating temperature rises, good adhesiveness is obtained with a retention time of not more than 10 minutes. Adhesiveness is still insufficient when the retention time is 5 minutes at 900°C, or 2 minutes at 1,000°C as substantial alloying process.

Industrial Applicability

As stated above, the present invention provides a hot press method for forming a high-strength automotive part, and will greatly contribute to the weight reduction of an automobile in the future.

CLAIMS

1. A high-strength alloyed aluminum-system plated steel sheet excellent in after-painting corrosion resistance, characterized by having an Fe-Al-system coating containing Mn and Cr of more than 0.1% in total on the surface of the steel sheet.

2. A high-strength alloyed aluminum-system plated steel sheet excellent in heat resistance and after-painting corrosion resistance, characterized by having an Fe-Al-system coating containing, in mass, Mn and Cr of more than 0.1% in total on the surface of the steel containing, in mass, C: 0.05 to 0.7%, Si: 0.05 to 1%, Mn: 0.5 to 3%, P: not more than 0.1%, S: not more than 0.1% and Al: not more than 0.2%, and, in addition, one or more element(s) selected from among Ti: 0.01 to 0.8%, Cr: not more than 3% and Mo: not more than 1%, so as to satisfy the following expression (1):

$$Ti + 0.5 \times Mn + Cr + 0.5 \times Mo > 0.4 \quad \ldots 1$$

3. A high-strength alloyed aluminum-system plated steel sheet excellent in heat resistance and after-painting corrosion resistance according to claim 2, characterized in that the steel further contains, in mass, one or more element(s) selected from among N: not more than 0.1%, Nb: not more than 0.1%, V: not more than 0.1%, Ni: not more than 1%, Cu: not more than 1%, B: 0.0003 to 0.03%, Sn: not more than 0.1% and Sb: not more than 0.1%.

4. A high-strength alloyed aluminum-system plated steel sheet excellent in heat resistance and after-painting corrosion resistance according to claim 1, characterized in that the steel contains, in mass, C: 0.15 to 0.55%, Si: not more than 0.5%, Mn: 0.2 to 3%, P: not more than 0.1%, S: not more than 0.04%, Al: 0.01 to 0.1% and N: not more than 0.01%, and also one or more element(s) selected from among B: 0.0002 to 0.0050%, Ti: 0.01 to 0.8%, Cr: not more than 2%, Mo: not more than 1%, Ni: not more than 1%, Cu: not more than 0.5% and Sn: not

more than 0.2%.

5. A high-strength alloyed aluminum-system plated steel sheet excellent in heat resistance and after-painting corrosion resistance according to any one of claims 1 to 4, characterized in that the Fe-Al-system coating further contains Si of 1 to 20%.

6. An alloyed aluminum-system plated steel sheet for high-strength automotive members according to any one of claims 1 to 5, characterized in that Al concentration in the Fe-Al-system coating layer is not more than 35% in weight.

7. A high-strength alloyed aluminum-system plated steel sheet excellent in heat resistance and after-painting corrosion resistance according to any one of claims 1 to 6, characterized in that the Fe-Al-system coating further contains either one or both of Zn: 1 to 50% and Mg: 0.1 to 10%.

8. A high-strength alloyed aluminum-system plated steel sheet excellent in heat resistance and after-painting corrosion resistance according to any one of claims 1 to 7, characterized in that the thickness of the Fe-Al-system coating layer is 3 to 35 μm.

9. An alloyed aluminum-system plated steel sheet for high-strength automotive members, characterized by having: a coating layer mainly composed of Fe-Al on the surface of the steel sheet; a ferrite layer having a thickness from not less than 2 μm to not more than one tenth of the steel sheet thickness at the underside of the coating layer; and the base steel mainly composed of martensite at the underside of the ferrite layer.

10. An alloyed aluminum-system plated steel sheet for high-strength automotive members according to claim 9, characterized in that the alloyed aluminum-system plated layer on the surface of the steel sheet and the ferrite layer at the underside of the intermetallic compound layer contain Si.

11. An alloyed aluminum-system plated steel sheet for high-strength automotive members according to claim 9 or 10, characterized in that the hardness of the ferrite phase is not higher than 200.

12. A high-strength automotive part formed by press forming, at least a portion of which is composed of a steel according to any one of claims 1 to 11.

13. A high-strength automotive part according to claim 12, characterized by having a coated film 1 to 200 μm in thickness on at least a part of the surface.

14. A hot press method for a high-strength automotive member, wherein, when the automotive member is produced by a hot press using a steel sheet produced by plating a steel containing C of not less than 0.05% in weight as a steel component with a metal mainly composed of Al, the member is formed by press forming after heated on the heating condition of the longer time period side than the following regions, A, B, C and D, and at least a part of the member is cooled at a cooling rate of not lower than 10°C/sec.:

A (800°C, 13 min.), B (900°C, 6 min.), C (1,050°C, 1.5 min.), D (1,200°C, 0.3 min.).

Fig.1

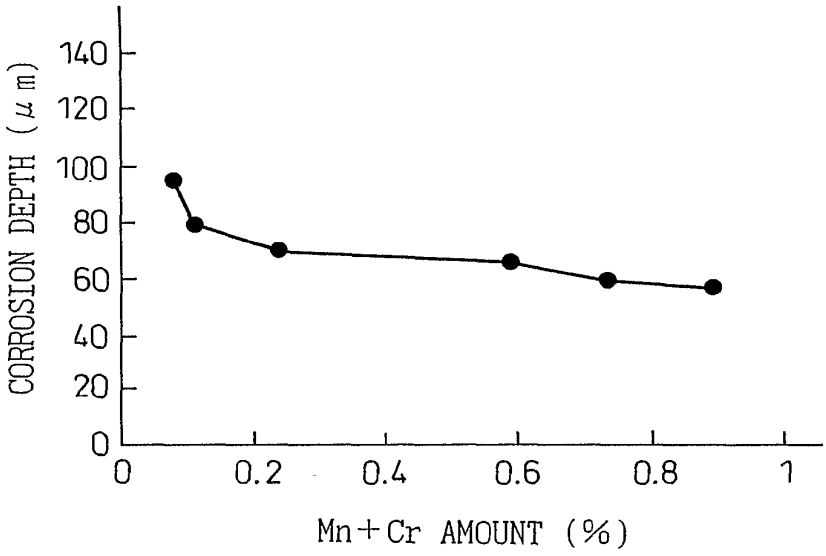

CORROSION DEPTH (μm)
140
120
100
80
60
40
20
0
0
0.2
0.4
0.6
0.8
1
Mn+Cr AMOUNT (%)

Fig.2

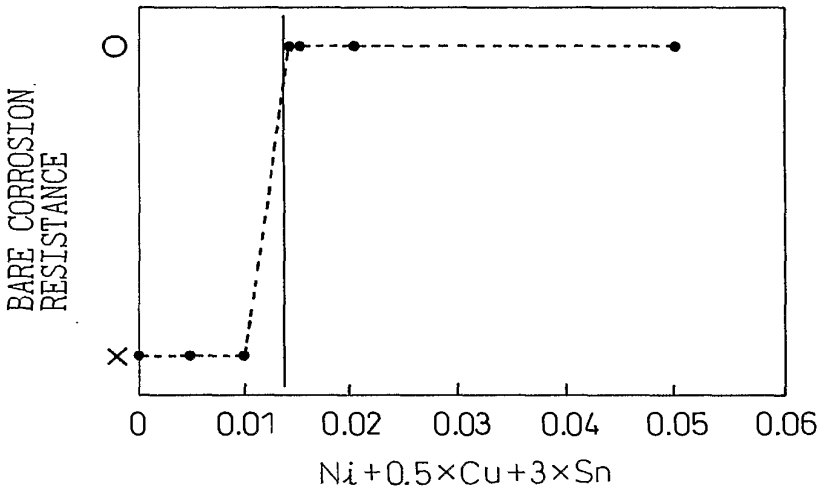

BARE CORROSION RESISTANCE
O
×
0
0.01
0.02
0.03
0.04
0.05
0.06
Ni+0.5×Cu+3×Sn

Fig.3

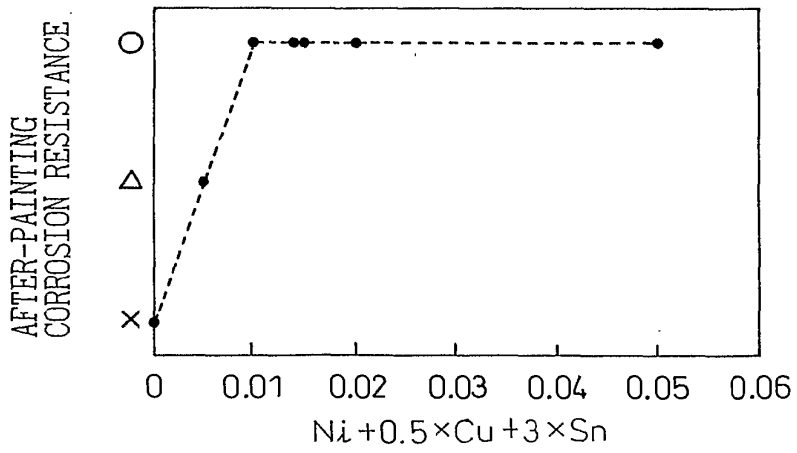

AFTER-PAINTING CORROSION RESISTANCE
O
△
×
0
0.01
0.02
0.03
0.04
0.05
0.06
Ni+0.5×Cu+3×Sn

Fig.4

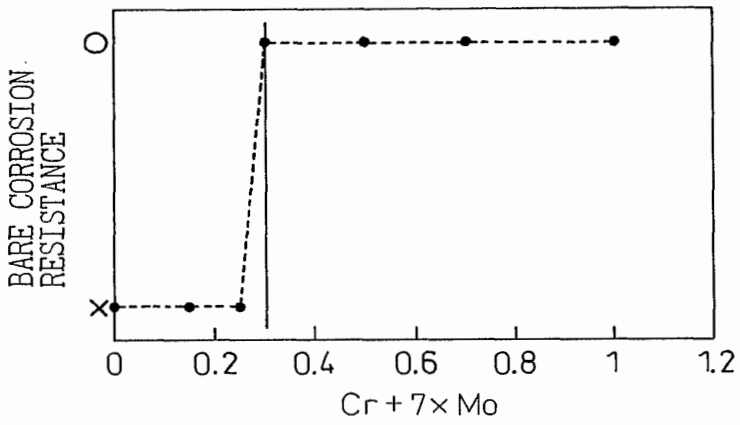
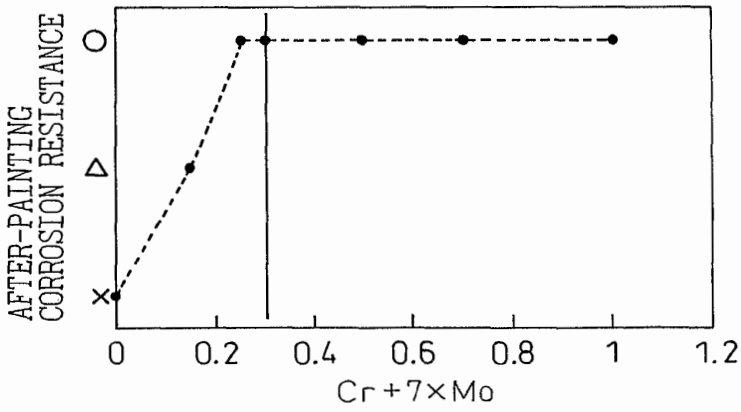


Fig.5



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Fig.6

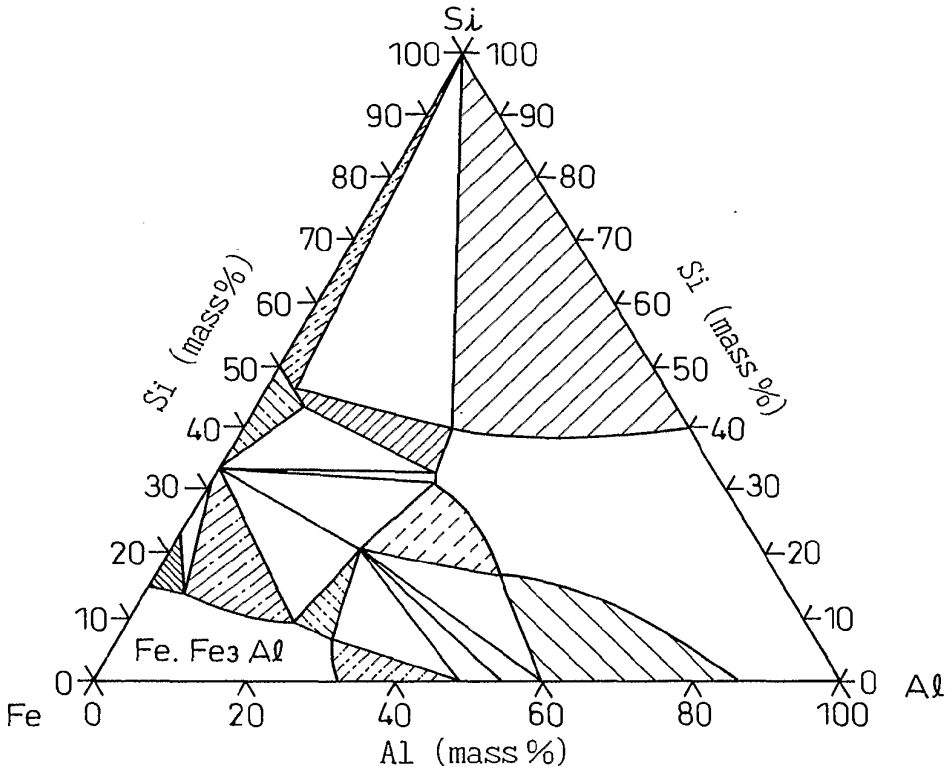

Si
100
90
80
70
60
50
40
30
20
10
0
Si (mass%)
Si (mass%)
Fe. Fe3 Al
Fe
0
20
40
60
80
100
Al
Al (mass%)

Fig.7

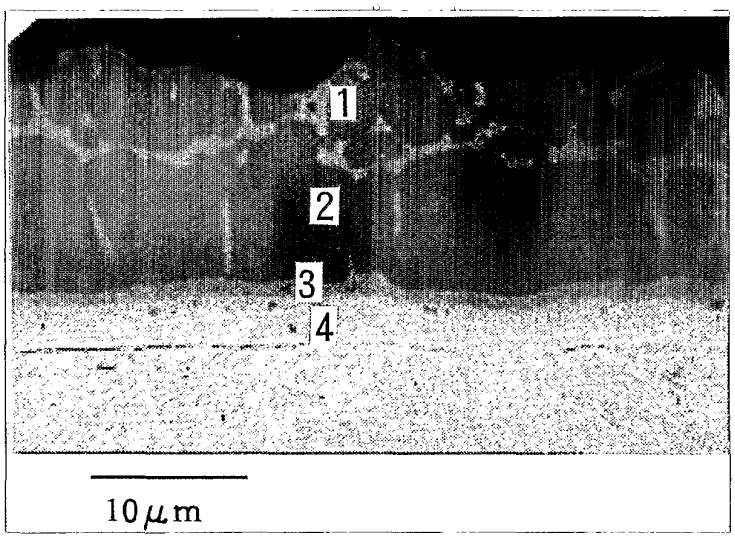

1
2
3
4
10μm

Fig.8

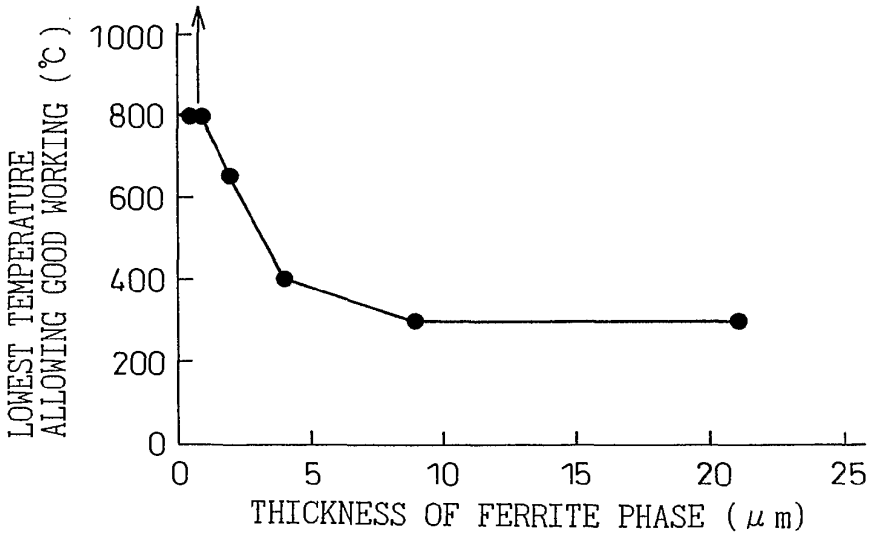

LOWEST TEMPERATURE ALLOWING GOOD WORKING (℃)
1000
800
600
400
200
0
0
5
10
15
20
25
THICKNESS OF FERRITE PHASE (μm)

Fig.9

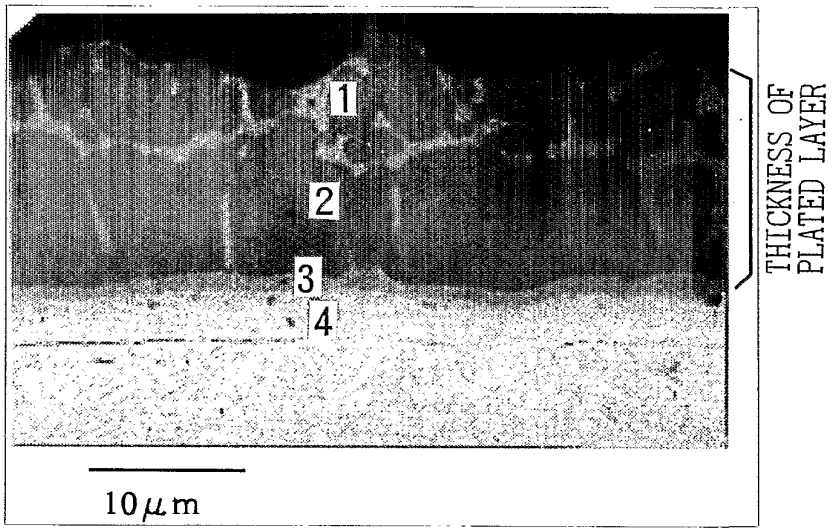


Fig.10

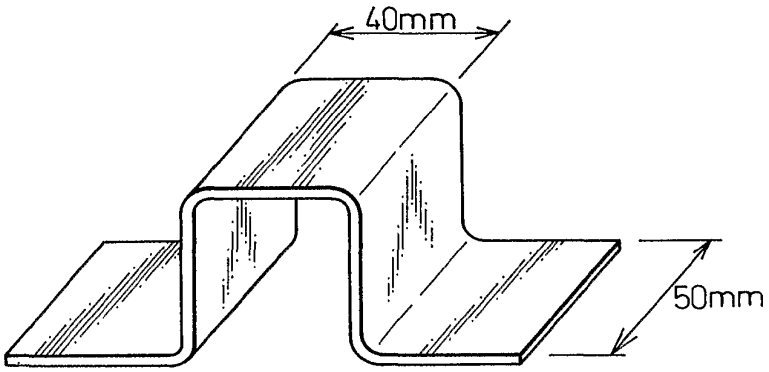
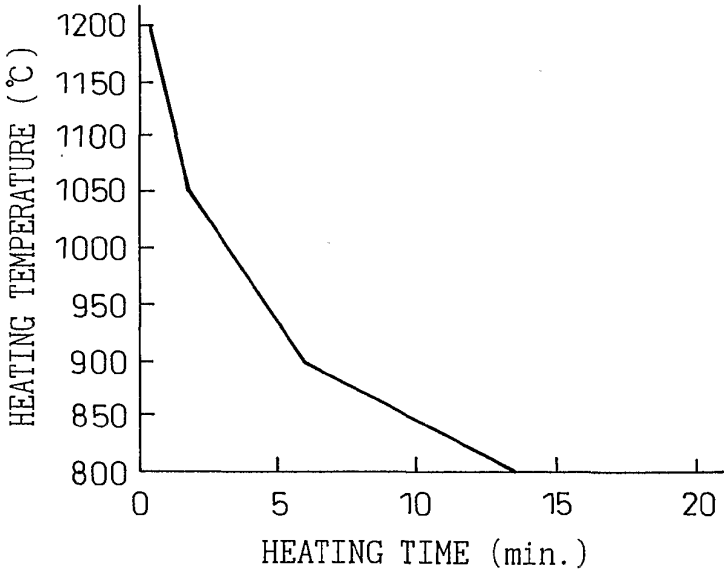

40mm
50mm

Fig.11


HEATING TEMPERATURE (℃)
1200
1150
1100
1050
1000
950
900
850
800
0
5
10
15
20
HEATING TIME (min.)

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant:	DRILLET et al.	Confirmation No.	6215
Application No.:	13/621,015		
Filing Date:	September 15, 2012		
Attorney Docket No.:	631.1028DIV		
Title:	**COATED STEEL STRIPS, METHODS OF MAKING THE SAME, METHODS OF USING THE SAME…**		

Submitted electronically via EFS-Web May 28, 2015

INFORMATION DISCLOSURE STATEMENT

S i r:

In accordance with the provisions of 37 C.F.R. §1.97, Applicants hereby make of record the documents listed on the accompanying Information Disclosure Statement by Applicant, PTO/SB/08a for consideration by the Examiner in connection with the examination of the above-identified patent application. While the references are being submitted herewith, some or all of the references may not constitute prior art under the U.S. patent laws.

This Information Disclosure Statement is filed under 37 C.F.R. §1.97(d). Applicant states under 37 C.F.R. §1.97(e)(1) that each item of information contained in the information disclosure statement was first cited in a communication from a foreign patent office in a counterpart foreign application not more than three months prior to the filing of the information disclosure statement. The disclosed documents were cited by in a counterpart Chinese application on February 28, 2015.

Respectfully submitted herewith is a check in the amount of $180.00 in accordance with 37. C.F.R. §1.17(p). In the event any additional fee is due in connection with this response or if any fee has been overpaid, the deficiency or overpayment should be charged to our Deposit Account No. 50-0552. Applicants respectfully request that the references cited in the accompanying PTO/SB/08a form be considered and made of record.

Respectfully submitted,
DAVIDSON, DAVIDSON & KAPPEL, LLC

By: /Jennifer L. O'Connell/
Jennifer L. O'Connell
(Reg. No. 57,392)

DAVIDSON, DAVIDSON & KAPPEL, LLC
589 Eighth Avenue, 16th Floor
New York, New York 10018
(212) 736-1940

Electronic Patent Application Fee Transmittal

Application Number:	13621015
Filing Date:	15-Sep-2012
Title of Invention:	COATED STEEL STRIPS, METHODS OF MAKING THE SAME, METHODS OF USING THE SAME, STAMPING BLANKS PREPARED FROM THE SAME, STAMPED PRODUCTS PREPARED FROM THE SAME, AND ARTICLES OF MANUFACTURE WHICH CONTAIN SUCH A STAMPED PRODUCT
First Named Inventor/Applicant Name:	Pascal DRILLET
Filer:	Jennifer Lauren O'Connell/Laura Steel
Attorney Docket Number:	704.1007DIV

Filed as Large Entity

Filing Fees for Utility under 35 USC 111(a)

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				
Extension-of-Time:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Miscellaneous:				
Submission- Information Disclosure Stmt	1806	1	180	180
		Total in USD ($)		**180**

Electronic Acknowledgement Receipt

EFS ID:	22474510
Application Number:	13621015
International Application Number:	
Confirmation Number:	6215
Title of Invention:	COATED STEEL STRIPS, METHODS OF MAKING THE SAME, METHODS OF USING THE SAME, STAMPING BLANKS PREPARED FROM THE SAME, STAMPED PRODUCTS PREPARED FROM THE SAME, AND ARTICLES OF MANUFACTURE WHICH CONTAIN SUCH A STAMPED PRODUCT
First Named Inventor/Applicant Name:	Pascal DRILLET
Customer Number:	23280
Filer:	Jennifer Lauren O'Connell
Filer Authorized By:	
Attorney Docket Number:	704.1007DIV
Receipt Date:	28-MAY-2015
Filing Date:	15-SEP-2012
Time Stamp:	16:27:11
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	Deposit Account
Payment was successfully received in RAM	$180
RAM confirmation Number	3070
Deposit Account	500552
Authorized User	O'CONNELL, JENNIFER L.
The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows:	

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Information Disclosure Statement (IDS) Form (SB08)	IDS_SB08a_28may15.pdf	613030 d2adae1dfab16417652dcd8d6c4ac12a22e5fb4c	no	5
Warnings:					
Information:					
2	Foreign Reference	W06IB4019US01_BET15P0879_A2.pdf	1885351 72c22424bdb658ad5db742f35320a28f15b09f33	no	44
Warnings:					
Information:					
3	Foreign Reference	W06IB4019US01_BET15P0879_A3.pdf	362217 99638dbbc44162c171ef8d6c95fab475cbcc278c	no	4
Warnings:					
Information:					
4	Non Patent Literature	W06IB4019US01_BET15P0879_A4.pdf	343034 75b28c0ba1cb8b194d588ddd8ff040dd0e1605b1	no	6
Warnings:					
Information:					
5	Foreign Reference	W06IB4019US01_BET15P0879_A5.pdf	503732 a2f719b6c6ab5382279067fedd746ff3eda35cff	no	17
Warnings:					
Information:					
6	Non Patent Literature	W06IB4019US01_BET15P0879_A6.pdf	134470 8800398acafd4a81d3d7d26507415458ec68540b	no	2
Warnings:					
Information:					
7	Foreign Reference	W06IB4019US01_BET15P0879_A7.pdf	512530 1d5a4aae4bc15a2adee55fdffd8410ea5053e144	no	12
Warnings:					
Information:					

8	Non Patent Literature	W06IB4019US01_BET15P0879_A8.pdf	874492 67bc16175f6abe820ce8f0c4f73f428da8fc53aa	no	15
Warnings:					
Information:					
9	Non Patent Literature	W06IB4019US01_BET15P0879_A9.pdf	1907724 898142962eeabf2fbd22da98419fd14a0f047feb	no	40
Warnings:					
Information:					
10	Foreign Reference	WO02103073A2.pdf	3277377 b33d84644a4377fc1929cc30f4bf06a35f2bacf9	no	70
Warnings:					
Information:					
11	Transmittal Letter	IDSLetter_28may15ff.pdf	58724 5dd59225268eebd077bb58d876ad136a68fa35ff	no	1
Warnings:					
Information:					
12	Fee Worksheet (SB06)	fee-info.pdf	30987 c9ed8c75e8f0664160017483501 74bfa4d329dae	no	2
Warnings:					
Information:					
		Total Files Size (in bytes):	10503668		

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111
If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371
If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office
If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
13/621,015	09/15/2012	Pascal DRILLET	704.1007DIV	6215

23280 7590 10/11/2016

Davidson, Davidson & Kappel, LLC
589 8th Avenue
16th Floor
New York, NY 10018

EXAMINER
SCHLEIS, DANIEL J

ART UNIT	PAPER NUMBER
1784	

NOTIFICATION DATE	DELIVERY MODE
10/11/2016	ELECTRONIC

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Notice of the Office communication was sent electronically on above-indicated "Notification Date" to the following e-mail address(es):

ddk@ddkpatent.com

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

Ex parte PASCAL DRILLET, DOMINIQUE SPEHNER, and RONALD KEFFERSTEIN

Appeal 2015-004912
Application 13/621,015
Technology Center 1700

Before MARK NAGUMO, BRIAN D. RANGE, and JENNIFER R. GUPTA, *Administrative Patent Judges*.

RANGE, *Administrative Patent Judge*.

DECISION ON APPEAL

SUMMARY

Appellants[1] appeal under 35 U.S.C. § 134(a) from the Examiner's decision rejecting claims 24–34. We have jurisdiction. 35 U.S.C. § 6(b).

We REVERSE.

---

[1] According to the Appellants, the real party in interest is ArcelorMittal France. Appeal Br. 2.

STATEMENT OF THE CASE

Appellants describe the present invention as relating to coated steels and method of making coating steels. Spec. 1:9–13. The coated steel could be shaped into parts (for example, automotive parts) after heating by stamping. Spec. 3:14–29. Claim 24, reproduced below with emphasis added to certain key recitations, is the only independent claim on appeal and is illustrative of the claimed subject matter:

> 24. A coated steel stamped product, which comprises:
>
> (a) a strip of base steel having a first side and a second side; and
>
> (b) a coating on at least one of said first side of said strip of base steel and said second side of said strip of base steel,
>
> wherein:
>
> (i) said coating results from the interdiffusion between said base steel, and aluminum or aluminum alloy pre-coating, and
>
> (ii) wherein said coating comprises, proceeding from the base steel outwards:
>
> (a) an Interdiffusion layer,
>
> (b) an Intermediate layer,
>
> (c) an Intermetallic layer, and
>
> (d) a Superficial layer,
>
> wherein **said coating has a thickness greater than 30 micrometers** and wherein said layer (a) has a thickness less than 15 micrometers.

Appeal Br.[2] 1 (Claims Appendix).

---

[2] In this decision, we refer to the Final Office Action mailed September 25, 2013 ("Final Act."), the Appeal Brief filed October 20, 2014 ("Appeal Br."), the Examiner's Answer mailed January 28, 2015 ("Ans."), and the Reply Brief filed March 26, 2015 ("Reply Br.").

REFERENCES

The Examiner relies upon the prior art below in rejecting the claims on appeal:

Laurent et al. (hereinafter "Laurent")	US 6,296,805 B1	Oct. 2, 2001
Takagi et al. (hereinafter "Takagi")	US 2004/0009366 A1	Jan. 15, 2004

Ford Engineering Material Specification WSB-M1A322-A1 (March 31, 1992) (hereinafter "Ford Specification").

REJECTIONS

The Examiner maintains the following rejections on appeal:

Rejection 1. Claims 24–31, 33, and 34 under 35 U.S.C. § 102(b) as anticipated by or, in the alternative, under 35 U.S.C. § 103 as unpatentable over Laurent. Ans. 2.

Rejection 2. Claims 24, 25, 31, 33, and 34 under 35 U.S.C. § 102(b) as anticipated by or, in the alternative, under 35 U.S.C. § 103 as unpatentable over Takagi. *Id.* at 5.

Rejection 3. Claim 32 under 35 U.S.C. § 103 as unpatentable over Takagi. *Id.* at 7.

Rejection 4. Claims 26–28 under 35 U.S.C. § 103 as unpatentable over Takagi and further in view of the Ford Engineering Specification. *Id.* at 8.

ANALYSIS

Rejection 1. The Examiner rejects claim 24 as anticipated by or obvious over Laurent. The Examiner finds that Appellants' process (as set forth in the Specification) is identical or substantially identical to the process of Laurent. Ans. 3. The Examiner then states "[w]here the claimed and prior art products are identical or substantially identical, or are produced by

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identical or substantially identical processes, the Office can require an applicant to prove that the prior art products do not necessarily or inherently possess the characteristics of the claimed product." Ans. 4; *see also In re Best*, 562 F.2d 1252, 1256 (CCPA 1977). Appellants, however, argue that one cannot assume that the process of Laurent will result in thickness of a coating "greater than 30 micrometers" as recited by claim 24. Appeal Br. 8; *see also* Reply Br. 2–4. The weight of the evidence supports Appellants on this point.

In particular, Laurent provides little guidance regarding what thickness of aluminum coating should be applied to the steel sheet except to state that the sheet, "[i]n an example of implementation . . . is coated with an aluminum-based layer about 20 μm [i.e., 20 micrometers] in thickness." Laurent 3:37–43. The Examiner finds that, in this regard, Laurent's process is the same as Appellants' process because "[t]he instant application sets forth providing an aluminum hot-dip coating that falls within the range of 20 to 33 microns." Appeal Br. 13 (citing Spec. 7:22–8:7). The Examiner further finds that "[t]he thickness corresponds to the pre-coat that is subsequently subjected to a heat-treatment process" and states that "it appears that the thickness of the coating within this range would result in the claimed coating thickness in the final product [i.e., greater than 30 micrometers]." Appeal Br. 13.

While the Specification suggests an initial thickness between 20 and 33 micrometers (Spec. 7:22–8:7) and describes "a preferred embodiment" having a total thickness of layers (a) to (d) greater than 30 micrometers, the Specification does not suggest that employing an initial thickness of 20 micrometers will result in the 30 micrometer thick layer preferred

embodiment. Moreover, the Examiner has not explained why heating would cause a 20 micrometer aluminum coating to ultimately be greater than 30 micrometers thick (a 50% expansion).

To employ *In re Best* properly here, the Examiner must compare Laurent's prior art process to a process in the Specification **that results in a product having the characteristics of claim 24** and establish that those two processes are identical or substantially identical. *In re Best*, 562 F.2d at 1255. Thus, the process of Laurent must be compared to a process in the Specification that results in a "coating [which] has a thickness greater than 30 micrometers." Appeal Br. 13 (Claims Appendix). Here, the record does not establish that the Specification's process that starts with a 20 micrometer coating will result in the preferred embodiment recited by claim 24—a claim that requires coating thickness greater than 30 micrometers. Therefore, because a preponderance of the evidence of record does not support the Examiner's finding that Laurent's process is identical or substantially identical to the Specification's process that results in a coating having a thickness as recited in claim 24, we do not sustain the Examiner's Laurent-based rejection of claims 24–31, 33, and 34.

Rejections 2–4. The Examiner rejects claims 24–28 and 31–34 as anticipated by or obvious over Takagi. Takagi teaches an initial aluminum coating between 10 to 20 micrometers. Takagi ¶ 3. The Examiner's rejections again employ an *In re Best* rationale as discussed above and find that Takagi inherently discloses the "greater than 30 micrometer" recitation of claim 24. Ans. 6–7, 14. Appellants again argue that the reasoning is flawed. Appeal Br. 10; Reply Br. 4. For reasons parallel to those explained above, a preponderance of the evidence does not support the Examiner's

finding that Takagi's process is identical or substantially identical to the Specification's process that results in a coating having a thickness as recited in claim 24.

The Examiner's reliance on the Ford Engineering Specification does not address this deficiency. Ans. 8–9. Therefore, we do not sustain the Examiner's Takagi-based rejections of claims 24–28 and 31–34.

DECISION

For the above reasons, we reverse the Examiner's rejection of claims 24–34.

REVERSED

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NOTICE OF ALLOWANCE AND FEE(S) DUE

23280 7590 12/08/2016

Davidson, Davidson & Kappel, LLC
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New York, NY 10018

EXAMINER
SCHLEIS, DANIEL J

ART UNIT	PAPER NUMBER
1784	

DATE MAILED: 12/08/2016

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
13/621,015	09/15/2012	Pascal DRILLET	631.1028DIV	6215

TITLE OF INVENTION: COATED STEEL STRIPS, METHODS OF MAKING THE SAME, METHODS OF USING THE SAME, STAMPING BLANKS PREPARED FROM THE SAME, STAMPED PRODUCTS PREPARED FROM THE SAME, AND ARTICLES OF MANUFACTURE WHICH CONTAIN SUCH A STAMPED PRODUCT

APPLN. TYPE	ENTITY STATUS	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	UNDISCOUNTED	$960	$0	$0	$960	03/08/2017

THE APPLICATION IDENTIFIED ABOVE HAS BEEN EXAMINED AND IS ALLOWED FOR ISSUANCE AS A PATENT. PROSECUTION ON THE MERITS IS CLOSED. THIS NOTICE OF ALLOWANCE IS NOT A GRANT OF PATENT RIGHTS. THIS APPLICATION IS SUBJECT TO WITHDRAWAL FROM ISSUE AT THE INITIATIVE OF THE OFFICE OR UPON PETITION BY THE APPLICANT. SEE 37 CFR 1.313 AND MPEP 1308.

THE ISSUE FEE AND PUBLICATION FEE (IF REQUIRED) MUST BE PAID WITHIN THREE MONTHS FROM THE MAILING DATE OF THIS NOTICE OR THIS APPLICATION SHALL BE REGARDED AS ABANDONED. THIS STATUTORY PERIOD CANNOT BE EXTENDED. SEE 35 U.S.C. 151. THE ISSUE FEE DUE INDICATED ABOVE DOES NOT REFLECT A CREDIT FOR ANY PREVIOUSLY PAID ISSUE FEE IN THIS APPLICATION. IF AN ISSUE FEE HAS PREVIOUSLY BEEN PAID IN THIS APPLICATION (AS SHOWN ABOVE), THE RETURN OF PART B OF THIS FORM WILL BE CONSIDERED A REQUEST TO REAPPLY THE PREVIOUSLY PAID ISSUE FEE TOWARD THE ISSUE FEE NOW DUE.

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I. Review the ENTITY STATUS shown above. If the ENTITY STATUS is shown as SMALL or MICRO, verify whether entitlement to that entity status still applies.

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III. All communications regarding this application must give the application number. Please direct all communications prior to issuance to Mail Stop ISSUE FEE unless advised to the contrary.

IMPORTANT REMINDER: Utility patents issuing on applications filed on or after Dec. 12, 1980 may require payment of maintenance fees. It is patentee's responsibility to ensure timely payment of maintenance fees when due.

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Page 443 of 624

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Complete and send this form, together with applicable fee(s), to: Mail **Mail Stop ISSUE FEE**
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(Depositor's name)
(Signature)
(Date)

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
13/621,015	09/15/2012	Pascal DRILLET	631.1028DIV	6215

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APPLN. TYPE	ENTITY STATUS	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	UNDISCOUNTED	$960	$0	$0	$960	03/08/2017

EXAMINER	ART UNIT	CLASS-SUBCLASS
SCHLEIS, DANIEL J	1784	428-653000

1. Change of correspondence address or indication of "Fee Address" (37 CFR 1.363).
- ❑ Change of correspondence address (or Change of Correspondence Address form PTO/SB/122) attached.
- ❑ "Fee Address" indication (or "Fee Address" Indication form PTO/SB/47; Rev 03-02 or more recent) attached. **Use of a Customer Number is required.**

2. For printing on the patent front page, list
(1) The names of up to 3 registered patent attorneys or agents OR, alternatively,
(2) The name of a single firm (having as a member a registered attorney or agent) and the names of up to 2 registered patent attorneys or agents. If no name is listed, no name will be printed.
1 _____
2 _____
3 _____

3. ASSIGNEE NAME AND RESIDENCE DATA TO BE PRINTED ON THE PATENT (print or type)

PLEASE NOTE: Unless an assignee is identified below, no assignee data will appear on the patent. If an assignee is identified below, the document has been filed for recordation as set forth in 37 CFR 3.11. Completion of this form is NOT a substitute for filing an assignment.

(A) NAME OF ASSIGNEE (B) RESIDENCE: (CITY and STATE OR COUNTRY)

Please check the appropriate assignee category or categories (will not be printed on the patent) : ❑ Individual ❑ Corporation or other private group entity ❑ Government

4a. The following fee(s) are submitted:
- ❑ Issue Fee
- ❑ Publication Fee (No small entity discount permitted)
- ❑ Advance Order - # of Copies _____

4b. Payment of Fee(s): (**Please first reapply any previously paid issue fee shown above**)
- ❑ A check is enclosed.
- ❑ Payment by credit card. Form PTO-2038 is attached.
- ❑ The director is hereby authorized to charge the required fee(s), any deficiency, or credits any overpayment, to Deposit Account Number _____ (enclose an extra copy of this form).

5. **Change in Entity Status** (from status indicated above)
- ❑ Applicant certifying micro entity status. See 37 CFR 1.29 — NOTE: Absent a valid certification of Micro Entity Status (see forms PTO/SB/15A and 15B), issue fee payment in the micro entity amount will not be accepted at the risk of application abandonment.
- ❑ Applicant asserting small entity status. See 37 CFR 1.27 — NOTE: If the application was previously under micro entity status, checking this box will be taken to be a notification of loss of entitlement to micro entity status.
- ❑ Applicant changing to regular undiscounted fee status. — NOTE: Checking this box will be taken to be a notification of loss of entitlement to small or micro entity status, as applicable.

NOTE: This form must be signed in accordance with 37 CFR 1.31 and 1.33. See 37 CFR 1.4 for signature requirements and certifications.

Authorized Signature _____ Date _____

Typed or printed name _____ Registration No. _____

PTOL-85 Part B (10-13) Approved for use through 10/31/2013. OMB 0651-0033 U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

ArcelorMittal Ex. 2017
Page 444 of 624

UNITED STATES PATENT AND TRADEMARK OFFICE

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www.uspto.gov

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
13/621,015	09/15/2012	Pascal DRILLET	631.1028DIV	6215

23280 7590 12/08/2016

Davidson, Davidson & Kappel, LLC
589 8th Avenue
16th Floor
New York, NY 10018

EXAMINER	
SCHLEIS, DANIEL J	

ART UNIT	PAPER NUMBER
1784	

DATE MAILED: 12/08/2016

Determination of Patent Term Adjustment under 35 U.S.C. 154 (b)
(Applications filed on or after May 29, 2000)

The Office has discontinued providing a Patent Term Adjustment (PTA) calculation with the Notice of Allowance.

Section 1(h)(2) of the AIA Technical Corrections Act amended 35 U.S.C. 154(b)(3)(B)(i) to eliminate the requirement that the Office provide a patent term adjustment determination with the notice of allowance. See Revisions to Patent Term Adjustment, 78 Fed. Reg. 19416, 19417 (Apr. 1, 2013). Therefore, the Office is no longer providing an initial patent term adjustment determination with the notice of allowance. The Office will continue to provide a patent term adjustment determination with the Issue Notification Letter that is mailed to applicant approximately three weeks prior to the issue date of the patent, and will include the patent term adjustment on the patent. Any request for reconsideration of the patent term adjustment determination (or reinstatement of patent term adjustment) should follow the process outlined in 37 CFR 1.705.

Any questions regarding the Patent Term Extension or Adjustment determination should be directed to the Office of Patent Legal Administration at (571)-272-7702. Questions relating to issue and publication fee payments should be directed to the Customer Service Center of the Office of Patent Publication at 1-(888)-786-0101 or (571)-272-4200.

OMB Clearance and PRA Burden Statement for PTOL-85 Part B

The Paperwork Reduction Act (PRA) of 1995 requires Federal agencies to obtain Office of Management and Budget approval before requesting most types of information from the public. When OMB approves an agency request to collect information from the public, OMB (i) provides a valid OMB Control Number and expiration date for the agency to display on the instrument that will be used to collect the information and (ii) requires the agency to inform the public about the OMB Control Number's legal significance in accordance with 5 CFR 1320.5(b).

The information collected by PTOL-85 Part B is required by 37 CFR 1.311. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, Virginia 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, Virginia 22313-1450. Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

Privacy Act Statement

The Privacy Act of 1974 (P.L. 93-579) requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether disclosure of these records is required by the Freedom of Information Act.
2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.
3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.
4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).
5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.
6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).
7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.
8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspection or an issued patent.
9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

Notice of Allowability	Application No. 13/621,015	Applicant(s) DRILLET ET AL.	
	Examiner DANIEL J. SCHLEIS	Art Unit 1784	AIA (First Inventor to File) Status No

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address--

All claims being allowable, PROSECUTION ON THE MERITS IS (OR REMAINS) CLOSED in this application. If not included herewith (or previously mailed), a Notice of Allowance (PTOL-85) or other appropriate communication will be mailed in due course. **THIS NOTICE OF ALLOWABILITY IS NOT A GRANT OF PATENT RIGHTS.** This application is subject to withdrawal from issue at the initiative of the Office or upon petition by the applicant. See 37 CFR 1.313 and MPEP 1308.

1. ☒ This communication is responsive to *Patent Board Decision mailed 10/11/16*.
   ☐ A declaration(s)/affidavit(s) under **37 CFR 1.130(b)** was/were filed on_____.
2. ☐ An election was made by the applicant in response to a restriction requirement set forth during the interview on _____; the restriction requirement and election have been incorporated into this action.
3. ☒ The allowed claim(s) is/are *24-34*. As a result of the allowed claim(s), you may be eligible to benefit from the **Patent Prosecution Highway** program at a participating intellectual property office for the corresponding application. For more information, please see http://www.uspto.gov/patents/init_events/pph/index.jsp or send an inquiry to PPHfeedback@uspto.gov.
4. ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

   Certified copies:

   a) ☐ All b) ☐ Some *c) ☐ None of the:
      1. ☐ Certified copies of the priority documents have been received.
      2. ☐ Certified copies of the priority documents have been received in Application No. _____ .
      3. ☐ Copies of the certified copies of the priority documents have been received in this national stage application from the International Bureau (PCT Rule 17.2(a)).

   * Certified copies not received: _____.

Applicant has THREE MONTHS FROM THE "MAILING DATE" of this communication to file a reply complying with the requirements noted below. Failure to timely comply will result in ABANDONMENT of this application.
THIS THREE-MONTH PERIOD IS NOT EXTENDABLE.

5. ☐ CORRECTED DRAWINGS (as "replacement sheets") must be submitted.
   ☐ including changes required by the attached Examiner's Amendment / Comment or in the Office action of Paper No./Mail Date _____.

   Identifying indicia such as the application number (see 37 CFR 1.84(c)) should be written on the drawings in the front (not the back) of each sheet. Replacement sheet(s) should be labeled as such in the header according to 37 CFR 1.121(d).
6. ☐ DEPOSIT OF and/or INFORMATION about the deposit of BIOLOGICAL MATERIAL must be submitted. Note the attached Examiner's comment regarding REQUIREMENT FOR THE DEPOSIT OF BIOLOGICAL MATERIAL.

Attachment(s)

1. ☐ Notice of References Cited (PTO-892)
2. ☒ Information Disclosure Statements (PTO/SB/08), Paper No./Mail Date 05/28/15
3. ☐ Examiner's Comment Regarding Requirement for Deposit of Biological Material
4. ☐ Interview Summary (PTO-413), Paper No./Mail Date _____ .
5. ☐ Examiner's Amendment/Comment
6. ☒ Examiner's Statement of Reasons for Allowance
7. ☐ Other _____.

/DANIEL J SCHLEIS/ Primary Examiner, Art Unit 1784	

REASONS FOR ALLOWANCE

The following is an examiner's statement of reasons for allowance:

The Patent Trial and Appeal Board determined that while the specification suggest an initial thickness between 20 and 30 micrometers and describes a preferred embodiment having a total thickness of layers (a) to (d) greater than 30 micrometers, the Specification does not suggest that employing an initial thickness of 20 micrometers will result in the 30 micrometer thick layer preferred embodiment. Therefore, the Board determined that rejections under 35 U.S.C. 102(b) or in the alternative 35 U.S.C. 103(a) over U.S. Patent Number 6,296,805 (Laurent) or U.S. Patent Application Publication 2004/0009366 (Takagi) were not appropriate.

The Specification as originally filed does not explicitly set forth the particular parameters necessary in order to produce the claimed invention of a coating having a thickness greater than 30 micrometers. The Specification as originally filed merely sets forth:

> [I]n a preferred embodiment, at every location on at least one face of the sheet or the blank, the thickness tp of the pre-coating is preferably from 20-33 micrometers in thickness, including 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31 and 32 micrometers and all ranges and subranges therebetween, and including all numbers between each listed value as if written out in its entirety (e.g., 22.34 micrometers)." [¶43 of corresponding 2013/0029172]

The Specification also teaches that in a preferred embodiment the total thickness of the layers is greater than 30 micrometers. [¶49 of corresponding 2013/0029172] The thickness of the pre-coating was the only difference in the process for producing the claimed product that was discussed by the Board in its decision. The Board determined that selecting a value of a pre-coating thickness in the range explicitly taught for the preferred embodiment would not result in a final coating thickness in the range explicitly taught for the preferred embodiment.

The Examiner is not in a position to determine which thicknesses for the pre-coating would result in the claimed invention's coating thickness. Since the Board determined that a preferred thickness in the pre-coating layer would not necessary result in the preferred thickness in the final product coating layer, the Examiner is unable to determine what particular value is necessary in the pre-coating to result in the claimed coating thickness, e.g. if only a portion of the preferred pre-coating thickness would result in the claimed coating thickness or if portions outside of the explicitly taught preferred pre-coating thickness would result in the claimed coating thickness. Therefore, a search of the prior art failed to turn up each and every limitation of the claimed product.

Any comments considered necessary by applicant must be submitted no later than the payment of the issue fee and, to avoid processing delays, should preferably accompany the issue fee. Such submissions should be clearly labeled "Comments on Statement of Reasons for Allowance."

Conclusion

Any inquiry concerning this communication or earlier communications from the examiner should be directed to DANIEL J. SCHLEIS whose telephone number is (571)270-5636. The examiner can normally be reached on Monday through Friday between the hours of 9:00 AM and 4:30 PM EST.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Humera Sheikh can be reached on (571)272-0604. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

/DANIEL J SCHLEIS/
Primary Examiner, Art Unit 1784

***

Search Notes	Application/Control No.	Applicant(s)/Patent Under Reexamination
	13621015	DRILLET ET AL.
	Examiner	Art Unit
	DANIEL J SCHLEIS	1784

CPC- SEARCHED		
Symbol	Date	Examiner

CPC COMBINATION SETS - SEARCHED		
Symbol	Date	Examiner

US CLASSIFICATION SEARCHED			
Class	Subclass	Date	Examiner

SEARCH NOTES		
Search Notes	Date	Examiner
Inventor Name Search	03/13	Schleis
PLUS Patent Search	03/13	Schleis
Non-Patent Literature Search - Google Scholar, Knovel, Science Direct	03/13	Schleis
EAST Text Search - See Search History	03/13	Schleis
Non-Patent Literature Search - Google Scholar, Knovel, Science Direct (Updated)	09/13	Schleis
EAST Text Search - See Search History (Updated)	09/13	Schleis
Discussed Application with Primary Examiner John Zimmerman	09/13	Schleis
Non-Patent Literature Search - Google Scholar, Knovel, Science Direct (Updated)	12/16	Schleis
EAST Text Search - See Search History (Updated)	12/16	Schleis

INTERFERENCE SEARCH			
US Class/ CPC Symbol	US Subclass / CPC Group	Date	Examiner
C21D	9/46	12/16	Schleis
B32B	15/012	12/16	Schleis

INTERFERENCE SEARCH			
US Class/ CPC Symbol	**US Subclass / CPC Group**	**Date**	**Examiner**
C23C	2/12; 2/26; 2/40	12/16	Schleis
Y10T	428/12389; 428/12396; 428/12757	12/16	Schleis

PTO/SB/08a (01-10)
Approved for use through 07/31/2012. OMB 0651-0031
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
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INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Not for submission under 37 CFR 1.99)

Application Number	13621015
Filing Date	2012-09-15
First Named Inventor	Drillet
Art Unit	1784
Examiner Name	Schleis
Attorney Docket Number	631.1028DIV

U.S.PATENTS Remove

Examiner Initial*	Cite No	Patent Number	Kind Code[1]	Issue Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1	6296805	B1	2001-10-02	Laurent et al.	
	2	7559998	B2	2009-07-14	Nishibata et al.	
	3	6815087	B2	2004-11-09	Takagi et al.	

If you wish to add additional U.S. Patent citation information please click the Add button. Add

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Examiner Initial*	Cite No	Publication Number	Kind Code[1]	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
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FOREIGN PATENT DOCUMENTS Remove

Examiner Initial*	Cite No	Foreign Document Number[3]	Country Code[2] i	Kind Code[4]	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear	T[5]
	1	1829813	CN	A	2006-09-06		See U.S. '998	☐

EFS Web 2.1.17

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /DJS/

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	13621015
	Filing Date	2012-09-15
	First Named Inventor	Drillet
	Art Unit	1784
	Examiner Name	Schleis
	Attorney Docket Number	631.1028DIV

	2	1531604	CN	A	2004-09-22		See WO '073	☐
	3	1472068	CN	A	2004-02-04		See U.S. '087	☐
	4	02/103073	WO	A2	2002-12-27		Published in English	☐

If you wish to add additional Foreign Patent Document citation information please click the Add button Add

NON-PATENT LITERATURE DOCUMENTS Remove

Examiner Initials*	Cite No	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc), date, pages(s), volume-issue number(s), publisher, city and/or country where published.	T5
	1	Properties of Aluminum-coated Steels for Hot-forming. Suehiro et al. Nippon Steel Technical Report, No. 88, July 2003, pages 15 to 20	☐
	2	Investigation of the thermo-mechanical properties of hot stamping steels. Merklein et al. Journal of Materials Processing Technology, Vol. 177/1-3 2006.	☐
	3	Basic Study on Hot Stamping of Ultrahigh-strength Steel, Dissertation for Degree of Master of Tongji University, Zhiyao Tan, July 2006. (Ref 9)	☐
	4	Analysis and Application of Axle Housing Hot Stamping Process, Qingyu Zhao, Forgining Machinery, published in March 2002. (Ref 6)	☐

If you wish to add additional non-patent literature document citation information please click the Add button Add

EXAMINER SIGNATURE

Examiner Signature	/Daniel J Schleis/	Date Considered	12/02/2016

*EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through a citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /DJS/

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	13621015
	Filing Date	2012-09-15
	First Named Inventor	Drillet
	Art Unit	1784
	Examiner Name	Schleis
	Attorney Docket Number	631.1028DIV

[1] See Kind Codes of USPTO Patent Documents at www.USPTO.GOV or MPEP 901.04. [2] Enter office that issued the document, by the two-letter code (WIPO Standard ST.3). [3] For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document. [4] Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST.16 if possible. [5] Applicant is to place a check mark here if English language translation is attached.

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /DJS/

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (**Not for submission under 37 CFR 1.99)**	Application Number	13621015
	Filing Date	2012-09-15
	First Named Inventor	Drillet
	Art Unit	1784
	Examiner Name	Schleis
	Attorney Docket Number	631.1028DIV

CERTIFICATION STATEMENT

Please see 37 CFR 1.97 and 1.98 to make the appropriate selection(s):

☒ That each item of information contained in the information disclosure statement was first cited in any communication from a foreign patent office in a counterpart foreign application not more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(1).

OR

☐ That no item of information contained in the information disclosure statement was cited in a communication from a foreign patent office in a counterpart foreign application, and, to the knowledge of the person signing the certification after making reasonable inquiry, no item of information contained in the information disclosure statement was known to any individual designated in 37 CFR 1.56(c) more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(2).

☐ See attached certification statement.

☒ The fee set forth in 37 CFR 1.17 (p) has been submitted herewith.

☐ A certification statement is not submitted herewith.

SIGNATURE

A signature of the applicant or representative is required in accordance with CFR 1.33, 10.18. Please see CFR 1.4(d) for the form of the signature.

Signature	/Jennifer L. O'Connell/	Date (YYYY-MM-DD)	2015-05-28
Name/Print	Jennifer L. O'Connell	Registration Number	57,392

This collection of information is required by 37 CFR 1.97 and 1.98. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 1 hour to complete, including gathering, preparing and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

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4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).

5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.

6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).

7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.

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ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /DJS/

Index of Claims	Application/Control No.	Applicant(s)/Patent Under Reexamination
	13621015	DRILLET ET AL.
	Examiner	Art Unit
	DANIEL J SCHLEIS	1784

✓	Rejected	-	Cancelled	N	Non-Elected	A	Appeal
=	Allowed	÷	Restricted	I	Interference	O	Objected

☒ Claims renumbered in the same order as presented by applicant ☐ CPA ☐ T.D. ☐ R.1.47

CLAIM		DATE								
Final	Original	12/02/2016								
-	1	-								
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-	22	-								
-	23	-								
1	24	=								
2	25	=								
3	26	=								
4	27	=								
5	28	=								
6	29	=								
7	30	=								
8	31	=								
9	32	=								
10	33	=								
11	34	=								

EAST Search History

EAST Search History (Prior Art)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
S1	13	((PASCAL) near2 (DRILLET)).INV.	US-PGPUB; USPAT; USOCR	OR	ON	2013/02/26 09:51
S2	8	((DOMINIQUE) near2 (SPEHNER)).INV.	US-PGPUB; USPAT; USOCR	OR	ON	2013/02/26 09:51
S3	11	((RONALD) near2 (KEFFERSTEIN)).INV.	US-PGPUB; USPAT; USOCR	OR	ON	2013/02/26 09:51
S4	0	("2013/0029172").URPN.	USPAT	OR	ON	2013/02/26 09:51
S5	9	("20030152796" | "3240269" | "5023113" | "6296805" | "6815087" | "7137201" | "7217331" | "7503116").PN. OR ("8307680").URPN.	US-PGPUB; USPAT; USOCR	OR	ON	2013/02/26 09:51
S6	4	("20030152796" | "5023113" | "6296805" | "7137201").PN.	US-PGPUB; USPAT; USOCR	OR	ON	2013/02/26 10:05
S7	9	("4891274" | "5133815" | "5178688" | "5656102").PN. OR ("6296805").URPN.	US-PGPUB; USPAT; USOCR	OR	ON	2013/02/26 10:37
S8	4	("3214820" | "6197132" | "6296805").PN. OR ("7708843").URPN.	US-PGPUB; USPAT; USOCR	OR	ON	2013/02/26 10:40
S9	16	("20010042393" | "20070082214" | "20070163685" | "20090242086" | "20090308499" | "20110006491" | "20110165436" | "4546051" | "6017643" | "6093498" | "6296805" | "6298905" | "6564604" | "6815087" | "7137201" | "7867344").PN. OR ("8066829").URPN.	US-PGPUB; USPAT; USOCR	OR	ON	2013/02/26 10:40
S10	1	("2003/0152796").URPN.	USPAT	OR	ON	2013/02/26 10:43
S11	17	("1423747" | "3240269" | "4657717" | "4921159" | "5056209" | "6337471").PN. OR ("7137201").URPN.	US-PGPUB; USPAT; USOCR	OR	ON	2013/02/26 10:45
S12	10	("3632453" | "3664293" | "4751957" | "4891274" | "5518772" | "5529816").PN. OR ("6017643").URPN.	US-PGPUB; USPAT; USOCR	OR	ON	2013/02/26 10:47
S13	195	(("5209860") or ("8066829") or	US-	OR	OFF	2013/02/26

		("8066829") or ("8307680") or ("20110006491") or ("20110165436") or ("20110214475") or ("20120064362") or ("20130029172") or ("6564604") or ("20010042393") or ("20120118437") or ("4846986") or ("20120085467") or ("20080261058") or ("4601766") or ("5248528") or ("5456953") or ("5568914") or ("5830290") or ("20040118482") or ("5287983") or ("4880481") or ("4344342") or ("4963400") or ("4999241") or ("5342672") or ("5792180") or ("6070444") or ("4353765") or ("5982073") or ("6129790") or ("6165595") or ("3798406") or ("4033918") or ("4311755") or ("4488862") or ("4508755") or ("4514264") or ("4525177") or ("4551085") or ("4554765") or ("4585519") or ("4842887") or ("4994517") or ("5273369") or ("5389452") or ("5538576") or ("5542978") or ("5639510") or ("5697715") or ("5729616") or ("5801128") or ("5837314") or ("5869160") or ("6020026") or ("6019923") or ("6251514") or ("6258425") or ("6262513") or ("6309748") or ("6340397") or ("6342108") or ("20020014181") or ("20090025836") or ("20090048127") or ("4374168") or ("4309951") or ("5810332") or ("5795661") or ("8349098") or ("20020160235") or ("20020166606") or ("20100294400") or ("20110056594") or ("20110056594") or ("20120085466") or ("5981089") or ("6197125") or ("4793867") or ("4941930") or ("4980241") or ("5238506") or ("5405427") or ("5939144") or ("6090873") or ("6241393") or ("3859239") or ("3850684") or ("3850647") or ("4316751") or ("4347085") or ("4401719") or ("4402994") or ("4533606") or ("4592958") or ("4867853") or ("5232619") or ("5242506") or ("5290362") or ("5332776") or ("5466280") or ("5608028") or ("5643474") or ("5700551") or ("5743536") or ("5783622") or ("5786098") or ("5851659") or ("5863640") or ("5890852") or ("5955201") or ("6001494") or ("6042949") or ("6083613") or ("6194088") or ("6197436") or ("6284059") or ("6329456") or ("6410626") or ("7533713") or ("8025965") or ("8025965") or ("20030150308") or ("20040129346") or ("20040216860") or ("20070209555") or ("20080090093") or ("20100175794") or ("20110300407") or ("20100199872") or ("4793218") or ("5584845") or ("5759304") or ("6463779") or ("7703820") or ("7926180") or ("7926180") or ("20070045384") or ("20070051434") or ("20090058111") or ("20100187291")).PN. or (("20110247467") or ("4384011") or ("5960930") or ("6120604") or ("4863650") or ("4926792") or ("4942061") or ("4035528") or ("4342418") or ("4355059")	PGPUB; USPAT; USOCR			10:54	

		or ("4490129") or ("4611610") or ("4818570") or ("4925213") or ("5300362") or ("5728474") or ("5809628") or ("5820954") or ("6037053") or ("6132864") or ("6403192") or ("8042484") or ("20080000417") or ("20080305358") or ("20090220815") or ("20120074106") or ("20120152410") or ("4486172") or ("4537588") or ("4844327") or ("4925518") or ("7955413") or ("4283225") or ("4302515") or ("4314661") or ("4316572") or ("4358325") or ("4480016") or ("4801072") or ("4853047") or ("5018259") or ("5271318") or ("5533423") or ("5622674") or ("5660443") or ("5926516") or ("6554919") or ("6986536") or ("RE40736") or ("7955413") or ("20010049956") or ("20050285416") or ("20050285417") or ("20080257110") or ("20090173129") or ("20110266724") or ("20120120561") or ("4251549")).PN.				
S14	0	("2012/0085466").URPN.	USPAT	OR	ON	2013/02/26 10:55
S15	0	("2012/0085467").URPN.	USPAT	OR	ON	2013/02/26 10:55
S16	0	("2011/0214475").URPN.	USPAT	OR	ON	2013/02/26 10:55
S17	1	("2011/0165436").URPN.	USPAT	OR	ON	2013/02/26 10:56
S18	1	("2011/0006491").URPN.	USPAT	OR	ON	2013/02/26 10:56
S19	8085	((428/601,600,602,653) or (420/104,120,121,126) or (148/531,535,534,537,635,653) or (72/364,342.1,47) or (280/1)).CCLS.	US-PGPUB; USPAT; USOCR	OR	OFF	2013/02/26 11:01
S20	2517	S19 and (steel ferrous) same (aluminum aluminium al)	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2013/02/26 11:02
S21	304	S20 and (interdiffusion intermediate intermetallic superficial) near3 layer	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2013/02/26 11:03
S22	14	("20020068189" | "20020104876" | "20030012977" | "20030207769" | "20040028939" | "3195991" | "4957822" | "4973523" | "5112416" | "5362574" | "5384205" | "5470666" | "7074496").PN. OR ("8053087").URPN.	US-PGPUB; USPAT; USOCR	OR	ON	2013/02/26 12:13
S23	8085	((428/601,600,602,653) or (420/104,120,121,126) or (148/531,535,534,537,635,653) or (72/364,342.1,47) or (280/1)).CCLS.	US-PGPUB; USPAT; USOCR	OR	OFF	2013/02/26 12:33
S24	286	S23 and (carbon c) same (manganese Mn) same (Silicon si) same (Chromium Cr) same (titanium ti) same (aluminum al) same	US-PGPUB; USPAT;	OR	ON	2013/02/26 12:33

		(Phosphorus P) same (Sulfur Sulphur S) same (Boron B)	USOCR; EPO; JPO; DERWENT			
S25	59	S24 and (aluminum aluminium al) near5 (pre-coat$4 precoat$4 layer coat$5)	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2013/02/26 12:35
S26	0	("2010/0294400").URPN.	USPAT	OR	ON	2013/02/26 12:36
S27	2	("2001/0001049").URPN.	USPAT	OR	ON	2013/02/26 12:40
S28	8224	((428/601,600,602,653) or (420/104,120,121,126) or (148/531,535,534,537,635,653) or (72/364,342.1,47) or (280/1)).CCLS.	US-PGPUB; USPAT; USOCR	OR	OFF	2013/09/19 16:58
S29	456	S28 and (interdiffusion intermediate intermetallic superficial) near3 layer	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2013/09/19 16:58
S30	4	S29 and (strain near3 ratio)	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2013/09/19 16:59
S31	36	S28 and (strain near3 ratio)	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2013/09/19 16:59
S32	16	("20060134451" | "20070113936" | "20070166565" | "20070246509" | "20090020276" | "20090165901" | "20100101688" | "20100112370" | "20100183897" | "20110014494" | "20110240280" | "20110287276" | "20110287277" | "5037707" | "6019939" | "7387844").PN. OR ("8247082").URPN.	US-PGPUB; USPAT; USOCR	OR	ON	2013/09/19 16:59
S33	0	("2010/0084057").URPN.	USPAT	OR	ON	2013/09/19 16:59
S34	13	("4673551" | "4906534" | "5037707" | "5100048").PN. OR ("6019939").URPN.	US-PGPUB; USPAT; USOCR	OR	ON	2013/09/19 17:00
S35	4	("2010/0112370").URPN.	USPAT	OR	ON	2013/09/19 17:00
S36	0	("2009/0252641").URPN.	USPAT	OR	ON	2013/09/19 17:00
S37	4	("4985196" | "4990545" | "5139832" | "6084849").PN. OR ("7060140").URPN.	US-PGPUB; USPAT; USOCR	OR	ON	2013/09/19 17:00
S38	15	("4196025" | "4309886" | "4793869" | "5507677" | "5509842" | "5618401" |	US-PGPUB;	OR	ON	2013/09/19 17:01

		"5625251" | "5629051" | "5646478").PN. OR ("5871851").URPN.	USPAT; USOCR			
S39	9	("4601766" | "5019191" | "5871851").PN. OR ("6129992").URPN.	US-PGPUB; USPAT; USOCR	OR	ON	2013/09/19 17:01
S40	4	("3795971" | "4455352" | "4956025").PN. OR ("5529644").URPN.	US-PGPUB; USPAT; USOCR	OR	ON	2013/09/19 17:01

EAST Search History (Interference)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
S41	5246	(C21D9/46 B32B15/012 C23C2/12 C23C2/26 C23C2/40 Y10T428/12389 Y10T428/12396 Y10T428/12757).cpc.	US-PGPUB; USPAT	OR	ON	2016/12/02 11:46
S42	1776	S41 and (aluminum aluminium al) near5 (pre-coat$4 precoat$4 layer coat$5)	US-PGPUB; USPAT	OR	ON	2016/12/02 11:46
S43	888	S41 and ((aluminum aluminium al) near5 (pre-coat$4 precoat$4 layer coat$5)).clm.	US-PGPUB; USPAT	OR	ON	2016/12/02 11:46
S44	136	S43 and ((interdiffusion intermediate intermetallic superficial) near3 layer).clm.	US-PGPUB; USPAT	OR	ON	2016/12/02 11:47

12/2/2016 11:59:05 AM
C:\Users\dschleis\Documents\EAST\Workspaces\13621015.wsp

Issue Classification	Application/Control No.	Applicant(s)/Patent Under Reexamination
	13621015	DRILLET ET AL.
	Examiner	**Art Unit**
	DANIEL J SCHLEIS	1784

CPC						
Symbol					**Type**	**Version**
C21D		9	/	46	F	2013-01-01
Y10T		428	/	12389	A	2015-01-15
Y10T		428	/	12396	A	2015-01-15
Y10T		428	/	12757	A	2015-01-15
B32B		15	/	012	I	2013-01-01
C23C		2	/	12	I	2013-01-01
C23C		2	/	26	I	2013-01-01
C23C		2	/	40	I	2013-01-01
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CPC Combination Sets							
Symbol				**Type**	**Set**	**Ranking**	**Version**
			/				
			/				

NONE		**Total Claims Allowed:**	
(Assistant Examiner)	(Date)	11	
/DANIEL J SCHLEIS/ Primary Examiner.Art Unit 1784	12/02/2016	O.G. Print Claim(s)	O.G. Print Figure
(Primary Examiner)	(Date)	24	1

Issue Classification	Application/Control No.	Applicant(s)/Patent Under Reexamination
	13621015	DRILLET ET AL.
	Examiner	**Art Unit**
	DANIEL J SCHLEIS	1784

US ORIGINAL CLASSIFICATION		INTERNATIONAL CLASSIFICATION										
CLASS	SUBCLASS	CLAIMED					NON-CLAIMED					
428	653	B	3	2	B	15 / 01 (2006.01.01)						

CROSS REFERENCE(S)					
CLASS	SUBCLASS (ONE SUBCLASS PER BLOCK)				

NONE (Assistant Examiner) (Date)	Total Claims Allowed: 11	
/DANIEL J SCHLEIS/ Primary Examiner.Art Unit 1784 12/02/2016 (Primary Examiner) (Date)	O.G. Print Claim(s) 24	O.G. Print Figure 1

Issue Classification	Application/Control No.	Applicant(s)/Patent Under Reexamination
	13621015	DRILLET ET AL.
	Examiner	**Art Unit**
	DANIEL J SCHLEIS	1784

☒ Claims renumbered in the same order as presented by applicant ☐ CPA ☐ T.D. ☐ R.1.47

Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original

NONE (Assistant Examiner) (Date)	**Total Claims Allowed:** 11	
/DANIEL J SCHLEIS/ Primary Examiner.Art Unit 1784 12/02/2016 (Primary Examiner) (Date)	O.G. Print Claim(s) 24	O.G. Print Figure 1

UNITED STATES PATENT AND TRADEMARK OFFICE
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Davidson, Davidson & Kappel, LLC
589 8th Avenue
16th Floor
New York, NY 10018





Courtesy Reminder for
Application Serial No: 13/621,015

Attorney Docket No: 631.1028DIV
Customer Number: 23280
Date of Electronic Notification: 12/08/2016

This is a courtesy reminder that new correspondence is available for this application. If you have not done so already, please review the correspondence. The official date of notification of the outgoing correspondence will be indicated on the form PTOL-90 accompanying the correspondence.

An email notification regarding the correspondence was sent to the following email address(es) associated with your customer number:
ddk@ddkpatent.com

To view your correspondence online or update your email addresses, please visit us anytime at **https://sportal.uspto.gov/secure/myportal/privatepair.** If you have any questions, please email the Electronic Business Center (EBC) at EBC@uspto.gov or call 1-866-217-9197.

Doc code: RCEX
Doc description: Request for Continued Examination (RCE)

PTO/SB/30EFS (07-14)
Approved for use through 07/31/2016. OMB 0651-0031
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it contains a valid OMB control number.

REQUEST FOR CONTINUED EXAMINATION(RCE)TRANSMITTAL
(Submitted Only via EFS-Web)

Application Number	13621015	Filing Date	2012-09-15	Docket Number (if applicable)	631.1028DIV	Art Unit	1784
First Named Inventor	Pascal Drillet			Examiner Name	Daniel J. Schleis		

This is a Request for Continued Examination (RCE) under 37 CFR 1.114 of the above-identified application.
Request for Continued Examination (RCE) practice under 37 CFR 1.114 does not apply to any utility or plant application filed prior to June 8, 1995, to any international application that does not comply with the requirements of 35 U.S.C. 371, or to any design application. The Instruction Sheet for this form is located at WWW.USPTO.GOV.

SUBMISSION REQUIRED UNDER 37 CFR 1.114

Note: If the RCE is proper, any previously filed unentered amendments and amendments enclosed with the RCE will be entered in the order in which they were filed unless applicant instructs otherwise. If applicant does not wish to have any previously filed unentered amendment(s) entered, applicant must request non-entry of such amendment(s).

☐ Previously submitted. If a final Office action is outstanding, any amendments filed after the final Office action may be considered as a submission even if this box is not checked.

☐ Consider the arguments in the Appeal Brief or Reply Brief previously filed on _____

☐ Other _____

☒ Enclosed

☐ Amendment/Reply

☒ Information Disclosure Statement (IDS)

☐ Affidavit(s)/ Declaration(s)

☐ Other _____

MISCELLANEOUS

☐ Suspension of action on the above-identified application is requested under 37 CFR 1.103(c) for a period of months _____
(Period of suspension shall not exceed 3 months; Fee under 37 CFR 1.17(i) required)

☐ Other _____

FEES

☒ **The RCE fee under 37 CFR 1.17(e) is required by 37 CFR 1.114 when the RCE is filed.**
The Director is hereby authorized to charge any underpayment of fees, or credit any overpayments, to Deposit Account No 500552

SIGNATURE OF APPLICANT, ATTORNEY, OR AGENT REQUIRED

☒ Patent Practitioner Signature

Applicant Signature

PTO/SB/30EFS (07-14)
Approved for use through 07/31/2016. OMB 0651-0031
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it contains a valid OMB control number.

Signature of Registered U.S. Patent Practitioner			
Signature	/williamcgehris/	Date (YYYY-MM-DD)	2017-03-07
Name	William C. Gehris	Registration Number	38156

This collection of information is required by 37 CFR 1.114. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450.

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

Privacy Act Statement

The Privacy Act of 1974 (P.L. 93-579) requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C. 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether the Freedom of Information Act requires disclosure of these records.

2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.

3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.

4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).

5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.

6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).

7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.

8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspections or an issued patent.

9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

631.1028DIV

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Re:	Application of:	Pascal Drillet et al.
	Serial No.:	13621015
	Filed:	09/15/2012
	For:	**COATED STEEL STRIPS, METHODS OF MAKING THE SAME, METHODS OF USING THE SAME, STAMPING BLANKS PREPARED FROM THE SAME, STAMPED PRODUCTS PREPARED FROM THE SAME, AND ARTICLES OF MANUFACTURE WHICH CONTAIN SUCH A STAMPED PRODUCT**
	Customer No.:	23280
	Examiner:	Daniel J. Schleis
	Art Unit:	1784
	Attorney Docket No.:	631.1028DIV

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

March 7, 2017

INFORMATION DISCLOSURE STATEMENT

S i r:

In accordance with the provisions of 37 C.F.R. § 1.97, Applicants hereby make of record the documents listed on the accompanying PTO-1449 Form (1 page) for consideration by the Examiner in connection with the examination of the above-identified patent application. While the references are being submitted herewith, some or all of the references may not constitute prior art under the U.S. patent laws.

This Information Disclosure Statement is filed together with a Request for Continued Examination. Therefore, no fee is believed due.

ArcelorMittal Ex. 2017
Page 471 of 624

In the event any additional fee is due in connection with this response or if any fee has been overpaid, the deficiency or overpayment should be charged to our Deposit Account No. 50-0552.

It is respectfully requested that the references cited in the accompanying PTO-1449 form be considered and made of record.

Respectfully submitted,
DAVIDSON, DAVIDSON & KAPPEL, LLC

By: /williamcgehris/
William C. Gehris, Reg. No. 38,156

DAVIDSON, DAVIDSON & KAPPEL, LLC
589 Eighth Ave, 16th Floor
New York, New York 10018
(212) 736-1940

FORM PTO-1449 (REV. 7-80)	U.S. DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE	ATTY DOCKET NO.	APPLICATION NO
		631.1028DIV	13621015
LIST OF PRIOR ART CITED BY APPLICANT		APPLICANT	
		Weiss	
(Use several sheets if necessary)		FILING DATE	GROUP
		09/15/2012	1784

U.S. PATENT DOCUMENTS

*EXAMINER INITIAL		DOCUMENT NUMBER	DATE	NAME	CLASS	SUB-CLASS	
	A01	US2001/0042393	Nov. 22, 2001	Kefferstein et al.			
	A02	US8127449 B2	Mar. 6, 2012	Bayer et al.			
	A03	US7137201	Nov. 21, 2006	Brodt et al.			
	A04	US7708843	May 4, 2010	Laurent et al.			
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EXAMINER	DATE CONSIDERED

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(71) Anmelder *(für alle Bestimmungsstaaten mit Ausnahme von US)*: **DAIMLERCHRYSLER AG** [DE/DE]; Epplestrasse 225, 70567 Stuttgart (DE).

(72) Erfinder; und

(75) Erfinder/Anmelder *(nur für US)*: **BAYER, Michael** [DE/DE]; Bronntor 6, 71083 Herrenberg (DE). **BRODT, Martin** [DE/DE]; Am Heinrichsberg 35, 71263 Weil der Stadt (DE).

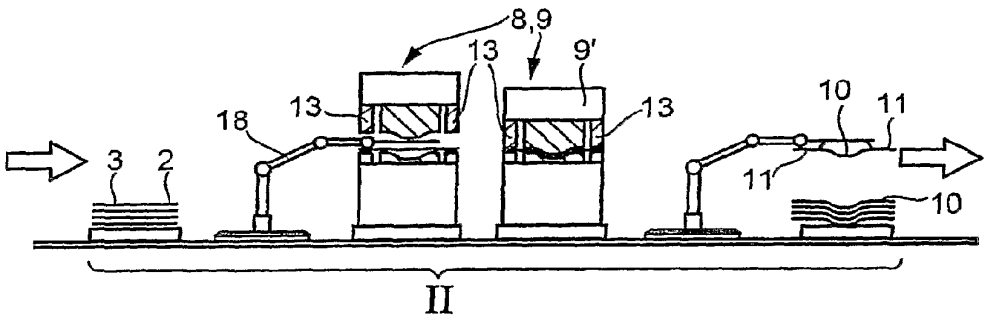
(74) Anwälte: **BOGERT, Valentin** usw.; DaimlerChrysler AG, Intellectual Property Management, IPM-C106, 70546 Stuttgart (DE).

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[Fortsetzung auf der nächsten Seite]

(54) Title: PRESS-HARDENED COMPONENT AND METHOD FOR THE PRODUCTION OF A PRESS-HARDENED COMPONENT

(54) Bezeichnung: PRESSGEHÄRTETES BAUTEIL UND VERFAHREN ZUR HERSTELLUNG EINES PRESSGEHÄRTETEN BAUTEILS



(57) Abstract: The invention relates to a method for the production of press-hardened components, more particularly press-hardened components of the bodywork of an automobile, consisting of a semi-finished product (2) made of non-hardened, sheet steel which can be deformed when warm, in addition to a press-hardened component produced according to said method. The inventive method consists of several steps. The semi-finished product (2), which is pre-coated with a first coating (33), is used to form a component blank (10) in a cold-forming method, especially a drawing process. The edge-side of the component blank (10) is cut to form an edge contour (12') approximately corresponding to the component (1) which is to be produced. The cut component blank (17) is heated and is press-hardened in a warm forming tool (23), whereupon the press-hardened component blank (18) is provided with a second anti-corrosion coating (34) in a coating step.

(57) Zusammenfassung: Die Erfindung betrifft ein Verfahren zur Herstellung von pressgehärteten Bauteilen, insbesondere eines Karosseriebauteils, aus einem Halbzeug (2) aus ungehärtetem, warm umformbaren Stahlblech, sowie ein nach diesem Verfahren hergestelltes pressgehärtetes Bauteil. In dem Verfahren werden verschiedene Verfahrensschritte ausgeführt. Aus dem mit einer ersten Schicht (33) vorbeschichteten Halbzeug (2) wird durch ein Kaltumformverfahren, insbesondere ein Ziehverfahren, ein Bauteil-Rohling (10) geformt. Der Bauteil-Rohling (10) wird randseitig auf eine dem herzustellenden Bauteil (1) näherungsweise entsprechende Randkontur (12') beschnitten. Der beschnittene Bauteil-Rohling (17) wird erwärmt und in einem Warmumform-Werkzeug (23) pressgehärtet, anschließend wird der pressgehärtete Bauteil-Rohling (18) in einem Beschichtungsschritt mit einer zweiten vor Korrosion schützenden Schicht (34) überzogen.

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PH, PL, PT, RO, RU, SC, SD, SE, SG, SK, SL, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, YU, ZA, ZM, ZW.

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Veröffentlicht:

— *mit internationalem Recherchenbericht*

— *vor Ablauf der für Änderungen der Ansprüche geltenden Frist; Veröffentlichung wird wiederholt, falls Änderungen eintreffen*

Zur Erklärung der Zweibuchstaben-Codes und der anderen Abkürzungen wird auf die Erklärungen ("Guidance Notes on Codes and Abbreviations") am Anfang jeder regulären Ausgabe der PCT-Gazette verwiesen.

Pressgehärtetes Bauteil und Verfahren zur Herstellung eines pressgehärteten Bauteils

Die Erfindung betrifft ein pressgehärtetes Bauteil sowie ein Verfahren zur Herstellung eines pressgehärteten Bauteils gemäß den Oberbegriffen der unabhängigen Ansprüche.

An Steifigkeit und Festigkeit von Karosseriebauteilen werden im Fahrzeugbau zunehmend hohe Anforderungen gestellt. Gleichzeitig wird jedoch im Interesse einer Gewichtsminimierung eine Verringerung der Materialdicke angestrebt. Eine Lösung zur Erfüllung der widersprüchlichen Anforderungen bieten hochfeste und höchstfeste Stahlwerkstoffe, welche die Herstellung von Bauteilen mit sehr hohe Festigkeiten bei gleichzeitiger geringer Materialdicke ermöglichen. Durch eine geeignete Wahl von Prozessparametern während eines bei diesen Werkstoffen üblichen Warmumformens können Festigkeits- und Zähigkeitswerte eines Bauteils gezielt eingestellt werden.

Ein solcher Werkstoff ist z.B. der von der Firma Usinor unter dem Handelsnamen Usibor 1500 vertriebene vorbeschichtete Borstahl. Der Stahl ist mit einer AlSi-Beschichtung versehen, die unter anderem im Rahmen der spätere Wärmebehandlung vorteilhafte korrosionshemmende Eigenschaften zeigt.

Zur Herstellung eines solchen Bauteils mit Hilfe der Warmumformung wird zunächst aus einem Coil eine Platine ausgeschnitten, die anschließend oberhalb der Gefügeumwandlungstemperatur des Stahlwerkstoffs, oberhalb derer das Werkstoffgefüge im austenitischen Zustand vorliegt, erwärmt, im erwärmten Zustand in ein Umformwerkzeug eingelegt und in die gewünschte Bauteilform umgeformt und unter mechanischer Fixierung des gewünschten Umformzustands abgekühlt, wobei eine Vergütung bzw. Härtung des Bauteils erfolgt.

Oftmals wird das Bauteil vor der eigentlichen Warmumformung einem Vorformschritt oder einem Beschneidungsschritt unterzogen. Dies ist beispielsweise in der DE 101 49 221 C1 beschrieben. Ein solches Verfahren kann jedoch Probleme hinsichtlich der Korrosion zur Folge haben, da eine üblicherweise aufgebrachte Bandbeschichtung beim Vorformen beschädigt wird. Ein übliches Vorformen und Beschneiden der Bauteile besonders bei vorbeschichteten hochfesten Stählen wie Usibor 1500 PC, welcher eine AlSi-Beschichtung aufweist, wird daher unterlassen.

Aufgabe der Erfindung ist, ein pressgehärtetes Bauteil sowie ein Herstellverfahren für pressgehärtete Bauteile anzugeben, welches einen sicheren Korrosionsschutz für vorbeschichtete, warm umformbare Stähle ermöglicht.

Die Aufgabe wird erfindungsgemäß mit den Merkmalen der unabhängigen Ansprüche 1, 2 und 8 gelöst.

Eine erste Ausführungsform des erfindungsgemäßen Verfahrens zur Herstellung von pressgehärteten Bauteilen umfasst die folgenden Verfahrensschritte: aus dem vorbeschichteten Halbzeug wird durch ein Kaltumformverfahren, insbesondere ein Ziehverfahren, ein Bauteil-Rohling geformt; der Bauteil-

Rohling wird randseitig auf eine dem herzustellenden Bauteil näherungsweise entsprechende Berandungskontur beschnitten; der beschnittene Bauteil-Rohling wird erwärmt und in einem Warmumform-Werkzeug pressgehärtet; der pressgehärtete Bauteil-Rohling wird in einem Beschichtungsschritt mit einer vor Korrosion schützenden Schicht überzogen.

Diese Ausgestaltung der Erfindung ermöglicht einerseits, den Bauteil-Herstellungsprozess so zu gestalten, dass auf die verfahrenstechnisch aufwändige und kostenintensive abschließende Beschneiden des gehärteten Bauteils verzichtet werden kann. Die Randbereiche werden daher bereits im ungehärteten Zustand des Bauteils abgeschnitten und nicht erst - wie herkömmlicherweise beim Warmumformen üblich - nach dem Erwärmungs- und Härteprozess. Indem das Werkstück bereits im weichen Zustand beschnitten wird, sind wesentlich geringere Schneidkräfte als zum kalten Schneiden gehärteter Werkstoffe erforderlich, was zu einem verminderten Werkzeugverschleiß und zu einer Reduktion der Instandhaltungskosten der Schneidwerkzeuge führt. Weiterhin wird beim Beschneiden des hochfesten Werkstoffs im ungehärteten Zustand die Gefahr einer schnellen Rissbildung aufgrund der hohen Kerbempfindlichkeit dieser Werkstoffe erheblich reduziert.

Die auf dem Halbzeug vorgesehene Vorbeschichtung vermeidet ein Verzundern des beschnittenen Bauteil-Rohlings bei dem Härteprozess, und die Anforderungen an eine inerte Atmosphäre beim Härten können verringert werden. Außerdem verhindert die Vorbeschichtung eine Entkohlung des Werkstoffs beim Härten. Nach dem Härteprozess wird erfindungsgemäß eine weitere vor Korrosion schützende Schicht aufgebracht, so dass das Bauteil vollständig, also auch an den Kanten, beschichtet ist.

In einer weiteren Ausführungsform des erfindungsgemäßen Verfahrens zur Herstellung von pressgehärteten Bauteilen werden die folgenden Verfahrensschritte durchgeführt: das mit einer ersten Schicht vorbeschichtete Halbzeug wird erwärmt und in einem Warmumform-Werkzeug pressgehärtet; der auf diese Weise erzeugte Bauteil-Rohling wird randseitig auf eine dem herzustellenden Bauteil entsprechende Berandungskontur beschnitten; der pressgehärtete, beschnittene Bauteil-Rohling wird in einem Beschichtungsschritt mit einer zweiten vor Korrosion schützenden Schicht überzogen.

In dieser Ausführungsform erfolgt das Beschneiden des gehärteten Bauteils vorzugsweise mit Hilfe eines Laser- oder des Wasserstrahl-Schneideverfahrens, durch die ein hochwertiger Beschnitt der Bauteilkanten erreicht werden kann. Das nachfolgende Aufbringen der zweiten Korrosionsschutzschicht stellt sicher, dass das Bauteil auch im Bereich der beschnittenen Ränder gegen Korrosion geschützt ist.

Wird die Schicht mit einem Feuerverzinkungs-Verfahren auf den pressgehärteten Bauteil-Rohling aufgebracht, kann eine vor Korrosion schützende Schicht aus Zink in einem geeignet in einen Fertigungsprozess integrierbaren Beschichtungsverfahren aufgebracht werden.

Wird die Schicht mit einem thermischen Diffusions-Verfahren auf den pressgehärteten Bauteil-Rohling aufgebracht, kann ein gut steuerbares Verfahren eingesetzt werden, mit dem vorzugsweise eine Schicht aus Zink oder einer Zinklegierung aufgebracht werden kann, das auch für komplexe Bauteil-Geometrien und zur Kantenschichtung geeignet ist. Die Schichtdicke kann gezielt zwischen einigen μm und über 100 μm eingestellt werden. Eine thermische Belastung des Bauteils ist gering. Bauteile können unabhängig von ihrer Größe, den Abmessungen,

Konfiguration, Komplexität und Gewicht beschichtet werden. Eine Reinigung vor dem Beschichtungsschritt mit einer Trockenreinigung, insbesondere ein Strahlen des pressgehärteten Bauteil-Rohlings mit Glaspartikeln oder Zinkpartikeln, kann entfallen, da durch die Vorbeschichtung ein Verzundern des Bauteil-Rohlings bei der Warmumformung im wesentlichen unterbleibt. Dadurch wird ein Prozessschritt eingespart; zusätzlich wird vermieden, dass ein zwar geringer, aber möglicherweise störender Bauteilverzug durch ein Strahlen der Bauteile mit Partikeln entsteht.

Bei einer Vorbeschichtung mit einer aluminiumhaltigen Schicht, vorzugsweise aus AlSi, und einer zinkhaltigen Beschichtung ergibt sich eine gute Haftung zwischen den beiden Beschichtungen. Zusätzlich ergibt sich ein guter Schutz des Werkstoffs gegen Wasserstoffversprödung, gegen die insbesondere Zink den Werkstoff schützen kann. Die zweite Schicht, die auf die erste Schicht der Vorbeschichtung aufgebracht ist, sorgt für eine Kantenbeschichtung und für eine Beschichtung solcher Bereiche, bei denen die erste Schicht der Vorbeschichtung z.B. bei der Vor-Umformung abgeplatzt ist oder durch zu hohe Reibung rissig wurde.

Wird der Bauteil-Rohling nach dem Beschichtungsschritt von Rückständen gereinigt, beispielsweise mit Ultraschall, und passiviert, wird eine Oberfläche gebildet, die einen guten Haftgrund für Beschichtungen, insbesondere Grundierungen von Lacken oder Lacke selbst, ergibt.

Vorteilhaft wird der Bauteil-Rohling nach dem Beschichtungsschritt getempert. Besonders vorteilhaft ist, wenn der Bauteil-Rohling mit einer zinkhaltigen Schicht beschichtet ist, da an der Oberfläche ein Oxid gebildet wird, welches als Haftgrund geeignet ist.

Ein erfindungsgemäßes pressgehärtetes Bauteil, insbesondere ein Karosseriebauteil, aus einem Halbzeug aus ungehärtetem warm umformbaren Stahlblech, ist nach zumindest einer der Weiterbildungen des erfindungsgemäßen Verfahrens hergestellt. Ein solches Bauteil ist besonders geeignet mit einer entsprechenden Serienfertigung in großen Stückzahlen herstellbar und verbindet eine vorteilhafte Gewichtsminderung des Bauteils mit einem ausgezeichneten Korrosionsschutz.

Weitere Vorteile und Ausgestaltungen der Erfindung sind den weiteren Ansprüchen und der Beschreibung zu entnehmen.

Im folgenden ist die Erfindung anhand eines in einer Zeichnung dargestellten Ausführungsbeispiels näher erläutert.

Dabei zeigen:

Fig. 1 ein Verfahrensschema des erfindungsgemäßen Verfahrens eines pressgehärteten Bauteils mit 1a: Zuschneiden der Platine (Schritt I); 1b: Kaltumformung (Schritt II); 1c: Beschneiden der Ränder (Schritt III); 1d: Warmumformung (Schritt IV); 1e: Beschichtung (Schritt V); 1f: alternatives Verfahren zu Beschichtung (Schritt V');

Fig. 2 perspektivische Ansichten ausgewählter Zwischenstufen bei der Herstellung eines Bauteils mit 2a: ein vorbeschichtetes Halbzeug; 2b: ein daraus geformter Bauteil-Rohling; 2c: ein beschnittener Bauteil-Rohling; 2d: ein beschichteter Bauteil-Rohling;

Fig. 3 einen alternativen Verfahrensablauf zur Herstellung eines pressgehärteten Bauteils mit 1a: Zuschneiden der Platine (Schritt I); 1b: Warmumformung (Schritt II'); 1c: Beschneiden der Ränder (Schritt III'); 1d: Beschichtung (Schritt IV').

Die Figuren 1a bis 1e zeigen schematisch ein erfindungsgemäßes Verfahren zur Herstellung eines räumlich geformten, pressgehärteten Bauteils 1 aus einem Halbzeug 2. Im vorliegenden Ausführungsbeispiel wird als Halbzeug 2 eine Platine 3 verwendet, welche aus einem abgewickelten Coil 5 ausgeschnitten wird. Alternativ kann als Halbzeug 2 auch ein Verbundblech zum Einsatz kommen, wie es z.B. in der DE 100 49 660 A1 beschrieben ist und das aus einem Basisblech und mindestens einem Verstärkungsblech besteht. Weiterhin kann als Halbzeug 2 auch ein Taylored Blank verwendet werden, welches aus mehreren zusammen geschweißten Blechen unterschiedlicher Materialstärke und/oder unterschiedlicher Materialbeschaffenheit besteht. Alternativ kann das Halbzeug 2 ein durch ein beliebiges Umformverfahren hergestelltes dreidimensional geformtes Blechteil sein, welches mit Hilfe des erfindungsgemäßen Verfahrens eine weitere Umformung sowie eine Festigkeits- und/oder Steifigkeitserhöhung erfahren soll.

Das Halbzeug 2 besteht aus einem ungehärtetem, warm umformbaren Stahlblech. Ein besonders bevorzugter Werkstoff ist ein borhaltiger Vergütungsstahl, z.B. Usibor 1500, Usibor 1500 P oder Usibor 1500 PC, welche von der Firma Usinor unter diesen Handelsnamen vertrieben werden.

In einem ersten Prozessschritt I wird die Platine 3 (Fig. 1a) aus einem abgewickelten und gerade gerichteten Abschnitt eines Coils 5 aus einem vorbeschichteten, warm umformbaren Blech ausgeschnitten. Vorzugsweise ist die Beschichtung eine Beschichtung aus Aluminium oder einer Aluminiumlegierung, insbesondere einer siliziumhaltigen Aluminiumlegierung AlSi. Der warm umformbare Werkstoff befindet sich zu diesem Zeitpunkt in einem ungehärteten Zustand, so dass Platine 3 problemlos mit Hilfe konventioneller mechanischer Schneidmittel

4, z.B. einer Hubschere, ausgeschnitten werden kann. Im Großserieneinsatz erfolgt das Zuschneiden der Platine 3 vorteilhafterweise mit Hilfe einer Platinenpresse 6, welche eine automatisierte Zuführung des Coils 5 und ein automatisches Ausstanzen und Abführen der ausgeschnittenen Platine 3 gewährleistet. Die auf diese Weise ausgeschnittene Platine 3 ist in Fig.2a in einer schematischen perspektivischen Ansicht dargestellt.

Die ausgeschnittenen Platinen 3 werden auf einem Stapel 7 abgelegt und in gestapelter Form einer Kaltumformstation 8 zugeführt (Fig. 1b). Hier wird in einem zweiten Prozessschritt II aus der Platine 3 mit Hilfe des Kaltumform-Werkzeugs 8, beispielsweise einem zweistufigen Tiefziehwerkzeug 9, ein Bauteil-Rohling 10 geformt. Um eine qualitativ hochwertige Ausformung der Bauteilgeometrie gewährleisten zu können, weist die Platine 3 Randbereiche 11 auf, die über eine Außenkontur 12 des zu formenden Bauteils 1 hinausragen. Im Rahmen dieses Kaltumformprozesses (Prozessschritt II) wird der Bauteil-Rohling 10 endkonturnah ausgeformt. Unter „endkonturnah" soll dabei verstanden werden, dass diejenigen Teile der Geometrie des fertigen Bauteils 1, welche mit einem makroskopischen Materialfluss einhergehen, nach Abschluss des Kaltumformprozesses vollständig in den Bauteil-Rohling 10 eingeformt sind. Nach Abschluss des Kaltumformprozesses sind somit zur Herstellung der dreidimensionalen Form des Bauteils 1 nur noch geringe Formanpassungen notwendig, welche einen minimalen (lokalen) Materialfluss erfordern; der Bauteil-Rohling 10 ist in Fig. 2b dargestellt.

Je nach Komplexität des Bauteils 1 kann die endkonturnahe Formgebung in einem einzigen Tiefziehschritt erfolgen, oder sie kann mehrstufig erfolgen (Fig. 1b). Anschließend an den Kaltumformprozess wird der Bauteil-Rohling 10 in eine

Schneidvorrichtung 15 eingelegt und dort beschnitten (Prozessschritt III, Fig. 1c). Der Werkstoff befindet sich zu diesem Zeitpunkt immer noch im ungehärteten Zustand, daher kann das Beschneiden mit Hilfe konventioneller mechanischer Schneidmittel 14, wie etwa Schneidmesser, Abkant- und/oder Stanzwerkzeugen, erfolgen.

Für das Beschneiden kann, wie in Fig. 1c gezeigt, eine separate Schneidvorrichtung 15 vorgesehen sein. Alternativ können die Schneidmittel 14 in die letzte Stufe 9' des Tiefziehwerkzeugs 9 integriert sein, so dass in der letzten Tiefziehstufe 9' zusätzlich zu der Fertigformung des Blechteil-Rohlings 10 auch das randseitige Beschneiden erfolgt.

Durch den Kaltumformprozess und das Beschneiden (Prozessschritte II und III) wird aus der Platine 3 ein endkonturnah beschnittener Bauteil-Rohling 17 hergestellt der sowohl in Bezug auf seine dreidimensionale Form als auch in Bezug auf seine Randkontur 12' nur wenig von der gewünschten Form des Bauteils 1 abweicht. Die abgeschnittenen Randbereiche 11 werden in der Schneidvorrichtung 15 abgeführt; der Bauteil-Rohling 17 (Fig. 2c) wird mit Hilfe eines Manipulators 19 aus der Schneidvorrichtung 15 entnommen und dem nächsten Prozessschritt IV zugeführt.

In einer besonders vorteilhaften Alternative sind die Prozessschritte II und III in einer einzigen Bearbeitungsstation integriert, in der das Umformen und Schneiden vollautomatisch vorgenommen wird. Die Entnahme des Bauteil-Rohlings 17 aus der Bearbeitungsstation kann automatisiert erfolgen oder es kann eine manuelle Entnahme und Abstapelung der Bauteil-Rohlinge 17 erfolgen.

In dem folgenden Prozessschritt IV (Fig. 1d) wird der beschnittene Bauteil-Rohling 17 einer Warmumformung in einem Warmumformbereich 26 unterzogen, im Rahmen derer er auf eine endgültige Form des Bauteils 1 ausgeformt und gehärtet wird. Der beschnittene Bauteil-Rohling 17 wird von einem Manipulator 20 in einen Durchlaufofen 21 eingelegt, wo er auf eine Temperatur erhitzt wird, die oberhalb der Gefügeumwandlungstemperatur in den austenitischen Zustand liegt; je nach Stahlsorte entspricht dies einer Erhitzung auf eine Temperatur zwischen 700°C und 1100°C. Für einen bevorzugten Werkstoff eines borhaltigen Stahls, insbesondere Usibor 1500P, ist ein günstiger Bereich zwischen 900°C und 1000°C. Die Atmosphäre des Durchlaufofens kann durch Zugabe eines Schutzgases inertisiert werden, durch die Vorbeschichtung der Platinen 3 wird jedoch bereits zumindest ein ganzflächiges Verzundern der Rohlingsoberfläche verhindert.

Die unbeschichteten Schnittstellen der Randkontur 12' der beschnittenen Bauteil-Rohlinge 17 stellen nur einen sehr geringen Flächenanteil des Bauteil-Rohlings 17 dar, so dass eine Haftung einer später aufgebrachten Schicht praktisch nicht beeinflusst wird. Ein geeignetes Schutzgas zur Inertisierung ist z.B. Kohlendioxid oder Stickstoff.

Der erhitzte beschnittene Bauteil-Rohling 17 wird dann mit Hilfe eines Manipulators 22 in ein Warmumform-Werkzeug 23 eingelegt, in dem die dreidimensionale Gestalt und die Randkontur 12' des beschnittenen Bauteil-Rohlings 17 auf ihr gewünschtes Maß gebracht werden. Da der beschnittene Bauteil-Rohling 17 bereits endkonturnahe Maße aufweist, ist während der Warmumformung nur noch eine geringe Formanpassung notwendig. Im Warmumform-Werkzeug 23 wird der beschnittene Bauteil-Rohling 17 fertig geformt und schnell abgekühlt, wodurch ein feinkörniges martensitisches oder bainitisches Werkstoffgefü-

ge eingestellt wird. Dieser Schritt entspricht einer Härtung des Bauteil-Rohlings 18 und ermöglicht eine gezielte Einstellung der Werkstofffestigkeit. Einzelheiten eines solchen Härtungsprozesses sind z.B. in der DE 100 49 660 A1 beschrieben. Es kann sowohl der ganze Bauteil-Rohling 17 gehärtet werden, als auch lediglich lokal an ausgewählten Stellen des Bauteil-Rohlings 17 eine Härtung vorgenommen werden. Ist der gewünschte Härtungsgrad des Bauteil-Rohlings 18 erreicht, wird der gehärtete Bauteil-Rohling 18 mit einem Manipulator aus dem Warmumform-Werkzeug 23 genommen und gegebenenfalls bis zur weiteren Verarbeitung gestapelt. Wegen dem dem Warmumform-Prozess vorgelagerten endkonturnahen Beschneiden des Bauteil-Rohlings 10 sowie der Formanpassung der Randkontur 12' im Warmumform-Werkzeug 23 weist das Bauteil 18 nach Abschluss des Warmumform-Prozesses bereits die gewünschte Außenkontur 24 des fertigen Bauteils 1 auf, so dass nach der Warmumformung kein zeitaufwändiges Beschneiden des Bauteilrandes notwendig ist.

Um eine schnelle Abschreckung des Bauteil-Rohlings 18 im Zuge der Warmumformung zu erreichen, kann der Bauteil-Rohling 18 in einem gekühlten Warmumform-Werkzeug 23 abgeschreckt werden. Da die Oberfläche durch die Schicht 33 der Vorbeschichtung nicht verzundert, kann eine anschließende Reinigung entfallen.

Da kein Laserschneiden des gehärteten Bauteil-Rohlings 18 erfolgen muss, sind die Taktzeiten im Fertigungsverfahren vorteilhaft kurz. Im Verfahrensablauf ist nunmehr das Abkühlen des Bauteil-Rohlings 18 ein möglicher Engpass. Um diesen zu entschärfen, können lufthärtende oder wasserhärtende Werkstoffe für die Bauteile 1 eingesetzt werden. Der Bauteil-Rohling 18 braucht dann nur soweit abzukühlen, bis eine ausreichende Warmfestigkeit, Steifigkeit und damit verbundene

Maßhaltigkeit des Bauteil-Rohlings 18 erreicht ist. Dann kann der Bauteil-Rohling 18 aus dem Werkzeug 23 entnommen werden, so dass der weitere Wärmebehandlungsvorgang an der Luft oder in Wasser außerhalb des Werkzeugs 23 erfolgt, das dann nach einigen Sekunden sehr schnell wieder zur Aufnahme weiterer Bauteil-Rohlinge 17 zur Verfügung steht.

In einem weiteren Prozessschritt V (Fig. 1e) wird der pressgehärtete Bauteil-Rohling 18 in einem Beschichtungsverfahren mit einer eine Korrosion des Bauteils 1 verhindernden Schicht 34 überzogen. Dazu werden Trommeln 31 mit den pressgehärteten Bauteil-Rohlingen 18 sowie einem zinkhaltigen Pulver, vorzugsweise eine Zinklegierung oder eine zinkhaltige Mischung, beschickt, geschlossen und in eine Beschichtungsanlage 30 eingebracht. Dort werden die Bauteil-Rohlinge 18 langsam mit etwa 5-10 K/min unter langsamer Rotation der Trommeln 31 auf etwa 300°C erwärmt. In diesem thermischen Diffusionsverfahren verteilt sich das Zink bzw. die Zinklegierung im wesentlichen homogen über die gesamte Oberfläche der Bauteil-Rohlinge 18 und verbindet sich mit der Oberfläche. Bei einer aluminiumhaltigen Vorbeschichtung der Platinen 3 bildet sich eine ausgezeichnete Haftung zwischen der Vorbeschichtung, insbesondere AlSi und der zinkhaltigen Schicht 34 aus. Gleichzeitig werden auch die unbeschichteten Schnittkanten mit der zinkhaltigen Schicht 34 überzogen.

In Abhängigkeit der Zusammensetzung des Pulvers, der Zeit und der Temperatur stellt sich auf den Bauteil-Rohlingen 18 eine gleichmäßige Schichtdicke ein, die beliebig zwischen einigen μm und über 100 μm, bevorzugt zwischen 5 μm und 120 μm, eingestellt werden kann. Die Schicht 34 ist schweißbar und ergibt eine Zugfestigkeit, die für ein Bauteil 1 aus BTR 165 mehr als 1300 MPa betragen kann. Bei dem thermischen Diffusi-

onsverfahren fallen praktisch keine Rückstände oder Emissionen in die Umwelt an.

Das Beschichtungsverfahren wird mit einem Passivierungsvorgang in einer angrenzenden Passivierungsstation 35 abgeschlossen, bei dem die Trommeln 31 aus der Beschichtungsanlage 30 ausgeschleust, in einer Kühlstation 36 gekühlt, in einer Reinigungsstation 37 mit Ultraschall von Rückständen des Beschichtungspulvers befreit und in einer Temperstation 38 bei einer Temperatur von etwa 200°C für etwa 1 h getempert werden, wobei die Schicht 34 passiviert wird. Gegebenenfalls können auch geeignete Passivierungszusätze zugegeben werden. Dann können die fertigen korrosionsgeschützten Bauteile 1 aus der Trommel 31 entnommen werden.

In einer alternativen Ausgestaltung (Prozessschritt V', Fig. 1f) wird die zinkhaltige Schicht 34 mit einem Feuerverzinkungs-Verfahren in einem Beschichtungsbereich 40 auf den pressgehärteten Bauteil-Rohling 18 aufgebracht. Bauteil-Rohlinge 18 werden in ein Tauchgehäuse 41 eingehängt, welches die Bauteil-Rohlinge 18 durch mehrere Stationen des Beschichtungsbereichs 40 transportiert. In einer Flux-Station 42 werden die Bauteil-Rohlinge 18 in ein geeignet temperiertes Flussmittelbad gehängt, vorzugsweise mit Zinkchlorid bei etwa 360°C, dann in einer Trockenstation 43 getrocknet, vorzugsweise bei 80°C und anschließend in ein Verzinkungsbad 44 bei etwa 400-450°C eingetaucht und verzinkt. Dann können die fertigen Bauteile 1 aus dem Tauchgehäuse 31 entnommen werden.

Figuren 3a bis 3d zeigen schematisch einen alternativen Verfahrensablauf zur Herstellung eines räumlich geformten, pressgehärteten Bauteils 1 aus einem Halbzeug 2, insbesondere aus einer vorbeschichteten Platine 3. Ebenso wie im Ausführungsbeispiel der Figuren 1a bis 1e wird auch hier in einem

ersten Prozessschritt (Fig. 3a) die Platine 3 in der Platinenpresse 6 aus einem vorbeschichteten, warm umformbaren Blech ausgeschnitten. Anschließend wird die beschichtete Platine 3 einem Warmumformschritt unterzogen (Fig. 3b). Hierzu wird die Platine 3 von einem Manipulator 20' in einen Durchlaufofen 21' eingelegt, in dem die Platine 3 auf eine Temperatur erwärmt wird, die oberhalb der Übergangstemperatur in den austenitischen Gefügezustand liegt. Anschließend wird die erhitzte Platine 3 in ein Warmumformwerkzeug 23' eingelegt, in dem aus der Platine 3 ein Bauteil-Rohling 10' der gewünschten dreidimensionalen Form ausgeformt wird; dabei wird der Bauteil-Rohling 10' so schnell abgekühlt, dass er eine (bauteilweite oder lokale) Härtung erfährt. Der Durchlaufofen 21' und das Warmumformwerkzeug 23' können sich in einer Schutzgasatmosphäre 26' befinden, durch die Vorbeschichtung der Platinen 3 wird jedoch eine ganzflächige Verzunderung der Platinen 3 vermieden.

Dann wird der gehärtete Bauteil-Rohling 10' an eine Schneidvorrichtung 15' übergeben (Fig. 3c), in der der Bauteil-Rohling 10' randseitig beschnitten wird, um einen Rohling 18' mit Randkontur 12 zu erzeugen. Das Beschneiden erfolgt vorzugsweise mit einem Laser 14'. Die abgeschnittenen Randbereiche 11' werden entsorgt. In dem anschließenden Prozessschritt der Figur 3d wird der pressgehärtete und beschnittene Rohling 18' - analog zu der Prozessstufe V oder V' der Figuren 1e bzw. 1f - in einer Beschichtungsanlage 30 beschichtet.

Das pressgehärtete, beschichtete Bauteil 1 ist insbesondere als Karosseriebauteil im Fahrzeugbau geeignet, welche in großen Stückzahlen hergestellt werden. Das erfindungsgemäße Verfahren ermöglicht eine vorteilhafte Prozessführung mit kurzen Taktzeiten, alle Prozessschritte haben Industrialisierungspotential. Trotz Verwendung eines vorbeschichteten Werkstoffs

ist ein Einsatz einer konventionellen Vor-Umformung möglich. Durch das nachträgliche Aufbringen eines zusätzlichen Korrosionsschutzes wird ein konventionelles Umformen und Beschneiden auch bei hochfesten Werkstoffen möglich, so dass - bei Verwendung des Herstellungsverfahrens gemäß Figur 1 - das bei großen Stückzahlen aufwändige Laserschneiden kostengünstig ersetzt werden kann. Blechbauteile können durch diese Fertigungsmethode bereits in der Entwicklung durch konventionelle Umform-Simulation auf ihre Herstellung abgesichert werden. Hinzu kommt eine günstige Verbindung der Korrosionsschutzeigenschaften der Vorbeschichtung 33 einerseits mit denen der Schicht 34 mit dem Vorteil der Kantenbeschichtung, insbesondere bei AlSi-Schichten 33 in Verbindung mit Zinkschichten 34. In einem Fahrzeug wiederum, das aus solchen Bauteilen gefügt ist, wird der Kraftstoffverbrauch durch die Verminderung des Gewichts der Bauteile gesenkt, da diese wesentlich dünner sein können als konventionelle Blechteile, während gleichzeitig die passive Sicherheit erhöht wird, da die Bauteile eine sehr hohe Festigkeit aufweisen.

Patentansprüche

1. Verfahren zur Herstellung von pressgehärteten Bauteilen, insbesondere eines Karosseriebauteils, aus einem Halbzeug (2) aus ungehärtetem, warm umformbaren Stahlblech, d a d u r c h g e k e n n z e i c h n e t , dass folgende Verfahrensschritte ausgeführt werden
   - aus dem mit einer ersten Schicht (33) vorbeschichteten Halbzeug (2) wird durch ein Kaltumformverfahren, insbesondere ein Ziehverfahren, ein Bauteil-Rohling (10) geformt;
   - der Bauteil-Rohling (10) wird randseitig auf eine dem herzustellenden Bauteil (1) näherungsweise entsprechende Randkontur (12') beschnitten;
   - der beschnittene Bauteil-Rohling (17) wird erwärmt und in einem Warmumform-Werkzeug (23) pressgehärtet;
   - der pressgehärtete Bauteil-Rohling (18) wird in einem Beschichtungsschritt mit einer zweiten, vor Korrosion schützenden Schicht (34) überzogen.

2. Verfahren zur Herstellung von pressgehärteten Bauteilen, insbesondere eines Karosseriebauteils, aus einem Halbzeug (2) aus ungehärtetem, warm umformbaren Stahlblech, d a d u r c h g e k e n n z e i c h n e t , dass folgende Verfahrensschritte ausgeführt werden

- das mit einer ersten Schicht (33) vorbeschichtete Halbzeug (2) wird erwärmt und in einem Warmumform-Werkzeug (23) pressgehärtet;
- der auf diese Weise erzeugte pressgehärtete Bauteil-Rohling (10') wird randseitig auf eine dem herzustellenden Bauteil (1) entsprechende Randkontur (12) beschnitten;
- der pressgehärtete Bauteil-Rohling (18') wird in einem Beschichtungsschritt mit einer zweiten, vor Korrosion schützenden Schicht (34) überzogen.

3. Verfahren nach Anspruch 1 oder 2,
d a d u r c h g e k e n n z e i c h n e t ,
dass die Schicht (34) mit einem Feuerverzinkungs-Verfahren auf den pressgehärteten Bauteil-Rohling (18,18') aufgebracht wird.

4. Verfahren nach Anspruch 1 oder 2,
d a d u r c h g e k e n n z e i c h n e t ,
dass die Schicht (34) mit einem thermischen Diffusions-Verfahren auf den pressgehärteten Bauteil-Rohling (18,18') aufgebracht wird.

5. Verfahren nach zumindest einem der vorangegangenen Ansprüche,
d a d u r c h g e k e n n z e i c h n e t ,
dass die Schicht (34) sowohl auf der Vorbeschichtung (33) als auch auf unbeschichteten Bereichen des Bauteil-Rohlings (18,18') abgeschieden wird.

6. Verfahren nach zumindest einem der vorangegangenen Ansprüche,
d a d u r c h g e k e n n z e i c h n e t ,
dass der beschichtete Bauteil-Rohling (18,18') nach dem

Beschichtungsschritt von Rückständen des Beschichtungsschritts gereinigt wird.

7. Verfahren nach zumindest einem der vorangegangenen Ansprüche,
d a d u r c h g e k e n n z e i c h n e t ,
dass der beschichtete Bauteil-Rohling (18,18') nach dem Beschichtungsschritt getempert wird.

8. Pressgehärtetes Bauteil, insbesondere Karosseriebauteil, aus einem Halbzeug (2) aus ungehärtetem, warm umformbaren, mit einer Korrosionsschutzschicht (33) vorbeschichteten Stahlblech,
d a d u r c h g e k e n n z e i c h n e t ,
dass es nach dem Verfahren nach zumindest einem der vorangegangenen Ansprüche hergestellt ist.

9. Pressgehärtetes Bauteil nach Anspruch 8,
d a d u r c h g e k e n n z e i c h n e t ,
dass ein Überzug aus einer ersten, aluminiumhaltigen Schicht (33) und einer darüber angeordneten zweiten, zinkhaltigen Schicht (34) auf dem Bauteil abgeschieden ist.

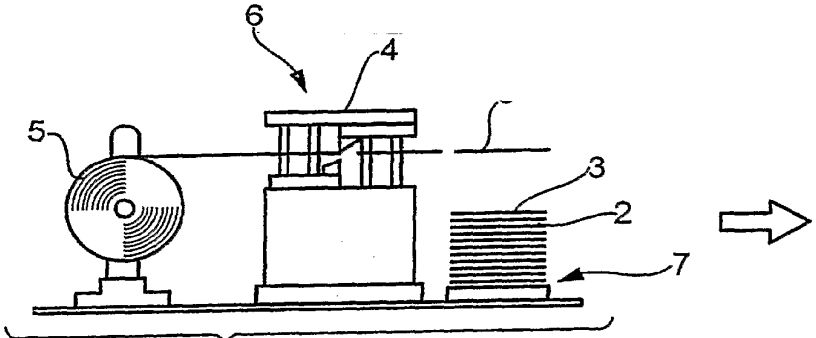


Fig. 1a

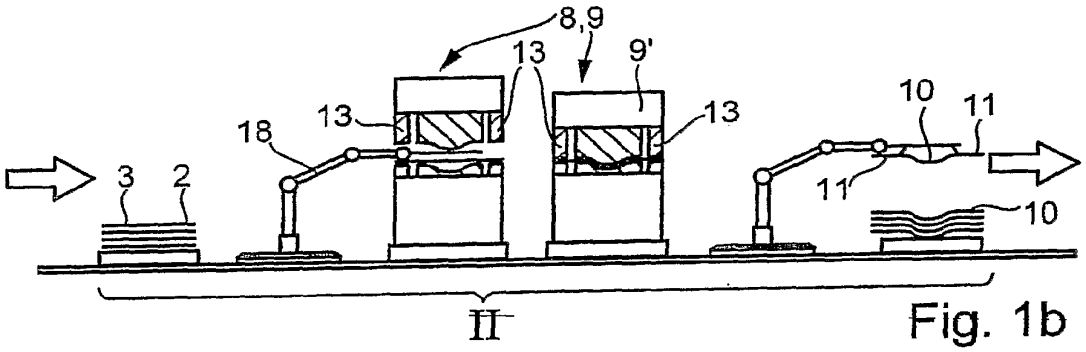


Fig. 1b

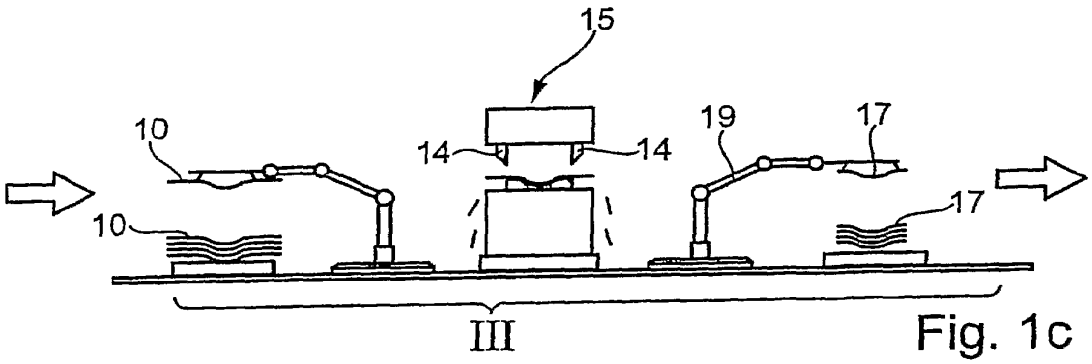


Fig. 1c

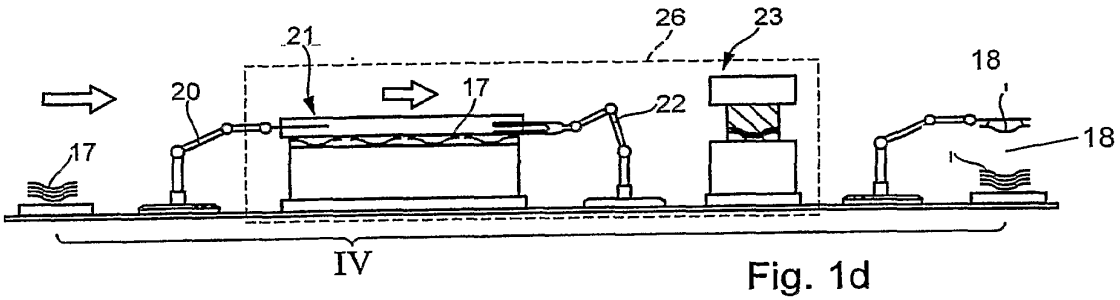


Fig. 1d

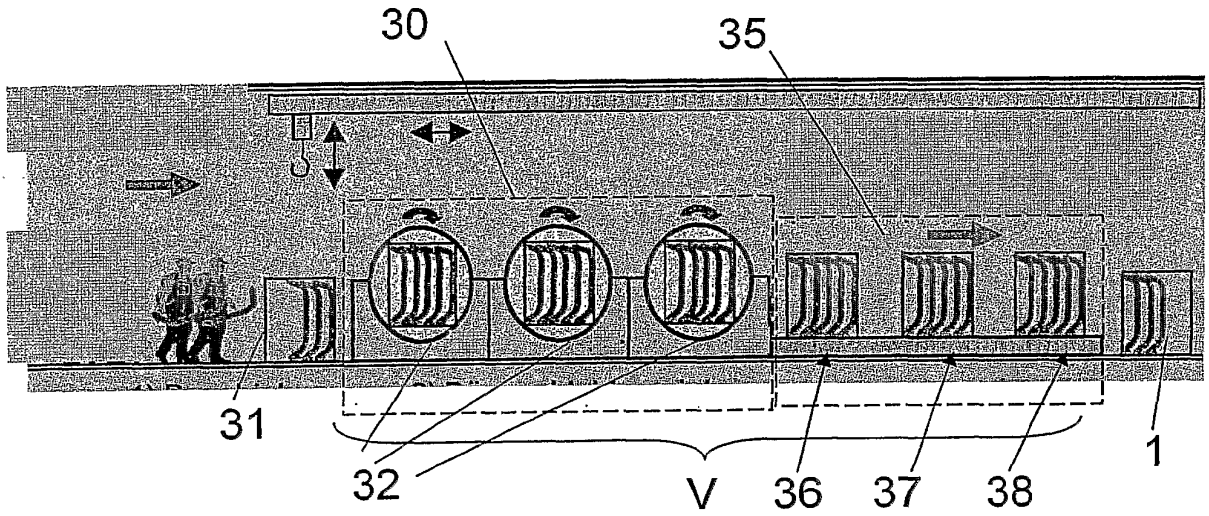


Fig. 1e

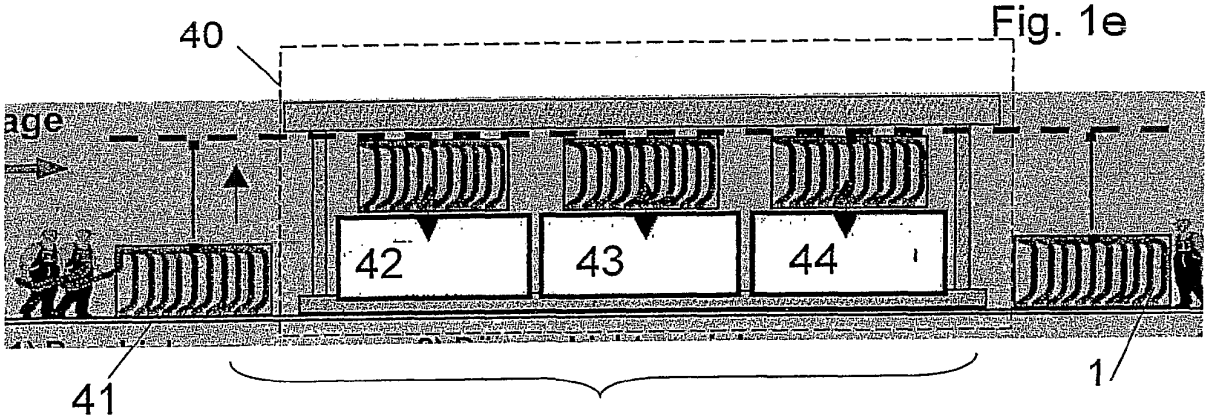


Fig. 1f

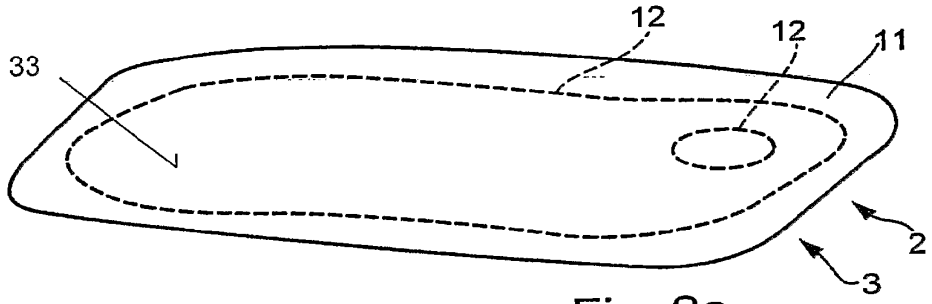


Fig. 2a

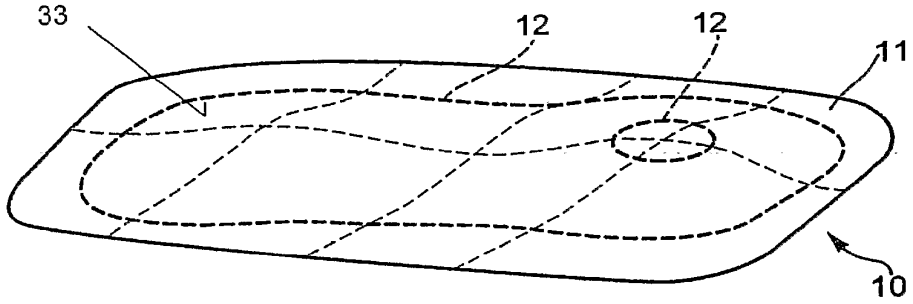


Fig. 2b

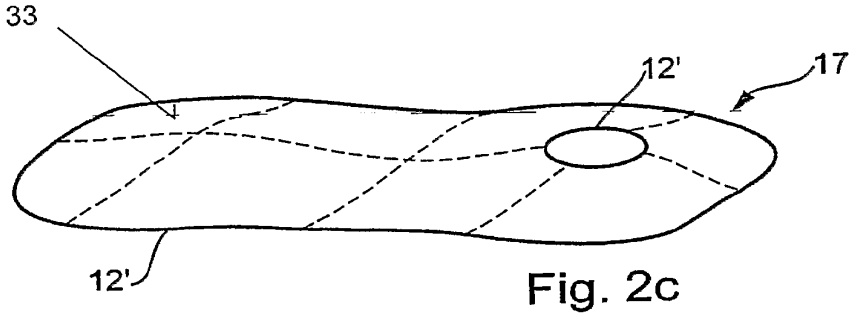


Fig. 2c

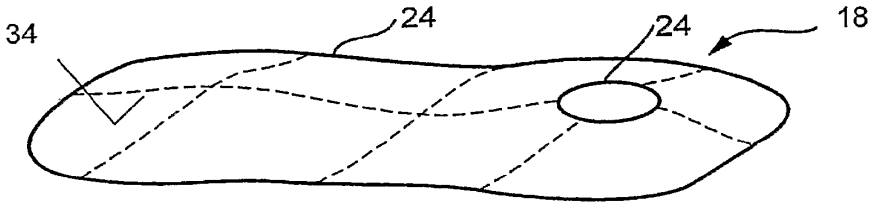


Fig. 2d

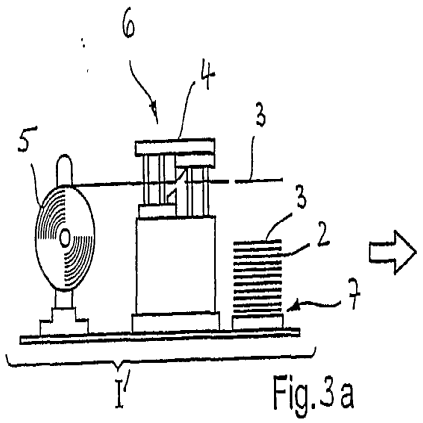


Fig. 3a

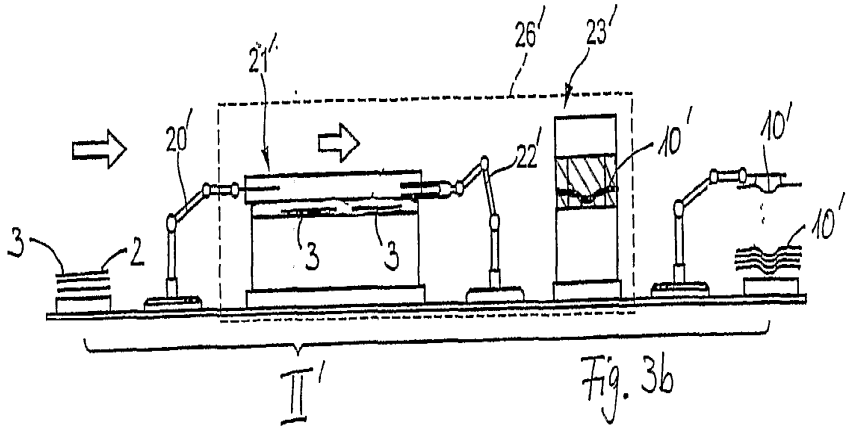


Fig. 3b

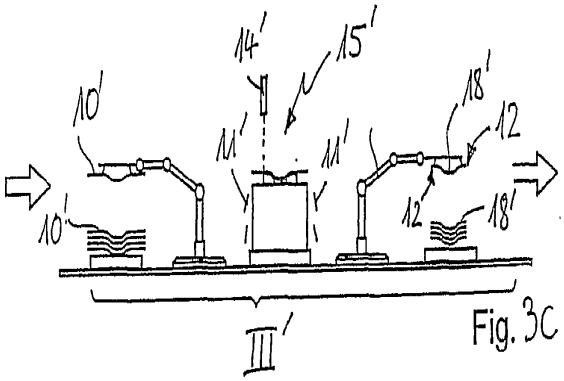


Fig. 3c

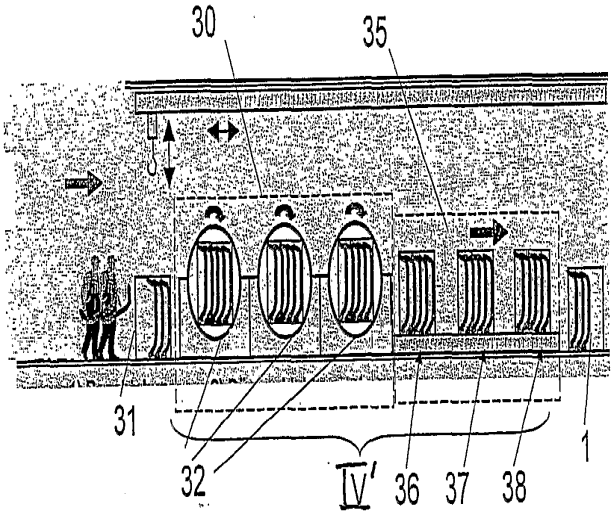


Fig. 3d

INTERNATIONAL SEARCH REPORT

International Application No
PCT/EP2004/008087

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 B21D35/00 C21D1/673 C21D9/46

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 B21D C21D

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal, WPI Data, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	DE 101 35 647 C (DAIMLER CHRYSLER AG) 25 July 2002 (2002-07-25) figures 1a,1b	1-9
A	DE 101 49 221 C (BENTELER AUTOMOBILTECHNIK GMBH) 8 August 2002 (2002-08-08) cited in the application claim 1; figures 1-3	1-9
A	DE 100 49 660 A (DAIMLER CHRYSLER AG ; BENTELER AUTOMOBILTECHNIK GMBH (DE)) 25 April 2002 (2002-04-25)	1-7
X	column 7, line 35 - column 7, line 57; claim 24	8,9
A	DE 43 07 563 A (BAYERISCHE MOTOREN WERKE AG) 23 September 1993 (1993-09-23) column 2, line 37 - column 2, line 44	8,9

-/--

[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

° Special categories of cited documents :

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
11 November 2004	29/11/2004

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Vinci, V

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INTERNATIONAL SEARCH REPORT

International Application No
PCT/EP2004/008087

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
P,A	WO 2004/033126 A (DAIMLER CHRYSLER AG ; FISCHER UWE (DE); MEHRHOLZ RALF (DE); BRODT MART) 22 April 2004 (2004-04-22) figures 1a-1e	1-9

Form PCT/ISA/210 (continuation of second sheet) (January 2004)

INTERNATIONAL SEARCH REPORT

›rmation on patent family members

Inter[redacted]nal Application No
PCT/EP2004/008087

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
DE 10135647 C	25-07-2002	DE 10135647 C1	25-07-2002
DE 10149221 C	08-08-2002	DE 10149221 C1	08-08-2002
		EP 1300475 A2	09-04-2003
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		JP 2002178069 A	25-06-2002
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		WO 2004033126 A1	22-04-2004

INTERNATIONALER RECHERCHENBERICHT

Internationales Aktenzeichen
PCT/EP2004/008087

A. KLASSIFIZIERUNG DES ANMELDUNGSGEGENSTANDES
IPK 7 B21D35/00 C21D1/673 C21D9/46

Nach der Internationalen Patentklassifikation (IPK) oder nach der nationalen Klassifikation und der IPK

B. RECHERCHIERTE GEBIETE

Recherchierter Mindestprüfstoff (Klassifikationssystem und Klassifikationssymbole)
IPK 7 B21D C21D

Recherchierte aber nicht zum Mindestprüfstoff gehörende Veröffentlichungen, soweit diese unter die recherchierten Gebiete fallen

Während der internationalen Recherche konsultierte elektronische Datenbank (Name der Datenbank und evtl. verwendete Suchbegriffe)
EPO-Internal, WPI Data, PAJ

C. ALS WESENTLICH ANGESEHENE UNTERLAGEN

Kategorie°	Bezeichnung der Veröffentlichung, soweit erforderlich unter Angabe der in Betracht kommenden Teile	Betr. Anspruch Nr.
A	DE 101 35 647 C (DAIMLER CHRYSLER AG) 25. Juli 2002 (2002-07-25) Abbildungen 1a,1b	1-9
A	DE 101 49 221 C (BENTELER AUTOMOBILTECHNIK GMBH) 8. August 2002 (2002-08-08) in der Anmeldung erwähnt Anspruch 1; Abbildungen 1-3	1-9
A	DE 100 49 660 A (DAIMLER CHRYSLER AG ; BENTELER AUTOMOBILTECHNIK GMBH (DE)) 25. April 2002 (2002-04-25)	1-7
X	Spalte 7, Zeile 35 - Spalte 7, Zeile 57; Anspruch 24	8,9
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[X] Weitere Veröffentlichungen sind der Fortsetzung von Feld C zu entnehmen

[X] Siehe Anhang Patentfamilie

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Datum des Abschlusses der internationalen Recherche	Absendedatum des internationalen Recherchenberichts
11. November 2004	29/11/2004

Name und Postanschrift der Internationalen Recherchenbehörde	Bevollmächtigter Bediensteter
Europäisches Patentamt, P.B. 5818 Patentlaan 2 NL – 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Vinci, V

Formblatt PCT/ISA/210 (Blatt 2) (Januar 2004)

INTERNATIONALER RECHERCHENBERICHT

Internationales Aktenzeichen
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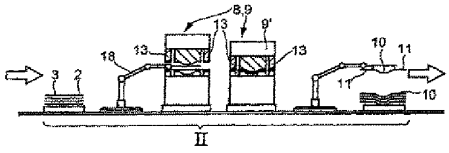
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(71)出願人　598051819
ダイムラークライスラー・アクチェンゲゼルシャフト
ドイツ連邦共和国　７０５６７　シュトットガルト，エップルシュトラッセ　２２５
(74)代理人　100123342
弁理士　中村　承平
(74)代理人　100111143
弁理士　安達　枝里
(72)発明者　ミヒャエル・バイヤー
ドイツ連邦共和国　７１０８３　ヘレンベルグ、ブロントール　６

最終頁に続く

(54)【発明の名称】プレス焼入れ部品及びその製造方法

(57)【要約】
本発明は、プレス焼入れ部品、より詳細には自動車の車体のプレス焼入れ部品を製造する方法に関し、該部品は、前記方法により製造されるプレス焼入れ部品の他に、非焼入れの、高温で変形可能な鋼板製半製品（２）で構成される。本発明的方法は様々な工程を含む。半製品（２）は、第１被膜（３３）でプレコートされており、冷間成形法、特に絞り加工によって部品ブランク（１０）を成形するのに使用される。部品ブランク（１０）の縁端側は、製造される部品（１）にほぼ一致する輪郭形状（１２’）を形成するよう切断される。切断された部品ブランク（１７）は、熱間成形器具（２３）内で加熱されかつプレス焼入れされる。その後、プレス焼入れされた部品ブランク（１８）には、被覆工程で第２の耐食被膜（３４）が施される。



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【特許請求の範囲】
【請求項1】
プレス焼入れ部品、特に車両車体構成部品を、非焼入れの熱間加工可能な鋼板製半製品（２）から製造する方法であって、
第１被膜（３３）でプレコートされた前記半製品（２）から、冷間成形法、特に絞り加工によって、部品ブランク（１０）が成形されるステップと、
該部品ブランク（１０）が、縁端部で、製造される部品（１）にほぼ一致する輪郭形状（１２’）にトリミングされるステップと、
該トリミングされた部品ブランク（１７）が、熱間成形器具（２３）内で加熱され、プレス焼入れされるステップと、
前記プレス焼入れされた部品ブランク（１８）が、被覆工程で第２の耐食被膜（３４）で被覆されるステップと、
が実行されることを特徴とする、方法。
【請求項2】
プレス焼入れ部品、特に車両車体構成部品を、非焼入れの熱間加工可能な鋼板製半製品（２）から製造する方法であって、
第１被膜（３３）でプレコートされた前記半製品（２）が、熱間成形器具（２３）内で加熱されプレス焼入れされるステップと、
該プレス焼入れされた部品ブランク（１０’）が、縁端部で、製造される部品（１）に一致する輪郭形状（１２）にトリミングされるステップと、
前記プレス焼入れされた部品ブランク（１８’）が、被覆工程で第２の耐食被膜（３４）で被覆されるステップと、
が実行されることを特徴とする、方法。
【請求項3】
前記被膜（３４）は、溶融亜鉛めっき被覆法によって前記プレス焼入れブランク（１８、１８’）へ塗付されることを特徴とする請求項１あるいは２に記載の方法。
【請求項4】
前記被膜（３４）は、熱拡散法によって前記プレス焼入れ部品ブランク（１８、１８’）へ塗付されることを特徴とする請求項１あるいは２に記載の方法。
【請求項5】
前記被膜（３４）は、前記部品ブランク（１８、１８’）の前記プレコート（３３）領域と非被覆領域との両方に溶着されることを特徴とする請求項１～４のいずれか一項に記載の方法。
【請求項6】
被覆された前記部品ブランク（１８、１８’）は、前記被覆工程後、前記被覆工程での残留物が取り除かれることを特徴とする請求項１～５のいずれか一項に記載の方法。
【請求項7】
被覆された前記部品ブランク（１８、１８’）は、前記被覆工程の後、焼戻しされることを特徴とする請求項１～６のいずれか一項に記載の方法。
【請求項8】
耐食被膜（３３）を施された非焼入れの熱間加工可能な鋼板製の半製品（２）から成形されたプレス焼入れ部品、特に車両車体構成部品であって、請求項１～７のいずれか一項に記載の方法により製造されることを特徴とするプレス焼入れ部品。
【請求項9】
第１のアルミニウム含有被膜とその上に配置された第２の亜鉛含有被膜とからなる被覆が、前記部品上に溶着されることを特徴とする請求項８に記載のプレス焼入れ部品。

【発明の詳細な説明】
【技術分野】
【0001】
本発明は、独立請求項の前段によるプレス焼入れ部品及びプレス焼入れ部品の製造方法

に関する。
【背景技術】
【0002】
車両の構造においては、車体部品の強度と剛性について厳しい要求が益々課されるようになっている。しかし同時に、軽量化のために、材料の厚さの削減も目指している。高強度及び超高強度素材は相反する要求を満たす解決策を提供し、これらの素材は、非常に高強度で同時に薄い材料厚さの部品の製造を可能にする。これらの材料の場合、従来の熱間成形中の加工パラメータの適切な選択によって、部品の強度と靭性の値を具体的に設定することが可能である。
【0003】
こうした材料には、例えば、Ｕｓｉｂｏｒ　１５００という登録商標でユシノール（Ｕｓｉｎｏｒ）社が販売しているプレコートホウ素鋼がある。スチールには、その後の熱処理過程で特に有利な錆止め特性を示す、ＡｌＳｉ被膜が施されている。
【0004】
熱間成形を用いてこうした部品を製造するには、まず最初に、板材がコイルから切り取られ、その後この板材は、スチール素材の変態温度より高い温度で加熱され、この温度を超えると材料構造はオーステナイト状態になり、加熱された状態で成形器具の中へ挿入され、所望の部品の形状に成形され、所望の成形状態が機械的に固定されている間冷却され、部品の焼戻し又は焼入れが行われる。
【0005】
部品は、実際の熱間成形の前に、しばしば予備成形工程又はトリミング工程にかけられる。このことは、例えば特許文献１に記載されている。しかし、このような方法は、普通に塗付されたコイルの被膜は予備成形中に損傷されるので、腐食に関連する問題を提起する。従って、特にＡｌＳｉ被膜を施したＵｓｉｂｏｒ　１５００　ＰＣのようなプレコートされた高強度鋼の場合、部品の従来の予備成形又はトリミングは、省略される。
【0006】
【特許文献1】独国特許発明第　１０１　４９　２２１　Ｃ１号明細書
【発明の開示】
【発明が解決しようとする課題】
【0007】
本発明の目的は、プレコートされた熱間加工可能な鋼材のために信頼性の高い錆止めを可能にするプレス焼入れ部品及びプレス焼入れ部品の製造方法とを特定することである。
【課題を解決するための手段】
【0008】
この目的は、本発明に従って独立請求項１、２及び８の特徴により達成される。
【0009】
プレス焼入れ部品を製造するための本発明による方法の第１の実施形態は、次の工程を含む：部品ブランクは、冷間成形法、特に絞り加工によって、半製品から成形される；部品ブランクは、縁端部で、製造される部品にほぼ一致する輪郭形状にトリミングされる；トリミングされた部品ブランクは、熱間成形器具内で加熱されかつプレス焼入れされる；プレス焼入れされた部品ブランクは、被覆工程で耐食被膜によって被覆される。
【0010】
本発明のこの構成は、まず部品製造工程において、焼入れされた部品の最終トリミングは加工が複雑で費用がかかるが、このトリミングを省くことが可能となるように構成されることを可能にする。縁端領域は、部品が非焼入れの状態で既に切り落とされてしまい、熱間成形中における従来の方法のように加熱及び焼入れ加工後までそのままにしておかない。仕掛品は既に柔軟な状態でトリミングされているので、必要とされる切断力は焼入れ材料を冷間切断するためよりもかなり小さく、切断器具の材料磨耗の軽減及び維持費用の削減をもたらす。さらに、高強度素材を非焼入れ状態でトリミングすると、これらの材料の高切欠き感度のために、急に亀裂を成す危険性が低下する。

【0011】
半製品に施されたプレコートは、焼入れ工程中のトリミング済部品ブランクから薄片がはがれ落ちるのを回避し、焼入れ中の不活性雰囲気のための要件は軽減可能である。これに加えてプレコートは、焼入れ中の材料の脱炭を防止する。本発明によると、焼入れ工程の後さらに別の耐食被膜が塗付されるので、部品は完全に、すなわち縁端部も被覆される。
【0012】
プレス焼入れ部品を製造する本発明による方法の別の実施形態では、次の工程が実施される：第１被膜でプレコートされた半製品は、熱間成形器具内で加熱されかつプレス焼入れされる；このようにプレス焼入れされた部品ブランクは、縁端部で、製造される部品に一致する輪郭形状にトリミングされる；プレス焼入れされ、トリミングされた部品ブランクは、被覆工程で第２の耐食被膜を被覆される。
【0013】
この実施形態では、焼入れ部品は、好ましくはレーザー切断加工もしくはウォータージェット切断加工を用いてトリミングされるので、それによって部品縁端部の高品質なトリミングの実現を可能にする。その後の第２耐食被膜の塗付により、部品はさらにトリミングされた縁端部付近の腐食からも確実に保護されるようになる。
【0014】
溶融亜鉛めっき被覆法によりプレス焼入れブランクに被膜が塗付される場合、亜鉛の耐食被膜は、製造工程に適切に統合可能な被覆工程によって、塗付されるようにすることも可能である。
【0015】
被膜が熱拡散法によってプレス焼入れ部品ブランクへ塗付される場合、容易に制御可能な、亜鉛もしくは亜鉛合金の被膜が塗付される加工法が使用されることも可能で、この方法は複雑な部品の幾何学的形状や縁端部被覆にとっても、適している。被膜厚は、数μｍ～１００μｍ超まで、具体的に設定されるようにすることも可能である。部品の熱応力は僅かである。部品は、大きさ、寸法、構成、複雑性、及び重量に関わりなく、被覆されることが可能である。プレコートは、熱間成形中の部品ブランクから薄片のはがれ落ちを実質的に防止するので、被覆工程前のドライクリーニングによる洗浄、特にガラス粒子又は亜鉛粒子によるプレス焼入れ部品ブランクのブラストは、省くことが可能である。それによって工程ステップは省略され、部品の微粒子によるブラストに起因する極僅かではあるが妨げになる可能性のある部品の歪みは、さらに回避される。
【0016】
アルミ含有被膜、好ましくはＡｌＳｉ被膜と、亜鉛含有被膜とによるプレコート中、２つの被膜の間に良好な密着性が得られる。これに加えて、水素脆化に対する材料の良好な保護が得られ、亜鉛は特にこの水素脆化に対して材料を保護することができる。プレコートの第１被膜に塗付される第２被膜は、縁端被覆と、例えば予備成形中に過剰な摩擦のためにプレコートの第１被膜がはがれた又はクラックが入った領域の被覆と、を提供する。
【0017】
被覆工程後、被覆された部品ブランクから被覆工程の残留物が取り除かれた場合、例えば超音波によって不動態化された場合、被膜、特に塗料の下塗り剤又は塗料そのものにとって、良好な付着土台を生成する表面が形成される。
【0018】
被覆部品ブランクは、被覆工程後、好適に焼戻しされる。これは、部品ブランクが亜鉛含有被膜で被覆される場合、付着土台として適した酸化物が表面に形成されるので、特に有利である。
【0019】
本発明によるプレス焼入れ部品、特に車両車体構成部品は、非焼入れの熱間加工可能な鋼板製の半製品で構成されており、本発明による方法の少なくとも１つの発展形態により製造される。このような部品は、大量の大規模生産に特に適した方法で製造されることが

可能であり、優良な錆止めを備えた部品の重量の好適な削減を兼ね備えている。

【0020】

本発明のさらなる利点及び構成は、さらなる請求項及び以下の記述から得られる。

【0021】

以下、図面に示す例示された実施形態を参照して、本発明をより詳細に説明する。

【発明を実施するための最良の形態】

【0022】

図１ａ～図１ｅは、半製品２から三次元成形されたプレス焼入れ部品１を製造するための本発明による方法を、概略的に示している。例示された本実施形態では、使用される半製品２は、巻き戻されるコイル５を切り取った板材３である。あるいはその代わりに、使用される半製品２は、複合材シート、例えば、独国特許出願公開第　１００　４９　６６０　Ａ１号明細書に記載のようなものでもよく、これはベースシート及び少なくとも１枚の補強シートで構成される。さらに、使用される半製品２は、異なる材料厚及び／又は異なる材料組成のシートが複数一緒に溶接されて構成される特別調整されたブランクであってもよい。あるいはその代わりに、半製品２は三次元に成形された板金部品でもよく、該部品はあらゆる所望の成形法で製造され、本発明による方法を用いて、さらに別の成形を受け、強度及び／又は剛性の増加がもたらされる。

【0023】

半製品２は非焼入れの熱間加工可能な鋼板で構成される。特に好ましい材料は焼戻しホウ素鋼であり、例えば、Ｕｓｉｂｏｒ　１５００、Ｕｓｉｂｏｒ　１５００　Ｐ、又はＵｓｉｂｏｒ　１５００　ＰＣなどがあり、これらの登録商標でユシノール（Ｕｓｉｎｏｒ）社により販売されている。

【0024】

第１工程ステップＩでは、板材３（図１ａ）は、プレコートされた熱間加工可能な板材で構成されるコイル５の巻き戻されて真直ぐに伸ばされた部分から切り取られる。被膜は、アルミニウム又はアルミニウム合金、特にアルミニウム・シリコン合金ＡｌＳｉの被膜が好ましい。この時点で、熱間加工可能な材料は非焼入れ状態であり、そのため板材３は、従来の機械的切断手段４、例えば往復剪断機を用いて、問題なく切り取られることが可能である。大規模生産で使用する場合、板材３は、打ち抜きプレス機６を用いて大きさに合わせて好適に切断され、該プレス機は、コイル５の自動的供給、及び自動打ち抜き、及び切り取られた板材３の取り出しを、確実に行う。この方法で切り取られた板材３は、図２ａの概略的斜視図に示されている。

【0025】

切り取られた板材３は、スタック７上に堆積され、積み重ねられた形で冷間成形ステーション８へ供給される（図１ｂ）。ここで、第２工程ステップＩＩでは、冷間成形器具８、例えば２段階深絞り加工器具９を用いて、板材３から部品ブランク１０が成形される。部品の幾何学的形状の高品質な成形を確保できるように、板材３は、成形される部品１の外側輪郭１２を越えて突き出ている縁端領域１１を有する。この冷間成形加工（工程ステップＩＩ）の工程では、部品ブランク１０はほぼ有効形状に成形される。この場合、「ほぼ有効形状」とは、巨視的材料の流れを伴う仕上がり部品１が、これらの部分の幾何学的形状が冷間成形加工の完了後に部品ブランク１０において完全に成形されることを意味する。従って、冷間成形加工の完了後に部品１の三次元形状を生成するために必要なのは、最小限度の（局部的）材料の流れを要する僅かな形状の適合だけである。部品ブランク１０は図２ｂに示す。

【0026】

部品１の複雑性次第で、ほぼ有効形状への成形は、単一の深絞り加工工程で実行されてもよく、又は複数の段階で実行されてもよい（図１ｂ）。冷間成形加工に続いて、部品ブランク１０は、切断装置１５内へ挿入され、そこでトリミングされる（工程ステップＩＩＩ、図１ｃ）。この時点の材料は、まだ非焼入れ状態であり、従ってトリミングは、例えば、切断ブレード、刃、及び／又は打ち抜き器具等の、従来の機械的切断手段１４で実施

されてもよい。

【0027】

図１ｃに示すように、独立した切断装置１５がトリミング用に設けられてもよい。あるいはその代わりに、切断手段１４が深絞り加工器具９の最終段階９’に組み込まれてもよく、それによって最終深絞り加工段階９’において、部品ブランク１０の仕上げ成形の他に、縁端トリミングが実行されてもよい。

【0028】

ほぼ有効形状にトリミングされた部品ブランク１７は、板材３から冷間成形加工及びトリミング（工程ＩＩ及びＩＩＩ）によって生成され、このトリミング済部品ブランク１７は、三次元形状及び輪郭形状１２’に関して、部品１の所望の形状から僅かしか逸脱していない。切り落とされた縁端領域１１は、切断装置１５内で取り除かれ、部品ブランク１７（図２ｃ）は切断装置１５からマニピュレーター１９を用いて取り出され、次の工程ステップＩＶへ送られる。

【0029】

特に有利な代替方法では、工程ＩＩ及びＩＩＩは１つの処理ステーションに統合され、そこで成形及び切断が完全に自動化された方法で実施される。部品ブランク１７は、処理ステーションから自動化された方法で取り出されてもよく、あるいは部品ブランク１７は手動で取り出され、積み重ねられてもよい。

【0030】

その後の工程ステップＩＶ（図１ｄ）では、トリミング済部品ブランク１７は熱間成形領域２６で熱間成形にかけられ、その工程において部品１の最終形状へ成形され、焼入れされる。トリミング済部品ブランク１７は、マニピュレーター２０を用いて連続炉２１内へ挿入され、そこで変態温度を超えるオーステナイト状態の温度へ加熱され、鋼のタイプによって７００℃～１１００℃の温度加熱に対応する。好ましいホウ素鋼素材、特にＵｓｉｂｏｒ　１５００Ｐ、にとって、好適な範囲は９００℃～１０００℃である。連続炉の雰囲気は、不活性ガスの添加によって不活性になるが、しかし、板材３のプレコートは既に板材の表面全体に対して少なくとも薄片のはがれ落ちを防止している。

【0031】

トリミング済部品ブランク１７の輪郭形状１２’の被覆されていない断面部は、部品ブランク１７の面積の極僅かな部分でしかないので、その後塗付される被膜の付着性は実質的に影響されない。周辺雰囲気に不活性をもたらすのに適した不活性ガスは、例えば、二酸化炭素又は窒素である。

【0032】

その後、加熱されたトリミング済部品ブランク１７は、マニピュレーター２２を用いて熱間成形器具２３内へ挿入され、その中でトリミング済部品ブランク１７の三次元形状及び輪郭形状１２’に所望の大きさが与えられる。トリミング済部品ブランク１７は、既にほぼ有効形状な寸法になっているので、熱間成形中に必要な形状の適合は僅かである。熱間成形器具２３内で、トリミング済部品ブランク１７は仕上げ成形され、急速冷却され、その結果、きめの細かいマルテンサイト又はベイナイトの素材構造が固定される。この工程は部品ブランク１８の焼入れに相当し、材料強度の具体的固定化を可能にする。こうした焼入れ工程の詳細は、例えば独国特許出願公開第　１００　４９　６６０　Ａ１号明細書に記載されている。部品ブランク１７全体及び部品ブランク１７の局部的に選択された点の両方とも焼入れを受けてもよい。部品ブランク１８の所望の焼入れ具合が達成された場合、焼入れ部品ブランク１８は熱間成形器具２３からマニピュレーターを用いて取り出され、必要なであれば、さらなる処理が行われるまで積み重ねられる。部品ブランク１０は、熱間成形加工前にほぼ有効形状へトリミングされていること、及び熱間成形器具２３における輪郭形状１２’の形状の適合を考慮すると、部品１８は熱間成形加工の完了後には既に仕上がり部品１の所望の外側輪郭２４を有しており、従って時間のかかる部品縁端部のトリミングは熱間成形後は必要ない。

【0033】

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熱間成形の工程において部品ブランク１８の急速な焼入れを実現するために、部品ブランク１８は、冷却された熱間成形器具２３内で焼入れされてもよい。プレコートの被膜３３は表面から薄片がはがれ落ちるのを防いでくれるので、その後のクリーニングは省略してもよい。

【0034】

焼入れ部品ブランク１８のレーザー切断は実行される必要がないので、製造方法のサイクルタイムは有利に短い。製法手順では、今度は部品ブランク１８の冷却がボトルネックとなる可能性がある。ボトルネックを緩和するために、空気焼入れ又は水焼入れ材料が部品１に使用されてもよい。その後、部品ブランク１８は、部品ブランク１８の十分な熱安定性、剛性、及び関連する寸法の正確性が達成されるまで、冷却されるだけでよい。その後部品ブランク１８は、器具２３から取り出され、それによってさらなる熱処理加工が器具２３の外で空気中又は水中で実施され、そして該器具２３は非常に速く数秒後には別の部品ブランク１７を受け入れて利用可能となる。

【0035】

さらなる工程ステップＶ（図１ｅ）では、プレス焼入れ部品ブランク１８は、部品１の腐食を防止する被膜３４による被覆工程で被覆される。この目的のために、ドラム３１にはプレス焼入れ部品ブランク１８と亜鉛含有粉、好ましくは亜鉛合金もしくは亜鉛混合物、とが充填され、閉じられて、被覆装置３０の中へ挿入される。部品ブランク１８は、そこでドラム３１をゆっくり回転させながら、約５～１０Ｋ／分で約３００℃まで加熱される。この熱拡散法では、亜鉛もしくは亜鉛合金が部品ブランク１８の表面全体を覆うように実質的には均一に分布され、表面と結合する。板材３のアルミニウム含有プレコートの場合、プレコート、特にＡｌＳｉと、亜鉛含有被膜３４との間に良好な密着性を形成する。同時に、非被覆の切断縁端部は亜鉛含有被膜３４で被覆される。

【0036】

粉末の組成、時間及び温度によって、部品ブランク１８上に均一な被膜厚が現れ、被膜厚は数μｍ～１００μｍ超、好ましくは５μｍ～１２０μｍの間で所望のとおり設定されてもよい。被膜３４は溶接可能で、ＢＴＲ１６５の部品１にとって、引張り強度は１３００ＭＰａより大きくなり得る。熱拡散法では、残留物又は環境に対する排出物は実質的に発生しない。

【0037】

被覆工程は、隣接する不動態化処理ステーション３５における不動態化作業によって完了され、その間、ドラム３１は、被覆装置３０から取り外され、冷却ステーション３６で冷却され、洗浄ステーション３７で被膜粉の残留物が除去され、焼戻しステーション３８で約２００℃の温度で約１時間かけて焼戻され、その工程中、被膜３４は不動態化される。必要があれば、適切な不動態化添加物が添加されてもよい。仕上げられ、錆止めされた部品１は、その後ドラム３１から取り出されてよい。

【0038】

別の構成では（工程ステップＶ’、図１ｆ）、亜鉛含有被膜３４が、被覆領域４０内において溶融亜鉛めっき被覆法によってプレス焼入れ部品ブランク１８に塗付される。部品ブランク１８は、浸漬ハウジング４１内に吊り下げられ、該ハウジングは、被膜領域４０の複数のステーションを通り抜けて部品ブランク１８を搬送する。フラックスステーション４２では、部品ブランク１８は、適切に温度管理された、好ましくは塩化亜鉛を入れた約３６０℃の、フラックス漕内に吊り下げられ、その後乾燥ステーション４３内で、好ましくは８０℃で乾燥され、それから亜鉛めっき漕４４内に約４００～４５０℃で浸漬され亜鉛めっきされる。仕上げられた部品１は、その後浸漬ハウジング３１から取り出される。

【0039】

図３ａ～図３ｄは、半製品２、特に、プレコートされた板材３から、三次元成形されたプレス焼入れ部品１を製造する代替方法手順を概略的に示している。ここでも、図１ａ～図１ｅの例示された実施形態と同様の方法で、第１加工工程で、打ち抜きプレス機６内に

おいて、プレコートされた熱間加工可能な金属板から板材３が切り取られる（図３ａ）。被覆された板材３は、その後熱間成形加工を受ける（図３ｂ）。このために、板材３はマニピュレーター２０’を用いて連続炉２１’内へ挿入され、その中で板材３は、オーステナイト状態の変態温度を超える温度まで加熱される。加熱された板材３はその後熱間成形器具２３’内へ挿入され、その中で、所望の三次元形状の部品ブランク１０’が板材３から成形され、その工程において、部品ブランク１０’は急速に冷却され、（部品の幅に全体にわたって又は局部的に）焼入れされる。連続炉２１’及び熱間成形器具２３’は、不活性ガス雰囲気２６’内に配置されてもよいが、しかし、板材３のプレコートが、表面全体にわたって板材３から薄片がはがれ落ちるのを回避する。

【0040】

その後、焼入れ部品ブランク１０’は切断装置１５’へ転送され（図３ｃ）、その中で部品ブランク１０’は、輪郭形状１２を備えたブランク１８’を生成するために、縁端部でトリミングされる。トリミングは、好ましくはレーザー１４’で実行される。切り落とされた縁端領域１１’は処分される。その後に続く図３ｄ工程ステップⅠでは、プレス焼入れされ被覆されたブランク１８’は、図１ｅ又は図１ｆの加工工程Ⅴ又はⅤ’にそれぞれ同様の方法で、被覆装置３０内で被覆される。

【0041】

プレス焼入れされ、被覆された部品１は、特に車両構造内の車体構成部品として適しており、これら車体構成部品は大量に生産される。本発明による方法は、サイクルタイムの短い有利な工程管理を可能にし、全加工工程が産業化の可能性を有する。プレコートされた材料の使用にも関わらず、従来の予備成形を使用することが可能である。追加の耐食被膜をその後塗付することにより、従来の成形及びトリミングは、高強度素材の場合でも可能であり、それによって、図１による製造方法を使用する場合、大量に行うには費用がかかるレーザー切断も、費用節減的方法に置き換えられることが可能である。これらの製造方法によって、板金部品は、それらの製造に関して、従来の成形シミュレーションの展開において既に実証可能である。さらに、縁端被覆の利点を備えた、プレコート３３の耐食特性と被膜３４の特性との好適な組み合わせもあり、特に、亜鉛被膜３４と組み合わせたＡｌＳｉ被膜３３の場合が好適である。このような部品から組み立てられた車両内では、部品は従来の板金部品よりかなり薄いので、部品の重量の削減により燃料消費が削減され、同時に、部品は非常に高い強度を有するので、パッシブセーフティが増大される。

【図面の簡単な説明】

【0042】

【図1】プレス焼入れ部品を製造する本発明による方法の図式を示す。
【図1a】板材を大きさに合わせて切断（ステップⅠ）
【図1b】冷間成形（ステップⅡ）
【図1c】縁端部のトリミング（ステップⅢ）
【図1d】熱間成形（ステップⅣ）
【図1e】被覆（ステップⅤ）
【図1f】代替被覆法（ステップⅤ’）
【図2】部品の製造中の選択された中間段階の斜視図を示す。
【図2a】プレコートされた半製品
【図2b】プレコートされた半製品から成形された部品ブランク
【図2c】トリミングされた部品ブランク
【図2d】被覆された部品ブランク
【図3】プレス焼入れ部品を製造する別の方法手順を示す。
【図3a】板材を大きさに合わせて切断（ステップⅠ’）
【図3b】熱間成形（ステップⅡ’）
【図3c】縁端部のトリミング（ステップⅢ’）
【図3d】被覆（ステップⅣ’）

【図1a】

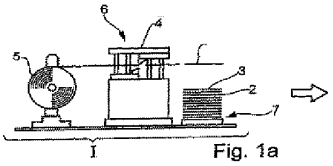


Fig. 1a

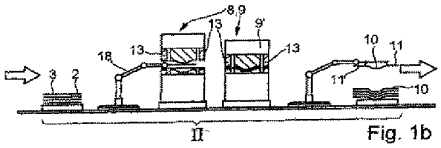


Fig. 1b

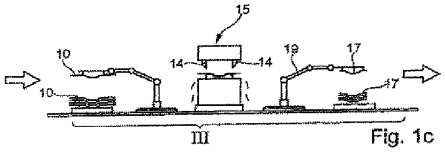


Fig. 1c

【図1b】

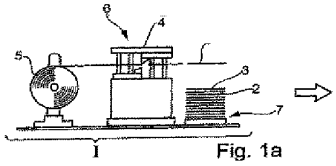


Fig. 1a

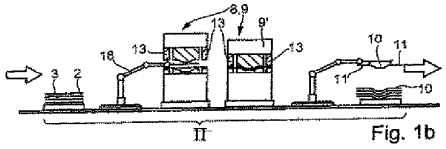


Fig. 1b

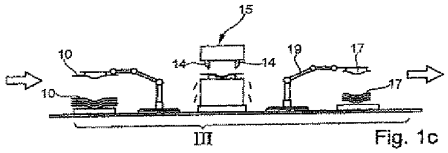


Fig. 1c

【図1c】

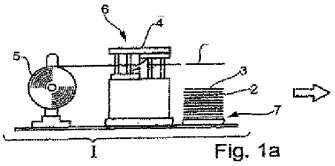


Fig. 1a

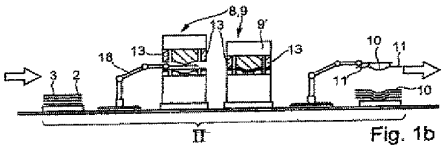


Fig. 1b

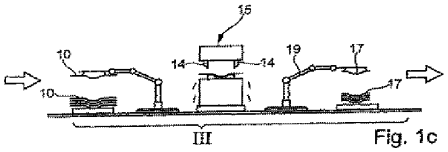


Fig. 1c

【図1d】

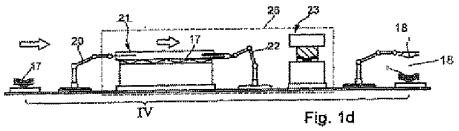


Fig. 1d

【図1e】

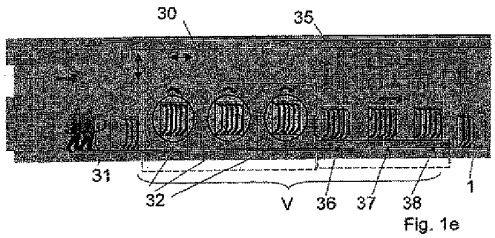


Fig. 1e

【図1f】

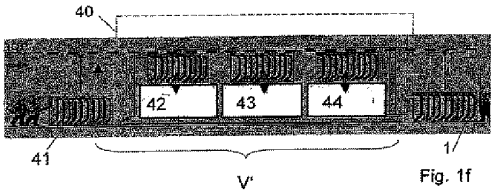


Fig. 1f

【図2a】

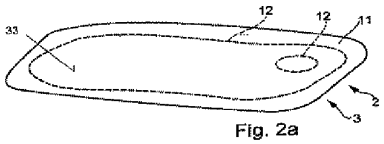


Fig. 2a

【図2b】

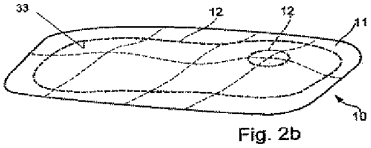


Fig. 2b

【図2c】

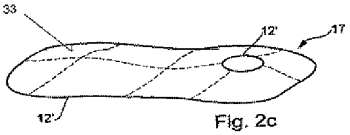


Fig. 2c

【図2d】

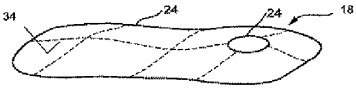
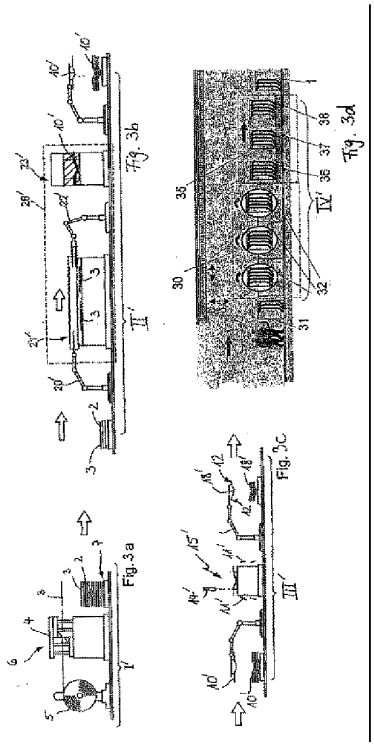
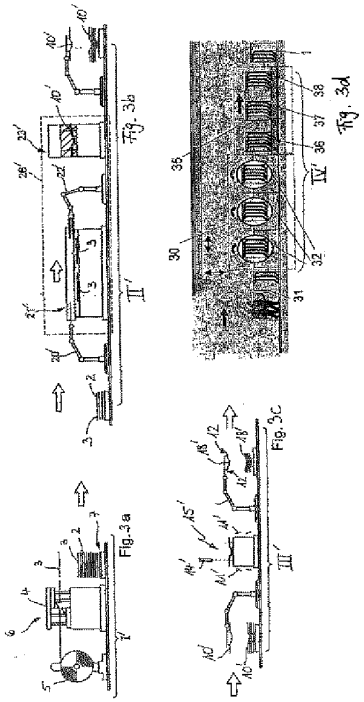


Fig. 2d

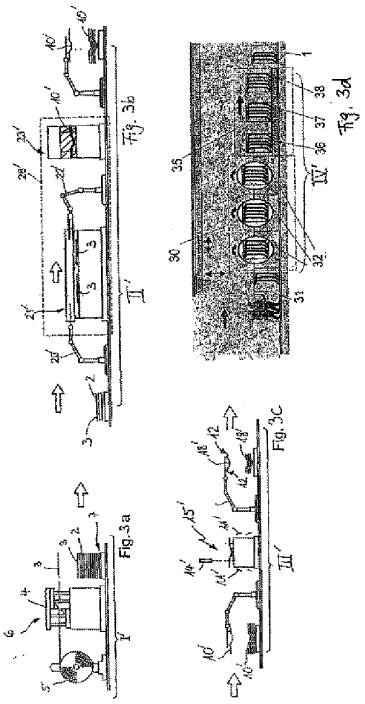
【図3a】



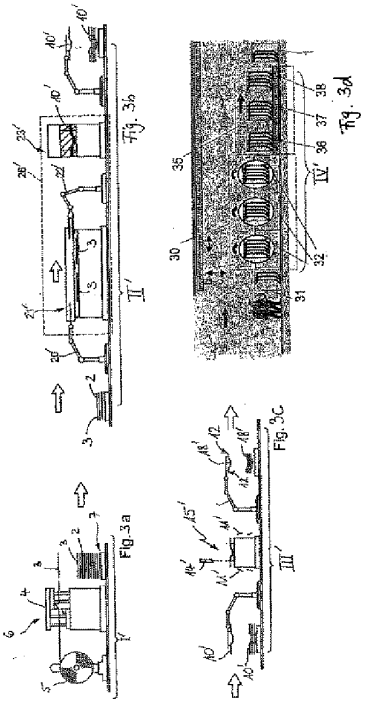
【図3b】



【図3c】



【図3d】



INTERNATIONAL SEARCH REPORT

International Application No
PCT/EP2004/008087

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 B21D35/00 C21D1/673 C21D9/46

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols).
IPC 7 B21D C21D

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal, WPI Data, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	DE 101 35 647 C (DAIMLER CHRYSLER AG) 25 July 2002 (2002-07-25) figures 1a,1b	1-9
A	DE 101 49 221 C (BENTELER AUTOMOBILTECHNIK GMBH) 8 August 2002 (2002-08-08) cited in the application claim 1; figures 1-3	1-9
A	DE 100 49 660 A (DAIMLER CHRYSLER AG ; BENTELER AUTOMOBILTECHNIK GMBH (DE)) 25 April 2002 (2002-04-25)	1-7
X	column 7, line 35 - column 7, line 57; claim 24	8,9
A	DE 43 07 563 A (BAYERISCHE MOTOREN WERKE AG) 23 September 1993 (1993-09-23) column 2, line 37 - column 2, line 44	8,9

-/--

[X] Further documents are listed in the continuation of box C.

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Date of the actual completion of the international search	Date of mailing of the international search report
11 November 2004	29/11/2004

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Vinci, V

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INTERNATIONAL SEARCH REPORT

International Application No
PCT/EP2004/008087

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
P,A	WO 2004/033126 A (DAIMLER CHRYSLER AG ; FISCHER UWE (DE); MEHRHOLZ RALF (DE); BRODT MART) 22 April 2004 (2004-04-22) figures 1a-1e	1-9

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INTERNATIONAL SEARCH REPORT

ormation on patent family members

International Application No
PCT/EP2004/008087

Patent document cited in search report		Publication date	Patent family member(s)		Publication date
DE 10135647	C	25-07-2002	DE 10135647	C1	25-07-2002
DE 10149221	C	08-08-2002	DE 10149221	C1	08-08-2002
			EP 1300475	A2	09-04-2003
			US 2003066582	A1	10-04-2003
DE 10049660	A	25-04-2002	DE 10049660	A1	25-04-2002
			EP 1195208	A2	10-04-2002
			JP 3553536	B2	11-08-2004
			JP 2002178069	A	25-06-2002
			US 2002069506	A1	13-06-2002
DE 4307563	A	23-09-1993	DE 4307563	A1	23-09-1993
WO 2004033126	A	22-04-2004	DE 10254695	B3	15-04-2004
			WO 2004033126	A1	22-04-2004

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INTERNATIONALER RECHERCHENBERICHT

Internationales Aktenzeichen
PCT/EP2004/008087

A. KLASSIFIZIERUNG DES ANMELDUNGSGEGENSTANDES
IPK 7　B21D35/00　C21D1/673　C21D9/46

Nach der Internationalen Patentklassifikation (IPK) oder nach der nationalen Klassifikation und der IPK

B. RECHERCHIERTE GEBIETE

Recherchierter Mindestprüfstoff (Klassifikationssystem und Klassifikationssymbole)
IPK 7　B21D　C21D

Recherchierte aber nicht zum Mindestprüfstoff gehörende Veröffentlichungen, soweit diese unter die recherchierten Gebiete fallen

Während der internationalen Recherche konsultierte elektronische Datenbank (Name der Datenbank und evtl. verwendete Suchbegriffe)
EPO-Internal, WPI Data, PAJ

C. ALS WESENTLICH ANGESEHENE UNTERLAGEN

Kategorie°	Bezeichnung der Veröffentlichung, soweit erforderlich unter Angabe der in Betracht kommenden Teile	Betr. Anspruch Nr.
A	DE 101 35 647 C (DAIMLER CHRYSLER AG) 25. Juli 2002 (2002-07-25) Abbildungen 1a,1b	1-9
A	DE 101 49 221 C (BENTELER AUTOMOBILTECHNIK GMBH) 8. August 2002 (2002-08-08) in der Anmeldung erwähnt Anspruch 1; Abbildungen 1-3	1-9
A	DE 100 49 660 A (DAIMLER CHRYSLER AG ; BENTELER AUTOMOBILTECHNIK GMBH (DE)) 25. April 2002 (2002-04-25)	1-7
X	Spalte 7, Zeile 35 - Spalte 7, Zeile 57; Anspruch 24	8,9
A	DE 43 07 563 A (BAYERISCHE MOTOREN WERKE AG) 23. September 1993 (1993-09-23) Spalte 2, Zeile 37 - Spalte 2, Zeile 44	8,9

-/--

[X] Weitere Veröffentlichungen sind der Fortsetzung von Feld C zu entnehmen　[X] Siehe Anhang Patentfamilie

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Datum des Abschlusses der internationalen Recherche	Absendedatum des internationalen Recherchenberichts
11. November 2004	29/11/2004

Name und Postanschrift der Internationalen Recherchenbehörde	Bevollmächtigter Bediensteter
Europäisches Patentamt, P.B. 5818 Patentlaan 2 NL – 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Vinci, V

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INTERNATIONALER RECHERCHENBERICHT

Internationales Aktenzeichen
PCT/EP2004/008087

C.(Fortsetzung) ALS WESENTLICH ANGESEHENE UNTERLAGEN

Kategorie°	Bezeichnung der Veröffentlichung, soweit erforderlich unter Angabe der in Betracht kommenden Teile	Betr. Anspruch Nr.
P,A	WO 2004/033126 A (DAIMLER CHRYSLER AG ; FISCHER UWE (DE); MEHRHOLZ RALF (DE); BRODT MART) 22. April 2004 (2004-04-22) Abbildungen 1a-1e	1-9

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INTERNATIONALER RECHERCHENBERICHT

Angaben zu Veröffentlichungen, die zur selben Patentfamilie gehören

Internationales Aktenzeichen
PCT/EP2004/008087

Im Recherchenbericht angeführtes Patentdokument		Datum der Veröffentlichung	Mitglied(er) der Patentfamilie		Datum der Veröffentlichung
DE 10135647	C	25-07-2002	DE	10135647 C1	25-07-2002
DE 10149221	C	08-08-2002	DE	10149221 C1	08-08-2002
			EP	1300475 A2	09-04-2003
			US	2003066582 A1	10-04-2003
DE 10049660	A	25-04-2002	DE	10049660 A1	25-04-2002
			EP	1195208 A2	10-04-2002
			JP	3553536 B2	11-08-2004
			JP	2002178069 A	25-06-2002
			US	2002069506 A1	13-06-2002
DE 4307563	A	23-09-1993	DE	4307563 A1	23-09-1993
WO 2004033126	A	22-04-2004	DE	10254695 B3	15-04-2004
			WO	2004033126 A1	22-04-2004

Formblatt PCT/ISA/210 (Anhang Patentfamilie) (Januar 2004)

(51)Int.Cl.　　ＦＩ　　テーマコード（参考）
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(81)指定国　　AP(BW,GH,GM,KE,LS,MW,MZ,NA,SD,SL,SZ,TZ,UG,ZM,ZW),EA(AM,AZ,BY,KG,KZ,MD,RU,TJ,TM),EP(AT,BE,BG,CH,CY,CZ,DE,DK,EE,ES,FI,FR,GB,GR,HU,IE,IT,LU,MC,NL,PL,PT,RO,SE,SI,SK,TR),OA(BF,BJ,CF,CG,CI,CM,GA,GN,GQ,GW,ML,MR,NE,SN,TD,TG),AE,AG,AL,AM,AT,AU,AZ,BA,BB,BG,BR,BW,BY,BZ,CA,CH,CN,CO,CR,CU,CZ,DE,DK,DM,DZ,EC,EE,EG,ES,FI,GB,GD,GE,GH,GM,HR,HU,ID,IL,IN,IS,JP,KE,KG,KP,KR,KZ,LC,LK,LR,LS,LT,LU,LV,MA,MD,MG,MK,MN,MW,MX,MZ,NA,NI,NO,NZ,OM,PG,PH,PL,PT,RO,RU,SC,SD,SE,SG,SK,SL,SY,TJ,TM,TN,TR,TT,TZ,UA,UG,US,UZ,VC,VN,YU,ZA,ZM,ZW

(72)発明者　マーティン・ブロート
ドイツ連邦共和国　７１２６３　ヴァイル　デア　シュタット、アム　ハインリッヒスベルグ　３５

Ｆターム(参考)　4K027　AA05　AB05　AB42　AB48　AC12　AC72
4K042　AA25　BA01　BA02　BA13　CA02　DA01　DA02　DB07　DC02　DC03
DD02　DD05　DE02　DE03

(19)日本国特許庁（ＪＰ）　(12) **公開特許公報（Ａ）**　(11)特許出願公開番号
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（P2002－178069A）
(43)公開日　平成14年６月25日(2002.6.25)

(51)Int.Cl.[7]	識別記号	ＦＩ		テーマコード（参考）
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22/02		22/02	Ｅ	
53/88		53/88	Ｚ	
Ｂ２３Ｋ　1/00	３３０	Ｂ２３Ｋ　1/00	３３０Ｚ	
3/06		3/06	Ｃ	

審査請求　有　　請求項の数27　ＯＬ　（全 14 頁）　　最終頁に続く

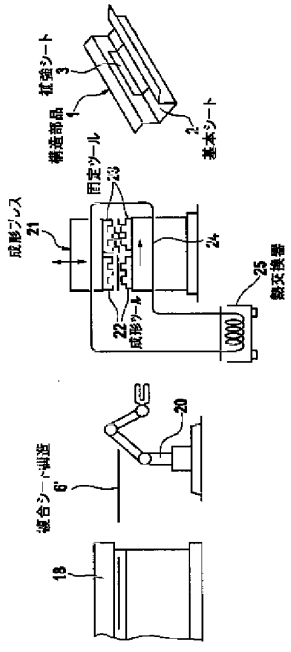
(21)出願番号　特願2001－310223(P2001－310223)
(22)出願日　平成13年10月５日(2001.10.5)
(31)優先権主張番号　１００４９６６０．１
(32)優先日　平成12年10月７日(2000.10.7)
(33)優先権主張国　ドイツ（ＤＥ）

(71)出願人　598051819
ダイムラークライスラー・アクチェンゲゼルシャフト
ドイツ連邦共和国　70567　シュトットガルト，エップルシュトラッセ　225
(72)発明者　マルチン・ブロット
ドイツ連邦共和国　71272　レンニンゲン，イーヒンゲル　ホフ　４
(72)発明者　マティアス・クレーガー
ドイツ連邦共和国　33034　ブラケル，ネデタルシュトラーセ　23
(74)代理人　10009/250
弁理士　石戸　久子　（外３名）

最終頁に続く

(54)【発明の名称】　局所的に補強されたシート・メタル成形品を製造する方法

(57)【要約】
【課題】　一般的なシート・メタル成形品製造方法を改良すること。
【解決手段】　パッチングされた(patched)複合シート構造（６’）が共成形(joint forming)の前に、材料の成形温度よりも高い温度に加熱され、その後、閉鎖された成形ツール（２２）内で冷却され、あるいは後段の固定ツール（２３）内で冷却され、所望の成形状態が機械的に固定される。



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【特許請求の範囲】
【請求項１】　基本シートと、基本シートよりも小さく、局所的に配置された少なくとも１枚の補強シートとからなる三次元形状の構造部品を製造する方法であって、構造部品の基本シートが、平坦な状態または不完全に成形された予備成形状態で、その後の補強点用の所定の点で補強シートに連結され、パッチングされた複合シート構造の各部がその後、開閉可能な成形ツールによって成形プレス内で共成形される方法において、パッチングされた(patched)複合シート構造（６、６’）が共成形(joint forming)の前に、材料の成形温度よりも高い温度に加熱され、その後、閉鎖された成形ツール（２２）内で冷却され、あるいは後段の固定ツール（２３、２６）内で冷却され、所望の成形状態が機械的に固定されることを特徴とする方法。
【請求項２】　パッチングされた複合シート構造（６’）の部品が構造変形温度(Structural transformation temperature)よりも高い温度に加熱され、前記構造変形温度よりも高い温度では、材料構造がオーステナイト状態になることを特徴とする、請求項１に記載の方法。
【請求項３】　パッチングされた複合シート構造（６’）が、共成形の前に、８５０℃から９３０℃の間の温度範囲内の特定の温度に加熱されることを特徴とする、請求項１に記載の方法。
【請求項４】　少なくとも１枚の補強シート（３’）または補強シートのうちの少なくとも１枚自体が、基本シート（２）上の所定の点で寸法的に正確に支持され、かつ前記基本シート（２）に固定できるように、補強ビード(reinforcing beads)（７）を取り付けることによって基本シート（２）と組み合わされる前に、予備成形されることを特徴とする、請求項１に記載の方法。
【請求項５】　加熱された複合シート構造（６’）を加熱装置、特に炉（１８）から抜き出すことと、定義された位置の複合シート構造（６’）を、開放された成形ツール（２２）に、その閉鎖を開始するまで投入し続けることが、３秒未満、好ましくは２秒未満（タイムスパンＥ）で行われることを特徴とする、請求項１に記載の方法。
【請求項６】　成形ツール（２２）の閉鎖を開始してから成形が完了するまでの間に、定義された位置で、開放された成形ツール（２２）に投入された、加熱された複合シート構造（６’）の共成形が少なくとも３秒から５秒（タイムスパンＳ）で行われることを特徴とする、請求項１に記載の方法。
【請求項７】　共成形された複合シート構造の冷却が、成形ツールに対する少なくとも第１の冷却段階において、内側から確実に冷却された（３３、３４）成形ツール（２２）に接触させることによって行われることを特徴とする、請求項１に記載の方法。
【請求項８】　共成形の後で、閉鎖された成形ツール（２２）内に残っているパッチングされた複合シート構造が、少なくとも約５００℃に冷却されることを特徴とする、請求項７に記載の方法。
【請求項９】　共成形の後で、閉鎖された成形ツール（２２）内に残っているパッチングされた複合シート構造が、まず少なくとも約５００℃に冷却され、その後、閉鎖状態において、正確な寸法を有するインプレッション(impression)によって固定ツールの両側の表面上に収容された成形済みの複合シート構造に接触し、引き続き複合シート構造の所望の成形状態を機械的に固定する隣接する開閉可能な固定ツール（２３、２６）に移送され、その時点で形成済み複合シート構造で優勢な高温状態で、固定ツールと一体化されたトリミング・ツールによってトリミングされ、固定ツールの確実に冷却されたインプレッションによって引き続き冷却されることを特徴とする、請求項１に記載の方法。
【請求項１０】　共成形の後で、パッチングされた複合シート構造の確実な冷却が、まず成形ツール（２２）内で行われ、その後、移送のために起こる短時間の中断を除き、複合シート構造の所望の成形状態が常に機械的に固定された状態で、開閉可能な固定ツール（２３、２６）のシーケンス、すなわち、閉鎖状態において正確な寸法を有するインプレッションにより各ケースで固定ツールの両側の表面上に収容された成形済みの複合シート構造に接触する隣接する開閉可能な固定ツール（２３、２６）のシーケンスによって行われ、固定ツール（２３、２６）から固定ツール（２６）に渡された複合シート構造が、固定ツール（２３、２６）のインプレッションにより複数の連続するステージ（Ｚ）で少なくとも１５０℃に冷却され、前記インプレッションが内側から確実に冷却されることを特徴とする、請求項１に記載の方法。
【請求項１１】　共成形の後で、パッチングされた複合シート構造が、成形ツール（２２）のみ、またはその後の固定ツール（２３、２６）のシーケンスとの協働によって、２０秒から４０秒、好ましくは約２５秒から３０秒の間冷却されることを特徴とする、請求項１または１０に記載の方法。
【請求項１２】　成形済みの複合シート構造でマルテンサイト材料構造を得るために、複合シート構造が、少なくとも８００℃から５００℃の間の温度範囲で急速に、すなわち、８００℃から５００℃に４秒未満の時間で冷却されることを特徴とする、請求項１に記載の方法。
【請求項１３】　成形済みの複合シート構造でベイナイト材料構造を得るために、複合シート構造が、少なくとも８００℃から５００℃の間の温度範囲で比較的ゆっくりと、厳密には、８００℃から５００℃に、４秒よりも長いタイムスパンで冷却されることを特徴とする、請求項１に記載の方法。

【請求項１４】　補強シート（３、３’）が基本シート（２）に取り付けられる前に、少なくとも１枚のシート（２）が、硬質はんだ（４）を用いて接触面上にそれを覆うように配置され、硬質はんだが、成形温度への加熱時に融解され、共成形された複合シート構造が、少なくとも硬質はんだ（４）が完全に凝固するまで冷却され、成形状態が、閉鎖された成形ツール（２２）内で機械的に固定されることを特徴とする、請求項１に記載の方法。

【請求項１５】　硬質はんだ（４）を備える少なくとも１枚のシート（２）の接触面が、余分の硬質はんだ（４）を備え、この余分（３５）の硬質はんだが、共成形中に補強シート（３）の縁部に現われることを特徴とする、請求項１４に記載の方法。

【請求項１６】　硬質はんだ（４）が塗布される前に、基本シート（２）と補強シート（３、３’）の両方の接触面が、硬質はんだ付けのために、クリーニングされ及び／又は活性化されることを特徴とする、請求項１４に記載の方法。

【請求項１７】　硬質はんだ（４）がペースト状で塗布されることを特徴とする、請求項１４に記載の方法。

【請求項１８】　硬質はんだがチップ形状で付与されることを特徴とする、請求項１４に記載の方法。

【請求項１９】　硬質はんだが、形状に従ってパンチングされたはんだ付けフォイル・ブランク(foil blank)の形で付与されることを特徴とする、請求項１４に記載の方法。

【請求項２０】　凝固温度が少なくとも５００℃、好ましくは少なくとも５５０℃である硬質はんだ（４）が使用されることを特徴とする、請求項１４に記載の方法。

【請求項２１】　硬質はんだ（４）が塗布され、補強シート（３、３’）が基本シート（２）上の画定された位置に配置された後で、補強シートと基本シートが、単一の点（５）によって暫定的に互いに固定されることを特徴とする、請求項１４に記載の方法。

【請求項２２】　パッチングされた複合シート構造（６）の加熱が、炉（１８）内の保護ガス雰囲気（保護ガス１９）で行われることを特徴とする、請求項１または１４に記載の方法。

【請求項２３】　基本シート（２）および／または補強シート（３、３’）が、以下にリストされた合金組成を有する水焼入れ熱処理可能な(water-hardening heat-treatable)鋼からなり、以下のリストにおいて、含有量は重量%で表されており、基本金属としての鉄に付加される量であることを特徴とする、請求項１または１４に記載の方法：

炭素：　　０．２３～０．２７%、
ケイ素：　　０．１５～０．５０%、
マンガン：　　１．１０～１．４０%、
クロム：　　０．１０～０．３５%、
モリブデン：　　０～０．３５%、
チタン：　　０．０３～０．０５%、
アルミニウム：　０．０２～０．０６%、
リン：　　最大０．０２５%、
硫黄：　　最大０．０１%、および
他の合計：　　０．００２０～０．００３５%。

【請求項２４】　基本シート（２）および／または補強シート（３、３’）が、腐食しないように無機物をプリコーティングされ、以下にリストされた合金組成を有する鋼からなり、以下のリストにおいて、含有量は重量%で表されており、基本金属としての鉄に付加される量であることを特徴とする、請求項１に記載の方法：

炭素：　　０．２０～０．２５%、
ケイ素：　　０．１５～０．３５%、
マンガン：　１．１０～１．３５%、
クロム：　　０．１０～０．３５%、
チタン：　　０．０２～０．０５%、
硫黄：　　最大０．０８%、および
他の合計：　０．００２～０．００４%。

【請求項２５】　複合シート構造の材料強度が、共加熱成形プロセスに組み込まれた熱処理によって約１３００ＭＰａ～１６００ＭＰａに高められることを特徴とする、請求項１または１４に記載の方法。

【請求項２６】　車体の乗員セルに組み込まれる中空部材用の局所的に補強されたシェル部品が、この方法によって製造されることを特徴とする、請求項１または１４に記載の方法。

【請求項２７】　車両のシャシに組み込まれる中空部材用の局所的に補強されたシェル部品が、この方法によって製造されることを特徴とする、請求項１または１４に記載の方法。

【発明の詳細な説明】

【０００１】

【発明の属する技術分野】本発明は、たとえば、ドイツ特許第４３０７５６３Ａ１号で知られているようにギャザリング可能な、請求項１の前提節による、特に車体の構造部品としての、局所的に補強されたシート・メタル成形品を製造する方法に関する。

【０００２】

【従来の技術】自動車の車体の重量を削減するために、車体のシート・メタル構造部品において力が作用する点に局所的に補強された補強シートを設け、構造部品全体を厚いシートで製造する必要をなくすことが知られている。シート・メタルシェルで形成された中空部材の曲げ抵抗を高めるには、中空部材の比較的長い領域にわたって延びる補強シートを少なくとも１つのシート・メタルシェルの内側または外側に一体化することができる。補強のために、一定の断面を有する補強チューブもすでに中空部材に埋め込まれている。しかし、この補強チューブは、中空部材の形状にほぼ従っているが、中空部材の

断面を完全に覆っているわけではなく、ウェブプレートを介するかあるいは直接、中空部材の壁に特定の点でのみ連結されている。中空部材の剛性を高めるこの種の構造は、たとえば、横からの衝突に備えて乗用車の車体の中央ピラー上に設けられている。通常、この場合も、重量上の理由で、中空部材の継手または連結点、すなわち、交差部で、局所的に絞られた補強物を横中空部材の壁に組み込むと有利である。

【０００３】従来、基本シートおよび補強シートが別々に深絞りされ、その後、これらの部品ワークが溶接されて完全な構造部品が形成され、したがって、２つの別々な絞り工程および成形工程、別々な２組のツール、および三次元形状のシート・メタル部品を組み立てるための独立の工程が前提とされている。これらはすべて、時間およびコストがかかる。

【０００４】ドイツ特許第４３０７５６３Ａ１号で知られている、自動車の車体用の局所的に補強されたシート・メタル構造部品を製造する方法では、構造部品の基本シートを形成するシートビレットが局所的に、すなわち、所定の点で平坦な状態で、好ましくはより強度の高いより小さな補強シートに連結され、その後、この主として平面状の複合シート構造がプレスにおいてまとめて深絞りされる。補強シート自体は、事前に部分的に成形し、たとえば、補強ビードを設けることができる。補強シートは、輪郭形状においてこのように設計され、深絞り後に、補強シートが力が作用する点を最適に覆うように位置決めされる。用途に応じて、補強シートは基本シートよりも高い強度を有することができ、この目的のために、補強シートの壁厚を大きくし、かつ／または材料の品質を高めることができる。いくつかの状況では、複数の層が好ましくは、ある程度異なるサイズを有する、補強シートの多層設計も推奨される。

【０００５】基本シートビレットおよび補強シートを連結する技法として、ドイツ特許第４３０７５６３Ａ１号は特に、硬化またはプレス組立て（いわゆるクリンチング(clinching)）を引用しており、これは、基本的に、成形工程または任意の固定要素、たとえば、パンチインナットやパンチインボルトの取付けにこの組立て技法を組み込むことができるので、特に有利であるとみなされる。この場合、いくつかの状況では、成形プレス内の基本シートの後の定義された位置に補強シートを配置するだけでよい。また、溶接連結技法および接着連結技法についても述べられており、これらの連結技法に関しては、特に、構造部品の表面が影響を受けないことが強調されている。この文献において、基本シートおよび補強シートの相互接触表面を腐食から保護しなければならないことが容易に認識されよう。というのは、その後これらの表面に施される塗料またはワックスによる腐食防止では水分の進入から永久的に保護することはできないからである。したがって、基本シートおよび補強シートの少なくとも一方の側が亜鉛めっきされたシートを使用するか、あるいはその代わりに、プラスチックまたは金属で作られた保護フィルムを接触点に挿入することが推奨されている。任意の接着層の腐食防止作用も強調されている。

【０００６】実際、基本部品と補強部品を別々に成形する、上記で概略的に説明した手順と比べて、ドイツ特許第４３０７５６３Ａ１号で知られている方法は、深絞り工程が単一の一様なワークサイクルと組み合わせられるので、ずっと費用的に有効である。しかし、一方、欠点として、特に、補強シートがより高い強度を有するか、あるいは場合によっては補強シート自体が多層設計を有するときに、この目的のために非常に高い成形力が必要である。このため、応力が高くなり、したがって、成形プレスの個々の部品の弾性変形度が高くなり、したがって、作業精度が低下し、成形プレスおよびプレスの有効寿命が短くなる。より高い応力またはプレス部品のより高い弾性変形度は、プレス部品をこれに対応して寸法付けすることによって補強することができる。ただし、この場合、プレスのコストが高くなる。しかし、ツールの磨耗の増大を補償することはできず、したがって同様に、製造される構造部品のピースコストが高くなる。

【０００７】本明細書で評価される、パッチングされた複合シートを共成形する既知の技法では、それによって実現することのできる補強度が限られていることを想起されたい。これは、補強シートの成形力または絞り力を補強シートにかなりの程度に伝達するには、基本シートを介し、補強シートの周辺に取り付けられた基本シートと補強シートとの間の連結点を介して間接的に伝達するしかないからである。補強シートが基本シートと比べて材料強度が高いか、あるいは壁厚が大きいか、あるいはその両方のために、基本シートよりも抵抗がかなり高い場合、基本シートと共に所望の方法で成形することはできない。局所的に特に高い補強度を実現する場合、基本シートおよび補強シートをそれぞれの場合に別々に成形し、その後、２つの部品を互いに溶接して複合部品を形成しなければならない。

【０００８】補強シートを基本シートと共に成形して構造部品を形成するか、それとも導入部で述べたように、基本シートおよび補強シートをそれぞれの場合に別々に成形し、その後２つの成形品を組み立てて構造部品を形成するかにかかわらず、重量上の理由で基本シートの壁厚が薄くなることが意図され、したがって、同様に腐食が低減されることに鑑みて、基本シートと補強シートの接触点に有効な腐食保護機構を有し、構造部品の有効寿命が短くなる可能性を回避することが特に重要である。ドイツ特許第４３０７５６３Ａ１号で知られている方法による各シートの接触点における有効な腐食保護機構は、腐食保護膜を介在させても確実に確保することはできない。厳密に言えば、基本シートと補強シートとの間

のパンクチフォーム連結点（クリンチまたは点溶接）によって、介在する腐食保護膜が破壊され、したがって、毛管作用によって進入する水分により、ちょうど連結点で腐食が起こり、やがて比較的薄い基本シートに穴があくことがある。塗料およびワックスによる腐食防止にもかかわらず、車体の保護されている内側領域でも、蒸散水が形成されることと、毛管作用のために、車体基本シートと補強シートとの間の接触表面に水分が進入することを予期しなければならない。

【０００９】ドイツ特許第４３０７６５３Ａ１号による既知の方法の上記の重要な評価に基づいて、システムに固有のこの方法の欠点を以下のように要約することができる。

－　共成形すべきシートの成形の程度が限られている。

－　共成形されるシートの回復挙動が大きい。

－　このため、構造部品の寸法精度がかなり低い。

－　成形力が補強シートに間接的に伝達されるので、補強点で実現できる補強度が限られている。

－　共成形時のプレス力が高く、したがって投資コストが高い。

－　ツールが激しく磨耗し、したがって、ピースコストが高くなる。

－　組立体表面に対する腐食保護が限られている。

【００１０】ドイツ特許第１９５２９８８１Ｃ１号は、シートが高温状態のときに深絞りされ、成形準備完了状態で、その後の熱処理によってばね鋼の硬度にされる硬化可能なばね鋼で深絞り部品を製造することを開示している。ただし、このような工程をどこでどのように行うかは述べられていない。深絞りに続く熱処理では、部品が反り、したがって、寸法および／または形状に関連する顕著な延展を受ける恐れがある。このこととは別に、構成要素に対する局所的に激しく変動する応力の場合、応力が最大になる点に対応して壁厚を設計しなければならず、したがって、応力が比較的弱い点で壁厚の寸法が過度に大きくなる。理論的には、その後、補強シートを溶接することによってこの成形品を局所的に補強することが考えられるが、基本シートの硬度および／または補強シートの強度が局所的に溶接部で失われるので、これは不都合である。使用するシートの強度が高い場合、はんだ付け、接着結合、クリンチングなど他の連結技法を除外するのが適切である。なぜなら、これらの連結技法を実施すると必ず基本シートおよび／または硬化された材料が損なわれ（はんだ付け、クリンチング）、あるいはこれらの連結技法では必要な強度が与えられないからである。埋め込みシートの所望の補強効果を実現するために、連結点は、硬化された基本シートと少なくともほとんど同じ強度を有する必要がある。したがって、ドイツ特許第１９５２９８８１Ｃ１号による既知の方法は、以下の欠点を有する。導入部で述べた参考文献に関する文を部分的に引用することができる。

－　壁厚が一様であるために軽量の構成しかできない。

－　局所的な補強が不可能である。

－　熱処理のために構造部品の寸法精度が比較的低い。

【００１１】

【発明が解決しようとする課題】本発明の目的は、以下の基準に関して一般的な製造方法を改良することである。

－　この方法の成果に関して、基本シートまたは非補強構成要素と比べてより高い局所補強度を単一の製造ステップで実現できるようにする。

－　この方法の結果に関して、成形品の従来よりも高い加工精度を実現できるようにする。

－　この方法を実施する手段に関して、成形ツールおよび成形プレスが予期されるよりも低い応力を受けるようにし、その範囲内で正当な有効寿命が予期できるようにする。

【００１２】

【課題を解決するための手段】包括的な方法に基づき、本目的は、本発明により請求項１の特性を決定する特徴によって達成される。これらの特徴によって、本発明により、パッチング複合シートが、加熱状態で所望の形状に成形され、成形状態を機械的に維持したまま、定義されたように成形ツール上で冷却される。

【００１３】本発明は、新規の軽量構成の概念を得る費用効果の大きい方法を提供する。これを説明するため、まず、ボディが軽量であることによって、自動車の性能（運転の楽しさ）と燃料消費（コスト・レベル）が本質的に相互に決定されるので、これが顧客の利益に直接つながることを思い起こすとよい。他方、乗員の安全性を高めるために、自動車のボディは乗員セルの領域をできる限り剛性にして、この効果がより重量の大きいボディに向くようにすべきである。更に、重量に関するこれら２つの相反する要件は、ボディのコストに直接関係する。一方でのコストと他方での重量とは互いに反対に増加する傾向がある。すなわち、ボディの設計がより軽量になるほど一般に製造コストがより高くなるが、利用できる軽量構成寸法の範囲を使い果たす程度がより低いボディ構成を、より大きい費用効果で製造することができる。しかし、このボディの機能、コスト、重量の関係のネットワーク内で、鋼製の構造部品の発明による加熱成形によって、適度なコストでの軽量構成を可能にする新しい境界状態が設定され、同時にその機能が増加する。本発明による製造方法の可能性および効果は下記の通りである。

－　費用効果の大きい軽量な構成が可能になる。

－　高強度および可能な最高強度の材料を使用することができる。達成できる材料強度は、従来の最大値に比べて約３倍に増加させることができる。

－　高強度の材料を使用しているにもかかわらず、高度の成形を容易に実現することができる。

－　基本シートの所望の程度の補強を、広い範囲内で実現することができる。
－　従来のシート・メタル・シェル構成と、これに関する設計および補修ノウハウとを維持することができる。後者により基盤構造の重要性が確実になる。
－　補強材が依然として必要となる限り、これらを１つのシェルに組み入れ、かつ後者の製造に組み入れることができる。
－　加熱成形により、成形プロセス後のシート・メタル部品の回復動作が無視できるものとなるため、製作精度が増加する。低い製作公差を容易に実現することができる。
－　成形ツールと構造部品との調整に関する費用は、単純なシート・メタル部品の成形の場合よりも高くなることはなく、低くなる。
－　設備投資、必要な機械時間、輸送および在庫管理のコストが削減される。

【００１４】本発明によるこの効果のリストには、種々の出典の従来技術から集めた効果の概要について共同の超過分を構成するものが含まれている。すなわち下記の点が相互の効果として特に強調される。
－　高強度の材料を使用しているにもかかわらず、高度の成形を容易に実現することができる。
－　基本シートの所望の程度の補強を、広い範囲内で実現することができる。
－　加熱成形により、成形プロセス後のシート・メタル部品の回復動作が無視できるものとなるため、製作精度が増加する。低い製作公差を容易に実現することができる。

【００１５】従って、製造された構造部品を、基本シートと補強シートとの間の接触領域の腐食からより効果的に保護することができる。本発明の適宜の実施形態では、補強シートが基本シートに取り付けられる前に、少なくとも１枚のシートの接触表面に表面を覆うように硬質はんだが設けられ、それにより両方の接触表面が予め清浄にされるので有利である。パッチング複合シート構造を成形温度まで加熱する際に（これは炉の保護ガス雰囲気中で行われることが好ましい）、塗布された硬質はんだが溶解する。成形プロセス中、密着した無孔のはんだ接合部が、共に変形され押圧されたシート・メタル部品により製造される。硬質はんだは、表面を覆うように接触域を塞ぎ、その後確実に湿気の侵入を防いで非常に効果的な腐食保護を提供する。硬質はんだは、成形中に補強シートの縁部に絞り出される余剰分をもって塗布されることが好ましい。はんだ付けにより、補強シートと基本シートとを連結するステップが成形プロセス中に容易に組み入れられる。例えば、はんだ塗布後かつ加熱前に補強シートと基本シートとの間に設置された１つの連結点により、処理中に補強シートと基本シートとが互いに所望の位置を明確に維持し、例えば互いに関して所定の位置から外れることが確実にできないようにすることのみが必要となる。

【００１６】本発明の更なる適宜の実施形態はサブクレームから集めることができ、更に、図面に例として示される種々の方法図および詳細により本発明を以下に説明する。

【００１７】

【発明の実施の形態】図１、図２に共に示す方法は、立体形状の構造部品１の製造に役立つものであり、構成部品１は基本シート２と、より小さく局所的に配置された補強シート３とからなる。この場合、構造部品の基本シート２が、平らな状態で次の補強点に対して所定の点で補強シート３に連結され、このようにパッチングされた複合シート構造６の部品が、図３に示すように、開閉可能な成形ツール２２により成形プレス２１内で連続して共に成形される。

【００１８】製品および方法の結果に関して製造方法を改良するため、また方法を行う手段に関してこれを緩和するために、本発明により、パッチング複合シート構造６が、共に成形される前に材料の成形温度を超える温度まで加熱され、加熱状態では適度のツール応力で所望の形状に形成され、続いて、閉じたままの成形ツール２２および／または次の固定および切取りツール２３内に機械的に固定された所望の成形状態で、定義されたように冷却され、結果として本質的に加熱処理される。

【００１９】図１、２に図示した設備は、本発明による方法を実行するために、それぞれの場合に基本シート用コイル１２および補強シート用コイル１３の巻き戻し装置を提供している。巻き戻されたシートは、まっすぐにされた後に、持上げシアー(shears)１４、１５で個々の基本シート（ビレット）２および更に間欠的に処理される個々の補強シート（ビレット）３とに分けられる。２つのコイル１２、１３は異なる幅のシート（ブランク）２、３に従い異なる幅となっている。個々のシート厚さは、一方で基本シートの補強していない領域の構造部品にかかる負荷に応じて決められ、他方で所望の補強効果に応じて決められ、個々の件について最適となるようにしなければならない。補強シートは、通常、基本シートよりも薄い。しかし、補強シートが基本シートよりも厚く局所的な補強が大きい場合も容易に想定できる。ある状況においては、一方を他方に重ねた大きさの異なる２枚の補強シートからなる多層補強材を有し、補強が層の数に従って外側縁部からステップ内で増加することが適切であることがここで明らかになる。

【００２０】補強シートの剛性に関し、この接合部においてさえ、材料の強度、シート厚さおよび／または層の数だけでなく、適宜の構造堅さによってもこれが影響を受けることを指摘することができる。正確には、図４の例示により、補強シート３’自体は、基本シート２との組合せ前に補強ビード７を取り付けられることにより予

備成形され、それにより構造的に堅くなる。しかし、この場合、予備成形された補強シート３’をそれにもかかわらず基本シート２上の所定の点に正確な寸法で確実に載せることができ、そこに固定することができる点に注意しなければならない。

【００２１】材料に関し、両シートは同一のまたは類似した材料からなることが好ましい。それ自体公知で、業界で深絞りシートとして入手可能であり、基本シート２および／または補強シート３、３’として考慮できる２つの異なる材料を以下に提示する。すなわち、一方はドイツの会社であるＢｅｎｔｅｌｅｒ　ＡＧの、業界名ＢＴＲ　１６５として販売されている水焼入れ加熱処理が可能な鋼をこれに関して挙げることができる。この鋼は以下に挙げる合金の組成を有し、基本の金属である鉄に加えられる合金パートナーの含有量を重量％で理解することができる。

炭素：　　０．２３～０．２７％
珪素：　　０．１５～０．５０％
マンガン：　１．１０～１．４０％
クロム：　　０．１０～０．３５％
モリブデン：　０　　～０．３５％
チタン：　　０．０３～０．０５％
アルミニウム：　０．０２～０．０６％
リン：　　最大　０．０２５％
硫黄：　　最大　０．０１％、および
その他合計：　０．００２０～０．００３５％

【００２２】他方、フランスの会社であるＳｏｌｌａｃ　ＳＡのシートも推奨できる。これは腐食に対して無機的にプリコーティングされており、業界名２２ＭｎＢ５として販売されている。シートを無機的にプリコーティングすること（加熱処理中に基本材料内に部分的に拡散して三相の積層材料Ａｌ／Ｓｉ／Ｆｅを形成するアルミニウム／珪素コーティング）により、加熱中のシートのスケーリング(scaling)および脱炭が防止され、シートの酸洗いおよびリン酸塩処理が不要となる。コーティングにより従来の溶接が容易にできるようになる。コーティングされていないシートは、以下に挙げる合金組成を有する鋼からなり、基本の金属である鉄に加えた含有量を同様に重量％で理解することができる。

炭素：　　０．２０～０．２５％
珪素：　　０．１５～０．３５％
マンガン：　１．１０～１．３５％
クロム：　　０．１０～０．３５％
チタン：　　０．０２～０．０５％
硫黄：　　最大　０．００８％、および
その他合計：　０．００２～０．００４％

【００２３】図１、２に示す方法図は、２つのブランクの硬質はんだ連結を提供する。従って、図１に示す例示的な実施形態では、アプリケータ・ロボット１６によって、例えばスプレー可能なペースト状に塗布された硬質はんだ塗布部４が、基本シート・ビレット２の所定の表面上に局所的に設けられている。この接合部では、他の形状の硬質はんだ塗布、例えば形状に従ってパンチングされたはんだフォイル・ブランクの位置へ塗布することや、チップの位置に広げまたは塗布することも想定できる点に注目してもよい。シート・メタル部品の硬質はんだ付け連結に関し、それはある状況では有利になり、更に、図１には示されていないが、基本シートおよび補強シートの両方の接触表面を硬質はんだ４の塗布前に清浄にし、および／または硬質はんだ付けのために活性化する場合に、有利となる。更に、完全にするために、硬質はんだを補強シート３の接触表面に追加して塗布し、または別法として塗布してもよいことに言及する。硬質はんだ４はいくらかの余剰分をもって適切に塗布されるので、シート・メタル部品の普通の加熱成形中、硬質はんだの溶解後にこの余剰分が補強シート３の縁部に絞り出される。図４およびその縁部に絞り出されたはんだの余剰分３５を参照のこと。この硬質はんだの余剰分の絞出しはガスの封入をなくして無孔のはんだ接合部を提供するだけでなく、補強シートの縁部が、縁部に集められメニスカス(meniscus)としてそこに生じる余剰分３５により効果的にシールされ、基本シートへの段付き移行が壁の厚さおよび切欠き作用に関してやや緩和される。

【００２４】硬質はんだの塗布後、シート・メタル部品２、３を、必要なシートの互いに所望の位置に従って定義された位置に、一方を他方に重ねて置く。これは補助装置を用いて効率的にかつ確実に行うことができる。続いて２枚のシートは、シート・メタル部品の相対位置を確実にするために、溶接ロボット１７を用いて、好ましくは１つの仮付け点５のみにより一時的に互いに固定される。

【００２５】シートの、または（コーティングされていないシートを使用した場合）シートの表面全体の、コーティングされていない境界面のスケーリングを防ぐために、このようにパッチングされた複合シート構造６の部品が、連続流炉１８に自動的に導入され、この炉の雰囲気は例えばガス・ボトルからの保護ガス１９を特にかつ十分に加えることにより不活性化される。保護ガスは、例えば二酸化炭素および／または窒素とすることができる。炉内では、複合シート構造は、材料の構造変態温度を超えるまで（通常は８５０～９３０℃の温度範囲内の特定の温度）加熱され、それを超えると材料の構造がオーステナイト状態となる。その結果、特定の冷却により材料を加熱処理することが可能となり、それにより達成できる材料強度の設定が可能となる。

【００２６】連続流炉の充填は、例えば炉用として公知の自動充填装置を用いて行うことができる。この場合、複合シート構造が炉内のグリップ互換定義された位置に確実にあり、シートに歪みがなく、火格子により支持されるほぼ全表面の平らな位置にあることに注意しなけれ

ばならない。対比すると、加熱した複合シート構造６’が炉から成形ツール内に急速に搬送されるので、炉１８から複合シート構造を摘出するために処理ロボット２０が設けられている。この処理ロボットは、定義された位置に既に置かれている加熱した複合シート構造６’を、炉内の所定の点で把持し、直後にそれを定義された位置内と同様に、開いた成形ツール２２内に導入する。この時間は、成形ツール２２が閉じ始めるまでの、たったの数秒間である。従って導入は２秒以下で終了することが好ましい（図６のプロセス開始時の時間Ｅ（導入）を参照のこと）ので、それにより生じる工作物の冷却はわずかであり、対応したより高い炉温度を選択することによって見越しておくことができる。

【００２７】図３でより詳細に示される例示的な実施形態では、成形ツール２２が、下部固定部内で、一般に１つの平面、通常は水平面に延びる固定された留め縁部をもつ雌の金型３０で構成されている。成形ツールの上部の持ち上げ可能な可動部分は、持ち上げ可能に可動となるよう別個に駆動できる留め装置３２(holding-downdevice)をもつ雄の金型３１からなり、その平面支持面が雌の金型の留め縁部に平行に配置されている。加熱した複合シート構造６’が開放した成形ツール内に導入されると、複合シート構造はまず外側のみの雌の金型の留め縁部上に置かれ、後者のインプレッションを自由にわたる。ツールを閉じる際には、まず留め装置３２が複合シート構造の縁部上に載せられ、縁部が特定の引張りにより締付け状態から滑り出ることができるように、予め決定できる締付け力で後者を締め付ける。それにより縁部の締付けが留め装置３２によって生じた後にのみ、雄の金型が複合シート構造上に設置されて、成形動作が開始する。

【００２８】加熱成形中、留め装置３２を絶縁すべきである。しかし、加熱成形は、留め装置がシートを急速に冷却することを妨げるので、留め装置なしで行うことが好ましい。

【００２９】雄の金型３１が持続して下降する結果、導入された加熱複合シート構造６’のシート・メタル部品が共に成形される。通常の厚いシート厚さにかかわらず、複合シート構造が加熱状態にあるので、一方での成形プレス２１に加わる力と、他方での成形ツール表面上で有効な摩擦力とがかなり低くなっている。従って通常の深絞り動作のための従来のプレス構造を使って、従来通りのコスト・レベルで作業を行うことができる。

【００３０】補強シート３は、確実に定位置に置かれているが、実際には基本シート２上に留めずに置かれており、一般に引張りがなくてもしわのないように所望の形状に成形することができる。これは、通常生じるように、補強すべき構造部品の域が、空間的にわずかにカーブした外形を有している場合に特に当てはまる。成形ツールを閉じるためおよびそれを成形するための時間Ｓ（図６参照）は、成形ツール２２を閉じ始めてから複合シート構造が完全に成形されるまでを数えて、非常に急速に複合シート構造の導入直後に生じる。この本質的な段階は、少なくとも３～５秒で終了する。認められているように、複合シート構造が成形ツールのインプレッションと部分的に接触するため、この時間の方が処理ロボットの熱保持トングを除いて複合シート構造が外気のみと接触する導入段階の間よりも、接触点での複合シート構造の熱損失が局所的に大きくなる。しかし下部の雌の金型３０のインプレッションは、初めは複合シート構造に全く接触せず、成形プロセスのまさに終了時にしか接触しない。更に、上部の雄の金型３１は、初めに複合シート構造に部分的に、および成形の程度が一般にいずれにしてもかなりわずかしかない領域のみで接触する。インプレッションにより接触していない、あるいはまだ接触していない領域では、加熱した複合シート構造が淀んだ空気に囲まれて、熱損失に対してその程度まで絶縁される。いずれにしても、複合シート構造は、成形段階の間に適度にのみ冷却され、成形ツールのインプレッションと部分的に接触するにもかかわらず、小さい力で大きく容易に加熱成形される。プレスと成形ツールを解放することに加えて、加熱形成は更に、（冷間成形と比べて）実質的により高度な複合シート構造の成形を１回の成形工程で行うことができるという、相当の利点を有している。

【００３１】成形ツールを閉じた結果として、複合シート構造の部品が共に加熱状態で所望の形状になった後、成形された複合シート構造は直後に冷却され、複合シート構造はこの冷却時間中に所望の成形状態に機械的に固定される。冷却の結果、硬質はんだが凝固してはんだ接合部にその後負荷がかかるだけでなく、定義された冷却により、使用する材料が特に加熱処理され、対応して特定の材料強度がそこに設定される。更に、必要な所望の状態での冷却中に成形されたシートを機械的に固定することにより、はんだ接合部は硬質はんだの凝固段階で閉じたままとなる。更に、加熱処理にかかわらず、複合シート構造の成形状態が確実に安定し正確な寸法となるだけでなく、回復傾向もなくなる。その結果、小さな寸法および／または形状に関連した塗布量をもつ非常に精密な工作物が製造される。

【００３２】成形ツールで成形された複合シート構造の特定の冷却を可能にするために、図３の例示により、雌の金型３０と雄の金型３１とのインプレッションに、表面近くを通り冷却回路２４に組み入れられる冷却ダクト３３、３４が設けられ、その冷却剤を図示しないポンプにより確実に循環することができる。加熱された冷却剤を、冷却回路に組み入れられた熱交換器２５により再び冷却することができ、この場合に使用される冷エネルギーは、例えば冷蔵アセンブリにより、または適宜の排水口（配水管、川）からの冷用水により印加される。例示

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した実施形態では、冷却中、工作物にすじの影響(streak effect)ができる限り残らないようにするために、一方の雌の金型の冷却ダクト３３と他方の雄の金型の冷却ダクト３４とを互いに交差させて配置している。

【００３３】以下で明らかになる理由により、図１、２による方法図に示す例では、冷却が２つの連続するステージで行われる。第１の冷却段階は成形ツール２２自体が確実に冷却されたインプレッションと接触することにより生じ、この第１の冷却段階の目標温度については２つの考察が決定的となる。一方では、複合構造でのシートの硬質はんだ連結の場合、最初に溶解した硬質はんだは少なくとも硬質はんだ４が完全に凝固するまで冷却されなければならず、成形された複合シート構造が同時に機械的に固定され、この凝固が希望通りの速さまたは希望通りの遅さで行われるようにする。他方、特定の材料の強度は加熱処理により達成することができ、その目的で、当該鋼に関して、５００℃の目標温度と特定の冷却率が重要となる。従って、普通の成形後に、閉じたままの成形ツール２２内に残るパッチング複合シート構造が、少なくとも約５００℃まで冷却されることは重要である。更に、融点だけでなく、特に凝固点、すなわち使用される硬質はんだの固相温度が５００℃を十分に超えることが重要である。

【００３４】維持すべき冷却率に関し、以下のことを適用できる。成形された複合シート構造内のマルテンサイト材料構造は、可能な最高強度が構造部品に必要とされ、延性は全く必要ないかわずかしか必要でない場合に適切となり得る。このような場合、加熱成形複合シート構造は８００～５００℃の温度範囲で急速に、すなわち８００℃から５００℃まで４秒未満で冷却されなければならない。

【００３５】しかし、クラッシュの際の構造部品の良好な故障動作を意図して、材料の高い延性に関連したかなり高い強度を達成することが通常の目的である。この場合、目標は成形された複合シート構造内のベイナイト材料構造である。このため、工作物は８００～５００℃の温度範囲でかなりゆっくりと、正確には８００℃から５００℃まで４秒よりも長い時間で冷却されなければならない。

【００３６】工作物が形成ツール内に残り、固定状態が維持されている間、特に制御されない構造変化なしに、工作物を容易に処理および／または保管できる温度まで前記工作物が続けて冷却されることが考えられる。ツールと一体化した冷却が効率的に設計される場合、このために必要な全体の冷却時間は、シートの厚さ、工作物の大きさ、および最終温度に応じて約２０～４０秒となり、大部分の場合には２５～３０秒の範囲となる。製造のパイロット・プラントまたは小さなバッチ・サイズの場合、このような１ステージ冷却が明らかに適切である。しかし、通常はこのタイプの構造部品は大量に必要とされ、効率的な質量製造を設定しなければならない。この推定に基づき、工作物を複数ステージで、少なくとも２ステージで冷却することが適切である。

【００３７】従って図２による方法図は、工作物を切り取るという必要な動作を約５００℃の上昇した温度でも行うことができ、これは特に材料強度が増加した場合には切断ツールをかなり解放することを示す。他方、２ステージ冷却の利点は、成形ツールが新たな複合シート構造を受けるために再びより急速に解放され、すなわち周期時間が短くなり製造が合理化されることである。

【００３８】２ステージ冷却では、普通の成形後、閉じたままの成形ツール２２に残る間に、パッチング複合シート構造がまず特定の時間平均温度勾配に沿って約５００℃まで冷却され、次に成形プレス内で隣接する開閉可能な固定ツール２３内に搬送される。２つの隣接するツール、正確には、一方の成形ツール２２と他方の固定ツール２３とが順次のツールのように成形プレス２１内に配置され、それ自体公知の搬送装置により連結され、この搬送装置は、プレスの開放時に、工作物を隣接するツールから同期して持ち出し、次のツールまたはプレスの外に配置された保管場所に渡す。

【００３９】固定ツールに受けられる複合シートはその中で、同様に、閉じた状態で、両側でその表面を覆って、寸法的に正確なインプレッションと接触し、したがって複合シート構造の望ましい形成状態が、機械的に固定されるように継続する。詳細には図示しないが、トリミング・ツールが固定ツール２３に一体化される。トリミング・ツールによって、形成された複合シート構造は、効果的な高温状態でトリミングされる。特に、もはや不要となった基本シートの留めまたは圧延縁部が切り取られる。この目的のためのトリミング装置はそれ自体よく知られており、やはり図示することはない。固定ツールのインプレッションは同様に、表面近傍で一体化された冷却ダクトにより能動的に冷却されて、その結果、接触により機械的に形状固定されたワークピースから継続して熱を抜き取ることができるようになる。冷却中のすじ効果を回避するために、固定ツールの場合、上側および下側に配置された冷却ダクトを互いに横切るように配置することが好都合である。固定およびトリミング・ツールが連結されたとき、現れるワークピース形状は機械的方法によってのみ獲得される、すなわち、力の作用の下で固定ツールの表面上で形成および摩擦的作業が行われることはない。したがって、固定ツールは、軽量構造として設計され、強度がより低い材料、たとえばアルミニウムから構成することが可能である。特に、固定ツールの表面は閉じている必要はない。対照的に、ダクト開口のグリッドをツール表面に向かって一体化することにより、ワークピースは冷却流体、特に冷却エアにより直接作用されることが可能である。水分のミストおよび／または液体エアを冷却エアと混合することにより、熱

伝達媒体としてのエアと共に、非常に高い冷却速度を実現できる。上記にすでに述べた、約２５～３０秒の冷却時間が、２ステージ冷却の場合にも達成される。ただし、冷却時の移送に起因する中断は含まれていない。

【００４０】２ステージ冷却後、加熱成形された構造部品は、硬質はんだ付けされた補強部品と共に、トリミングされた状態で引き出してさらに処理することができる。ワークピースは、強度が高く、軽量で、部品コストが安く、寸法および形状関連の精度が高いという特徴を有する。熱処理を共通の加熱成形工程と統合することにより、複合シート構造の材料強度は約１３００～１６００ＭＰａまで高めることができる。材料強度が高いことにより、先のようにして局所的に補強された構造部品は、軽量構造に対して、特に車両本体の乗員セルに一体化された中空部材用のシェル部品として非常に好適である。車両構造内の他の使用分野は、車両のシャシに一体化された中空部材用の局所補強シェル部品である。

【００４１】可能なだけサイクル・タイムを短くしたために、本目的は必然的に、特に構造変化が抑制されないということなしに、形成プレス内の形成済みワークピースを容易に取扱いおよび／または保存可能な温度にまで冷却するということになる。そのような温度は通常、１００～１５０℃とみなされる。一般には、そのような温度にある部品はマニュアルで扱うことはできない。したがって、冷却ゾーンに沿った冷却エアにより成形プレスの外側でさらに冷却することが勧められる。その場合は、ワークピースは、熱ひずみを回避するために共形の通過可能にされた支持シェルにより支持されるべきである。この場合、冷水ミストおよび／または特に室温により近い液体エアを冷却エアに加えてよい。

【００４２】図１および２による方法図に関し、やはり完全となることを目的として該方法の種々の変更形態について記載する。

【００４３】形成されたシート・メタル部品２および３の硬質はんだ付け連結を加熱成形により特に有利に組み合わせられるにもかかわらず、該方法は、この型の連結に依拠するものではない。硬質はんだ付け連結ではなく、溶接による連結を考慮してもよく、現行溶接接合のすべてが本明細書で関係するものである。これに関して、スポット溶接、ＭＩＧ／ＭＡＧ溶接またはレーザ溶接について言及することになる。この場合、図１の方法図において、硬質はんだの塗布が不要となり、代わりに、溶接作業が溶接ロボット１７によってより包括的に行われ、ある状況では他の溶接手段で行われる。上記すべての連結点または溶接シーム片は、補強シートの縁部に位置することになる。一般には、溶接スポット１つだけまたは数個だけにより補強シートを基本シートに対して連結することが原理的にまず可能であり、形成後のみに完全な耐荷重連結を実現することが可能である。しかし、加熱成形の前であったとしても、様々な理由により、補強シートと基本シートを一体に少なくとも縁部領域で完全に溶接することが勧められる。一方で、平坦な状態で、シートはより簡単に取り扱うことが可能であり、より効率的かつより高いプロセス信頼性のもとで溶接することが可能である。他方、すでに熱処理済みのシートが続けて溶接される変更例と比較すると、溶接が熱処理をも経るとすれば、その方が好ましい。最後に、関係するシートが互いに確実に連結されるとすれば、その方が形成プロセスにとって好ましい。シリコーン手段または同様な封止材料によりシートを互いに封止することが可能である。

【００４４】方法の別の変更例において、熱形成後の複合シート構造の冷却速度は、局所的に必要とされる別の材料強度によって異なるものである。構造部品の手順に基づいた衝突挙動の理由により、高い延性および低い強度がその中で局所的に現れる適用例が想定される。このタイプの領域は、これらの点で冷却されないか、または極めて遅く冷却される熱形成複合シート構造によって容易に実現できる。ただし、低強度領域から所望の高い材料強度を有する領域までの移行領域の冷却を持続することによって、低強度点（高温）から高強度領域（低温）への焼戻し効果がないことを確実にするように注意が必要である。

【００４５】次いで、図５および図６に関連して、加熱成形され局所的に補強された構造部品を生産するための４ステージ方法の変更例を取り扱う。詳細を図５に示す方法図は、図２による図例に主として対応しており、可能な限りの参照が、上記に概説した方法に関連した記述（ｓｔａｔｅｍｅｎｔ）に対してなされるものとする。ただし、成形プレス２１’は、ちょうど４ステージとなり、２ステージだけを備えた図２の成形プレス２１とはステージ数で異なっている。成形プレス２１’の始めの２個のステージは、やはり成形プレス２１の２個の単一ステージに主として等しい、すなわち、同様にまず、成形プレス２１’において、能動的に冷却された成形ツール２２が設けられ、同様に、冷却された固定ツールおよびトリミング・ツール２３がそれに続く。図２による特徴と比較すると、成形プレス２１’の詳細な特徴は、より長い成形プレス２１’内に、同様に冷却され、一方が他方に等距離をおいて後続する、別の２個の固定ツール２６が配置されていることである。それらは、トリミング装置を含まないという点で、固定およびトリミング・ツール２３と異なるだけである。

【００４６】成形プレス２１’に統合された４個のツール２２、２３、２６および２６により、加熱成形複合シート構造を連続する４個のステージで冷却することが可能になり、このため、図２に示す方法図による２ステージ冷却と比較して、サイクル・タイムを半分に短縮することになる。４個のツールのインプレッションは、両側で実質的に表面全体でワークピースと接触し、各ケース

においてそれらを高信頼度で所望の形状に固定する。ワークピースを直接または間接に能動冷却することにより、それらから熱を迅速に取り去ることが可能である。図３に示したように成形ツール２２のインプレッションは一体化された冷却ダクトにより能動冷却され、一方、固定ツール２３および２６は冷却ダクトのグリッドを担持し、これらはインプレッションの成形画定表面の向かって開放されており、その結果、冷却媒体、すなわちエア、エア／水分ミスト混合物、エア／液体エア混合物がワークピースに対して直接作用できる。さらに、ツールはすべて、移送装置によって互いに連結されて、ワークピースがツールからツールへ断続的に送られるようになっている。

【００４７】４ステージ冷却を用いた方法における手順を図６と関連して以下に説明する。図６は、平均ワークピース温度に関連して未定量化である温度／時間のグラフ、すなわち成形およびその後のマルチ・ステージ冷却の際の時間における温度プロフィルを示す。

【００４８】時間点ゼロは、パッチングされた複合シート構造が約９３０℃で炉１８から引き出された瞬間を指定している。短い引出し段階Ｅの間、シートはすでに幾分か冷却され、少なくとも約８５０℃で開放成形ツール２２に送られる。

【００４９】導入動作Ｅが過ぎると、プレスの作業サイクルが開始される。これについて、図６は、成形プレス２１’を経由して断続的に導かれるワークピースの、連続する４つのサイクルＺと、関連する温度プロフィルとを示す。各サイクルは、閉鎖段階Ｓ、固定段階Ｆ、および開放段階Ｏから構成される。少なくとも成形ツール２２において、閉鎖段階Ｓではまだ、ワークピースが冷却されたインプレッションと表面全体で接触することはないので、その結果、インプレッションの冷却作用は閉鎖および成形段階中は十分に行き渡ることはない。ワークピースが固定ツール２３および２６に配置されるその後のサイクルＺの際も、十分な冷却作用は、閉鎖動作Ｓが終了したときにのみ開始される。

【００５０】ツールを閉鎖する動作が終了し次第、成形ツールの場合、パッチングされた複合シート構造の加熱成形もこの時点で終了し、固定段階Ｆが開始され、その間に、ツールのインプレッションをワークピースに緊密に接触させることによって、後者の事実上の冷却がそれぞれのサイクル内で行われる。硬質はんだ付けがツール開放後に保持されるように、たとえば部分的に裂けることがないように、加熱成形に続く第１の固定および冷却段階で、ワークピースは硬質はんだの凝固温度E_Lの下へ十分に冷却されなければならない。さらに、ワークピースで所望の材料強度が得られるように、第１の固定および冷却段階で、ワークピースは約５００℃まで冷却し、同時に時間に対する特定の温度勾配を維持しなければならない。固定および冷却段階Ｆは、サイクル・タイムＺの大部分を占めるので、サイクル・タイムＺに対してクリティカルである。

【００５１】一サイクル内の固定および冷却段階が終了し次第、成形プレスおよび、それと共に、ツールが開放される。すなわち、開放段階Ｏである。ツールが部分的に開放されても、移送装置は、ツール内でワークピースを露出されてまま把持し、それらを雌型から取り外して、後続のツールの雌型に移送し、順序にしたがってそこに載置して、次の閉鎖動作がすでに開始されることになる。この開放段階Ｏの際、ワークピースはそれぞれの下側ツール部品のインプレッション内にゆるく載置されているだけであり、上面にも、または下側から領域全体にかけてもそれぞれのインプレッションに接触することがないので、開放段階の間でも、インプレッションの冷却作用は適度に行われるだけである。

【００５２】ワークピースと冷却媒体の間の温度勾配を低減するために、さらなる後方でのサイクル中の冷却速度は、より大きな温度差のもとで行われる、さらなる前方での冷却動作中よりも低くしてある。

【００５３】

【発明の効果】以上のように本発明によれば、基本シートまたは非補強構成要素と比べて、より高い局所補強度を単一の製造ステップで実現でき、また、成形品の従来よりも高い加工精度を実現できる。更に、成形ツールおよび成形プレスが予期されるよりも低い応力を受けるようにし、その範囲内で正当な有効寿命が予期できるものである。

【図面の簡単な説明】

【図１】補強シートが基本シートに硬質はんだ付けされた、基本シートと補強シートの普通の加熱成形の第１の例示的な実施形態による方法図である。

【図２】図１と共に、補強シートが基本シートに硬質はんだ付けされた、基本シートと補強シートの普通の加熱成形の第１の例示的な実施形態による方法図である。

【図３】図１、図２による確実に冷却した成形ツールを拡大して示した部分断面図である。

【図４】補強ビードを備えた補強シートが基本シートとの組合わせ前に予備成形される、パッチング複合シート構造の更に例示的な実施形態の横断面図である。

【図５】普通の加熱成形後に一連の確実に冷却した固定ツールのステップで基本シートと補強シートとが冷却される、基本シートと補強シートとの加熱成形を一部のみ示した更なる方法図である。

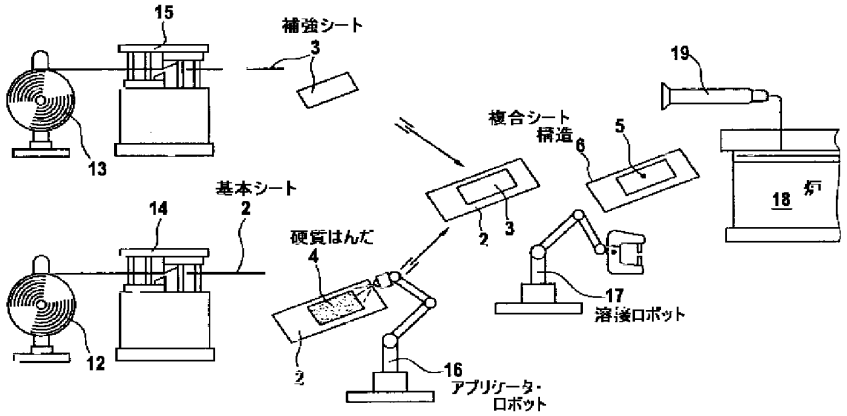
【図６】図５による方法の設備で製造される成形品の、製造中の温度分布を示す温度／時間グラフである。

【符号の説明】

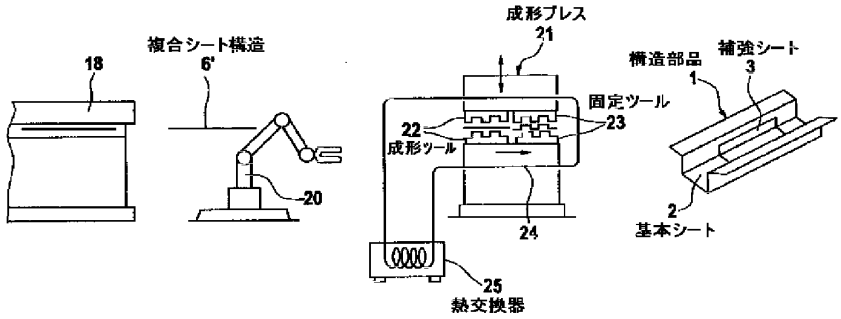
２　基本シート
３、３’　補強シート
４　硬質はんだ
５　仮付け点

６、６’　パッチング複合シート構造
７　補強ビード
１８　連続流炉
１９　保護ガス
２２　成形ツール
２３、２６　固定ツール
３３、３４　冷却ダクト
３５　余剰分
Ｅ　時間

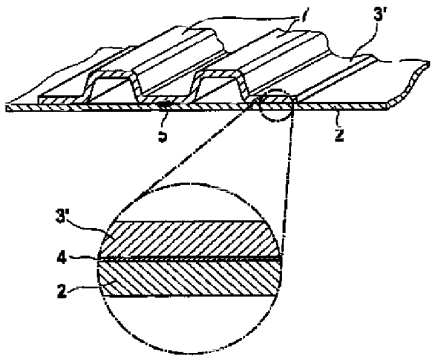
【図１】



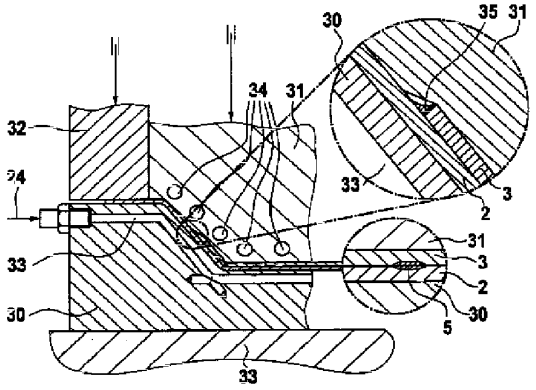
【図２】



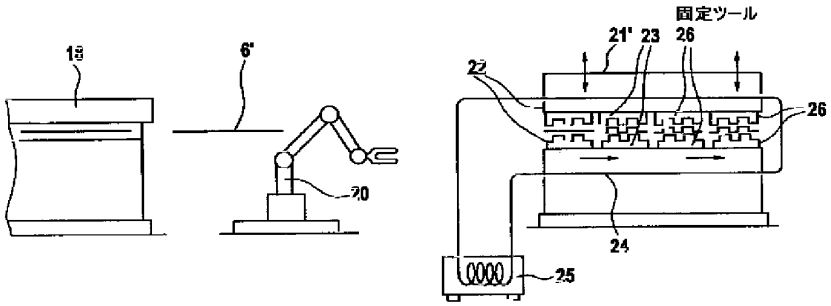
【図４】



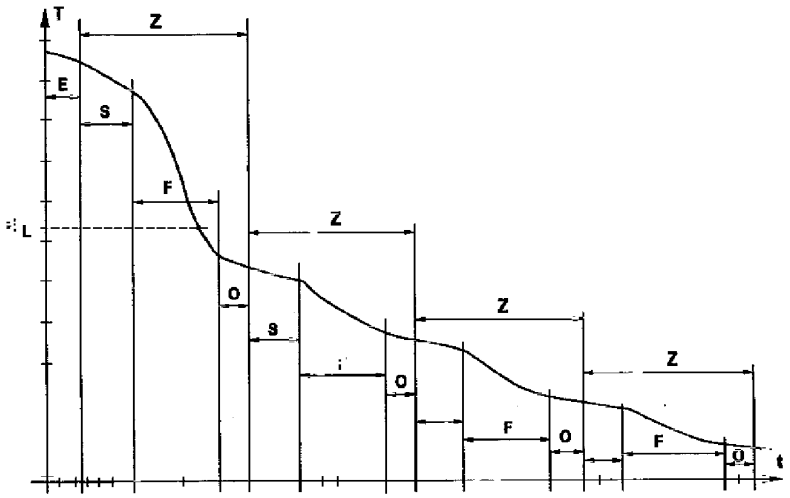
【図３】


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【図５】


固定ツール
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【図６】


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(72)発明者　ヴォルフガング・レウテル
ドイツ連邦共和国　71229　レオンベルク，グレムスシュトラーセ　41

(72)発明者　ロベルト・マイアーフォファー
ドイツ連邦共和国　71032　ベーブリンゲン，フィヒテシュトラーセ　67

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(71)出願人　000006655
新日本製鐵株式会社
東京都千代田区大手町２丁目６番３号

(72)発明者　加田　好実
千葉県富津市新富20－１　新日本製鐵株式会社技術開発本部内

(72)発明者　植田　浩平
千葉県富津市新富20－１　新日本製鐵株式会社技術開発本部内

(72)発明者　西村　一実
千葉県富津市新富20－１　新日本製鐵株式会社技術開発本部内

(74)代理人　弁理士　石田　敬　（外３名）

最終頁に続く

(54)【発明の名称】　成形性及び耐食性に優れたプレコートアルミニウム合金板

(57)【要約】

【課題】　厳しい成形加工部に使用しても、塗膜剥離や割れなどが発生せず、外観良好な、成形性及び耐食性に優れた、自動車ボディ用に適したプレコートアルミニウム合金板の提供。

【解決手段】　０．５ｗｔ％以上のＭｇ含有アルミニウム合金板上の片面もしくは両面に、化成処理皮膜を有し、更にその上に樹脂塗膜を被覆したプレコートアルミニウム合金板であって、樹脂塗膜が引張試験において弾性比例限界を有し、かつ２０～３００ｋｇ／ｍｍ^{2}の引張弾性率を有することを特徴とする成形性及び耐食性に優れたプレコートアルミニウム合金板である。前記樹脂塗膜は、更に弾性限界伸びが１５％以下であること、また、引張試験において降伏点伸びを有することが好ましい。

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【特許請求の範囲】
【請求項１】　０．５ｗｔ％以上のＭｇ含有アルミニウム合金板上の片面もしくは両面に、化成処理皮膜を有し、更にその上に樹脂塗膜を被覆したプレコートアルミニウム合金板であって、樹脂塗膜が引張試験において弾性比例限界を有し、かつ２０～３００ｋｇ／ｍｍ^2 の引張弾性率を有することを特徴とする成形性及び耐食性に優れたプレコートアルミニウム合金板。
【請求項２】　樹脂塗膜が引張試験において１５％以下の弾性限界伸びを有することを特徴とする請求項１に記載の成形性及び耐食性に優れたプレコートアルミニウム合金板。
【請求項３】　樹脂塗膜が引張試験において降伏点伸びを有することを特徴とする請求項１または２に記載の成形性及び耐食性に優れたプレコートアルミニウム合金板。
【請求項４】　請求項１～３いずれかのプレコートアルミニウム合金板を使用することを特徴とする成形性及び耐食性に優れた自動車ボディ用パネル材。
【発明の詳細な説明】
【０００１】
【発明の属する技術分野】本発明は、自動車用の内板や外板など絞り加工を行うことで製品を成形する部位に用いる成形性及び耐食性の優れたプレコートアルミニウム合金板、特に、自動車ボディ用プレコートアルミニウム合金板に関する。
【０００２】
【従来の技術】自動車用の内板や外板など絞り加工を行うことで製品を成形する部位に用いる自動車材料としては、例えば、特開平９－１９３２８６号公報には、鋼板に特定の樹脂塗膜を被覆することにより、絞り成形性に優れたプレコート鋼板が開示されている。
【０００３】他方、最近では、車体の軽量化を狙ってアルミニウムまたはアルミニウム合金板を車体に使用することが多くなっている。絞り加工部へプレコートアルミニウム合金板を適応する際には、従来技術では塗膜の引張試験による伸び率の高い塗膜やＴ折り曲げ試験結果の良い塗膜を選択し、円筒絞りや角筒絞り試験を実施して評価結果の良いものを絞り加工部に適用してきた。
【０００４】しかしながら、特開平９－１９３２８６号公報は、鋼板用の技術であり、アルミニウム合金板の場合、鋼板に比べて化成処理性が悪く、化成処理が悪い場合には耐食性も低下してしまう問題がある。
【０００５】
【発明が解決しようとする課題】絞り加工は、アルミニウム合金板に引張と圧縮の歪みが発生する変形様式であり、曲げ加工性が良く、単に伸びるだけの塗膜では絞り加工に十分に適用されず、加工後に塗膜が剥離してしまう場合が多い。そこで、本発明の目的は、絞り加工部にプレコートアルミニウム合金板を適応した場合に塗膜剥離や塗膜割れ等が発生せず外観良好な絞り成形性の優れたプレコートアルミニウム合金板を提供することにある。
【０００６】
【課題を解決するための手段】本発明者らは、絞り成形性に優れたプレコートアルミニウム合金板を得るために種々の樹脂塗膜について検討した。その結果、樹脂塗膜の物理的性質を特定することによって絞り成形に十分適応できることを知見した。本発明は、この知見に基づくものであって、その要旨は下記のとおりである。
【０００７】（１）０．５ｗｔ％以上のＭｇ含有アルミニウム合金板上の片面もしくは両面に、化成処理皮膜を有し、更にその上に樹脂塗膜を被覆したプレコートアルミニウム合金板であって、樹脂塗膜が引張試験において弾性比例限界を有し、かつ２０～３００ｋｇ／ｍｍ^2 の引張弾性率を有することを特徴とする成形性及び耐食性に優れたプレコートアルミニウム合金板。
【０００８】（２）樹脂塗膜が引張試験において１５％以下の弾性限界伸びを有することを特徴とする前記（１）に記載の成形性及び耐食性に優れたプレコートアルミニウム合金板。
（３）樹脂塗膜が引張試験において降伏点伸びを有することを特徴とする前記（１）または（２）に記載の成形性及び耐食性に優れたプレコートアルミニウム合金板。
【０００９】（４）前記（１）～（３）いずれかのプレコートアルミニウム合金板を使用することを特徴とする成形性及び耐食性に優れた自動車ボディ用パネル材。
【００１０】
【発明の実施の形態】本発明のプレコートアルミニウム合金板に適用するアルミニウム合金板は、０．５ｗｔ％以上のＭｇ含有アルミニウム合金板で、特に制約するものではないが、特に自動車用に適した５０００系アルミニウム合金板や６０００系アルミニウム合金板が好ましい。
【００１１】アルミニウム合金板上には、良好な塗膜密着性及び耐食性を有するために、化成処理皮膜を有する必要がある。化成処理皮膜は、クロメート皮膜あるいはリン酸亜鉛皮膜を含むノンクロメート皮膜いずれでもよい。クロメート皮膜あるいはノンクロメート皮膜は５～１５０ｍｇ／ｍ^2 、リン酸亜鉛皮膜は０．５～２ｇ／ｍ^2 が好ましい。化成処理皮膜量が下限値以下であると耐食性が不十分となる。また、上限値を超えると密着性が低下してしまう。
【００１２】本発明のプレコートアルミニウム合金板においては、絞り成形性を良好とするために、アルミニウム合金板上に被覆する樹脂塗膜の引張特性を規定する。本発明の樹脂塗膜は、絞り成形性を確保するために、引張試験において弾性比例限界を有し、かつ引張弾性率を２０～３００ｋｇ／ｍｍ^2 の範囲に制約する。この条件から外れる樹脂塗膜では、絞り成形性を十分に得ること

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はできず、絞り部で塗膜にしわがよったり剥離するため好ましくない。

【００１３】上記樹脂塗膜は、絞り成形性を良好とするために弾性限界伸びを１５％以下とすることが好ましく、これ以上では成形したときにコーナー部で塗膜に割れが生じてしまい好ましくない。一方、全伸びについては、１５％以上が好ましい。また、上記樹脂塗膜は、引張試験した際に、降伏点伸びを有することが、さらに絞り成形性を良くするために好適である。降伏点伸びを有すると、成形したときに塗膜に絞り部でしわがよったり剥離したり、コーナー部で割れたりしない。

【００１４】以上のように樹脂塗膜の引張特性を規定することによって、絞り成形性が優れる理由は、不明であるが、絞り成形様式の引張と圧縮をアルミニウム合金板が受けた際に、アルミニウム合金板上の樹脂塗膜もアルミニウム合金板の変形にうまく追従して変形するために上記条件がうまく作用しているものと考えられる。塗膜として用いる樹脂は、特に制約するものではないが、ポリエステル樹脂、アクリル樹脂、エポキシ樹脂等を用いることができる。これら樹脂に上記引張特性を付与するには、樹脂塗膜のＴｇを上げる、樹脂に硬化剤を添加する、塗膜の焼き付け温度を高くすることで塗膜の架橋密度を上げる等の手段が挙げられ、これらを必要に応じて組み合わせることによって前記引張り特性が得られる。

【００１５】

【実施例】板厚１．０ｍｍのＡ６００９合金及びＡ５１８２合金板上に化成処理を施し、その上にポリエステル系プライマー塗膜を５μｍ塗装し、その上に表１に示す機械特性値を持った塗膜を膜厚：１５μｍ塗装し、プレコートアルミニウム合金板を作成した。その後に角筒成形試験を行い、コーナー絞り部の塗膜の破壊形態を観察した。塗膜には高分子ポリエステル系樹脂をベースとした塗料を用いた。

【００１６】塗膜の機械特性値については、まず塗膜をテフロンシート上にバーコーターで膜厚：１５μｍ塗装し、焼き付け後、テフロンシートより塗膜を剥離して塗膜のフリーフィルムを作成し、このフリーフィルムから１０ｍｍ×５０ｍｍの試験片を作成し、引張試験を実施した。引張試験条件はオリエンテック社製「テンシロンＣＴ－１０Ｔ」を用いて室温で引張スピード１０ｍｍ／ｍｉｎで行い、塗膜の荷重－伸びより引張特性を得た。

【００１７】角筒絞り条件は、ポンチサイズ：□７０ｍｍ、ポンチ肩Ｒ：２ｍｍ、ポンチコーナーＲ：１０ｍｍの金型を使い、ブランクサイズ：□１４０ｍｍ、ＢＨＦ：５ｔ、成形高さ：３０ｍｍで実施し、成形品のコーナー絞り部の外観観察を行い、以下の基準で判定した。

◎：塗膜剥離、塗膜割れが認められない

○：塗膜剥離、塗膜割れが少し認められるが問題ないレベル

△：塗膜剥離、塗膜割れが共に認められる

×：塗膜剥離、塗膜割れが共に大いに認められる

評価結果を表１に示す。この表から明らかなように、応力－伸び線図で弾性比例限が存在し、引張弾性率が２０～３００ｋｇ／ｍｍ^2 の塗膜が絞り成形性に優れ、外観が良く、塗膜剥離、塗膜割れが認められない。また、弾性限界伸びが１５％以下、および／または、降伏点伸びが現れ全伸びが１５％以上、であるような樹脂であれば、更に絞り成形性が良く、特に前記すべての条件を満たす樹脂であれば塗膜剥離、塗膜割れが全く認められない。

【００１８】また、プレコートアルミニウム合金に、自動車用のパネル材と同様の中塗り塗装（膜厚３５μｍ）及び上塗り塗装（膜厚３５μｍ）を施したのち、耐食性及び密着性を行った。耐食性は上塗り塗装を施した塗膜にＮＴカッターでクロスカットを入れた後、塩水噴霧（５％ＮａＣｌ水溶液、３５℃、２４ｈｒ）→湿潤試験（５０℃ｘ８５％ＲＨ、１２０ｈｒ）を１サイクルとして、８サイクル実施し、クロスカット部からの塗膜の膨れ幅の最大膨れ幅によって評価した。評価は、○：膨れ幅１ｍｍ未満、△：膨れ幅１ｍｍ以上３ｍｍ未満、×：膨れ幅３ｍｍ以上で判断した。

【００１９】塗膜密着性は、上塗り塗装を施したサンプルを４０℃の蒸留水に１０日間浸漬後、直ちに塗膜にＮＴカッターで１ｍｍ角の碁盤目が１００個できるようにカットを入れ、テープ剥離後の碁盤目の残り具合を観察した。評価は、○：碁盤目の剥離なし、△：碁盤目の剥離面積が５％未満、×：碁盤目の剥離面積が５％以上で判断した。

【００２０】

【表１】

表　1

No	化成処理	弾性限界伸び(%)	引張弾性率 (kg/mm²)	降伏点伸び	全伸び(%)	絞り成形外観	耐食性	密着性	備考
1	C	4.0	300	無	4.0	○	○	○	本発明
2	A	13.7	242	無	13.7	○	△	△	
3	B	13.7	242	無	13.7	○	○	○	
4	C	13.7	242	無	13.7	○	○	○	
5	D	13.7	242	無	13.7	○	○	○	
6	E	15.8	242	有	57.2	○	○	△	
7	F	15.8	242	有	57.2	○	△	△	
8	G	15.8	242	有	57.2	○	○	○	
9	H	15.8	242	有	57.2	○	○	○	
10	I	3.7	242	有	15.2	◎	○	○	
11	J	3.7	242	有	15.2	◎	△	△	
12	K	3.7	242	有	15.2	◎	○	○	
13	C	10.0	100	有	17.1	◎	○	○	
14	C	13.6	27	有	55.6	◎	○	○	
15	C	60.0	18	無	60.0	△	○	○	比較例
16	C	4.1	366	無	4.1	×	○	○	
17	C	比例弾性なし			9.0	×	○	○	
18	C	比例弾性なし			42.5	×	○	○	
19	C	比例弾性なし			63.4	△	○	○	
20	C	比例弾性なし			232.6	△	○	○	

化成処理：Ａ；クロメート　２ｍｇ／ｍ²
Ｂ；クロメート　５ｍｇ／ｍ²
Ｃ；クロメート　５０ｍｇ／ｍ²
Ｄ；クロメート　１５０ｍｇ／ｍ²
Ｅ；クロメート　２５０ｍｇ／ｍ²
Ｆ；リン酸亜鉛　０．１ｇ／ｍ²
Ｇ；リン酸亜鉛　０．５ｇ／ｍ²
Ｈ；リン酸亜鉛　１．２ｇ／ｍ²
Ｉ；リン酸亜鉛　２．０ｇ／ｍ²
Ｊ；リン酸亜鉛　３．０ｇ／ｍ²
Ｋ；Ｚｒ酸　５０ｍｇ／ｍ²

【００２１】
【発明の効果】以上説明した通り、本発明のプレコートアルミニウム合金板は、塗膜の引張特性を規定することにより、絞り成形加工を行っても塗膜剥離や塗膜割れが発生しない。これにより、深絞り加工など厳しい成形加工部にもプレコートアルミニウム合金板を使用する事が可能となり、プレコートアルミニウム合金板の適用用途が広まる。また、現在プレコートアルミニウム合金板を折り曲げ加工で使用している製品についても、絞り成形で製造する事が可能となり、製品のデザイン面でも自由度が増し、加工形状をより広範囲に選択できる。従って、本願発明は工業的価値の極めて高い発明であるといえる。

フロントページの続き

(72)発明者　西岡　良二
千葉県君津市君津１番地　新日本製鐵株式会社君津製鐵所内

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Espacenet

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PRECOATED ALUMINUM ALLOY SHEET EXCELLENT IN FORMABILITY AND CORROSION RESISTANCE

Inventor(s): KADA YOSHIMI; UEDA KOHEI; NISHIMURA KAZUMI; NISHIOKA RYOJI ± (KADA YOSHIMI, ; UEDA KOHEI, ; NISHIMURA KAZUMI, ; NISHIOKA RYOJI)

Applicant(s): NIPPON STEEL CORP ± (NIPPON STEEL CORP)

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Abstract of JPH11156293 (A)

PROBLEM TO BE SOLVED: To produce a precoated aluminum alloy sheet suitable for an automobile body without the coating film being released or cracked even when used for the part to be formed to a high degree, good in appearance and excellent in formability and corrosion resistance. SOLUTION: This precoated aluminum alloy sheet excellent in formability and corrosion resistance has a chemical film on one or both sides of an aluminum alloy sheet contg. >=0.5 wt.% Mg and further a resin coating film thereon. The resin film has an elastic proportional limit in a tensile test and 20-300 kg/mm<2> tensile elastic modulus. The resin coating film should have 15% elastic limit elongation and an yield elongation in the tensile test.

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CLAIMS JPH11156293

[1]

1. On one side or both sides of the 0.5wt% or more of Mg-containing aluminum alloy plate, it has a chemical conversion coating, further a pre-coated aluminum alloy sheet coated with a resin coating film on it, in the resin coating film tensile test elastic proportionality has a limit, and pre-coated aluminum alloy sheet having excellent formability and corrosion resistance characterized by having a tensile modulus of 20~300kg / mm2.

2.

Precoated aluminum alloy sheet having excellent formability and corrosion resistance according to claim 1, characterized in that it has 15% or less of the elastic limit elongation in the resin coating film is a tensile test.

3.

Precoated aluminum alloy sheet having excellent formability and corrosion resistance according to claim 1 or 2, characterized in that it has a yield point elongation in the resin coating film is a tensile test.

4.

Claims 1 to 3, any of formability and excellent automobile body panel material in corrosion resistance, characterized by using a pre-coated aluminum alloy sheet.

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DESCRIPTION JPH11156293

[0001]

The present invention relates to the inner plate and formabiliity used to the site to shape the product by performing such as the outer plate drawing and corrosion resistance of the excellent pre-coated aluminum alloy sheet for automobiles, in particular, for a motor vehicle body on pre-coated aluminum alloy plate.

[0002]

As the automotive material used for the site to mold the product by performing the Prior Art] the inner plate and such as outer plate drawing for an automobile, for example, in Japanese Unexamined Patent Publication (Kokai) No. 9-193286, a particular resin coating on the steel plate by coating the film, excellent pre-coated steel sheet drawabiliity is disclosed.

[0003]

On the other hand, recently, it has been often used aluminum or aluminum alloy plate to the vehicle body aimed at weight reduction of the vehicle body. Stop when adapting the pre-coated aluminum alloy plate to the processing section, and choose a good coating film of the coating of the tensile test the growth rate of high coating film and T bending test results of the prior art, the aperture cylindrical aperture and square tube test the has been applied to the processing unit stop good things to the evaluation results implementation.

[0004]

However, JP-A-9-193286 is a technology of steel plate, if the aluminum alloy sheet, poor chemical conversion as compared to steel, corrosion resistance is a problem that deteriorates when chemical conversion treatment is poor .

[0005]

Iris [invention is a problem to be solved] processing is a modified manner in which the distortion of the compression and tensile aluminum alloy plate occurs, good bending workability, are fully applicable to the drawing process is simply just a coating film extends not, in many cases the coating film after processing peels. It is an object of the present invention is to provide a good appearance drawabiliity superior precoat aluminum alloy sheet without coating peeling or coating cracking or the like occurs when applied to pre-coated aluminum alloy plate in the drawing unit It is in.

[0006]

The present inventors Means for Solving the Problems] were examined for various resin film to obtain a precoat aluminum alloy plate having excellent drawabiliity. As a result, it was found that the sufficient adapted to draw forming by identifying the physical properties of the resin film. The present invention has been made based on this finding, the gist is as follows.

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[0007]

(1) on one or both sides of the 0.5 wt% or more Mg-containing aluminum alloy sheet having a chemical conversion coating, a further pre-coated aluminum alloy sheet coated with a resin coating thereon, the resin coating film tensile testing an elastic proportionality limit in, and pre-coated aluminum alloy sheet having excellent formability and corrosion resistance characterized by having a tensile modulus of 20~300kg / mm2.

[0008]

(2) pre-coated aluminum alloy sheet having excellent formability and corrosion resistance according to (1), characterized in that it has 15% or less of the elastic limit elongation at a tensile resin coating film test. (3) wherein characterized by having a yield point elongation at a tensile resin coating Test (1) or pre-coated aluminum alloy sheet having excellent formability and corrosion resistance according to (2).

[0009]

(4) above (1) to (3) any of the moldability and excellent automobile body panel material in corrosion resistance, characterized by using a pre-coated aluminum alloy sheet.

[0010]

Aluminum alloy plate to be applied to the pre-coated aluminum alloy plate of the embodiment of the present invention is, in 0.5wt% or more of Mg-containing aluminum alloy plate, it shall not specifically be restricted, particularly suitable for automotive 5000 system aluminum alloy plate or 6000 series aluminum alloy plate is preferred.

[0011]

On the aluminum alloy plate, in order to have good paint adhesion and corrosion resistance, it is necessary to have a chemical conversion treatment film. Chemical conversion coating may be either non-chromate film containing a chromate film or a zinc phosphate coating. Chromate film or a non-chromate coatings 5~150mg / m2, zinc phosphate coating 0.5~2g / m2 is preferred. Corrosion resistance is insufficient when the chemical conversion coating weight is equal to or lower than the lower limit. Further, the adhesion is lowered to exceed the upper limit.

[0012]

In the pre-coated aluminum alloy sheet of the present invention, in order to improve the drawability, to define the tensile properties of the resin coating film coated on an aluminum alloy plate. Resin coating film of the present invention, in order to ensure drawability, an elastic proportionality limit in the tensile test, and constraining the tensile modulus in the range of 20~300kg / mm2. The resin coating film deviates from this condition, it is impossible to sufficiently obtain drawability, the diaphragm portion is not preferred for peeling or wrinkled coating film with.

[0013]

The resin coating film is preferably to the elastic limit elongation 15% or less in order to improve the drawability, cracking will undesirably occur on the coating film at the corner portion when the molded in further. On the other hand, the total elongation, preferably at least 15%. Further, the resin coating film, upon a tensile test, have a yield point elongation, is suitable for improving the further drawing formability. As having a yield point elongation, or peeling or wrinkled in the throttle section in the coating film at the time of molding, not cracked at the corners.

[0014]

By defining the tensile properties of the resin film as described above, the reason for drawing formability is excellent, which is unknown, in the compression and tension of the draw-forming manner received by the aluminum alloy sheet, an aluminum alloy plate resin coating film is also believed that the above conditions in order to be successfully follow the deformation of the aluminum alloy plate deformation is acting well. Resin used as a coating, particularly but not restrict, a polyester resin, an acrylic resin, an epoxy resin or the like. To impart the tensile properties of these resins, raising the Tg of the resin film, adding

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a curing agent to the resin, include means such as increasing the crosslink density of the coating by increasing the baking temperature of the coating film is the tensile properties by combining accordance with these demands is obtained.

[0015]

EXAMPLES subjected to a chemical conversion treatment on the A6009 alloy and A5182 alloy plate with a thickness of 1.0mm, a polyester-based primer coating to 5μm painted on it, with the mechanical properties values shown in Table 1 on the coating film thickness: to 15μm paint, it creates a pre-coated aluminum alloy plate. Then to do the square tube molded test, to observe the destruction form of a coating film of the corner throttle portion. The coated film was used paint based on polymer polyester resin.

[0016]

The mechanical characteristic value of the coating film, first, a coating film thickness with a bar coater onto a Teflon sheet: to 15μm coating, after baking, to create a free film of the coating film was peeled off the coating film from the Teflon sheet, the free to prepare a test piece 10 mm × 50 mm from the film, and a tensile test. Tensile test conditions is carried out at a pulling speed of 10mm / min at room temperature using a Orientec Co. "TENSILON CT-10T", load of the coating film - to obtain a tensile than elongation properties.

[0017]

Square tube stop conditions, punch size: □ 70mm, punch shoulder R: 2mm, punch corner R: use the mold of 10mm, blank size: □ 140mm, BHF: 5t, forming height: carried out at 30mm, the molded article carried out of the corner throttle portion of the external observation, it was judged by the following criteria. ◉: paint stripping, not paint film cracking was observed ○: paint stripping, no, but the coating film cracking is a little recognized problem level △: paint stripping, × coating film cracking is observed both: paint stripping, coating the evaluation results of film cracking are both much appreciated shown in Table 1. As it is apparent from this table, the stress - elastic proportional limit present in elongation diagram, tensile modulus excellent moldability diaphragm coating 20~300kg / mm2, good appearance, the coating film peeling, coating film crack is not observed. Further, the elastic limit elongation of 15% or less, and / or, as long as it is a resin such as the total elongation yield point elongation appears is 15% or more, may further drawing formability, particularly the all satisfied resin if the paint stripping, is not observed at all coating film cracking.

[0018]

Further, the pre-coated aluminum alloy, after subjected to the same intermediate coating and panel material for automobiles (thickness 35 .mu.m) and top coating (film thickness 35 .mu.m), it was subjected to corrosion resistance and adhesion. After the corrosion resistance put a cross cut by NT cutter on the coating film subjected to the finish coating, salt spray (5% NaCl aqueous solution, 35 ° C, 24hr) → wet test (50 ° Cx85% RH, 120hr) as one cycle It was performed 8 cycles was evaluated by the maximum blister width of the blister width of the paint film from the cross-cut portion. Evaluation, ○: less than blistering width 1mm, △: less than blistering width 1mm more than 3mm, ×: swelling was determined by the width of 3mm or more.

[0019]

Coating adhesion is, after the distilled water to dip 10 days of the sample 40 ° C (104 ° F) which has been subjected to finish coating, a cross-cut of 1mm angle put the cut so that it can be 100 immediately NT cutter on the paint film, after the tape peeling It was observed for the remaining degree of cross-cut. Evaluation, ○: crosscut without peeling, △: peeling area of the cross-cut is less than 5%, ×: peeling area of the cross-cut is determined by more than 5%.

[0020]

As described above, according to the present invention, pre-coated aluminum alloy plate of the present invention, by defining the tensile properties of the coating, paint stripping and coating film cracking even if the stop molding does not occur. Accordingly, also it is possible to use pre-coated aluminum alloy plate in severe molding unit such as deep drawing, applying the use of pre-coated aluminum alloy sheet is spread. As for the products used in bending a current precoat aluminum alloy plate, the diaphragm forming with it possible to manufacture, also increased flexibility in the design surface of the product, can be selected machining shape more widely. Therefore, it can be said that the present invention is extremely high invention industrial value.

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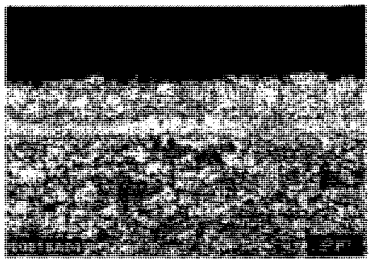
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(71)出願人　506166491
アルセロールミタル・フランス
フランス国、９３２００・サン・ドウニ、リユ・リユイジ・シユリユビニ、１－５
(74)代理人　100062007
弁理士　川口　義雄
(74)代理人　100114188
弁理士　小野　誠
(74)代理人　100140523
弁理士　渡邊　千尋
(74)代理人　100119253
弁理士　金山　賢教
(74)代理人　100103920
弁理士　大崎　勝真

最終頁に続く

(54)【発明の名称】熱処理後に極めて高い耐性を有する被覆鋼部材の製造法

(57)【要約】
本発明は、熱間圧延または冷間圧延による帯鋼を原材料とする機械的性質に非常に優れた部材の製造法であって、アルミニウムまたはアルミニウム合金による該帯鋼の予備被覆と、予備被覆を施した帯鋼の冷間変形と、場合によって行う部材の最終形状に合わせた余分な金属板の切断と、鋼と被覆との界面から金属間化合物を生成し鋼をオーステナイト化するための部材の加熱と、装置への部材の移送と、冷却後に鋼がマルテンサイト構造、ベイナイト構造またはマルテンサイト－ベイナイト構造となるような速度で行う装置内での部材の冷却とを含む製造法に関する。予備被覆は、電気めっき、化学もしくは物理蒸着、または共圧延によって行う。



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【特許請求の範囲】
【請求項1】
熱間圧延または冷間圧延による帯鋼から機械的性質に非常に優れた部材を製造する方法であって、
該帯鋼にアルミニウムまたはアルミニウム合金による予備被覆を施す工程と、
該被覆を施した帯鋼を冷間で変形させる工程と、
該部材の最終的な幾何学形状に合わせて余分な板部を場合によって取り除く工程と、
該部材表面に鋼と予備被覆との界面から金属間化合物が形成され、鋼がオーステナイト化されるように該部材を加熱する工程と、
該部材を装置に移動する工程と、
冷却後に鋼がマルテンサイト構造もしくはベイナイト構造またはマルテンサイト－ベイナイト構造を持つような速度で該部材を装置内で冷却する工程と、
を連続して含む製造法において、
該加熱の前には該帯鋼と予備被覆との界面が金属間相を含んでおらず、該予備被覆が少なくとも１つのアルミニウムもしくはアルミニウム合金の電気めっき工程によって、少なくとも１つのアルミニウムもしくはアルミニウム合金の化学蒸着工程によって、少なくとも１つのアルミニウムもしくはアルミニウム合金の物理蒸着工程によって、または該帯鋼をアルミニウム箔もしくはアルミニウム合金箔とともに圧延する少なくとも１つの共圧延によって形成され、該少なくとも１つの予備被覆工程は単独でも組み合わせでも行うことができることを特徴とする、製造法。
【請求項2】
前記冷間変形の一般化ひずみが少なくとも前記部材の１カ所で２０％超であることを特徴とする、請求項１に記載の製造法。
【請求項3】
請求項１または２に従って製造される、帯鋼から得られる機械的性質に非常に優れた部材の陸上自動車の構造部材または安全部材の製造のための使用。

【発明の詳細な説明】
【技術分野】
【0001】
本発明は、高い機械的強度と優れた耐食性を持つ熱間圧延または冷間圧延被覆鋼部材の製造に関する。
【背景技術】
【0002】
ある種の用途では、高い機械的強度、優れた耐衝撃性、優れた耐食性を兼ね備えた鋼部材を作り出すことが望まれる。これらの特徴の兼備は、軽量化著しい車両を製造することが目標とされる自動車産業にあっては特に望ましい。その目標は、とりわけ、非常に優れた機械的性質を持つ鋼材を使用することによって果たすことができるものであり、たとえば、自動車の貫入防止部材、構造部材または安全部材（フェンダークロスメンバー、ドアまたはセンターピラーの補強材、サスペンションアーム（ｗｈｅｅｌ　ａｒｍｓ））などでは上述の性質が要求される。
【0003】
特許ＦＲ２８０７４４７は、５００　ＭＰａ前後の引張り強さを有する母材の鋼板を金属の予備被覆を施した状態で用意し、冷間絞りや冷間ロール成形などの冷間成形加工を行い、さらに熱処理を加えた後に部材の幾何学形状に合った形状の装置の中で鋼板を急冷する製造法を開示している。この熱処理の加熱段階では、当初の予備被覆が母材の鋼と合金化することによって部材の表面に金属間被覆が形成される。これにより、機械的強度が１５００ＭＰａ超などの耐食性部材を得る。
【0004】
母材の鋼板に対しては、溶融めっき法などによってアルミニウムまたはアルミニウム合金の予備被覆を施すことができる。しかし、場合によっては、この方法の実施に制約が生

じることがある。熱処理前の部材に対して行われる冷間成形加工の際、一部の区域がより大きな変形を受け、それによって基材と予備被覆との界面に局所的な剥離の形で損傷が生じる可能性がある。その場合、その後の熱処理によって界面の合金層の周辺にスケールを生じる可能性がある。このスケールの存在は母材の鋼とアルミニウムを含む予備被覆との十分な合金化のためには有害である。

【0005】

さらに、アルミナイズ処理を施した部材は、冷間成形後、それに続く合金化のための熱処理の前に余分な材料を取り去るため、その切断、押抜きまたは型取りを行うことがある。溶融めっきによるアルミニウム系予備被覆の存在は切削工具の損耗の原因となることが考えられる。

【0006】

また、溶融アルミニウムめっきを施した鋼板の予備被覆は標準厚さと比べて厚さにばらつきを生じる可能性がある。合金化のための熱処理の際の加熱は、典型的には数分というごく短時間で行われることから、厚さの超過が過大である場合には、被覆の合金化が不完全となる。通常の予備被覆の融点は、アルミニウムの場合で６６０℃、１０％のケイ素／アルミニウム合金の場合で５８０℃であることから、被覆が厚い方の側では、部材がオーステナイト化温度に達する以前に早すぎる溶融が起こる可能性がある。一般に熱処理は、部材がローラの上を移動する形の炉で行われるため、ローラの表面が予備被覆の部分的溶融によって生じる層で汚染され、炉の正しい動作に支障を来たすことになる。また、予備被覆の不完全な合金化はその後の電気泳動の工程にも有害である。

【発明の開示】

【発明が解決しようとする課題】

【0007】

本発明の目的は上述の諸問題を解決することにある。本発明がとりわけその目的とするのは、アルミニウムまたはアルミニウム合金の予備被覆を施した熱間圧延または冷間圧延による鋼部材の製造法において、合金化処理前に事前の冷間での大きな変形を許容しつつ、それによって合金化処理に関して事後のリスクを生じることのない鋼部材の製造法を提供することである。本発明の目的は、合金化のための熱処理に先立つ機械加工の際の工具の損耗を減らすことにある。また、本発明は、熱処理の後、アルミニウムまたはアルミニウム合金の予備被覆の完全な合金化を得ることも目的とする。

【課題を解決するための手段】

【0008】

そのため、本発明は、熱間圧延または冷間圧延による帯鋼を原材料とする機械的性質に非常に優れた部材を製造するための以下の連続した工程を含む方法をその対象とする。

【0009】

帯鋼にアルミニウムまたはアルミニウム合金による予備被覆を施す。この予備被覆は、以下に示す方法をそれぞれ単独で、または組み合わせて行うことによる１つまたは複数の工程によって行うことができる。

１つまたは複数のアルミニウムまたはアルミニウム合金の電気めっき工程による予備被覆。

１つまたは複数のアルミニウムまたはアルミニウム合金の化学蒸着工程による予備被覆。

１つまたは複数のアルミニウムまたはアルミニウム合金の物理蒸着工程による予備被覆。

帯鋼をアルミニウムまたはアルミニウム合金箔とともに圧延する１つまたは複数の共圧延工程による予備被覆。

これらの予備被覆法を実施することで、帯鋼と予備被覆との界面に金属間相は生じない。

【0010】

被覆を施した帯鋼を冷間で変形させる。

【0011】
当該部材の最終的な幾何学形状に合わせて板材の余分な部分を場合によって取り除く。
【0012】
部材を炉などで加熱することで、部材表面に鋼と予備被覆との界面から金属間化合物を形成し、鋼をオーステナイト化する。この熱処理の加熱段階では、当初の予備被覆層が母材の鋼と合金化することによって部材の表面に金属間被覆が形成されるが、この合金化は予備被覆層の全厚にわたって得られる。
【0013】
加熱後、部材を装置に移動する。加熱段階から部材が装置と接触するまでの移動時間は、その間にオーステナイトの変態が起こることのない十分に短いものである。装置の幾何学形状および設計は、処理する部材および急冷の度合いに合わせたものとされる。特に、装置は、工程の生産性を向上させ、および／または急冷の度合いを高めるため、流体の循環などによって冷却することができる。締付けの力を加えれば、部材と装置とを密着させ、それによって伝導による冷却の効率化と変形の最小化を図ることができる。装置内における部材の冷却は、鋼が冷却後にマルテンサイト構造もしくはベイナイト構造またはマルテンサイトーベイナイト構造となるような速度で行う。
【0014】
一実施形態では、冷間変形による一般化ひずみは少なくとも部材の１カ所において２０％を超える。
【0015】
また、本発明は、上述の実施方法のいずれか１つに基づいて製造される、帯鋼から得られる機械的性質に非常に優れた部材を陸上自動車の構造部材または安全部材の製造に使用することもその対象とする。
【発明を実施するための最良の形態】
【0016】
本発明のその他の特徴および利点は、例を示しながら行う以下の説明を通して明らかになるであろう。
【0017】
従来の製造法における鋼と被覆との界面の変化を調べた。この目的のため、重量比率で以下のような組成を持つ厚さ１．２または２ｍｍの鋼部材について検討した。
炭素：０．１５～０．２５％
マンガン：０．８～１．５％
ケイ素：０．１～０．３５％
クロム：０．０１～０．２％
チタン：＜０．１％
リン：＜０．０５％
硫黄：＜０．０３％
Ｂ：０．０００５～０．０１％
【0018】
これらの部材を以下のものを含むアルミニウム系めっき浴に漬け、従来の溶融めっき法による予備被覆を施した。
ケイ素：９～１０％
鉄：２～３．５％
残りはアルミニウムおよび不可避の不純物である。
【0019】
鋼を６６０℃超で純粋なアルミニウム浴に接触させると、$FeAl_3$－Fe_2Al_5などを含め、金属間合金の厚い層が極めて急速に形成されることが知られている。この層は変形に対する適応性が低いため、１０％のケイ素を浴に追加することによってこの中間層の厚さを減らすことができる。図１は、ビッカース硬さが６００～８００の金属間層の厚さが約７ミクロンであり、その層の上を覆うアルミニウム系金属層の厚さが約１５ミクロ

ンであることを示している。

【0020】

予備被覆を施した部材はナカジマ式試験片を使って冷間変形にかけられ、一軸引張りや等二軸引張りなど、様々な方法で試験片に外力が加えられた。あらかじめ光溶着させた円形パターンの格子を使って、様々な地点で主ひずみε１およびε２、すなわち基準座標系におけるひずみが測定された。その様々な地点の一般化ひずみ

【数1】

$$\bar{\varepsilon}=\frac{2}{\sqrt{3}}\sqrt{(\varepsilon_1^2+\varepsilon_1\varepsilon_2+\varepsilon_2^2)}$$

がそこから導き出された。

【0021】

同時に、その様々な地点における予備被覆の挙動が観察された。観察の結果、１０％前後の一般化ひずみまででは、中間層に細かく規則的に亀裂が生じているが、それを覆う上層の金属アルミニウム層には影響は出ていないことが明らかになった。その後、９００℃の炉で５～７分間の熱処理を行い、水冷式の装置内で急冷すると、当初の予備被覆は完全に合金化し、その限られた範囲の亀裂のネットワークも消失する（図３）。一般化ひずみが２０％を超えると、金属間層が断片化し（図２）、場所によってアルミニウム系金属被覆が劣化する。その場合、その後の合金化のための熱処理によってスケール層が成長したり、鋼表面の脱炭を来たしたりする可能性があるが（図４）、これらは、塗装など、その後の部材の加工にとって有害となる。

【0022】

このように、大きなひずみを生じる冷間変形加工の実施は、従来のアルミニウム系予備被覆では問題を生じる可能性がある。この問題は、鋼とアルミニウムとの界面に金属間相が含まれなければ解決することが本発明の枠組みの中で既に実証されている。これは、アルミニウムまたはアルミニウム合金がその面心立方構造による固有の延性を有していることにより、予備被覆を施された鋼材が著しい冷間変形によっても界面または予備被覆の劣化を来たすことがなく、そのためにその後の合金化処理が最適な条件のもとで行われることによる。

【0023】

アルミニウムまたはアルミニウム合金の予備被覆は、電気めっき、物理蒸着、化学蒸着、または、帯鋼をアルミニウム箔またはアルミニウム合金箔とともに圧延する共圧延によって形成する。これら各種の工程により、合金化処理前の母材の鋼と予備被覆の間に金属間層のない部材を得る。本発明による方法は、同じ予備被覆の工程を１回だけ、または数回にわたって適用することによって行うことができる。また、本発明による方法は、被覆の様々な方法および様々な特徴に固有の利点が生かされるように、各種予備被覆工程を順次組み合わせて行うことができる。

【0024】

本発明による方法を適用することにより、冷間成形加工の後の部材に対する切断、押抜きまたは型取り作業の実施が容易になる。実際のところ、合金化処理で再加熱しなければならない金属の量を減らす目的での中間段階における機械加工工程の有用性が明らかになる可能性がある。本発明では、従来の方法にあった硬い（ビッカース硬さ６００～８００）金属間層が存在しないことによってこの中間段階における機械加工が容易となる。その結果、切削工具の損耗も少なくなる。

【0025】

さらに、本発明による予備被覆工程によって得られる被覆は厚さがきわめて規則的である。たとえば、蒸着法による予備被覆の条件では、１５～２０ミクロンの範囲の厚さの被覆を１ミクロンオーダの厚さのばらつきで得ることができる。

【0026】

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溶融アルミニウムめっきの場合、顕微鏡断面測定による予備被覆の厚さのばらつきは、２５ミクロンの平均厚さに対しておよそ±１０ミクロンであることができる。生産性を最大限にするため、合金化のための熱処理の際の加熱はできるだけ迅速に行われることが望ましい。厚さ超過があることがわかっている場合には、合金化が完全に行われるように加熱段階が延長されることがある。ある一定の熱処理に関して、過大な厚さ超過があることがわかっていない場合には、合金化が不完全となり、予備被覆の部分的な溶融に至る可能性がある。

【0027】

本発明による予備被覆工程は厚さのばらつきを小さくし、それによって溶融のリスクを減らし、炉の動作安定性を高める。

【0028】

さらに、オーステナイト化後、装置内での急冷処理によって鋼にマルテンサイトもしくはベイナイト構造またはマルテンサイト－ベイナイト構造が与えられる。鋼の組成、とりわけその炭素含有量や、マンガン、クロム、ホウ素の含有量によって、本発明による部材において得られる最大強度は１２００～１７００ＭＰａの範囲で変わる。

【0029】

完全または部分的なマルテンサイト構造は局所的な応力集中効果に対する感受性が本質的に高いことが知られているが、本発明によれば、金属間層がないために切断はよりきれいに行えることから、急冷処理後の切断縁の切欠き効果は比較的小さい。

【0030】

そのため、本発明は、冷間変形を高いレベルまで行うことができることから、優れた性質を備えながら、より複雑な形状を持つ被覆部材の製造を可能とするものである。本発明の実施は、合金化処理前の冷間変形の一般化ひずみ度が２０％を超える場合に特に有利であり、中間の切断作業における工具の損耗を減らし、最終的な合金化処理の効率を高めることができる。

【図面の簡単な説明】

【0031】

【図1】冷間変形前の鋼と溶融めっきしたアルミニウム合金被覆との界面の例を示す図である。

【図2】冷間で２０％超の一般化ひずみが生じた後の同じ界面の変化を示す図である。

【図3】冷間変形を行わない場合の鋼と溶融めっきしたアルミニウム合金被覆との界面の合金化処理後の例を示す図である。

【図4】２０％超の冷間変形後に合金化処理を行った表面層を示す図である。

【図1】

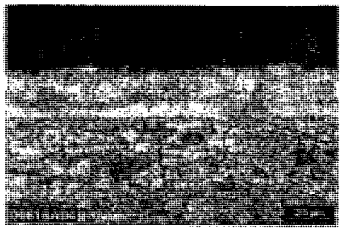


Figure 1

【図2】

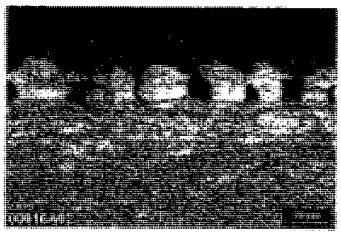


Figure 2

【図3】

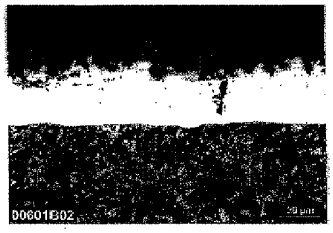


Figure 3

【図4】



Figure 4

INTERNATIONAL SEARCH REPORT

International application No
PCT/FR2006/000466

A. CLASSIFICATION OF SUBJECT MATTER
INV. C23C22/78 C23F17/00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
C21D C25D C23F

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal, PAJ, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 6 197 132 B1 (ANDERSSON-DRUGGE ING-MARIE) 6 March 2001 (2001-03-06). column 1, lines 5-11 column 2, lines 1-12,35-67; figures 2,4; example 2 column 4, lines 10-13 claims 1-4	1-3
Y	US 6 296 805 B1 (LAURENT JEAN-PIERRE ET AL) 2 October 2001 (2001-10-02) column 3, line 60 - column 4, line 17	1

-/--

[X] Further documents are listed in the continuation of Box C. [X] See patent family annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier document but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
23 June 2006	30/06/2006
Name and mailing address of the ISA/ European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Authorized officer Handrea-Haller, M

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INTERNATIONAL SEARCH REPORT

International application No
PCT/FR2006/000466

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	EP 1 403 388 A (THYSSENKRUPP STAHL AG) 31 March 2004 (2004-03-31) page 2, paragraphs 1,10 page 3, paragraphs 13,14 page 4, paragraph 26 page 5, paragraph 33 page 6, paragraphs 40,45,46 claims 1,12,13,15,18,21,22	1-3
Y	US 3 214 820 A (SMITH EDWIN J ET AL) 2 November 1965 (1965-11-02) column 1, lines 9,10,68-72 column 2, lines 41-54 column 3, lines 1-20 column 4, lines 6-17,35-37 column 5, lines 5-9,41-50 column 6, lines 45-47,51,66,67 claims 1-3,8,11	1-3
Y	FR 857 779 A (COSTE & COMPAGNIE) 28 September 1940 (1940-09-28) the whole document	1-3
Y	DE 102 24 319 A1 (BENTELER AUTOMOBILTECHNIK GMBH) 18 December 2003 (2003-12-18) column 1, paragraphs 1,4 column 1, paragraph 6 - column 2, paragraphs 7-9,11,13 column 3, paragraph 17 - column 4, paragraph 23 claims 1,3-6	1-3
Y	GB 1 489 618 A (SUMITOMO METAL IND LTD) 26 October 1977 (1977-10-26) page 1, lines 7-9,25-46 page 2, lines 1-12; examples 2,4 claims 1-4,6-8	1-3
Y	WO 99/55469 A (WEIRTON STEEL CORPORATION) 4 November 1999 (1999-11-04) the whole document	1-3
A	DE 12 90 024 B (INTERLICENCE S. A) 27 February 1969 (1969-02-27) the whole document	1-3
A	EP 1 013 785 A (SOLLAC) 28 June 2000 (2000-06-28) the whole document	1-3

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/FR2006/000466

Patent document cited in search report		Publication date	Patent family member(s)			Publication date
US 6197132	B1	06-03-2001	DE	69712636	D1	20-06-2002
			DE	69712636	T2	12-12-2002
			EP	0944744	A1	29-09-1999
			ES	2176765	T3	01-12-2002
			JP	2000517002	T	19-12-2000
			SE	508150	C2	07-09-1998
			SE	9603152	A	01-03-1998
			WO	9808986	A1	05-03-1998
US 6296805	B1	02-10-2001	AT	240419	T	15-05-2003
			BR	9902712	A	08-03-2000
			CA	2276911	A1	09-01-2000
			DE	69907816	D1	18-06-2003
			DE	69907816	T2	11-03-2004
			DK	971044	T3	11-08-2003
			EP	0971044	A1	12-01-2000
			ES	2196740	T3	16-12-2003
			FR	2780984	A1	14-01-2000
			JP	2000038640	A	08-02-2000
			PT	971044	T	29-08-2003
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			WO	2004031418	A2	15-04-2004
US 3214820	A	02-11-1965	BE	643299	A	03-08-1964
			DE	1527572	A1	23-07-1970
			GB	1056131	A	25-01-1967
			LU	45354	A1	04-08-1964
			NL	6400848	A	10-08-1964
FR 857779	A	28-09-1940	NONE			
DE 10224319	A1	18-12-2003	NONE			
GB 1489618	A	26-10-1977	DE	2461730	A1	10-07-1975
			FR	2256258	A1	25-07-1975
WO 9955469	A	04-11-1999	NONE			
DE 1290024	B	27-02-1969	NONE			
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Page 555 of 624

RAPPORT DE RECHERCHE INTERNATIONALE

Demande internationale n°
PCT/FR2006/000466

A. CLASSEMENT DE L'OBJET DE LA DEMANDE
INV. C23C22/78 C23F17/00

Selon la classification internationale des brevets (CIB) ou à la fois selon la classification nationale et la CIB

B. DOMAINES SUR LESQUELS LA RECHERCHE A PORTE

Documentation minimale consultée (système de classification suivi des symboles de classement)
C21D C25D C23F

Documentation consultée autre que la documentation minimale dans la mesure où ces documents relèvent des domaines sur lesquels a porté la recherche

Base de données électronique consultée au cours de la recherche internationale (nom de la base de données, et si cela estréalisable, termes de recherche utilisés)
EPO-Internal, PAJ, WPI Data

C. DOCUMENTS CONSIDERES COMME PERTINENTS

Catégorie*	Identification des documents cités, avec, le cas échéant, l'indication des passages pertinents	no. des revendications visées
Y	US 6 197 132 B1 (ANDERSSON-DRUGGE ING-MARIE) 6 mars 2001 (2001-03-06) colonne 1, ligne 5-11 colonne 2, ligne 1-12,35-67; figures 2,4; exemple 2 colonne 4, ligne 10-13 revendications 1-4	1-3
Y	US 6 296 805 B1 (LAURENT JEAN-PIERRE ET AL) 2 octobre 2001 (2001-10-02) colonne 3, ligne 60 - colonne 4, ligne 17	1

-/--

[X] Voir la suite du cadre C pour la fin de la liste des documents

[X] Les documents de familles de brevets sont indiqués en annexe

* Catégories spéciales de documents cités:

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"X" document particulièrement pertinent; l'invention revendiquée ne peut être considérée comme nouvelle ou comme impliquant une activité inventive par rapport au document considéré isolément

"Y" document particulièrement pertinent; l'invention revendiquée ne peut être considérée comme impliquant une activité inventive lorsque le document est associé à un ou plusieurs autres documents de même nature, cette combinaison étant évidente pour une personne du métier

"&" document qui fait partie de la même famille de brevets

Date à laquelle la recherche internationale a été effectivement achevée	Date d'expédition du présent rapport de recherche internationale
23 juin 2006	30/06/2006

Nom et adresse postale de l'administration chargée de la recherche internationale	Fonctionnaire autorisé
Office Européen des Brevets, P.B. 5818 Patentlaan 2 NL – 2280 HV Rijswijk Tel. (+31–70) 340–2040, Tx. 31 651 epo nl, Fax: (+31–70) 340–3016	Handrea-Haller, M

Formulaire PCT/ISA/210 (deuxième feuille) (avril 2005)

RAPPORT DE RECHERCHE INTERNATIONALE

Demande internationale n°
PCT/FR2006/000466

C(suite). DOCUMENTS CONSIDERES COMME PERTINENTS

Catégorie*	Identification des documents cités, avec, le cas échéant, l'indication des passages pertinents	no. des revendications visées
Y	EP 1 403 388 A (THYSSENKRUPP STAHL AG) 31 mars 2004 (2004-03-31) page 2, alinéas 1,10 page 3, alinéas 13,14 page 4, alinéa 26 page 5, alinéa 33 page 6, alinéas 40,45,46 revendications 1,12,13,15,18,21,22	1-3
Y	US 3 214 820 A (SMITH EDWIN J ET AL) 2 novembre 1965 (1965-11-02) colonne 1, ligne 9,10,68-72 colonne 2, ligne 41-54 colonne 3, ligne 1-20 colonne 4, ligne 6-17,35-37 colonne 5, ligne 5-9,41-50 colonne 6, ligne 45-47,51,66,67 revendications 1-3,8,11	1-3
Y	FR 857 779 A (COSTE & COMPAGNIE) 28 septembre 1940 (1940-09-28) le document en entier	1-3
Y	DE 102 24 319 A1 (BENTELER AUTOMOBILTECHNIK GMBH) 18 décembre 2003 (2003-12-18) colonne 1, alinéas 1,4 colonne 1, alinéa 6 - colonne 2, alinéas 7-9,11,13 colonne 3, alinéa 17 - colonne 4, alinéa 23 revendications 1,3-6	1-3
Y	GB 1 489 618 A (SUMITOMO METAL IND LTD) 26 octobre 1977 (1977-10-26) page 1, ligne 7-9,25-46 page 2, ligne 1-12; exemples 2,4 revendications 1-4,6-8	1-3
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Formulaire PCT/ISA/210 (suite de la deuxième feuille) (avril 2005)

RAPPORT DE RECHERCHE INTERNATIONALE

Renseignements relatifs aux membres de familles de brevets

Demande internationale n°
PCT/FR2006/000466

Document brevet cité au rapport de recherche		Date de publication	Membre(s) de la famille de brevet(s)		Date de publication
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			DE	69712636 T2	12-12-2002
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			CA	2276911 A1	09-01-2000
			DE	69907816 D1	18-06-2003
			DE	69907816 T2	11-03-2004
			DK	971044 T3	11-08-2003
			EP	0971044 A1	12-01-2000
			ES	2196740 T3	16-12-2003
			FR	2780984 A1	14-01-2000
			JP	2000038640 A	08-02-2000
			PT	971044 T	29-08-2003
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FR 857779	A	28-09-1940	AUCUN		
DE 10224319	A1	18-12-2003	AUCUN		
GB 1489618	A	26-10-1977	DE	2461730 A1	10-07-1975
			FR	2256258 A1	25-07-1975
WO 9955469	A	04-11-1999	AUCUN		
DE 1290024	B	27-02-1969	AUCUN		
EP 1013785	A	28-06-2000	FR	2787735 A1	30-06-2000

Formulaire PCT/ISA/210 (annexe familles de brevets) (avril 2005)

(51)Int.Cl.			F I		テーマコード（参考）
Ｃ２３Ｃ	10/02	(2006.01)	Ｂ２１Ｂ	1/22	Ｂ
Ｃ２２Ｃ	38/32	(2006.01)	Ｃ２１Ｄ	9/46	Ｓ
			Ｃ２３Ｃ	10/02	
			Ｃ２２Ｃ	38/32	

(81)指定国　AP(BW,GH,GM,KE,LS,MW,MZ,NA,SD,SL,SZ,TZ,UG,ZM,ZW),EA(AM,AZ,BY,KG,KZ,MD,RU,TJ,TM),EP(AT,BE,BG,CH,CY,CZ,DE,DK,EE,ES,FI,FR,GB,GR,HU,IE,IS,IT,LT,LU,LV,MC,NL,PL,PT,RO,SE,SI,SK,TR),OA(BF,BJ,CF,CG,CI,CM,GA,GN,GQ,GW,ML,MR,NE,SN,TD,TG),AE,AG,AL,AM,AT,AU,AZ,BA,BB,BG,BR,BW,BY,BZ,CA,CH,CN,CO,CR,CU,CZ,DE,DK,DM,DZ,EC,EE,EG,ES,FI,GB,GD,GE,GH,GM,HR,HU,ID,IL,IN,IS,JP,KE,KG,KM,KN,KP,KR,KZ,LC,LK,LR,LS,LT,LU,LV,LY,MA,MD,MG,MK,MN,MW,MX,MZ,NA,NG,NI,NO,NZ,OM,PG,PH,PL,PT,RO,RU,SC,SD,SE,SG,SK,SL,SM,SY,TJ,TM,TN,TR,TT,TZ,UA,UG,US,UZ,VC,VN,YU,ZA,ZM,ZW

(74)代理人　100124855
弁理士　坪倉　道明
(72)発明者　ロラン，ジヤンーピエール
フランス国、１３８００・イストル、アレ・ドユ・フオワン・ドウ・クロー・１２
(72)発明者　ドウブロツク，ジヤツク
フランス国、１３２００・アルル、アブニユ・ビクトル・ユゴー・２３

Ｆターム(参考)　4E002 AD12 CB01
4K028 CA02 CB03 CB06 CB08 CC02 CD02
4K037 EA02 EA06 EA11 EA15 EA23 EA25 EA27 EA31 EB05 EB08
EC04 FB00 FG00 FM04 GA05 JA02

(12) NACH DEM VERTRAG ÜBER DIE INTERNATIONALE ZUSAMMENARBEIT AUF DEM GEBIET DES PATENTWESENS (PCT) VERÖFFENTLICHTE INTERNATIONALE ANMELDUNG

(19) Weltorganisation für geistiges Eigentum
Internationales Büro

(43) Internationales Veröffentlichungsdatum
25. August 2005 (25.08.2005)

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(10) Internationale Veröffentlichungsnummer
WO 2005/078144 A1

(51) Internationale Patentklassifikation[7]: C21D 9/46

(21) Internationales Aktenzeichen: PCT/EP2005/000853

(22) Internationales Anmeldedatum:
28. Januar 2005 (28.01.2005)

(25) Einreichungssprache: Deutsch

(26) Veröffentlichungssprache: Deutsch

(30) Angaben zur Priorität:
10 2004 007 071.7
13. Februar 2004 (13.02.2004) DE

(71) Anmelder *(für alle Bestimmungsstaaten mit Ausnahme von US)*: **AUDI AG** [DE/DE]; 85045 Ingolstadt (DE).

(72) Erfinder; und

(75) Erfinder/Anmelder *(nur für US)*: **SCHIESSL, Gerhard** [DE/DE]; Sonnenstr. 4, 85092 Kösching (DE).

(74) Gemeinsamer Vertreter: **GEISSLER, Manfred**; Audi AG, Patentabteilung I/EX, 85045 Ingolstadt (DE).

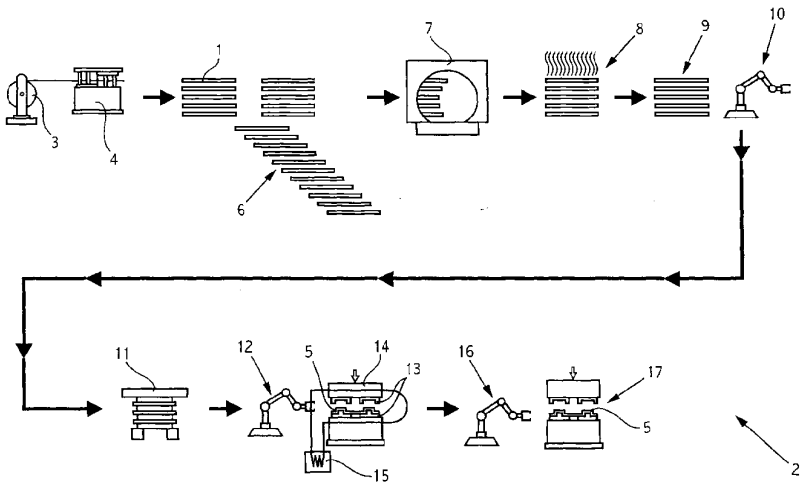
(81) Bestimmungsstaaten *(soweit nicht anders angegeben, für jede verfügbare nationale Schutzrechtsart)*: AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BW, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DK, DM, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NA, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RU, SC, SD, SE, SG, SK, SL, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, YU, ZA, ZM, ZW.

(84) Bestimmungsstaaten *(soweit nicht anders angegeben, für jede verfügbare regionale Schutzrechtsart)*: ARIPO (BW, GH, GM, KE, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), eurasisches (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), europäisches (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IS, IT, LT, LU, MC, NL,

[Fortsetzung auf der nächsten Seite]

(54) Title: METHOD FOR PRODUCING A COMPONENT BY RESHAPING A PLATE, AND DEVICE FOR CARRYING OUT SAID METHOD

(54) Bezeichnung: VERFAHREN ZUR HERSTELLUNG EINES BAUTEILS DURCH UMFORMEN EINER PLATINE UND VORRICHTUNG ZUR DURCHFÜHRUNG DES VERFAHRENS



(57) Abstract: The invention relates to a method for producing a component (5) by reshaping a coated plate (1) consisting of tempering steel, said plate being austenitised before the reshaping by means of a first heat treatment, followed by the growth of the layer thickness. The aim of the invention is to optimise the process and to prevent the production of scrap plates caused by interruptions to the process. To this end, after being rapidly cooled, the heat-treated plate (1) is temporarily stored, and is briefly heated again to the austenitisation temperature, directly before being reshaped to form the component (5). Once the structure has been modified, the plate (1) is reshaped and hardened. Preferably, the plate (1) is heated a second time by induction.

[Fortsetzung auf der nächsten Seite]

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PL, PT, RO, SE, SI, SK, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Erklärungen gemäß Regel 4.17:

— *hinsichtlich der Berechtigung des Anmelders, ein Patent zu beantragen und zu erhalten (Regel 4.17 Ziffer ii) für die folgenden Bestimmungsstaaten AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BW, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DK, DM, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NA, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RU, SC, SD, SE, SG, SK, SL, SM, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, UZ, VC, VN, YU, ZA, ZM, ZW, ARIPO Patent (BW, GH, GM, KE, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), eurasisches Patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), europäisches Patent (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IS, IT, LT, LU, MC, NL, PL, PT, RO, SE, SI, SK, TR), OAPI Patent (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG)*

— *Erfindererklärung (Regel 4.17 Ziffer iv) nur für US*

Veröffentlicht:

— *mit internationalem Recherchenbericht*

Zur Erklärung der Zweibuchstaben-Codes und der anderen Abkürzungen wird auf die Erklärungen ("Guidance Notes on Codes and Abbreviations") am Anfang jeder regulären Ausgabe der PCT-Gazette verwiesen.

(57) Zusammenfassung: Die Erfindung bezieht sich auf ein Verfahren zur Herstellung eines Bauteils (5) durch Umformen einer beschichteten Platine (1) aus einem Vergütungsstahl, wobei sie vor dem Umformen über eine erste Wärmebehandlung austenitisiert wird, wobei sich darüber hinaus ein Schichtdickenwachstum vollzieht. Eine Optimierung im Prozessablauf und ein Vermeiden von Ausschußplatinen bei Prozessstörungen ist dadurch erreichbar, dass nach einem raschen Abkühlen die wärmebehandelte Platine (1) zwischengelagert wird, dass unmittelbar vor dem Umformen zum Bauteil (5) die Platine einer erneuten, kurzzeitigen Erwärmung auf Austenitisierungstemperatur unterzogen wird und dass nach erfolgter Gefügeumwandlung das Umformen und Härten der Platine (1) vonstatten geht. Vorzugsweise geschieht die zweite Erwärmung der Platine (1) durch Induktion.

IP 5081
Ge/Sc

Verfahren zur Herstellung eines Bauteils durch Umformen einer Platine und Vorrichtung zur Durchführung des Verfahrens

BESCHREIBUNG

Die Erfindung bezieht sich auf ein Verfahren zur Herstellung eines Bauteils durch Umformen einer beschichteten, vorzugsweise aluminiumbeschichteten Platine aus einem Vergütungsstahl nach dem Oberbegriff des Patentanspruches 1. Die Erfindung betrifft des weiteren eine Vorrichtung zur Durchführung des Verfahrens.

Im Stand der Technik sind verschiedene Umformverfahren für Platinen aus einem Vergütungsstahl in Verbindung mit Härtungsprozessen allgemein bekannt. Bei einem sogenannten „direkten" Umformverfahren wird eine ebene Platine aus einem Vergütungsstahl in einem Ofen, vorzugsweise einem Durchlaufofen, unter Schutzgasatmosphäre austenitisiert. Beispielsweise kann ein Vergütungsstahl in der Qualität 22MnB5 verwendet werden, der für die Austenitisierung mehrere Minuten bei ca. 950°C geglüht wird. Anschließend wird mit einer vorzugsweise automatisierten Transfereinrichtung die heiße austenitisierte ebene Platine in ein für Serienprozesse gekühltes Umform-/Vergütungswerkzeug eingelegt. Dieses Werkzeug ist Bestandteil einer Presse und beim Schließen derselben wird die heiße Platine zu einem Bauteil auf Endform umgeformt und im geschlossenen Werkzeug bei aufgebrachter Schließkraft relativ schnell abgekühlt und dadurch gehärtet. Das gehärtete Bauteil wird aus dem Werkzeug entnommen und, falls es sich um ein unbeschichtetes Blech handelt, in einem Reinigungsschritt beispielsweise durch Sand- oder Kugelstrahlen entzundert (dies ist bei beschichteten Bauteilen entbehrlich, da z. B. aluminierte Bleche ausreichend Korrosionsschutz bieten und eine Verzunderung verhindert wird). Abschließend folgt ein Fertigkontur- und Lochbeschnitt des fertig geformten und gehärteten Bauteiles, vorzugsweise mittels Laserschneiden. Auch ein mechanisches Schneiden im sogenannten Pressenverbund ist denkbar.

Während der Wärmebehandlung im Ofen erfährt z. B. eine im Ausgangszustand etwa 25 µm starke Aluminiumbeschichtung ein Schichtdickenwachstum auf etwa 45 µm, wobei sich unmittelbar an das Grundmaterial der Platine angrenzend eine AlSi-Schicht mit eindiffundiertem Eisen heraus bildet, die eine darüber hinaus sich bildende, relativ

harte und spröde AlSi-Schicht trägt, die die eigentliche Korrosionsschutzfunktion erfüllt.

Ein typischer Verfahrensablauf (Warmumformkurve 20) hinsichtlich der Wärmebehandlung der Platine im Zuge ihres Umformens ist beispielsweise in Fig. 1 in einem Zeit- Temperatur- Diagram dargestellt. Je nach verwendeter Vergütungsstahlqualität, Blechdicke, Ausgangsschichtdicke u.s.w. sind die in Fig.1 angegebenen Werte natürlich auch gewissen Schwankungen unterworfen (Wärmebehandlungunter- / obergrenze 18, 19). So ist ohne weiteres denkbar, dass die Platine sich über eine Verweildauer von bis zu 30 Minuten im Ofen befindet.

Der verwendete Ofen ist häufig ein sogenannter Durchlaufofen mit Formnestern oder Platinenaufnahmen oder ein Rostdurchschubofen mit Rosten, welche die Platine tragen und diese innerhalb von etwa 2 Minuten mittels Gasbrenner auf Austenitisierungstemperatur erwärmen und anschließend mehrere Minuten mittels elektrischer Heizung auf dieser Temperatur halten. Vorzug des Gasbrenners ist eine höhere Leistung, wohingegen elektrische Heizungen besser regelbar sind.

Gemäß Fig. 1 wird also die Platine im Ofen auf eine Solltemperatur von etwa 950° C erhitzt und auf dieser Temperatur gehalten. Die Austenitisierung vollzieht sich bei Temperaturen oberhalb etwa 720° C. Üblicherweise beträgt die Verweildauer im Ofen ca. 9 Minuten, wobei sich die Platine innerhalb der ersten beiden Minuten auf Solltemperatur erwärmt, während in den darauffolgenden etwa 7 Minuten das Umkörnen des Grundmaterials vom kubisch- raumzentrierten Ferrit/Perlit- Gefüge ins kubisch- flächenzentrierte Austenit, das für ein Härten notwendig ist, vonstatten geht. Daneben ist die genannte Zeitspanne vor allem auch wichtig, um ein ausreichendes Anwachsen der AlSi-Schutzschicht zu erreichen.

Insbesondere hinsichtlich minimaler Glühtemperatur und maximaler Verweildauer der Platine im Ofen gibt es gewisse, mehr oder weniger enge Grenzen, innerhalb derer der Prozess noch Gutteile liefert, d. h., dass die aus dem Ofen entnommenen Platinen überhaupt noch für den Umformprozess und die weitere Verwendung verwertbar sind.
Stellt sich nun im weiteren Ablauf eine Störung ein, sei es bei der Entnahme einer Platine aus dem Ofen und ihrem Weitertransport zum Umform-/ Vergütungswerkzeug bzw. innerhalb der Station des Fertigkontur- und Lochbeschnittes, so kann für die Dauer der Störung keine Platine mehr aus dem Ofen entnommen werden, die maximal zulässige Verweildauer wird in der Regel überschritten und sämtliche im Ofen befindlichen Platinen sind Ausschuss und müssen von daher entsorgt werden.

Der Erfindung liegt die Aufgabe zugrunde, das gattungsgemäße Verfahren zur Herstellung eines Bauteiles durch Umformen einer beschichteten Platine aus einem Vergütungsstahl in der Weise weiterzubilden, dass eine Optimierung im Prozessablauf erreichbar ist und dass insbesondere bei eventuellen Prozessstörungen dem kostenträchtigen Anfallen von Ausschussplatinen vorgebeugt werden kann.

Diese Aufgabe wird hinsichtlich des Verfahrens mit den weiteren Merkmalen nach dem Kennzeichen des Patentanspruches 1 und hinsichtlich der Vorrichtung zur Durchführung des erfindungsgemäßen Verfahrens mit den Merkmalen des Patentanspruches 10 gelöst.

Die Vorteile der erfindungsgemäßen Vorgehensweise sind mannigfaltig. So besteht nun keine Abhängigkeit mehr bezüglich der Verweildauer der Platinen innerhalb des Ofens und Ablaufstörungen im Prozess außerhalb des Ofens. Durch die Entkopplung der Abläufe ergibt sich für den eigentlichen Prozess der Platinenumformung ein geringerer Flächenbedarf und ein Weniger an Infrastruktur. Eine Pufferung / Zwischenlagerung der wärmebehandelten Platinen ist möglich, so dass eine Wärmebehandlung, unter anderem zur Beeinflussung der AlSi-Schicht, ohne weiteres auch bereits beim Stahlhersteller bzw. Blechlieferanten erfolgen kann.

Eine solche ausgelagerte, vorgeschaltete Wärmebehandlung ist an sich bereits bekannt, wie aus der EP 0 946 311 B1 und der DE 102 12 400 C1 hervorgeht. Auch eine Glühbehandlung mittels Induktionserwärmung ist für sich gesehen bereits bekannter Stand der Technik, wie dies im letztgenannten Dokument beispielsweise auch erwähnt ist.

Vorteilhafte Ausgestaltungen und Weiterbildungen der Erfindung sind in den jeweiligen Unteransprüchen beansprucht.

Die Erfindung ist nachstehend anhand eines Ausführungsbeispieles näher erläutert. In der Zeichnung zeigen:

Fig. 1 den erfindungsgemäßen Verfahrensablauf zur Herstellung eine Bauteiles durch Umformen einer Platine,

Fig. 2 ein Temperatur- Zeit- Diagramm der ersten Platinen- Wärmebehandlung und

Fig. 3 ein Temperatur- Zeit- Diagramm der zweiten Platinen- Wärmebehandlung.

In Fig. 1 ist schematisch der erfindungsgemäße Verfahrensablauf zur Herstellung eines Bauteiles 5 durch Umformen einer beschichteten Platine 1 aus einem Vergütungsstahl mittels einer hierfür geeigneten Vorrichtung 2 gezeigt. Von dem im aufgerolltem Zustand angelieferten Stahl, einem sogenannten Coil 3, wird mittels eines Werkzeuges 4

der Stahl abgerollt, geglättet und die für das fertige Bauteil 5 notwendige Größe der Platine 1 ausgestanzt bzw. abgeschnitten. Von dort aus werden die Platinen 1 einer Pufferzone 6 zugeführt. Dieses Zwischenlagern ist allerdings nicht unbedingt erforderlich, vielmehr können die Platinen 1 auch unmittelbar nach Verlassen des Werkzeuges 4 einem ersten Ofen 7 zugeführt werden, in dem sie eine Wärmebehandlung gemäß dem Temperatur- Zeit- Diagramm nach Fig. 2 erfahren. Unmittelbar dem ersten Ofen 7 nachgelagert ist eine Abkühlzone 8, in der die Platinen 1 abgeschreckt werden und die abschließenden Phasen der Wärmebehandlung durchlaufen. Die Abkühlzone 8 verlassend werden die wärmebehandelten Platinen 1 einem Zwischenlager 9 zugeführt.

Der erste Ofen 7 kann vom konstruktiven Aufbau her ein bereits erwähnter Durchlaufofen, ein Karussell- Ofen oder dergleichen sein.

Die einzelnen Phasen der Wärmebehandlung wurden bereits eingangs mit Hinweis auf Fig. 2 erläutert. Das relativ langsam vonstatten gehende Aufheizen auf Solltemperatur sowie die übrige Verweildauer im ersten Ofen 7 zum Herbeiführen der Austenitisierung und zum Verändern der Topographie (Beschichtungsaufbau, Schichtdicke) summiert sich auf eine Gesamt- Verweildauer von etwa 9 Minuten, wobei erfahrungsgemäß eine maximale Verweildauer von 30 Minuten nicht überschritten werden darf, damit die Platine nicht unbrauchbar wird. Der Transport in die Abkühlzone 8 und die dortige Abschreckung der Platine 1 vollzieht sich innerhalb relativ kurzer Zeiträume, während ein restliches Abkühlen auf Raumtemperatur RT im Zwischenlager 9 erfolgen kann. Am Ende der Wärmebehandlung weist die Platine 1 ein Martensitgefüge auf.

Mittels einer geeigneten Transportvorrichtung 10, beispielsweise einem Gelenkarmroboter, werden die Platinen 1 einem Induktionsofen 11 zugeführt, von wo aus sie über eine weitere Transportvorrichtung 12, z. B. wiederum ein Gelenkarmroboter, in ein für Serienprozesse geeignetes, gekühltes Umform-/Vergütungswerkzeug 13 eingelegt werden. Diesem ist eine Presseneinrichtung 14 sowie eine Kühlvorrichtung 15 zugeordnet, und beim Schließen der Presseneinrichtung 14 wird die heiße Platine 1 zu einem Bauteil 5 auf Entform umgeformt und im geschlossenen Umform-/Vergütungswerkzeug 13 bei aufgebrachter Schließkraft schnell abgekühlt und dadurch gehärtet. In einem letzten Verfahrenschritt wird jedes Bauteil 5 über eine Transportvorrichtung 16 einer Beschnittvorrichtung 17 zugeführt, wo ein Fertigkontur- und Lochbeschnitt des fertig geformten und gehärteten Bauteiles 5 vorzugsweise mittels Laserschneiden durchgeführt wird. Selbstverständlich kann dies auch über geeignete Beschnittmesser auf mechanischem Wege erfolgen.

Die im Induktionsofen 11 und im nachgeschalteten Umform-/Vergütungswerkzeug 13 vonstatten gehende Wärmebehandlung der Platine 1 ist im Temperatur- Zeit- Diagramm gemäß Fig. 3 anhand der Warmumformkurve 20 und der Wärmebehandlungsunter- / obergrenze 18, 19 dargestellt. Sie ist gekennzeichnet durch eine ausgesprochen kurze Verweildauer der Platine im Induktionsofen 11. Während das Aufheizen auf Solltemperatur (Austenitisierungstemperatur) innerhalb weniger Sekunden (ca. zehn sec.) erfolgt dient eine nachgeschaltete kurze Verweilzeit von etwa zehn Sekunden bis maximal zwei Minuten dazu, eine Gefügeumwandlung vonstatten gehen zu lassen. Eine Änderung von Dicke und Aufbau der Beschichtung ist nicht mehr erforderlich, da dies bereits im ersten Ofen 7 erfolgt ist. Nach demzufolge äußerst kurzer Verweildauer im Induktionsofen 11 kann die Platine bereits dem Umfom-/Vergütungswerkzeug 13 zugeführt werden, in dem neben der Umformung das Abschrecken in gleicher Weise (gleicher Verlauf der Warmumformkurve 20) vonstatten geht wie in der Abkühlzone 8. Beim Verlassen des Umform-/Vergütungswerkzeuges 13 weist das Bauteil 5 bereits Martensitgefüge auf, die Abkühlung auf Raumtemperatur RT kann beim Weitertransport zur bzw. innerhalb der Beschnittvorrichtung 17 erfolgen.

Auf diese Weise wurde eine eine ursprüngliche Zugfestigkeit von etwa 500 bis 600 N/mm^2 aufweisende Platine 1 in ein eine Zugfestigkeit von etwa 1300 bis 1500 N/mm^2 aufweisendes Bauteil 5 umgeformt.

In vorteilhafter Weiterbildung der Erfindung wäre denkbar, im Induktionsofen 11 die Platine 1 partiell unterschiedlich stark zu erwärmen, mit der Folge, dass, falls dies gewünscht ist, das umgeformte und abgeschreckte Bauteil 5 partiell unterschiedliche Festigkeiten aufweist.

Weiter wäre vorteilhaft möglich, die Platine 1 vor der zweiten Wärmebehandlung (Induktionsofen 11) zum Beispiel durch Aufschweißen von Verstärkungsblechen (Patches) lokal zu verstärken. Ein solchermaßen gepatchtes Verbundblech könnte dann dem zweiten Ofen und danach dem Umform-/Vergütungswerkzeug 13 zugeführt werden. Dies hätte insgesamt positive Auswirkungen auf die Werkstoffeigenschaften und die Formgenauigkeit.

Das erfindungsgemäße Verfahren ist auch bei Verwendung von Tailored blanks Platinen vorteilhaft anwendbar.

Ein wesentlicher Vorteil der Erfindung ist die Möglichkeit der Entkopplung der einzelnen Verfahrensschritte. So kann die erste Wärmebehandlung im Ofen 7 bereits beim Stahl- bzw. Blechhersteller erfolgen und die so vorbehandelten Platinen 1 können dann

dem weiterverarbeitenden Unternehmen (z. B. Fahrzeughersteller) bereitgestellt werden (Zwischenlager 9).

In einer weiteren vorteilhaften Weiterbildung der Erfindung ist denkbar, der Transportvorrichtung 10 einen Induktor zuzuordnen bzw. diesen in die Transportvorrichtung 10 baulich zu integrieren, so dass die Wärmebehandlung der Platine 1 während ihres Transportes zum Umform-/Vergütungswerkzeug 13 vonstatten gehen kann. Ein separater Induktionsofen 11 sowie eine diesem nachgeschaltete weitere Transportvorrichtung 12 könnten dadurch entfallen.

IP 5081
Ge/Sc

ANSPRÜCHE

1. Verfahren zur Herstellung eines Bauteils durch Umformen einer beschichteten, vorzugsweise aluminiumbeschichteten Platine aus einem Vergütungsstahl, wobei vor dem Umformen in einem ersten Verfahrensschritt die Platine einem ersten Ofen zugeführt und dort austenitisiert wird und wobei die Verweildauer der Platine im ersten Ofen so gewählt wird, dass neben der Gefügeumwandlung ein Schichtdickenwachstum vonstatten geht, gekennzeichnet durch folgende weitere Verfahrensschritte:

   - schnelles Abkühlen und anschließendes Zwischenlagern der wärmebehandelten Platine (1)
   - erneutes, kurzzeitiges Erwärmen der Platine (1) in einem zweiten Ofen (11) auf Austenitisierungstemperatur unmittelbar vor dem Umformen zum Bauteil (5) und
   - nach erfolgter Gefügeumwandlung Umformen und Härten der Platine (1).

2. Verfahren nach Patentanspruch 1, gekennzeichnet durch eine Verweildauer im ersten Ofen (7) zwischen neun Minuten und dreißig Minuten.

3. Verfahren nach Patentanspruch 1, dadurch gekennzeichnet, dass bei der wiederholten Erwärmung der Platine (1) auf Austenitisierungstemperatur im zweiten Ofen (11) die Verweildauer so gewählt wird, dass lediglich eine Gefügeumwandlung, aber kein Schichtdickenwachstum mehr statt findet.

4. Verfahren nach Patentanspruch 3, gekennzeichnet durch eine Verweildauer der Platine (1) im zweiten Ofen (11) von zehn Sekunden bis zweieinhalb Minuten.

5. Verfahren nach Patentanspruch 1, dadurch gekennzeichnet, dass die Erwärmung der Platine (1) im ersten Ofen (7) auf Elektro- oder Gas-Basis erfolgt, während die Erwärmung im zweiten Ofen (11) durch Induktion vonstatten geht.

6. Verfahren nach Patentanspruch 1, dadurch gekennzeichnet, dass die erste Erwärmung beim Stahl- bzw. Blechhersteller erfolgt, während die zweite Wärmebehand-

lung beim weiterverarbeitenden Unternehmen, z. B. Fahrzeughersteller, vonstatten geht.

7. Verfahren nach Patentanspruch 1, dadurch gekennzeichnet, dass während der zweiten Wärmebehandlung die Platine (1) über ihre Oberfläche unterschiedlich stark erwärmt wird.

8. Verfahren nach Patentanspruch 1, dadurch gekennzeichnet, dass die Platine (1) vor dem erneuten Erwärmen im zweiten Ofen (11) durch Aufbringen von mindestens einem Verstärkungsblech lokal verstärkt wird.

9. Verfahren nach Patentanspruch 1, gekennzeichnet durch die Verwendung eines Tailored blanks als Platine (1).

10. Vorrichtung zur Durchführung des Verfahrens nach einem der Patentansprüche 1-9, gekennzeichnet durch

- ein Werkzeug (4) zum Herstellen von Platinen (1) aus einem Coil (3),
- einen ersten Ofen (7) zur ersten Wärmebehandlung einschließlich Herbeiführen eines Schichtdickenwachstums der Platinen (1),
- eine Abkühlzone (8) für die Platinen (1),
- ein Zwischenlager (9) für die Platinen (1),
- einen zweiten Ofen (11) zur erneuten Wärmebehandlung der Platinen (1),
- ein Umform-/Vergütungswerkzeug (13) mit einer Presseneinrichtung (14) und einer Kühlvorrichtung (15) und
- eine Beschnittvorrichtung (17) zur Herstellung eines Fertigkontur- und Lochbeschnittes.

11. Vorrichtung nach Patentanspruch 10, gekennzeichnet durch einen ersten Ofen (7) auf Elektro-und/oder Gas-Basis und einen Induktionsofen (11) zur zweiten Wärmebehandlung.

12. Vorrichtung nach Patentanspruch 11, dadurch gekennzeichnet, dass ein Induktor in eine Transportvorrichtung (10) integriert ist, die zwischen Zwischenlager (9) und Umform-Vergütungswerkzeug (13) angeordnet ist.

13. Vorrichtung nach Patentanspruch 10, dadurch gekennzeichnet, dass zwischen der Abkühlzone (8) und dem zweiten Ofen (11) eine Station zum Aufbringen, insbesondere Aufschweißen, von mindestens einem Verstärkungsblech auf die Platine (1) angeordnet ist.

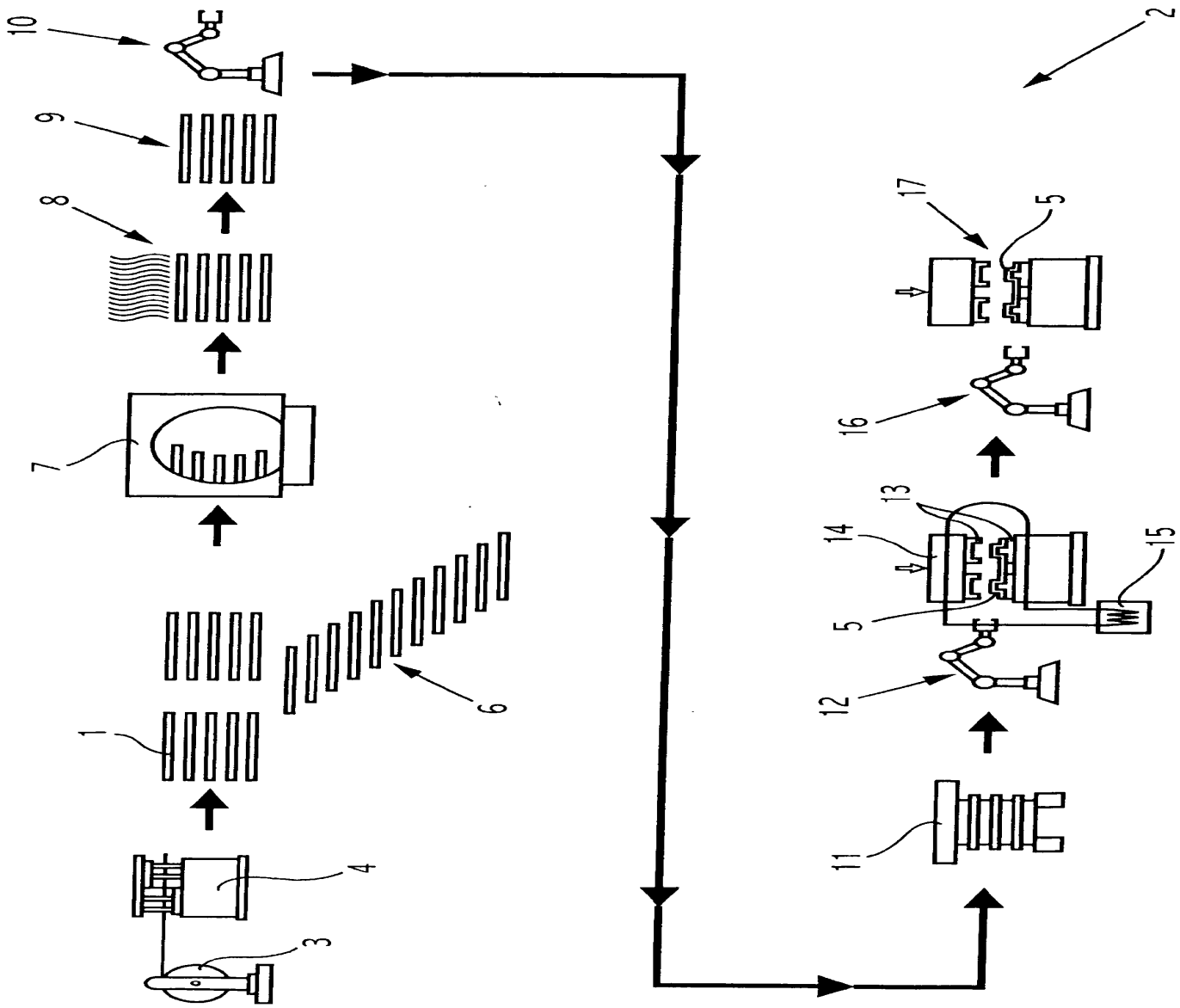


FIG.1

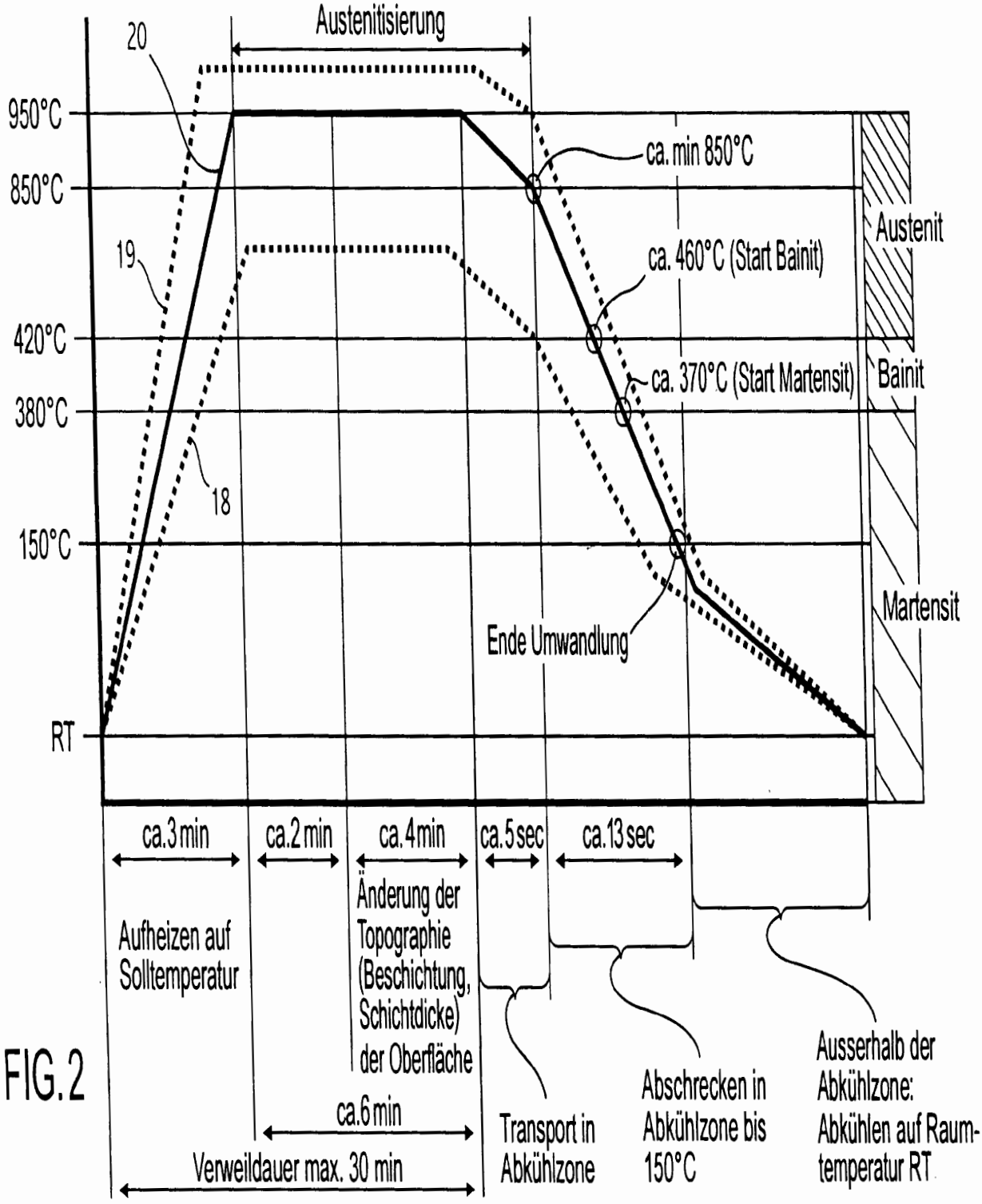
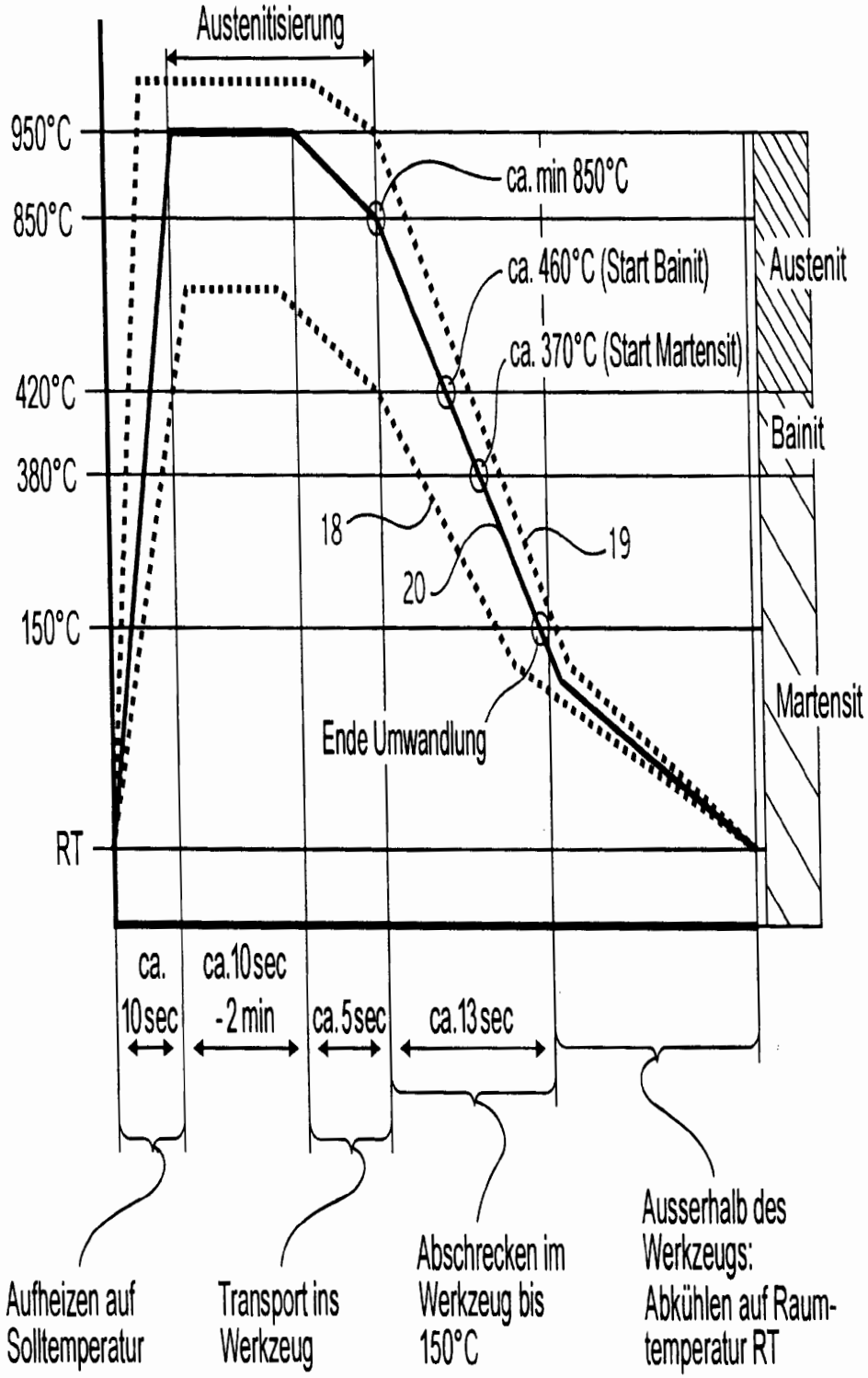

Austenitisierung
20
19
18
950°C
850°C
420°C
380°C
150°C
RT
ca. min 850°C
ca. 460°C (Start Bainit)
ca. 370°C (Start Martensit)
Ende Umwandlung
Austenit
Bainit
Martensit
ca.3 min
ca.2 min
ca.4 min
ca.5 sec
ca.13 sec
Aufheizen auf Solltemperatur
Änderung der Topographie (Beschichtung, Schichtdicke) der Oberfläche
ca.6 min
Verweildauer max. 30 min
Transport in Abkühlzone
Abschrecken in Abkühlzone bis 150°C
Ausserhalb der Abkühlzone: Abkühlen auf Raumtemperatur RT

FIG.2

FIG. 3


Austenitisierung
950°C
850°C
420°C
380°C
150°C
RT
ca. min 850°C
ca. 460°C (Start Bainit)
ca. 370°C (Start Martensit)
Austenit
Bainit
Martensit
18
19
20
Ende Umwandlung
ca. 10 sec
ca. 10 sec - 2 min
ca. 5 sec
ca. 13 sec
Aufheizen auf Solltemperatur
Transport ins Werkzeug
Abschrecken im Werkzeug bis 150°C
Ausserhalb des Werkzeugs: Abkühlen auf Raumtemperatur RT

INTERNATIONAL SEARCH REPORT

International Application No
PCT/EP2005/000853

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 C21D9/46

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 C21D

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal, PAJ, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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A	US 4 517 229 A (NICKOLA ET AL) 14 May 1985 (1985-05-14) the whole document ----- -/--	1-13

[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
25 April 2005	06/05/2005

Name and mailing address of the ISA	Authorized officer
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INTERNATIONAL SEARCH REPORT

International Application No
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INTERNATIONALER RECHERCHENBERICHT

Internationales Aktenzeichen
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A. KLASSIFIZIERUNG DES ANMELDUNGSGEGENSTANDES
IPK 7 C21D9/46

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B. RECHERCHIERTE GEBIETE

Recherchierter Mindestprüfstoff (Klassifikationssystem und Klassifikationssymbole)
IPK 7 C21D

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C. ALS WESENTLICH ANGESEHENE UNTERLAGEN

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C.(Fortsetzung) ALS WESENTLICH ANGESEHENE UNTERLAGEN

Kategorie°	Bezeichnung der Veröffentlichung, soweit erforderlich unter Angabe der in Betracht kommenden Teile	Betr. Anspruch Nr.
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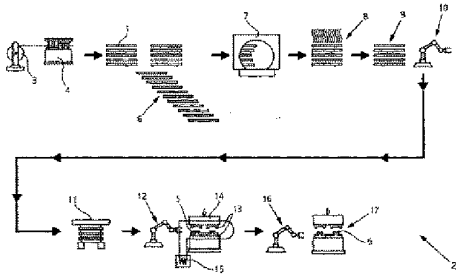
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(71)出願人　500085758
アウディー　アーゲー
ドイツ連邦共和国　デー－８５０４５　インゴルシュタット
(74)代理人　100113859
弁理士　板垣　孝夫
(74)代理人　100068087
弁理士　森本　義弘
(74)代理人　100096437
弁理士　笹原　敏司
(74)代理人　100100000
弁理士　原田　洋平
(72)発明者　シィースル、ゲルハルト
ドイツ連邦共和国、８５０９２　ケーシング、ゾンネンシュトラーセ　４
最終頁に続く

(54)【発明の名称】鋼板を変形して構成部品を製造する方法およびその方法を実施する装置

(57)【要約】
本発明は、変形する前に第１の熱処理によってオーステナイト化して被覆層厚さを生長させた焼戻し鋼からなる被覆鋼板を変形することで構成部品を製造する方法に関する。発明の目的はプロセスを最適化し、プロセスの中断によって起こされるスクラップ鋼板の発生を防止することにある。このため急速に冷却したあと熱処理鋼板１を一時収容し、構成部品５への変形の前に直接、再度短時間でオーステナイト化温度に加熱し、組織変態があった後で鋼板１を変形および硬化させる。鋼板の第２の加熱は誘導加熱で加熱するのが好ましい。
【選択図】図１



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【特許請求の範囲】
【請求項1】
焼戻し鋼板からなる好ましくはアルミニウムで被覆された被覆鋼板を変形することで構成部品を製造する方法であって、変形の前に第１の方法ステップで鋼板は第１の炉に導びかれてオーステナイト化され、第１の炉における鋼板の炉内滞留時間は組織変態のほかに被覆層厚さの生長が行われるように選択される方法において、
熱処理された鋼板（１）を急速に冷却し、引き続き一時収容するステップと、
構成部品（５）に変形する前に直接第２の炉（１１）においてオーステナイト化温度で鋼板（１）を再度短時間で加熱するステップと、
生じた組織変態の後で鋼板（１）を変形および硬化させるステップと
からなることを特徴とする方法。
【請求項2】
第１の炉（７）における炉内滞留時間は９分から３０分の間であることを特徴とする請求項１に記載の方法。
【請求項3】
第２の炉（１１）においてオーステナイト化温度で鋼板（１）の加熱を繰り返す際には、炉内滞留時間は、組織変態のみが生じて被覆層厚さの生長はこれ以上生じないように選択されることを特徴とする請求項１に記載の方法。
【請求項4】
第２の炉（１１）における炉内滞留時間は１０秒から２分３０秒の間であることを特徴とする請求項３に記載の方法。
【請求項5】
第１の炉（７）における鋼板（１）の加熱は電気またはガスに基づいて行われ、これに対し第２の炉（１１）における加熱は誘導加熱によって行われることを特徴とする請求項１に記載の方法。
【請求項6】
第１の加熱は鋼板あるいは薄板製造者のもとで行われ、これに対し第２の熱処理はさらなる処理を行う企業、例えば自動車製造業者のもとで行われることを特徴とする請求項１に記載の方法。
【請求項7】
第２の熱処理の間では鋼板（１）の表面が異なる強さで加熱されることを特徴とする請求項１に記載の方法。
【請求項8】
鋼板（１）は第２の炉（１１）で再度加熱される前に少なくとも補強薄板を適用して局部的に補強されることを特徴とする請求項１に記載の方法。
【請求項9】
鋼板（１）としてテイラーブランクが使用されることを特徴とする請求項１に記載の方法。
【請求項10】
請求項１ないし９のいずれか１項に記載の方法を実施する装置であって、
コイル（３）から鋼板（１）を作る工具（４）と、
鋼板（１）の被覆層厚さの生長を引き起こすことを含んで第１の熱処理をする第１の炉（７）と、
鋼板（１）の冷却領域（８）と、
鋼板（１）の一時収容場（９）と、
鋼板（１）を再度熱処理する第２の炉（１１）と、
プレス成形装置（１４）と冷却装置（１５）を備えた変形／焼戻し工具（１３）と、
最終輪郭切断および穴切断を行う切断装置
とから構成されることを特徴とする装置。

【請求項11】
第１の炉（７）では電気および／またはガスに基づき熱処理が行われ、第２の熱処理は誘導炉（１１）で行われることを特徴とする請求項１０に記載の装置。
【請求項12】
一時収容場（９）と変形／焼戻し工具（１３）との間に配置された搬送装置（１０）に誘導子が組み込まれることを特徴とする請求項１１に記載の装置。
【請求項13】
鋼板（１）に少なくとも補強薄板が、特に溶接で適用される場所が冷却領域（８）と第２の炉（１１）との間に配置されることを特徴とする請求項１０に記載の装置。

【発明の詳細な説明】
【技術分野】
【0001】
本発明は請求項１の前提部に記載の焼戻し鋼からなる好ましくはアルミニウムで被覆された被覆鋼板を変形することで構成部品を製造する方法に関する。さらに本発明はその方法を実施する装置に関する。
【背景技術】
【0002】
技術の現状では硬化処理に関連して焼戻し鋼板からなる鋼板を変形する種々な方法が一般に知られている。いわゆる「直接」変形方法の場合、炉、好ましくは通過炉内で保護ガス雰囲気のもとで焼戻し鋼から平坦な鋼板がオーステナイト化される。例えば、品質が２２ＭｎＢ５の焼戻し鋼が使用され、オーステナイト化のため９５０℃で数分間熱せられる。続いて、好ましくは自動化された搬送装置を使用し、オーステナイト化された熱い平坦な鋼板が連続処理のために冷却された変形／焼戻し工具に投入される。この工具は構成部品がプレスであり、これを閉じる際に熱い鋼板は最終形状の構成部品に変形し、閉鎖された工具で適用された閉鎖圧力のもとで比較的急速に冷却されて硬化される。硬化された構成部品は工具から取り出されるが、被覆されない薄板の場合が問題となり、洗浄ステップ

で、例えばサンドまたは鋼球によってスケールが除去される（例えばアルミニウム被覆薄板は十分に耐食性がありスケール発生が阻止されるので、被覆された構成部品の場合にはスケール除去は不必要となる）。引き続き、変形して硬化が完了した構成部品の最終輪郭切断および穴切断が好ましくはレーザー切断で行われる。いわゆるプレスと結びついた機械的切断も考えられる。

【0003】

炉における熱処理の間に、例えば出口状態で約２５μｍ厚さのアルミニウム被覆が約４５μｍの被覆厚さに生長し、鋼板の基礎材料に直接接して鉄が拡散したＡｌＳｉ層が形成されて、本来の防食機能を満たす比較的硬くて脆いＡｌＳｉ層となる。

【0004】

鋼板の熱処理に関する典型的な方法経過は変形の流れで例えば図１の時間－温度グラフに示す。使用する焼戻し鋼の品質、薄板の厚さ、出口の被覆層厚さなどに応じて、もちろん図１に示す値は一定の変動も伴う（熱処理下限／上限１８，１９）。したがって鋼板が３０分以下の炉内滞留時間にわたって炉内に存在することは簡単に考えられる。

【0005】

使用する炉はしばしば、形状ネットまたは鋼板受け入れ部を備えたいわゆる通過炉または格子を備えた格子スライド炉であり、鋼板を支持して、ガスバーナによって約２分以内でオーステナイト化する温度まで加熱し、引き続き電気加熱によって数分間この温度に保持する。ガスバーナは出力が大きいのが利点であるが、これに対し電気加熱は制御が良好であるのが利点となる。

【0006】

図１によると鋼板は炉内で約９５０℃の基準温度に加熱されてこの温度で保持される。オーステナイト化は約７２０℃以上の温度で実施される。炉内滞留時間は通常は約９分とされ、鋼板は最初の数分以内で基準温度まで加熱される。それに続く約７分で硬化に必要な基礎材料の再生アニールが行われ、体心立方フェライト／パーライト組織から面心立方オーステナイトになる。その上、ＡｌＳｉ保護層を十分に生長させるため前記の時間間隔は特に重要となる。

【0007】

特に炉内における鋼板の最小赤熱温度および最大炉内滞留時間に関し、プロセスで良好な部品が提供される、すなわち炉から取り出された鋼板がまだ変形プロセスおよびさらなる用途に活用できる、多少とも狭い限界が確かに存在する。さらなる経過において障害が現れるとすると、それは鋼板を炉から取り出して変形／焼戻し工具へのさらなる搬送中のとき、あるいは最終輪郭切断および穴切断の場所内にあるときであり、したがって障害が存在する間、鋼板はこれ以上炉から取り出すことができず、通常は最大許容炉内滞留時間を超え、炉内に存在する鋼板はすべて不良品となるので、取り出して処理しなければならない。

【発明の開示】

【発明が解決しようとする課題】

【0008】

本発明の課題は、焼戻し鋼板からなる被覆鋼板を変形することで構成部品を製造するこの種の方法において、プロセス経過の最適化を達成し、特に場合によっては起こりうるプロセス障害の際のコストのかかる不良鋼板の発生量を防止することである。

【課題を解決するための手段】

【0009】

この課題は方法に関しては請求項１に記載の特徴およびこれに従うさらなる特徴によって解決され、発明による方法を実施する装置に関しては請求項１０に記載の特徴によって解決される。

【発明の効果】

【0010】

発明による方法には様々な利点がある。鋼板の炉内滞留時間および炉外のプロセスの経

過障害に関してもはや左右されない。経過を分離することによって、鋼板変形の本来のプロセスのため、より少ない面積ニーズおよびより少ないインフラストラクチュアが生じる。焼戻し鋼板の緩衝／一時収容が可能となり、特にＡｌＳｉ層に影響を及ぼす熱処理が鋼板製造業者あるいは薄板納入業者でも簡単に行われる。

【0011】

このような別の場所の連続する熱処理はＥＰ０９４６３１１Ｂ１およびＤＥ１０２１２４００Ｃ１で開示されているようにすでに公知である。誘導加熱による赤熱処理もすでに技術の現状であり、例えば後者の文献に述べられている。

【0012】

発明による有利な実施形態およびさらなる形態はそれぞれ従属請求項に記載される。

【発明を実施するための最良の形態】

【0013】

以下に発明を実施形態に基づいて詳細に説明する。

図１に、このために適した装置２を使用して焼戻し鋼からなる被覆鋼板１を変形することで構成部品５を作る本発明による方法の経過の概略を示す。巻回された状態で供給される鋼、いわゆるコイル３から工具４を使用して鋼を広げて平坦にし、完成した構成部品５に必要な寸法の鋼板１に打抜きあるいは切断される。そこから鋼板１は緩衝領域６に導かれる。この一時収容は必ずしも必要ではなく、むしろ鋼板１は工具４を出た後、第１の炉７に直接導くことができ、ここで図２の温度－時間グラフによる熱処理を行う。第１の炉７の直後に冷却領域８が設けられ、ここで鋼板１は急冷されて熱処理の最終段階を経過する。冷却領域８を出て熱処理を終えた鋼板１は一時収容場９に導かれる。

【0014】

第１の炉７は構造の観点から、すでに述べた通過炉、カルッセル（Karussell）炉などにすることができる。

熱処理の個々の段階は図２に言及してすでに背景技術の項で始めに説明した。第１の炉７における比較的緩慢に行われる基準温度への加熱および残りの炉内滞留時間はオーステナイト化を引き起こしトポグラフィ（被覆層構造、被覆層厚さ）を変化させるため約９分の合計炉内滞留時間になる。鋼板を使用不可にしないため、経験によると最大炉内滞留時間は３０分を超えてはならない。鋼板１の冷却領域８への搬送およびそこでの急速冷却は比較的短い時間内で行われ、残りの冷却は一時収容場９において室温ＲＴで行われる。熱処理の最後には鋼板１はマルテンサイト組織になる。

【0015】

適切な搬送装置１０、例えば連結アームロボットを使用して鋼板１は誘導炉１１に導かれ、そこから、さらなる搬送装置１２、例えば再度連結アームロボットによって連続工程に適し冷却された変形／焼戻し工具１３に入れられる。この工具にはプレス成形装置１４および冷却装置１５が付設される。プレス成形装置１４を閉じるときに高温の鋼板１は構成部品５に変形され、閉鎖された変形／焼戻し工具１３において閉鎖力が適用される際、急速に冷却され、これによって硬化する。方法の最終ステップにおいて各構成部品５は搬送装置１６によって切断装置１７に導かれ、変形と硬化が終わった構成部品５の最終輪郭切断および穴切断が好ましくはレーザー切断を使用して行われる。勿論、適切な切断刃によって機械的手段でこれを行うこともできる。

【0016】

誘導炉１１および後続の変形／焼戻し工具１３で行われる鋼板１の熱処理を図３における温度－時間グラフで熱変形曲線２０および熱処理下限／上限１８、１９によって示す。この熱処理では鋼板の誘導炉１１内滞留時間が短いのが特徴となる。基準温度（オーステナイト化温度）への加熱が数秒（約１０秒）内で生じ、それに続く約１０秒から最大２分までの短い炉内滞留時間が加わって組織変態が進む。第１の炉７ですでに被覆の厚さと被覆構造の変化が生じたので、これ以上必要ではない。誘導炉１１における極めて短い炉内滞留時間の後、鋼板は変形／焼戻し工具１３に導かれ、ここで変形のほかに急速冷却が冷却領域８と同じように（熱変形曲線２０と同じ経過で）進行する。変形／焼戻し工具１３

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を出ると、構成部品５はマルテンサイト組織になっており、室温ＲＴにおける冷却がさらなる搬送中あるいは切断装置１７内で行われる。

【0017】

この方法で、最初に約５００から６００Ｎ／ｍｍ^{2}の引張強さであった鋼板１が約１３００から１５００Ｎ／ｍｍ^{2}の引張強さの構成部品５に変形される。

発明の有利なさらなる構成によると、誘導炉１１で鋼板１を部分的に異なった強さに加熱することが考えられ、この結果、これが所望される場合には、変形され急速冷却された構成部品５が部分的に異なった強さを備えることになる。

【0018】

さらに、第２の熱処理（誘導炉１１）の前に、例えば補強薄板（当て板）を溶接して局部的に補強することが可能であり有利になる。このように当て板された結合薄板は第２の炉に導かれ、その後、変形／焼戻し工具１３に導かれる。このことは原材料の特性および形状精度に全体として好ましい効果を及ぼす。

【0019】

発明による方法はテイラー（Tailored）ブランク板を使用する際にも適用でき有利である。

発明の重要な利点は方法の個々のステップを分離する可能性にある。炉７における第１の熱処理は鋼板あるいは薄板製造業者ですでに行われ、したがってそのように予め処理された鋼板１がさらなる処理を行う企業（例えば自動車製造業者）に用意される（一時収容場９）。

【0020】

発明のさらに有利なさらなる構成において、搬送装置１０に誘導子を配属するか搬送装置１０に構造的に組み入れることが考えられ、その結果、変形／焼戻し工具１３への搬送の間に鋼板１の熱処理が進行する。分離した誘導炉１１およびこれに続くさらなる搬送装置１２はそれによって省略することができる。

【図面の簡単な説明】

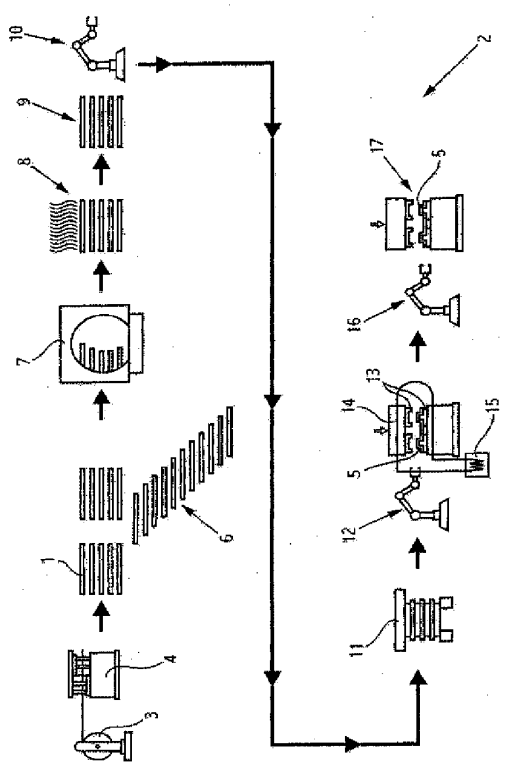
【0021】

【図1】鋼板の変形によって構成部品を製造する発明による方法の経過を示す。

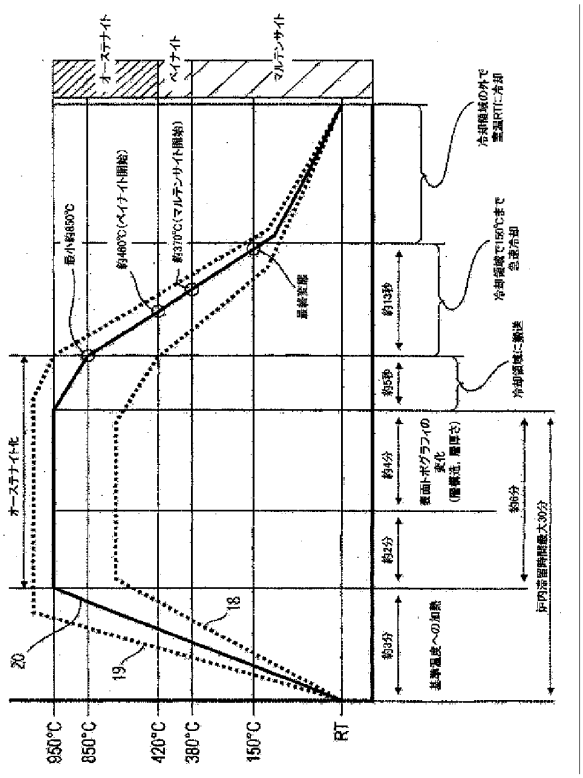
【図2】第１の鋼板熱処理の温度－時間グラフを示す。

【図3】第２の鋼板熱処理の温度－時間グラフを示す。

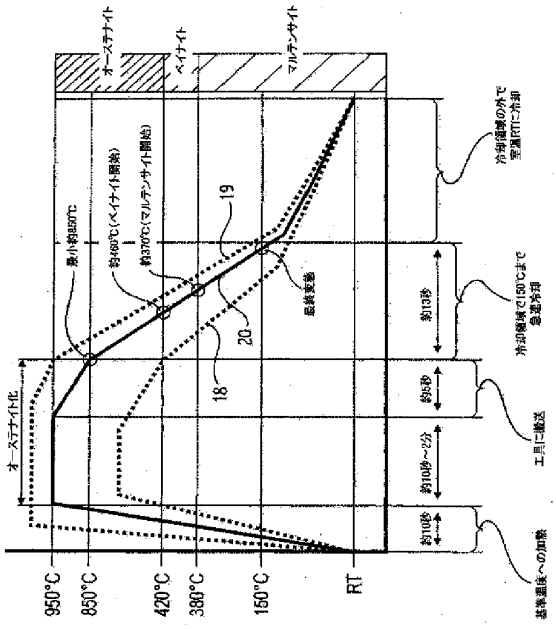
【図1】



【図2】


オーステナイト
ベイナイト
マルテンサイト
950°C
850°C
420°C
380°C
150°C
RT
オーステナイト化
最小値850°C
約460°C(ベイナイト開始)
約370°C(マルテンサイト開始)
最終変態
約13秒
約5秒
約4分
約2分
約5分
約6分
約30分
20
19
18

【図3】


オーステナイト
ベイナイト
マルテンサイト
950°C
850°C
420°C
380°C
150°C
RT
オーステナイト化
最小値850°C
約460°C(ベイナイト開始)
約370°C(マルテンサイト開始)
最終変態
約13秒
約5秒
約10秒～2分
約10秒
20
19
18

INTERNATIONAL SEARCH REPORT

International Application No
PCT/EP2005/000853

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 C21D9/46

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 C21D

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal, PAJ, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	EP 1 380 666 A (NISSAN MOTOR CO., LTD) 14 January 2004 (2004-01-14) the whole document	1-13
A	PATENT ABSTRACTS OF JAPAN vol. 2003, no. 11, 5 November 2003 (2003-11-05) -& JP 2003 181549 A (NIPPON STEEL CORP), 2 July 2003 (2003-07-02) the whole document	1-13
A	US 4 517 229 A (NICKOLA ET AL) 14 May 1985 (1985-05-14) the whole document	1-13

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[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

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'&' document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
25 April 2005	06/05/2005

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Swiatek, R

Form PCT/ISA/210 (second sheet) (January 2004)

INTERNATIONAL SEARCH REPORT

International Application No
PCT/EP2005/000853

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 6 185 977 B1 (SCHIESSL GERHARD ET AL) 13 February 2001 (2001-02-13) cited in the application the whole document -----	1-13
A	DE 102 12 400 C1 (BENTELER AUTOMOBILTECHNIK GMBH) 3 April 2003 (2003-04-03) cited in the application the whole document -----	1-13

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No
PCT/EP2005/000853

Patent document cited in search report		Publication date	Patent family member(s)		Publication date
EP 1380666	A	14-01-2004	JP	2004043887 A	12-02-2004
			CN	1472068 A	04-02-2004
			EP	1380666 A1	14-01-2004
			US	2004009366 A1	15-01-2004
JP 2003181549	A	02-07-2003	CN	1531604 A	22-09-2004
			WO	02103073 A2	27-12-2002
US 4517229	A	14-05-1985	AT	36874 T	15-09-1988
			CA	1223158 A1	23-06-1987
			DE	3473775 D1	06-10-1988
			EP	0149655 A1	31-07-1985
			JP	5055594 B	17-08-1993
			JP	60501765 T	17-10-1985
			WO	8500386 A1	31-01-1985
			US	4837091 A	06-06-1989
			US	4666794 A	19-05-1987
US 6185977	B1	13-02-2001	DE	19653543 A1	25-06-1998
			DE	59702545 D1	30-11-2000
			WO	9828097 A1	02-07-1998
			EP	0946311 A1	06-10-1999
			ES	2151299 T3	16-12-2000
			JP	2001506543 T	22-05-2001
DE 10212400	C1	03-04-2003	FR	2837216 A1	19-09-2003

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INTERNATIONALER RECHERCHENBERICHT

Internationales Aktenzeichen
PCT/EP2005/000853

A. KLASSIFIZIERUNG DES ANMELDUNGSGEGENSTANDES
IPK 7　C21D9/46

Nach der Internationalen Patentklassifikation (IPK) oder nach der nationalen Klassifikation und der IPK

B. RECHERCHIERTE GEBIETE

Recherchierter Mindestprüfstoff (Klassifikationssystem und Klassifikationssymbole)
IPK 7　C21D

Recherchierte aber nicht zum Mindestprüfstoff gehörende Veröffentlichungen, soweit diese unter die recherchierten Gebiete fallen

Während der internationalen Recherche konsultierte elektronische Datenbank (Name der Datenbank und evtl. verwendete Suchbegriffe)
EPO-Internal, PAJ, WPI Data

C. ALS WESENTLICH ANGESEHENE UNTERLAGEN

Kategorie*	Bezeichnung der Veröffentlichung, soweit erforderlich unter Angabe der in Betracht kommenden Teile	Betr. Anspruch Nr.
A	EP 1 380 666 A (NISSAN MOTOR CO., LTD) 14. Januar 2004 (2004-01-14) das ganze Dokument	1-13
A	PATENT ABSTRACTS OF JAPAN Bd. 2003, Nr. 11, 5. November 2003 (2003-11-05) -& JP 2003 181549 A (NIPPON STEEL CORP), 2. Juli 2003 (2003-07-02) das ganze Dokument	1-13
A	US 4 517 229 A (NICKOLA ET AL) 14. Mai 1985 (1985-05-14) das ganze Dokument	1-13

-/--

[X] Weitere Veröffentlichungen sind der Fortsetzung von Feld C zu entnehmen

[X] Siehe Anhang Patentfamilie

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"&" Veröffentlichung, die Mitglied derselben Patentfamilie ist

Datum des Abschlusses der internationalen Recherche	Absendedatum des internationalen Recherchenberichts
25. April 2005	06/05/2005

Name und Postanschrift der Internationalen Recherchenbehörde	Bevollmächtigter Bediensteter
Europäisches Patentamt, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Swiatek, R

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INTERNATIONALER RECHERCHENBERICHT

Internationales Aktenzeichen
PCT/EP2005/000853

C.(Fortsetzung) ALS WESENTLICH ANGESEHENE UNTERLAGEN

Kategorie°	Bezeichnung der Veröffentlichung, soweit erforderlich unter Angabe der in Betracht kommenden Teile	Betr. Anspruch Nr.
A	US 6 185 977 B1 (SCHIESSL GERHARD ET AL) 13. Februar 2001 (2001-02-13) in der Anmeldung erwähnt das ganze Dokument ----	1-13
A	DE 102 12 400 C1 (BENTELER AUTOMOBILTECHNIK GMBH) 3. April 2003 (2003-04-03) in der Anmeldung erwähnt das ganze Dokument ----	1-13

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INTERNATIONALER RECHERCHENBERICHT

Angaben zu Veröffentlichungen, die zur selben Patentfamilie gehören

Internationales Aktenzeichen
PCT/EP2005/000853

Im Recherchenbericht angeführtes Patentdokument		Datum der Veröffentlichung	Mitglied(er) der Patentfamilie		Datum der Veröffentlichung
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			EP	1380666 A1	14-01-2004
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JP 2003181549	A	02-07-2003	CN	1531604 A	22-09-2004
			WO	02103073 A2	27-12-2002
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(81)指定国　　AP(BW,GH,GM,KE,LS,MW,MZ,NA,SD,SL,SZ,TZ,UG,ZM,ZW),EA(AM,AZ,BY,KG,KZ,MD,RU,TJ,TM),EP(AT,BE,BG,CH,CY,CZ,DE,DK,EE,ES,FI,FR,GB,GR,HU,IE,IS,IT,LT,LU,MC,NL,PL,PT,RO,SE,SI,SK,TR),OA(BF,BJ,CF,CG,CI,CM,GA,GN,GQ,GW,ML,MR,NE,SN,TD,TG),AE,AG,AL,AM,AT,AU,AZ,BA,BB,BG,BR,BW,BY,BZ,CA,CH,CN,CO,CR,CU,CZ,DK,DM,DZ,EC,EE,EG,ES,FI,GB,GD,GE,GH,GM,HR,HU,ID,IL,IN,IS,JP,KE,KG,KP,KZ,LC,LK,LR,LS,LT,LU,LV,MA,MD,MG,MK,MN,MW,MX,MZ,NA,NI,NO,NZ,OM,PG,PH,PL,PT,RO,RU,SC,SD,SE,SG,SK,SL,SY,TJ,TM,TN,TR,TT,TZ,UA,UG,US,UZ,VC,VN,YU,ZA,ZM,ZW

Ｆターム(参考)　4K037 FM00　GA00　JA01　JA10
4K042 AA25　BA13　DA01　DA02　DA06　DB01　DB06　DB07　DC02　DC03
DC04　DD06　DE02　DE06　DF01　EA01

Electronic Patent Application Fee Transmittal

Application Number:	13621015
Filing Date:	15-Sep-2012
Title of Invention:	COATED STEEL STRIPS, METHODS OF MAKING THE SAME, METHODS OF USING THE SAME, STAMPING BLANKS PREPARED FROM THE SAME, STAMPED PRODUCTS PREPARED FROM THE SAME, AND ARTICLES OF MANUFACTURE WHICH CONTAIN SUCH A STAMPED PRODUCT
First Named Inventor/Applicant Name:	Pascal DRILLET
Filer:	William C. Gehris/Simon Steiner
Attorney Docket Number:	631.1028DIV

Filed as Large Entity

Filing Fees for Utility under 35 USC 111(a)

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				
Extension-of-Time:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Miscellaneous:				
RCE- 1st Request	1801	1	1200	1200
		Total in USD ($)		**1200**

Electronic Acknowledgement Receipt	
EFS ID:	28554632
Application Number:	13621015
International Application Number:	
Confirmation Number:	6215
Title of Invention:	COATED STEEL STRIPS, METHODS OF MAKING THE SAME, METHODS OF USING THE SAME, STAMPING BLANKS PREPARED FROM THE SAME, STAMPED PRODUCTS PREPARED FROM THE SAME, AND ARTICLES OF MANUFACTURE WHICH CONTAIN SUCH A STAMPED PRODUCT
First Named Inventor/Applicant Name:	Pascal DRILLET
Customer Number:	23280
Filer:	William C. Gehris/Simon Steiner
Filer Authorized By:	William C. Gehris
Attorney Docket Number:	631.1028DIV
Receipt Date:	07-MAR-2017
Filing Date:	15-SEP-2012
Time Stamp:	12:20:23
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	DA
Payment was successfully received in RAM	$1200
RAM confirmation Number	030717INTEFSW00011143500552
Deposit Account	500552
Authorized User	Simon Steiner
The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows: 37 CFR 1.16 (National application filing, search, and examination fees) 37 CFR 1.17 (Patent application and reexamination processing fees)	

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37 CFR 1.20 (Post Issuance fees)

37 CFR 1.21 (Miscellaneous fees and charges)

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1	Request for Continued Examination (RCE)	RCE.PDF	1350096 8b47510f1e2aff9d8e3343d52e92420dcc0c9eb3	no	3
Warnings:					
Information:					
2	Transmittal Letter	IDSltr.pdf	141057 a8788463f01e408f2871c0693dc2adc2c85ef117	no	2
Warnings:					
Information:					
3	Information Disclosure Statement (IDS) Form (SB08)	1449.pdf	279897 203fbeb659bf8979df21f35b0453199487f183ec	no	1
Warnings:					
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Warnings:					
Information:					
5	Foreign Reference	JP2006529002A.pdf	683453 92950aa2d62caff26bbd30abad93931c418bea52	no	18
Warnings:					
Information:					
6	Foreign Reference	JP2002178069A.pdf	845906 ec489be27ddd4c361f27cdb10c5f3cf699f60f57	no	14
Warnings:					

Information:					
7	Foreign Reference	JPH11156293A.pdf	194328 aa32e8acd0f359c3c7ba5d139d59007780d63c13	no	4
Warnings:					
Information:					
8	Foreign Reference	abs293.pdf	171417 fedd206266620f062ed1ee80908beee4e8e4350d	no	1
Warnings:					
Information:					
9	Foreign Reference	H11156293-Claims-en.pdf	184909 df4c978fe12aba116b9485f53d8aa0404d5a3a73	no	1
Warnings:					
Information:					
10	Foreign Reference	H11156293-Desc-en.pdf	878923 8444b9b55a40a9317c5f6181a75184a3406815ab	no	4
Warnings:					
Information:					
11	Foreign Reference	JP2008537977A.pdf	511460 ba0ce62916c95dfe6f31af42a6982cdd2a68d7cf	no	14
Warnings:					
Information:					
12	Foreign Reference	WO2005078144A1.pdf	770216 a2686f536789419d5e33154df30fc38a2223304c	no	19
Warnings:					
Information:					
13	Foreign Reference	JP2007522345A.pdf	402884 75b213c97a69a95dde2d5ca9e356a1cef168bc4f	no	14
Warnings:					
Information:					

14	Fee Worksheet (SB06)	fee-info.pdf	30700 e763f8a34eb25352be75635648efc820ac32a975	no	2
Warnings:					
Information:					
		Total Files Size (in bytes):	7925270		

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111
If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371
If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office
If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

NOTICE OF ALLOWANCE AND FEE(S) DUE

23280 7590 03/16/2017

Davidson, Davidson & Kappel, LLC
589 8th Avenue
16th Floor
New York, NY 10018

EXAMINER
SCHLEIS, DANIEL J

ART UNIT	PAPER NUMBER
1784	

DATE MAILED: 03/16/2017

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
13/621,015	09/15/2012	Pascal DRILLET	631.1028DIV	6215

TITLE OF INVENTION: COATED STEEL STRIPS, METHODS OF MAKING THE SAME, METHODS OF USING THE SAME, STAMPING BLANKS PREPARED FROM THE SAME, STAMPED PRODUCTS PREPARED FROM THE SAME, AND ARTICLES OF MANUFACTURE WHICH CONTAIN SUCH A STAMPED PRODUCT

APPLN. TYPE	ENTITY STATUS	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	UNDISCOUNTED	$960	$0	$0	$960	06/16/2017

THE APPLICATION IDENTIFIED ABOVE HAS BEEN EXAMINED AND IS ALLOWED FOR ISSUANCE AS A PATENT. PROSECUTION ON THE MERITS IS CLOSED. THIS NOTICE OF ALLOWANCE IS NOT A GRANT OF PATENT RIGHTS. THIS APPLICATION IS SUBJECT TO WITHDRAWAL FROM ISSUE AT THE INITIATIVE OF THE OFFICE OR UPON PETITION BY THE APPLICANT. SEE 37 CFR 1.313 AND MPEP 1308.

THE ISSUE FEE AND PUBLICATION FEE (IF REQUIRED) MUST BE PAID WITHIN THREE MONTHS FROM THE MAILING DATE OF THIS NOTICE OR THIS APPLICATION SHALL BE REGARDED AS ABANDONED. THIS STATUTORY PERIOD CANNOT BE EXTENDED. SEE 35 U.S.C. 151. THE ISSUE FEE DUE INDICATED ABOVE DOES NOT REFLECT A CREDIT FOR ANY PREVIOUSLY PAID ISSUE FEE IN THIS APPLICATION. IF AN ISSUE FEE HAS PREVIOUSLY BEEN PAID IN THIS APPLICATION (AS SHOWN ABOVE), THE RETURN OF PART B OF THIS FORM WILL BE CONSIDERED A REQUEST TO REAPPLY THE PREVIOUSLY PAID ISSUE FEE TOWARD THE ISSUE FEE NOW DUE.

HOW TO REPLY TO THIS NOTICE:

I. Review the ENTITY STATUS shown above. If the ENTITY STATUS is shown as SMALL or MICRO, verify whether entitlement to that entity status still applies.

If the ENTITY STATUS is the same as shown above, pay the TOTAL FEE(S) DUE shown above.

If the ENTITY STATUS is changed from that shown above, on PART B - FEE(S) TRANSMITTAL, complete section number 5 titled "Change in Entity Status (from status indicated above)".

For purposes of this notice, small entity fees are 1/2 the amount of undiscounted fees, and micro entity fees are 1/2 the amount of small entity fees.

II. PART B - FEE(S) TRANSMITTAL, or its equivalent, must be completed and returned to the United States Patent and Trademark Office (USPTO) with your ISSUE FEE and PUBLICATION FEE (if required). If you are charging the fee(s) to your deposit account, section "4b" of Part B - Fee(s) Transmittal should be completed and an extra copy of the form should be submitted. If an equivalent of Part B is filed, a request to reapply a previously paid issue fee must be clearly made, and delays in processing may occur due to the difficulty in recognizing the paper as an equivalent of Part B.

III. All communications regarding this application must give the application number. Please direct all communications prior to issuance to Mail Stop ISSUE FEE unless advised to the contrary.

IMPORTANT REMINDER: Utility patents issuing on applications filed on or after Dec. 12, 1980 may require payment of maintenance fees. It is patentee's responsibility to ensure timely payment of maintenance fees when due.

ArcelorMittal Ex. 2017
Page 599 of 624

PART B - FEE(S) TRANSMITTAL

Complete and send this form, together with applicable fee(s), to: Mail **Mail Stop ISSUE FEE**
Commissioner for Patents
P.O. Box 1450
Alexandria, Virginia 22313-1450
or Fax (571)-273-2885

INSTRUCTIONS: This form should be used for transmitting the ISSUE FEE and PUBLICATION FEE (if required). Blocks 1 through 5 should be completed where appropriate. All further correspondence including the Patent, advance orders and notification of maintenance fees will be mailed to the current correspondence address as indicated unless corrected below or directed otherwise in Block 1, by (a) specifying a new correspondence address; and/or (b) indicating a separate "FEE ADDRESS" for maintenance fee notifications.

CURRENT CORRESPONDENCE ADDRESS (Note: Use Block 1 for any change of address)

23280 7590 03/16/2017
Davidson, Davidson & Kappel, LLC
589 8th Avenue
16th Floor
New York, NY 10018

Note: A certificate of mailing can only be used for domestic mailings of the Fee(s) Transmittal. This certificate cannot be used for any other accompanying papers. Each additional paper, such as an assignment or formal drawing, must have its own certificate of mailing or transmission.

Certificate of Mailing or Transmission
I hereby certify that this Fee(s) Transmittal is being deposited with the United States Postal Service with sufficient postage for first class mail in an envelope addressed to the Mail Stop ISSUE FEE address above, or being facsimile transmitted to the USPTO (571) 273-2885, on the date indicated below.

(Depositor's name)
(Signature)
(Date)

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
13/621,015	09/15/2012	Pascal DRILLET	631.1028DIV	6215

TITLE OF INVENTION: COATED STEEL STRIPS, METHODS OF MAKING THE SAME, METHODS OF USING THE SAME, STAMPING BLANKS PREPARED FROM THE SAME, STAMPED PRODUCTS PREPARED FROM THE SAME, AND ARTICLES OF MANUFACTURE WHICH CONTAIN SUCH A STAMPED PRODUCT

APPLN. TYPE	ENTITY STATUS	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	UNDISCOUNTED	$960	$0	$0	$960	06/16/2017

EXAMINER	ART UNIT	CLASS-SUBCLASS
SCHLEIS, DANIEL J	1784	428-653000

1. Change of correspondence address or indication of "Fee Address" (37 CFR 1.363).
- ❑ Change of correspondence address (or Change of Correspondence Address form PTO/SB/122) attached.
- ❑ "Fee Address" indication (or "Fee Address" Indication form PTO/SB/47; Rev 03-02 or more recent) attached. **Use of a Customer Number is required.**

2. For printing on the patent front page, list
(1) The names of up to 3 registered patent attorneys or agents OR, alternatively,
(2) The name of a single firm (having as a member a registered attorney or agent) and the names of up to 2 registered patent attorneys or agents. If no name is listed, no name will be printed.
1 _____
2 _____
3 _____

3. ASSIGNEE NAME AND RESIDENCE DATA TO BE PRINTED ON THE PATENT (print or type)

PLEASE NOTE: Unless an assignee is identified below, no assignee data will appear on the patent. If an assignee is identified below, the document has been filed for recordation as set forth in 37 CFR 3.11. Completion of this form is NOT a substitute for filing an assignment.

(A) NAME OF ASSIGNEE (B) RESIDENCE: (CITY and STATE OR COUNTRY)

Please check the appropriate assignee category or categories (will not be printed on the patent) : ❑ Individual ❑ Corporation or other private group entity ❑ Government

4a. The following fee(s) are submitted:
- ❑ Issue Fee
- ❑ Publication Fee (No small entity discount permitted)
- ❑ Advance Order - # of Copies _____

4b. Payment of Fee(s): (**Please first reapply any previously paid issue fee shown above**)
- ❑ A check is enclosed.
- ❑ Payment by credit card. Form PTO-2038 is attached.
- ❑ The director is hereby authorized to charge the required fee(s), any deficiency, or credits any overpayment, to Deposit Account Number _____ (enclose an extra copy of this form).

5. **Change in Entity Status** (from status indicated above)
- ❑ Applicant certifying micro entity status. See 37 CFR 1.29 — NOTE: Absent a valid certification of Micro Entity Status (see forms PTO/SB/15A and 15B), issue fee payment in the micro entity amount will not be accepted at the risk of application abandonment.
- ❑ Applicant asserting small entity status. See 37 CFR 1.27 — NOTE: If the application was previously under micro entity status, checking this box will be taken to be a notification of loss of entitlement to micro entity status.
- ❑ Applicant changing to regular undiscounted fee status. — NOTE: Checking this box will be taken to be a notification of loss of entitlement to small or micro entity status, as applicable.

NOTE: This form must be signed in accordance with 37 CFR 1.31 and 1.33. See 37 CFR 1.4 for signature requirements and certifications.

Authorized Signature _____ Date _____

Typed or printed name _____ Registration No. _____

PTOL-85 Part B (10-13) Approved for use through 10/31/2013. OMB 0651-0033 U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

ArcelorMittal Ex. 2017
Page 600 of 624

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
13/621,015	09/15/2012	Pascal DRILLET	631.1028DIV	6215

23280 7590 03/16/2017

Davidson, Davidson & Kappel, LLC
589 8th Avenue
16th Floor
New York, NY 10018

EXAMINER	
SCHLEIS, DANIEL J	

ART UNIT	PAPER NUMBER
1784	

DATE MAILED: 03/16/2017

Determination of Patent Term Adjustment under 35 U.S.C. 154 (b)
(Applications filed on or after May 29, 2000)

The Office has discontinued providing a Patent Term Adjustment (PTA) calculation with the Notice of Allowance.

Section 1(h)(2) of the AIA Technical Corrections Act amended 35 U.S.C. 154(b)(3)(B)(i) to eliminate the requirement that the Office provide a patent term adjustment determination with the notice of allowance. See Revisions to Patent Term Adjustment, 78 Fed. Reg. 19416, 19417 (Apr. 1, 2013). Therefore, the Office is no longer providing an initial patent term adjustment determination with the notice of allowance. The Office will continue to provide a patent term adjustment determination with the Issue Notification Letter that is mailed to applicant approximately three weeks prior to the issue date of the patent, and will include the patent term adjustment on the patent. Any request for reconsideration of the patent term adjustment determination (or reinstatement of patent term adjustment) should follow the process outlined in 37 CFR 1.705.

Any questions regarding the Patent Term Extension or Adjustment determination should be directed to the Office of Patent Legal Administration at (571)-272-7702. Questions relating to issue and publication fee payments should be directed to the Customer Service Center of the Office of Patent Publication at 1-(888)-786-0101 or (571)-272-4200.

OMB Clearance and PRA Burden Statement for PTOL-85 Part B

The Paperwork Reduction Act (PRA) of 1995 requires Federal agencies to obtain Office of Management and Budget approval before requesting most types of information from the public. When OMB approves an agency request to collect information from the public, OMB (i) provides a valid OMB Control Number and expiration date for the agency to display on the instrument that will be used to collect the information and (ii) requires the agency to inform the public about the OMB Control Number's legal significance in accordance with 5 CFR 1320.5(b).

The information collected by PTOL-85 Part B is required by 37 CFR 1.311. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, Virginia 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, Virginia 22313-1450. Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

Privacy Act Statement

The Privacy Act of 1974 (P.L. 93-579) requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether disclosure of these records is required by the Freedom of Information Act.
2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.
3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.
4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).
5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.
6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).
7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.
8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspection or an issued patent.
9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

Notice of Allowability	Application No. 13/621,015	Applicant(s) DRILLET ET AL.	
	Examiner DANIEL J. SCHLEIS	Art Unit 1784	AIA (First Inventor to File) Status No

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address--

All claims being allowable, PROSECUTION ON THE MERITS IS (OR REMAINS) CLOSED in this application. If not included herewith (or previously mailed), a Notice of Allowance (PTOL-85) or other appropriate communication will be mailed in due course. **THIS NOTICE OF ALLOWABILITY IS NOT A GRANT OF PATENT RIGHTS.** This application is subject to withdrawal from issue at the initiative of the Office or upon petition by the applicant. See 37 CFR 1.313 and MPEP 1308.

1. ☒ This communication is responsive to *Request for Continued Examination filed 7 March 2017*.
   ☐ A declaration(s)/affidavit(s) under **37 CFR 1.130(b)** was/were filed on_____.
2. ☐ An election was made by the applicant in response to a restriction requirement set forth during the interview on _____; the restriction requirement and election have been incorporated into this action.
3. ☒ The allowed claim(s) is/are *24-34*. As a result of the allowed claim(s), you may be eligible to benefit from the **Patent Prosecution Highway** program at a participating intellectual property office for the corresponding application. For more information, please see http://www.uspto.gov/patents/init_events/pph/index.jsp or send an inquiry to PPHfeedback@uspto.gov.
4. ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

   Certified copies:

   a) ☐ All b) ☐ Some *c) ☐ None of the:
   1. ☐ Certified copies of the priority documents have been received.
   2. ☐ Certified copies of the priority documents have been received in Application No. _____ .
   3. ☐ Copies of the certified copies of the priority documents have been received in this national stage application from the International Bureau (PCT Rule 17.2(a)).

   * Certified copies not received: _____.

Applicant has **T**HREE MONTHS FROM **T**HE "MAILING DAT**E**" of this communication to file a reply complying with the requirements noted below. Failure to timely comply will result in ABANDONMENT of this application.
THIS THREE-MONTH PERIOD IS NOT EXTENDABLE.

5. ☐ CORRECTED DRAWINGS (as "replacement sheets") must be submitted.
   ☐ including changes required by the attached Examiner's Amendment / Comment or in the Office action of Paper No./Mail Date _____.

   Identifying indicia such as the application number (see 37 CFR 1.84(c)) should be written on the drawings in the front (not the back) of each sheet. Replacement sheet(s) should be labeled as such in the header according to 37 CFR 1.121(d).
6. ☐ DEPOSIT OF and/or INFORMATION about the deposit of BIOLOGICAL MATERIAL must be submitted. Note the attached Examiner's comment regarding REQUIREMENT FOR THE DEPOSIT OF BIOLOGICAL MATERIAL.

Attachment(s)

1. ☐ Notice of References Cited (PTO-892)
2. ☒ Information Disclosure Statements (PTO/SB/08), Paper No./Mail Date 03/07/17
3. ☐ Examiner's Comment Regarding Requirement for Deposit of Biological Material
4. ☐ Interview Summary (PTO-413), Paper No./Mail Date _____ .
5. ☐ Examiner's Amendment/Comment
6. ☒ Examiner's Statement of Reasons for Allowance
7. ☐ Other _____.

/DANIEL J SCHLEIS/ Primary Examiner, Art Unit 1784	

REASONS FOR ALLOWANCE

The following is an examiner's statement of reasons for allowance:

This Notice of Allowance is in response to the Request for Continued Examination filed on 7 March 2017, which included an Information Disclosure Statement (IDS) by Applicant with references to be considered. This IDS has been considered.

The instant application remains allowable for the reasons set forth in the Notice of Allowance mailed on 8 December 2016.

Any comments considered necessary by applicant must be submitted no later than the payment of the issue fee and, to avoid processing delays, should preferably accompany the issue fee. Such submissions should be clearly labeled "Comments on Statement of Reasons for Allowance."

Conclusion

Any inquiry concerning this communication or earlier communications from the examiner should be directed to DANIEL J. SCHLEIS whose telephone number is (571)270-5636. The examiner can normally be reached on Monday through Friday between the hours of 9:00 AM and 4:30 PM EST.

Examiner interviews are available via telephone, in-person, and video conferencing using a USPTO supplied web-based collaboration tool. To schedule an interview, applicant is encouraged to use the USPTO Automated Interview Request (AIR) at http://www.uspto.gov/interviewpractice.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Humera Sheikh can be reached on (571)272-0604. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

/DANIEL J SCHLEIS/
Primary Examiner, Art Unit 1784

***

FORM PTO-1449 (REV. 7-80)	U.S. DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE	ATTY DOCKET NO. 631.1028DIV	APPLICATION NO 13621015
LIST OF PRIOR ART CITED BY APPLICANT		APPLICANT Weiss	
(Use several sheets if necessary)		FILING DATE 09/15/2012	GROUP 1784

U.S. PATENT DOCUMENTS

*EXAMINER INITIAL		DOCUMENT NUMBER	DATE	NAME	CLASS	SUB-CLASS	
	A01	US2001/0042393	Nov. 22, 2001	Kefferstein et al.			
	A02	US8127449 B2	Mar. 6, 2012	Bayer et al.			
	A03	US7137201	Nov. 21, 2006	Brodt et al.			
	A04	US7708843	May 4, 2010	Laurent et al.			
	A05	US2007/0163683	Jul. 19, 2007	Schiessl			
	A06	US2007/0175040	Aug. 2, 2007	Bayer et al.			
	A07	US3240269	Mar. 15, 1966	Thomas			
	A08	US7503116	Mar. 17, 2009	Machrowicz et al.			
	A09	US7217331	May 15, 2007	Jambu et al.			

FOREIGN PATENT DOCUMENTS

		DOCUMENT NUMBER	DATE	COUNTRY	CLASS	SUB-CLASS	TRANSLATION	
							YES	NO
	A10	WO2005009642	Feb. 3, 2005	WO			See US 8127449	
	A11	JP2006529002	Dec. 28, 2003	JP			See US8127449	
	A12	JP2002178069	Jun. 25, 2002	JP			See US7137201	
	A13	JPH11156293	Jun. 15, 1999	JP			See English Abstract and EPO machine translation	
	A14	JP2008537977	Oct. 2, 2008	JP			See US7708843	
	A15	WO2005078144	Aug. 25, 2005	WO			See US2007/0163683	
	A16	JP2007522345	Aug. 9, 2007	JP			See US2007/0163683	
	A17							
	A18							
	A19							
	A20							
	A21							

OTHER REFERENCES *(Including Author, Title, Date, Pertinent Pages, Etc.)*

	A22	
	A23	

EXAMINER /Daniel J Schleis/	DATE CONSIDERED 03/10/2017

*EXAMINER: Initial if reference considered, whether or not citation is in conformance with **MPEP 609**; Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /DJS/

EAST Search History

EAST Search History (Prior Art)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
S1	13	((PASCAL) near2 (DRILLET)).INV.	US-PGPUB; USPAT; USOCR	OR	ON	2013/02/26 09:51
S2	8	((DOMINIQUE) near2 (SPEHNER)).INV.	US-PGPUB; USPAT; USOCR	OR	ON	2013/02/26 09:51
S3	11	((RONALD) near2 (KEFFERSTEIN)).INV.	US-PGPUB; USPAT; USOCR	OR	ON	2013/02/26 09:51
S4	0	("2013/0029172").URPN.	USPAT	OR	ON	2013/02/26 09:51
S5	9	("20030152796" | "3240269" | "5023113" | "6296805" | "6815087" | "7137201" | "7217331" | "7503116").PN. OR ("8307680").URPN.	US-PGPUB; USPAT; USOCR	OR	ON	2013/02/26 09:51
S6	4	("20030152796" | "5023113" | "6296805" | "7137201").PN.	US-PGPUB; USPAT; USOCR	OR	ON	2013/02/26 10:05
S7	9	("4891274" | "5133815" | "5178688" | "5656102").PN. OR ("6296805").URPN.	US-PGPUB; USPAT; USOCR	OR	ON	2013/02/26 10:37
S8	4	("3214820" | "6197132" | "6296805").PN. OR ("7708843").URPN.	US-PGPUB; USPAT; USOCR	OR	ON	2013/02/26 10:40
S9	16	("20010042393" | "20070082214" | "20070163685" | "20090242086" | "20090308499" | "20110006491" | "20110165436" | "4546051" | "6017643" | "6093498" | "6296805" | "6298905" | "6564604" | "6815087" | "7137201" | "7867344").PN. OR ("8066829").URPN.	US-PGPUB; USPAT; USOCR	OR	ON	2013/02/26 10:40
S10	1	("2003/0152796").URPN.	USPAT	OR	ON	2013/02/26 10:43
S11	17	("1423747" | "3240269" | "4657717" | "4921159" | "5056209" | "6337471").PN. OR ("7137201").URPN.	US-PGPUB; USPAT; USOCR	OR	ON	2013/02/26 10:45
S12	10	("3632453" | "3664293" | "4751957" | "4891274" | "5518772" | "5529816").PN. OR ("6017643").URPN.	US-PGPUB; USPAT; USOCR	OR	ON	2013/02/26 10:47
S13	195	(("5209860") or ("8066829") or	US-	OR	OFF	2013/02/26

		("8066829") or ("8307680") or ("20110006491") or ("20110165436") or ("20110214475") or ("20120064362") or ("20130029172") or ("6564604") or ("20010042393") or ("20120118437") or ("4846986") or ("20120085467") or ("20080261058") or ("4601766") or ("5248528") or ("5456953") or ("5568914") or ("5830290") or ("20040118482") or ("5287983") or ("4880481") or ("4344342") or ("4963400") or ("4999241") or ("5342672") or ("5792180") or ("6070444") or ("4353765") or ("5982073") or ("6129790") or ("6165595") or ("3798406") or ("4033918") or ("4311755") or ("4488862") or ("4508755") or ("4514264") or ("4525177") or ("4551085") or ("4554765") or ("4585519") or ("4842887") or ("4994517") or ("5273369") or ("5389452") or ("5538576") or ("5542978") or ("5639510") or ("5697715") or ("5729616") or ("5801128") or ("5837314") or ("5869160") or ("6020026") or ("6019923") or ("6251514") or ("6258425") or ("6262513") or ("6309748") or ("6340397") or ("6342108") or ("20020014181") or ("20090025836") or ("20090048127") or ("4374168") or ("4309951") or ("5810332") or ("5795661") or ("8349098") or ("20020160235") or ("20020166606") or ("20100294400") or ("20110056594") or ("20110056594") or ("20120085466") or ("5981089") or ("6197125") or ("4793867") or ("4941930") or ("4980241") or ("5238506") or ("5405427") or ("5939144") or ("6090873") or ("6241393") or ("3859239") or ("3850684") or ("3850647") or ("4316751") or ("4347085") or ("4401719") or ("4402994") or ("4533606") or ("4592958") or ("4867853") or ("5232619") or ("5242506") or ("5290362") or ("5332776") or ("5466280") or ("5608028") or ("5643474") or ("5700551") or ("5743536") or ("5783622") or ("5786098") or ("5851659") or ("5863640") or ("5890852") or ("5955201") or ("6001494") or ("6042949") or ("6083613") or ("6194088") or ("6197436") or ("6284059") or ("6329456") or ("6410626") or ("7533713") or ("8025965") or ("8025965") or ("20030150308") or ("20040129346") or ("20040216860") or ("20070209555") or ("20080090093") or ("20100175794") or ("20110300407") or ("20100199872") or ("4793218") or ("5584845") or ("5759304") or ("6463779") or ("7703820") or ("7926180") or ("7926180") or ("20070045384") or ("20070051434") or ("20090058111") or ("20100187291")).PN. or (("20110247467") or ("4384011") or ("5960930") or ("6120604") or ("4863650") or ("4926792") or ("4942061") or ("4035528") or ("4342418") or ("4355059")	PGPUB; USPAT; USOCR			10:54	

		or ("4490129") or ("4611610") or ("4818570") or ("4925213") or ("5300362") or ("5728474") or ("5809628") or ("5820954") or ("6037053") or ("6132864") or ("6403192") or ("8042484") or ("20080000417") or ("20080305358") or ("20090220815") or ("20120074106") or ("20120152410") or ("4486172") or ("4537588") or ("4844327") or ("4925518") or ("7955413") or ("4283225") or ("4302515") or ("4314661") or ("4316572") or ("4358325") or ("4480016") or ("4801072") or ("4853047") or ("5018259") or ("5271318") or ("5533423") or ("5622674") or ("5660443") or ("5926516") or ("6554919") or ("6986536") or ("RE40736") or ("7955413") or ("20010049956") or ("20050285416") or ("20050285417") or ("20080257110") or ("20090173129") or ("20110266724") or ("20120120561") or ("4251549")).PN.				
S14	0	("2012/0085466").URPN.	USPAT	OR	ON	2013/02/26 10:55
S15	0	("2012/0085467").URPN.	USPAT	OR	ON	2013/02/26 10:55
S16	0	("2011/0214475").URPN.	USPAT	OR	ON	2013/02/26 10:55
S17	1	("2011/0165436").URPN.	USPAT	OR	ON	2013/02/26 10:56
S18	1	("2011/0006491").URPN.	USPAT	OR	ON	2013/02/26 10:56
S19	8085	((428/601,600,602,653) or (420/104,120,121,126) or (148/531,535,534,537,635,653) or (72/364,342.1,47) or (280/1)).CCLS.	US-PGPUB; USPAT; USOCR	OR	OFF	2013/02/26 11:01
S20	2517	S19 and (steel ferrous) same (aluminum aluminium al)	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2013/02/26 11:02
S21	304	S20 and (interdiffusion intermediate intermetallic superficial) near3 layer	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2013/02/26 11:03
S22	14	("20020068189" | "20020104876" | "20030012977" | "20030207769" | "20040028939" | "3195991" | "4957822" | "4973523" | "5112416" | "5362574" | "5384205" | "5470666" | "7074496").PN. OR ("8053087").URPN.	US-PGPUB; USPAT; USOCR	OR	ON	2013/02/26 12:13
S23	8085	((428/601,600,602,653) or (420/104,120,121,126) or (148/531,535,534,537,635,653) or (72/364,342.1,47) or (280/1)).CCLS.	US-PGPUB; USPAT; USOCR	OR	OFF	2013/02/26 12:33
S24	286	S23 and (carbon c) same (manganese Mn) same (Silicon si) same (Chromium Cr) same (titanium ti) same (aluminum al) same	US-PGPUB; USPAT;	OR	ON	2013/02/26 12:33

		(Phosphorus P) same (Sulfur Sulphur S) same (Boron B)	USOCR; EPO; JPO; DERWENT			
S25	59	S24 and (aluminum aluminium al) near5 (pre-coat$4 precoat$4 layer coat$5)	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2013/02/26 12:35
S26	0	("2010/0294400").URPN.	USPAT	OR	ON	2013/02/26 12:36
S27	2	("2001/0001049").URPN.	USPAT	OR	ON	2013/02/26 12:40
S28	8224	((428/601,600,602,653) or (420/104,120,121,126) or (148/531,535,534,537,635,653) or (72/364,342.1,47) or (280/1)).CCLS.	US-PGPUB; USPAT; USOCR	OR	OFF	2013/09/19 16:58
S29	456	S28 and (interdiffusion intermediate intermetallic superficial) near3 layer	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2013/09/19 16:58
S30	4	S29 and (strain near3 ratio)	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2013/09/19 16:59
S31	36	S28 and (strain near3 ratio)	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2013/09/19 16:59
S32	16	("20060134451" | "20070113936" | "20070166565" | "20070246509" | "20090020276" | "20090165901" | "20100101688" | "20100112370" | "20100183897" | "20110014494" | "20110240280" | "20110287276" | "20110287277" | "5037707" | "6019939" | "7387844").PN. OR ("8247082").URPN.	US-PGPUB; USPAT; USOCR	OR	ON	2013/09/19 16:59
S33	0	("2010/0084057").URPN.	USPAT	OR	ON	2013/09/19 16:59
S34	13	("4673551" | "4906534" | "5037707" | "5100048").PN. OR ("6019939").URPN.	US-PGPUB; USPAT; USOCR	OR	ON	2013/09/19 17:00
S35	4	("2010/0112370").URPN.	USPAT	OR	ON	2013/09/19 17:00
S36	0	("2009/0252641").URPN.	USPAT	OR	ON	2013/09/19 17:00
S37	4	("4985196" | "4990545" | "5139832" | "6084849").PN. OR ("7060140").URPN.	US-PGPUB; USPAT; USOCR	OR	ON	2013/09/19 17:00
S38	15	("4196025" | "4309886" | "4793869" | "5507677" | "5509842" | "5618401" |	US-PGPUB;	OR	ON	2013/09/19 17:01

		"5625251" | "5629051" | "5646478").PN. OR ("5871851").URPN.	USPAT; USOCR			
S39	9	("4601766" | "5019191" | "5871851").PN. OR ("6129992").URPN.	US-PGPUB; USPAT; USOCR	OR	ON	2013/09/19 17:01
S40	4	("3795971" | "4455352" | "4956025").PN. OR ("5529644").URPN.	US-PGPUB; USPAT; USOCR	OR	ON	2013/09/19 17:01
S45	40	(("20010042393") or ("8127449") or ("7137201") or ("7708843") or ("20070163683") or ("20070175040") or ("3240269") or ("7503116") or ("7217331")).PN.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	OR	OFF	2017/03/10 08:29
S46	10	(("20010042393") or ("8127449") or ("7137201") or ("7708843") or ("20070163683") or ("20070175040") or ("3240269") or ("7503116") or ("7217331")).PN.	US-PGPUB; USPAT; USOCR	OR	OFF	2017/03/10 08:43
S47	4	("3214820" | "6197132" | "6296805").PN. OR ("7708843").URPN.	US-PGPUB; USPAT; USOCR	OR	ON	2017/03/10 08:48

EAST Search History (Interference)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
S41	5246	(C21D9/46 B32B15/012 C23C2/12 C23C2/26 C23C2/40 Y10T428/12389 Y10T428/12396 Y10T428/12757).cpc.	US-PGPUB; USPAT	OR	ON	2016/12/02 11:46
S42	1776	S41 and (aluminum aluminium al) near5 (pre-coat$4 precoat$4 layer coat$5)	US-PGPUB; USPAT	OR	ON	2016/12/02 11:46
S43	888	S41 and ((aluminum aluminium al) near5 (pre-coat$4 precoat$4 layer coat$5)).clm.	US-PGPUB; USPAT	OR	ON	2016/12/02 11:46
S44	136	S43 and ((interdiffusion intermediate intermetallic superficial) near3 layer).clm.	US-PGPUB; USPAT	OR	ON	2016/12/02 11:47

3/10/2017 9:14:57 AM
C:\Users\dschleis\Documents\EAST\Workspaces\13621015.wsp

Index of Claims	Application/Control No.	Applicant(s)/Patent Under Reexamination
	13621015	DRILLET ET AL.
	Examiner	**Art Unit**
	DANIEL J SCHLEIS	1784

✓	Rejected	-	Cancelled	N	Non-Elected	A	Appeal
=	Allowed	÷	Restricted	I	Interference	O	Objected

☒ Claims renumbered in the same order as presented by applicant ☐ CPA ☐ T.D. ☐ R.1.47

CLAIM		DATE								
Final	Original	12/02/2016								
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-	2	-								
-	3	-								
-	4	-								
-	5	-								
-	6	-								
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9	32	=								
10	33	=								
11	34	=								

Search Notes	Application/Control No.	Applicant(s)/Patent Under Reexamination
	13621015	DRILLET ET AL.
	Examiner	Art Unit
	DANIEL J SCHLEIS	1784

CPC- SEARCHED		
Symbol	Date	Examiner

CPC COMBINATION SETS - SEARCHED		
Symbol	Date	Examiner

US CLASSIFICATION SEARCHED			
Class	Subclass	Date	Examiner

SEARCH NOTES		
Search Notes	Date	Examiner
Inventor Name Search	03/13	Schleis
PLUS Patent Search	03/13	Schleis
Non-Patent Literature Search - Google Scholar, Knovel, Science Direct	03/13	Schleis
EAST Text Search - See Search History	03/13	Schleis
Non-Patent Literature Search - Google Scholar, Knovel, Science Direct (Updated)	09/13	Schleis
EAST Text Search - See Search History (Updated)	09/13	Schleis
Discussed Application with Primary Examiner John Zimmerman	09/13	Schleis
Non-Patent Literature Search - Google Scholar, Knovel, Science Direct (Updated)	12/16	Schleis
EAST Text Search - See Search History (Updated)	12/16	Schleis
Non-Patent Literature Search - Google Scholar, Knovel, Science Direct (Updated)	03/17	Schleis
EAST Text Search - See Search History (Updated)	03/17	Schleis

INTERFERENCE SEARCH

US Class/ CPC Symbol	US Subclass / CPC Group	Date	Examiner
C21D	9/46	12/16	Schleis
B32B	15/012	12/16	Schleis
C23C	2/12; 2/26; 2/40	12/16	Schleis
Y10T	428/12389; 428/12396; 428/12757	12/16	Schleis

Issue Classification	Application/Control No.	Applicant(s)/Patent Under Reexamination
	13621015	DRILLET ET AL.
	Examiner	**Art Unit**
	DANIEL J SCHLEIS	1784

CPC						
Symbol					**Type**	**Version**
C21D		9	/	46	F	2013-01-01
Y10T		428	/	12389	A	2015-01-15
Y10T		428	/	12396	A	2015-01-15
Y10T		428	/	12757	A	2015-01-15
B32B		15	/	012	I	2013-01-01
C23C		2	/	12	I	2013-01-01
C23C		2	/	26	I	2013-01-01
C23C		2	/	40	I	2013-01-01
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CPC Combination Sets								
Symbol					**Type**	**Set**	**Ranking**	**Version**
			/					
			/					

NONE (Assistant Examiner)	(Date)	**Total Claims Allowed:** 11	
/DANIEL J SCHLEIS/ Primary Examiner.Art Unit 1784 (Primary Examiner)	03/10/2017 (Date)	O.G. Print Claim(s) 24	O.G. Print Figure 1

Issue Classification	Application/Control No.	Applicant(s)/Patent Under Reexamination
	13621015	DRILLET ET AL.
	Examiner	**Art Unit**
	DANIEL J SCHLEIS	1784

US ORIGINAL CLASSIFICATION		INTERNATIONAL CLASSIFICATION										
CLASS	SUBCLASS	CLAIMED					NON-CLAIMED					
428	653	B	3	2	B	15 / 01 (2006.01.01)						

CROSS REFERENCE(S)						
CLASS	SUBCLASS (ONE SUBCLASS PER BLOCK)					

NONE		Total Claims Allowed:	
(Assistant Examiner)	(Date)	11	
/DANIEL J SCHLEIS/ Primary Examiner.Art Unit 1784	03/10/2017	O.G. Print Claim(s)	O.G. Print Figure
(Primary Examiner)	(Date)	24	1

Issue Classification	Application/Control No.	Applicant(s)/Patent Under Reexamination
	13621015	DRILLET ET AL.
	Examiner	**Art Unit**
	DANIEL J SCHLEIS	1784

☒ Claims renumbered in the same order as presented by applicant ☐ CPA ☐ T.D. ☐ R.1.47

Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original

NONE		Total Claims Allowed:	
(Assistant Examiner)	(Date)	11	
/DANIEL J SCHLEIS/ Primary Examiner.Art Unit 1784	03/10/2017	O.G. Print Claim(s)	O.G. Print Figure
(Primary Examiner)	(Date)	24	1

PART B - FEE(S) TRANSMITTAL

Complete and send this form, together with applicable fee(s), to: Mail **Mail Stop ISSUE FEE**
Commissioner for Patents
P.O. Box 1450
Alexandria, Virginia 22313-1450
or Fax (571)-273-2885

INSTRUCTIONS: This form should be used for transmitting the ISSUE FEE and PUBLICATION FEE (if required). Blocks 1 through 5 should be completed where appropriate. All further correspondence including the Patent, advance orders and notification of maintenance fees will be mailed to the current correspondence address as indicated unless corrected below or directed otherwise in Block 1, by (a) specifying a new correspondence address; and/or (b) indicating a separate "FEE ADDRESS" for maintenance fee notifications.

CURRENT CORRESPONDENCE ADDRESS (Note: Use Block 1 for any change of address)

23280 7590 03/16/2017
Davidson, Davidson & Kappel, LLC
589 8th Avenue
16th Floor
New York, NY 10018

Note: A certificate of mailing can only be used for domestic mailings of the Fee(s) Transmittal. This certificate cannot be used for any other accompanying papers. Each additional paper, such as an assignment or formal drawing, must have its own certificate of mailing or transmission.

Certificate of Mailing or Transmission
I hereby certify that this Fee(s) Transmittal is being deposited with the United States Postal Service with sufficient postage for first class mail in an envelope addressed to the Mail Stop ISSUE FEE address above, or being facsimile transmitted to the USPTO (571) 273-2885, on the date indicated below.

(Depositor's name)
Submitted via EFS-Web (Signature)
(Date)

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
13/621,015	09/15/2012	Pascal DRILLET	631.1028DIV	6215

TITLE OF INVENTION: COATED STEEL STRIPS, METHODS OF MAKING THE SAME, METHODS OF USING THE SAME, STAMPING BLANKS PREPARED FROM THE SAME, STAMPED PRODUCTS PREPARED FROM THE SAME, AND ARTICLES OF MANUFACTURE WHICH CONTAIN SUCH A STAMPED PRODUCT

APPLN. TYPE	ENTITY STATUS	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	UNDISCOUNTED	$960	$0	$0	$960	06/16/2017

EXAMINER	ART UNIT	CLASS-SUBCLASS
SCHLEIS, DANIEL J	1784	428-653000

1. Change of correspondence address or indication of "Fee Address" (37 CFR 1.363).
- ☐ Change of correspondence address (or Change of Correspondence Address form PTO/SB/122) attached.
- ☐ "Fee Address" indication (or "Fee Address" Indication form PTO/SB/47; Rev 03-02 or more recent) attached. **Use of a Customer Number is required.**

2. For printing on the patent front page, list
(1) The names of up to 3 registered patent attorneys or agents OR, alternatively,
(2) The name of a single firm (having as a member a registered attorney or agent) and the names of up to 2 registered patent attorneys or agents. If no name is listed, no name will be printed.

1 Davidson, Davidson & Kappel, LLC
2
3

3. ASSIGNEE NAME AND RESIDENCE DATA TO BE PRINTED ON THE PATENT (print or type)

PLEASE NOTE: Unless an assignee is identified below, no assignee data will appear on the patent. If an assignee is identified below, the document has been filed for recordation as set forth in 37 CFR 3.11. Completion of this form is NOT a substitute for filing an assignment.

(A) NAME OF ASSIGNEE: ArcelorMittal France

(B) RESIDENCE: (CITY and STATE OR COUNTRY): Saint Denis, France

Please check the appropriate assignee category or categories (will not be printed on the patent) : ☐ Individual ☒ Corporation or other private group entity ☐ Government

4a. The following fee(s) are submitted:
- ☒ Issue Fee
- ☐ Publication Fee (No small entity discount permitted)
- ☐ Advance Order - # of Copies _____

4b. Payment of Fee(s): (**Please first reapply any previously paid issue fee shown above**)
- ☐ A check is enclosed.
- ☐ Payment by credit card. Form PTO-2038 is attached.
- ☒ The director is hereby authorized to charge the required fee(s), any deficiency, or credits any overpayment, to Deposit Account Number 500552 (enclose an extra copy of this form).

5. **Change in Entity Status** (from status indicated above)
- ☐ Applicant certifying micro entity status. See 37 CFR 1.29 — NOTE: Absent a valid certification of Micro Entity Status (see forms PTO/SB/15A and 15B), issue fee payment in the micro entity amount will not be accepted at the risk of application abandonment.
- ☐ Applicant asserting small entity status. See 37 CFR 1.27 — NOTE: If the application was previously under micro entity status, checking this box will be taken to be a notification of loss of entitlement to micro entity status.
- ☐ Applicant changing to regular undiscounted fee status. — NOTE: Checking this box will be taken to be a notification of loss of entitlement to small or micro entity status, as applicable.

NOTE: This form must be signed in accordance with 37 CFR 1.31 and 1.33. See 37 CFR 1.4 for signature requirements and certifications.

Authorized Signature /williamcgehris/ Date June 12, 2017

Typed or printed name William C. Gehris Registration No. 38156

PTOL-85 Part B (10-13) Approved for use through 10/31/2013. OMB 0651-0033 U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

Electronic Patent Application Fee Transmittal

Application Number:	13621015
Filing Date:	15-Sep-2012
Title of Invention:	COATED STEEL STRIPS, METHODS OF MAKING THE SAME, METHODS OF USING THE SAME, STAMPING BLANKS PREPARED FROM THE SAME, STAMPED PRODUCTS PREPARED FROM THE SAME, AND ARTICLES OF MANUFACTURE WHICH CONTAIN SUCH A STAMPED PRODUCT
First Named Inventor/Applicant Name:	Pascal DRILLET
Filer:	William C. Gehris/Simon Steiner
Attorney Docket Number:	631.1028DIV

Filed as Large Entity

Filing Fees for Utility under 35 USC 111(a)

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				
UTILITY APPL ISSUE FEE	1501	1	960	960

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Extension-of-Time:				
Miscellaneous:				
		Total in USD ($)		**960**

Electronic Acknowledgement Receipt	
EFS ID:	29469053
Application Number:	13621015
International Application Number:	
Confirmation Number:	6215
Title of Invention:	COATED STEEL STRIPS, METHODS OF MAKING THE SAME, METHODS OF USING THE SAME, STAMPING BLANKS PREPARED FROM THE SAME, STAMPED PRODUCTS PREPARED FROM THE SAME, AND ARTICLES OF MANUFACTURE WHICH CONTAIN SUCH A STAMPED PRODUCT
First Named Inventor/Applicant Name:	Pascal DRILLET
Customer Number:	23280
Filer:	William C. Gehris/Simon Steiner
Filer Authorized By:	William C. Gehris
Attorney Docket Number:	631.1028DIV
Receipt Date:	12-JUN-2017
Filing Date:	15-SEP-2012
Time Stamp:	17:03:37
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	DA
Payment was successfully received in RAM	$960
RAM confirmation Number	061317INTEFSW00004452500552
Deposit Account	500552
Authorized User	Simon Steiner
The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows: 37 CFR 1.16 (National application filing, search, and examination fees) 37 CFR 1.17 (Patent application and reexamination processing fees)	

37 CFR 1.19 (Document supply fees)

37 CFR 1.20 (Post Issuance fees)

37 CFR 1.21 (Miscellaneous fees and charges)

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Issue Fee Payment (PTO-85B)	issuefees.PDF	1008120 689258d4475362c407ae5a820f307b7d2210b918	no	1
Warnings:					
Information:					
2	Fee Worksheet (SB06)	fee-info.pdf	30901 31054297861e4fcf5e46b49092e6d03f3521b25e	no	2
Warnings:					
Information:					
		Total Files Size (in bytes):	1039021		

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

Form PTO 1449 (Modified)	U.S. DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE	ATTY DOCKET NO. 404951US	SERIAL NO. 13/621,015 ~~New Application~~
LIST OF REFERENCES CITED BY APPLICANT		APPLICANT Pascal DRILLET, et al.	
		FILING DATE ~~Herewith~~ 09/15/12	GROUP 1784

Change(s) applied to document, /S.D/ 12/16/2016

U.S. PATENT DOCUMENTS

EXAMINER INITIAL		DOCUMENT NUMBER	DATE	NAME	CLASS	SUB CLASS	FILING DATE IF APPROPRIATE
	AA	6 296 805	~~10/02/2001~~ 10/2001	Jean-Pierre LAURENT, et al.			
	AB	2003 0152796	08-14-2003	Catherine CLANCY, et al.			
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	AN						

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		DOCUMENT NUMBER	DATE	COUNTRY	TRANSLATION YES	TRANSLATION NO
	AO	1 013 785	06/28/2000	EP		XXX
	AP	1 336 666	08/20/2003	EP (equivalent of US 2003 0152796)		XXX
	AQ	0 356 783	03/07/1990	EP (equivalent of US 5 023 113)		XXX
	AR	2 720 079	11/24/1995	FR		XXX
	AS	2 758 571	07/24/1998	FR		XXX
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OTHER REFERENCES (Including Author, Title, Date, Pertinent Pages, etc.)

	AW	A technical specification by Ford (1992).
	AX	Aruna Bahadur et al., "Structural Studies of Hot Dip Aluminized Coatings on Mild Steel," Materials Transactions, JIM, Vol. 32, No. 11 (1991), pp. 1053-1061.
	AY	L. Vaissiere et al., "Development of Pre-Coated Boron Steel for Applications on PSA Peugeot Citroen and RENAULT Bodies in White," presented at the "International Body Engineering Conference," Paris, Society of Automotive Engineers, July 9-11, 2002.
	AZ	X. Bano, et al., "Heat Treated Boron Steels in the Automobile Industry," 39th MWSP Conf. Proc., ISS, Vol. XXXV, 1998.

☐ Additional References sheet(s) attached

Examiner	Date Considered

*Examiner: Initial if reference is considered, whether or not citation is in conformance with MPEP 609; Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /D.J.S.

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APPLICATION NO.	ISSUE DATE	PATENT NO.	ATTORNEY DOCKET NO.	CONFIRMATION NO.
13/621,015	07/18/2017	9708683	631.1028DIV	6215

23280 7590 06/28/2017

Davidson, Davidson & Kappel, LLC
589 8th Avenue
16th Floor
New York, NY 10018

ISSUE NOTIFICATION

The projected patent number and issue date are specified above.

Determination of Patent Term Adjustment under 35 U.S.C. 154 (b)
(application filed on or after May 29, 2000)

The Patent Term Adjustment is 287 day(s). Any patent to issue from the above-identified application will include an indication of the adjustment on the front page.

If a Continued Prosecution Application (CPA) was filed in the above-identified application, the filing date that determines Patent Term Adjustment is the filing date of the most recent CPA.

Applicant will be able to obtain more detailed information by accessing the Patent Application Information Retrieval (PAIR) WEB site (http://pair.uspto.gov).

Any questions regarding the Patent Term Extension or Adjustment determination should be directed to the Office of Patent Legal Administration at (571)-272-7702. Questions relating to issue and publication fee payments should be directed to the Application Assistance Unit (AAU) of the Office of Data Management (ODM) at (571)-272-4200.

APPLICANT(s) (Please see PAIR WEB site http://pair.uspto.gov for additional applicants):

Pascal DRILLET, Rozerieulles, FRANCE;
Dominique Spehner, Balan, FRANCE;
Ronald Kefferstein, Saint Mitre Les Ramparts, FRANCE;

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