PRODUCING A PRODUCT FROM A FLEXIBLE ROLLED STRIP MATERIAL

Applicant: MUHR UND BENDER KG, Attendorn (DE)

Inventors: Thomas Muhr, Attendorn (DE); Christoph Schneider, Lennestadt-Eilspe (DE); Jürgen Butzkamm, Olpe-Thieringhausen (DE); Hubert Steffens, Drohsagn (DE); Wolfgang Eberlein, Wilnsdorf (DE)

Assignee: Muhr und Bender KG, Attendorn (DE)

Appl. No.: 14/896,749

PCT Filed: Jun. 17, 2014

PCT No.: PCT/EP2014/062693

§ 371 (c)(1), (2) Date: Dec. 8, 2015

Foreign Application Priority Data

Jun. 17, 2013 (DE) 10 2013 010 025.9

Publication Classification

Int. Cl.
C22C 3/14 (2006.01)
C22C 3/12 (2006.01)
C25D 5/00 (2006.01)
C23C 2/06 (2006.01)
C25D 5/36 (2006.01)
C25D 5/50 (2006.01)
C25D 5/18 (2006.01)
C21D 8/00 (2006.01)
C21D 9/00 (2006.01)
C22C 3/840 (2006.01)
C22D 3/22 (2013.01); C22D 6/00 (2013.01); C22C 3/14 (2013.01); C22C 3/12 (2013.01); C22C 3/04 (2013.01); C23C 2/06 (2013.01); C25D 5/36 (2013.01); C25D 5/50 (2013.01); C25D 5/18 (2013.01); C21D 8/005 (2013.01); C25D 5/00 (2013.01)

ABSTRACT

A product is made from a rolled strip material with the steps: rolling of a strip material from a sheet metal; working of a blank out of the rolled strip material; forming of the blank to a formed part; cleaning the formed part such that an amount of maximal 0.7 ppm of diffusible hydrogen is introduced into the formed part by cleaning, and coating the formed part with a metal coating material for producing a corrosion protection coating, wherein the step of coating is carried out in an immersion bath with an electrolyte solution, wherein between the formed part and the electrolyte solution a flow is generated.

R

13

A

12

14

13

A-A

12'

14

15

16
PRODUCING A PRODUCT FROM A FLEXIBLE ROLLED STRIP MATERIAL

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application is a National Stage of, and claims priority to, Patent Cooperation Treaty Application No. PCT/EP2014/062693, filed on Jun. 17, 2014, which claims priority to German Patent Application No. 10 2013 010 025.9, filed on Jun. 17, 2013, each of which application are hereby incorporated herein by reference in their entireties.

DESCRIPTION

[0002] The present disclosure relates to a method for producing a product from a rolled strip material, as well as a product made from a rolled strip material, especially as a structural component for a motor vehicle.

[0003] From DE 10 2004 037 206 A1 a car body for a motor vehicle is known which is made from single elements. For this, single elements made from a flexible rolled sheet steel with a sheet thickness variable along one direction, are used, in which the distribution width of the specific loading across the individual elements is reduced by the selection of the sheet thickness distribution. Such sheet elements with variable thickness are also called Tailor Rolled Blanks (TRB).

[0004] The trend present in the motor vehicle industry towards a lightweight design and passenger protection leads to an increased use of high strength and super high strength car body steels. In the course of this development, multiphase steels and martensite phase steels especially are used. The latter steels are generally worked to structural components by an indirect or direct hot-forming method.

[0005] Generally, structural components for motor vehicles are provided with a coating which shall protect the sheet steel against corrosion. However, the implementation of a reliable corrosion protection is difficult especially with regard to hot-formed steel materials. Various coatings and coating methods are known, which differ from each other by applying the coating before or after the hot-forming.

[0006] From EP 2 327 805 A1 a method and a production facility for producing a sheet metal part with a corrosion protection coating are known. The method comprises the steps: forming a starting material to a formed sheet metal part, electrolytic coating the formed sheet metal part for producing the corrosion protection coating and subsequent heat treatment of the coated formed sheet metal part.

[0007] From EP 2 412 848 A1 a similar method is known, wherein a zinc-nickel-coating is applied as a corrosion protection coating on the formed sheet metal part. Thereby, initially a thin nickel layer is deposited at the beginning of the coating process, which shall prevent a subsequent hydrogen embrittlement of the sheet steel material.

[0008] A method for coating steel components is galvanic zinc coating (electrolytrogalvanising) for example. During galvanising, the workpiece is dipped into a zinc electrolyte. Electrodes of zinc act as “sacrificial anode”, because of their metal, which is less noble compared to the workpiece. The workpiece to be galvanised acts as a cathode; that is why the coating is also referred to as a cathodic corrosion protection.

[0009] Further known coating methods are hot-dip galvanising, zinc spraying by thermal spraying, flame spraying, high velocity flame spraying, arc spraying or plasma spraying, sherardizing, galvanising, electrostatic deposition of metal powder on the component surface or further deposition methods from the gas phase (CVD).

[0010] With regard to the industrial scale coating methods for ultra high strength structural components it is a problem that corrosion protection of coatings applied before hot-forming negatively changes the features of the component and of the coating due to the temperatures acting on the coating system before and during the hot-forming. This can lead to a solder cracking and micro cracks in the component, which has a negative effect on the material properties of the workpiece. Coating systems and methods like flame spraying and sherardizing, which are applied after the hot-forming, have the great disadvantage that the layer thickness shows large fluctuations and the methods are in total very cumbersome.

[0011] Regarding the full surface batch galvanising of components from the liquid phase (hot-dip galvanising), the galvanising temperature of above 420°C reduces the strength of the component. With regard to the electrolytical hot-dip galvanising the danger exists, that hydrogen is introduced into the component by the preceding cleaning process and the galvanic coating process. The introduced hydrogen can lead to a material failure in the high strengths of the components.

[0012] Therefore, disclosed herein is a method for producing a product from rolled strip material, which offers a particular good corrosion protection.

[0013] A method for producing a product from a rolled strip material includes the following steps: rolling of a strip material from sheet metal; working a blank from the rolled strip material; forming the blank to a formed part; cleaning the formed part such that an amount of at most 0.7 ppm of diffusible hydrogen is introduced into the formed part by cleaning; and coating the formed part with a metal coating material for producing a corrosion protection coating.

[0014] Advantageously, during the cleaning process no diffusible hydrogen is introduced into the material or at most only in very small amounts. In this manner, unwashed hydrogen embrittlements of the steel material can be prevented or at least can be reduced. An advantage of the batch coating, i.e., coating the already cut blanks respectively the formed parts produced therefrom, is that the coating is not negatively influenced by subsequent heat-treatment processes. This again has advantageous effects on the quality of the coating and, thus, on the corrosion resistance of the produced formed part.

[0015] Preferably, cleaning is carried out such that the proportion of diffusible hydrogen measured directly before and after the cleaning processes is less than 0.7 ppm (parts per million), especially less than 0.3 ppm, preferably less than 0.1 ppm, or even less than 0.05 ppm. Directly before and after the cleaning can include a time frame of respectively up to 10 minutes before or after, within which the content of diffusible hydrogen is measured in the material.

[0016] For producing the product, preferably a hardenable, in particular a manganese containing steel material is used. This can contain still further micro-alloying elements, like for example niobium and/or titanium, wherein the proportion of the mass of these micro-alloying elements is preferably at most 1000 ppm of the total mass. Further micro-alloying elements, like boron and/or vanadium, can be added in small proportions of mass. Examples for a useable steel material are 17MnB5, 22MnB5, 26MnB5 or 34MnB5. The starting material (strip material) has preferably a tensile strength of at least 450 MPa and/or at most 850 MPa. The finished formed part
can have a final tensile strength of at least 1100 MPa, preferably of at least 1300 MPa, especially preferred of even 1500 MPa, at least in partial areas.

[0017] According to a possible embodiment, rolling is conducted as flexible rolling, wherein a variable thickness is produced along the length of the strip material. By flexible rolling a rolling process is meant, wherein a steel strip with a uniform thickness along the length is rolled to a strip material with a variable thickness along the length. The starting thickness before the flexible rolling can be up to 8 mm. As a strip material for the flexible rolling, a hot (rolled) strip or cold (rolled) strip can be used, wherein these terms have to be understood in the sense of the technical terminology. A hot (rolled) strip is a rolled steel product (steel strip), which is produced by rolling subsequently to previous heating. A cold (rolled) strip is a cold rolled steel strip (flat steel), in which the last thickness reduction is carried out by rolling without previous heating. After the flexible rolling, the strip material can have, for example, a thickness of up to 6.0 mm at the thickest point.

[0018] Preferably the flexible rolling is carried out such that at least two portions with different thickness are produced, wherein the ratio of a first thickness of a thinner first portion to a second thickness of a second portion is smaller than 0.8, in particular smaller than 0.7, preferably smaller than 0.6. It is to be understood, however, that depending on the requirements of the finished product any deliberate number of portions with different thickness can be produced in principle. The thickness is adjusted along the length in particular such, that the loadings of the component are at least substantially uniform, respectively that loading peaks are prevented or are at least reduced.

[0019] The step of working out conceptually means any type of producing blanks or form cuts from the strip material. This can be done by mechanical cutting, like punching or cutting, or by laser cutting. Blanks refer to in particular rectangular sheet panels, which are separated from the strip material. Form cuts are understood to be sheet elements worked from the strip material, which outer contour is already adapted to the form of the final product. During the production of the form cuts or blanks, an edge can remain on the strip material, which is not further processed, wherein also a simple cutting of the strip material into pieces can be carried out, in which no edge would remain. In this disclosure, the term “blank” is used for form cuts as well as for rectangular blanks.

[0020] It will be recognized that further steps can additionally be carried out before, during, or after the above named method steps. For example, a heat treatment of the strip material can be carried out before the flexible rolling. After the flexible rolling, a strip straightening can be provided. Furthermore, a pre-treatment, like rinsing and/or pickling (surface activation), of the workpieces can be provided before the coating process. After the coating process, a further heat treatment can be carried out.

[0021] According to a possible embodiment it is provided that the cleaning of the formed part is carried out mechanically. Cleaning in this context means any treatment in which unwashed contaminations present after the forming process are removed mechanically from the surface. An advantage of the mechanical cleaning is that no unwashed hydrogen is introduced into the workpiece. Preferably, the formed part is blasted or brushed. Shot-blasting, blasting with corundum or with dry ice (CO2) can be used as a method for blasting. For the shot-blasting, steel balls with a preferred ball diameter of 0.7 to 0.9 mm can be used. By the blasting process a rougher surface is produced than in the unblasted condition, which is advantageous with regard to the adhesion properties of a subsequently applied coating. However, in principle it is also possible that the cleaning of the formed part is carried out in a different manner, so that a proportion of maximal 0.7 ppm, in particular 0.1 ppm, especially maximal 0.05 ppm, of diffusible hydrogen (H) is introduced into the formed part by the cleaning process. For example, cleaning can be carried out by pickling as an alternative method step. A first method variant is anodic pickling, wherein the formed parts are dipped into an immersion bath, wherein removal of scale and other impurities takes place under the influence of direct current. According to an alternative method variant the removal of scale and other impurities can take place purely chemical, for example by an inhibited pickling.

[0022] According to an embodiment, the forming of the workpiece comprises a hot-forming. Hot-forming here means that before the forming process the workpieces are heated above the austenitizing temperature and at least partial regions are hardened during the forming process. The heating is carried out in a suitable heating device, for example, in an oven. The hot-forming can be carried out according to a first possibility as an indirect process, which comprises the sub-steps cold-preforming of the blanks to a pre-formed component, subsequent heating at least partial regions of the cold preformed component up to the austenitizing temperature as well as subsequent hot-forming for producing the final contour of the product. The austenitizing temperature is understood as a temperature range, in which at least a partial austenitization (structure in the two-phase range ferrite and austenite) is present. Furthermore, it is also possible, to austenitize only partial regions of the blanks to enable, for example, a partial hardening. The hot-forming can also be carried out according to a second possibility as a direct process, which is characterised in that at least partial regions of the blanks are directly heated to the austenitizing temperature and are then hot-formed to the required final contour and hardened in one step. An earlier (cold) pre-forming is not carried out in this case. Also in the direct process, a partial hardening can be achieved by austenitization of partial regions. For both processes it applies that a hardening of partial regions of the components is possible also by differently tempered tools, or by the use of several tool materials, which enable different cooling velocities. In the latter, the whole blank or the whole component can be completely austenitized.

[0023] According to an embodiment, the sheet blanks can also be cold-formed. Cold-forming is understood as forming processes, in which the blanks are not heated in a targeted manner before the forming process. The forming thus takes place at room temperature; the blanks are heated by the dissipation of the introduced energy. Cold-forming is used in particular as a process for forming soft car body steels. Subsequently to the cold-forming, the formed parts can optionally be hardened.

[0024] During and after the forming process, a heat treatment can be provided as an integrated or separate method step, wherein regions with different ductility are produced in the workpiece. Ductility is the formability of the steel material without damage or crack forming. The ductility can be evaluated for example by the elongation at break or the contraction at fracture in a tensile test. An increased ductility in
partial regions leads in an advantageous manner to a reduced edge cracking susceptibility and an improvement of the weldability of the material in said regions.

The ductility can in particular be selected such, that one or more first regions of the formed part have a larger yield strength of at least 800 MPa and/or that one or more second regions have a lower yield strength of maximal 800 MPa. The strength in the first region can be at most 1100 MPa and/or in the second region at least 100 MPa.

For producing areas of different ductility, different embodiments are possible. According to a first possibility, a temperature gradient can be produced in the workpiece during the heat treatment carried out before the forming process. After the heat treatment, which for example can be carried out in an oven, areas with higher or with lower temperature are then present. The subsequent forming process leads then to an increased ductility, respectively a lower strength in the regions with higher temperature, while in the regions of lower temperature a lower ductility and higher strength, respectively, is produced. Alternatively, a temperature gradient can be produced in the workpiece also during the transfer processes between the heat treatment and the forming process, for example such that partial regions of the workpiece, completely heat treated beforehand, are cooled before insertion into the forming tool. According to a further possibility, the ductility can also be adjusted during the forming process, for example by differently tempering partial regions of the tool. For this, the forming tool can have respective means, such as channels through which a cooling medium flows. In the cooled areas of the tool, a higher strength and lower ductility is produced in the formed part; correspondingly the hotter areas of the forming tool cause the formation of lower strengths and higher ductility. According to a further possibility, the regions of high ductility can be produced during the coating process, in particular by hot-dip galvanising. In this case, the high temperature of the liquid coating material leads to a softening in the coated regions, and thus to a higher ductility.

A heat treatment step can be carried out as an integrated or a separate method step before, during, or after the forming process, wherein surface areas with lower hardness than in the core area are produced in the workpiece. This can be achieved by targeted surface decarburisation, in which a depletion of alloying components is caused in the starting material across the thickness, i.e., the proportion of alloying components like carbon or manganese is larger in a core area of the strip material than in the surface area. Preferably, the depleted area has a hardness, which is reduced by at least 50 HV₀.₁ compared to the core area. The depletion of the alloying elements can, for example, be achieved by a heat treatment during a galvannealing treatment or by heating above the AC₁-temperature. The extent of the surface decarburisation is determined by the process parameters in the oven. Especially the atmosphere in the oven, i.e. the gas mixture in the oven, or also the temperature count thereto.

The coating process is in particular carried out with a coating material that has a proportion of at least 50 mass percent zinc, preferably at least 90 mass percent zinc, wherein the zinc content can also be 100 percent (pure zinc coating).

According to an embodiment, the coating can be applied galvanically (electrolytically). For this, anodes are used from a coating material, i.e., from pure zinc or from zinc and other alloying elements, which, when energised, release metal ions to the electrolyte. Alternatively, also form-stable anodes can be used; in this case, the coating material is already dissolved in the electrolyte. The zinc ions and if applicable, ions of the further alloying elements are deposited as atoms on the formed part, which is connected as a cathode, and form the coating. The coating process is carried out by dipping the workpiece into an immersion bath with an electrolyte solution, preferably in a continuous process, wherein between the formed part and the electrolyte solution a flow is generated. By the flow provided between the formed part and the electrolyte solution, an electrolyte impoverishment is avoided and thus an unwanted hydrogen introduction into the workpiece is avoided. The flow can generally be achieved by moving the formed part relative to the electrolyte and/or by moving the electrolyte relative to the formed part. By using a continuous process, i.e., by continuous movement of the workpiece, a good reproducibility of the coating process can be achieved as well as a uniform coating across the surface of the workpiece. However, thus also temporal pauses, in which the advance is temporarily stopped, should be comprised in a specific extent as they may be present, for example, in a chain conveyor system. The flow can be produced such that the formed parts are moved through an immersion bath by a device, i.e., the formed parts move relative to the immersion bath and to the electrolyte solution. Alternatively or in addition, a flow of the electrolyte solution can be produced by an appropriate design of the coating facility. For this, the coating facility can be provided with pumps, which agitate the electrolyte solution to a flow movement relative to the workpiece. Preferably, the electrolyte solution is ejected by jets onto the formed parts, which can be done under a jet angle of 90° up to ±45° in relation to the surface of the workpiece. Generally, an inhomogeneous distribution of the current density can be present in an electrolyte solution. Thus, the flow of the electrolyte solution can be adjusted relative to the workpiece such, that a homogeneous distribution of the current density is generated.

According to an embodiment, the coating process can be carried out such that the formed part to be coated is subjected to a pulsed current in at least one step. Alternatively or in addition, the formed part can also be subjected to an unpulsed current. More specifically, the step of coating by an electrolyte solution can especially comprise following sub-steps: in a first workstation, the electrolytic solution is subjected to a pulsed current for coating the formed part; in a following second workstation, the electrolytic solution is subjected to an unpulsed current for coating the formed part. It is understood that a reverse order for treatment with pulsed and unpulsed current is also possible. By a pulsed current feed of a pair of anodes in the first step, a nanocrystalline layer structure is achieved, which, for example, can have a layer thickness of 1 to 2 micrometers. Thus, the coating has a particular fine granulation close to the workpiece, so that the formation of rust is prevented.

According to an embodiment, the coating process can also comprise hot-dip galvanising, wherein the formed part is dipped into a dipping bath of molten coating material with a temperature of at least 350° C., preferably at least 420° C. and/or the AC₁-temperature of the steel material at most, preferably at a maximum of 600° C. In this manner, the coated regions are softened because of the introduced heat, so that here the material obtains a higher ductility than the uncoated areas. The coating material is preferably configured as described above, i.e., it has a proportion of at least 50 percent by mass of zinc, if necessary with additional alloying ele-
ments. Further possible coating methods are flame spraying or chemical vapour deposition (CVD).

As a further method step before or after the coating process, a heat treatment of the coated formed part can additionally be carried out at a temperature of more than 210°C, in particular more than 220°C, preferably more than 230°C. The maximum temperature for the heat treatment is preferably up to the AC1-temperature of the steel material, in particular not more than 400°C. The heat treatment, which also can be referred to as effusion annealing, reduces internal stresses in the workpiece, respectively stress peaks in the hardened component, respectively increases the failure strain. At the same time, the hydrogen effusion is accelerated by the selected temperature, so that in total a lower hydrogen embrittlement is achieved in the finished product. The heat treatment can be carried out in a time frame of several hours up to 3 hours. Furthermore, the heat treatment can take place after the coating process or between the individual coating process steps. A heat treatment following the coating process accelerates in an advantageous manner the drying of the formed parts and when using high strength steels, the material properties concerning the ductility and the elongation at fracture are improved by annealing.

The solution for the above named object is further a product, which is produced from a flexible rolled sheet steel according to the above named method. Thus, said advantages of a uniform layer thickness of the corrosion protection coating across the coated surface of the formed part as well as a lower risk of the hydrogen embrittlement are achieved. The formed part can be produced according to one or more of the above-mentioned method steps, so that concerning the steps and the advantages connected thereto it is referred to the above description.

Overall, a formed part is produced, which by its sheet thicknesses and the applied corrosion protection system is advantageously adapted to the requirements concerning light weight design, crash properties and life time (corrosion protection). The formed part can be any car body component of a motor vehicle, for example a structural component like an A-, B- or C-pillar.

Following, a preferred embodiment is described by means of the drawings.

FIG. 1 shows a method for producing a product from a flexible rolled strip material schematically as a process diagram.

FIG. 2A shows a coating schematically as a detail in a side view.

FIG. 2B shows a coating schematically in a cross-sectional view according to section A-A of FIG. 2A.

FIGS. 1 and 2 are jointly described in the following.

In the method step V1, the strip material, which is wound to a coil in the starting condition, is processed in a rolling manner, i.e., in particular by flexible rolling. For this, the strip material that has a substantially uniform sheet thickness along the length before flexible rolling, is rolled by rollers such that it receives a variable sheet thickness along the rolling direction. During rolling, the process is monitored and controlled, wherein the data, determined from a sheet thickness measurement, are used as input signal for controlling the rolling process. After the flexible rolling the strip material has different thicknesses in rolling direction. The strip material is again wound to a coil after the flexible rolling, so that it can be transported to the next process step.

The material for the strip material is a hardenable steel material, like, for example, 17MnB5, 22MnB5, 26MnB5 or 34MnB5. The starting material has preferably a tensile strength of at least 450 MPa and at most 850 MPa. It can be provided for specific components, that the starting material has a depletion of alloying components across the thickness, i.e., the proportion of alloying components like carbon or manganese is larger in a core region of the strip material than in the surface region. Preferably, the depleted region has a hardness reduced by at least 50 HV0.2, compared to the core region. The depletion of the alloying components can be achieved by a heat treatment during a Galvannealing treatment or by heating above the AC1-temperature.

After the flexible rolling, the strip material can be smoothed in a strip straightening device. The method step of smoothing is optional and can also be omitted.

After the flexible rolling (V1) and smoothing, respectively, individual sheet blanks are worked out of the strip material during the next method step V2. The working of the sheet blanks from the strip material takes place preferably by punching or cutting. Depending on the shape of the sheet blanks to be produced, a sheet blank can be punched from the strip material as a contour cut wherein an edge of the strip material remains that is not further used, or the strip material can simply be cut into partial pieces.

After producing the blanks from the strip material, forming of the blanks to the required end product can then be carried out. According to a first possibility, the blanks are hot-formed or according to a second possibility can be cold-formed.

The hot-forming can be carried out as a direct or indirect process. In the direct process, the blanks are heated to the austenitizing temperature (method step V3) before forming, which can for example be carried out by induction or in an oven. The austenitizing temperature is to be understood as a temperature range, at which at least a partial austenitization (a structure in the two-phase range ferrite and austenite) is present. However, also only partial areas of the blank can be austenitized, to enable for example a partial hardening.

After heating to the austenitizing temperature, the heated blank is formed in a forming tool and is cooled at the same time with a high cooling velocity, wherein the component receives its final contour and is hardened at the same time. This process, which is called hot-forming, is represented as method step V4. A special form of the hot-forming is the press-hardening, which is carried out at high pressures.

For indirect hot-forming, the blank undergoes a pre-forming before the austenitization. The pre-forming is carried out in a cold condition of the blank, which means without previous heating. During the pre-forming, the component receives its profile, which does not yet correspond to the final shape, however is approximated to it. After the pre-forming, an austenitizing and hot-forming then is carried out, as during the direct process, wherein the component receives its final contour and is hardened.

During the forming, areas with different ductility and/or areas with different strength can be produced in the workpiece.

The steel material should, if a hot-forming (direct or indirect) is provided, contain a proportion of carbon of at least 0.1 percent by mass up to 0.35 percent by mass. Independent of the type of hot-forming, the complete workpiece or only partial areas can be hardened. When the hot-forming is carried out such that only partial areas are hardened, the formed
part has areas with reduced strength with at the same time increased tensile strength. By means of applying a coating in a later method step only in these soft zones, the danger of hydrogen embrittlement is reduced here.

Alternatively to the hot-forming as a forming process, the blanks can also be cold-formed. The cold-forming is especially suitable for soft car body steels or components, which have essentially strengths of less than 1200 MPa. For cold-forming, the blanks are formed at room temperature.

After the forming (method step V4), the formed parts are undergoing a cleaning process in method step V5. The cleaning of the formed parts is carried out such that an amount of maximal 0.7 ppm, in particular of up to 0.3 ppm, preferably up to 0.1 ppm, or where appropriate up to 0.05 ppm, of diffusible hydrogen (H1) is introduced into the formed part. For this, a preferably mechanical cleaning process or a pickling process is provided, during which unwashed contaminations are removed mechanically, respectively electrochemically when using pickling, from the surface of the formed part. For mechanical cleaning in particular shot-blasting or brushing can be used for cleaning the formed parts, wherein the shot-blasting is preferably carried out with steel balls with a particle size of approximately 0.7 mm to 0.9 mm. Because of the shot-blasting, the surface of the formed part receives a rough surface, by which a good adhesion of a later applied coating is achieved. As an alternative, a pickling process can be used.

After the step of cleaning, in the next method step (V6), a cutting of the formed part to the final contour can be carried out, for example by a laser, or an oiling of the formed part as anti-corrosion protection can be carried out for a following interim storage. If, however, the workpiece can directly be further processed, an oiling is sensibly not carried out.

After the intermediate step (V6), the formed parts are provided with a corrosion protection. For this, the formed parts are provided through an electrolytic coating facility, which comprises several workstations.

During a method step (V7), the formed parts are initially rinsed. After the rinsing, the formed parts are pickled during the method step (V8). For this, the formed parts are freed of unwashed oxides by means of dipping into a diluted acid.

After pickling, the formed parts are provided with a corrosion protection layer in the method step V9. For the coating process, coating material with a proportion of preferably at least 50 percent by mass of zinc, especially at least 90 percent by mass of zinc, is used, wherein also a pure zinc coating may be considered. The coating material can also contain further alloying elements.

The step of coating can be carried out galvanically by means of an electrolyte solution, into which the formed parts are dipped. Preferably, the step of coating is carried out in an immersion bath with an electrolyte solution, wherein a flow is generated between the formed part and the electrolyte solution. A corresponding coating device is shown schematically in FIGS. 2A and 2B. Formed parts 12 are visible, which are moved in feed direction R relative to the dimensionally stable anodes 13 and jet bars 14 with respect to several jets 15. The formed parts 12 can, for example, be structural components of the car body of a motor vehicle, like A-, B- or C-pillars or other car body parts. The anodes 13 are shaped in the form of gratings, so that they can be passed through by the electrolyte solution exiting from the jet devices 14. Jet devices 14 are arranged on both sides of the immersion bath, between which the formed parts 12, 12' are moved along. The electrolyte flow is drawn schematically as 16. It is directed towards the formed parts 12, 12' and serves for a uniform distribution of the current density in the electrolyte solution and thus, serves for an even layer structure on the surface of the formed parts 12, 12'.

It is advantageous for a good reproducibility of the method if the coating is continuously carried out, wherein a flow is produced between the formed parts 12, 12' and the electrolyte solution. The flow is mainly produced by moving the formed parts 12, 12' through an immersion bath, wherein the electrolyte solution can alternatively or additionally be set in a flow movement relative to the formed parts by pumps. For the electrolytic coating process, anodes 13 are used made of the coating material, i.e., made from pure zinc or from zinc and other alloying elements, which, when a current is applied to them, release metal ions into the electrolyte, or dimensionally stable anodes are used which are made of specifically coated conductive material (Releasing station 9). The zinc ions and where applicable ions of the further alloying elements are deposited as atoms on the formed part 12, 12', which is connected as a cathode, and form the corrosion protection coating.

It is advantageous if the electrolyte solution is subjected to a pulsed current at least at one sub-step for producing the coating. For example, in a first partial step (V91) a pulsed current can be used for the coating process. Thus, an especially fine grained layer with a thickness of for example 1 up to 2 micrometers, is formed on the surface of the workpiece. Following, in a second partial step (V92), the electrolyte solution, respectively the anodes, are fed with an unpulsed current for coating the formed part, till the corrosion protection layer has reached the complete thickness of for example 7 to 8 micrometers. The coating facility can in practice be formed such that an elongated immersion bath is provided, through which the individual formed parts 12, 12' are continuously moved in longitudinal direction R. Hereby, in a first portion of the immersion bath, a first arrangement of anodes 13 can be provided, which are fed by a pulsed current, while the workpiece is moved passing the same. In a second portion, following the first portion in feed direction R of the workpiece the anodes 13 provided there are subjected to an unpulsed current, while the workpieces 12, 12' move passing the same.

Here the galvanic coating process of the formed parts is described by using an electrolyte solution. It is however obvious that the method step V9 of the coating process can alternatively be carried out by means of hot-dip galvanising, flame spraying or chemical vapour deposition (CVD), too.

Independently of the type of the coating process, the formed parts can be coated completely or only partially. When only partial portions of the formed parts are coated, the expenditure and, thus, the costs can be reduced, and also a following welding process, if necessary, for connecting the formed part to other components can be simplified. Furthermore, hydrogen can easily be effused in the uncoated areas, so that the risk of a hydrogen embrittlement is reduced. In this regard it is favourable if the formed parts are only coated with the corrosion protection coating in the corrosion-endangered areas. These are for example areas, which increasingly get wet in motor vehicles and are, thus, also called wet areas.
After the coating process the formed parts are optionally rinsed in the method step V10. After the rinsing process (V10), the formed parts can be heat treated in the method step V11. The heat treatment can, in principle, be carried out in any technically suitable manner, for example in a batch annealing process or also by an inductive heating, to only name two methods for example. The heat treatment can be carried out at a temperature of more than 210°C, preferably more than 220°C, where applicable more than 230°C. The maximum temperature for the heat treatment is preferably less than the AC1-temperature of the steel material, especially at most 400°C. By means of the heat treatment, which can also be called effusion annealing, internal stresses in the workpiece or stress peaks in the hardened component are reduced, respectively the failure strain is increased. At the same time, the hydrogen effusion is accelerated by the selected temperature, so that as a whole a lower hydrogen embrittlement is achieved. The heat treatment can be carried out in a time frame of several hours up to 3 hours, where appropriate also above 3 hours, in particular 6 to 8 hours. The heat treatment following the coating process accelerates the drying of the components and when using high-strength steels, the material properties concerning ductility and failure strain are improved by means of annealing.

A characteristic of the disclosed method is that the electrolytic coating (V9) is carried out after the flexible rolling (V1), after the cutting of the blanks (V2) and after the forming (V4). The coating deposited on the formed parts has a uniform thickness, i.e., independent of the respective thickness of the workpiece. Also the stronger rolled areas have a sufficiently thick coating, which protects reliably against corrosion. A further characteristic is the step of the preferably mechanical cleaning (V5), respectively of cleaning with anodic or inhibited pickling, whereby the introduction of unwashed hydrogen into the workpiece and thus the hydrogen embrittlement is prevented. By means of the upstream or downstream heat treatment in a temperature range between preferably 230°C and 400°C, internal stresses in the workpiece are reduced and the hydrogen effusion is accelerated, which also leads to a lower hydrogen embrittlement of the material.

It is understood that the method according to the present disclosure can also be modified. For example, also intermediate steps, not specifically shown here, can be provided between the mentioned steps. For example, the formed parts can be provided with an intermediate layer before the electrolytic coating process, especially with a nickel-, aluminum- or manganese layer. This intermediate layer forms an additional protection of the surface and improves the adhesion of the following applied coating containing zinc.

A method for producing a product from a rolled strip material, comprising:

- rolling a strip material from sheet metal;
- working a blank from the rolled strip material;
- forming the blank to a formed part;
- cleaning the formed part such that an amount of at most 0.7 parts per million (ppm) of diffusible hydrogen is introduced into the formed part by cleaning; and coating at least a portion of the formed part with a metal coating material for producing a corrosion protection coating, wherein said coating is carried out in an immersion bath with an electrolytic solution,

wherein a flow is generated between the formed part and the electrolytic solution.

The method of claim 17, wherein said cleaning is carried out by pickling.

The method of claim 17, wherein said cleaning is carried out mechanically.

The method of claim 19, wherein said cleaning is carried out by blasting or brushing.

The method of claim 21, wherein the rolling of the strip material is a flexible rolling, wherein a variable thickness is produced along the length of the strip material.

The method of claim 22, wherein the flexible rolling is carried out such that at least two portions are produced with different thicknesses, wherein a first thickness is smaller than a second thickness and the ratio of the first thickness to the second thickness is less than 0.8.

The method of claim 17, wherein the forming is a hot-forming with simultaneous hardening, the forming further comprising:

- heating at least one partial area of the blank to an austenitizing temperature; and
- hot-forming the blank with quick cooling, wherein the at least one heated partial area is hardened.

The method of claim 17, wherein the forming is a cold-forming, wherein the cold-formed part is hardened before the coating.

The method of claim 17, wherein the coating is carried out with a coating material, which has a mass proportion of zinc of at least 50%.

The method of claim 17, wherein the coating is carried out continuously.

The method of claim 17, wherein the coating is carried out such that the electrolytic solution is subjected to a pulsed current.

The method of claim 17, wherein the coating comprises hot-dip galvanizing, wherein the formed part is dipped into an immersion bath of molten coating material with a temperature of at least 350°C and at most the AC1-temperature of the steel material.

The method of claim 17, further comprising, after said coating, heat treating the coated formed part at a temperature of at least 200°C and at a temperature of at most the AC1-temperature of the steel material.

The method of claim 17, wherein the steel material includes manganese and at least one of the micro-alloying elements niobium and titanium, wherein the total proportion of said micro-alloying elements amounts to 1000 ppm of the total mass at most.

The method of claim 17, wherein areas of different ductility are produced in the formed part.

A product made from a flexible rolled metal sheet, produced by:

- rolling a strip material from sheet metal;
- working a blank from the rolled strip material;
- forming the blank to a formed part;
- cleaning the formed part such that an amount of at most 0.7 parts per million (ppm) of diffusible hydrogen is introduced into the formed part by cleaning; and coating at least a portion of the formed part with a metal coating material for producing a corrosion protection
coating, wherein said coating is carried out in an immersion bath with an electrolytic solution, wherein a flow is generated between the formed part and the electrolytic solution.