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(54) **METHOD FOR PRODUCING A MOLDED
SHEET METAL PART FROM AN AS-ROLLED,
NON-HARDENABLE ALUMINUM ALLOY**

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(57) **ABSTRACT**

Method for producing an open molded sheet metal part from a non-hardenable aluminum alloy that has the following steps:

- a) a sheet is prepared that is made of a non-hardenable aluminum alloy, the temper of which is H12, H14, H16, H18, H19, H22, H24, H26, H28, H32, H34, H36 or H38 according to European Standard EN 515:1993 and that in addition to aluminum includes at least magnesium and where necessary manganese;
- b) the aluminum is heated at least locally to a temperature between 200° C. and 350° C. within a period of 1 to 60 seconds;
- c) the heated sheet is placed in a cold forming die of a forming press and the sheet is formed, creating a molded sheet metal part.

**METHOD FOR PRODUCING A MOLDED
SHEET METAL PART FROM AN AS-ROLLED,
NON-HARDENABLE ALUMINUM ALLOY**

CLAIM OF PRIORITY

[0001] Applicants hereby claim the priority benefits under the provisions of 35 U.S.C. §119, basing said claim of priority on German Patent Application Serial No. 102009008282.4, filed Feb. 10, 2009.

FIELD OF THE INVENTION

[0002] The invention relates to a method for producing a molded sheet metal part from an as-rolled, non-hardenable aluminum alloy.

BACKGROUND OF THE INVENTION

[0003] Producing highly-stressed vehicle components from aluminum sheet is known. Primarily hardenable alloys are used for this. Normally production consists of pre-forming the low-strength aluminum sheet and then aging it to obtain increased strength.

[0004] Forming is the only way to increase the strength of those aluminum alloys in which an increase in hardness cannot be attained using a thermal treatment (natural or artificial aging). In order to be able to produce complex geometries from sheets of these alloys, as well, they are generally shaped in a soft temper, like the hardenable alloys. This means that these non-hardenable aluminum alloys are for instance soft-annealed in advance.

[0005] It is a disadvantage that the strength of pressed parts that are produced by shaping these soft-annealed, non-hardenable aluminum alloys increases considerably only in areas that have undergone significant shaping. The result is that there is relatively limited potential in lightweight design for using shaped parts that are made of the inexpensive, non-hardenable aluminum alloys. This is also the reason that non-hardenable aluminum alloys are used predominantly as thick-walled components in the chassis. Non-hardenable aluminum alloys are generally distinguished by very good resistance to corrosion. In addition, they are frequently used in components that are not subject to high stress, but in applications in which the focus is not specifically on lightweight design.

[0006] There must be an effort to save weight in all components in order to satisfy current and future requirements for motor vehicles to optimize weight. This applies to components made of non-hardenable aluminum alloys, as well. These aluminum alloys are available as high-strength and higher-strength sheets that are produced by cold rolling or by cold rolling with partial annealing. However, in the past it has not been possible to produce complex components from these commercially readily available semi-finished products, even though this would be very attractive economically due to the potential weight reduction and savings in materials.

SUMMARY OF THE INVENTION

[0007] The underlying object of the invention is therefore to provide an option for producing a high-strength component

that is complex in terms of shaping from sheets that comprise as-rolled, non-hardenable aluminum alloys.

**DESCRIPTION OF THE PREFERRED
EMBODIMENTS**

[0008] This object is attained in a method having the features of patent claim 1. One essential step of the invention is that the temperature range at which the sheet is to be heated is less than 300° C., in particular is less than 250° C. This is because of the fact that most of the strength is lost after heating in the furnace when conventional heating methods to temperatures of about 300° C. are used. However, it has been found that both the recrystallization and the recovery of the structure are a function of a temperature threshold. Therefore the invention provides that an as-rolled, non-hardenable aluminum sheet is heated at an extremely high speed. The sheet temper is H12, H14, H16, H18, H19, H22, H24, H26, H28, H32, H34, H36 or H38 according to European Standard EN515:1993, the disclosure of which is included herein by reference. In addition to aluminum, the sheet includes at least magnesium and where necessary manganese as alloy components. Then the sheet is shaped so rapidly in a cold shaping tool that most of the strength is retained in the entire component. To this end the sheet must be heated at least locally to a temperature between 200° C. and 250° C., preferably 240° C., within a period of 1 to 60 seconds. This heating period is preferably significantly shorter and is especially a period of 1 to 10 seconds.

[0009] European Standard EN 515 establishes how to designate basic tempers for aluminum semi-finished products. The letter H means strain hardened. This designation applies for products that are subjected to cold deformation or a combination of cold deformation and recovery annealing and stabilization after soft annealing (or after hot forming) to assure the established mechanical properties. Two digits follow the letter H; the first identifies the type of thermal treatment, and the second identifies the degree of strain hardening.

[0010] Cold deformation includes plastic deformation of a metal at a temperature and speed that leads to strain hardening. Strain hardening is the change in the metal structure due to cold deformation, which leads to increased strength and hardness, reducing formability.

[0011] H1x means only cold-worked products that are strain hardened, without additional thermal treatment, to attain the desired strength.

[0012] H2x means cold-worked and partially annealed. It applies to products that are strain hardened beyond the desired final strength and then are reduced in strength to the desired strength level by partial annealing.

[0013] H3x means cold-worked and stabilized and applies to strain-hardened products whose mechanical properties are stabilized either by a low temperature thermal treatment or as a result of heat introduced during fabrication. Stabilization improves formability in general. This designation applies only to alloys that lose strength without stabilization by being stored at room temperature.

[0014] The second digit after the H indicates the final degree of strain hardening, which is characterized by the minimum value of the tensile strength. The number 8 is associated with the hardest tempers that are normally produced. The number 9 identifies tempers whose minimum tensile strength is about 10 MPa or more above the H8x tempers. The numbers 2, 4, and 6 identify intermediate tempers. Consequently, H12 means strain hardened—1/4 hard, H14 means

strain hardened—1/2 hard, H16 means strain hardened—3/4 hard, and H18 means strain hardened—4/4 hard (fully hardened). Therefore strain hardened and partially annealed materials are categorized in tempers H22/24/26/28 and strain hardened and stabilized materials are categorized in tempers H32/34/36/38. Overall, therefore, sheets that are as-rolled and thus have been strain-hardened by rolling should be used.

[0015] The advantage of the invention is that a relatively complex component can be fabricated that is made of an as-rolled, non-hardenable aluminum alloy and that has high strength overall or in parts. What is particularly noteworthy is that the parts that have high strength do not depend on the forming and the degree of forming. The result is an alternative fabrication compared to hardenable alloys that are associated with high production costs due to lengthy thermal treatment for up to 24 hours.

[0016] In the context of this invention, an open molded sheet metal part is an element manufactured from a sheet metal plate using molding, that is, from an essentially flat start condition. The starting material has been strain hardened by rolling to a specific target value. An open molded sheet metal part in the context of the invention is not a hollow profile.

[0017] In the framework of the invention, the as-rolled, non-hardenable aluminum sheet should preferably be completely heated and formed. However, partial thermal forming, in which different areas of the sheet metal are heated to different temperatures, is also possible. It is also possible for the sheet metal to have areas that have been heated for different lengths of time, whether to attain different target temperatures or to use the length of heating time to influence the local deformation properties of the sheet metal, and thus its tensile strengths.

[0018] The sheet metal can preferably be heated resistively, conductively, or capacitively.

[0019] With the inventive method it is also possible to create components that should have high strength only in certain areas, it being possible for the components to have a lower strength in other areas, with improved strain values at the same time. The goal pursued is to create a component that is in general better than a completely hard component. It will especially have better properties in terms of deformation behavior in an accident, whether with respect to energy absorption or savings in weight.

[0020] In the framework of the invention it is also possible to continue heating the sheet by area for different lengths of time and to different temperatures during the forming process. To this end the forming die can have a cavity with at least one area that is heated. Locations in the die that are to be heated alternatively or additionally can also be provided cooled areas. The heated areas in the forming die provide the opportunity to keep the die at a higher temperature within an additional period in that a specific area is first heated continuously for a longer period.

[0021] In multi-stage forming, it is also possible to provide cavities that are partially heated in additional die steps. In the same manner, in a process step that follows the forming it is possible to have temporally extended heating using an oven that is active at times or using an inductor. However, it is considered useful to have the extended heating time or higher temperature prior to the forming and not following the forming.

1. Method for producing an open molded sheet metal part from an as-rolled, non-hardenable aluminum alloy that has the following steps:

a) preparing a sheet that is made of a non-hardenable aluminum alloy, the temper of which is H12, H14, H16, H18, H19, H22, H24, H26, H28, H32, H34, H36 or H38 according to European Standard EN 515:1993 and that in addition to aluminum includes at least magnesium and where necessary manganese;

b) heating the aluminum at least locally to a temperature between 200° C. and 350° C. within a period of 1 to 60 seconds;

c) placing the heated sheet in a cold forming die of a forming press and forming the sheet, creating a molded sheet metal part.

2. Method in accordance with claim 1, characterized in that the sheet is heated to a temperature between 200° C. and 240° C. in a period of 1 to 10 seconds.

3. Method in accordance with claim 2, characterized in that the sheet is heated to different temperatures by area prior to forming.

4. Method in accordance with claim 3, characterized in that the sheet is heated resistively, conductively, or capacitively.

5. Method in accordance with claim 3, characterized in that areas of the sheet are heated for different lengths of time.

6. Method in accordance with claim 5, characterized in that the sheet is heated resistively, conductively, or capacitively.

7. Method in accordance with claim 6, characterized in that the forming die has a cavity that has at least one area that is heated.

8. Method in accordance with claim 2, characterized in that areas of the sheet are heated for different lengths of time.

9. Method in accordance with claim 8, characterized in that the sheet is heated resistively, conductively, or capacitively.

10. Method in accordance with claim 2, characterized in that the sheet is heated resistively, conductively, or capacitively.

11. Method in accordance with claim 2, characterized in that the forming die has a cavity with at least one area that is heated.

12. Method in accordance with claim 1, characterized in that the sheet is heated to different temperatures by area prior to forming.

13. Method in accordance with claim 12, characterized in that areas of the sheet are heated for different lengths of time.

14. Method in accordance with claim 13, characterized in that the sheet is heated resistively, conductively, or capacitively.

15. Method in accordance with claim 12, characterized in that the sheet is heated resistively, conductively, or capacitively.

16. Method in accordance with claim 12, characterized in that the forming die has a cavity with at least one area that is heated.

17. Method in accordance with claim 1, characterized in that areas of the sheet are heated for different lengths of time.

18. Method in accordance with claim 17, characterized in that the sheet is heated resistively, conductively, or capacitively.

19. Method in accordance with claim 1, characterized in that the sheet is heated resistively, conductively, or capacitively.

20. Method in accordance with claim 1, characterized in that the forming die has a cavity with at least one area that is heated.