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(54) **METHOD AND INSTALLATION FOR PRODUCING ALUMINUM CAN SHEET**

(57) A method for producing aluminum can sheet comprises the following steps: providing a body made of an aluminum alloy; heating the body to a homogenization temperature; hot rolling said body in a hot rolling mill to produce a hot rolled sheet, said hot rolled sheet exiting the hot rolling mill at a hot rolling exit temperature with a hot mill exit gauge, wherein the hot rolling exit temperature is selected to substantially avoid recrystallization of the hot rolled sheet; cold rolling the hot rolled sheet in a cold rolling mill to apply a cold reduction to produce a cold rolled sheet with a cold mill exit gauge smaller than the hot mill exit gauge; annealing the cold rolled sheet in an intermediate temperature range selected to allow recrystallization of the cold rolled sheet to obtain a recrystallized annealed sheet; cold rolling the recrystallized annealed sheet to apply a cold reduction to produce a cold rolled sheet with a final gauge.

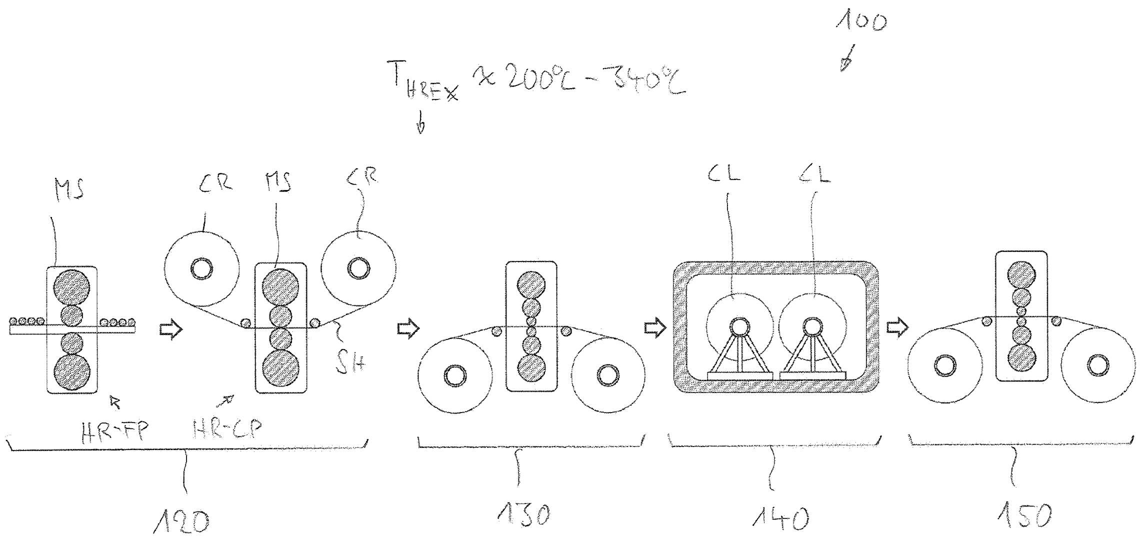

Fig. 1

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Description

TECHNICAL FIELD AND PRIOR ART

[0001] The present invention relates to a method for producing aluminum can sheet and to an installation configured to perform the method.

[0002] When aluminum can sheet is formed into cup-shaped articles, a phenomenon known as "earing" usually occurs to some extent. Earing can be observed as a wave-shaped appearance around the top edge of the formed cup. The wave-like protruding portions, also known as "ears", are formed during the deep drawing step in the fabrication of the cup and represent an undesirable feature of the article. In aluminum can body stock (CBS), the cup is subsequently ironed in multiple rings which can accentuate the wavy ears. High earing can create transport problems with the cup as well as insufficient trim after ironing, clipped ears, and trimmer jams. These artifacts are not desirable in aluminum can manufacturing. Thus, it is desired to minimize earing in order to avoid these problems and to increase the quality of the cup.

[0003] It is known that can body stock material such as AA3004, AA3104 or other aluminum alloy is basically suitable for making aluminum can sheet with low earing characteristics provided that a suitable manufacturing process can be established.

[0004] There is a well-known process established in the aluminum industry for the production of aluminum strip suitable for can body stock. This process includes hot rolling of an aluminum ingot through a rougher mill and then through a multi stand hot rolling mill, usually exiting at a high temperature to ensure fully recrystallized material obtained through a self-anneal process. This well-known method produces a final product with low earing and desirable mechanical characteristics. However, the installation and operation of such a hot continuous mill requires a major capital expenditure.

[0005] Modifications have already been proposed in the past in order to produce can sheet with commercially acceptable earing characteristics from a single stand reversing mill (see e.g. US 5,362,340 and US 5,362,341). According to the method of US 5,362,340 an aluminum alloy ingot is provided and is heated to a temperature between about 527°C to 571°C. After this, the ingot is hot rolled in a single-stand reversible hot mill to produce an intermediate gauge sheet. The intermediate gauge sheet, which is self-annealed or batch annealed, is then cold rolled to produce a final gauge aluminum can sheet having low earing characteristics. The relative low temperature homogenization (527°C to 571°C) is applied in order to avoid uncontrolled recrystallization during hot rolling in the single stand reversing mill.

[0006] Patent application US 2002/0062889 A1 discloses a process and a plant for producing hot-rolled aluminum strip for can making. The plant includes a reversing roughing stage for the feed material, which is used hot, and immediately thereafter finishing rolling of the strip, which is followed by heat treatment of the strip coiled up into coils. During the last finishing rolling passes, recrystallization in the rolled material is suppressed by means of controlled temperature management of the hot strip. In the embodiment temperature is maintained in the noncritical temperature range from 260’ C. to 280’ C to avoid recrystallization. The recrystallization is brought about only outside the rolling train. For this purpose, the hot rolled material is transferred to a continuous furnace directly following the finishing rolling. The direct transfer brings about the advantage that a furnace used for recrystallization only has to apply a relatively small temperature difference (e.g. about 40°C - 60°C) between the rolling temperature and the recrystallization temperature, and thus achieves a favorable energy balance.

SUMMARY OF THE INVENTION

[0007] It is an object of the invention to provide a method and an installation for producing aluminum can sheet suitable for making aluminum cans, wherein the aluminum sheet exhibits favorable earing characteristics after a deep drawing step and further allows producing stable cans with thin wall thickness.

[0008] This object is solved by a method comprising the features of claim 1 and an installation comprising the features of claim 8. Preferred embodiments are defined in the dependent claims.

[0009] According to the method for producing aluminum can sheet, a body (also denoted as ingot) made of an aluminum alloy is provided. The body can be made of cast aluminum, which has subsequently been scalped to obtain a body suitable for further processing. The body is heated to a homogenization temperature. The main purpose of this heating step is to homogenize the material. Homogenization temperatures may be in the range from about 500°C to about 600°C, for example depending on the desired temperature for the next process step. The body may be cooled down to temperatures suitable for hot rolling. In a next step, the body is hot rolled in a hot rolling mill to produce a hot rolled sheet. The hot rolled sheet exiting the hot rolling mill exits the hot rolling mill at a hot rolling exit temperature. The hot rolling step produces a hot rolled sheet having a hot mill exit gauge, which is the thickness of the rolled aluminum sheet after hot rolling. In the hot rolling step, temperature control is made such that the hot rolling exit temperature is selected so as to substantially avoid recrystallization of the hot rolled sheet. In the context of this application, the term "recrystallization" refers to a process by which deformed grains in a metallic body are replaced by a new set of grains that are essentially free of defects and nucleate and grow until the original grains have been entirely consumed. Recrystallization reduces the strength and hardness of the material while at the same time the ductility is increased. In the present process, the hot rolling exit temperature is selected such that the sheet exiting the hot rolling mill exhibits a high density of defects, such as dislocations, etc. and relative high strength and hardness, while at the same time ductility may be relatively low.

[0010] In a next step, the hot rolled sheet is cold rolled in a cold rolling mill. The purpose of this process step is to achieve a cold reduction, meaning that the gauge (or thickness) of the sheet is further reduced. The cold reduction is performed to produce a cold rolled sheet having a cold mill exit gauge which is smaller than the hot mill exit gauge. Cold rolling follows the hot rolling step, after the sheet has cooled down to temperatures of approximately 100°C or lower, e.g. as low as 50°c to 60°C.

[0011] The cold rolled sheet (having the cold mill exit gauge) is then transferred to a furnace to anneal the cold rolled sheet in an intermediate temperature range with temperatures selected to allow recrystallization of the cold rolled sheet. The annealing step results in a fully recrystallized sheet having the cold mill exit gauge. The microstructure of the recrystallized sheet typically exhibits a new set of relative defect-free grains replacing the defective microstructure obtained by cold rolling.

[0012] In a subsequent step, the recrystallized sheet is cold rolled to apply a cold reduction to produce a cold rolled sheet with a final gauge, the final gauge being smaller than the cold mill exit gauge.

[0013] When developing a new process, the inventors have identified certain shortcomings of conventional methods and now propose a new way of producing aluminum can sheet in an economic way avoiding shortcomings of the prior art. For example, studying the process disclosed in US 5,362,340, it has been found that the relative low temperature homogenization treatment, in combination with the chemical composition of the aluminum alloy, could produce strong cube texture upon annealing (either self-annealing or batch-annealing at hot mill exit gauge) which in some cases the cold rolling process that follow the annealing cannot balance. This may result in aluminum can sheets with 0° / 90° earing or very low 45° earing. This earing characteristic may produce, during subsequent drawing and ironing processes, cans with pinched ears at 0° / 180° with respect to the rolling direction as well as increased tear-off cans and low performance at the can-makers.

[0014] Additionally, some limitations of single stand reversing mills may cause problems in conventional processes. The hot rolling exit gauge from a single stand reversing mill may typically range down to values about 2.0 mm. Producing lower exit gauge from a single stand reversing mill is generally difficult and may not be feasible due to difficulties in controlling crown, wedge and flatness of the sheet. On the other hand, the tendency of the can-makers is to reduce the thickness of the can sheet, this tendency also known as "down-gauging". If it is desired to produce a lower thickness final product with similar earing and strength properties when compared to nowadays usual thicknesses it is required to keep the same total cold reduction applied to the material after intermediate annealing at hot gauge thickness (either self-annealing or batch annealing). Achieving this goal would require lowering the hot mill exit gauge to values significantly below 2 mm. The new process is capable of substantially avoiding these problems identified in conventional processes.

[0015] The process according to the above formulation of the invention introduces a cold rolling step inserted between the preceding hot rolling step and the subsequent intermediate annealing step. The new sequence of steps has at least two significant effects. A first effect may be understood considering the final product, the other effect may be understood when considering the thermo-mechanical process itself.

[0016] It has been found that the final product generally exhibits relatively low earing values. The resulting ears are more pronounced at about 45° (relative to the rolling direction). This earing orientation is usually preferable from the final customer's point of view, i.e. from the point of view of the can maker. The new method generally avoids or reduces high ears at 0° / 90° which are not desirable from the can maker's point of view and which are very likely obtained with the process described in the prior art, such as US 5,362,340. From a metallurgical point of view it is believed that the cold reduction introduced after hot rolling and performed on a material which is essentially un-recrystallized can enhance the particle stimulated nucleation (PSN) mechanism which lowers the cube texture density that the material will have after the intermediate annealing. The lower cube texture after annealing will result in an earing tending towards 45° instead of 0 / 90° to the final product.

[0017] Regarding the second effect (on the capability of the thermal-mechanical process) it is observed that the final strength of the material and the earing is highly dependent from the amount of cold work after intermediate annealing at hot gauge. For example, if, in a present conventional process, a material with final gauge 0.26 mm is produced, the intermediate annealing may be performed at about 2 mm gauge. Therefore, the total cold reduction is about 87%. Consider now a case where the final customer requires 0.24 mm final gauge. In order to produce the same earing and properties it would be necessary to make the intermediate annealing at about 1.85 mm. This relatively small thickness often cannot be achieved satisfactorily in a single stand reversing mill due to flatness and thickness range limitations. These limitations do not exist in the new method. Applying the new method enables a producer to produce thicker material from the hot mill (for example about 2.5 mm), make a light cold reduction to the required intermediate annealing gauge (1.85 mm in this hypothetical example), and anneal the sheet at intermediate annealing at this gauge to make the material fully soft before it is cold rolled to the final gauge. In other words: Some limitations of using a single stand reversing mill as a hot rolling mill do no longer limit the capabilities of the overall process. If a single stand reversing mill is used as a hot rolling mill, the method can also increase a lot the output of the single stand hot mill, since it is producing thicker gauge.

[0018] From another point of view, advantages of the new process result at least partly from the fact that cold rolling is performed in two separate steps, wherein the first cold rolling step is performed after hot rolling and before intermediate annealing (on the un-recrystallized material) and the second cold rolling step is performed after the recrystallization annealing (at intermediate temperature) on a material which is recrystallized. As a result, preferable earing characteristics and strength as well as thin final gauges can be obtained even when hot rolling is performed with a single stand reversing mill.

[0019] Considering the advantages of the process described above, a single stand reversing mill is used as a hot rolling mill in a preferred embodiment of the process and installation. While a tandem mill can be used instead of a single stand reversing mill for performing the hot rolling step, use of a single stand reversing mill is typically much less expensive so that the final product can be made in an economical fashion.

[0020] In preferred embodiments the single stand reversing mill is utilized in two different operation modes, wherein a first operation mode includes one or more flat passes and a second operation mode, utilized after the first operation mode, includes one or more coiling passes producing coiled sheet having the hot mill exit gauge.

[0021] The hot rolling step shall be performed such that recrystallization of the hot rolled sheet is substantially avoided. In preferred processes, the hot rolling exit temperature is in a range from about 200°C to about 320°C, with preferred hot rolling exit temperatures being lower than 290°C. These temperatures are usually suitable to avoid recrystallization completely, which enhances the advantages of the overall process. The correct temperatures to avoid recrystallization completely may be selected depending from the alloy type and may differ from alloy to alloy.

[0022] When designing the cold rolling step it has been found that a cold reduction between 5% and 70% is preferably applied in the cold rolling mill rolling the hot rolled sheet. Cold reductions in this range are particularly capable of enhancing the particle stimulated nucleation (PSN) which is believed to lower the cube texture density in the annealed material.

[0023] The cold rolling step can be performed at least in the last rolling passes so that coils of cold rolled sheet are obtained in the single stand mill. In this case, it may be preferable that annealing the cold rolled sheet is performed in a batch furnace. As an alternative, a continuous furnace may be used for the annealing step in the intermediate temperature range to obtain the recrystallized sheet.

[0024] As the overall process allows high degrees of total reduction, a total reduction of more than 70% is applied to the aluminum sheet between the hot mill exit gauge and the final gauge. The total reduction may be 80% or more or even 85% or more. This is partly due to the fact that cold rolling to reduce the gauge is performed in two steps instead of one single step.

[0025] The invention also relates to an installation for producing aluminum can sheet, the installation being configured to perform the method according to the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

[0026] In the following, an embodiment of the invention will be described in detail with reference to the drawings.

Fig. 1 shows a schematic drawing of a portion of an installation configured to manufacture aluminum can sheet suitable for making cup-shaped articles;

Fig. 2 shows a diagram illustrating the relation between the degree of recrystallization of the sheet material after the initial hot rolling step and the amount and type of earing after applying cold reduction to the final gauge; and

Fig. 3 shows a diagram illustrating the influence of cold reduction prior to the intermediate annealing and the effect on the type and degree of earing after cold reduction to the final gauge.

DETAILED DESCRIPTION OF EMBODIMENTS OF THE INVENTION

[0027] Sufficiently high strength and formability (incl. limited earing) are amongst the major requirements for aluminum can body sheet. High strength is needed to achieve sufficient structural stability and to avoid buckling of the can base (dome reversal) under high internal pressure. High strength is also needed to obtain stable cans with very thin can wall after ironing. Good Formability is required as the material undergoes heavy forming operations. Anisotropic material flow due to the texture of the sheet - controlled by balancing the hot strip cube and cold rolling texture - always forms an uneven rim of the can during the deep drawing and ironing operations. This unevenness is also known as "earing". Highly uneven cup rims are detrimental for transport of the can bodies or affect the whole process when ears are stretched and clipped off during ironing, leading to machine down time, reducing efficiency.

[0028] Embodiments of the invention are capable of addressing both requirements in a satisfactory way using an economically feasible production process.

[0029] Figure 1 shows a schematic drawing of a portion of an installation 100 configured to manufacture aluminum can sheet suitable for making cup-shaped articles. The schematic figure shows only some of the devices utilized in the production route.

[0030] The production installation typically includes casting devices to produce large cast ingots from aluminum alloy melt. The cast ingots typically consist of coarse grains with dendrite structure and random texture. Precipitates comprising aluminum and other constituents, such as Fe, Mn, and Si are typically distributed inhomogeneously in the cast ingot.

[0031] In a next step, the cast ingots are homogenized in a homogenization furnace (also denoted as preheating furnace, not shown in Fig. 1). The homogenization treatment is typically accompanied by characteristic changes of the solute content and the precipitation microstructure later affecting recrystallization, grain size and texture during the sheet production.

[0032] The homogenized ingots are then transferred to the hot rolling stage. A single stand reversing mill 120 is used for hot rolling in the preferred installation. The single stand reversing mill 120 is capable of being operated in two different operation modes drawn separately in schematic Fig. 1. In a first operation mode HR-FP (shown on the left hand side of single stand reversing mill 120), the incoming ingots are reduced in thickness using several flat passes where the material is rolled back and forth without being coiled on either side of the rolls. In a second operation mode HR-CP, shown on the right-hand side of the drawing representing the single stand reversing mill 120, coiling reels CR on either side of the mill stand MS are used to coil the sheet SH between coiling passes performed in mutually opposite rolling directions. In either coiling pass, one of the reels is operating as pay-off reel providing an incoming strip to the rolling gap formed in the mill stand. The other reel is used as a tension reel coiling the outgoing strip after the rolling path. Since single-stand reversing mills are generally known in the art, a detailed description is considered as not necessary in this application.

[0033] The hot rolled material is then - after cooling down - transferred as a coil to a cold rolling stage 130 arranged downstream of the hot rolling stage in the material flow direction. The cold rolling mill could be a single stand (as shown) or a multiple stands cold mill.

[0034] A batch furnace 140 is arranged downstream of the cold rolling stage 130. The batch furnace is configured to receive multiple coils CL after cold rolling and to perform intermediate annealing of the cold material to achieve full recrystallization of the sheet material.

[0035] A further cold rolling stage 150 is arranged downstream of the intermediate annealing batch furnace 140 to apply cold rolling to the recrystallized material to obtain cold rolled material at the final gauge desired for further processing steps, e.g. as a H1X material or, more specifically, as a H19 material. The cold rolling mill 150 comprises a single stand in the embodiment of Fig. 1.

[0036] An exemplary process for producing aluminum can sheet on the installation 100 was performed as follows.

[0037] In a preparatory step, an aluminum alloy was cast to form a casting and subsequently scalped to obtain a body of cast and scalped aluminum alloy suitable for further processing. This body is also denoted as ingot in the following. The aluminum alloy can be a can body stock material such as AA3004, AA3104 or other aluminum alloy basically suitable for making aluminum can sheet.

[0038] After casting and scalping, the ingot was homogenized at about 500 - 595°C with soaking time e.g. from 5 to 20 hours, followed by ingot cooling down to about 490 - 530°C.

[0039] The homogenized ingot (aluminum body) was then transferred to the hot rolling mill without significant intermediate cooling so that hot rolling of the ingot started at about this temperature, i.e. at about 490-530°C. A single stand-reversing mill 120 was utilized as hot rolling mill in this installation setup.

[0040] Several flat passes were carried out, down to about 25 to 45mm gauge. The ingot temperature after the last flat pass was between about 290 and 350°C. The number of flat passes may range, for example, from 15 to 50.

[0041] After the flat passes, the thickness of the material was further reduced with hot rolling on the same single stand-reversing mill 120, with the difference that the material was coiled after each pass (coiling passes). The number of coiling passes was from 2 to 8.

[0042] The thickness of the material after the last coiling pass was from about 1.7mm to about 5mm. In the experiments reported here, the exit temperature of the material after hot rolling, i.e. the hot rolling exit temperature T_{HREX}, was low enough to ensure the absence of recrystallization. Typically, the hot rolling exit temperature was in a range from about 200°C to about 340°C and preferably between about 220°C and about 280°C. The reduction of each coiling pass was between 20 and 70%.

[0043] The hot rolled material was cooled down and then transferred to a cold rolling mill.

[0044] A cold reduction from 5% to 70% was applied to the material in the cold rolling mill directly at the hot band not recrystallized material.

[0045] The cold rolled sheet was then transferred in coiled form to an batch furnace 140 for intermediate annealing. An intermediate annealing step was then applied to the cold rolled sheet. Annealing temperatures and annealing times were selected so that the annealed material was allowed to become fully recrystallized and to develop a strong cube texture. A typical range of annealing temperature is from 280°C to 450°C with 1 to 12 hours holding time.

[0046] The recrystallized annealed sheet was then subject to cold rolling to apply a cold reduction suitable to produce a cold rolled sheet with a final gauge. Preferably, cold rolling from 70% to 95% reduction was applied to the recrystallizes sheet, giving the material the required strength and balancing the cube texture with rolling texture. In case of recrystallization (partial or full) at the thickness of the hot band (either self-annealing or after batch anneal), the cube texture developed after annealing was weak and the final product had high 45° earing.

[0047] With the method described above, the un-recrystallized hot band undergoes a relative low cold reduction and then an intermediate annealing is applied to the material to become fully soft. With this method, there is an intermediate annealing thickness reduction with cold rolling without deterioration of the strong cube texture after annealing.

[0048] The combination of the low cold reduction to the un-recrystallized structure directly after hot rolling and batch annealing to produce fully recrystallized material could be applied also to the conventional method of producing can body stock through a tandem hot rolling mill. In other words, in an alternative embodiment a tandem hot rolling mill may be used instead of a single stand reversing mill to perform the hot rolling step preceding the cold rolling step.

[0049] In the following, some characteristic aspects of the new, beneficial process are explained in connection with the schematic diagrams of Figs. 2 and 3. Fig. 2 schematically illustrates the technical connection between the degree of recrystallization of the sheet material after the initial hot rolling step and the amount and type of earing after applying cold reduction to the final gauge. Fig. 3 illustrates the importance of the step of cold reduction prior to the intermediate annealing and the effect on the type and degree of earing after cold reduction to the final gauge.

[0050] In each diagram of Figs. 2 and 3, the x-axis represents the degree of cold reduction (in percent) applied after the intermediate annealing. In other words, the x-axis represents the amount of cold reduction achieved in the cold rolling mill 150 situated downstream of the intermediate annealing furnace 140. The y-axis represents the type and amount of earing (in percent). The area above the baseline BL corresponds to 0 - 90° earing, whereas the area below the baseline BL represents 45° earing. The absolute distance of a data point from the baseline in the y-direction of the diagram represents the amount or strength of the respective earing, meaning that a point on the baseline BL corresponds to a sheet showing no earing at all. The curves of the diagram represent general trends established in a high number of experiments. The schematic box plots BP in Fig. 3 indicate that the trends represented by the lines are considered to be significant.

[0051] Fig. 2 basically illustrates the importance of the requirement that the hot rolling exit temperature should be selected such that any recrystallization of the hot rolled sheet should be avoided as much as possible.

[0052] The solid line represents a case where the rolled sheet is substantially un-recrystallized after finishing the hot rolling operation. This is an embodiment of the claimed invention. For comparison, the lower curve (dashed line) represents reference cases where the sheets were partially recrystallized after finishing the hot rolling step which, in other words, means that the recrystallization was not sufficiently avoided in the presented reference processes. The solid line shows that there is a high degree of 0 - 90° earing at the fully recrystallized material after intermediate annealing and before the cold reduction starts (at value of cold reduction = 0%). As cold reduction is increased, the degree of 0 - 90° earing is continuously decreased so that shortly before obtaining the final gauge (at the highest point of cold reduction) there is no discernible earing (solid curve crosses the baseline). In the final product after the full cold reduction is applied to the sheet, a certain amount of 45° earing is discernible, but the degree of earing is low in absolute terms.

[0053] In contrast, where the material shows a significant amount of recrystallization after finishing the hot rolling step (dashed line), the degree of 0 - 90° earing is lower than in cases according to embodiments of the invention. As cold reduction is increased, the degree of 0 - 90° earing decreases and would vanish completely at a cold reduction which is not sufficient to obtain the thinner final gauge. As the amount of cold reduction is increased to obtain the thinner final gauge the character of the earing changes from 0° - 90° earing to predominantly 45° earing and the amount of 45° earing increases to a level much higher in absolute terms than in the material according to the claimed process (solid line). This shows that the degree of recrystallization after the hot rolling step has a significant influence on the amount and character of earing in the final product.

[0054] The diagram in Fig. 3 can be read in a similar way. The diagram illustrates the importance of the step of cold reduction applied prior to the immediate annealing. In the diagram, the upper curve (dashed line) corresponds to a case where no cold reduction was applied prior to annealing. This could be a process similar to the processes described in the prior art mentioned in the beginning of this application. It is seen that a high degree of 0° - 90° earing is present immediately after the intermediate annealing. When the material is finally cold rolled to the final gauge (maximum amount of cold reduction) there is almost no or very little earing in the final product. If a certain amount of 45° earing is present, the absolute amount is small.

[0055] In contrast to that, the dotted line below the dashed line represents processes according to embodiments of the invention where a cold reduction is applied prior to the intermediate annealing in a cold mill rolling the (essentially un-recrystallized) material exiting the hot rolling state before the material is transferred to the intermediate annealing. In the beginning, before cold reduction is applied, the amount of 0 - 90° earing is less than in the case of no cold reduction prior to annealing. Once the sheet is reduced in thickness to the final gauge (at maximum cold reduction), there is a significant amount of 45° earing, which is a property desired by many can makers working with a very thin aluminum sheet.

Claims

1. A method for producing aluminum can sheet comprising:

   providing a body made of an aluminum alloy;
   heating the body to a homogenization temperature;
   hot rolling said body in a hot rolling mill to produce a hot rolled sheet, said hot rolled sheet exiting the hot rolling mill at a hot rolling exit temperature with a hot mill exit gauge, wherein the hot rolling exit temperature is selected to substantially avoid recrystallization of the hot rolled sheet;
   cold rolling the hot rolled sheet in a cold rolling mill to apply a cold reduction to produce a cold rolled sheet with a cold mill exit gauge smaller than the hot mill exit gauge;
   annealing the cold rolled sheet in an intermediate temperature range selected to allow recrystallization of the cold rolled sheet to obtain a recrystallized annealed sheet;
   cold rolling the recrystallized annealed sheet to apply a cold reduction to produce a cold rolled sheet with a final gauge.

2. The method according to claim 1, wherein a single stand reversing mill is utilized as a hot rolling mill.

3. The method according to claim 2, wherein the single stand reversing mill is utilized in two different operation modes, wherein a first operation mode includes one or more flat passes and a second operation mode, utilized after the first operation mode, includes one or more coiling passes producing coiled sheet having the hot mill exit gauge.

4. The method according one of the preceding claims, wherein the hot rolling exit temperature is in a range from 200°C to 320°C, wherein preferably the hot rolling exit temperature is lower than 290°C.

5. The method according to one of the preceding claims, wherein a cold reduction between 5% and 70% is applied in the cold rolling mill rolling the hot rolled sheet.

6. The method according to one of the preceding claims, wherein annealing the cold rolled sheet is performed in a batch furnace

7. The method according to one of the preceding claims, wherein a total reduction of more than 70% is applied to the aluminum sheet between hot mill exit gauge and the final gauge.

8. An installation (100) for producing aluminum can sheet comprising:

   a preheating furnace for heating a body made of an aluminum alloy to a homogenization temperature;
   a hot rolling mill (120) arranged downstream of the preheating furnace for hot rolling said body to produce a hot rolled sheet, the hot rolling mill configured so that a hot rolled sheet exits the hot rolling mill at a hot rolling exit temperature with a hot mill exit gauge, wherein the hot rolling exit temperature is selected to substantially avoid recrystallization of the hot rolled sheet;
   a cold rolling mill (130) arranged downstream of the hot rolling mill (120) and configured to receive the hot rolled sheet and to apply a cold reduction to produce a cold rolled sheet with a cold mill exit gauge smaller than the hot mill exit gauge;
   an annealing furnace (140) arranged downstream of the cold rolling mill for annealing the cold rolled sheet in an intermediate temperature range selected to allow recrystallization of the cold rolled sheet to obtain a recrystallized annealed sheet;
   a cold rolling mill (150) arranged downstream of the annealing furnace (140) for cold rolling the recrystallized annealed sheet to apply a cold reduction to produce a cold rolled sheet with a final gauge.

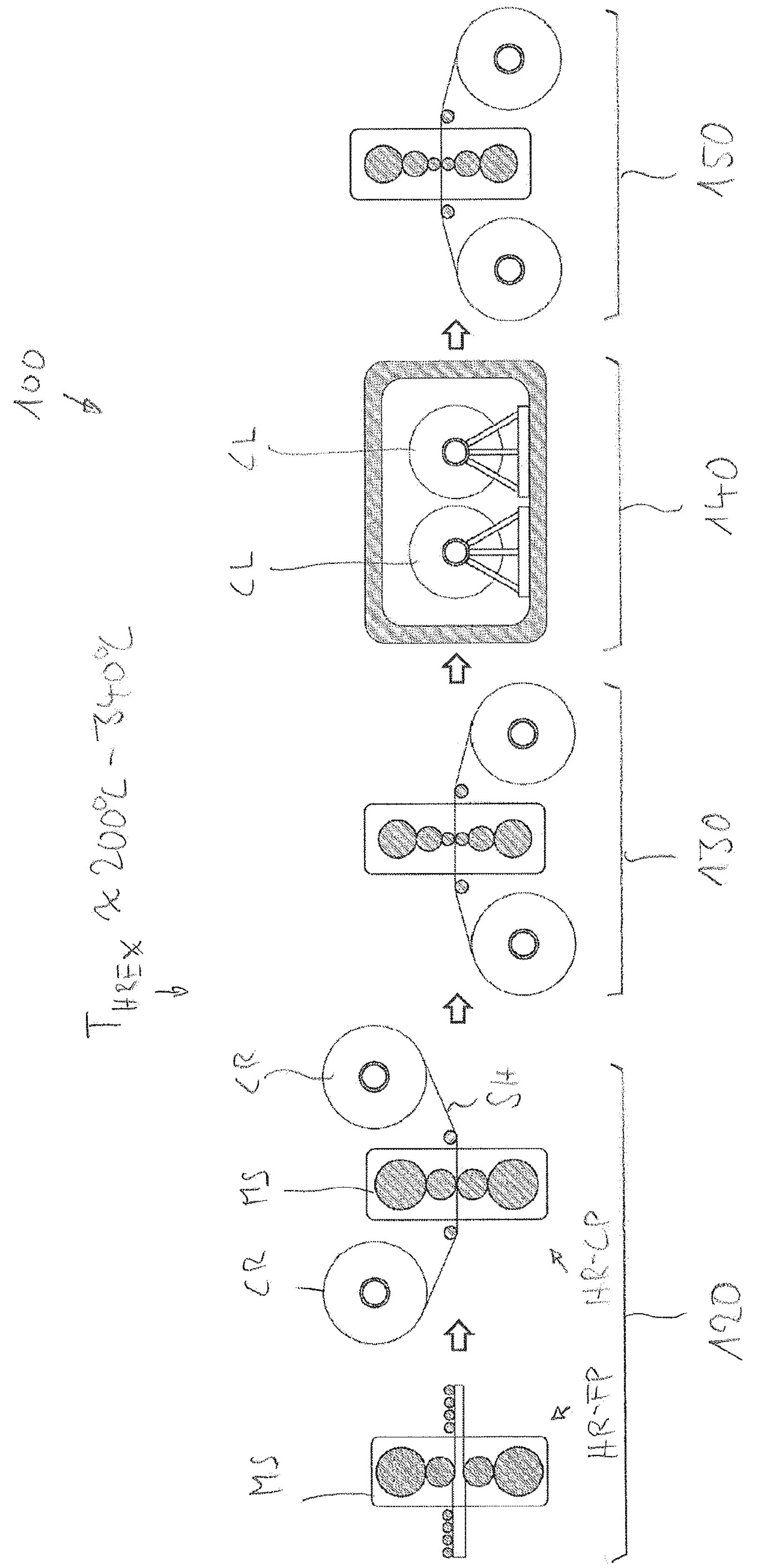

Fig. 1

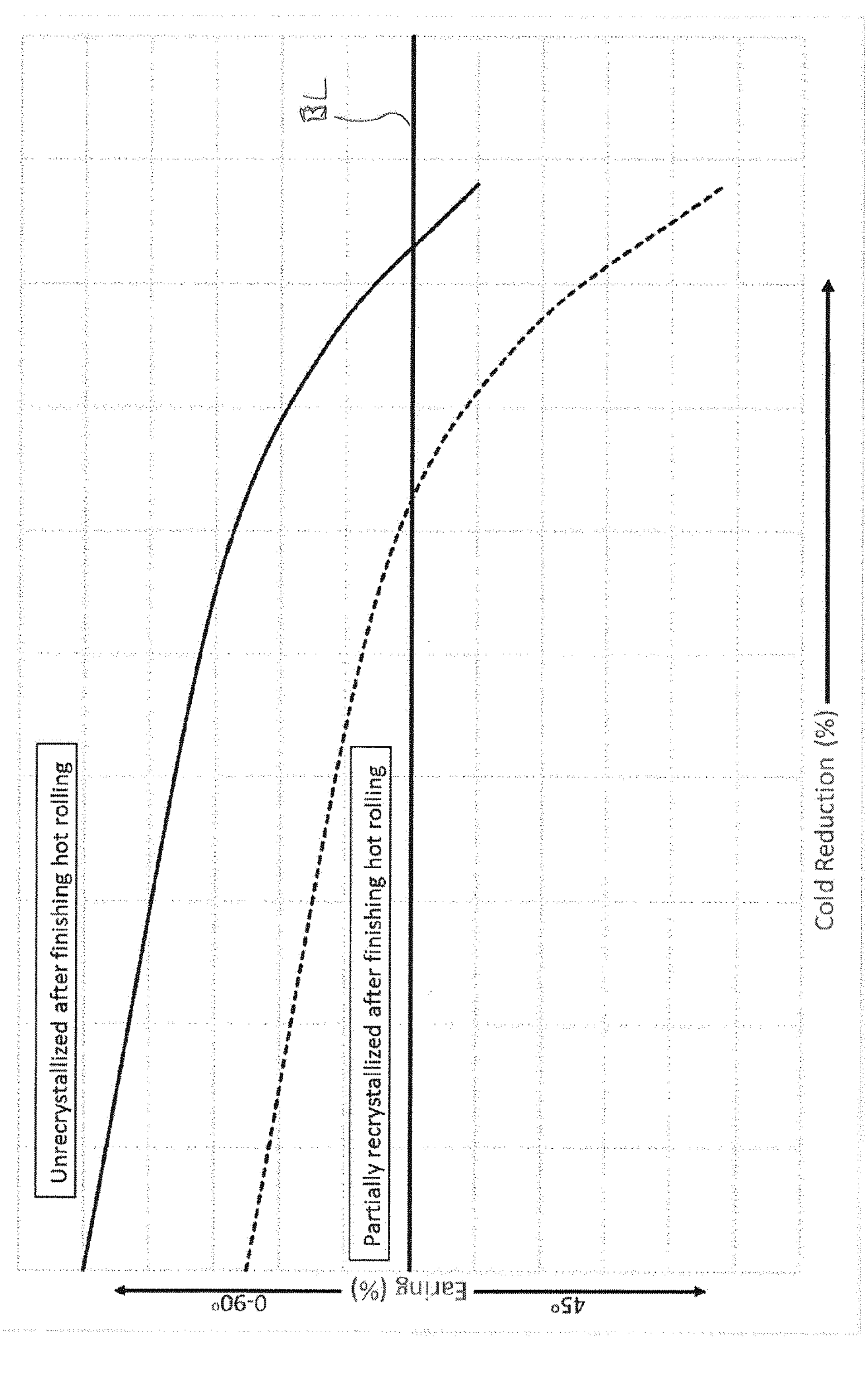
BL
Unrecrystallized after finishing hot rolling
Partially recrystallized after finishing hot rolling
Cold Reduction (%)
Earing (%)
0-90°
45°

Fig. 2

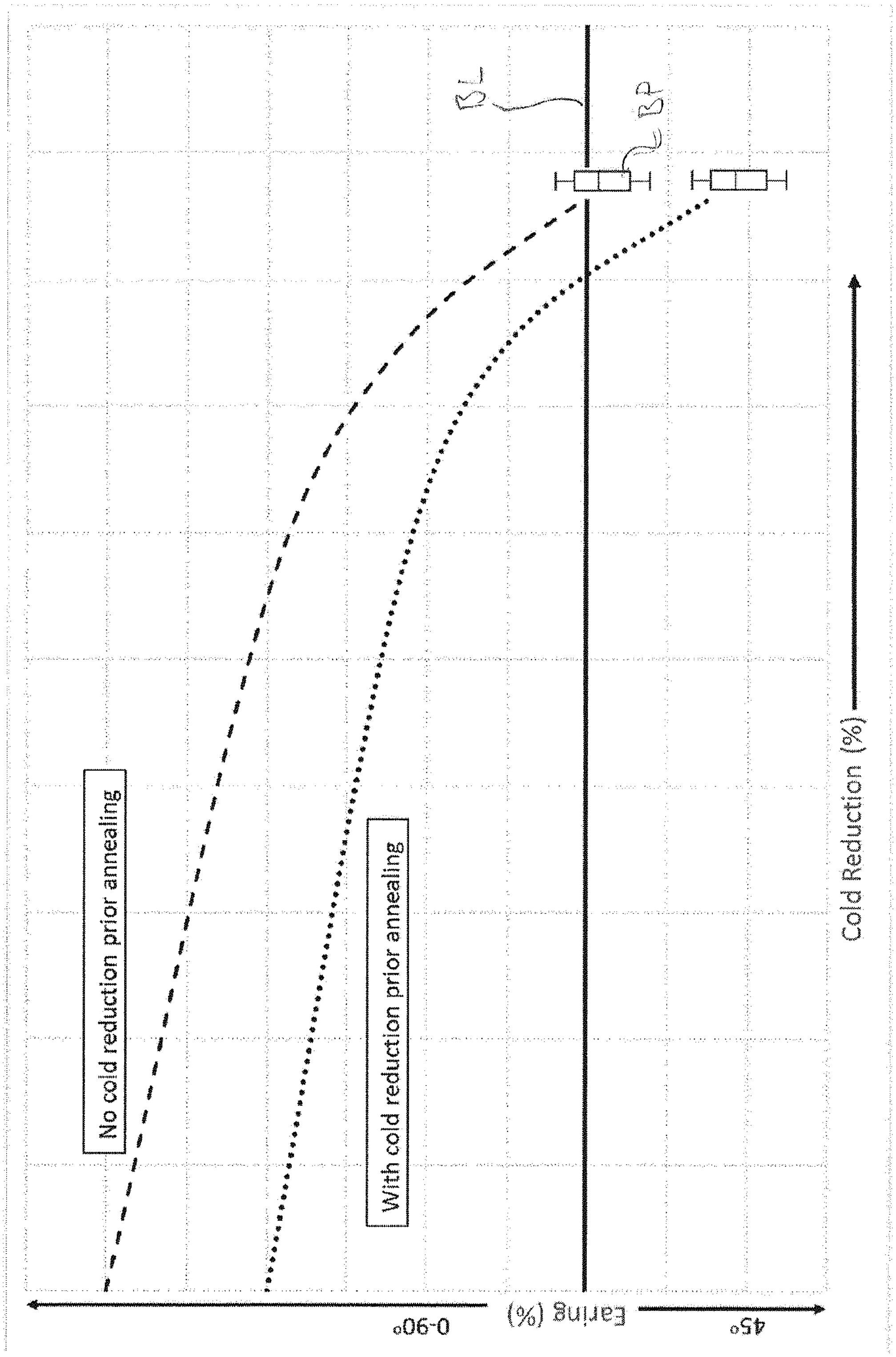
No cold reduction prior annealing
With cold reduction prior annealing
BL
BP
Cold Reduction (%)
Earing (%)
0-90°
45°

Fig 3

Europäisches Patentamt
European Patent Office
Office européen des brevets

EUROPEAN SEARCH REPORT

Application Number
EP 20 16 0733

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	WO 2015/140833 A1 (UACJ CORP [JP]) 24 September 2015 (2015-09-24) * claims 1-7; tables 1-4 * -----	1-8	INV. C22F1/04
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Place of search	Date of completion of the search	Examiner
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