670338

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PATENTS ACT 1990

PATENT REQUEST: STANDARD PATENT

I/We, the Applicant(s)/Nominated Person(s) specified below, request I/We be granted a patent for the invention disclosed in the accompanying standard complete specification.

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[54] Invention Title:

Method of Manufacturing Can Body Sheet Using Two Sequences of Continuous, In-Line Operations

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NOTICE OF ENTITLEMENT

I, Alan G. Longmuir, of Kaiser Aluminum & Chemical Corporation, Pleasanton, California, U.S.A.

being authorised by the Applicant(s)/Nominated Person(s) in respect of Application No 51992/93 state the following:-

The Applicant/Nominated Person has entitlement from the actual inventors as follows:-

The Applicant/Nominated Person is the assignee of the actual inventors.

The Applicant/Nominated Person is entitled to rely on the basic applications listed on the Patent Request as follows:

The Applicant/Nominated Person is the assignee of the basic applicant.

The basic application listed on the Patent Request is the first application made in a Convention country in respect of the invention.

DATED this 6th day of December 1993

.....
(Signature)
Alan G. Longmuir, Vice President
.....
(Name & Title)

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(56) Prior Art Documents
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(57) Claim

1. A method for manufacturing can body sheet in which the process is carried out in two sequences of continuous, in-line operation comprising, in the first sequence, continuously hot rolling a hot aluminum feedstock to reduce its thickness, coiling the hot rolled feedstock while it is hot, holding the hot reduced feedstock at or near the hot rolling exit temperature for at least two minutes to effect recrystallization and solutionization without intermediate heating, and, in the second continuous in-line sequence, the steps of uncoiling the hot coiled feedstock and quenching the annealed feedstock immediately and rapidly to a temperature sufficient for cold rolling.

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METHOD OF MANUFACTURING CAN BODY SHEET USING TWO SEQUENCES OF CONTINUOUS, IN-LINE OPERATIONS

Background Of The Invention

The present invention relates to a two-sequence continuous in-line process for economically and efficiently producing aluminum alloy beverage can body stock.

PRIOR ART

It is now conventional to manufacture aluminum cans such as beverage cans in which sheet stock of aluminum in wide widths [for example, 60 inches (152.4 cm)] is first blanked into a circular configuration and cupped, all in a single operation. The sidewalls are then drawn and ironed by passing the cup through a series of dies having diminishing bores. The dies thus produce an ironing effect which lengthens the sidewall to produce a can body thinner in dimension than its bottom. The resulting can body has thus been carefully designed to provide a shape yielding maximum strength and minimum metal.

There are three characteristics that are common to prior art processes for manufacturing can body stock: a) the width of the body stock is wide [typically greater than 60 inches(152.4 cm)], b) the body stock is produced by large plants employing large sophisticated machinery and c) the body stock is packaged and shipped long distances to can making customers. Can stock in wide widths suitable for utilization by current can makers has necessarily been produced by a few large, centralized rolling plants. Such plants typically produce many products in addition to can body stock, and this

the use of flexible manufacturing on a large scale, with attendant cost and efficiency disadvantages. The width of the product necessitates the use of large-scale machinery in all areas of the can stock producing plants, and the quality requirements of can body stock, as well as other products, dictate that this machinery be sophisticated. Such massive, high-technology machinery represents a significant economic burden, both from a capital investment and an operating cost perspective. Once the can body stock has been manufactured to finish gauge as described in detail hereinafter, it is carefully packaged to seal against moisture intrusion for shipment to customers' can making facilities. These facilities are typically located remote from the can stock manufacturers' plant; indeed, in many cases they are hundreds or even thousands of miles apart. Packaging, shipping, and unpackaging therefore represent a further significant economic burden, especially when losses due to handling damage, atmospheric conditions, contamination and misdirection are added. The amount of product in transit adds significant inventory cost to the prior art process.

Conventional manufacturing of can body stock employs batch processes which include an extensive sequence of separate steps. In the typical case, a large ingot is cast and cooled to ambient temperature. The ingot is then stored for inventory management. When an ingot is needed for further processing, it is first treated to remove defects such as segregation, pits, folds, liquation and handling damage by machining of its surfaces. This operation is called scalping. Once the ingot has surface defects removed, it is heated to a required homogenization temperature for several hours to ensure that the components of the alloy are uniformly distributed through the metallurgical structure, and then cooled to a lower temperature for hot rolling. While it is still hot, the ingot is subjected to breakdown hot rolling in a number of passes using reversing or non-reversing mill stands which serve to reduce the thickness of the ingot. After breakdown hot rolling, the ingot is then typically supplied to a tandem mill for hot finishing

rolling, after which the sheet stock is coiled, air cooled and stored. The coil may be annealed in a batch step. The coiled sheet stock is then further reduced to final gauge by cold rolling using unwinders, rewinders and single and/or tandem rolling mills.

Batch processes typically used in the aluminum industry require many different material handling operations to move ingots and coils between what are typically separate processing steps. Such operations are labor intensive, consume energy, and frequently result in product damage, re-working of the aluminum and even wholesale scrapping of product. And, of course, maintaining ingots and coils in inventory also adds to the manufacturing cost.

Aluminum scrap is generated in most of the foregoing steps, in the form of scalping chips, end crops, edge trim, scrapped ingots and scrapped coils. Aggregate losses through such batch processes typically range from 25 to 40%. Reprocessing the scrap thus generated adds 25 to 40% to the labor and energy consumption costs of the overall manufacturing process.

It has been proposed, as described in U.S. Patent Nos. 4,260,419 and 4,282,044, to produce aluminum alloy can stock by a process which uses direct chill casting or minimill continuous strip casting. In the process there described, consumer aluminum can scrap is remelted and treated to adjust its composition. In one method, molten metal is direct chill cast followed by scalping to eliminate surface defects from the ingot. The ingot is then preheated, subjected to hot breakdown rolling followed by continuous hot rolling, coiling, batch annealing and cold rolling to form the sheet stock. In another method, the casting is performed by continuous strip casting followed by hot rolling, coiling and cooling. Thereafter, the coil is annealed and cold rolled. The minimill process, as described above, requires about ten material handling operations to move ingots and coils between about nine process steps. Like other conventional processes described earlier, such operations are labor intensive, consume energy and

frequently result in product damage. Scrap is generated in the rolling operations resulting in typical losses throughout the process of about 10 to 20%.

In the minimill process, annealing is typically carried out in a batch fashion with the aluminum in coil form. Indeed, the universal practice in producing aluminum alloy flat rolled products has been to employ slow air cooling of coils after hot rolling. Sometimes the hot rolling temperature is high enough to allow recrystallization of the hot coils as the aluminum cools down. Often, however, a furnace coil batch anneal must be used to effect recrystallization before cold rolling. Batch coil annealing as typically employed in the prior art requires several hours of uniform heating and soaking to achieve recrystallization. Alternatively, after breakdown cold rolling, prior art processes frequently employ an intermediate annealing operation prior to finish cold rolling. During slow cooling of the coils following annealing, some alloying elements which had been in solid solution in the aluminum will precipitate, resulting in reduced strength attributable to solid solution hardening.

The foregoing patents (No. 4,260,419; and No. 4,292,044) employ batch coil annealing, but suggest the concept of flash annealing in a separate processing line. These patents suggest that it is advantageous to slow cool the alloy after hot rolling and then reheat it as part of a flash annealing process. That flash annealing operation has been criticized in U.S. Patent No. 4,614,224 as not economical.

There is thus a need to provide a continuous, in-line process for producing aluminum alloy can body stock which avoids the unfavorable economics embodied in conventional processes of the types described.

It is accordingly an object of the present invention to provide a process for producing heat treated aluminum alloy can body stock which can be carried out without the need for either a batch annealing furnace or a flash annealing furnace.

It is a more specific object of the invention to provide a process for commercially producing heat treated

aluminum alloy can body stock in a two-sequence continuous process which can be operated economically and provide a product having equivalent or better metallurgical properties needed for can making.

These and other objects and advantages of the invention appear more fully hereinafter from a detailed description of the invention.

Summary Of The Invention

The concepts of the present invention reside in the discovery that it is possible to produce heat treated aluminum alloy can body stock in a two-stage continuous process having the following operations combined in the two sequences of two continuous lines. The first sequence includes the continuous, in-line steps of casting, hot rolling, coiling and self-annealing; The second sequence includes the continuous, in-line steps of uncoiling while still hot, quenching, cold rolling and coiling. This process eliminates the capital cost of an annealing furnace while obtaining strength associated with heat treatment. The two-step operation in place of many step batch processing facilitates precise control of process conditions and therefore metallurgical properties. Moreover, carrying out the process steps continuously and in-line eliminates costly materials handling steps, in-process inventory and losses associated with starting and stopping the processes.

The process of the present invention thus involves a new method for the manufacture of heat treated aluminum alloy can body stock utilizing the following two continuous in-line sequences:

Stage one having in-line the following continuous operations:

(a) A hot aluminum feedstock is provided, such as by strip casting;

(b) The feedstock is hot rolled to reduce its thickness;

(c) The hot reduced feedstock is coiled hot; and

(d) The hot reduced feedstock is thereafter held in coil form at the hot rolling exit temperature (or a few degrees lower as temperature decays) for 2 to 120 minutes to effect recrystallization and solutionization without intermediate heating;

Stage two has the following in-line continuous operations:

(a) Uncoiling hot product;

(b) Quenching the annealed product immediately and rapidly to a temperature suitable for cold rolling;

(c) Cold rolling the quenched feedstock to produce can body sheet stock having desired thickness and metallurgical properties; and

(d) Coiling or an alternate operation such as blanking and cupping.

In accordance with a preferred embodiment of the invention, the strip is fabricated by strip casting to produce a cast thickness less than 1.0 inch (2.454 cm), and preferably within the range of 0.05 to 0.2 inches (0.12 to 0.50 cm).

In another preferred embodiment, the width of the strip, slab or plate is narrow, contrary to conventional wisdom; this facilitates ease of in-line threading and processing, minimizes investment in equipment and minimizes cost in the conversion of molten metal to can body stock.

In a further preferred embodiment, resulting favorable capacity and economics mean that small dedicated can stock plants may conveniently be located at can-making facilities, further avoiding packaging and shipping of can stock and scrap web, and improving the quality of the can body stock as seen by the can maker.

Brief Description Of The Drawings

Fig. 1 is a plot of in-process thickness versus time for conventional minimill, and the two-step "micromill" process of the present invention.

Fig. 2 is a plot of temperature versus time for the present invention, referred to as the two-step micromill process, as compared to two prior art processes.

Fig. 3 is a block diagram showing the two-step process of the present invention for economical production of aluminum can body sheet.

Fig. 4 shows a schematic illustration of the present invention with two in-line processing sequences from casting throughout finish cold rolling.

Detailed Description Of The Invention

In the preferred embodiment, the overall process of the present invention embodies three characteristics which differ from the prior art processes;

(a) The width of the can body stock product is narrow;

(b) The can body stock is produced by utilizing small, in-line, simple machinery; and

(c) The said small can stock plants are located in or adjacent to the can making plants, and therefore packaging and shipping operations are eliminated.

The in-line arrangement of the processing steps in a narrow width [for example, 12 inches (30.5 cm)] makes it possible for the invented process to be conveniently and economically located in or adjacent to can production facilities. In that way, the process of the invention can be operated in accordance with the particular technical and throughput needs for can stock of can making facilities.

Furthermore, elimination of shipping mentioned above leads to improved overall quality to the can maker by reduced traffic damage, water stain and lubricant dry-out; it also presents a significant reduction in inventory of transportation palettes, fiber cores, shrink wrap, web scrap and can stock. Despite the increased number of cuppers required in the can maker's plant to accommodate narrow sheet, overall reliability is increased and cupper jams are less frequent because the can body stock is narrow.

As can be seen from the foregoing prior art patents, the batch processing technique involves fourteen separate steps while the minimill prior art processing involves about nine separate steps, each with one or more handling operations. The present invention is different from that prior art by virtue of in-line flow of product through the fabrication operations involving only two or three handling steps and the metallurgical differences that the method produces as discussed hereinafter. Fig. 1 shows the thickness of in-process product during manufacture for conventional, minimill, and micromill processes. The conventional method starts with up to 30-in.(76.2 cm) thick ingots and takes 14 days. The minimill process starts at 0.75-in. (1.90 cm) thickness and takes 9 days. The micromill process starts at 0.140-in. (0.36 cm) thickness and takes 1/2 day (most of which is the melting cycle, since the in-line process itself takes less than two hours). The symbols in Fig. 1 represent major processing and/or handling steps. Fig. 2 compares typical in-process product temperature for three methods of producing can body stock. In the conventional ingot method, there is a period for melting followed by a rapid cool during casting with a slow cool to room temperature thereafter. Once the scalping process is complete, the ingot is heated to an homogenization temperature before hot rolling. After hot rolling, the product is again cooled to room temperature. At this point, it is assumed in the figure that the hot rolling temperature and slow cool were sufficient to anneal the product. However, in some cases, a batch anneal step of about 600°F (315.6°C) is needed

at about day 8 which extends the total process schedule an additional two days. The last temperature increase is associated with cold rolling, and it is allowed to cool to room temperature.

In the minimill process, there is again a period of melting, followed by rapid cooling during slab casting and hot rolling, with a slow cool to room temperature thereafter. Temperature is raised slightly by breakdown cold rolling and the product is allowed to cool again slowly before being heated for batch annealing. After batch annealing, it is cooled slowly to room temperature. The last temperature increase is associated with cold rolling and it is allowed to cool to room temperature.

In the micromill process of the preferred embodiment of the present invention, there is in-line melting, strip casting, hot rolling, and coiling. Immediately after recrystallization, which in the preferred embodiment takes several minutes, the hot-rolled coil is processed through a second in-line sequence of uncoiling, quenching, cold rolling, and coiling.

As can be seen from Fig. 2, the present invention differs substantially from the prior art in duration, frequency and rate of heating and cooling. As will be appreciated by those skilled in the art, these differences represent a significant departure from prior art practices for manufacturing aluminum alloy can body sheet.

In the preferred embodiment of the invention as illustrated in Figs. 3 and 4, the sequence of steps employed in the practice of the present invention is illustrated. One of the advances of the present invention is that the processing steps for producing can body sheet can be arranged in two continuous steps whereby the various processes are carried out in sequence. Thus, numerous handling operations are entirely eliminated.

In the preferred embodiment, molten metal is delivered from a furnace 1 to a metal degassing and filtering device 2 to reduce dissolved gases and particulate matter from

the molten metal, as shown in Fig. 4. The molten metal is immediately converted to a cast feedstock 4 in casting apparatus 3. As used herein, the term "feedstock" refers to any of a variety of aluminum alloys in the form of ingots, plates, slabs and strips delivered to the hot rolling step at the required temperatures. Herein, an aluminum "ingot" typically has a thickness ranging from about 6 inches to about 30 inches (15.24-76.2 cm), and is usually produced by direct chill casting or electromagnetic casting. An aluminum "plate", on the other hand, herein refers to an aluminum alloy having a thickness from about 0.5 inches to about 6 inches (1.27-15.24 cm), and is typically produced by direct chill casting or electromagnetic casting alone or in combination with hot rolling of an aluminum alloy. The term "slab" is used herein to refer to an aluminum alloy having a thickness ranging from 0.375 inch to about 3 inches (0.95-7.62 cm), and thus overlaps with an aluminum plate. The term "strip" is herein used to refer to an aluminum alloy, typically having a thickness less than 0.375 inch (0.95 cm). In the usual case, both slabs and strips are produced by continuous casting techniques well known to those skilled in the art.

The feedstock employed in the practice of the present invention can be prepared by any of a number of casting techniques well known to those skilled in the art, including twin belt casters like those described in U.S. Patent No. 3,937,270 and the patents referred to therein.

The present invention contemplates that any one of the above physical forms of the aluminum feedstock may be used in the practice of the invention. In the most preferred embodiment, however, the aluminum feedstock is produced directly in either slab or strip form by means of continuous casting.

The feedstock 4 is moved through optional pinch rolls 5 into hot rolling stands 6 where its thickness is decreased. The hot reduced feedstock 4 exits the hot rolling stands 6 and is then passed to coiler 7.

While the hot reduced feedstock 4 is held on coiler 7 for 2 to 120 minutes at the hot rolling exit temperature and during the subsequent decay of temperature it undergoes self-annealing. As used herein, the term "self-anneal" refers to a heat treatment process, and includes recrystallization, solutionization and strain recovery. During the hold time on the coil, insulation around the coil may be desirable to retard the decay of temperature.

It is an important concept of the invention that the feedstock 4 be immediately passed to the coiler 7 for annealing while it is still at an elevated temperature from the hot rolling operation of mills 6 and not allowed to cool to ambient temperature. In contrast to the prior art teaching that slow cooling to ambient temperature following hot rolling is metallurgically desirable, it has been discovered in accordance with the present invention that it is not only more thermally efficient to utilize self-annealing but also, combined with quenching, it provides much improved strength over conventional batch annealing and equal or better metallurgical properties compared to on-line or off-line flash annealing. Immediately following the prescribed hold time coiler 7 and uncoiler 13, the coil is unwound continuously, while hot, to quench station 8 where the feedstock 4 is rapidly cooled by means of a cooling fluid to a temperature suitable for cold rolling. In the most preferred embodiment, the feedstock 4 is passed from the quenching station to one or more cold rolling stands 9 where the feedstock 4 is worked to harden the alloy. After cold rolling, the strip or slab 4 is coiled on a coiler 12.

Alternatively, it is possible, and sometimes desirable, to immediately cut blanks and produce cups for the manufacture of cans instead of coiling the strip or slab 4. Thus, in lieu of coiler 12, there can be substituted in its place a shear, punch, cupper or other fabricating device. It is also possible to employ appropriate automatic control apparatus; for example, it is frequently desirable to employ a surface inspection device 10 for on-line monitoring of surface quality. In addition, a thickness measurement device 11

conventionally used in the aluminum industry can be employed in a feedback loop for control of the process.

It has become the practice in the aluminum industry to employ wider cast strips or slabs for reasons of economy. The reasoning behind the conventional wisdom is illustrated in the following Table I, wherein the effect of wider widths on recovery in the can plant itself can be seen. "Recovery" is defined as the percentage of product weight to input materials weight.

Table I

Can Plant Cupper Recovery

	Width, inches (cm)	Recovery, %
Prior Art	30-80 (76.2-203.2)	85-88
Present Invention	6-20 (15.2-50.8)	68-83

From Table I, it seems obvious that wider width is more economical because of less scrap return in the web. However, Table II below shows what is not obvious; by combining the prior art can stock production process with the prior art can making process, the overall recovery is less than the process of the present invention.

Table II

Can Stock Plant and Overall Recovery

	Can Stock Plant Recovery, %	Overall Recovery, %
Prior Art Conventional	60-75	51-66
Prior Art Minimill	80-90	68-79
Present Invention	92-97	63-81

In the preferred embodiment of this invention, it has been found that, in contrast to this conventional approach, the economics are best served when the width of the cast feedstock 4 is maintained as a narrow strip to facilitate ease of processing and use of small decentralized strip rolling plants.

Good results have been obtained where the cast feedstock is less than 24 inches (61 cm) wide, and preferably is within the range of 6 to 20 inches (15.2-50.8 cm) wide. By employing such narrow cast strip, plant investment can be greatly reduced through the use of small in-line equipment, such as two-high rolling mills. Such small and economic micromills of the present invention can be located near the points of need, as, for example, can-making facilities. That in turn has the further advantage of minimizing costs associated with packaging, shipping of products and customer scrap. Additionally, the volume and metallurgical needs of the can plant can be exactly matched by the output of an adjacent can stock micromill.

It is an important concept of the present invention that coil self-annealing (immediately after hot rolling of the feedstock 4 without significant intermediate cooling) be followed by quenching. The sequence and timing of process steps in combination with the heat treatment and quenching operations provide equivalent or superior metallurgical characteristics in the final product compared to ingot methods. In the prior art, the industry has normally employed slow air cooling after hot rolling. Only in some installations is the hot rolling temperature sufficient to cause full annealing by complete recrystallization of the aluminum alloy before the metal cools down. It is far more common that the hot rolling temperature is not high enough to cause full annealing. In that event, the prior art has employed separate batch annealing steps before and/or after breakdown cold rolling in which the coil is placed in a furnace maintained at a temperature sufficient to cause full recrystallization. The use of such furnace batch annealing operations represents a significant disadvantage. Such batch annealing operations require that the coil be heated for several hours at the correct temperature, after which such coils are typically cooled under ambient conditions. During such slow heating, soaking and cooling of the coils, many of the elements present in the aluminum which had been in solution in the aluminum are caused to precipitate.

That in turn results in reduced solid solution hardening and reduced alloy strength.

In contrast, the process of the present invention achieves full recrystallization and retains alloying elements in solid solution for greater strength for a given cold reduction of the product.

In the practice of the invention, the hot rolling exit temperature must be maintained at a high enough temperature to allow self-annealing to occur within two to sixty minutes which is generally in the range of 500°F to 950°F (260°-510°C). Immediately following self-annealing at those temperatures, the feedstock in the form of strip 4 is water quenched to a temperature necessary to retain alloying elements in solid solution and cold rolled [typically at a temperature less than 300°F(149°C)].

As will be appreciated by those skilled in the art, the extent of the reductions in thickness effected by the hot rolling and cold rolling operations of the present invention are subject to a wide variation, depending upon the types of feedstock employed, their chemistry and the manner in which they are produced. For that reason, the percentage reduction in thickness of each of the hot rolling and cold rolling operations of the invention is not critical to the practice of the invention. However, for a specific product, practices for reductions and temperatures must be used. In general, good results are obtainable when the hot rolling operation effects a reduction in thickness within the range of 40 to 99% and the cold rolling effects a reduction within the range of 20 to 75%.

One of the advantages of the method of the present invention arises from the fact that the preferred embodiment utilizes a thinner hot rolling exit gauge than that normally employed in the prior art. As a consequence, the method of the invention obviates the need to employ breakdown cold rolling prior to annealing.

Having described the basic concepts of the invention, reference is now made to the following example which is provided by way of illustration of the practice of the

invention. The sample feedstock was as cast aluminum alloy solidified rapidly enough to have secondary dendrite arm spacings below 10 microns.

Example

This example employed an alloy having the following composition within the range specified by AA 3104:

Metal	Percent by Weight
Si	0.32
Fe	0.45
Cu	0.19
Mn	0.91
Mg	1.10
Al	Balance

A strip having the foregoing composition was hot rolled from 0.140 inch to 0.021 inch (0.355 cm to 0.053 cm) in two quick passes. It was held at 750°F (399°C) for fifteen minutes and water quenched. The sample was 100 percent recrystallized. When cold rolled for can making, the cup and can samples were satisfactory, with suitable formability and strength characteristics.

~~What is claimed is:~~

The claims defining the invention are as follows:

1. A method for manufacturing can body sheet in which the process is carried out in two sequences of continuous, in-line operation comprising, in the first sequence, continuously hot rolling a hot aluminum feedstock to reduce its thickness, coiling the hot rolled feedstock while it is hot, holding the hot reduced feedstock at or near the hot rolling exit temperature for at least two minutes to effect recrystallization and solutionization without intermediate heating, and, in the second continuous in-line sequence, the steps of uncoiling the hot coiled feedstock and quenching the annealed feedstock immediately and rapidly to a temperature sufficient for cold rolling.

2 A method as defined in claim 1 wherein the feedstock is provided by continuous strip or slab casting.

3. A method as defined in claim 1 wherein the feedstock is formed by depositing molten aluminum alloy on an endless belt formed of a heat conductive material whereby the molten metal solidifies to form a cast strip, and the endless belt is cooled when it is not in contact with the metal.

4. A method as defined in claim 1 which includes, as a continuous in-line step, cold rolling the quenched feedstock.

5. A method as defined in claims 3 or 4 which includes the further step of forming cups from the cold rolled sheet stock.

6. A method as defined in claims 3 or 4 which includes the step of coiling the cold rolled feedstock after cold rolling.

7. A method as defined in claim 6 wherein the coiling of the cold rolled sheet stock is in-line.

8. A method as defined in claim 5 wherein the cupping is carried out in-line.

9. A method as defined in claims 3 or 4 which includes the further step of forming in-line blanks from the cold rolled feedstock.

10. A method as defined in claims 3 or 4 which includes the further in-line step of shearing the cold rolled feedstock to predetermined lengths.

11. A method as defined in claim 1 wherein the hot rolling reduces the thickness of the feedstock by 40 to 99%.

12. A method as defined in claim 1 wherein the hot rolling of the feedstock is carried out at a temperature within the range of 600°F (315.6°C) to the solidus temperature of the feedstock.

13. A method as defined in claim 1 wherein the annealing and solution heat treating is carried out at a temperature within the range of 750°F (399°C) to the solidus temperature of the feedstock.

14. A method as defined in claim 1 wherein the hot rolling exit temperature is within the range of 600 to 1000°F (315.6°C to 538°).

15. A method as defined in claim 1 wherein the annealing and solution heat treating is carried out in the range of 2-120 minutes.

16. A method as defined in claim 1 wherein the annealed and solution heat treated feedstock is quenched to a temperature less than 300°F (149°C).

17. A method as defined in claim 4 wherein the cold rolling step effects a reduction in the thickness of the feedstock of 20 to 75%.

18. A method as defined in claim 1 wherein the feedstock is an aluminum alloy containing from about 0 to 0.6% by weight silicon, from 0 to about 0.8% by weight iron, from 0 to about 0.6% by weight copper, from about 0.2 to about 1.5% by weight manganese, from about 0.8 to about 4% magnesium, from 0 to about 0.25% by weight zinc, 0 to 0.1 % by weight chromium with the balance being aluminum and its usual impurities.

19. A method as defined in claim 1 wherein the aluminum alloy is selected from the group consisting of AA 3004, AA 3104 and AA 5017.

20. A method for manufacturing can body sheet in which the process is carried out in two sequences of continuous, in-line operation comprising, in the first sequence, continuously hot rolling a hot aluminum feedstock to reduce its thickness, coiling the hot rolled feedstock while it is hot, holding the hot reduced feedstock at or near the hot rolling exit temperature for at least two minutes to effect recrystallization and solutionization without intermediate heating, and, in the second continuous in-line sequence, the steps of uncoiling the hot coiled feedstock and quenching the annealed feedstock immediately and rapidly to a temperature sufficient for cold rolling and cold rolling the feedstock to produce can body sheet stock.

21. A method as defined in claim 20 which includes the further step of forming cups from the aluminum alloy strip.

22. A method as defined in claim 20 which includes the step of coiling the aluminum alloy strip after cold rolling.

23. A method as defined in claim 20 which includes the further in-line step of shearing the cold rolled aluminum alloy strip to predetermined lengths.

24. A method as defined in claim 1 which includes the step of immediately transferring the feedstock to a can body plant.

25. A method as defined in claim 24 which includes the step of coordinating the feedstock with the production capacity of the can body plant whereby the output of the manufacturer of can body sheet substantially matches the production of the can body plant.

26. A method as defined in claim 20 which includes the step of immediately transferring the feedstock to a can body plant.

27. A method as defined in claim 26 which includes the step of coordinating the feedstock with the production capacity of the can body plant whereby the output of the manufacturer of can body sheet substantially matches the production of the can body plant.

28. A method as defined in claim 1 wherein the width of the feedstock is less than 24 inches (61 cm).

29. A method as defined in claim 20 wherein the width of the feedstock is less than 24 inches (61 cm).

30. A method for manufacturing can body sheet as defined in claim 1 and substantially as herein described with reference to Figs. 1-4.

31. Can body sheet when prepared by the method of claim 30.

3 November, 1993
Kaiser Aluminum & Chemical Corporation

Patent Attorneys for the Applicant
SPRUSON AND FERGUSON

ABSTRACT

A method for manufacturing can body sheet in which the process is carried out in two sequences of continuous, in-line operation is described. The method includes in the first sequence, continuously hot rolling a hot aluminum feedstock (4) to reduce its thickness, coiling the hot rolled feedstock (4) while it is hot, holding the hot reduced feedstock (4) at or near the hot rolling exit temperature for at least two minutes to effect recrystallization and solutionization without intermediate heating, and, in the second continuous in-line sequence, the steps of uncoiling the hot coiled feedstock (4) and quenching the annealed feedstock (4) immediately and rapidly to a temperature sufficient for cold rolling. This two-sequence continuous in-line process can be used to produce can body sheet both economically and efficiently.

Figure 4.

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FIG. 1

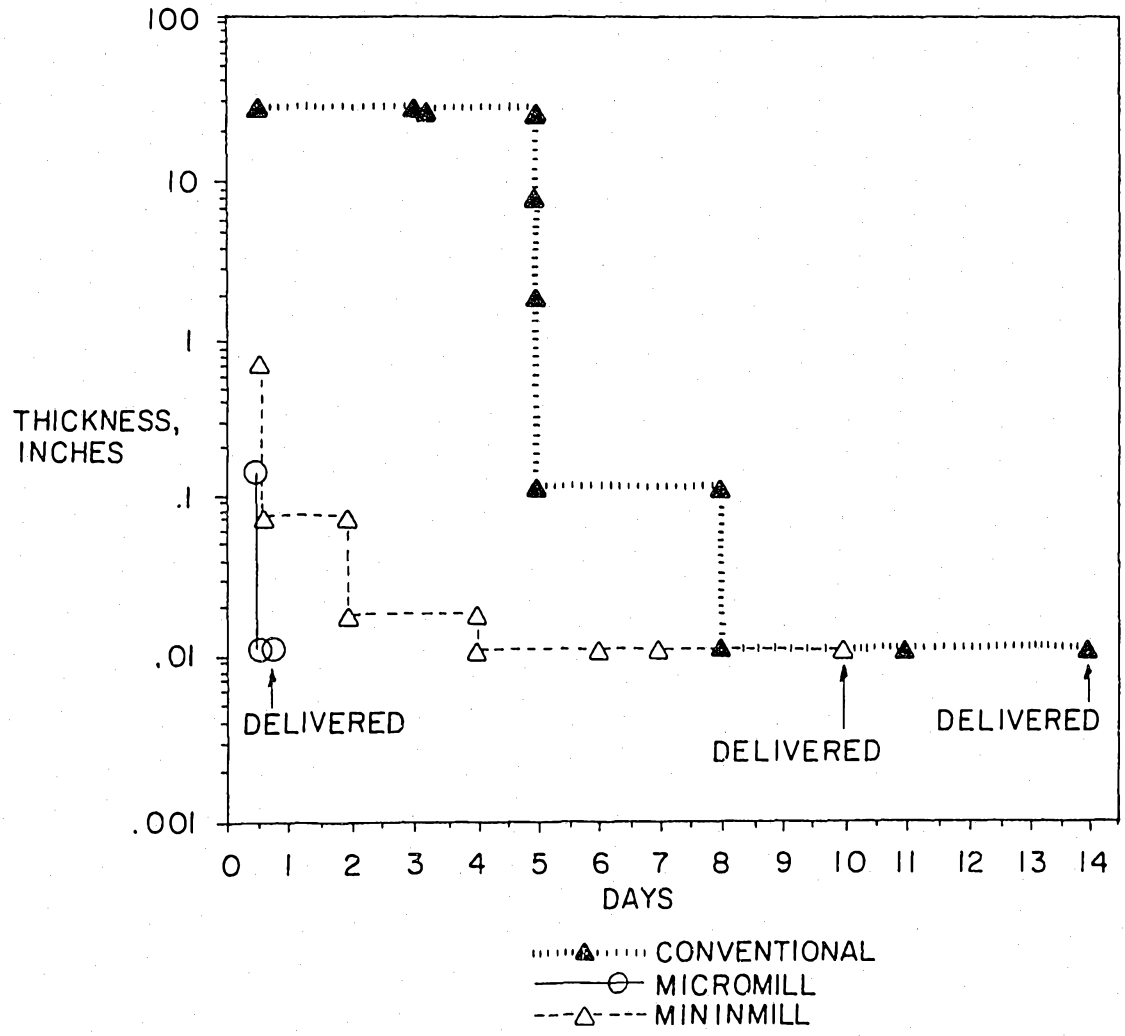

FIG.2a

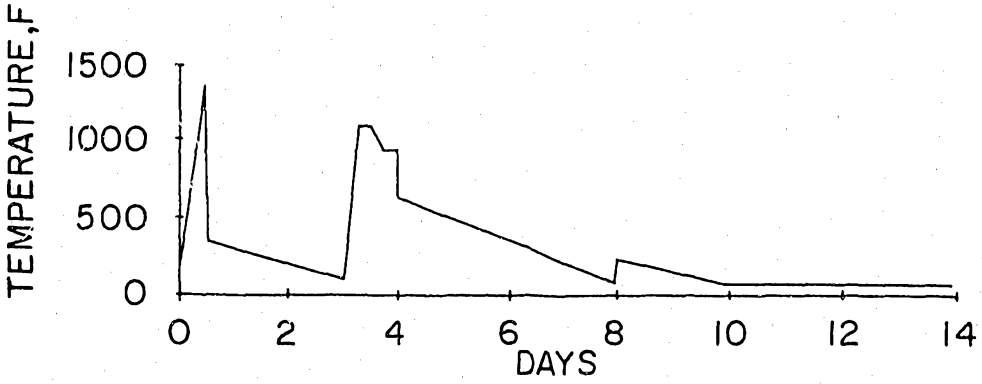

FIG.2b

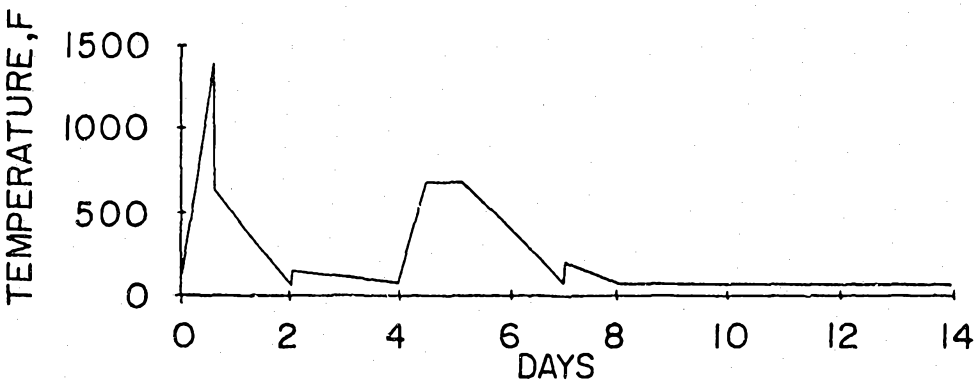

FIG.2c

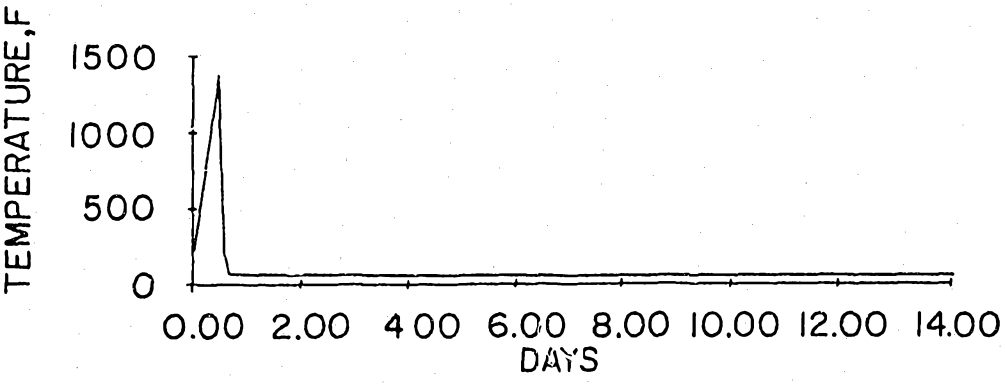

FIG.3

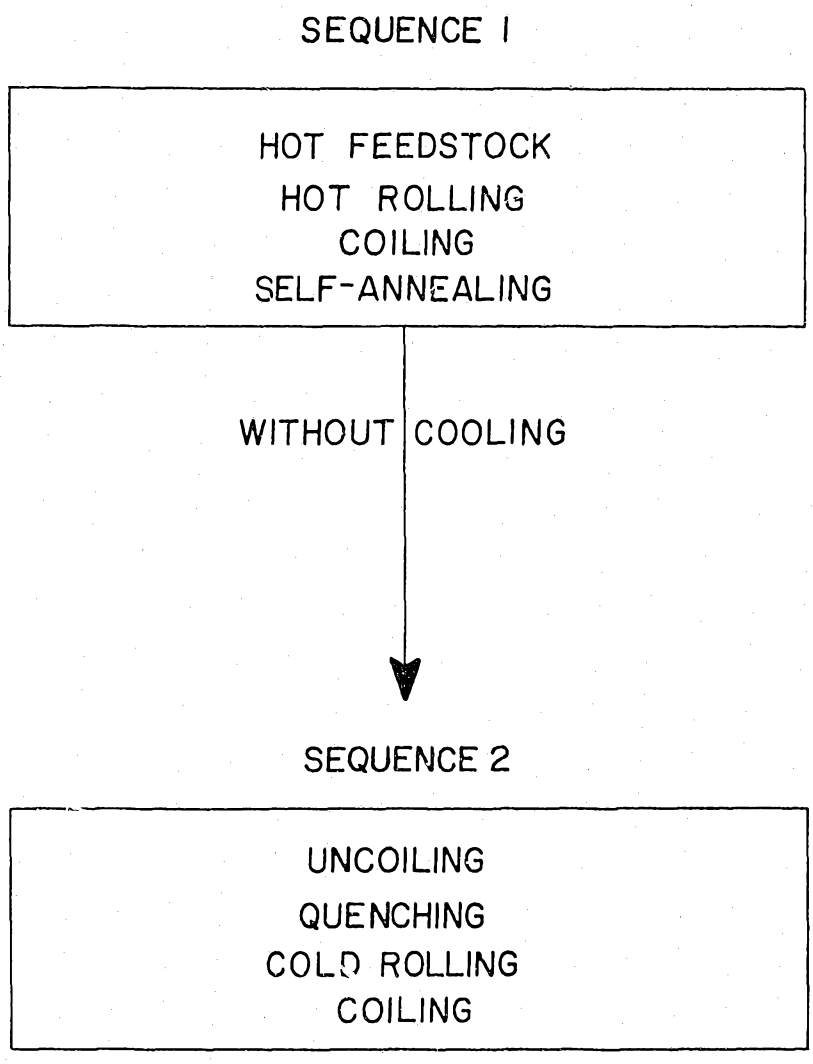
SEQUENCE 1
HOT FEEDSTOCK
HOT ROLLING
COILING
SELF-ANNEALING
WITHOUT COOLING
SEQUENCE 2
UNCOILING
QUENCHING
COLD ROLLING
COILING

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FIG. 4

