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(54) **Coated aluminum strip and method for manufacturing**

Beschichteter Aluminiumstreifen und Verfahren zur Herstellung

Bande d'aluminium revêtu et procédé de fabrication

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## Description

**[0001]** The invention relates to a method for manufacturing a strip for retortable food packages made of an aluminum alloy as well as to the use of a coated aluminum alloy strip, a retortable food package made of said aluminum alloy strip and an apparatus for carrying out the inventive method.

**[0002]** Retortable and corrosion resistant aluminum or aluminum alloy strips are used for the manufacturing of packages like cans or cup-like food packages. In particular, foodstuffs often contain ingredients which can cause corrosion of aluminum or an aluminum alloy used for manufacturing the package of the grocery, for example a food can. Thus, the aluminum or the aluminum alloy of i.e. a food can has to be protected against corrosion. Commonly this is done by a coating which is applied onto the aluminum strip prior to forming the food package. Such a food package is known for example from the German patent application DE 40 30 646 A1. However, the conventional food package has several problems. On the one hand, when the coated aluminum strip or aluminum alloy strip is formed to the food package part i.e. by deep drawing the corrosion protecting coating sometimes shows damages. Thus, the corrosion protecting layer has to be provided with a greater thickness in order to prevent cracks or damages during deep drawing for example. On the other hand coating of a food package after deep drawing of the aluminum strip is expensive.

**[0003]** High resistance against corrosion induced by the contact with corrosion active media like water or rain is also a challenge with architectural sheets, which are used for example as facade sheets at the outer surface of buildings. For the architectural sheets it is very important that they do not change their appearance in the presence of aggressive substances incorporated in the air in cities or near industrial factories for years. Additionally, these sheets are formed by roll forming, bending, or drawing and are subjected to cutting processes, which leads to problems in the vicinity of locally high sheet deformation degrees or in the vicinity of cut edges. In particular coated architectural sheets have the problem that corrosion might lift up the coating which deteriorates the appearance of the sheets dramatically.

**[0004]** A method for manufacturing an aluminum or aluminum alloy sheet or plate, which provides a high corrosion resistance is disclosed in US 3,902,976. According to US 3,902,976 the aluminum or aluminum alloy sheet or plate is first anodized applying AC current in an electrolyte consisting of an aqueous solution of a mineral acid such as to form on the aluminum or aluminum alloy surface an aluminum oxide film and subsequently electrolytically treated in an aqueous solution of sodium silicate such as to form a durable abrasion resistant and corrosion-resistant barrier layer. This process has the disadvantage that rinsing after anodizing and rinsing after electro-silicating is on the one hand costly and it requires on the other hand permanent treating of waste water. DE

10 2011 002 837 A1 refers to a method of corrosion-proof pretreatment of tinplate.

**[0005]** DE 195 08 126 A1 discloses a method for optimizing paint adhesion on metal surfaces, in particular on aluminum surfaces, wherein the metal surface is anodized in an acid electrolyte and subsequently brought into contact with a further liquid solution.

**[0006]** WO 99/19086 shows an anodized aluminium sheet intended for use as closure stock for cans with a polyacrylic adhesion layer.

**[0007]** US 2004/0054044 A1 discloses different coatings of a metal sheet surface, but does not show any hints to retortable food packages. The same applies also to the German patent application DE 102 27 362 A1.

**[0008]** A method for manufacturing an aluminum strip, wherein the method comprises the steps of anodizing the strip and subsequently applying a passivation layer by immersing the strip into an immersion bath is known from EP 0 127 774 A2.

**[0009]** Therefore, it is an object of the present invention to provide a cost effective method for manufacturing an aluminum alloy strip for retortable food packages, which provide a much better corrosion behavior. Furthermore, it is an object of the present invention to provide an advantageous use of an aluminum alloy strip for retortable food package, a formed retortable food package made of the aluminum alloy strip as well as an apparatus for carrying out the inventive manufacturing method.

**[0010]** According to a first teaching of the present invention the above mentioned object is solved by a method for manufacturing a strip for retortable food packages made of an aluminum alloy comprising the steps of:

- degreasing and anodizing the surface of the strip by immersing the strip in an acid electrolyte bath and applying AC current, wherein the degreasing and anodizing the surface of the strip leads to an artificially grown oxide layer, optionally followed by a desmutting step and
- applying a passivation layer on the surface of the strip by a no-rinse coil coating process,
- wherein the applied passivation layer has a thickness of 2 to 10 g/m<sup>2</sup>.

**[0011]** It was found out by the invention that an aluminum strip or an aluminum alloy strip which has been applied to the aforementioned manufacturing steps offers a very good corrosion resistant and additionally a very good adhesion for an additional top coating which allows making i.e. food packages by deep drawing the aluminum strip without damaging the top coating during the deep drawing step. Also architectural sheets can be manufactured from these above mentioned aluminum or aluminum alloy strips comprising an improved corrosion resistance. The optional desmutting step improves application of the passivation layer after immersing in the elec-

trolyte bath. Degreasing and anodizing the surface of the aluminum or aluminum alloy strip by immersing the strip in an acidic electrolyte bath and applying AC-current leads to an artificially grown oxide layer which provides a very good corrosion resistant compared to the natural oxide layer which is built up after manufacturing, i.e. after rolling. The passivation layer on the other hand provides a very good adhesion for a top coating since adhesion properties of an artificially grown oxide layer are usually low. Thus, i.e. retortable food packages can be manufactured with an aluminum alloy strip, which has a very good resistance against filling goods and a very high adhesion for a top coating. Additionally, coated architectural sheets take benefit of the inventive manufacturing steps in that they have a much better corrosion resistance and the improved adhesion of a coating on the inventively manufactured strip contrary to conventional architectural sheets.

**[0012]** In order to improve the corrosion resistance according to an embodiment of the present invention during the degreasing and anodizing step a new oxide layer with a thickness of 50 nm to 300 nm is built on the surface of the strip. Preferably an oxide layer of 50 nm to 160 nm is built since it allows achieving the intended corrosion resistance combined with satisfying manufacturing speeds.

**[0013]** According to a next embodiment the degreasing and anodizing of the surface of the strip and optionally the desmutting of the strip are carried out inline with applying the passivation layer on the strip. Carrying out the manufacturing strips inline means that the manufacturing steps are made without coiling and decoiling the metal strip between those steps. This allows to optimize productivity of the inventive method as well as to reduce production time and expenses to manufacture such aluminum or aluminum alloy strips.

**[0014]** According to a next embodiment of the present invention said degreasing and anodizing step is carried out with a sulfuric acid at a concentration of 10 wt.-% to 25 wt.-% as electrolyte with a temperature of 65°C to 90°C by applying an AC-current density of 2 to 25 A/dm<sup>2</sup> for an immersing time of the strip of 1.5 s to 10 s. It has been found out that the mentioned range of parameters regarding the electrolyte bath, the concentration of the sulfuric acid, the temperature range and the density of the AC-current as well as the immersing time provides the possibility to increase the manufacturing speed. These parameters allow high speed growth of the intended corrosion inhibiting oxide layer as well as an effective removal of surface contaminations of the aluminum strip which are caused by the manufacturing process like cold rolling. In particular good results has been achieved by an AC-current with a frequency of 50 Hz and a current density of 4 to 22 A/dm<sup>2</sup> with a temperature of 75 to 85°C with a sulfuric acid comprising 15 wt.-% as a concentration and a contact time of 3 to 6 s.

**[0015]** The passivation layer is according to a next embodiment based on a chromate-free passivation or a zir-

conium or titan passivation. A chromate-free passivation as well as the passivation layer based on a zirconium or titan passivation has the advantage that during production less harmful materials are used.

5 **[0016]** A very high accuracy of the thickness of the passivation layer is achieved in that the passivation layer is coated by using roller coaters.

**[0017]** According to the present invention the applied passivation layer has a thickness of 2 to 10 g/m<sup>2</sup>, in particular 4 to 7 g/m<sup>2</sup> of the wet film which allows achieving the desired adhesion properties of the aluminum or aluminum strip.

10 **[0018]** To ensure a precise control of the thickness of the passivation layer according to a further embodiment of the present invention applying the passivation layer is controlled by an inline measurement.

15 **[0019]** Furthermore, according to a next embodiment after applying and drying the passivation layer of the strip at least one further coating is applied onto the passivation layer of the strip. As already outlined the adhesion properties of a passivation layer on the strips are very good in particular for polymer coatings or lacquered coatings. In particular during forming processes like deep drawing it has been shown that such an additional coating is not damaged during forming of the aluminum strip to a formed metal part like i.e. a cup-like food package or a coated architectural sheets, since the adhesion properties of the manufactured aluminum strips are very good. This applies in particular for a single-layer varnish top coatings and polymer coatings.

20 **[0020]** According to a further embodiment, the degreasing and anodizing step and the step of applying the passivation layer are carried out inline with applying of a further coating onto the passivation layer. The expenses to manufacture an aluminum strip of which formed metal parts for grocery packages or coated architectural sheets can be manufactured are decreased significantly. Additionally, the quality of the top coating is increased significantly, so that the following production steps like forming, drawing, roll forming, bending can be accomplished with very low defective products.

25 **[0021]** According to a next teaching of the present invention the above mentioned object is solved by an aluminum or aluminum alloy strip manufactured by the inventive method comprising an anodic oxide layer with a thickness of 50 to 300 nm, preferably 50 to 160 nm and a chromate-free passivation layer on the oxide layer. As already outlined such an aluminum or aluminum alloy strip comprises a very good corrosion resistance because of the artificially grown oxide layer on top of the aluminum layer and as well as very good adhesion properties for a top coating which allows to produce formed metal parts like food packages or coated architectural sheets. Nevertheless, this applies to all coated formed metal parts made of aluminum or an aluminum alloy strip.

30 **[0022]** According to a next embodiment the strip additionally comprises an organic coating on top of the passivation layer, wherein preferably the organic coating is

a lacquer, preferably a single-layer varnish or a polymer coating. Organic coatings protect the aluminum layer additionally from the influence of the corrosive parts of for example groceries or corrosive components in the environment. The aluminum or aluminum alloy strip comprising the additional organic coating can be easily manufactured to formed metal parts for example by deep drawing, such as cup-like food packages or architectural sheets. Both comprise very good properties with respect to the corrosion resistance. Coatings for architectural sheets are based on for example polyurethane, polyamide, polyester, high durable polyester PVDF-systems etc..

**[0023]** In order to provide the different desired properties with regard to the mechanical strength, formability and recyclability according to an embodiment the aluminum or aluminum alloy strip comprises an aluminum alloy of the type AA1xxx, AA3xxx, AA5xxx or AA8xxx. For food packages the thickness of the strips are preferably between 0,05 mm to 1 mm. However, architectural sheets preferably have a thickness of between 0,15 mm and 2 mm.

**[0024]** Furthermore, the above mentioned object is solved by a formed metal part made of an aluminum or aluminum alloy strip manufactured according to the present invention. The formed metal parts according to the present invention comprise a high resistance against damages of the top coating during forming operations of the metal parts. The inventive formed metal part can be manufactured with a very low ratio of defective products.

**[0025]** Preferably according to another embodiment the formed metal part is a package for groceries or an architectural sheet. The packages for groceries have to provide different properties like formability, high corrosion resistance and a top coating which should be biocompatible. Preferably, these top coatings are made of a polymer resin or a lacquer more preferably a single-layer varnish. Due to the good adhesion properties of the aluminum or aluminum alloy strip of the present invention comprising the artificial oxide layer and the passivation layer a package for groceries made of the inventive aluminum or aluminum strip can be produced with lower expenses and insures a very high level of package quality. The architectural sheet has to provide a very good corrosion resistance as well as very good adhesion properties for the top coating which is applied commonly on both sides of sheet. Typical architectural sheets are façade components, roller shutters and façade structural components which are in permanent contact with water, i.e. rain and the humidity of the air.

**[0026]** Finally the above mentioned object is solved by an apparatus for carrying out the inventive manufacturing method comprising:

- an uncoiler for uncoiling a strip made of aluminum or aluminum alloy,
- means for degreasing and anodizing The strip by

immersing the strip into a bath of an acid electrolyte and means to apply an AC current to the strip,

- optionally means for desmutting the anodized strip,
- means to apply a no-rinse coil coating passivation on the strip surface,
- means to dry the passivation layer on the strip and
- a recoiler for recoiling the strip.

**[0027]** With the inventive apparatus it is possible to manufacture a coated aluminum strip with the inventive manufacturing method without coiling and decoiling the strip between the step of degreasing and anodizing and the application of the passivation layer. With the aforementioned apparatus it is possible to provide a coil of an aluminum or aluminum alloy strip comprising an anodic oxide layer with the thickness of 50 nm to 300 nm, preferably 50 nm to 160 nm and comprising a passivation layer, in particular a chromate-free passivation layer on top of the anodic oxide layer. Means to dry the passivation layer allow a quick coiling of the passivated aluminum strip. The optional means for desmutting the anodized strip allow a quick preparing of the aluminum strip for the application of the passivation layer in the next manufacturing step. Such a coil can be coated easily with a top coating for a desired package, wherein the coating can be adapted to the particular application like food packages or architectural sheets.

**[0028]** Furthermore, according to a next embodiment of the inventive apparatus the apparatus comprises additionally means to coat the strip with a top coating on the passivation layer. An organic coating on the passivation layer may serve to improve the properties for forming food packages by deep drawing as well as providing additionally a protection for corrosion.

**[0029]** The inventive method, aluminum strip, formed metal part and apparatus for manufacturing such an aluminum strip according to further embodiments are described below in connection with the drawings. The drawings show in

Fig. 1 a schematical sketch of the different manufacturing steps of an embodiment,

Fig. 2 an embodiment of an inventive apparatus for manufacturing a coated aluminum or aluminum alloy strip,

Fig. 3a, b) a comparison between a conventional formed metal part and an inventive formed metal part according to a further embodiment,

Fig. 4 a microscopic sectional view of an inventive embodiment after degreasing an ano-

dizing step,

Fig. 5a, b) a perspective view and a sectional view of an architectural sheet and

Fig. 6) a further architectural sheet in the form of a roller shutter in a perspective view.

**[0030]** At first Fig. 1 shows in a schematical view the different manufacture steps A, B, C, D and E on the right side and on the left side sectional views of the strip resulting from step B, C, D and E and with respect to step A a sectional view of an aluminum or aluminum alloy strip with which the shown embodiment starts with.

**[0031]** An aluminum alloy strip made of the aluminum alloys of type AA1xxx, AA3xxx, AA5xxx or AA8xxx is the starting point of the inventive manufacturing process. The thickness of the strip depends on the application. In general the thicknesses of the aluminum or aluminum alloy strip is between 0,05 mm and 2,5 mm, preferably for food packages between 0,05 mm and 1,0 mm and for architectural sheets between 0,15 mm and 2,0 mm. As shown the aluminum alloy strip 1 prior to step A with comprises on top of the aluminium alloy strip 1 a first layer 2 which is the natural oxide layer of the strip comprising additionally undesirable contaminations. The oxide layer and the contaminations present in the surface of the aluminum or aluminum alloy strip result from the rolling process of the strip. Such a strip is uncoiled in the step A and is provided to a degreasing and anodizing step 3. The degreasing an anodizing step is preferably carried out with a sulfuric acid at a concentration of 10 wt.-% to 25 wt.-%, preferably 12 wt.-% to 17 wt.-% as an electrolyte with a temperature of 65°C to 90°C by applying an AC-current density of 2 to 25 A/dm<sup>2</sup>, preferably 4 to 22 A/dm<sup>2</sup> for an immersing time of the strip of 1.5 s to 10 s, preferably 3 to 6 s. As shown on the left side of step B the aluminum alloy strip 1 now comprises an artificially grown anodic oxide layer 3 on top of the surface of the aluminum strip 1. Compared to the naturally given oxide layer with a thickness of 5 nm to 10 nm the degreased and anodized aluminum or an aluminum alloy strip comprises an oxide layer with a thickness of 50 nm to 300 nm, preferably 50 nm to 160 nm. Due to the thickness of the oxide layer the aluminum below the oxide layer is protected effectively against corrosion. In the present drawings the thicknesses of the different layers are not true to scale.

**[0032]** Such a strip is now provided to the next manufacturing step C according which a passivation layer 4 is applied on top of the oxide layer 3. However, optionally a desmutting step B' can be applied to the degreased and anodized strip in order to provide an optimized surface for applying the passivation layer.

**[0033]** Although the present embodiment shows that the passivation layer 4 is applied on both sides of the aluminum strip 1 it is possible that only on one side a passivation layer is applied to the aluminum strip. The passivation layer has a thickness of 2 to 10 g/m<sup>2</sup> of the

wet film before drying the no-rinse passivation layer. In particular it is advantageously to apply a passivation layer which is chromate-free or a zirconium or titan passivation. The zirconium or titan passivation is one particular chromate-free passivation. With a chromate-free passivation layer the use of harmful substances during production can be avoided. Architectural sheets as well as food packages take benefit of the improved adhesion properties caused by the passivation layer of the strip in the view of the adhesion of the top coating.

**[0034]** After applying the passivation layer in manufacturing step C the aluminum strip or aluminum alloy strip may be recoiled because after passivation the aluminum strip or aluminum alloy strip can be stored in step C' in order to optimize production capacity. After storage in step C' or subsequently after step C the strip is coated in the next manufacturing step D with a top coating on top of the passivation layer. As shown on the left side of step D the sectional view of the aluminum alloy strip 1 shows that the strip now comprises an outer layer 5 which may be an organic coating 5 consisting of a lacquer, i.e. a one-layer varnish or for example of a polymer coating.

**[0035]** According to step E the aluminum alloy strip 1 of step D can be easily manufactured to a cup like food package as shown on the left side of step E. As can be realized by the sectional view in Fig. 1 at step E the coated aluminum strip according to step D is preferably formed into a food package or an architectural sheet by deep drawing or other forming techniques, like roll forming or the like. In step E the strip may be cut into sheets first and is formed subsequently to food package or architectural sheet. However, it is also possible to form first the product by forming the strip and than cutting the strip into separate products.

**[0036]** The advantage of the inventive aluminum or aluminum alloy strip is that during deep drawing or other forming steps to build a food package or architectural sheet 6 as shown on the left side to step E the top coating 5 of the aluminum or aluminum alloy strip is not damaged. This is caused by the good adhesion properties of the passivation layer manufactured by said no-rinse step.

**[0037]** An embodiment of an inventive apparatus for carrying out the inventive manufacturing process is shown in a schematical view in Fig. 2. At first using an uncoiler 7 an aluminum or an aluminum alloy strip 1 is uncoiled and provided to a degreasing and anodizing step B in which the degreasing and anodizing is carried out by using sulfuric acid under the condition already outlined under manufacturing step B of Fig. 1. In step B' the aluminum or aluminum alloy strip 1 is desmuted and optionally dried.

**[0038]** The aluminum strip or aluminum alloy strip 1 is than provided to a device which carries out the manufacturing step C which applies a passivation layer onto the surface of the strip by using a no-rinse coil coating application. As indicated in Fig. 2 application of the passivation layer is preferably done by using roller coaters C1 and C2. Means to measure the passivation layer thick-

ness are not shown in Fig. 2 but are advantageously used to control the thickness of the passivation layer. In device 8 the no-rinse passivation layer 4 which is preferably a chromate-free passivation layer or a zirconium or titan passivation layer is dried and in device 9 the aluminum strip is cooled again. In general it is possible to coil the coated strip 1 now, because due to the passivated surface of the strip it is possible to store a coil of the strip with such a coating without problems.

**[0039]** According to the present embodiment shown in Fig. 2, however, the aluminum or aluminum alloy strip 1 is provided inline to a further coating step D in which a top coating 5 is applied onto the aluminum strip or aluminum alloy strip. Preferably, for applying the top coat a roller coater is used again. However, depending from the particular coating other coating methods can be applied, too. The top coat is than dried in device 8' and the aluminum or aluminum alloy strip 1 is cooled down in device 9' in order to prepare the aluminum strip 1 for recoiling on recoiler 10.

**[0040]** Fig. 3a) and b) show photos of an exemplary embodiment Fig. 3a) and an inventive embodiment, Fig. 3b). The exemplary embodiment Fig. 3a) comprises a top coating which is damaged at a specific location of the deep drawn food package 11 shown in Fig. 3a) which is caused by a low adhesion of the top coating on the surface of the aluminum alloy strip. As shown in Fig. 3b) the deep drawn inventive embodiment does not have any damages in the top coating of the food package 11.

**[0041]** Fig. 4 shows the anodic oxide layer 12 having a thickness of nearly to 100 nm in a micro section. The combination of the relatively thick anodic oxide layer of 50 nm up to 300 nm which provides a very effective corrosion resistant together with the use of a passivation layer applied by no-rinse coil coating process allows to produce an aluminum strip or aluminum alloy strip which provides very good corrosion resistance combined with a good adhesion for top coatings. Thus, aluminum or aluminum alloy strip according to the present invention can be used very easily to manufacture food packages or i.e. architectural sheets, which comprise necessarily a top coating and which are formed by applying forming operations to a coated strip or coated sheet.

**[0042]** Finally, Fig. 5 shows an architectural sheet 13. The architectural sheet 13 comprises a plurality of cuttings 14 and bended parts 13a. Preferably the cuttings are made into the architectural sheet 13 after applying the inventive method, thus the inventive method is applied to an aluminum strip without cuttings. The strip is than coated with a top coat which can be made of a polymer. Although, cuttings are made into the architectural sheet after applying the method the architectural sheet has a good corrosion resistance due to the excellent corrosion resistance and adhesion properties of the coated areas. Furthermore, bending of the flat strip to a bended architectural sheet as shown in Fig. 5b) does not change the corrosion resistance, since the architectural sheet has beside the corrosion resistance of the anodic oxide

layer very good adhesion properties for its top coating.

**[0043]** Another application of an architectural sheet is the roller shutter 15 shown in Fig. 6. A roller shutter made from an aluminum alloy strip treated with the inventive method offers higher corrosion resistance combined with a very good adhesion of the top coating on the passivation layer. In particular the good adhesion properties of the passivation layer combined with the high corrosion resistance of the anodic oxide layer leads to less defective goods during production of the roller shutter 15, in particular during rollforming of the coated strip. Furthermore, the roller shutter 15 comprises excellent corrosion resistance even in the vicinity of cuttings of the roller shutter (not shown in the drawings).

## Claims

1. Method for manufacturing a strip for retortable food packages made of an aluminum alloy comprising the steps of:
  - degreasing and anodizing the surface of the strip by immersing the strip in an acid electrolyte bath and applying AC current, wherein the degreasing and anodizing the surface of the strip leads to an artificially grown oxide layer, optionally followed by a desmutting step and
  - applying a passivation layer on the surface of the strip using a no-rinse coil coating process,
  - the applied passivation layer has a thickness of 2 to 10 g/m<sup>2</sup> of the wet film.
2. Method according to claim 1, **characterized in that**, during the degreasing and anodizing step a new oxide layer with a thickness of 50 nm to 300 nm is built on the surface of the strip.
3. Method according to claim 1 or 2, **characterized in that**, the degreasing and anodizing of the surface of the strip and optionally the desmutting of the strip are carried out inline with applying the passivation layer on the strip.
4. Method according to one of claim 1 to 3, **characterized in that**, degreasing and anodizing step is carried out with a sulfuric acid at a concentration of 10 wt.-% to 25 wt.-% as electrolyte with a temperature of 65°C to 90°C by applying an AC-current density of 2 to 25 A/dm<sup>2</sup> for an immersing time of the strip of 1,5 s to 10 s.
5. Method according to one of claim 1 to 4, **characterized in that**, passivation layer is based on a chromate-free passivation or a zirconium or titan passivation.

6. Method according to one of claim 1 to 5, **characterized in that**, the passivation layer is coated by using roller coat-ers.
7. Method according to one of claim 1 to 6, **characterized in that**, applying passivation layer is controlled by an inline measurement.
8. Method according to one of claim 1 to 7, **characterized in that**, after applying and drying the passivation layer at least one further coating is applied onto the passi- vation layer of the strip.
9. Method according to one of claim 1 to 8, **characterized in that**, the degreasing and anodizing step and the step of applying the passivation layer are carried out inline with applying of a further coating onto the passivation layer.
10. Use of an aluminum alloy strip for retortable food packages manufactured by a method according to claim 1 to 9 comprising an anodic oxide layer with a thickness of 50 to 300 nm and a chromate-free pas- sivation layer on the oxide layer, wherein the applied passivation layer has a thickness of 2 to 10 g/m<sup>2</sup> of the wet film.
11. Use according to claim 10, **characterized in that**, the strip additionally comprises an organic coating on top of the passivation layer.
12. Use according to claim 10 or 11, **characterized in that**, the strip comprises an aluminum alloy of the type AA1xxx, AA3xxx, AA5xxx or AA8xxx.
13. A formed food package made of an aluminum alloy strip of claim 10 to 12.
14. Apparatus for carrying out a method according to claim 1 to 8 comprising:
- an uncoiler for uncoiling a strip made of alumi- num or aluminum alloy,
  - means for degreasing and anodizing the strip by immersing the strip into a bath of an acid elec- trolyte and means to apply an AC current to the strip,
  - optionally means for desmutting the anodized strip,
  - means to apply a no-rinse coil coating passi- vation on the strip surface,
  - means to dry the passivation layer on the strip

and  
- a recoiler for recoiling the strip.

- 5 15. Apparatus according to claim 14, **characterized in that**, the apparatus comprises additionally means to coat the strip with a top coating on the passivation layer.

#### 10 Patentansprüche

1. Verfahren zur Herstellung eines Bands für sterilisier- bare Lebensmittelverpackungen, die aus einer Alu- miniumlegierung hergestellt sind, mit den Schritten:
- Entfetten und Eloxieren der Oberfläche des Bands durch Eintauchen des Bands in ein Säure- elektrolytbad und Anlegen von Wechsel- strom, wobei das Entfetten und Eloxieren der Oberfläche des Bands zu einer künstlich aufge- bauten Oxidschicht führt, optional gefolgt von einem Dekapierungsschritt, und
  - Aufbringen einer Passivierungsschicht auf der Oberfläche des Bands unter Verwendung eines No-Rinse-Coil-Beschichtungsverfahrens,
  - wobei die aufgebrachte Passivierungsschicht eine Dicke von 2 bis 10 g/m<sup>2</sup> des nassen Films aufweist.
2. Verfahren nach Anspruch 1, **dadurch gekenn- zeichnet, dass** während des Entfettungs- und Eloxierungsschritts eine neue Oxidschicht mit einer Dicke von 50 nm bis 300 nm auf der Oberfläche des Bands aufgebaut wird.
3. Verfahren nach Anspruch 1 oder 2, **dadurch ge- kennzeichnet, dass** das Entfetten und Eloxieren der Oberfläche des Bands und das optionale Dekapieren des Bands in- line mit dem Aufbringen der Passivierungsschicht auf dem Band durchgeführt werden.
4. Verfahren nach einem der Ansprüche 1 bis 3, **da- durch gekennzeichnet, dass** der Entfettungs- und Eloxierungsschritt mit einer Schwefelsäure in einer Konzentration von 10 Gew.- % bis 25 Gew.-% als Elektrolyt mit einer Temperatur von 65 °C bis 90 °C durch Anwenden einer Wechselstromdichte von 2 bis 25 A/dm<sup>2</sup> für eine Eintauch- zeit des Bands von 1,5 s bis 10 s durchgeführt wird.
5. Verfahren nach einem der Ansprüche 1 bis 4, **da- durch gekennzeichnet, dass** die Passivierungsschicht auf einer chromatfreien Passivierung oder auf einer Zirconium- oder Titan- Passivierung basiert.

6. Verfahren nach einem der Ansprüche 1 bis 5, **dadurch gekennzeichnet, dass** die Passivierungsschicht unter Verwendung eines Rollenbeschichters aufgebracht wird. 5
7. Verfahren nach einem der Ansprüche 1 bis 6, **dadurch gekennzeichnet, dass** das Aufbringen einer Passivierungsschicht durch eine Inline-Messung gesteuert wird. 10
8. Verfahren nach einem der Ansprüche 1 bis 7, **dadurch gekennzeichnet, dass** nach dem Aufbringen und Trocknen der Passivierungsschicht wenigstens eine weitere Beschichtung auf der Passivierungsschicht des Bands aufgebracht wird. 15
9. Verfahren nach einem der Ansprüche 1 bis 8, **dadurch gekennzeichnet, dass** der Entfettungs- und Eloxierungsschritt und der Schritt des Aufbringens der Passivierungsschicht inline mit dem Aufbringen einer weiteren Beschichtung auf der Passivierungsschicht durchgeführt werden. 20
10. Verwendung eines Aluminiumlegierungsbands für retortierbare Lebensmittelverpackungen, die gemäß einem Verfahren nach Anspruch 1 bis 9 hergestellt sind, die eine anodische Oxidschicht mit einer Dicke von 50 bis 300 nm und eine chromatfreie Passivierungsschicht auf der Oxidschicht aufweisen, wobei die aufgebrachte Passivierungsschicht eine Dicke von 2 bis 10 g/m<sup>2</sup> des nassen Films aufweist. 25
11. Verwendung nach Anspruch 10, **dadurch gekennzeichnet, dass** das Band zusätzlich eine organische Beschichtung auf der Oberseite der Passivierungsschicht aufweist. 30
12. Verwendung nach Anspruch 10 oder 11, **dadurch gekennzeichnet, dass** das Band eine Aluminiumlegierung des Typs AA1xxx, AA3xxx, AA5xxx oder AA8xxx aufweist. 35
13. Geformte Lebensmittelverpackung hergestellt aus einem Aluminiumlegierungsband nach Anspruch 10 bis 13. 40
14. Vorrichtung zur Durchführung eines Verfahrens nach Anspruch 1 bis 8, aufweisend: 45
- eine Abwickelvorrichtung zum Abwickeln eines Bands aus Aluminium oder aus einer Aluminiumlegierung,
  - Mittel zum Entfetten und Eloxieren des Bands durch Eintauchen des Bands in ein Bad eines Säureelektrolyts und Mittel zum Anlegen eines Wechselstroms auf das Band, 50
  - optional Mittel zum Dekapieren des eloxierten Bands,
  - Mittel zum Aufbringen einer No-rinse-Coil-Beschichtungspassivierung auf der Bandoberfläche,
  - Mittel zum Trocknen der Passivierungsschicht auf dem Band und
  - eine Aufwickelvorrichtung zum Aufwickeln des Bands. 55
15. Vorrichtung nach Anspruch 14, **dadurch gekennzeichnet, dass** die Vorrichtung zusätzlich Mittel zum Beschichten des Bands mit einer Deckschicht auf der Passivierungsschicht enthält.

### Revendications

1. Procédé de fabrication d'une bande pour emballages alimentaires stérilisables composés d'alliage d'aluminium, comprenant les étapes de :
- dégraissage et anodisation de la surface de la bande en immergeant la bande dans un bain électrolytique acide et en appliquant du courant alternatif, le dégraissage et l'anodisation de la surface de la bande entraînant la croissance artificielle d'une couche d'oxyde, suivies en option d'une étape de décapage et
  - application d'une couche de passivation sur la surface de la bande de en utilisant un procédé de revêtement par prélaquage continu sans rinçage,
  - la couche de passivation ayant une épaisseur de 2 à 10 g/m<sup>2</sup> du film humide.
2. Procédé selon la revendication 1, **caractérisé en ce que**, pendant l'étape de dégraissage et d'anodisation, une nouvelle couche d'oxyde d'une épaisseur de 50 nm à 300 nm se constitue sur la surface de la bande.
3. Procédé selon la revendication 1 ou 2, **caractérisé en ce que** le dégraissage et l'anodisation de la surface de la bande et optionnellement le décapage de la bande sont réalisés en ligne de l'application de la couche de passivation sur la bande.
4. Procédé selon une des revendications 1 à 3, **caractérisé en ce que** l'étape de dégraissage et d'anodisation est réalisée avec un acide sulfurique à une concentration de 10 % en poids à 25 % en poids sous forme d'électrolyte à une température de 65 °C à 90 °C en appliquant une densité de courant alternatif de 2 à 25 A/dm<sup>2</sup> pendant une durée d'immersion de la bande de 1,5

- s à 10 s.
5. Procédé selon une des revendications 1 à 4, **caractérisé en ce que** la couche de passivation est basée sur une passivation sans chromate ou une passivation au zirconium ou au titane. 5
6. Procédé selon une des revendications 1 à 5, **caractérisé en ce que** la couche de passivation est revêtue en utilisant des coucheuses à rouleaux. 10
7. Procédé selon une des revendications 1 à 6, **caractérisé en ce que** l'application de la couche de passivation est contrôlée par une mesure en ligne. 15
8. Procédé selon une des revendications 1 à 7, **caractérisé en ce que,** après l'application et le séchage de la couche de passivation, au moins un autre revêtement est appliqué sur la couche de passivation de la bande. 20
9. Procédé selon une des revendications 1 à 8, **caractérisé en ce que** l'étape de dégraissage et d'anodisation et l'étape d'application de la couche de passivation sont réalisées en ligne de l'application d'un autre revêtement sur la couche de passivation. 25  
30
10. Utilisation d'une bande d'alliage d'aluminium pour emballages alimentaires stérilisables fabriqués par un procédé selon les revendications 1 à 9, comprenant une couche d'oxyde anodique d'une épaisseur de 50 à 300 nm et une couche de passivation sans chromate sur la couche d'oxyde, la couche de passivation appliquée ayant une épaisseur de 2 à 10 g/m<sup>2</sup> du film humide. 35  
40
11. Utilisation selon la revendication 10, **caractérisée en ce que** la bande comprend en outre un revêtement organique au-dessus de la couche de passivation. 45
12. Utilisation selon la revendication 10 ou 11, **caractérisée en ce que** la bande contient un alliage d'aluminium du type AA1xxx, AA3xxx, AA5xxx ou AA8xxx. 50
13. Emballage alimentaire moulé composé d'une bande d'alliage d'aluminium selon les revendications 10 à 12.
14. Appareil pour la réalisation d'un procédé selon les revendications 1 à 8, comprenant : 55
- une débobineuse pour dérouler une bande
- composée d'aluminium ou d'alliage d'aluminium,
- un moyen de dégraissage et d'anodisation de la bande en immergeant la bande dans un bain électrolytique acide et un moyen d'application d'un courant alternatif sur la bande,
  - optionnellement un moyen de décapage de la bande anodisée,
  - un moyen d'application d'une passivation par revêtement par prélaquage continu sans rinçage sur la surface de la bande,
  - un moyen de séchage de la couche de passivation sur la bande et
  - une rembobineuse pour rembobiner la bande.
15. Appareil selon la revendication 14, **caractérisé en ce que** l'appareil comprend en outre un moyen de revêtement de la bande avec un revêtement supérieur sur la couche de passivation.

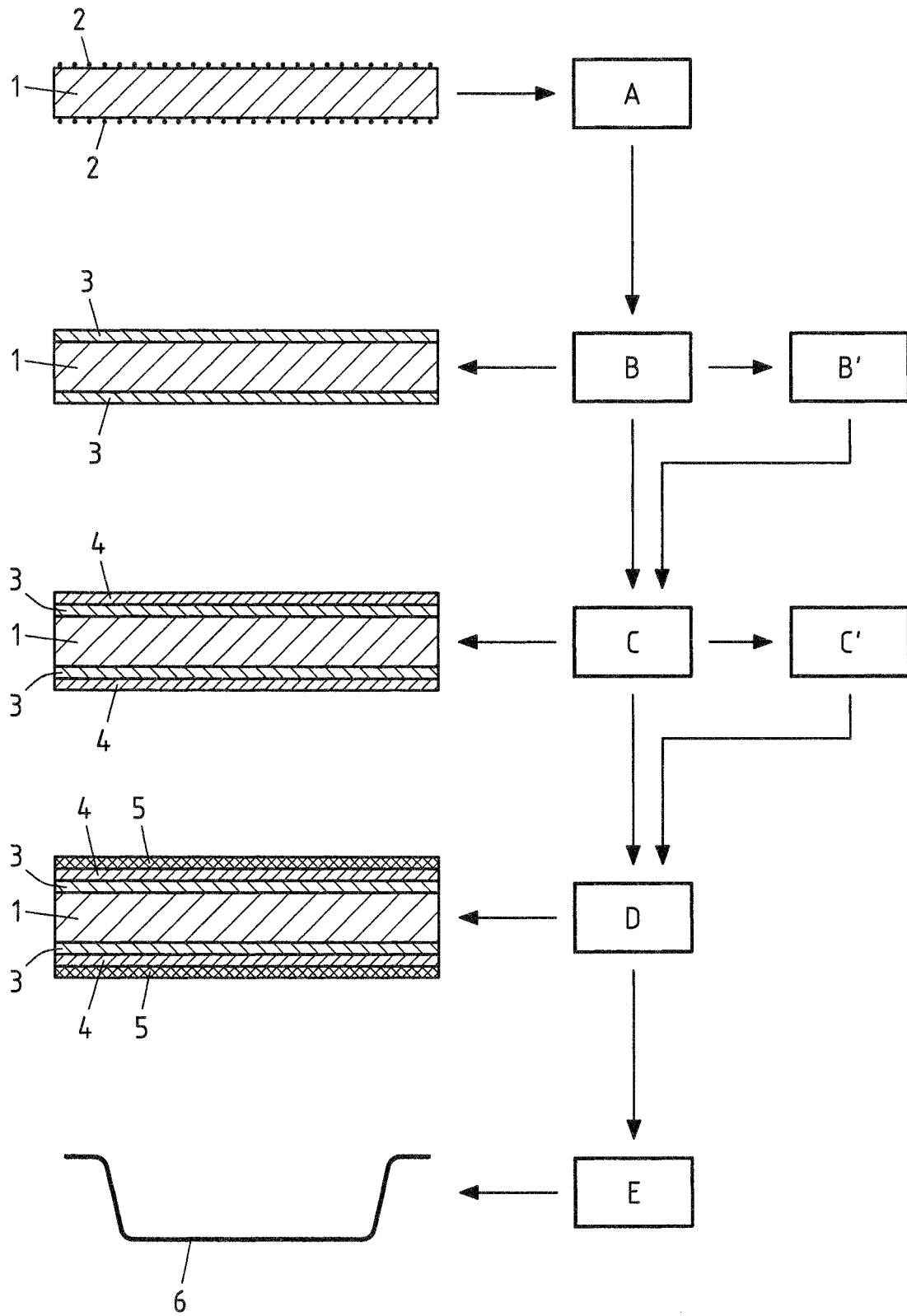


Fig.1

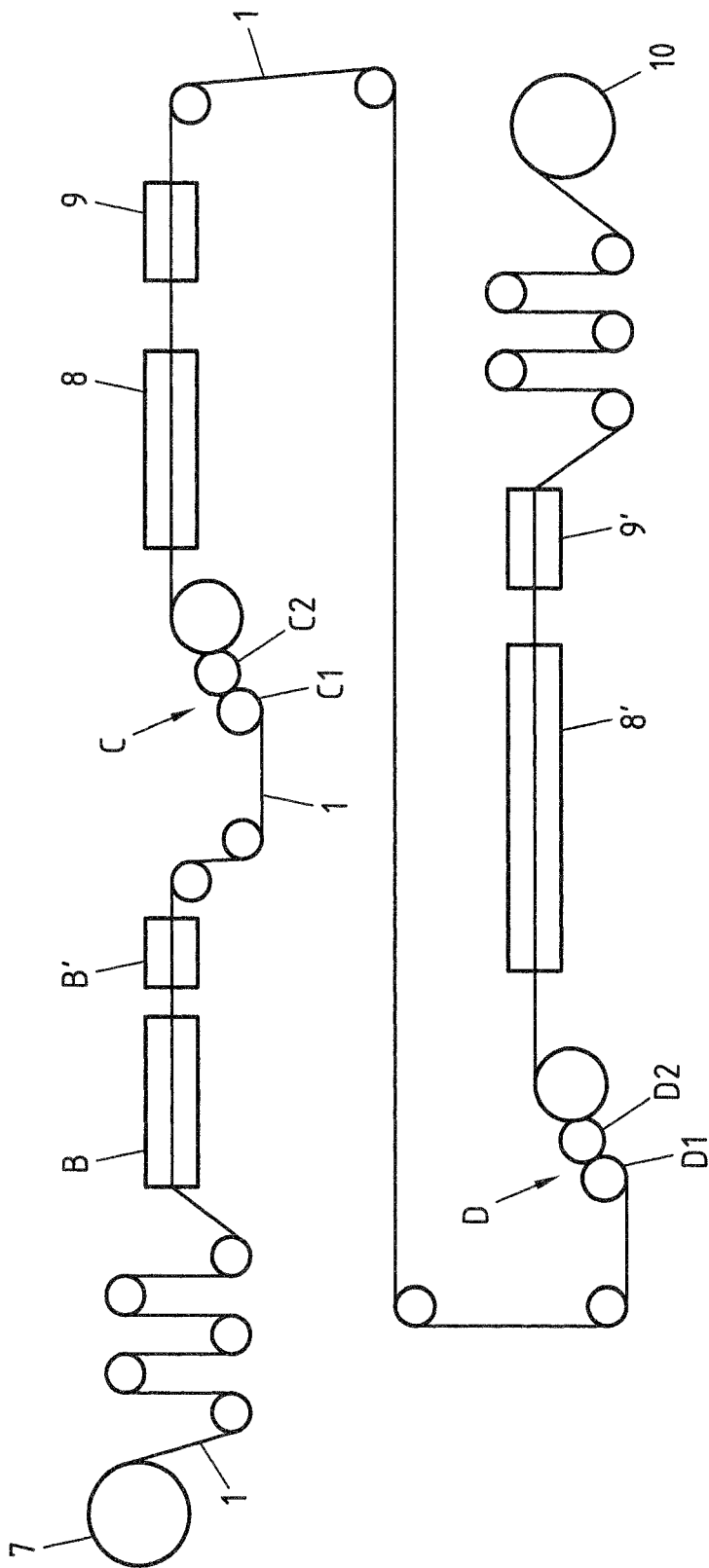


Fig.2

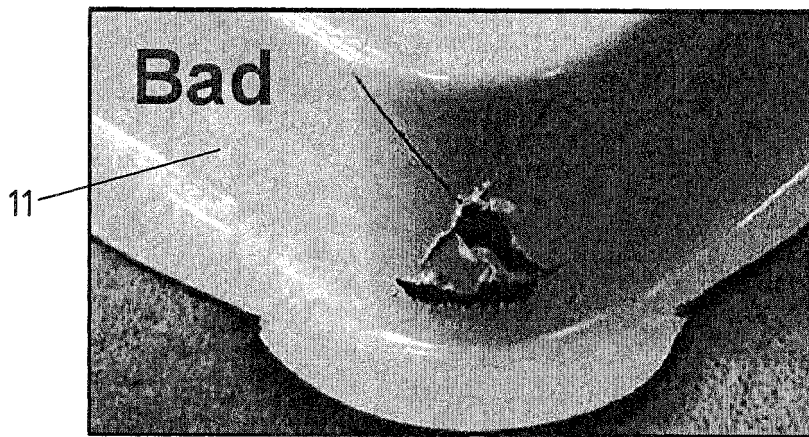


Fig.3a



Fig.3b

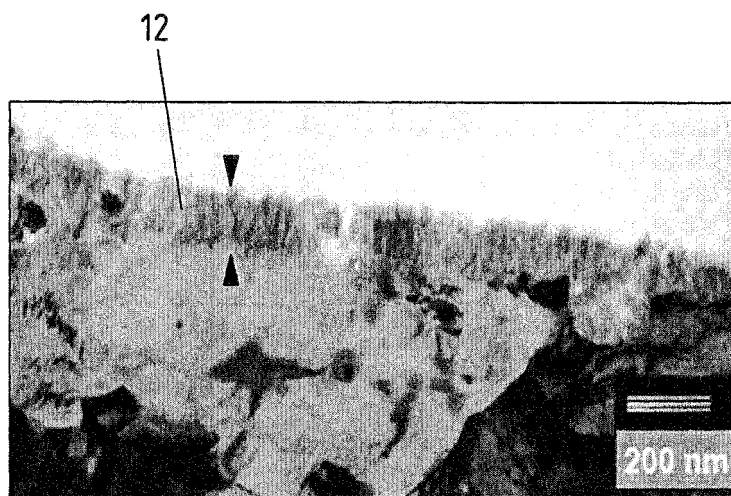


Fig.4

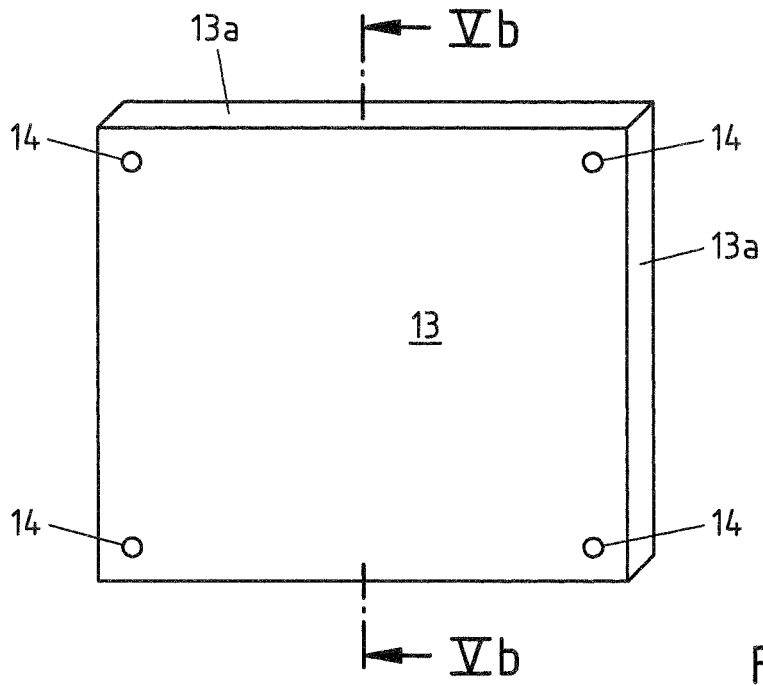


Fig.5a

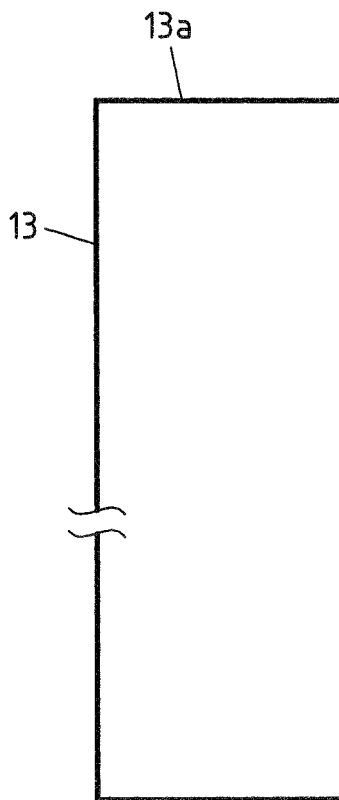


Fig.5b

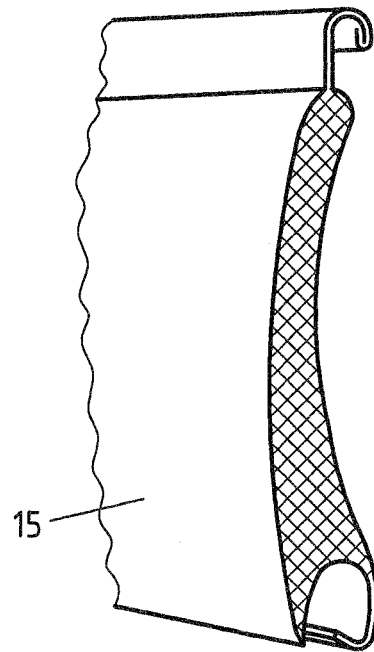


Fig.6

**REFERENCES CITED IN THE DESCRIPTION**

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