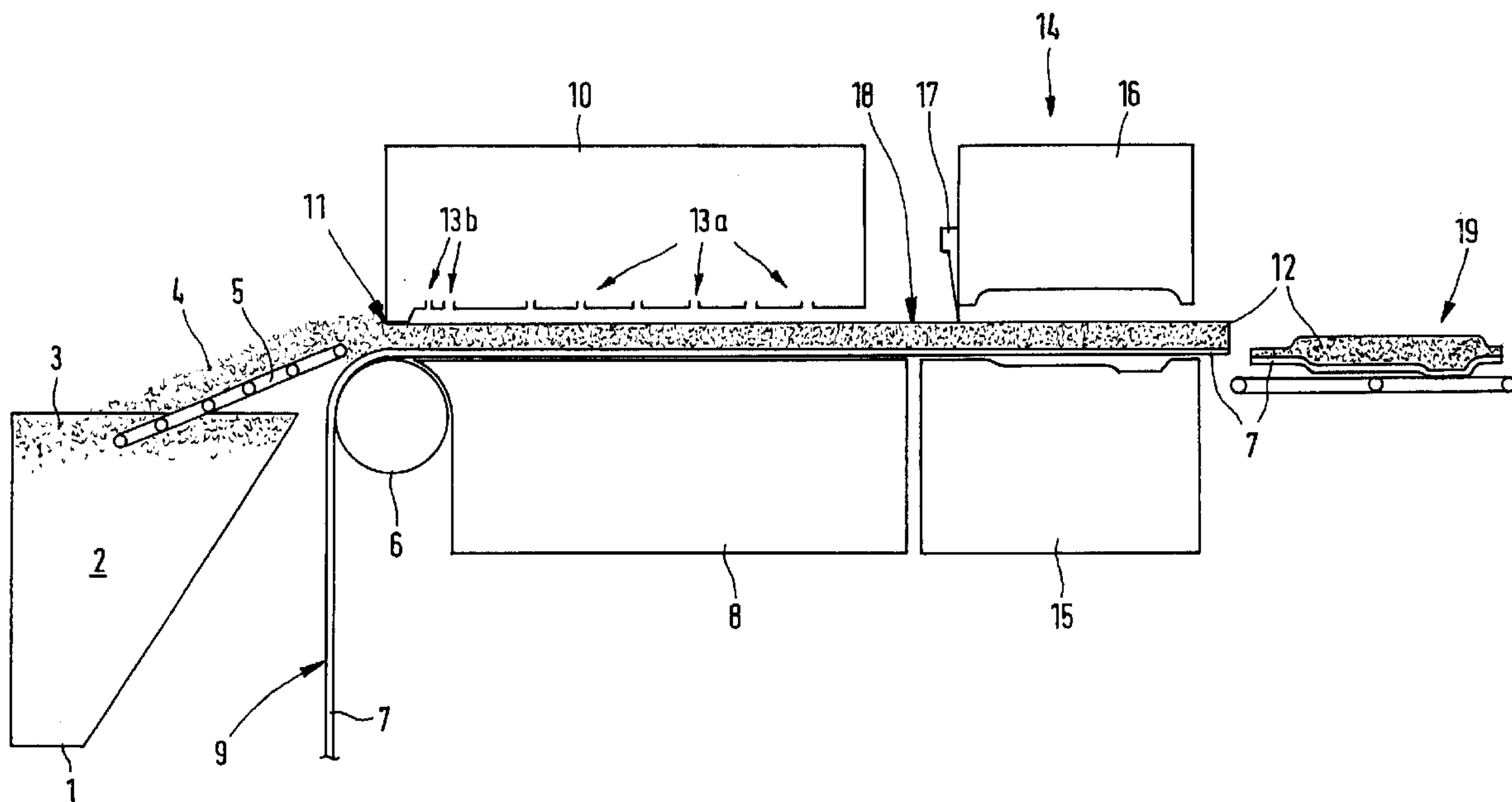




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(54) Titre : METHODE ET DISPOSITIF POUR LA FABRICATION D'UN ELEMENT COMPOSITE
(54) Title: METHOD AND DEVICE FOR MANUFACTURING A COMPOSITE COMPONENT



(57) **Abrégé/Abstract:**

In a method for manufacturing a bonded part (19), consisting of an aluminum sheet (7) and an aluminum foam layer (12), molten aluminum foam (4) is placed directly on the preheated aluminum sheet (7). This produces diffusion welding between the aluminum sheet (7) and the aluminum foam (4) and thus produces a permanent bond. Compared to subsequent gluing of aluminum foam plates and aluminum sheets, the method according to the invention is highly economical.



Method and Device for Manufacturing a Bonded Part

Abstract

In a method for manufacturing a bonded part (19), consisting of an aluminum sheet (7) and an aluminum foam layer (12), molten aluminum foam (4) is placed directly on the preheated aluminum sheet (7). This produces diffusion welding between the aluminum sheet (7) and the aluminum foam (4) and thus produces a permanent bond. Compared to subsequent gluing of aluminum foam plates and aluminum sheets, the method according to the invention is highly economical.

Method and Device for Manufacturing a Bonded Part

The invention relates to a method for manufacturing a bonded part according to the preamble of Claim 1 as well as a device for using the method as well as the use of a bonded part.

JP-OS 1-275831 A describes the manufacture of an aluminum bonded part: thin aluminum foam disks are cut from an aluminum foam block and glued over a large area of an aluminum sheet. The known manufacturing method for a bonded part according to the species is very costly: in a first step, an aluminum foam block is produced, from which flat aluminum disks are cut in a second step. In a third step, these disks are glued to the aluminum sheet. Since the surfaces of the aluminum foam disks to be glued have open pores because of the cutting process, considerable amounts of adhesive are required and this also contributes to increased weight of the bonded part. In addition, the method described is only suitable for making flat bonded parts.

The goal of the invention therefore is to provide a method and a device for simple, rapid, and economical manufacture of a bonded part so that the disadvantages of the prior art can be avoided.

This goal is achieved by the characterizing features of Claim 1. Claims 8 to 10 relate to devices according to the invention for using the method.

The basic idea of the invention is to produce the bond between the metal plate and the metal foam in the manner of diffusion adhesion in which a hot, not preformed metal foam is applied directly to the metal plate. In this respect it is suggested to combine the manufacture of the bonded part directly with the manufacture of the metal foam. In this manner, a metal foam block is not manufactured first which must be cut into metal foam disks after it cools and then glued to the metal plate in a separate work step, but the foam production and manufacture of

the bonded part take place in direct sequence. This produces a simple and economical method with which bonded parts according to the species can be made without using an adhesive.

The metal foam according to the invention is in a state in which it can still be molded, preferably in a molten state. Even doughy metal foam ("semi-solid foam") can be processed.

The term "metal" is defined in conjunction with the invention as a metal alloy with viscosity-increasing components that serve to stabilize the molten foam structure.

The "metal plates" of the present invention are not necessarily flat structures but can be shaped as desired within wide limits as to their dimensions and shape, as is the case for example in body parts produced by deep-drawing metal.

The improvement to the invention according to Claim 2 ensures a safe and load-carrying bond between the metal foam and the metal plate, in which, by preheating the metal plate, a cooling of the metal foam that impedes diffusion adhesion is avoided at the interface with the metal plate.

In addition, the embodiment of the invention according to Claim 3 creates the preconditions required for bonding the two bonded components. The gelling agent used reduces surface tension and can also result in etching of the surface of the metal plate.

As a result of the advantageous embodiment of the invention according to Claim 4, a manufacturing method is made available that can be used commercially that permits automated mass production of bonded parts in an economical fashion. The metal foam is supplied in a continuous process to one edge of the metal plate, which can be made for example as an endless metal sheet, so that insertion and removal of individual metal plates is avoided.

Foam can be manufactured for example by the method described in U.S. Patent 4,973,358A.

The method described in Claim 5 makes it possible to adjust the thickness of the metal foam layer individually in a simple fashion, with the regulating device ensuring a constant thickness and smooth surface.

Heating the regulating device (Claim 6) facilitates the manufacture of a flat surface on the metal foam layer. Depending on the temperature and shape

of the regulating device it is possible to produce a closed metal foam surface. Thus the finished bonded part can be cleaned even on the metal foam side in simple fashion or provided with additional elements.

To cool the metal foam it is possible for example to provide, connected downstream from the regulating device, a cooling device with air outlet openings facing the metal foam.

The improved manufacturing method according to Claim 7 is particularly economical since the bonded parts do not have to be removed from the device for embossing and placed in a separate embossing device. In addition the embossing of the bonded parts, depending on the material used and the requirements imposed, can be performed individually at the correct temperature, with heating or cooling being applied between the regulating and embossing devices. By using an embossing/cutting tool, combined embossing and cutting in one work step is possible so that manufacturing costs and times are reduced and parts tolerances can be minimized. The desired contour can be embossed on the bonded part both on the metal plate side and on the metal foam side.

The method according to Claim 8 uses a cast shape that is simple to handle and works like a cake mold. The metal plate itself forms the lower part of the mold and becomes part of the later bonded part. The upper part of the mold is lowerable into the lateral enclosing part of the mold. This principle ensures great freedom as far as shaping the bonded part is concerned; wall thicknesses and contours can be selected very freely. With the method described, both simple and complicated

bonded parts can be manufactured. The wall thickness of the metal foam can be constant or can vary over the surface of the metal plate. The metal plate can be flat or preshaped. The upper part can be made congruent to the metal plate or shaped as desired. By applying force to the upper part in the direction of the metal plate, the metal foam can be slightly compressed at least in its areas near the surface, producing a closed surface. In addition, by heating the individual cast parts, a closed surface can be produced on the metal foam layer. In particular, the metal plate can be preheated to provide a firm bond.

The metal foam required for feeding the casting mold can be produced for example by the method described in WO 91/01387 A1. Alternatively, metal foam can be cropped from the melting crucible as in US 4,973,358 A and placed in the casting mold. Other manufacturing methods can be also used to make metal foam.

The device according to Claim 9 permits continuous automated manufacturing processes in which for example sheet metal from a coil can be coated with metal foam rapidly, economically, and with constant quality. Eliminating the insertion tasks that would be required for individual metal plates enables a higher output.

The deflecting and transport devices can be combined for example and can be in the form of a powered roller located in the vicinity of the feed device. It is also possible to use a deflecting roller in the vicinity of the feed device and to use a conveyor belt with a large surface that also serves to guide the metal sheet.

Although a device is known from US 4, 973,358 A that uses a conveyor belt, this device however merely serves to produce the metal foam: the metal foam that is placed on the heat-resistant conveyor belt hardens to form an irregular surface with increasing distance from the melting crucible and is removed in a solid state from the conveyor belt for further processing. In

contrast, the present invention comprises a device for making a complete bonded part with the principle of preparation of the metal foam according to the U.S. patent being completely usable. In general, however, other methods can be used to produce the metal foam.

According to the improvement on the invention in Claim 10 a device is available in which, by arranging the two stations in a line (coating, embossing) continuous manufacture of bonded parts is possible in a continuous production process. By eliminating the insertion and removal steps between the stations, manufacturing time is shortened and high output and low manufacturing costs can be achieved as well. Manufacturing can largely be automated.

The embossing and cutting device must move in its lowered position along with the conveyor device for the bonded part for example by locking when placed upon lateral guides for the conveyor device.

Claim 11 describes an especially advantageous use of a bonded part: by combining the two components, the metal sheet is available as a paintable outer body hull. The metal foam can fulfill various tasks on the inside, for example for increase the rigidity of the outer hull or for sound insulation. Thus for example by using metal foam a stiffening inner body panel can be eliminated which in many cases is expensive to manufacture and is characterized by relatively high weight. At the same time the stiffening metal foam can perform a sound insulating function. Possible applications include for example bonded parts according to the invention such as engine hoods, trunk lids, sliding roof covers, etc. In the case of the engine hood it is also advantageous if the metal foam is not flammable.

In addition to parts of the outer hull, bonded parts according to the invention can also be used in the vehicle interior, for example as a partition between the engine and the interior. In

this case the metal foam is intended primarily to absorb sound.

Bonded parts in the area of the front and the rear of the vehicle with correspondingly thick metal foam layers are especially suitable for absorbing impact by plastic deformation of the metal foam.

Coverings or components can be fastened especially simply to the metal foam layer, for example with sheet metal screws. In addition, molly-type mounting elements whose projections correspond to the numerous sharp-edged thin partitions of the bubblelike cavities in the metal foam are especially suitable.

One possible embodiment of the invention will now be described in greater detail with reference to the drawing. The single figure shows a device for making a bonded part, in a side view and in a highly schematic representation.

A melting crucible 1 contains an aluminum alloy 2 in a molten state. When a gas is supplied,

a surface layer 3 of aluminum foam 4 filled with gas bubbles forms on the surface of aluminum melt 2. By means of a conveyor 5, aluminum foam 4 is fed to a transport roller 6 that functions as a deflecting and transport device. Transport roller 6 reverses an aluminum sheet 7 and feeds it to a horizontal sheet guide 8. Aluminum foam 4 is brought to the top 9 of aluminum sheet 7 by conveyor 5. A regulating device 10 located above transport roller 6, with a doctor blade 11 facing conveyor 5, adjusts the thickness of aluminum foam layer 12. Regulating device 10 has openings 13a and 13b to supply cold or hot air. An embossing and cutting device 14 abuts regulating device 10. It consists of an embossing mold 15 located below aluminum sheet 7, an embossing punch 16 located above aluminum foam layer 12, and a cutting tool 17.

Both the transport of aluminum sheet 7 and the transport of aluminum foam 4 are continuous. Aluminum sheet 7 is heated by devices not shown, both ahead of transport roller 6 and in sheet guide 8. At the end of conveyor 5, aluminum foam 4 is brought to aluminum sheet 7 moving away beneath conveyor 5. Regulating device 10 limits the height of aluminum foam layer 12. It is likewise heatable so that top 18 of aluminum foam layer 12 is as smooth as possible. Through openings 13a of regulating device 10, either hot air for further support of surface smoothing or cold air to accelerate the setting of aluminum foam layer 12 can be introduced. The supply of gelling agent

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through openings 13b facilitates the formation of a smooth surface 18.

By the shape of embossing mold 15 and embossing punch 16 the contour of bonded part 19 is determined. Cutting tool 17 separates finished bonded parts 19 from continuous aluminum sheet 7.

Claims

1. A method of manufacturing a bonded part comprising the steps of:
 providing a metal plate; and
 applying at least one metal foam layer to said metal plate, said at least one metal foam layer being in a moldable state,
 wherein a bond is formed between the metal foam layer and the metal plate.
2. The method according to Claim 1, wherein the metal plate is heated before the metal foam is applied.
3. The method according to either one of Claims 1 or 2, wherein a surface of the metal plate facing the metal foam is provided with a gelling agent before metal foam is applied.
4. The method according to any one of Claims 1 to 3, wherein the metal foam layer is supplied continuously by a feeding device to the metal plate, with feed taking place in a direction substantially parallel to the plane of the metal plate and with the metal plate moving away from the feed device.
5. The method according to Claim 4 wherein, within the vicinity of the feed device above the metal plate, a regulating device is provided for adjusting the thickness of the layer of metal foam.
6. The method according to Claim 5 wherein the regulating device is heated.

7. The method according to any one of Claims 1 to 6, wherein the metal plate and the metal foam layer are jointly embossed immediately after their combination.

8. A device for manufacturing a bonded part according to at least one of Claims 1 to 3 characterized in that a casting mold is used consisting essentially of a lowerable upper part and a surrounding enveloping part surrounding the upper part whereby, in a first step, the enveloping part extending at least approximately perpendicularly to the metal plate is placed in a sealing fashion on the metal plate or the metal plate is inserted in sealing fashion into the enveloping part, in a second step, the metal foam is applied to the metal plate and, in a third step, the upper part is lowered in the direction of the metal plate.

9. A device for working the method according to Claim 1 in which the metal foam is continuously supplied by a feed device to a metal plate moving away from the feed device and designed as an endless metal sheet, with a deflecting device for the metal sheet located in the vicinity of feed device, and with a transport device for moving the metal sheet away from the feed device.

10. The device according to claim 9 with an embossing and/or cutting device abutting the feed device, said cutting device being located above the metal sheet as it passes through and being movable in a direction perpendicular to the metal sheet.

11. A use of a bonded part consisting of a metal plate and a metal foam layer and produced by a method according to at least one of Claims 1 to 7, as a car body part for a motor vehicle, with the side of the metal plate facing away from the metal foam layer forming a part of the outer surface of the body.

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