(54) Title: PRODUCTION OF LAMINAR MOULDINGS THAT COMPRISE FOAMABLE MATERIAL SUPPORTED ON A MOULDED CARRIER

(57) Abstract: Laminar mouldings consisting of a foamable (2) material supported on a moulded carrier (1) are obtained by simultaneously moulding the carrier at a first temperature and the foamable material at a lower temperature, and bringing the moulded foamable material into contact with the moulded carrier at a temperature at which it adheres to the carrier to produce the laminar moulding.
PRODUCTION OF LAMINAR MOULDINGS THAT COMPRISe FOAMABLE MATERIAL SUPPORTED ON A MOULDED CARRIER

The present invention relates to the production of laminar mouldings that comprise foamable material supported on a moulded carrier.

Laminar mouldings that comprise foamable material supported on a moulded carrier find uses as reinforcing components in the automobile and other industries. They are particularly useful in systems where the foamable material is designed to expand at temperatures employed after metal coating operations so that the laminar moulding may be placed inside the metal frame of a vehicle whilst leaving a clearance between the moulding and the metal frame to allow the metal coating operation. Following the metal coating operation such as in the heated drying and baking of the coating the foamable material is foamed to bridge the clearance and bond the carrier to the interior wall of the metal frame of the vehicle.

This technology is practiced in automobile manufacture when the metal coating operation is the electrocoat anti corrosion process (sometimes known as a e-coat) and the foaming takes place in the oven employed to dry and cure the e-coat. The technology is described in, inter alia, PCT Patent Publications 95/32110; 00/37302.

The laminar materials that are used in such processes can be produced by a variety of methods. For instance the carrier may be from a thermoplastic material and produced by extrusion, blow moulding or injection moulding. The carriers are sometimes complex in shape or configuration and then injection moulding is the preferred method of production. Alternatively the carrier may be a metal in which case it may be produced by cutting or stamping. The foamable layer can be applied to the carrier in a variety of ways. For example it may be overmoulded onto the injection moulded carrier although this suffers from the disadvantage that two separate moulds and moulding operations are required. Alternatively the foamable material may be extruded, cut into ribbons and adhesively bonded to the carrier, this is however a laborious and time consuming process.

As mentioned, in certain instances, particularly where the carrier is a complicated shape injection moulding is a preferred technique for the production of the carrier. Overmoulding has been the preferred technique to provide the foamable material on the surface of the carrier. However, in order to successfully overmould the foamable material the foamable
material must be such that it will flow readily under the over moulding conditions, and will not foam, will not degrade and will adhere to the injection moulded carrier.

Mouldings have become bigger and the shape of mouldings has become more complex. The distances that the foambale material is required to flow in the overmoulding process have become larger and the flow paths required have become more tortuous, particularly when using low melt viscosity foambale materials such as foambale epoxy resin. Furthermore there are difficulties in that the moulding of the foambale material must occur at a temperature below that at which it will foam and moulding over long distances at lower temperatures can be difficult. All this has lead to increasing difficulties in overmoulding particularly on temperature control to ensure flow and prevent foaming and degradation. Furthermore, with the larger mouldings the shrinkage of the carrier after moulding has become greater and the tolerances have increased leading to overmoulding being more difficult to perform and the results less accurate.

We have now developed a moulding process which overcomes these difficulties and which enables the production of laminar mouldings, particularly mouldings of a complex shape, in a single moulding operation.

Accordingly to the present invention laminar mouldings are produced in a moulding operation in which a carrier material is formed in a first injection process performed at a first temperature and a foambale material is formed in a second parallel injection process performed at a lower temperature and the foambale material is transferred to the surface of the carrier material at a temperature such that the foambale material becomes heat bonded to the carrier material but does not foam.

The moulded foambale material may be transferred to the surface of the moulded carrier as it is cooling down from its moulding temperature. Alternatively the moulded carried and the moulded foambale material may both be removed from their respective moulds and transferred to a temperature controlled environment when the temperature is maintained at a level where the foambale material softens and is adhesive and does not foam. The moulded foambale material may then be transferred onto the surface of the carrier.

In order to achieve their reinforcing function reinforcing members tend to be larger and to have a more complex structure than previous structural reinforcing members. It has been found that such structures can be conveniently formed by injection moulding of thermoplastics and accordingly it is preferred that the carrier be produced by injection
moulding, preferably of polypropylene or nylon and particular nylon that is fibre filled especially glass filled nylon. Polyamides, particularly glass filled polyamides are suitable materials due to their high strength to weight ratio. It is preferred that the moulding is provided with means enabling fluid drainage. For example, holes may be provided in the moulding to allow the drainage of water, which may condense in the structure over time.

Examples of suitable foamable materials that may be used to produce hard foams include foamable epoxy-base resins and examples of such materials are the products L5206, L5207, L5208 and L5209, which are commercially available from L & L Products of Romeo Michigan USA, and the Core Products 5204, 5206, 5205 and 5208 available from Core Products, Strasbourg, France. The product should be chosen so that it softens and becomes adhesive at temperatures below that at which it foams and according to the rate of expansion and foam densities required. It is further preferred that it expand at the temperatures experienced in the oven used to dry and cure the anticorrosion coating deposited in the e-coat process, typically 130°C to 150°C. The expandable adhesive material is preferably dry and not tacky to the touch at ambient temperature, since this facilitates shipping and handling and prevents contamination.

With the larger mouldings of complex structure and the need to provide foam at only certain locations on the carrier we have found it useful to adopt certain techniques to guide the foaming. We have found it useful to provide ribs in the carrier which help to direct the direction of expansion of the foamable material as it foams. Such a technique is described in our United Kingdom Patent Publication GB 2375328A and is useful in that it helps confine the foam to the areas where it is required so economising on the amount of foamable material required. The presence of the ribs also prevents the expanding foam contaminating areas of the carrier designed to serve another function.

The increase in the size and complexity of the reinforcing members brings with it a preferment that the foamable material will foam at a lower temperature. Hitherto foamable materials have been designed to foam at temperatures between 165°C and 185°C, the temperatures employed for the drying and baking of the anticorrosion coating in the e-coat process. Foaming temperatures of between 115°C and 140°C are however preferred in the present invention. It is of course necessary that little or any foaming of the foamable material should occur during the moulding and bonding of the foamable material according to the process of this invention. Accordingly we prefer to use a foamable material that can be moulded and bonded at temperatures below 120°C preferably below 110°C and which can be foamed at temperatures between 115°C and 140°C preferably
between 120°C and 135°C. Preferred foamable materials comprise an epoxy resin that softens and flows below 120°C preferably below 110°C and containing a blowing agent and a curing agent that are activated at temperatures in the range 115°C to 140°C, preferably in the range 120°C to 135°C when the invention is sued to produce reinforcing members for automobiles. The foamable material may be chosen so that it will foam under the conditions that are used to dry the e-coat which is typically cured in an oven after application by dipping.

Where the present invention is used to produce reinforcing members for vehicles it must also satisfy certain other requirements in relation to the construction of the vehicle. The members should be provided with means whereby they can be placed and retained in the appropriate location in the vehicle. In many instances the reinforcing members are placed in the vehicle by robots and the members are therefore preferably provided with locator means to enable the robot to locate the member and lift it and place it in the vehicle. The locator means may comprise locations such as holes in the member which can be located by sensors on the robot. In addition the member can be provided with extensions which enable the robot to pick up the member and transfer it to the appropriate location in the vehicle metal structure. The manner by which the member is retained within the metal structure depends upon the position of the part within the structure and if it is provided to a horizontal or inclined element of the vehicle metal structure. If the member is provided to lie horizontally within the metal structure it may be provided with tabs which enable it to rest on the metal structure. In other environments clips or other forms of attachment may be required.

Where the process is used to produce reinforcing members that are to be used for strengthening automobiles it is important that the e-coat anticorrosion fluid which is applied prior to foaming can flow through the tubular metal structures when the vehicle metal structure containing one or more reinforcing members passes through the bath of the fluid. Accordingly it may be necessary to provide channels in the reinforcing member to enable flow of the e-coat fluid. Furthermore it may be necessary to ensure provision of an adequate gap between the foamable material and the metal for flow of the e-coat fluid. Such a gap may be provided by an appropriate means of attachment or spacers such as is illustrated in Japanese Patent Application 7-117728. Alternatively or additionally the structural reinforcing member may be provided with small lugs, which enable it to stand away from the interior walls of the hollow structure. In this way fastening devices may not be required and the area of contact between the structural reinforcing member and the interior walls of the frame of the vehicle is minimised.
In automobile reinforcement the clearance between the extremity of the reinforcing member and the interior walls of the hollow section should preferably be wide enough to enable the liquid used in the electrocoat bath to flow between the reinforcing member and the interior walls of the sections of the vehicle in sufficient quantity to enable an effective anti-corrosion coating to be deposited. On the other hand, the clearance must not be too wide since this can result in a lack of rigidity in the structure when the expandable adhesive is foamed to bond the structural reinforcing member to the walls of the hollow section other than the external panel. It is preferred that the clearance be no more than 1 centimetre and is more preferably 3 to 10 millimetres.

The techniques of the present invention are useful in the production of mouldings of the type discussed above. For example a dual component moulding may be manufactured by a process in which the carrier is produced by injection moulding in a first cavity. Typically if the carrier is produced from polyamide and particularly glass filled polyamide it will be injected at a temperature of between 150°C and 190°C. The foamable material may be simultaneously injected into a second cavity in order to produce a pattern of the foam it is desired to apply to the carrier. Where the foamable material is an epoxy foam it is typically injected at a temperature of between 100°C and 120°C being a temperature below that at which the material will foam.

Once the carrier has been formed by injection at the desired temperature it is cooled usually by cooling the mould. As the carrier cools its temperature will pass through the temperature range at which the foamable material will soften but not foam because it is at a temperature below its foaming temperature. The foamable material may be brought into contact with the moulded carrier while it is at this temperature so that it will soften and adhere to the carrier to produce a structural reinforcing member.

The process of the present invention is illustrated in the schematic flow chart which is Figure 1 hereto. In stage 1 (Injection moulding) a nylon carrier (1) and the desired foam structure (2) are separately moulded. In the embodiment illustrated they are then placed in a controlled temperature environment (regulated pre-heating) where their temperatures are controlled by heaters (3) and (4). When they are at the desired temperature they are brought together (heat bonding) to form the desired part (5).
CLAIMS

1. A moulding operation in which a carrier material is formed in a first injection process performed at a first temperature and a foamable material is formed in a second parallel injection process performed at a lower temperature and the foamable material is transferred to the surface of the carrier material when it is at a temperature such that the foamable material becomes heat bonded to the carrier material but does not foam.

2. An operation according to Claim 1 in which the carrier be produced by injection moulding, of polypropylene, nylon or fibre filled nylon.

3. An operation according to Claim 1 or Claim 2 in which the foamable material is an epoxy-base resin.

4. An operation according to any of Claim 1 to 3 in which the foamable material foams at 130°C to 150°C.

5. An operation according to Claim 4 in which the foamable material that can be moulded and bonded at temperatures below 120°C preferably below 110°C.

6. An operation according to any of the preceding claims in which the foamable material can be foamed at temperatures between 115°C and 140°C preferably between 120°C and 135°C.

7. An operation according to any of the preceding Claims in which the carrier is produced from polyamide and particularly glass filled polyamide and is injected at a temperature of between 150°C and 190°C and the foamable material is simultaneously injected into a second cavity in order to produce a pattern of the foam it is desired to apply to the carrier.

8. An operation according to Claim 6 in which the foamable material is an epoxy foam.

9. An operation according to any of the preceding Claims in which once the carrier has been formed by injection at the desired temperature it is cooled and as the carrier cools when its temperature passes through the temperature range at which
the foamable material will soften but will not foam the foamable material is brought into contact with the moulded carrier so that it will soften and adhere to the carrier to produce a structural reinforcing member.

10. An operation according to any of Claims 1 to 8 in which the carrier and the moulded foamable material are removed from their moulds, placed in a temperature controlled environment at a first temperature and subsequently brought together at a second temperature at which the foamable material will bond to the carrier.

11. An operation according to Claim 10 in which the second temperature is higher than the first temperature.
ASSEMBLY PROCESS

1) Injection molding

2) Regulated pre-heating

3) Heat-bonding

foam
nylon
### INTERNATIONAL SEARCH REPORT

**A. CLASSIFICATION OF SUBJECT MATTER**

B29C44/04  B29C44/18  B29C45/00

According to International Patent Classification (IPC) or to both national classification and IPC

**B. FIELDS SEARCHED**

Minimum documentation searched (classification system followed by classification symbols)

- B29C

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

- EPO-Internal, WPI Data, PAJ

**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

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<td>Y</td>
<td>EP 1 484 162 A (WEENER PLASTIK GMBH &amp; CO. KG) 8 December 2004 (2004-12-08) paragraphs '0053! - '0059! -----</td>
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**X**

Further documents are listed in the continuation of Box C.

**X**

See patent family annex.

* Special categories of cited documents:

- "A" document defining the general state of the art which is not considered to be of particular relevance
- "E" earlier document but published on or after the international filing date
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- "P" document published prior to the international filing date but later than the priority date claimed

**T**

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Document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

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Document member of the same patent family

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7 March 2006

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14/03/2006

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<td>EP 1 149 679 A (NEO-EX LAB. INC) 31 October 2001 (2001-10-31) paragraph '0017'  paragraph '0044'</td>
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