METHOD AND DEVICE FOR MANUFACTURING A MOULDED PART FROM A SHEET-LIKE MATERIAL

The invention relates to a method for manufacturing a moulded part from a sheet-like material (40). The method comprises the steps of providing a first mould half (10) of a form-retainig material; providing a second mould half (20) in the form of a collection of material particles (21) situated in enclosing means (22); deforming the sheet-like material (40) under pressure between the two mould halves (10, 20). The invention also relates to a device (1) for performing the method and to a moulded part obtainable with the method.

FIG. 1
Declaration under Rule 4.17:
— as to applicant’s entitlement to apply for and be granted a patent (Rule 4.17(ii))

Published:
— with international search report
— before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments
Method and device for manufacturing a moulded part from a sheet-like material

The invention relates to a method for manufacturing a moulded part from a sheet-like material. The invention also relates to a device for manufacturing the moulded part. The invention further relates to a moulded part obtainable with the invented method.

A number of methods are known for manufacturing a moulded part from a sheet-like material. The sheet-like material can for instance be a metal layer or a plastic layer, or in particular a fibre-reinforced plastic layer, or optionally an assembly of such layers. Methods are thus known in which sheet-like material, optionally in heated state, is formed into a moulded part under pressure between two mould halves. In such methods (also referred to as pressing or as compression moulding) both mould halves are generally constructed from metal so as to be able to obtain the required dimensional accuracy, wear resistance and durability. A drawback of the use of metal mould halves is that they must have a particularly accurate dimensioning, since in the case of small variations in the dimensioning the pressure exerted by the mould halves on the sheet-like material during the pressing becomes non-homogeneous. During pressing some parts of the material will be subjected to high pressures and other parts will hardly be placed under pressure. Particularly when the sheet-like material is constructed from different layers, which must be mutually connected (must be “consolidated”) during the pressing, this can result in locally poorly consolidated layers and a risk of delamination. The use of mould halves of a softer material, such as for instance rubber, does not solve this problem. When rubber mould halves are used the pressure distribution is not homogeneous either, and the use of rubber moreover detracts from the wear resistance and the durability of the relevant mould half. In methods in which relatively high temperatures are applied, a dimensional accuracy which is per se sufficient at room temperature may in addition be lost due to the relatively high thermal expansion of rubber. Deformation of the rubber mould half can result in poorly formed moulded parts, which for instance have rounded corners where straight corners were desired.

0457228. The pressure is obtained by the own weight of the material particles described in EP-A-60179222 by arranging an additional static weight.


The German patent application DE2134168 describes a method for manufacturing a moulded part from a sheet-like material. A form-retaining mould half with the desired form of the moulded part is pressed against the sheet-like material, wherein the sheet-like material rests on a collection of material particles received in enclosing means.

The present invention has for its object, among others, to provide an improved method and device for manufacturing a moulded part from sheet-like material, which do not have at least some of the above stated drawbacks.

The method according to the invention for manufacturing a moulded part from a sheet-like material comprises for this purpose the steps of:

a) providing a first mould half of a form-retaining material;
b) providing a second mould half in the form of a collection of material particles situated in enclosing means;
c) displacing under pressure between the two mould halves at least part of the particles from the enclosing means to a position against the sheet-like material, whereby this material is deformed and pressed against the first mould half.

By displacing the collection of material particles from the enclosing means to a position against the sheet-like material during the shaping thereof a homogeneous pressure distribution is obtained over the moulded part, wherein the pressure can be built up as desired and controlled during the shaping independently of the form of the first mould half. Once the moulded part has been pressed almost completely against the first mould half and hereby substantially attained its final form, it is still possible according to the invention to further increase the pressure exerted by the material particles by supplying more particles from the enclosing means. The method disclosed in DE2134168 does not
have this advantage. In the known method the number of particles in the enclosing means is constant, so that the pressure developed depends on the compressed volume of the particles. The pressure cannot therefore be controlled independently of the shaping, and is moreover limited by the number of particles received in the volume of the enclosing means.

A moulded part is hereby obtained with improved mechanical properties. A moulded part with an improved delamination resistance compared to the prior art is obtained particularly when the sheet-like material is constructed from a stack of a plurality of material layers. Due to the exceptionally favourable pressure distribution during the pressing, moulded parts of complicated form can also be obtained, wherein undesirable effects such as for instance crack-forming in the sheet-like material as a result of the strong deformation during the pressing are reduced or avoided. The first mould half is manufactured from a form-retaining material such as for instance a metal. Form-retaining is understood to mean that the first mould half hardly changes shape at all when the sheet-like material is deformed under pressure.

According to the invention a sheet-like material is brought to a first temperature and then placed between the two mould halves. At least one mould half is subsequently moved to a position almost against the material. This will generally be the second mould half, although this is not essential. In this situation at least part of the particles is then displaced under pressure from the enclosing means to the sheet-like material, whereby the material is deformed and pressed against the first mould half. Both mould halves are then opened after a suitable period of time and the moulded part is removed.

With the invented method it is particularly possible to obtain moulded parts with undercuts. Such moulded parts cannot be manufactured with the known method since the mould halves do not fit together. The improved pressure distribution on the sheet-like material during the pressing is obtained particularly in that the material particles, when displaced under pressure against the sheet-like material - whereby the material is deformed and pressed against the first mould half - are driven substantially into all available space. They will moreover have a packing in this process which is adjusted to the pressure. This results in the pressure distribution being much more homogeneous than is the case in the known method. Furthermore, this pressure distribution is brought
about as it were automatically due to mutual displacement and deformation of particles. A further advantage of the method according to the invention is that, when damage to the second mould half occurs, it does not have to be replaced. It has been found that a second mould half remains usable when it contains damaged material particles, because the particles substantially retain their original form. Should the number of damaged particles be too great, or the damage become too serious, it then suffices in such a case to remove the damaged material particles from the collection and to add new particles if desired, after which the mould half can be used again. This saves considerable costs and moreover prevents time loss during production. Another advantage of the method according to the present invention is that no special provisions are necessary in addition to those already known from the prior art. It is thus not at all necessary for instance to provide precise sealing means, as is for instance the case in so-called hydroforming, wherein an enclosed fluid medium is applied as mould half. Strict requirements are set in hydroforming for the sealing means, which must ensure that the fluid medium cannot escape. This is not necessary in the present method.

A preferred embodiment of the method according to the invention is characterized in that the displacement under pressure of at least part of the particles to a position against the sheet-like material is accompanied by breaking of a wall part of the enclosing means. Such a variant requires no moving parts to cause the collection of material particles to escape the enclosing means under pressure, and is thereby little susceptible to malfunction and is low-maintenance.

Yet another preferred embodiment of the method according to the invention has the feature that the displacement under pressure of at least part of the particles to a position against the sheet-like material is accompanied by displacement of a wall part of the enclosing means, whereby an opening is created. Such a preferred variant comprises moving parts, although the escape of the material particles from the enclosing means can take place in controlled manner, wherein the risk of unexpected release of the particles is reduced. In a further preferred embodiment of the method according to the invention the enclosing means comprise an open wall part directed toward the moulded part for forming, and the particles are only supplied to the enclosing means when the enclosing means already almost connect with the open wall part onto the moulded part.
for forming. Such a preferred variant comprises no moving parts and escape of the material particles from the enclosing means can still take place in controlled manner.

The method according to the invention is preferably characterized in that the displacement under pressure of at least part of the particles to a position against the sheet-like material is accompanied by displacement of a flexible wall part of the enclosing means, whereby this part is pressed against the sheet-like material. In such a preferred embodiment of the method the material particles do not come into direct contact with the sheet-like material. Furthermore, the material particles are still situated in the enclosing means after the shaping process, whereby the second mould half can be used again almost immediately. The surface of the moulded part which has come into contact with the material particles, and will therefore show the imprint thereof, will further be visibly smoother, which is important for some applications. The presence of the flexible wall part, for instance in the form of a foil, will after all make this imprint less readily visible.

Another preferred variant of the method according to the invention has the feature that after performing of step c) the material particles are removed by means of extraction means. Such means are per se known and can for instance comprise a device which suctions the particles away and immediately feeds them back again to the enclosing means. It is also possible to remove the material particles manually or using blowing means.

The method according to the invention can in principle be performed with material particles of random form. It is however advantageous to characterize the method in that at least part of the particles has a form such that the collection of material particles has the closest possible packing when arranged in the enclosing means, and more preferably when arranged at random in the enclosing means. The pressure distribution will hereby become even more homogeneous. Not all material particles need have the same form here. It may even be favourable to give groups of particles a form different from another group in order to thus obtain the desired closest possible packing. This preferred embodiment further has the advantage that the enclosing means are filled less high, which increases the efficiency of the method. There is further also less chance of internal folding in the moulded part. In this respect a distinction is made between a so-
called random loose packing and a random close packing. The first results from random
filling of the enclosing means with the material particles, the second by subsequently
subjecting the whole to vibration. The random loose packing and the random close
packing of the material particles in the enclosing means are preferably both maximized
by selecting a suitable form of the material particles. It has been found that a
particularly suitable form herefor is a (substantially) ellipsoid form. There are additional
advantages when the ratio of the three axes of the ellipsoid particles lies between 0.6 : 1
: 1.50 and 0.9 : 1 : 1.10, and more preferably amounts to 0.8 : 1 : 1.25. It will be
apparent that the method according to the invention also operates well when the
material particles are packed in ordered manner.

The method according to the invention can in principle be performed using particles of
any material and of any average size. At a relatively small average size of the material
particles the pressure distribution will generally become more homogeneous and the
imprint less clearly visible, although this is to the detriment of the sealing and enclosing
of the particles. A moulded part obtainable with the method according to the invention
will comprise at least one surface with a surface texture in the form of deeper-lying
parts surrounded by elevated edges. This surface corresponds with the surface which
has come into contact with the material particles during performing of the method. The
deeper-lying parts are created by the imprints of the material particles in the surface of
the not yet fully shaped sheet-like material. Because no material can be lost, a part of
the sheet-like material will be elevated along the edges of the imprints. The elevation
may be hardly visible here, although it is also possible for the edges to be clearly
discernible. Depending on among other factors the dimensions of the material particles,
it is however also possible when performing the method according to the invention that
a surface texture in the form of deeper-lying parts surrounded by elevated edges is not
visible at all. It is also possible that the surface structure is only microscopically visible.

When particles with a relatively low hardness are applied, less pressure is required to
deform the particles themselves into a homogeneous second mould half. This enhances
the homogeneity of the pressure distribution. Such a second mould half can moreover
well withstand high pressures, since at a high pressure the particles are supported by
adjacent particles and/or by the enclosing means such that they hardly further deform.
In a further preferred variant of the method according to the invention the particles are selected from the group of metal particles, plastic particles and mineral particles. The particles are preferably rubber particles, and more preferably silicone rubber particles. Such silicone rubber particles have an improved resistance to high temperatures.

Displacement under pressure of at least part of the material particles to a position against the sheet-the material, whereby the material is deformed and pressed against the first mould, can in principle take place at any suitable pressure. The applied pressures are here preferably sufficiently high to make the space between the particles small, whereby a homogeneous pressure distribution is obtained. The pressures are further preferably high enough to overcome the deformation resistance of the rubber particles and the sheet-like material for forming. Typical pressures generally lie between 5 and 500 bar, wherein pressures lying between 10 and 200 bar are preferable, and pressures lying between 20 and 100 bar are most preferable.

The invention also relates to a device for manufacturing a moulded part from a sheet-like material, which device comprises:

a) at least a first mould half of a form-retaining material;
b) at least a second mould half in the form of a collection of material particles;
c) enclosing means for receiving the material particles;
d) pressing means for deforming the sheet-like material under pressure, wherein the collection of material particles is located between the pressing means and the first mould half.

The advantages of the device have already been discussed at length in the context of the method according to the invention already described above. By deforming the sheet-like material according to the present invention between a collection of material particles and a form-retaining mould, wherein the collection of material particles is placed between the pressing means and the sheet-like material, a better pressure distribution on the sheet-like material for deforming is obtained than according to the prior art.

According to the invention the sheet-like material is brought to a first temperature before it is placed between the mould halves and deformed under pressure. The height of the first temperature depends on, among other factors, the type of thermoplastic
plastic, the type of metal, but for instance also on the form of the moulded part to be manufactured, and can vary from temperatures below room temperature to hundreds of °C. It is advantageous here to select the first temperature higher than the glass transition temperature of the thermoplastic plastic or, in the case a plurality of thermoplastic plastics is applied, higher than the lowest glass transition temperature. The first temperature is more preferably higher than the melting temperature of the thermoplastic plastic or, in the case a plurality of thermoplastic plastics is applied, higher than the lowest melting temperature. A suitable method for heating to a first temperature consists for instance of heating the sheet-like material using contact heat by placing the material between hot plates or rollers. The use of rollers has the advantage that the sheet-like material can be simultaneously heated and transported. It is also possible to heat the assembly by means of radiant heat, for instance infrared (IR), which is recommended in particular cases. Once heated, the sheet-like material is placed for instance in a press comprising both mould halves. At least the first mould half here has a second temperature, which is generally, though not necessarily, lower than the first temperature. By closing the press the mould halves are pressed together, thus deforming the sheet-like material, wherein in the case the sheet-like material is constructed from multiple layers, these are mutually connected or consolidated. Another possible embodiment consists of bringing the sheet-like material to the first temperature by placing it in a mould heated to the first temperature. The mould is then closed and cooled to the second temperature. A further advantage of the method according to the invention is that the applied temperatures are not limited by the applied mould material. The material particles can undergo a certain degree of degradation without this being particularly disadvantageous for the visual and mechanical properties of the moulded part formed with the method.

In the case a thermocuring plastic is applied, the first temperature is generally lower than the second temperature, for instance room temperature. A sheet-like material on the basis of a thermocuring plastic does not generally need to be heated prior to placing between the two mould halves. Heating can even be disadvantageous because of the risk of premature curing. In the present embodiment variant at least the first mould half has a second temperature which is generally, though not necessarily, higher than the first temperature. By closing the press the mould halves are pressed together, thus deforming the sheet-like material, wherein, in the case the sheet-like material is constructed from
multiple layers, these layers are mutually connected or consolidated by chemical curing of the thermocuring matrix.

Where reference is made in this application to a first and a second temperature, this is understood to mean an average temperature. It will be apparent that, when reference is for instance made to bringing the sheet-like material to a first temperature, this is understood to mean that the material has on average acquired the first temperature, wherein local variations may occur. The same is true for bringing at least one mould half to the second temperature. It is also possible here for a different temperature to prevail locally, although this will not vary much from the average second temperature.

The method according to the invention is not limited to determined thermoplastic and/or thermocuring plastics. All plastics are suitable in principle.

The method according to the invention is preferably characterized in that the sheet-like material comprises a fibre-reinforced plastic. Suitable reinforcing fibres are for instance glass fibres, carbon fibres, metal fibres, reinforced thermoplastic plastic fibres, such as for instance aramid fibres and ultra-high molecular weight polyethylene or polypropylene fibres, as well as natural fibres such as for instance flax, wood and hemp fibres.

The method according to the invention can however also be applied to manufacture moulded parts from metal, such as for instance steel alloys, aluminium alloys and the like. Combinations of metal layers with fibre-reinforced plastic layers are also possible.

It is also possible in the method according to the invention to apply a sheet-like material comprising at least one fibre layer. Such a dry fibre layer (not impregnated with a thermocuring or thermoplastic plastic) or partially impregnated fibre layer (semi-preg) has the advantage that it is relatively easily deformable. The use thereof moreover increases the flexibility of the method. Because the pressure distribution is more homogeneous in the invented method, the method is more "tolerant", which in the present case is understood to mean that, by deforming at least one fibre layer together with the other plastic layers of the sheet-like material, surprisingly a well consolidated moulded part is obtained, wherein the wetting (impregnation) of the fibres with the plastic takes place during the deforming process. It is also possible to apply so-called
comingled and/or intermingled rovings in such an embodiment. Such rovings comprise a reinforcing fibre and a thermoplastic plastic in fibre form.
The fibre layer and/or the fibre-reinforced plastic layer preferably comprises substantially continuous fibres extending in two substantially orthogonal directions (so-called isotropic fabric). In another preferred embodiment the fibre layer and/or the fibre-reinforced plastic layer comprises substantially continuous fibres extending substantially in one direction (so-called UD-fabric). It is also possible to apply discontinuous fibres.

After bringing the sheet-like material to the first temperature, it is then transferred to a shaping device comprising at least a first and a second mould half and being at least partially at a second temperature. In order to facilitate the transfer the sheet-like material can optionally be received in a clamping frame. An additional advantage of the use of a clamping frame or so-called holding-down clamp is that it allows the sheet-like material, in the case it for instance comprises metal layers, to be plastically deformed together with the shaping at the position where the yield stress is reached due to deformation. The clamping frame usually runs along the peripheral edges of the sheet-like material.

The invention is elucidated hereinbelow with reference to the accompanying figures, without however being limited thereto. In the figures:
Fig. 1 shows a schematic view of a part of a device according to the invention;
Fig. 2 shows schematically the steps of an embodiment of the method according to the invention;
Fig. 3 shows a schematic view of a part of the device according to the invention; and
Fig. 4 shows an imprint of a pressure foil placed in the mould halves in the known method; and finally
Fig. 5 shows an imprint of a pressure foil placed in the mould halves in the method according to the invention.

Referring to figure 1, a part of a device 1 is shown for manufacturing a moulded part from a sheet-like material 40, for instance a number of layers of thermoplastic composite. Device 1 comprises a first mould half 10 which is provided with a mould cavity 11. The geometry of mould cavity 11 determines the final form of the moulded
part manufactured with the method. Device 1 also comprises a second mould half 20 in the form of a collection of material particles 21 which can be received in enclosing means 22. In the shown embodiment enclosing means 22 comprise a peripheral body 23 which is provided on the top side thereof with an inlet opening 240. The collection of material particles 21 can be supplied through inlet opening 240. Device 1 further comprises means 24 for displacing at least part of the material particles 21 under pressure to mould cavity 11. In the shown variant pressing means 24 comprise a pressure plate 29 which is formed such that it can be displaced in peripheral body 23 in the indicated direction R. This is realized by means (not further shown) such as for instance a hydraulic pump, which can move pressure plate 29 via pressure cylinder 290. Enclosing means 22 further comprise an end plate 25 provided on its underside with an opening 27. Material particles 21 can gain access to mould cavity 11 by means of opening 27. The end plate also has a recessed wall part 26 in which a slide 28 can slide. If desired, opening 27 can be closed using slide 28.

Referring to figure 2, means 30 are shown for arranging thermoplastic composite 40 between the two mould halves 10, 20. These means 30 likewise form part of device 1 and comprise a clamping frame which is formed by mutually connectable transverse and longitudinal braces 32, 33. Thermoplastic composite 40 is secured to the clamping frame by tensioning clamps 34. Clamping frame 32, 33 is connected to pivotable leg profiles 35 arranged at the position of the corner points of the clamping frame. They are connected in pairs to a coupling rod 31. Leg profiles 35 are pivotable around shaft 36, whereby the clamping frame can be placed at different heights.

Figure 2 shows a preferred variant of the method according to the invention. As shown in figure 2, a first mould half 10 provided with a mould cavity 11 is provided, as well as a second mould half in the form of a collection of material particles 21 situated in enclosing means 23. The collection of material particles is closed off by means of a displaceable wall part 28 of the enclosing means, for instance a slide. Further provided is a sheet-like material 40 which is brought to a first temperature by means of heating means 50, as shown schematically in figure 2 under A. Heating means 40 for instance comprise an infrared oven or panels, although any other method of heating is also suitable. As shown in figure 2 under B, the sheet-like material brought to the first temperature is arranged between the two mould halves by means of the clamping frame
30 shown in figure 3. In the shown embodiment of the method the second mould half 21, 23 is then brought into the vicinity of the sheet-like material. This is shown in figure 2 under C. In step D wall part 28 is then removed, whereby the collection of particles 21 is released from enclosing means 23 and comes into contact with sheet-like material 40. Particles 21 are subsequently displaced under pressure to mould cavity 11, whereby material 40 is deformed and pressed against mould cavity 11. This step is illustrated in figure 2 under E. Plate 25 functions here as holding-down clamp for sheet-like material 40. Particles 21 are pressed into mould cavity 11 under pressure by plunger construction (29, 290). In this step material 40 is pressed uniformly against mould cavity 11, whereby after a determined time the material will acquire the temperature prevailing at the position of mould cavity 11. In the context of this application this temperature is designated as second temperature. For a thermoplastic material it is recommended to select the first temperature high enough to enable easy deformation of the material, for instance higher than the glass transition temperature and/or the melting temperature of the thermoplastic. The second temperature will then generally be lower than the glass transition temperature and/or the melting temperature of the thermoplastic. For a thermocuring material it is recommended to select the first temperature low enough so as not to cause premature curing of the material. The second temperature will then generally be chosen such that the thermocuring material can cure at least partially in a suitable period of time. In both cases the formed moulded part has a sufficiently stable form after a suitable period of time to enable removal thereof after opening of the two mould halves, as shown in figure 2 under F. In or after this step the relevant material particles 21 are removed from enclosing means 23 and/or the manufactured moulded part 400 by means of extraction means (not shown). As also shown in figure 2F, it is possible to reuse at least part of the thus removed material particles 21 by feeding them via a filling opening 241 to enclosing means 23, after which the method cycle can be resumed.

Referring to figure 4, an imprint is shown of a pressure foil which has been arranged in the mould cavity of the first mould half prior to performing of the known method. The first mould half had a U-shaped mould cavity. The second mould half was a stamp manufactured from rubber with practically the same form. In the first mould half a strip of pressure foil was arranged, which ran from the one side of the U-shape to the opposite side. In figure 4 the pressure foil is laid flat after removal from the mould. The
left side surface runs over the distance indicated with A, the base over the distance indicated with B, and the right side surface over the distance indicated with C. At high pressures the pressure foil has a darker discolouration than at low pressures. The central strip D has a darker colour and represents the relatively homogeneous pressure over the base of the U-profile. Two light strips E and F are visible directly adjacent hereof on the left and right-hand side. These areas correspond to the corners of the U-profile. It can clearly be seen that a lower pressure has prevailed here during the pressing.

Imprints G and H are visible further outward, these being typical for respectively left and right-hand side surfaces. Imprints G and H also show an inhomogeneous pressure distribution, wherein the discolouration starts by being darker adjacent of the corners and becomes increasingly lighter in outward direction. The shown highly inhomogeneous pressure profile is caused by barrel formation of the rubber stamp, wherein the side surfaces thereof bend outward. This is unfavourable for the properties of the moulded part.

Referring to figure 5, an imprint is shown of strips of pressure foil which have been arranged in the mould cavity of the first mould half and on parts of the outer surface of the - cylindrically formed - enclosing means prior to performing of the method according to the invention. The method was performed with cube-shaped rubber particles, this form not being per se optimal for achieving a homogeneous pressure distribution, among other reasons because the stacking of cube-shaped particles does not have the closest packing. A shows the imprint of a strip of pressure foil placed on the bottom of the first mould half. Imprints B and C relate to strips of pressure foil arranged on the inner surface of the enclosing means. As can be readily discerned, the pressure foils all have the same pressure profile. No difference can be discerned in imprints A, B and C individually, nor between imprints A, B and C mutually. With the invented method a pressure profile is thus obtained which is macroscopically homogeneous, or only varies slightly therefrom. The imprint of the cube-shaped particles can also be clearly discerned. This imprint can be described as areas 210 with high pressure, surrounded by edges 211 with lower pressure. On the contact side of the moulded part with the second mould half this pressure profile causes a surface texture in the moulded part in the form of deeper-lying parts surrounded by elevated edges. The deeper-lying parts correspond with areas 210, the elevated edges with areas 211. It will be apparent that the pressure profile can also be made microscopically more
homogeneous by selecting the form of the particles such that they have a high degree of packing when arranged in the closing means and/or by selecting sufficiently small particles.

The moulded parts obtained with the method according to the invention can be used as lightweight construction element in industrial applications, such as for instance in constructions, buildings, vehicles, ships, and so on. It is however also possible to apply the invented method for mutual connection of thermoplastic moulded parts. It is thus possible for instance to apply the method for thermal welding of thermoplastic moulded parts. In thermal welding electrically conductive material is arranged between the moulded parts for connecting. This is then heated. In order to obtain a good connection, the moulded parts must here be held together with a certain pressure. The invented method is highly suitable for this purpose. Another application comprises of creep-forming of reinforcing fibres, and in particular of polyethylene fibres.

A great advantage of the method according to the invention is that moulded parts can hereby be manufactured in simple manner, wherein the moulded part has good mechanical properties. Using the invented method a moulded part can further be made from layers of sheet-like material, wherein the different layers are properly consolidated, particularly also on standing surfaces.
Claims

1. Method for manufacturing a moulded part from a sheet-like material, which method comprises the steps of:
   a) providing a first mould half of a form-retaining material;
   b) providing a second mould half in the form of a collection of material particles situated in enclosing means;
   c) displacing under pressure between the two mould halves at least part of the particles from the enclosing means to a position against the sheet-like material, whereby this material is deformed and pressed against the first mould half.

2. Method as claimed in claim 1, characterized in that the displacement under pressure of at least part of the particles to a position against the sheet-like material is accompanied by breaking of a wall part of the enclosing means.

3. Method as claimed in claim 1, characterized in that the displacement under pressure of at least part of the particles to a position against the sheet-like material is accompanied by displacement of a wall part of the enclosing means, whereby an opening is created.

4. Method as claimed in claim 1, characterized in that the enclosing means comprise an open wall part directed toward the moulded part for forming, and that the particles are only supplied to the enclosing means when the enclosing means already almost connect with the open wall part to the sheet-like material.

5. Method as claimed in claim 1, characterized in that the displacement under pressure of at least part of the particles to a position against the sheet-like material is accompanied by displacement of a flexible wall part of the enclosing means, whereby this part is pressed against the mould cavity.

6. Method as claimed in any of the foregoing claims, characterized in that after step c) the material particles are removed by means of extraction means.
7. Method as claimed in any of the foregoing claims, characterized in that at least part of the particles has a form such that the collection of material particles has the closest possible packing when arranged in the enclosing means.

8. Method as claimed in any of the foregoing claims, characterized in that at least part of the particles has a substantially ellipsoid form.

9. Method as claimed in claim 8, characterized in that the ratio of the three axes of the particles lies between 0.6 : 1 : 1.50 and 0.9 : 1 : 1.10.

10. Method as claimed in claim 9, characterized in that the ratio of the three axes of the particles amounts to 0.8 : 1 : 1.25.

11. Method as claimed in any of the foregoing claims, characterized in that the particles are selected from the group of metal particles, plastic particles and mineral particles.

12. Method as claimed in claim 11, characterized in that the particles are silicone rubber particles.

13. Method as claimed in any of the foregoing claims, characterized in that the pressure in step c) lies between 5 and 500 bar.

14. Method as claimed in claim 13, characterized in that the pressure in step c) lies between 10 and 200 bar.

15. Method as claimed in claim 14, characterized in that the pressure in step c) lies between 20 and 100 bar.

16. Method as claimed in any of the foregoing claims, characterized in that the sheet-like material comprises a fibre-reinforced plastic.
17. Moulded part obtainable with the method as claimed in any of the claims 1-16, of which at least one of the surfaces has a surface texture in the form of deeper-lying parts surrounded by elevated edges.

18. Moulded part obtainable with the method as claimed in any of the claims 1-16, of which at least one of the surfaces has a surface texture in the form of deeper-lying parts surrounded by elevated edges, and wherein this surface structure is only microscopically visible.

19. Device for manufacturing a moulded part from a sheet-like material, which device comprises:
   a) at least a first mould half of a form-retaining material;
   b) at least a second mould half in the form of a collection of material particles;
   c) enclosing means for receiving the material particles;
   d) pressing means for deforming the sheet-like material under pressure between the two mould halves,
   wherein the collection of material particles is located between the pressing means and the first mould half.
FIG. 4

210 211

A

FIG. 5

B

C
INTERNATIONAL SEARCH REPORT

A. CLASSIFICATION OF SUBJECT MATTER

INV. B29C5/08  B29C7/44  B29C6/02

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)
B2C  B30B

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

<table>
<thead>
<tr>
<th>Category</th>
<th>Citation of document, with indication, where appropriate, of the relevant passages</th>
<th>Relevant to claim No.</th>
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<tbody>
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<td>X</td>
<td>DE 21 34 168 A1 (HOLZWERK BECKER KG) 18 January 1973 (1973-01-18) cited in the application page 3, line 24 - page 4, line 25 page 9, lines 11-24 page 10, line 25 - page 11, line 9 claims 1, 6, 8, 9 figures</td>
<td>1-19</td>
</tr>
</tbody>
</table>

Further documents are listed in the continuation of Box C. See patient family annex.

* Special categories of cited documents:
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Date of the actual completion of the international search
26 September 2008

Date of mailing of the international search report
07/10/2008

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