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Insulation packaging for thermal insulation or shock absorption made from straw or hay

For the storage and shipment of temperature sensitive goods, insulation packaging is required to ensure that a predetermined temperature inside the packaging is not exceeded or fallen below. Such packagings are mainly used for pharmaceutical products, medical products and food. Non-compliance with these temperature limits, often regulated by law, poses a high liability risk for the consignor and a health risk for the recipient.

To create an insulation effect for an insulation packaging, the three heat transfer phenomena convection, conduction and thermal radiation must be minimized. Air is an ideal insulation medium due to its low thermal conductivity and simple availability. The changes in density of air at different temperatures causes a movement of air (convection), this can be reduced by restricting the movement of the air. Thermal radiation can be reduced by the selection and arrangement of suitable materials.

For the aforementioned physical reasons of heat transfer phenomena, insulation packagings are typically bulky hollow bodies of a plurality of small air chambers. With regular movements of goods, disposal of these bulky packagings leads to a large problem for the end customers and also poses ecological issues with increased online trading.

An easy to dispose, environmentally friendly insulation packaging providing a shock absorbent function is the key factor for the required consumer acceptance of the commercial growing online grocery market.

The insulation packaging used on the market is predominantly made from expanded polystyrene (EPS). These provide a good insulation effect, the ability of freeform shaping and is cost-efficient to manufacture due to high volume production. However, the production of insulation packagings made from EPS is very energy intensive. The environmental impact during disposal is controversial due to the contained contaminants (flame-retardants, styrene, plasticizers and pentane). The humidity in an EPS box reaches between 80% – 90% by using thermal packages. Moisture sensitive products, for example bakery products, can be damaged at this.

Alternative insulation packaging has been developed to meet the demand for a more environmentally friendly and easier to dispose insulation packaging.

From literature there are known insulation packagings based on starch foam. For example, a layer composite material based on starch foam is disclosed in EP0656830B1. The production of insulating packagings made of starch foam is energy intensive and therefore costly. Due to the moisture sensitivity, an impenetrable water and vapor barrier is required. As with EPS, no humidity regulation takes place. For these reasons, no starch-based products have been successful in establishing themselves on the market.

Besides, insulation packagings composed of inflatable air cushions exist, such as disclosed in US005533888A. These insulation packagings made of a plurality of interconnected layers in aluminum plastic films provide sufficient insulation performance. They are, however, susceptible to mechanical damage whereby a total failure of the insulation effect occurs and, owing to the complicated manufacturing process, are considerably more expensive than comparable EPS packaging. In addition, they are made of conventional plastic and have to be disposed as residual waste. As with EPS, no humidity regulation takes place.

In the construction industry the use of plants and plant ingredients (hemp fibers, straw, hay, etc.) for manufacturing insulation panels has always been known in the building industry and has recently established itself as a niche product for building insulation. Therefore, two different basic materials are used: plant derived fibers as well as plants or plant components (such as leaves, stems or stalks) in their raw form.

Fibers obtained from plants are processed further by mechanical, chemical and thermal processes for nonwovens and nonwoven fabrics. The plant fibers are often expensively derived from hemp, flax or linen. The process corresponds to the textile nonwoven production. In the current opinion, nonwovens are defined according to DIN EN ISO 9092:2012-01 in general as a sheet made of fibers, continuous filaments or cut yarns. Only approximately 20-30% of the plant can be used as fiber. Thin fibers are not able to take compression forces but only tensile forces. For mechanical stabilization, they must therefore be agglutinated, bonded and/or felted to mats. For further mechanical stabilization, the nonwovens are usually quilted, riveted or bonded with additional layers. The use of nonwovens and nonwoven fabrics as insulation packaging is therefore complex and expensive. In addition, the nonwovens are difficult to unravel again. As such, disposal must be carried out as a whole. A free form designing is not possible. The nonwovens are always made into large laminated plates and mats.

Packaging material is for instance disclosed in EP0644044A1 with a laminate cushioning inner layer made of natural fiber fleece and two double-sided cover sheets characterized in that the cover sheets are made of a biodegradable film. In DE19846704C2, an insulation mat made of hemp with a two-sided lamination for the building industry is disclosed, characterized in that the filling is formed of unroasted hemp fiber products of a mixture of long fibers, short fibers and shives. To prevent setting of the insulation mat quilting seams, rivets or a mesh integrated into the filling are necessary.

In EP1840043B1, a three-dimensional packaging element on the basis of natural fibers with a reduced amount of binders is disclosed. The product shall replace packaging elements, which so far are made out of pulp in a wet process. The packaging element is made by hot pressing of a nonwoven with high pressure. The nonwoven material is made of fine natural fibers, which by the addition of water form hydrogen bridge bonds with each other. Added binders and/or supporting fibers agglutinate the composite during hot pressing. The amount of binders can be reduced, if the natural fibers still contain lignin, which leaks out during hot pressing and agglutinate the fibers. By hot pressing under high pressure, a smooth surface area is generated. Furthermore, a sandwich composition is described where on the upper side and the lower side of a packaging element a layer e.g. out of plastic is applied. Hot pressed packaging elements are used for instance as egg cartons or other moldings. Due to the finely digested fibers, high pressure and/or adhesives must be applied in order to reach form stability. The described two-sided lamination also serves as functional surface. Typically, thus manufactured products have a thin wall thickness (few millimeters), high density on average and are therefore not usable as insulation packagings.

Largely in raw form available components of plants such as leaves, stems or stalks are usually agglutinated with a binder for the manufacture of insulation panels. In DE19810862C2 for example, an insulation panel made of straw for the construction industry is described. The insulation panel consists of a homogeneous mixture of chopped straw and 10 - 30 % binder. On both sides, a grid coating is glued on. These insulation panels bonded with a binder are expensive in production and are difficult to manually separate. The smooth surfaces of the straw require a

special chemical or mechanical treatment for agglutination. An ecologically beneficial composting is also problematic with the plastic binder usually being used.

5 In EP1958762B1, a natural fiber fleece made of straw and further natural fibers and a matrix of PLA is described. By the influence of temperature, the PLA fibers melt and thus form a natural fiber composite material. By compression molding under the influence of heat, one layer of the hybrid non-woven fabric is then produced which is for example surrounded with a PLA foil. The PLA foil can already be pressed in the forming press. These resulting moldings can be used as a packaging material or in several layers as wall elements. The natural fiber fleece consists of about 35% of expensive PLA bioplastic and is therefore not competitive with polystyrene.

10 In EP0570018B1, a packaging made of pressed straw or hay is shown characterized in that no addition of binder or adhesive takes place. Due to the strong compression of soaked or prepared straw or hay a smooth packaging member, for instance a container or a box shall result. Due to the strong pressing, the surface is smooth and printable.

15 Manufacturing of such packaging members made of plants and without binders is achieved by pressing at high pressure and high temperatures, as shown in EP1377418B1 or DE202009013015U1, for instance. The aim is, to free the vegetable binders in the plants, such as the biopolymer lignin and to releases it as adhesives. Instead of using external introduced adhesives, the adhesive included in the plants is used. The extensive design freeform of such members is advantageous. Due to the high pressures, there are barely any air cavities present, 20 whereby the use as insulating packaging is not ensured any more. The result is a solid, agglutinated body, which can no longer be separated. A shock-absorbing effect is not ensured.

To reduce the cost of agglutinated insulation panels for the construction industry, it is proposed in DE8536156U1 to coat a composite of order less and agglutinated straw with paper sheets on both sides and then to thread with small intervals for mechanical fixing. This threading has the 25 disadvantage that the straw insulation panel is difficult to separate manually. Therefore, they must be disposed as a whole. Also only large panels can be made in this way. Further, free shaping is not possible. Since the insulation panel is not closed on all sides, unfixed pieces of straw or dust can be easily detached from the composite. Insulation panels configured in this way are therefore not suitable as insulation packaging, as they would contaminate or damage the 30 objects to be protected.

In DE4333758A1 and DE4317239A1, an insulation mat from a biomass such as straw for the construction industry is disclosed. The biomass is preferably stitched, agglutinated or needled and is equipped fire retardant. A packaging material composing of untreated biomass loosely filled in a net is also mentioned. Nets stuffed with biomass are not shape retarding without 35 reinforcements like quilting or riveting, exhibit a non-uniform density distribution and therefore are not appropriate for an effective insulation because of the large voids. They can be used as filler material at the most.

In JPH10287370 (A), a padding material made of straw for shock-absorption is disclosed. The molding is reached by quilting of the straw and by agglutinating with a cladding.

40 Up to now, no plant based insulation packaging has been able to prevail in the market. The insulation materials made of plant components or plant fibers developed for the construction industry are not suitable for insulation packaging, as the underlying requirements are

fundamentally different. Insulation used as building materials are fire-retardant, pest resistant and mechanically designed in a way, that they achieve faultless insulating effect even after decades. For example settling which is a reduction of an original material volume by gravity over decades must be prevented. Manufacturing of insulation materials is complex and expensive and is not suitable to be used for insulation packaging. In addition, materials manufactured in this way are difficult to shred and to dispose. Generally, the narrow side faces of insulation panels for the construction industry are not concealed, as no functional surface is present here but the panels are pinched between beams. Components of this insulating material can break off and may contaminate or damage products. For manufacturing of modern insulation packagings, it is also necessary to allow an extensive free forming to satisfy the varied requirements of the packaging market. Existing plant based insulating materials without binders are only known as panels, free forming is not possible.

Due to the aforementioned disadvantages of insulating panels and insulation packagings from prior art, no environmentally friendly alternative to EPS was able to establish on the market up to now.

The objective of the here claimed invention is therefore to produce an insulation packaging for temperature-sensitive and/or shock-sensitive products which has, besides excellent insulating and damping effect, an improved environmental performance, a simplified disposal and a free forming also economic advantages over the established EPS packaging. The insulation packaging must also meet the strict hygienic requirements for foodstuff commodity. They should be suitable as disposable packaging. Furthermore, a method for manufacturing such an insulation packaging is to be created.

This objective is solved according to the present invention by an insulation packaging according to claim 1 and a method for producing the insulation packaging according to claim 10. Advantageous further developments are described in the dependent claims.

As raw material, hay or straw is used in either mono-material, in a mixture or in components. Further, a mixture out of different straw or hay varieties as well as the mixture of hay and straw is possible. Here, straw is used as the collective term for dried stalks, stems and leaves of cereal plants, oil plants, fiber plants and legumes. Hay is used as the collective term for dried fodder plants such as herbs, grasses or legumes.

Straw or hay from sweet grasses is used, as the stalks are hollow and do not contain marks. The diameter of the stalks is ideally between 1 mm and 10 mm. In this way, the stalks form small interior air chambers preventing convection in their inside within the straw itself.

Cereal straw from barley is particularly advantageous, as it is available at low cost, has a low tendency for fungal attack and has excellent insulating properties. Cereal straw accrues in large quantities as an agricultural by-product and can be removed from the field up to 1/3 without any ecological disadvantage. Depending on regional availability, other straw or hay species may be more advantageous.

Fig. 1 shows a simple embodiment of the invention in the form of an insulation packaging which consists of an insulation core (1) and a cladding (2).

The objective of the insulation core (1) is to reduce the convection and heat conduction as much as possible. Air is used as the insulating medium because of its low thermal conductivity of

0.0267 W / mK. However, the air is subjected to a temperature dependent density such that heat transfer by convection takes place. To prevent this, the air must be restricted as much as possible in its movement. In its original condition, cereal straw has a density of approximately 20 kg / m³. Thereby, the stalks of the straw sometimes form cavities with the size of several centimeters so that the thermal insulating effect is significantly reduced by free convection. The insulation core according to claim 1 has an adjustable density of 40 kg / m³ to 250 kg / m³. The cavities in such an insulation core are smaller than 0.5x0.5x0.5 cm³ whereby convection is largely excluded. With that, density must be adapted to the requirements of the packed goods. When taking into account the material consumption an optimal insulating effect is achieved at around 60 kg / m³ to 80 kg / m³. With this, a thermal conductivity value of 0.043 W / mK comparable to polystyrene is achieved. For shock absorption of heavy objects during transportation, a density of around 250 kg / m³ is useful. For a shock absorption for lighter, more fragile objects around 40 kg / m³ is better. The thickness of the insulation core is theoretically not limited, however, a thickness of 1 cm to 15 cm has proven to be advantageous for the applications listed here.

The insulation core (1) consists of an arrangement of hay and/or straw wherein stalks of the hay or straw have a length from 0.5 cm to 50 cm. It has proven advantageous to use a mixture of different lengths. The short stalks are arranged so that a uniform density distribution occurs within the insulation core. Thus, a uniform insulation effect is achieved without thermal bridges for convection. For example, for barley and wheat straw, stalks with lengths of 1 cm to 25 cm have proven particularly advantageous. Undamaged hay and straw pieces can be used. However, due to the use of current harvesters, always a certain damage occurs to the stalk structure which, however, is not necessarily required.

It has proven particularly advantageous if the straw and hay stalks are orientated predominately (>80%) perpendicular to the heat flow of the insulation core. The heat flow from a hot side to a cold side of the insulation core is significantly lower when the heat must cross the longitudinal side of the straw and hay.

The structure of the insulation core is developed such that by taking advantage of the natural buckling stiffness (absorbing forces in the longitudinal direction) of the straw or hay, any shape such as holes, convex/concave surfaces, undercuts, sharp edges, etc. is made possible (Fig. 1, Fig. 3, Fig. 4). This is mandatory, to be able to adjust common forms of packaging such as shell elements, crates, boxes or trays to the requirements of the packaged good. The shape retention of the insulation core can be maintained without externally supplied or inherent plant binders. The stems and stalks do not need to be connected to each other firmly bonded. The shape retention also requires no mechanical fasteners. The used straw or hay is also not separated into its structural components such as fibers or shives. Just with this, the plants natural buckling stiffness remains unaffected, which is needed for the shape retention of the insulation core. the plant fibers used in the prior art can no longer resist compressive forces and as such can exhibit compressive strength just in compacted or bonded nonwoven materials.

Binders are understood here as all additives, which due to their mechanical, physical or chemical interaction with the straw and/or hay of the insulation core would affect the shape retention of the insulation core or the insulation packaging (for example tensile strength, dimensional stability, compressive strength, resilience behavior). As binders typically polymer fibers, adhesives (e.g. starch, alkali silicates, latex, resin), bicomponents, thermosetting resin or thickeners are used in prior art. Additives, which would modify the characteristics of the straw and/or hay in a way that

the plant components would act as binders themselves, are also understood as binders here. By chemical additives, the lignin of the plants can for example be modified in a way that it agglutinates without external pressure. Binders can be added to insulation materials for different reasons. Starch or their derivatives are used as binders but also as means for hydrophobising in prior art.

Mechanical fasteners are understood here as macroscopic elements, which can influence the shape retention of the insulation core or the shape retention of the insulation core together with the cladding by friction connection and/or form locking. This includes for example quilting, riveting, lamination or the introduction of nonwovens or nets. Mechanical fasteners can also be added to insulation materials for other reasons, for example only for optical reasons.

According to the present invention, no binders or mechanical fasteners are necessary for the shape retention of the insulation core with or without cladding. The form locking and friction connection between the individual straw and/or hay stalks and between the cladding and the insulation core are sufficient. Nevertheless, it can be useful for different reasons to add binders or mechanical fasteners even if they are not mandatory. This may be useful for example for optical reasons, commercial reasons, for hydrophobising or smoothing surfaces, to improve the printability or to specifically influence mechanical characteristics.

Shape retention of the insulation core and the insulation core together with the cladding is understood here as capability of these to withstand external stress (e.g. forces, temperature, air humidity) to such a degree, that handling during the production steps as well as an intended use are possible.

Pressure loads can be absorbed by the insulation core very well without permanent deformation. For example, with a load of 10 N/cm^2 applied for 1 minute on a 60 kg/m^3 insulation core and made of barley straw, a spring back is 95%. After removing external pressure, the insulation core returns to its original starting shape without appreciable setting.

As the straw and/or hay of the insulation core is not mandatorily agglutinated, dust particles and plant residuals may leak out sporadically. For this reason, the insulation core is surrounded by a flexible cladding. It is sufficient to link the insulation core with the cladding only by form close. There is no need for mechanical fasteners such as threads or rivets, as well no binders are necessary for the connection of the cladding with the insulation core. This means that the cladding can be easily separated from the insulation core and disposed of separately if needed. The cladding also provides important functional properties on the surface.

The cladding can be made of plastic, paper, cardboard, organic plastic (e.g. PLA), nonwoven of natural or artificial origin, starch (foamed or non-foamed) or similar materials. For plastic films, a thickness of $10 \text{ }\mu\text{m}$ to $500 \text{ }\mu\text{m}$ has proven to be suitable. With claddings made of paper, cardboard or cellulose, a thickness of $30 \text{ }\mu\text{m}$ to $500 \text{ }\mu\text{m}$ has proven its worth. With a cladding made of paper, cardboard or cellulose, a standard thickness of $30 \text{ }\mu\text{m}$ to 5 mm is useful. The height of the layer thickness depends on the expected external loading, as the insulation core does not exert force on the cladding from the inside. For a complete biodegradability, a cladding made from starch or starch foam may be used.

It is particularly advantageous that the cladding is configured vapor permeable for regulating humidity regulation within the packaging container. This can be achieved by suitable material

selection or by perforating the cladding. When using insulation boxes made from EPS the humidity in the inside of the box increases to more than 80%. Especially moisture sensitive products can be damaged in this way. If the air humidity increases from 50% to 80%, the straw and/or hay of the insulation core is able to absorb around 10% of its own weight of the water and as such can buffer the air humidity, accordingly. With an insulation core with a mass of 1 kg, this corresponds to an absorbing capacity of 100 ml of water.

The cladding can also be made of a food grade material such that the cladding can be used for direct contact with food.

If the cladding is chosen transparent, the insulation core made from straw and/or hay becomes visible. This can be noted, especially in the food sector, as a visual advantage.

The cladding can also be configured odor inhibiting or antibacterial.

To further increase the insulation effect it is advantageous to make the cladding partially or entirely of a material with a low emissivity, preferable aluminum. Thus, the cladding absorbs a lower amount of heat radiation and emits a lower amount of heat radiation at the same time. The aluminum can holohedral or partially be vaporized or may be laminated in the form of films or composite films. The aluminum layer thickness should be at least 40 nanometers for an effective shield.

A particular advantage of the invention is the use of all available disposal options. If no binder is used, or a biodegradable binder is used, the insulation core can be disposed of in the on-site compost or the regional bio-waste bin. It can also be used in the garden or as litter. If the cladding is made of a non-biodegradable material, the cladding can be easily separated from the insulation core and disposed of separately. With the high heat value of straw with 3.8 kWh/kg and the pollution free, climate neutral combustion, energetic recovery is also reasonable. Typically, the legal framework for waste management differs greatly between regions. For the end user all disposal procedures are open, which he can choose the most convenient for himself. A cumbersome disposal at a recycling center can be avoided. Due to the use of inexpensive basic materials and simple disposal options, the insulation packaging of the invention is ideally suited for disposable use.

Below five further embodiments are described.

In Fig. 2, an embodiment is shown in which the insulation packaging consists of a one-piece insulation core (1) with a cellophane cladding (2) and forming a cubic cavity (3) for receiving cargo.

In Fig. 3, an embodiment is shown in which the insulation packaging consists of two hollow shells. The outer surface is convex shaped and the inner side (4) forms a concave cavity. Both insulation cores (1) are surrounded by a cladding (2) made of opaque paper.

In Fig. 4, a further embodiment is shown in which an insulation packaging consists of two covered insulation cores (1) with a hollow inner structure (6) for storing sensitive object (5) to protect it from shocks. The insulation cores have a density of 130 kg/m³. The cladding (2) consists of 200 µm thick craft paper.

In Fig. 5 a further embodiment is shown in which the insulation packaging consists of six plate shaped insulation cores (1) having a density of 80 kg/m^3 and forming a cubic hollow space (7). The insulation cores are surrounded by a food safe cladding (2) which is made from $15 \text{ }\mu\text{m}$ thick plastic (PET / PE / PET). The claddings have perforations (8) so that the moist air from the inside of the box can pass over into the insulation cores. The outwards facing surfaces of the insulation packaging are vapor-coated with a 50-nanometer thick aluminum layer (9) reflecting heat radiation. The insulation packaging is inserted in a standard cardboard box (10) for shipment.

In Fig. 6, a further embodiment is shown in which the insulation packaging has an elliptical, pocket-like shape that has only one open side (11) into which objects to be cooled may be introduced. The cladding (2) is made of a biodegradable plastic, preferably PLA, with a thickness of $20 \text{ }\mu\text{m}$. The insulation core (1) has a density of 60 kg/m^3 . A self-adhesive strap (12) enables closing of the insulation packaging.

Method Description

The manufacturing of the insulation plate according to the described embodiment happen by the following steps:

1. Cleaning of the straw and/or hay;
2. Chemical treatment of the straw and/or hay;
3. Mechanical treatment of the straw and/or hay;
4. Mixing of different straw and/or hay batches;
5. Disinfecting the straw and/or hay;
6. Dosing of the straw and/or hay;
7. Plasticizing of the straw and/or hay;
8. Shaping of the straw and/or hay;
9. Cooling of the straw and/or hay while maintaining the shape;
10. Drying the straw and/or hay;
11. Product-specific mechanical processing;
12. Providing the straw and/or hay with a cladding.

Each individual step is explained in the following and possible modifications are also described. Further modifications are possible in which the sequence of steps is modified, wherein, under certain circumstances, single steps may be omitted.

Step 1:

The straw used is usually present in the form of pressed square or round bales. Uncut straw and/or hay is advantageously used as a basic material for being able to modify the structural properties of the straw and/or hay to the requirements. The stalk length is between 20 cm and 100 cm depending on the variety. Advantageous is a ratio of length/diameter of less than 300:1 and greater than 5:1. The thickness of the stalks may be between 0.1 mm and 15 mm. Stalks with

a thickness of 0.1 mm to 5 mm are particularly advantageous. Because of the mechanical and agricultural processing, shorter pieces and dust are present in the bales.

- 5 The straw and/or hay bales are mechanically loosened up and sent to a mechanical cleaning. The mechanical cleaning takes place, for instance, with the use of a cutter which is provided by a centrifugal cutter, a gravity cutter, a magnetic cutter, a sieve, a zigzag sifter, a filter or a combination of these. Mechanical cleaning can be carried out wet or dry. The mechanical cleaning shall remove dust, stones, lumps and other undesirable components.

Step 2:

- 10 A chemical treatment can be carried out for the purpose of further cleaning as well as for the introduction of pesticides, fungicides, preservatives, disinfectants or other additives. As chemical treatment, for instance, degreasing, loosening, adsorbing, absorbing, drying, etching, bleaching, or coating may be named. Further additives can be for example glues, resins, paraffins, waxes, fillers, colorants, fibers or other binders. Mechanical fasteners such as particles, fibers, nets, etc. can also be introduced.
- 15 For example, the introduction of electrochemically activated water (ECA) at a concentration of 0.1% to 20% in an aqueous solution is beneficial. Especially beneficial is a concentration of 0.1% to 2% ECA dissolved in water. It is more advantageous to dose the thus prepared ECA solution with 0.1% – 20% referred to the weight of the straw and/or hay. It is especially advantageous to use a dosing of the solution of 0.5% to 12% referred to the weight of the straw and/or hay. With the
- 20 ECA, a pre-disinfection of straw and/or hay takes place. In addition, all parts of the production facility which come into contact with the treated straw and/or hay are disinfected. The risk of cross-contamination can be reduced, the cleaning intervals of the production facility can be extended.
- In an embodiment, an aqueous solution of ECA with a concentration of 5% is generated. With the
- 25 help of an atomizer, the ECA solution is continuously misted into a mass flow of hay and/or straw, so that the ratio of the mass flow of ECA solution and hay and/or straw is 3:100. In a further embodiment, a commercially available anti-bacterial and anti-fungal agent is sprayed into the straw and/or hay, which increases the durability of the insulation core in adverse storage conditions.
- 30 The chemical removal of the wax layer on the straw and/or hay can also be beneficial for improving the adsorption of water. With the water vapor-permeable cladding, the moisture-regulating effect of the insulation packaging according to the present invention can be increased.
- By treating the straw and/or hay with a substance for reducing the pH value of a aqueous solution, a natural antibacterial effect can be generated for the event that the straw and/or hay
- 35 gets wet in the later use. In addition, the effectiveness of subsequent disinfection can be increased. A reduction of the pH value in the wet state (at 20% moisture level) to a value of 5.5 or lower is advantageous, whereby numerous bacteria are prevented from growth. Advantageous is for instance the enrichment of straw and/or hay with 0.5% to 3% lactic acid referred to the raw mixture weight of the straw and/or hay.
- 40 By bleaching, the visual appearance of the straw and/or hay can be improved in that the straw and/or hay is lightened up and colored impurities due to sooty mold fungi will be removed.

With the application of odor inhibitors such as, for instance, soda the inherent odor of the straw and/or hay can be eliminated. With the insertion of flavors or fragrant plant components, the packaging can be made fragrant. Parts of for example mint, lavender or roses can be added to the straw and/or hay. This can also be done for pure optical reasons.

- 5 The chemical treatment may take place at any arbitrary time in the process, depending on the requirements and method of treatment.

Steps 3 and 4:

10 Straw and hay are natural products, which may be subject to certain variations in their quality and properties. This depends on the climatic conditions during growth and harvest, on the soils, the type of equipment used, the used plant varieties and the storage conditions. To be able to produce an insulation core of consistent quality and properties, or to cause an improvement of existing properties, it may be necessary to mechanically, chemically or biologically treat the straw or hay.

15 In addition, it can be useful to mix different varieties of straw and/or hay which possibly may also have experienced a different processing.

As mechanical treatments, slitting, transverse cutting, squeezing, compressing, grinding or rubbing can be used.

The mechanical treatments has significant influence on, among others, the following parameters:

- Density
- 20 - Insulation performance
- Water adsorption
- Mold-filling properties
- Flow behavior
- Young's modulus for tensile and flexural rigidity
- 25 - Tensile strength
- Coefficient of friction

30 In an embodiment, uncut barley straw with a stalk length of 50 cm is shortened with a blade-cutting unit for a first batch to a length of 25 cm and for a second batch to a length of 5 cm via transverse cutting. Both batches are mixed with a weight ratio of 50:50 and blown into a silo for further processing. If it is detected during production that the insulation core has a too low tensile strength the weight ratio of 25 cm stalks can, for example, be increased to 65%. The longer stalks cause stronger coherence of the insulation core. However, at the same time, the risk of defects in the insulation core increases, because the quite stiff barely stalks displace adjacent stalks especially in the area of kinked stalks. Voids in the insulation core are areas where in a radius of 35 2.5 mm no straw and/or hay is present. In voids, heat transfer takes place by convection, which impairs the insulation effect of the insulation core. The risk of voids increases with decreasing density of the insulation cores. Densities of 40 kg/m³ to 65 kg/m³ are particularly susceptible to voids.

In a further embodiment, uncut barley straw with a stalk length of 45 cm is cut with a blade-cutting unit to a length of 15 cm by transverse cutting and mixed with 40 cm long soft uncut oat straw at a weight ratio of 30:70. The soft oat straw adapts optimal to the external shaping during the later pressure process while the stiffer barley straw increases the flexural rigidity of the insulation core. If larger insulation cores are produced, the increase of the flexural rigidity of the insulation cores can be realized by raising the ratio of barley straw to a weight ratio of 50:50.

In a further embodiment, uncut wheat straw with a stalk length of 60 cm is supplied to a splice device. This cuts the straws in the longitudinal direction. Subsequent, a shortening to a length of 15 cm occurs by a blade cutter. The very rigid straw becomes more flexible and can be further processed in a mixture or in pure form. Also, other very rigid straw and/or hay varieties can be adapted to the requirements in their specific flexural rigidity.

In a further embodiment, 30 cm long cut barley straw is continuously shredded by a profiled pair of rollers with variable spacing. The bending strength at the point of shredding is greatly reduced, without affecting the tensile strength of the resulting insulation core.

15 Step 5:

Volume or weight measurement can be used for the dosing of straw and/or hay. Since the volume of straw and/or hay is highly dependent on the variety and mechanical processing, a complete weight measurement is preferable. A volume measurement is beneficial if the straw and/or hay is to be discharged onto a continuous conveyor belt, as this can be implemented with less effort.

20 With volume measurement, it is advantageous when the produced insulation core is weighed and has influence on the target volume. Dosing can take place at any time prior to molding. It is beneficial to perform the dosing at the earliest after the mechanical cleaning, since in this case considerable amounts of straw and/or hay is discarded.

Step 6:

25 As a natural commodity, straw is heavily colonized with microorganisms. Typically, in the delivery condition, the total number of straw and hay is $5 \cdot 10^6$ germ-forming units per gram (CFU/g), bacteria and fungi at the most. To be used as a packaging material, the germ count should be reduced by several orders of magnitude and pathogenic bacteria should not be detectable. For the disinfection of straw or hay, all conventional methods are suitable in principle. Thus, irradiation, fumigation, use of liquid disinfectants or a heat treatment is possible. The use of moist heat has proven to be particularly advantageous. The straw and/or hay is treated with superheated steam, saturated steam or wet steam at ambient pressure or elevated pressure. Under saturated or wet steam conditions, temperatures of 90 ° C to 150 ° C have been proven as advantageous. Under saturated or wet steam conditions, temperatures from 95 ° C to 130 ° C is advantageous. The duration of treatment depends on the desired reduction of germ count and is heavily dependent on the chosen steam temperature. In saturated steam of 100 ° C, a treatment time of 3 minutes has been shown to be particularly suitable. With an increased pressure of 3 bar and 130 ° C steam temperature, however, a few seconds are sufficient for an adequate disinfection.

40 Step 7:

Straw and hay consist primarily of cellulose, lignin and hemicellulose. The individual plant components such as the cell wall or middle lamella are composed mainly of these materials in

different structural compositions. The lignocellulose, which forms the cell wall of woody plants, is a structure composite in which the cellulose and the hemicellulose form a framework in which the lignin is incorporated. While the cellulose and hemicellulose can absorb tensile forces, the lignin stabilizes against compressive forces. The composite is therefore comparable to a reinforced concrete construction.

It is known that lignin can be plasticized by heat. With an increase in humidity, the glass transition temperature of the lignin is lowered. With cooling below the glass transition temperature, the lignin hardens again. The procedure is largely reversible. In the dry state (8% moisture content) the glass transition temperature is 130 ° C - 180 ° C and in the wet state it is about 80 ° C - 90 ° C.

The glass transition temperature of hemicellulose and cellulose is also strongly dependent on humidity. In the wet state, the glass transition temperature drops even to room temperature. The straw and/or hay is plasticized by the impact of moist or dry heat. The biopolymers lignin, cellulose and hemicellulose are heated above their glass transition temperature. The effect of moist heat is particularly beneficial, as the glass transition temperature of lignin can be lowered. The straw and/or hay is thereby heated to at least 80°C. A moisture content of 5% - 25% is to aim for, depending on the straw or hay variety. For barley straw, the optimum moisture content is 8% - 20%.

Moisture can be introduced prior to heating into the straw and/or hay or be introduced simultaneously with the heating. Therefore, there are the two alternatives of using moist straw and/or hay or dry straw and/or hay.

If dry straw and/or hay is to be plasticized with moist heat, steaming with steam (saturated steam or wet steam) is particularly beneficial. The hot steam causes a temperature increase of the straw and/or hay as well as humidification due to adsorption. Steam has a much higher internal energy (enthalpy) than air at the same temperature. As such, the heating is particularly effective. At the same time, the thermal conductivity is dramatically increased by the introduced moisture, so that a particularly rapid heating is possible. The temperature of the steam should be in the range of 90 ° C to 150 ° C. For steam temperatures above 100 ° C, the steaming is to be carried out under pressure to comply with the saturated steam conditions or wet steam conditions. For a steam temperature of 130 ° C, for example, a pressure of 3 bar is required. An increased pressure accelerates adsorption of water into the straw and/or hay significantly. The process time can be significantly reduced with higher pressure.

Plasticizing of 0.25 kg of barley straw at 98 ° C, as well as ambient pressure and a heating performance of 8 kW of steam generation, results in a process time of 5 seconds. The barley straw absorbs about 18 grams of water. The moisture content increases from 8% to 14.7%.

If moisture straw and/or hay is to be plasticized by moist heat, steam (wet steam or saturated steam) can also be used for heating in the temperature range from 90 ° C to 150 ° C. However, it is particularly beneficial in this case to heat only the existing water in the straw and/or hay, without increasing the moisture content of the straw and/or hay further. At principal, a heating with hot air flowing through with microwave radiation is suitable, by contact heating, by superheated steam or a combination of these. Especially advantageous is the use of superheated steam, as it has a very high internal energy and a high thermal conductivity and thereby the process time can be made very short and in addition allows a uniform heating. A temperature of superheated

steam from 101 ° C to 150 ° C at ambient pressure is suitable for that. Superheated steam at a temperature of 102 ° C to 130 ° C is particularly beneficial.

The heating of moist straw and/or hay may also be accompanied by simultaneous drying whereby steam is transported away. In this case, however, molding should take place before plasticization.

- 5 The moisture in the straw and/or hay prevents breakage of the straw and/or hay at low compression.

Step 8:

After plasticization in step 7, molding of the straw and/or hay takes place.

- 10 At room temperature, moist or dry straw and/or hay has a very good resilience and cannot be formed without the use of binders. Only with very high pressures associated with high temperatures, straw and/or hay can be formed to solid compacts. The excellent insulating effect of straw and hay gets largely lost during such processing.

- 15 In contrast, after the plasticizing of straw and/or hay, described in Step 7 of this invention, the resiliency is almost completely abolished, such that even small force impact, from 0.1 to 10 N/cm², on the straw and/or hay is sufficient for molding. Especially beneficial is a force of 0.1 N/cm² to 2 N/cm². Depending on the process design, the molding can take place before or after the plasticizing of straw and/or hay.

The molding is divided into the inner and outer molding:

- 20 Outer molding is understood here as the temporary or permanent fixation of the straw and/or hay in an at least partially deterministic defined shape. It determines at least in part surfaces the outer contour of the straw and/or hay after molding. The outer molding is done according to the present invention by at least partially molding of geometrically defined objects, by subtractive or additive molding processes such as cutting, stamping, etc. or by the impact of fluids or gases.

- 25 The inner molding is understood here as a temporary or permanent fixation of the straw and/or hay in stochastically defined shape, whereby the influence of physical properties of the composite of straw and/or hay is in the foreground. For example, it determines the stochastic distribution of straw and/or hay inside the outer shape or the nature, frequency and quality of form closure and frictional connection between the hay and/or straw parts. The inner molding may be influenced by the nature of the external molding, by the impact of fluids, gases and by geometrically defined or geometrically undefined objects.

For example, the external molding can form the straw and/or hay into sheets, blanks and freeform bodies each with or without notches. The inner molding can for example evenly distribute the straw and/or hay, locally accumulate, hook, layer or arrange the stalks of straw and/or hay.

- 35 In an embodiment, 25 cm long barley straw is blown pneumatically into a rectangular chamber with dimensions of 30x30x30 cm³. The barley straw is thereby distributed such that the area weight in the boundary region is 2.4 kg/m² and towards the center decreases to 1.2 kg/m². The height of straw in the chamber is approximately 12 cm at the boundary region and decreases towards the center to 6 cm. Additionally, the stalks are aligned in a preferred direction, parallel
40 with the chamber bottom. Nevertheless, the stalks of straw and/or hay are still three-

- dimensionally hooked with each other. The volume of the chamber is reduced by a rectangular plunger to $30 \times 30 \times 2 \text{ cm}^3$. The density of the straw and/or hay is increased to 120 kg/m^3 in the boundary region of the chamber and to 60 kg/m^3 in the middle. No cavities greater than $0.5 \times 0.5 \times 0.5 \text{ cm}^3$ are formed by the uniform distribution. The insulation core is now defined in its inner and outer molding, but is not mechanically stable due to the ongoing plasticization of the straw and/or hay.

Step 9 and 10:

- After molding, the defined internal shape needs to be stabilized. For that, the lignin in the straw and/or hay undershooting their glass transition temperature is sufficient. The cellulose and hemicellulose do not necessarily need to be brought below their glass transition temperature for stabilizing. This allows for example a particularly advantageous implementation of the invention in which the resultant insulation core is still moist but stable in shape and can be dried in a second step. The glass transition temperature of the lignin can be undershot by cooling or drying or by a combination of cooling and drying. With the inner shape, automatically the outer shape is also stabilized.

For example, cooling can be carried out by common methods using cold gases, such as air or nitrogen, by evaporative cooling, or by contact cooling with cold solids. Drying can be performed by all conventional methods, such as hot-air drying, vacuum drying, superheated steam drying (with superheated steam), microwave drying or a combination of these methods.

- Drying with superheated steam at 101°C to 150°C and at a pressure of 0 - 5 bar above ambient pressure proved to be advantageous, as the heat transfer is particularly effective and with that the process time can be reduced. To improve efficiency, there is the possibility to recirculate the steam after passing it through the straw and/or hay, to overheat it and to blow it again through the straw.
- Drying with superheated steam at 102°C to 120°C and at a pressure of 0 to 1 bar above ambient pressure has proven particularly beneficial.

Adding air from 1% to 50% into the superheated steam has proven as advantageous, because with this the drying is further accelerated. An addition of air of 1% - 20% has proven particular as advantageous.

- The insulation core gets its shape retention to a sufficient degree by form locking and/or friction connection between the straw and/or hay stalks. Substance-to-substance bonding with binders or further form locking and/or friction connecting connections with additional mechanical fasteners are not necessary for the shape retention of the insulation core. An addition of binders can however be advantageous for other reasons, for example for the hydrophobising of the insulation core. In an embodiment, in accordance with step 7, straw and/or hay is plasticized under moist heat with saturated steam and thereby brought to a moisture level of 20% and a temperature of 95°C . While retaining the shape, ambient air is blown at a flow rate of 1 m/s through the moist and hot straw and/or hay until the temperature is 50°C . The resultant insulation core has a residual moisture level of 15% after cooling and is stable in shape.
- In a further embodiment, in accordance with step 7, straw and/or hay is plasticized under moist heat with saturated steam and thereby brought to a moisture level of 20% and a temperature of 95°C . Subsequently, superheated steam (120°C , ambient pressure) with an addition of 20% air

and a flow rate of 1 m/s is blown through the moist and hot straw and/or hay, until the moisture level of the straw and/or hay is 8%. The resulting insulation core has a temperature of 97 ° C and is stable in shape.

Step 11:

- 5 The insulation core manufactured by steps 1 – 10 can be further processed with other mechanical methods. For example, cutting, punching, bending, pressing, stacking, or joining is possible or a new insulation core can be manufactured by combination of several insulation cores.

Step 12:

- 10 One or all of the produced insulation cores being generated by the steps 1-11 are provided in the last step with one or several all sided claddings. It is especially advantageous to use only the form locking of the cladding to connect it with the insulation core and to relinquish mechanical fasteners such as quilting, riveting as well as binders. For connecting the cladding with the isolation core, this allows the cladding of insulation core to be separated from the isolation core when needed and to be simply discarded. The use of mechanical fasteners and/or binders for
15 fixing the cladding with the insulation core can be reasonable for optical reasons or to specifically influence mechanical characteristics.

- The cladding can be made of plastic, paper, cardboard, organic plastic (eg. PLA), natural or artificial nonwoven, starch (foamed and not foamed) or the like. The cladding may be applied to the insulation core in a solid, liquid or pasty state. During application, through treatment
20 methods, such as drying, curing, cross-linking, bonding, welding, crimping, shrinking, wrapping or the like, the shape of the cladding can be adapted to the outer shape of the insulation core. Especially beneficial is a tight cladding on all sides, as this protects and stabilizes the insulation core particularly well. The cladding may also be printed or coated as well as put together from individual components disclosed above.

- 25 In an embodiment, the insulation core is first covered into a PLA film and the PLA film is subjected to a heat treatment for shrinkage such that the PLA sheet adapts to the outer shape of the insulation core. Several such insulation cores are then placed in a box so that all the inner sides of the boxes are completely and overlapping covered with the insulation cores.

- 30 In another embodiment, the insulation core is inserted into a similar size cross bottom bag made of craft paper and the cross bottom bag is sealed by a self-adhesive flap.

- Under some circumstances it may be advantageous to provide the straw and/or hey already before or during the molding temporarily with the cladding (step 8) and to perform the molding together with the cladding. For example, straw and/or hay can be welded into a cladding of a reinforced cellulose nonwoven and then can be subjected to plasticizing (step 7) and subsequent
35 molding (step 8).

The described method for producing an insulation packaging may be facility engineering implemented either continuous, discontinuous or in a mixture. Below, two embodiments are given for a production facility:

Embodiment for method – discontinuous:

First, the mechanical loosening of straw in a bale opener takes place. The straw is cut in a cross cutter to 15 cm in length. Dust removing of the straw takes place by a suction machine. By a material transport blower, the straw is fed to a gravity separator and then into a silo. There the straw is sprayed with 1% aqueous solution of ECA wherein a dosing of the solution of 1 % is performed with reference to the straw weight. From the silo, straw is discharged onto a conveyor type weigher by rollers until a target weight of 260 grams is achieved. The portion of straw is conveyed via a material transport blower into a cup-shaped mold and is there evenly distributed, so that 80% of the straw stalks are oriented substantially parallel to the base area of the mold. The straw is treated within the mold for 2 minutes at 98 °C with saturated steam. With this, the straw is disinfected and plasticized simultaneously. With this, the straw is subjected to an increase in the moisture level from 8% to 17%. Then, the straw is compressed by a cup-shaped stamp in its density of 30 kg/m³ to 80 kg/m³. For this purpose, a low pressing pressure of 0.1 N/cm² is applied. Then, the slightly compressed straw is flown through by superheated steam of 120 °C under ambient pressure until a moisture level of 8% is reached. This process takes about 30 seconds. Thereafter, the now finished insulation core is ejected. In the state produced such, the insulation core is slightly stable in shape. Sharp edges, radii and large areas can be replicated precisely. After a brief cooling, the insulation core is welded into a 20µm thick PLA film and the PLA film is then subjected to shrinkage by heat. Thereby, the shrinking film lays itself form locking around the insulation core. As such, the insulation packaging is completed.

20 Exemplary embodiment for method – continuous:

First, the mechanical loosening of straw in a bale opener takes place. The straw is cut in a cross cutter to 15 cm in length and conveyed into the silo 1. In a second step, the loosening of hay in a bale opener takes place. The hay remains in the original length of about 30 cm and is conveyed into the silo 2. A dust removing of the straw and hay takes place in the silos. The straw and hay is discharged from the silos with conveyor type weigher and pneumatically mixed at a ratio of 50%. Then the straw/hay mixture is supplied with a material transport blower into a third silo. The straw/hay mixture is discharged in a uniform height of 25 cm on a continuously moving conveyor from the silo. Then, the straw/hay mixture is passed through in a steam tunnel for 3 minutes by saturated steam (100 °C, ambient pressure) in which it is disinfected and plasticized. A moisture level of 18% arises in the straw/hay mixture. This is followed by compressing the straw/hay-mixture by a converging belt press, wherein the belts of the belt press are equipped with a three-dimensional diamond profile so that areas of higher density and areas of lower density are formed. The belts of the press are actively flown through by a cold airflow (20 °C, ambient pressure). Thereby the straw/ hay mixture cools to 45 °C and hardens. The thus produced straw/hay mixture is slightly stable in shape and has a moisture level of 15%. Then, the straw/hay-mixture is fed to a belt dryer, which reduces the moisture level from 15% to 8% in the run. For this purpose, the straw/hay mixture is flown through by warm air (75 °C). From the so produced insulation cores, panels are cut out by longitudinal and cross cutting, which are form locking inserted in a cladding made of craft-paper.

Patentkrav

1. Isoleringspakning til varmeisolering og/eller stødabsorption bestående af en eller flere isoleringskerner (1) af presset halm og/eller hø og mindst en skal (2),
5 **kendetegnet ved,**
at isoleringskernen (1) er udformet formstabil og formtilpasset uden fast forbindelse mellem de enkelte hø- og/eller halmstrå,
idet høets og/eller halmens strå har en længde fra 0,5 cm til 50 cm og foreligger som blanding af forskellige længder uden oplukning af de i høet og/eller halmen
10 indeholdte fibre,
isoleringskernen (1) er fuldstændigt omgivet af en damppermeabel skal (2), som blot er forbundet formsluttende med isoleringskernen (1) uden yderligere forbindelseselementer,
og isoleringspakningens massefylde udgør mellem 40 kg/m³ og 250 kg/m³.
15
2. Isoleringspakning ifølge krav 1, **kendetegnet ved, at** isoleringskernen (1) har en tykkelse fra 1 cm til 15 cm.
3. Isoleringspakning ifølge krav 1 eller 2, **kendetegnet ved, at** mindst 80 % af
20 isoleringskernens halm- og/eller høstrå er rettet vinkelret på isoleringspakningens varmestrøm.
4. Isoleringspakning ifølge et af kravene 1 til 3, **kendetegnet ved, at** der er tilvejebragt mindst to isoleringskerner (1), som har form som to hule skåle, der
25 kan have udsparinger til optagelse af en genstand (5).
5. Isoleringspakning ifølge et af kravene 1 til 4, **kendetegnet ved, at** der er tilvejebragt mindst to, fortrinsvis seks isoleringskerner (1), som danner et lukket hulrum og fortrinsvis er udformet pladeformet.
30
6. Isoleringspakning ifølge et af kravene 1 til 3, **kendetegnet ved,**
at isoleringskernen (1) har en taskeagtig form aufweist og kun har en åben side (11).

- 7.** Isoleringspakning ifølge et af kravene 1 til 6, **kendetegnet ved, at** skallens (2) materiale har en defineret damppermeabilitet, eller denne realiseres med en perforation, idet
 5 skallens (2) kan bestå af en fleksibel kunststoffolie eller en kunststoffiberdug, fortrinsvis af en biokunststoffolie, såsom PLA eller cellofan, som har en tykkelse fra 10 µm til 500 µm.
- 8.** Isoleringspakning ifølge et af kravene 1 til 6, **kendetegnet ved, at** skallens (2) består af papir eller pap, som har en tykkelse fra 30 µm til 5 mm, eller
 10 skallens (2) består af cellulose eller af stivelse, idet skallens (2) delvis eller fuldstændigt kan have et metallag, fortrinsvis af aluminium, og/eller kan være fremstillet fødevarer-sikker og/eller gennemsigtig.
- 9.** Isoleringspakning ifølge et af kravene 1 til 8, **kendetegnet ved, at** skallens (2)
 15 består af cellulose eller af stivelse, og skallens (2) delvis eller fuldstændigt kan have et metallag, fortrinsvis af aluminium, og/eller skallens (2) kan være fremstillet fødevarer-sikker og/eller gennemsigtig.
- 10.** Fremgangsmåde til Fremstilling af en isoleringspakning til varmeisolering
 20 og/eller stødabsorption bestående af en eller flere isoleringskerner (1) af presset halm og/eller hø og mindst en skal (2), idet isoleringskernens (1) ydre form er geometrisk defineret og formbestandig, isoleringskernens formbestandighed afgørende er givet ved en indre formgivning ved en stokastisk fordeling og form af de enkelte halm-
 25 og/eller høstrå, og fibre af halm- og/eller høstænglerne forbliver uopløst indlejret i stråenes naturlige struktur, isoleringskernen (1) er omgivet af en skal (2) på alle sider, som afgørende er forbundet formluttende med isoleringskernen (1), og isoleringspakningens massefylde udgør mellem 40 kg/m³ og 250
 30 kg/m³, **kendetegnet ved** følgende trin:
- halm eller hø eller en blanding af de to blødgøres,
 - den blødgjorte halm og/eller det blødgjorte hø wird underkastes en formgivning,

- under bibeholdelse af formgivningen ophæves blødgøringen, og halmen og/eller høet hærdes uden signifikant fast forbindelse mellem de enkelte halm- og/eller høstrå,
- halmen og/eller høet forsynes på alle sider med en skal.

5

11. Fremgangsmåde ifølge krav 10, **kendetegnet ved, at** halmen og/eller høet forarbejdes i usnittet form og/eller renses mekanisk, og halmen og/eller høet kan behandles med pesticider, fungicider, konservieringsmidler, desinfektionsmidler eller rengøringsmidler og/eller kan behandles med en vandig opløsning af
10 elektrokemisk aktiveret vand (ECA) i en koncentration fra 0,1% til 20%, idet der doseres 0,1% - 20% af opløsningen beregnet på vægten af halm og/eller hø.

12. Fremgangsmåde ifølge krav 10 eller 11, **kendetegnet ved, at** halmen og/eller høet fuldstændigt eller delvis afvokses, og/eller af halmens og/eller høets
15 pH-værdi sænkes, og/eller halmen og/eller høet bleges, og/eller halmen og/eller høet behandles med lugthæmmende eller lugtdannende stoffer, og/eller halmen og/eller høet behandles mekanisk, og/eller det samlede kimal af halm og/eller hø nedsættes.

20 **13.** Fremgangsmåde ifølge krav 10 til 12, **kendetegnet ved, at** halmen og/eller høet, som er behandlet kemisk og/eller mekanisk på forskellig måde, anvendes i blanding.

14. Fremgangsmåde ifølge krav 10 til 13, **kendetegnet ved, at** halmen og/eller
25 høet blødgøres ved fugtig varme og/eller ved en tørreproces, idet der fortrinsvis foregår en tørring med overhedet damp som tørremedium.

15. Fremgangsmåde ifølge krav 10 til 14, **kendetegnet ved, at** halmen komprimeres uensartet ved formgivningen.

30

16. Fremgangsmåde ifølge krav 10 til 15, **kendetegnet ved, at** isoleringskernen (1) afformes i fugtig tilstand.

17. Fremgangsmåde ifølge et af kravene 10 til 16, **kendetegnet ved, at** halmen og/eller høet forsynes med en skal før formgivningen eller under formgivningen eller før blødgøringen eller under blødgøringen.

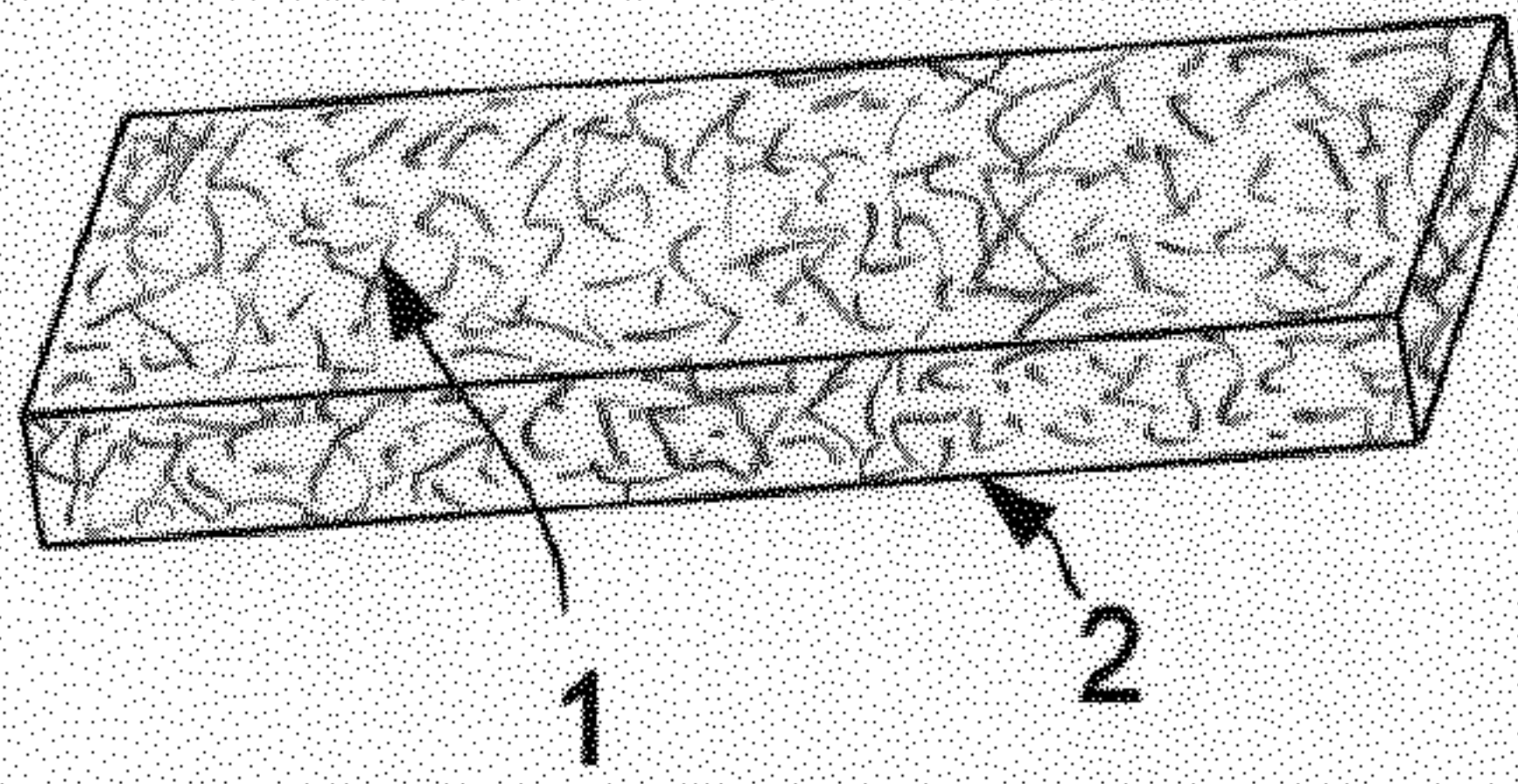


Fig. 1

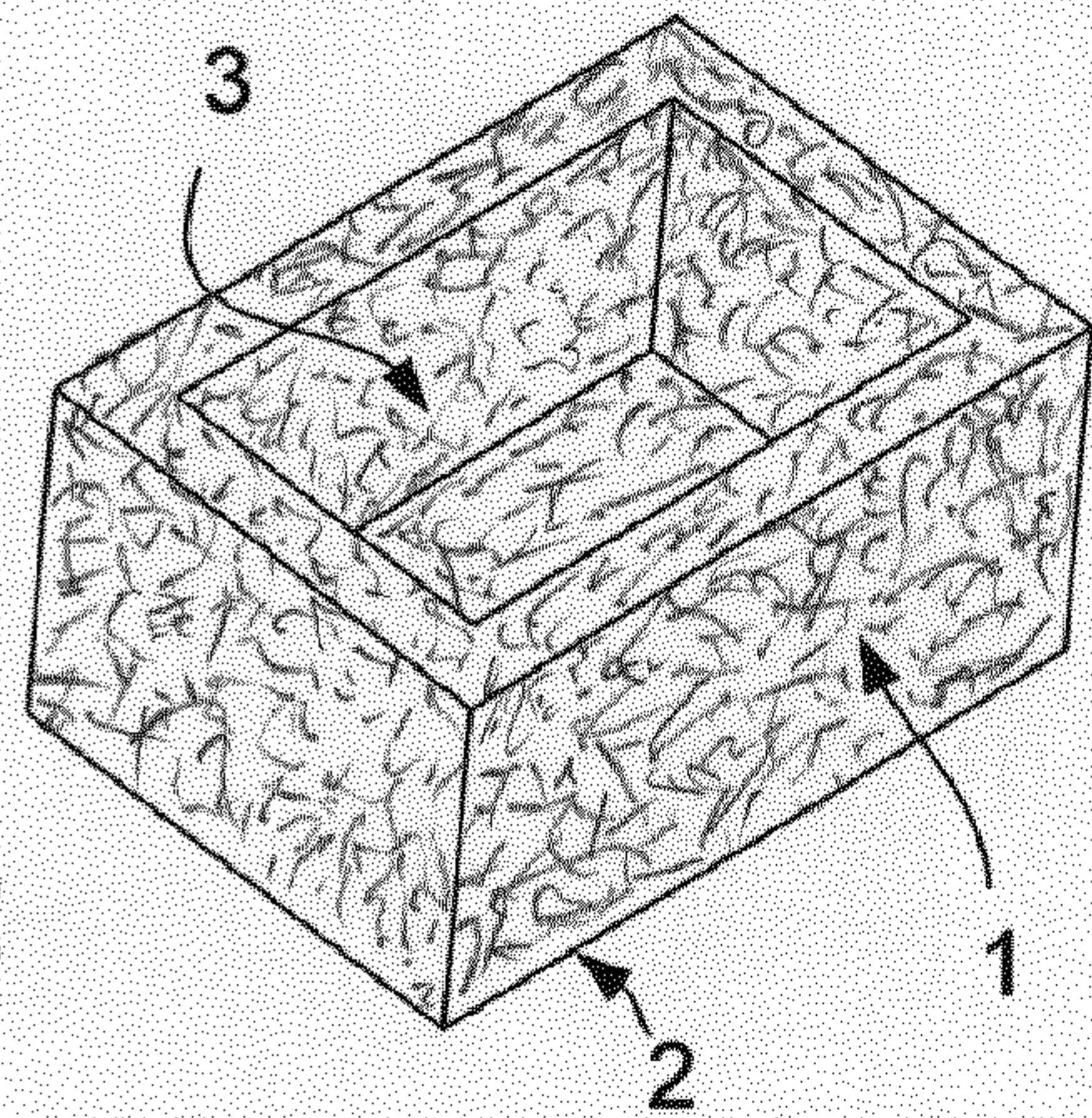


Fig. 2

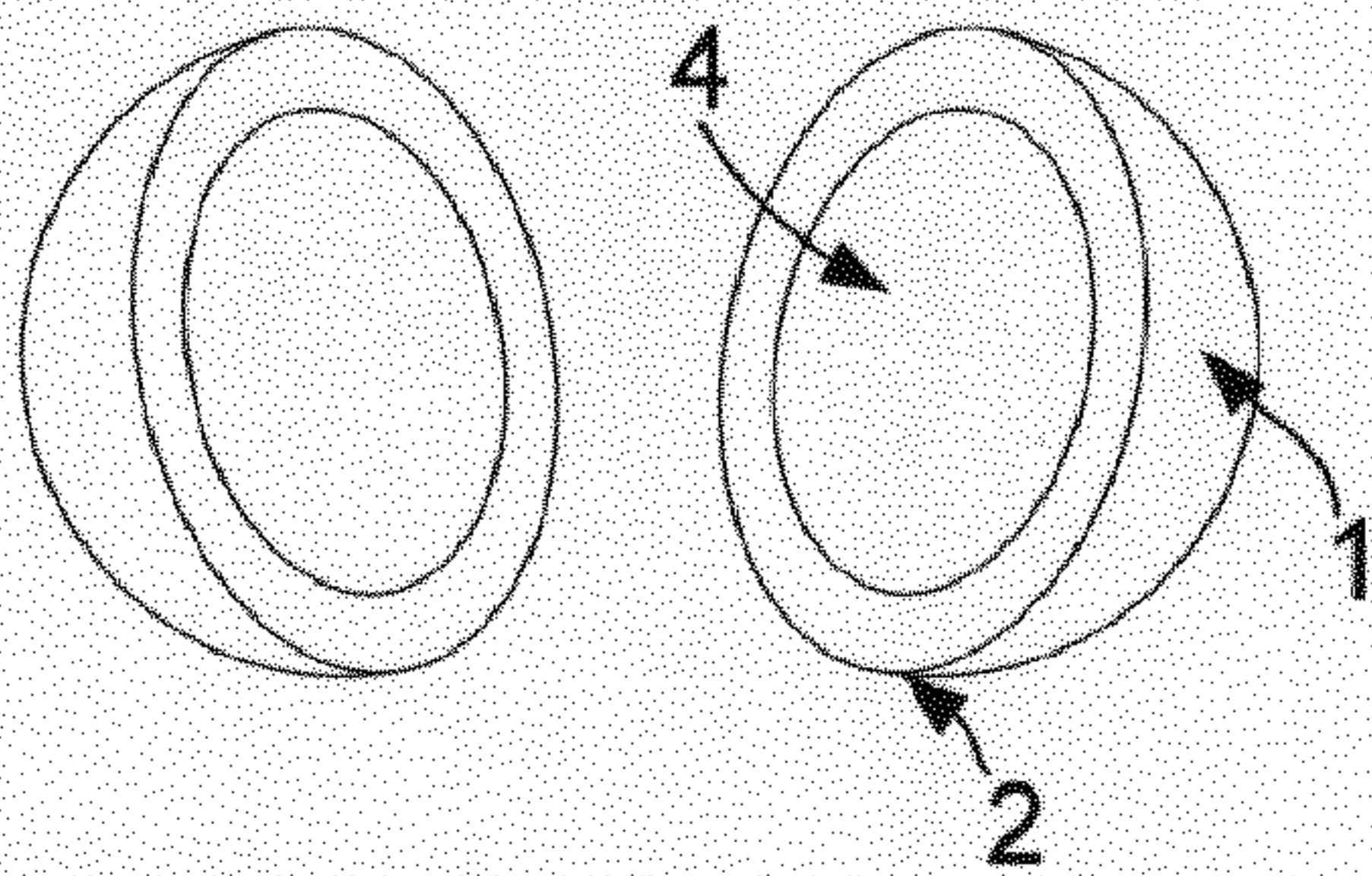


Fig. 3

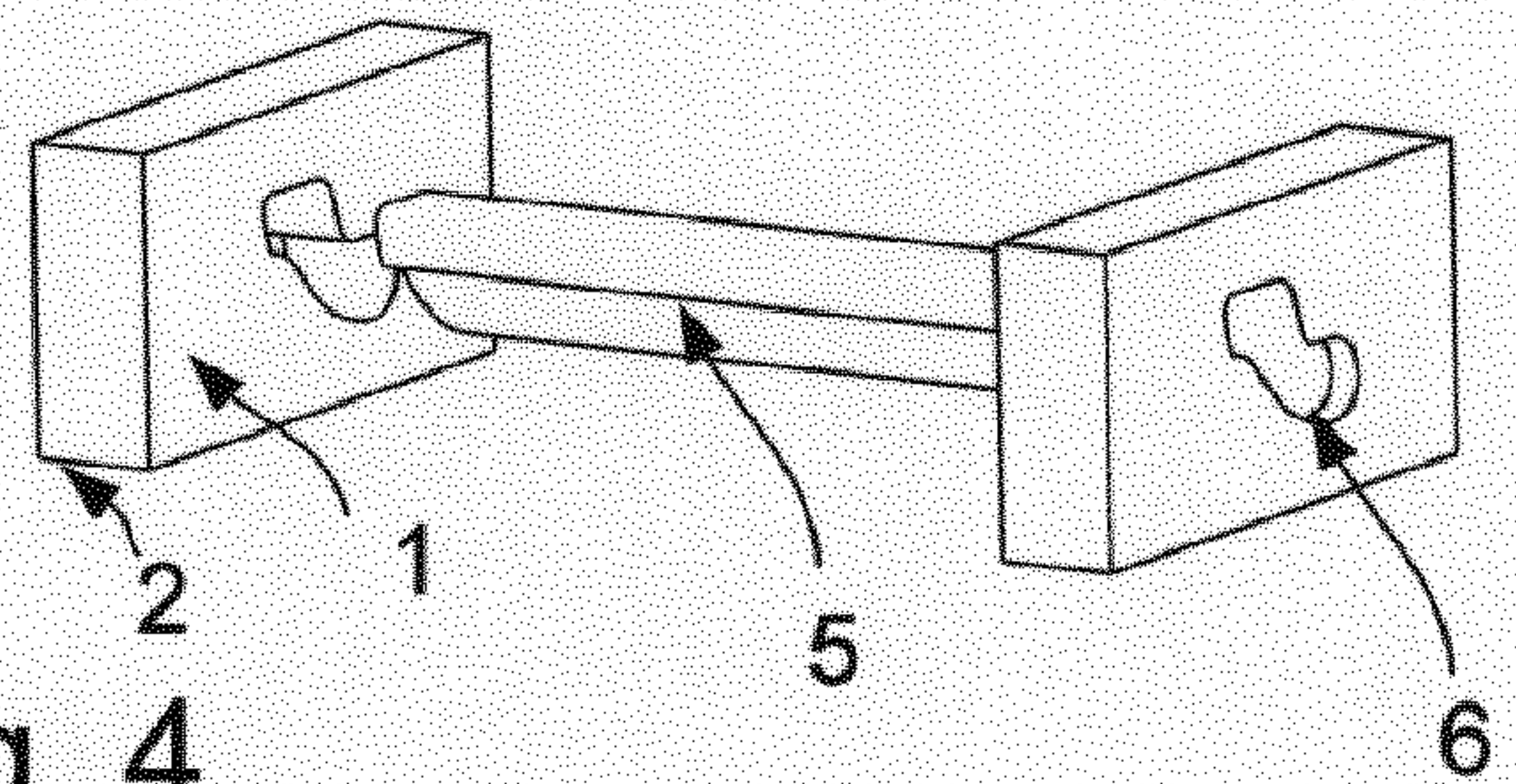


Fig. 4

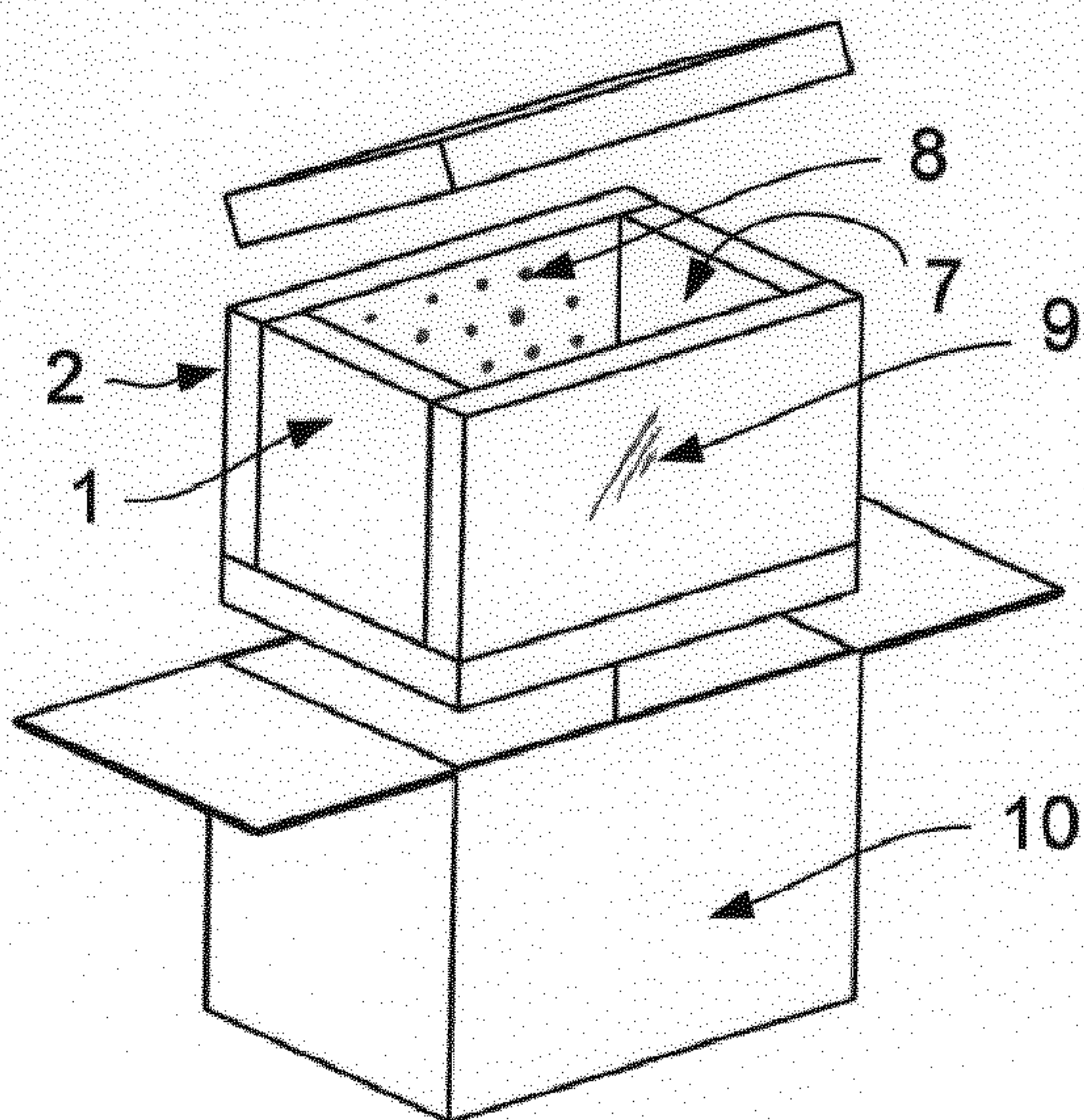


Fig. 5

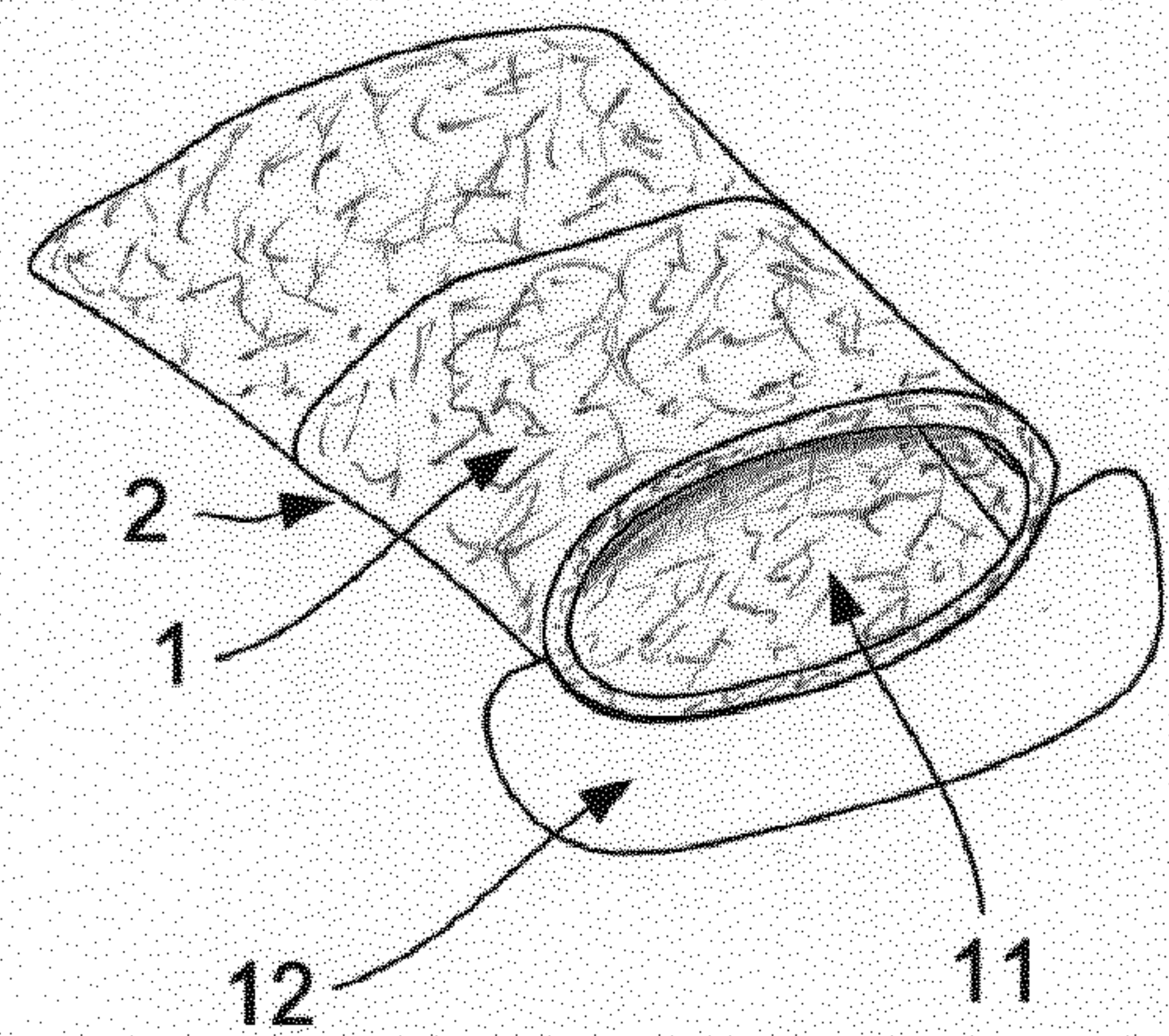


Fig. 6