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BEVERAGE CAPSULE

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Abstract

Coffee Capsule and Seal

A capsule for use in a coffee machine having a brew chamber, which capsule is formed from a ductile metal such as aluminium. The capsule has a generally frusto-conical form with an upper surface and a lower surface, an annular flange being provided at the lower surface. An annular seal is provided on the annular flange having first and second layers, wherein the first layer comprises long, well-bound fibres of a cellulose material.

Beverage Capsule

The present application is a divisional of Australian Patent Application No. 2020269937 titled "Beverage Capsule" which is a national phase of PCT application PCT/EP2020/062787 filed on 7 May 2020 and which claims priority to GB application 1906430.2 filed on 7 May 2019, the content of which is hereby incorporated by reference in its entirety.

The invention relates to a beverage capsule for an espresso machine, in particular for making espresso under high pressure.

Powered espresso machines are well known. The conventional espresso machine comprises a water chamber, a heating element adapted to heat the water to around 95-98 C, which is then pumped under high pressure of 15 to 19 bar to a filter holder or portafilter. Lower pressure systems also exist. The filter holder typically comprises a handle portion and a holder portion provided with two or three lugs that are adapted to engage in the installed position with the machine brewhead to where the water is pumped. The holder portion is adapted to receive a filter, which is usually a metal bowl with a number of perforations through its bottom. In use, the filter is filled with finely ground coffee and the water is forced through the coffee at the high pressure generated by the pump to produce the espresso coffee which is collected in a cup placed under the filter holder.

The classic coffee machine suffers from two potential drawbacks. The first drawback is that ground coffee starts to lose its freshness and flavour after a few days and so for the optimum espresso, the user will also need to have a coffee grinder. The other drawback is that the used espresso coffee has to be removed from the filter, which can lead to mess as the grinds are fine.

This led to the development of ESE coffee pods, which can be used in many espresso machines. Coffee pods are generally individually wrapped to maintain freshness and consist of a small pod made of a perforated filter paper which contains the coffee. The pod is placed in the filter holder and then disposed of after use. Coffee pods are convenient but have to fit the filter holder and be placed correctly otherwise water can leak around the edge.

This in turn lead to the development of capsule machines. The coffee capsules for these machines are completely sealed. The capsule machines do not use the conventional filter holder. A capsule machine typically has a two part mechanism. The first part receives the capsule and is provided with an extraction surface upon which the capsule rests. The second part is provided with a locking lever which is used to make the first and second parts integral. In use, the second part cuts the upper surface of the capsule to allow water to enter the capsule and percolate down

through the capsule, where it exits through the lower surface of the capsule at multiple locations determined by the geometry of the extraction surface. An example of such a machine is disclosed in EP 0870457 or WO2005/004683. Capsules in the known capsule coffee machines are, in use, inserted into a capsule cage of the machine which holds the capsule in position so that it may be cut by a cutting member.

Capsule machines have proved to be commercially very successful as they are very convenient to use and produce a consistent product. However, each manufacturer's coffee machines and capsules are designed to work with the manufacturers own brand. The most popular brand of capsule is Nespresso®, which uses a sealed capsule made of aluminium. In use, the capsule is clamped into position in the machine with a capsule cage part holding the capsule so that it can be cut by typically three prongs to enable water under pressure to enter the coffee capsule.

Aluminium has the considerable advantage that it is oxygen and water impermeable, which means that the coffee in the capsules has a long shelf life. Aluminium however also suffers from several major drawbacks in that the aluminium is easily deformed during the filling and packing stage and it is difficult and expensive to produce a reliable seal on the capsule rim. The only known seal that works is a silicone elastomer disclosed in EP1654966 despite significant research effort. In these capsules the edge of the aluminium rim is rolled over where the front foil seal is attached. The known solutions to these problems further require an extremely high capital investment beyond most companies.

It has been proposed to use raised ribs formed by pushing out material from the capsule rim. These seals are functional but reduce the effective sealing area on the front circumference of the capsule where the capsule is sealed with a foil. This results in unacceptably high failure rates of the foil seal so that the filled capsule degasses with the consequence that the coffee becomes stale.

Attempts to use paper gaskets have also failed for several reasons. Known paper gaskets tend to delaminate due to the rapid depressurisation of the brew chamber, when the handle is lifted on the coffee machine, causing the laminate layers of the material to separate and become detached from the capsule. A further type of delamination occurs when ink printed onto the surface prevents pressure within the gasket from escaping as it forms a waterproof barrier.

This delaminated gasket material can over time build up on the brew chamber within the machine and cause subsequent capsules to leak during extraction and produce a short shot / insufficient extraction.

A further problem is that paper gaskets tend to burst as they do not have sufficient wet strength to survive the high pressures that occur during coffee extraction. The gasket disintegrates in small areas allowing water to escape and reducing pressure.

A further problem with aluminium capsules arises due to the puncture of the capsule foil to allow water to pass through the coffee for extraction. The size of the holes affects the flow rate of the water into and through the capsule with the larger the hole the greater the flow rate and the smaller the hole the lower the flow rate. Controlling the flow rate is therefore important to the quality of the coffee as too slow a flow rate results in over-extraction rendering the coffee bitter and too fast a flow rate results in too weak an extraction, so the coffee lacks flavour.

The present invention therefore seeks to provide an improved coffee capsule.

According to a first aspect of the invention there is provided a capsule for use in a coffee machine in accordance with the features of Claim 1, which machine has a capsule cage for retaining the capsule in an extraction position, wherein the capsule is formed from a ductile metal.

Preferred aspects of the invention are disclosed in the sub-claims.

The seal of the invention advantageously provides a good seal for the capsule and is more easily recycled than the known silicone seals.

Exemplary embodiments of the invention will now be described with reference to the drawings, in which:

Fig. 1a shows schematically a cross section of a capsule

Fig. 1b shows schematically a cross section of the capsule interfacing with machine blades

Fig. 1c shows schematically a brewhead of a coffee machine

Fig. 2 shows a perspective view of the capsule

Fig. 3a shows a first layered seal

Fig. 3b shows a second layered seal

Fig. 4 shows a laminated structure of a seal

Fig. 5a shows schematically a first alternative structure

Fig. 5b shows schematically a second alternative structure

Figure 1a shows a cross-section of capsule 1 having a generally frustoconical form for the main body 2. The upper end 3 of the capsule has a second frustoconical section 4 with a smaller diameter than the lower end. The upper end 3 is further provided with an additional frustoconical indent 5 at the centre of the upper end 3. The capsule is provided with a flange 7 at the end of main body 2 remote from the upper end 3.

To ensure that the capsule functions effectively in the wide range of capsule coffee machine on the market, the four dimensions marked V, W, X and Y are critical and need to be used if problems with the insertion and ejection of the capsule in the machines is to be avoided.

Figure 1b shows a further dimension on the capsule, namely A, which is the distance between the capsule sealing surface to the surface of the capsule interfacing with the machine blades at the top of the capsule and Figure 1c shows a dimension B, which is the distance between the coffee machine brew head or capsule cage sealing surface and the tip of the blade 20. Dimension A varies with the thickness of the seal on the flange, whereas dimension B is determined by the capsule coffee machine design. The piercing depth of the blades is deduced by subtracting Dimension B from Dimension A.

Figure 2 shows a perspective view of the capsule, which is provided with an annular protruding surface 10 outwards from the upper surface. The protruding surface 10 is chamfered or inclined but could also be a radiused surface. The protruding surface 10 provides a steeper angle than the surface 4 to the blades, which improves the entry of the blade. The flange 7 comprises an upstanding wall 8, which thereby forms a gutter 9 between the wall of the capsule and the upstanding wall 8. The upstanding wall 8 then bends back down towards the same side as the opening such that the distal end is substantially in the longitudinal plane of the capsule but below the gutter 9. The shape of the distal end forms an open hook. The open hook receives a seal to close the capsule after packing or filling. The open hook shape provides a plurality of webs at the rim of the flange which provide a degree of reinforcement so that the foil can be easily attached to a capsule made of softer, more ductile materials such as aluminium.

The annular surface 10 is raised from the surrounding plane of the capsule surface 12 by between 0.15 and 0.35mm and in a particularly preferred embodiment 0.25mm. The surface has a width of around 0.2-0.3mm, to allow for tolerances between machines. The angle of the surface to the planar surface of the capsule is between 30 and 34° with the angle increasing from the centre to the to the edge of the capsule. Within the range of heights of the protruding surface, the blades of the brew head maintain an incident angle of around 30° to the planar surface of the capsule 12. If the incident angle of the blades is greater than around 35° or less than around 25° there is a tendency for the capsule to deform under the action of the blades rather than be pierced. Within

the ranges of the specific embodiments, a hole size of between 0.95 and 1.05mm diameter can be achieved, which allows an optimal flow rate for a standard espresso grind.

A seal 9, having a generally annular form is provided on the flange with exemplary seal structures shown in Figures 3a, 3b and 4. Exemplary seals contain a layer of chemical (sulphate) pulp or CTMP (chemi-thermomechanical pulp) or 3 layers with a layer of chemical (sulphate) pulp and CTMP (chemi-thermomechanical pulp). The chemical pulping process produces long, well-bound fibres, which give the material high strength and water-resistant properties.

The material structure also provides good edge wick holdout. Edge wick defines a resistance to liquid penetration along the exposed edge of a board, which helps to maintain the strength and rigidity of the gasket in use.

PE:

Property	Exemplary Specification
Thickness (microns)	200-595
Grammage (gsm)	150-550
Tear Resistance (mN) <i>Test method: ISO 1974</i>	3000-5000
Internal Bond Strength (J/m ²) <i>Test method: T 596</i>	≥90
Moisture content <i>Test method: ISO 287</i>	7.0%-8.5%
Edge wick (mm) <i>Test method: Hot Water 95°C, 10 minutes</i>	≤5mm wicking distance.

A further exemplary embodiment shown in Fig 3a and 3b is a hybrid laminate option in which the hybrid concept can be a laminate of elastic material (for example one of foam / plastic / silicon) and non elastic deformable material (i.e. paper). The lamination can be 2 or more layers where paper is the outer or upper layer so it plastically deforms.

Residual water in the brewhead causes a small amount of swelling of the paper or cellulose material when the coffee machine is in use, which swelling enables a better engagement with castellations on the brewhead thereby improving the seal.

The seal can be retained in position either by adhesive or a mechanical means.

In a first embodiment, the seal is fixed to the flange with an adhesive, in particular a starch based biodegradable adhesive having a melt range around 140 degrees, which is sufficiently above 100 degrees seen during coffee extraction, but low enough to activate during the short dwell time during capsule filling. Using an elevated sealing head temperature enables a temperature of 140 degrees to be reached in that short time.

In an alternative embodiment, the gasket can be applied with pressure and/or heat without using an adhesive. This could either be a dry heat process or it would be possible to use steam. As pressure and/or the heat is applied the gasket swages out and tightens around the internal diameter, creating a tight fit over the capsule. The outer diameter also increases, pushing the gasket against the rim of the capsule.

In a further alternative embodiment, it is possible to apply a liquid heat sealable adhesive directly to the board. This can be used instead of adhering a film to the board would help reduce cost and improve recyclability. The liquid heat sealable adhesive is applied in one or more coats. The first acts as a primer, the subsequent coat or coats are applied to build up a level of thickness that is on the surface, ensuring not all the adhesive has been absorbed into the board. An exemplary grammage for heat seal adhesive applied is 4 to 30 gsm.

For cosmetic reasons it is preferable to use a gasket that is colour matched to the capsule. The known approaches suffer from the problem that the gasket adheres to the Brew Chamber during / after extraction when the capsule is ejected. The reason for this is likely to be the inks soften when exposed to the heat and pressure and re-activate (soften). Then when cooling, the ink and gasket stick to the brew chamber. This can leave all or some of the gasket on the brew chamber, resulting in build-up which ultimately leads to leaks during extraction. The printed gasket may also prevent pressure release from gasket

In a preferred aspect the seal is made from a non-coated board or only on one side and ink is applied to the non coated side, for example to colour match the seal to the capsule body. This approach advantageously allows the ink to soak into the core of the board, making delamination less likely. Alternatively, it is possible to apply a pattern to the non coated side, which breaks up

the print layer into small pieces, allowing pressure to escape. If delamination does start, the pattern reduces the likelihood of the delamination spreading. The pattern can comprise dots / hashed lines / wavy line etc. Aesthetically the pattern can be chosen so that the board looks fully printed.

This can be solved by laminating over the top of the printed surface as shown in Figure 4, the ink is not in direct contact with the brew chamber. Therefore, even if it does re-activate, it cannot stick to the brew chamber.

The capsule wall is provided with flutes which extend over substantially the length of the side wall part 2 of the main body. The flutes are recessed by between 0.1 and 0.3mm from the maximum outer radius of the side wall 2. The flute may be between 0.5 and 10mm wide. The flutes may be substantially contiguously disposed in the side wall.

It has been surprisingly discovered that the provision of the flutes extending over a substantial part of the side wall 2 greatly increase the strength of the capsule, which becomes much less likely to deform. The fluted design capsule requires a force of 20N to deform the side of the capsule by 2.0mm, whereas known capsules require a force of 10N to 15N. The force is applied using a 9.0mm diameter pad, 1/3 up from the gasket sealing surface, in a direction normal to the axis of the capsule. This greatly improves the ease of handling the capsule both in the manufacture of the capsule and its filling. It is also less likely to be damaged in transit. This will reduce wastage in capsule production and facilitate the wider use of aluminium capsules which are preferable to plastic with respect to their recyclability.

In capsule of the invention the aluminium is between 0.075 to 0.125mm thick.

Figure 5a shows an alternative arrangement of the seal in which the annular seal 9 is provided with an annular groove or concave rib 15. A corresponding annular groove 16 is formed on the annular flange of the capsule. The annular groove 10 can receive the capsule cage of the coffee machine.

Figure 5b shows an alternative arrangement to that of Figure 5a, in which the seal is provided with an annular protrusion or convex rib 17. The annular flange is provided with a corresponding protrusion or rib 18. In use, the capsule cage of the coffee machine can engage on the protrusion to form a seal.

Although the capsule has been specifically described as being used to make espresso coffee, it would be possible to use the capsule to make other beverage capsules such as tea or chocolate.

The reference to any prior art in this specification is not, and should not be taken as, an acknowledgement or any form of suggestion that such prior art forms part of the common general knowledge.

It will be understood that the terms “comprise” and “include” and any of their derivatives (e.g. comprises, comprising, includes, including) as used in this specification, and the claims that follow, is to be taken to be inclusive of features to which the term refers, and is not meant to exclude the presence of any additional features unless otherwise stated or implied.

In some cases, a single embodiment may, for succinctness and/or to assist in understanding the scope of the disclosure, combine multiple features. It is to be understood that in such a case, these multiple features may be provided separately (in separate embodiments), or in any other suitable combination. Alternatively, where separate features are described in separate embodiments, these separate features may be combined into a single embodiment unless otherwise stated or implied. This also applies to the claims which can be recombined in any combination. That is a claim may be amended to include a feature defined in any other claim. Further a phrase referring to “at least one of” a list of items refers to any combination of those items, including single members. As an example, “at least one of: a, b, or c” is intended to cover: a, b, c, a-b, a-c, b-c, and a-b-c.

It will be appreciated by those skilled in the art that the disclosure is not restricted in its use to the particular application or applications described. Neither is the present disclosure restricted in its preferred embodiment with regard to the particular elements and/or features described or depicted herein. It will be appreciated that the disclosure is not limited to the embodiment or embodiments disclosed, but is capable of numerous rearrangements, modifications and substitutions without departing from the scope as set forth and defined by the following claims.

Claims

1. A capsule for use in a coffee machine, which machine has a capsule cage for retaining the capsule in an extraction position, wherein the capsule is formed from a ductile metal, which capsule has a generally frusto-conical form with an upper surface and a lower surface, an annular flange being provided at the lower surface, wherein an annular seal is provided on the annular flange comprising a cellulose material such as paper that deforms in use, wherein the annular seal comprises first and second layers, wherein the annular seal is provided with an annular groove or concave rib.
2. A capsule according to Claim 1, wherein the annular groove can receive the capsule cage of the coffee machine.
3. A capsule according to Claim 1 or Claim 2, wherein a corresponding annular groove is formed on the annular flange of the capsule.
4. A capsule according to Claim 1 or Claim 2, wherein the rib is annular.
5. A capsule according to any one of Claims 1 to 3, wherein the seal further comprises a layer for adhesive for attaching the seal to the capsule rim.
6. A capsule according to any one of Claims 1 to 4, wherein the first layer is formed from chemical (sulphate) pulp or CTMP (chemi-thermomechanical pulp).
7. A capsule according to any one of Claims 1 to 5, wherein the seal comprises a layer of a liquid heat sealable adhesive.
8. A capsule according to any one of Claims 5 to 7, wherein the adhesive is starch based biodegradable adhesive having a melt range around 140 degrees Celsius.
9. A capsule according to any one of Claims 1 to 4 or 6, wherein the seal is applied with pressure and/or heat without using an adhesive.
10. A capsule according to Claim 9, wherein as pressure and/or the heat is applied the gasket swages out and tightens around the internal diameter of the seal to fix the seal in position on the capsule.

11. A capsule according to any one of Claims 1 to 10, wherein the seal is made from a non-coated board or only is only coated on one side and ink is applied to the non coated side.
12. A capsule according to any one of Claims 1 to 9, wherein a pattern is applied to a or the non coated side of the seal, which breaks up the print layer into small pieces, thereby allowing pressure to escape.
13. A capsule according to Claim 11 or Claim 12, wherein the seal is laminated over the top of the printed surface so that the ink is not in direct contact with the brew chamber of a coffee machine.
14. A capsule according to any one of Claims 1 to 11, wherein the edge wick is less than 5mm in an edge wick test with Hot Water at 95°C for 10 minutes.
15. A capsule according to any one of Claims 1 to 12, wherein the seal has a tear resistance of 3000-5000 mN and an internal bond strength of greater than or equal to 90J/m².

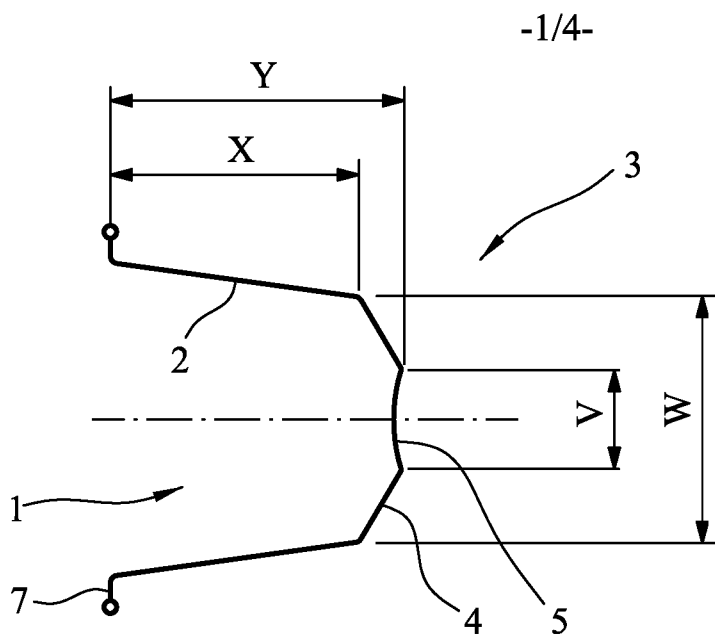


Fig. 1a

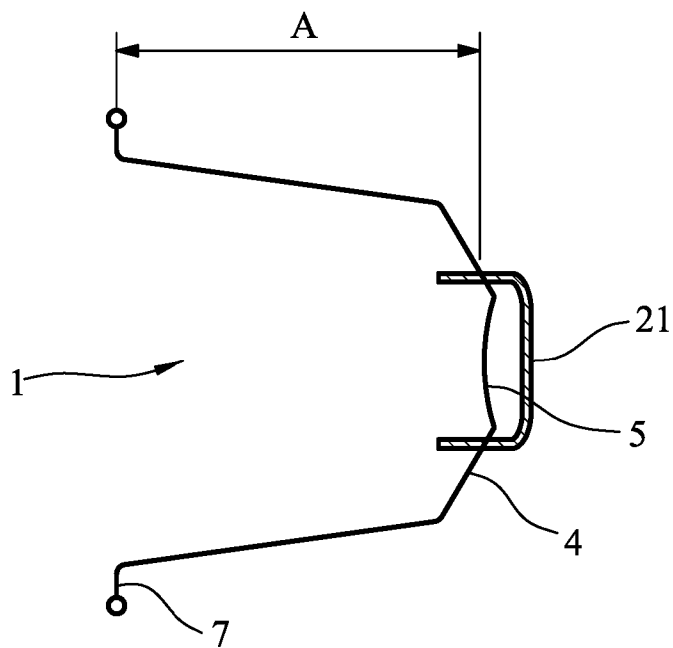


Fig. 1b

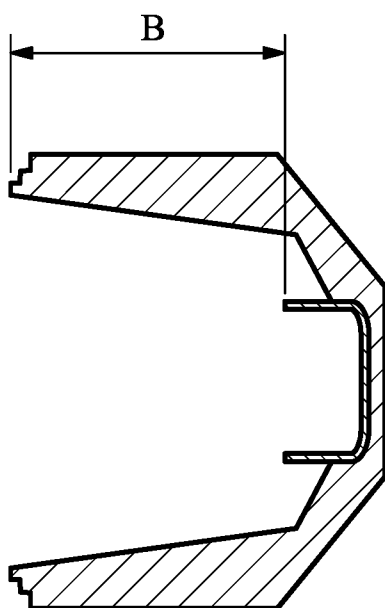


Fig. 1c

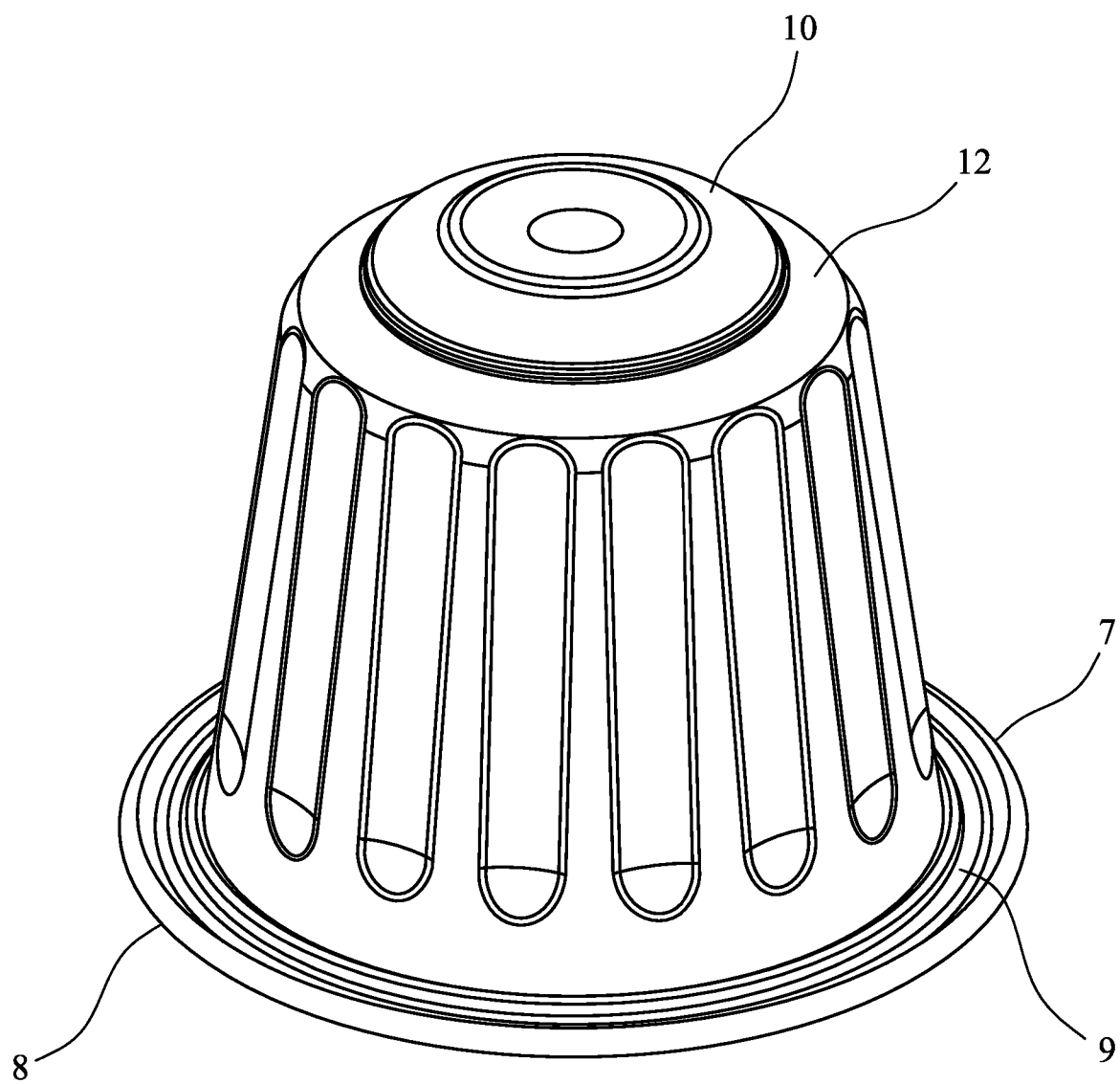


Fig. 2

-3/4-

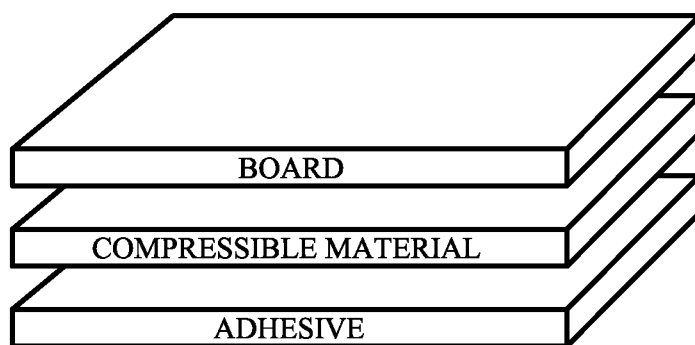


Fig. 3a

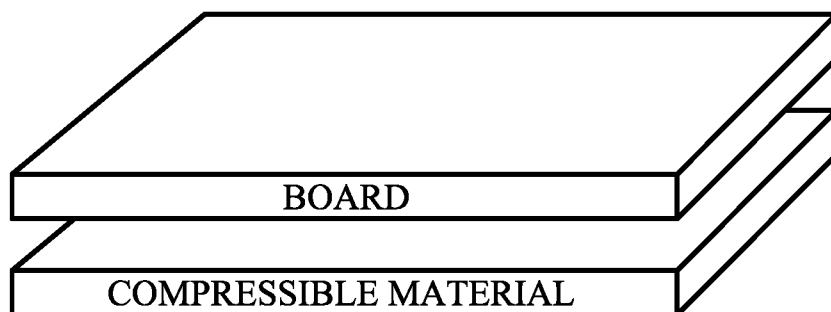


Fig. 3b

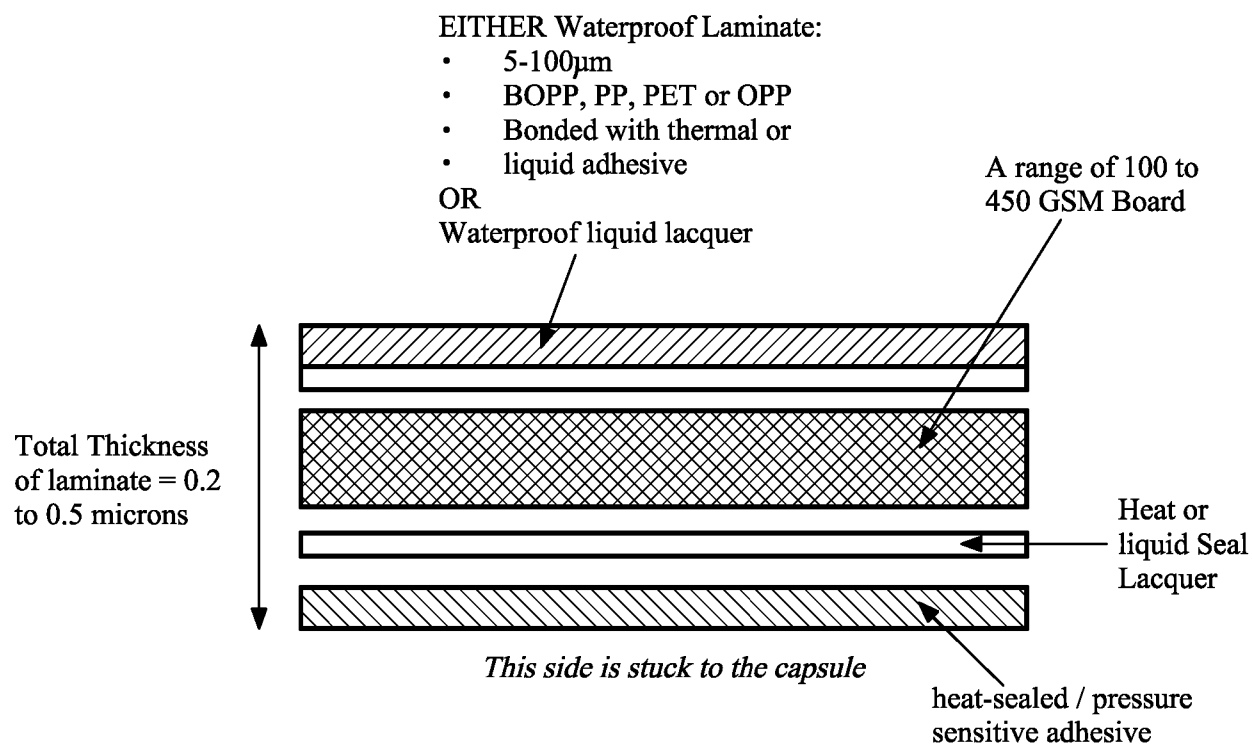


Fig. 4

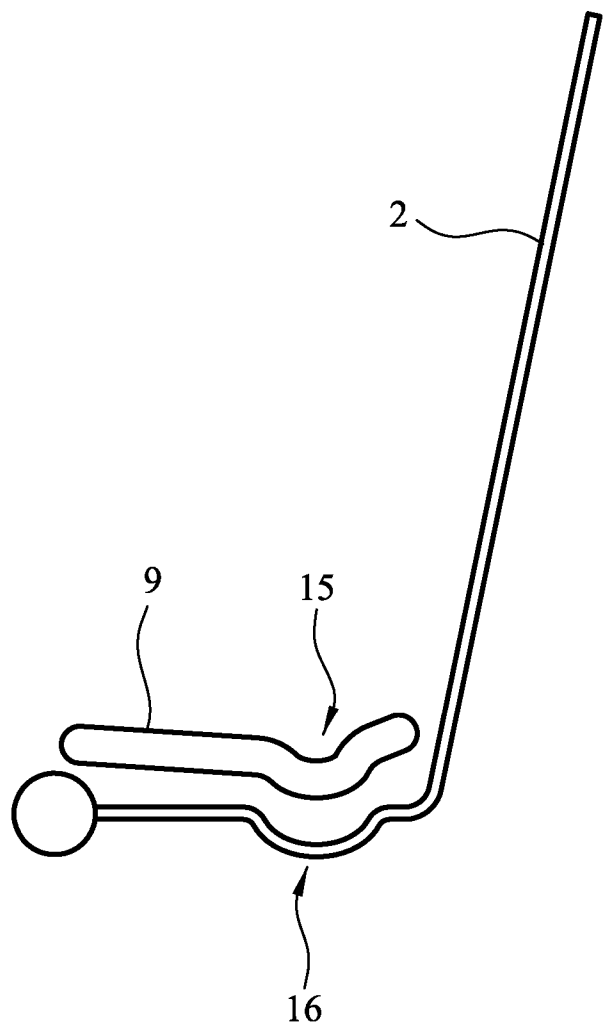


Fig. 5a

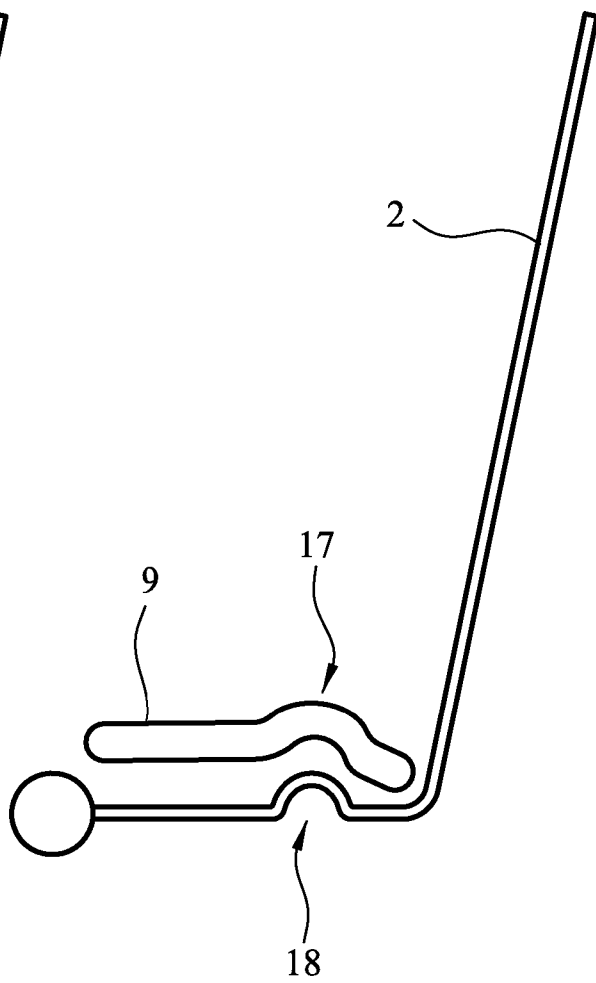


Fig. 5b