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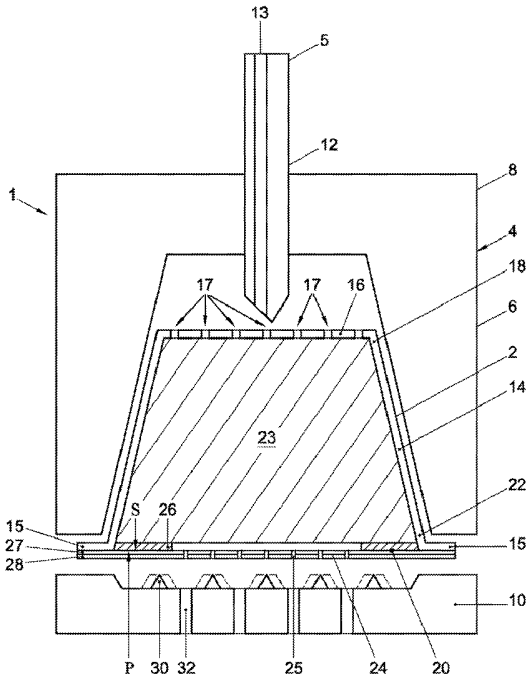

FIG. 1

(57) Abstract: Capsule (2) for preparing a predetermined quantity of beverage suitable for consumption using an extractable product, for instance roast and ground coffee, comprising a substantially rigid circumferential wall (14), a bottom (16) closing the circumferential wall at a first end (18), and a lid (20) closing the circumferential wall at a second, open, end (22), wherein the circumferential wall, the bottom and the lid enclose an inner space (23) comprising the extractable product, wherein the lid (20) comprises a flexible foil (24) with a plurality of exit openings (25) for draining of the prepared beverage, wherein inside the capsule (2) between the extractable product and the lid (20) a substantially sheet shaped filter layer (26) is provided that does not cover any of the exit openings (25) in the foil (24).

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Title: Capsule, system and method for preparing a beverage

The invention relates to a capsule for preparing a predetermined quantity of beverage suitable for consumption using an extractable product, for instance roast and ground coffee, the capsule comprising a substantially rigid circumferential wall, a bottom closing the circumferential wall at a first end, and a lid closing the circumferential wall at a second, open, end opposite the bottom, wherein the circumferential wall, the bottom and the lid enclose an inner space comprising the extractable product, wherein the lid comprises a flexible foil having a plurality of exit openings defining an exit area for draining of the prepared beverage.

Such a capsule is for instance known from WO2010137953 and can be used in an apparatus for preparing a beverage. Such a capsule provides convenience in use as well as reproducible extraction conditions, resulting in easy preparation of a cup of coffee with a constant quality. Since the known capsule comprises a flexible foil with a plurality of exit openings defining the exit area for draining of the prepared beverage, this capsule is known as an open capsule. Such a capsule can be used in a beverage production apparatus in which a liquid under pressure enters the capsule via the bottom in order to interact with the extractable product in the capsule. Upon interaction of the liquid and the extractable product the beverage is obtained. During preparation of the beverage, the foil will keep intact such that the prepared beverage leaves the capsule via the exit openings provided in the lid and the roast and ground coffee remains inside the capsule. However, applicant found that due to the material of the lid defining the exit area only limited possibilities regarding the coffee parameters of the capsule for brewing coffee are available. Therefore, varying with different coffee flavours may be limited as well. When preparing a beverage, coffee particles inside the capsule may move towards the foil during supply of the fluid inside the capsule which particles may

contribute to the creation of a flow restriction. However, also the fine particles may displace and end up in accumulating in front of or covering at least part of the exit openings in the foil. This may be disadvantageous because the flow restriction may be come too high. The brewing time of the beverage when using said known capsule may be relatively long, which may be inconvenient for a user of the beverage production apparatus. Besides, when using the known capsule small particles, i.e. so called fines, of the roast and ground coffee may end up in the prepared beverage, which may lead to a coffee with an inferior quality.

Therefore, it is an object of the invention to provide an improved open capsule for the preparation of a beverage and more specifically to diminish at least part of the above mentioned problems.

Thereto, according to a first aspect of the invention, a capsule of the above described type is provided, wherein inside the capsule between the extractable product and the lid a substantially sheet shaped filter layer is provided that does not cover any of the exit openings in the foil. This means that each opening is completely uncovered by the filter layer.

By providing a filter layer between the extractable product, i.e. roast and ground coffee, and the foil with exit openings of the lid, the smallest particles of the roast and ground coffee, i.e. the fines, are caught by the filter layer material. The fines will spread in the filter layer before said particles will reach the exit openings in the foil. Since at least not all fines will reach the exit openings, a desired flow restriction, thus not restricting the water flow too much, is obtained. When using the improved coffee capsule, the process of preparing a beverage may be better controllable and thus better reproducible. With such an improved capsule the extraction conditions of the coffee may be improved. The cooperation between the foil with exit openings and the additional filter layer enables the possibility to vary with the coffee parameters such as the amount of coffee and the dimensions of the coffee particles, which may for instance be advantageous

to prepare coffee with different coffee flavours. Applicant found that the capsule according to the invention may especially be used to advantage when comprising coffee particles that are brittle and thus comprise a large amount of fines. For instance, decaffeinated coffee particles may comprise a relative large amount of fines.

Due to the filter layer, accumulating of the fines and/or covering of the exit openings is minimized. As the liquid under pressure enters the capsule via the bottom (which may be provided with inlet openings such as slits or may be opened by a coffee apparatus) in order to interact with the extractable product, the extractable product may be compacted. The presence of a filter layer between the extractable product, i.e. roast and ground coffee, and the foil with exit openings of the lid, may allow a preferred flow to form through the filter layer, because the flow resistance through the filter layer is smaller than the flow resistance through the compacted extractable product. This preferred flow also positively influences the brewing time of a beverage. Also excessive compression of the coffee bed is minimized. Also area of compacted coffee in the prior art capsule is now filled with filtering paper, thereby providing a lower flow resistance in such area. As the liquid under pressure enters the capsule via the bottom in order to interact with the extractable product, the extractable product may be compacted. The presence of a filter layer between the extractable product, i.e. roast and ground coffee, and the foil with exit openings of the lid, may allow a preferred flow to form through the filter layer, because the flow resistance through the filter layer is smaller than the flow resistance through the compacted extractable product. This preferred flow also positively influences the brewing time of a beverage. Furthermore, the improved capsule enables brewing of coffee with a brewing time that is better controllable. For instance, to prepare a coffee lungo, the brewing time may be between 40-50 seconds instead of between 38-55 seconds as with the known prior art capsule. Thus, the brewing time range will be smaller.

Since fine particles of the roast and ground coffee are captured by the filter layer, these particles will not end up in the prepared beverage.. The foam layer is of a good quality. The foam layer is stable, has a clean appearance and has a uniform distribution of air bubbles. It is noted that "foam layer" refers to the crema layer that is provided on top of the prepared beverage. The crema layer will be generally thicker than the case wherein the complete foil and/to each exit opening would be covered by the filter layer. It was surprisingly found that due to preventing fines from reaching the foil, the capsule can be filled with a larger amount of coffee, and/or coffee with smaller particles may be used. The capsule according to the invention has a positive effect on the brewing time of the coffee and on the amount of dry matter comprised in the prepared beverage. When preparing coffee using a capsule according to the invention, the prepared coffee comprises more dry material (DMA), for instance approximately 15%, with respect to the described known open capsule. Furthermore, the amount of oil in the prepared coffee may be greatly reduced. This results in a coffee beverage of high quality. Since the foil stays intact during preparation of the beverage, the filter layer that is provided between said foil and the roast and ground coffee thus will also stay intact during preparation of the beverage.

Preferably, the substantially sheet shaped filter layer comprises a layer of paper filtering material, a layer of non-woven material or a layer of woven material. Preferably, the sheet shaped filter layer comprises a layer of paper filtering material or a layer of non-woven material. Such paper filtering material may comprise relatively small pores, at least smaller than the exit openings of the foil, which pores are adapted to retain the small particles of the roast and ground coffee before reaching the exit openings.

It is noted that WO2010137952 and WO2010137963 both disclose a capsule for preparing a predetermined quantity of beverage suitable for consumption, wherein the capsule may be an open capsule comprising a lid having an exit area for draining prepared beverage from the capsule. In

both publications, the lid may comprise multiple layers of suitable porous and/or perforate material. However, the problem of accumulating of the fines that may cover the openings of the exit area is not recognised nor a suitable combination of layers is suggested to overcome said problem.

In further elaboration of the invention, the filter layer preferably extends substantially parallel along the lid at least across the maximal transversal cross section of the second open end of the capsule. The filter layer may comprise an opening in a centre area thereof. Alternatively, the filter layer may comprise one or more openings, possibly provided in a pattern, such as circular openings, rectangular openings and/or triangular openings.

According to a further aspect of the capsule according to the invention, the filter layer may abut against the lid. The filter layer may be provided against the lid and may stay at the desired location due to the fact that it is pressed tightly between the roast and ground coffee and the lid. Then the filter layer does not have to be connected to the capsule and/or the lid. Instead, the filter layer may be connected at a circumferential edge of the filter layer, preferably adjacent a circumferential edge of said lid. In another embodiment of the capsule according to the invention, the filter layer may be connected to the lid along the entire surface of the filter layer. The assembly of the filter layer and the lid can be prefabricated such that it can be mounted to the capsule in a single operating step. When connecting the filter layer to the lid, at least partly, the circumferential edge of the filter layer may be enclosed between the lid and an outwardly extending rim of the capsule. The filter layer may extend along the entire radial length of the outwardly extending rim such that the lid is connected to the rim via the filter layer. In that case the filter layer must be provided with at least one opening so that the exit openings are not covered by the filter layer. Alternatively, the filter layer may only extend along part of the radial length of the outwardly extending rim. Then, the lid is connected directly to

the rim along the part of the radial length thereof that is not covered by the filter layer. It was found that if the filter material of the filter layer is relatively thin, the filter layer may be kept in position by the sealed connection between the foil and the rim. When the outer circumferential edge of the filter layer is connected to the rim or to the flexible foil, prepared beverage will not bypass the filter layer. The filter layer may have a thickness of approximately between 10µm-1mm, preferably between 50µm-0.2mm. The filter layer may also have a thickness in the range of 0.2mm- 10 mm, preferably 0.2 mm- 5mm, more preferably 0.2-2mm while excluding 0.2 mm from such range. In another embodiment of the invention, the filter layer may comprise sealing properties for enhancing the sealing capability thereof.

To obtain the desired spreading of the small particles of the roast and ground coffee along the filter material, it may be advantageous if the paper filtering material is of paper having a weight of approximately 1-250 grams/m2, more preferably between 10-100 grams/m2, preferably approximately 15-50 grams/m2. Alternatively, the filter layer may comprise a non-woven material layer comprising a synthetic material, for instance comprising high density polyethylene (HDPE). An example of such a filter material is Tyvek. Such a non-woven material layer may comprise a similar thickness and weight as above indicated with the paper filtering material. In a further alternative embodiment, the filter layer may comprise a screen of woven or non-woven material. The screen may for instance be of a plastic material, such as PE, or of a metal, for instance a thin layer of aluminium.

The paper filtering material or the non-woven material of the filter layer may have an air permeability of maximal 550 mm/second measured at a pressure of approximately 200 Pascal. Such air permeability is indicative of filtering properties that enhance retaining the fines to prevent that said fines from reaching the exit holes in the foil. It is noted that the air permeability is measured with an Akustron Air Permeability

Tester that is configured to measure air permeability of filter papers, non-wovens and textile fabrics within a range of 10-3000mm/second at Δp=200 Pascal.

In order to enhance the sealing properties of the filter layer for sealing it to the foil, the filter layer material may comprise a plastic or may be coated. In that case preferably the coating or plastic faces the foil. For instance, the filter layer may be provided with polyethylene (PE) or another suitable plastic.

In an alternative embodiment, the filter layer may be connected to the foil at one surface of the filter layer and to another foil layer provided on an opposing surface of the filter layer. Such further foil layer may comprise openings that are slightly larger than the openings in the lid and much larger than the pores in the filter layer. Such an exit layer may be prefabricated and easily connected to the capsule body.

The foil of the lid may be configured to stay in tact when being used in an apparatus that comprises lid piercing means intended for piercing a lid of a closed capsule, i.e. a capsule at least comprising a closed lid. The tear strength and stiffness of the foil may thus be chosen such that rupture of the foil against the lid piercing means under the influence of e.g. fluid pressure is prevented.

In an embodiment of the invention, the foil may be a multilayer foil. The multilayer foil may comprise a first material layer and a second material layer. The first layer may have a higher stiffness than the second layer and the second layer may have a higher tear strength than the first layer. The first layer may be of polyethylene terephthalate (PET-P) and the second layer may be of co-polymer polypropylene (CPP). Preferably, the layer of PET-P has a thickness of approximately 15µm and the layer of CPP has a thickness of approximately 30µm. The layer of CPP may have higher tear strength than the layer of PET-P. The layer of PET-P may have a higher stiffness than the layer of CPP. These layers are bonded together.

Such a multilayer foil avoids the rupture of the lid under the influence of e.g. fluid pressure.

The exit area of the foil may for instance comprise 50-250 openings, preferably 70-190, more preferably 100-160 openings. The open surface of the foil, i.e. the total surface of the openings, may be approximately between 0.4-49.1mm^2. The average diameter of the exit openings may be between 0.1 and 0.5mm. The foil may comprise a combination of openings with different diameters and/or provided in different patterns. Such a foil may form a sufficiently low flow resistance to prevent tearing of the lid of the capsule during preparation of the beverage which is advantageous for controlled preparation of the beverage. As mentioned before, due to the foil, the filter layer will stay intact as well.

The capsule according to the invention is suitable for preparing a predetermined amount of beverage by supplying a predetermined amount of hot water under high pressure to the capsule, thereby extracting the beverage ingredient with the supplied water. For instance, the exchangeable capsule may comprise a predetermined amount of beverage ingredient, for instance 4-11 grams, preferably 5-8 grams, more preferably 5.3-6 grams. Such a capsule is suitable and intended, for preparing a single portion of the beverage, preferably a single cup of the beverage, e.g. from 20-30 ml excluding 30 ml or 30-200ml of the prepared beverage. The exchangeable capsule, thus, is a single-portion-pack. The exchangeable capsule according to the invention may be a disposable capsule. Preferably, the capsule inner space may have a volume of approximately 10-20 ml, preferably 11 – 18 ml. This generally makes the capsule suitable for preparing one cup of a beverage. A capsule for instance for preparing an espresso may have an inner space of approximately 12 ml. To enable the liquid entering the capsule, the bottom of the capsule may comprise an entrance filter, for instance a substantially rigid bottom comprising a plurality of entrance openings or for instance of a porous sheet, such as a sheet of paper or the

like non-woven material, or a perforate sheet, such as a polymeric film provided with a plurality of entrance openings, for supplying the fluid to the extractable product there through. The entrance filter may, for example, comprise a substantially rigid bottom with slits. In an embodiment, the slits may extend from a centre of the bottom radially outward towards the outer circumferential edge of the entrance filter. In an alternative embodiment, the slits may be arranged in a different pattern. By providing the entrance opening with an entrance filter, spoiling roast and ground coffee for instance when removing the capsule from the apparatus is prevented as well. The entrance filter may comprise, at a centre area thereof, a recess. Such an entrance filter is for instance described in WO2012019902. The entrance filter may be configured to remain intact upon use of the capsule in an apparatus for preparing a beverage. Even if the apparatus comprises bottom piercing means to pierce a bottom of a closed capsule, the bottom of the capsule according to the invention can be configured to remain intact. In an alternative embodiment of the invention, the capsule may comprise a closed bottom that in use is pierced by the lid piercing means to provide a supply opening in the capsule to enable fluid supply to the capsule inner space.

This generally makes the capsule suitable for preparing one cup of a beverage. Preferably the exit openings directly face the extractable product. This has as an advantage that, in use, the exit openings may be partly blocked by fines in the ingredient. If the exit openings are partly blocked, in use, there will be a raise of pressure if water under pressure (for example 1—20 bar)is submitted into the capsule. This raise of pressure has a result that gases may escape from the extractable product if the extractable product is ground coffee. These gasses provide a crema layer on to[of the beverage if the beverage is collected in a cup. The filter layer makes sure on the other had that the exit openings are not blocked to such an extend that the brewing time becomes unacceptable high such as for example around 55-65 seconds. It is believed that due to the relatively low

flow resistance of the filter layer a flow rate of the fluid in the capsule may increase which may have as a result that the exit openings are not blocked to an unacceptable extend. Also the brewing time does not become unacceptable small so that the amount of DMA in the beverage would become to small. Directly faces implies that an exit opening is not covered by a separate sheet such that such opening is adjacent to or substantially abuts against the extractable product. The plurality of uncovered exit openings may however be separated from the extractable product by an empty space. However, it will be appreciated that this space is free from additional elements or materials. In this way, in use, a desired flow restriction is obtained by a build-up of fines reaching the plurality of exit openings that directly faces the extractable product.

Thus by dimensioning the size of the filter layer, the amount and positions of the exit openings and the size of the exit openings depending on the type of ingredient a well balanced process for brewing the beverage is obtained. For example, the surface of the foil which is not covered by the filter layer comprises p% of the total surface area of the foil which forms a boundary of the inner space of the capsule wherein p lays in the range of 29-99.5, preferably in the range of 44-99.5, more preferably in the range of 54-99.5. Preferably the surface area of the foil which is not covered by the filter layer and which is provided with the exit openings is f*p% wherein f lays in the range of 0.5-1. If p=1 the exit openings are spread all over the surface of the foil which is not covered by the filter layer. Experiments have however shown that the exit openings may also lay in only a portion of the area of the foil which is not covered by the paper layer. It has for example been found that it may be beneficial if an circumferential area of the foil which is adjacent the circumferential wall is not provided with the exit openings wherein this area is not covered by the filer layer in addition to other areas which are provided with exit opening and which are not covered by the filter layer so as the provide a reduced brewing time on the one hand without

substantially lowering the amount of DMA in the beverage on the other hand. Alternatively the filter layer extends to the circumferential wall, more particularly wherein the full outer boundary of the filter layer extends to the circumferential wall. In an embodiment a first portion of the surface area of the foil which is covered by the filter layer lays at least substantially completely adjacent the circumferential wall. More particularly in such an embodiment c% an outer boundary of the first portion of the foil lays adjacent the circumferential wall, wherein c is greater than 50, preferably greater than 85, more preferably greater than 95 and wherein c is most preferably 100. Such embodiment may provide satisfactory brewing results as discussed above wherein the brewing result is also very predictable. A distance is for example adjacent if the distance is smaller than 3% of a largest diameter of the inner space of the capsule adjacent the foil and/or wherein preferably b is smaller than 0.5mm>. In the embodiment discussed preferably the filter layer extends to each position of the circumferential wall adjacent the foil. In the capsule there is a preferred flow from the entrance side (the bottom) to the exit side (the foil) of the capsule along the circumferential side wall. It is believed that this flow is deflected into the filter layer and continues towards a centre area of the capsule because the filter layer has a relatively low flow resistance. Thereby the brewing time is improved.

In an alternative embodiment the filter layer does not extend to the circumferential wall. In that case it may form an island in a centre area of the foil . In that case the flow of fluid in the direction from the entrance side towards the filter layer on the exit side may be deflected into the filter layer and flows in a radial direction in the direction of the circumferential wall towards the exit openings, Again the flow through the filter layer is believed to be relatively easy due to the relative low flow resistance of the filer layer in the capsule during use. Thereby the speed of the fluid may be increased resulting in a prevention of the exit openings becoming blocked to

much, so that the brewing time remains acceptable short on the one hand and the height of the crema layer on the beverage as well as the amount of DMA in the beverage becomes predictably and satisfactory on the other hand.

It is further possible in each of the embodiments discussed that the filter layer comprises an (additional) opening, for example in a centre area of the filter layer. The opening has a surface area which is greater than surface area of exit opening having the largest surface area. In the area of the opening in the filter layer at least one or a plurality of exit openings may be provided. If no exit openings are provided, this area is especially used to balance the average flow resistance of the fluid in the capsule. Also the filter layer may comprise a plurality of openings. In that case preferably each opening has a surface area which is greater than surface area of exit opening having the largest surface area.

In an embodiment a second portion of the surface area of the foil wherein the plurality of exit openings are distributed lays at least substantially completely at a distance from the circumferential wall. In that case the filer layer may for example have the shape of a ring.

In an embodiment a third portion of the surface area of the foil which is covered by the filter layer lays at least substantially completely at a distance from the circumferential wall. In that case the filter layer may have the shape of an island as discussed above. In that case the filter layer may have the shape of a disc. The filter layer may even have the shape of the DE-brand, which shape is shown in figure 12.

Preferably it would hold that a'% of an outer circumferential boundary of the third portion of the surface area of the foil lays at a distance from the circumferential wall, wherein a is greater than 50, preferably greater than 85, more preferably greater than 95 and wherein a is most preferably 100 and wherein a distance is defined as 5-30% from a diameter of the inner space adjacent the foil. If a=100, the filter layer could be an island relative

to the circumferential wall , if a is smaller than 100 it could be a peninsula. relative to the circumferential wall

In the example of the ring a centre opening of the or ring could have for example a largest diameter lays within the range of 25%-75% of the largest diameter of the inner space of the capsule at the foil. The area of the foil adjacent the circumferential wall and which is not covered by the ring may preferably x% of the total area of the foil which forms a boundary of the inner space wherein x lays in the range of 10-50, preferably in the range of 15-40. This provides satisfactory brewing results. A centre opening of the ring may for example have a largest diameter lays within the range of 15%-60% of the largest diameter of the inner space at the foil. In that case preferably an outer circumferential boundary of the filter layer lays adjacent the circumferential wall and wherein preferably the centre area has a cross section of S mm wherein S lays in the range of 12-26, preferably in the range of 14-25 and more preferably within the range of 16-24 and wherein preferably the outer diameter of the portion of the filter layer which forms a boundary of the inner space has across section of about 28-30mm and/or wherein preferably the diameter of the inner space near the foil is about 28-30mm .

Alternatively the filter layer may have the shape of a strip. In that case the filter layer having the shape of a strip may be provided with two opposite ends laying adjacent the circumferential wall and two opposite sides each laying at a distance from the circumferential wall.

Possibly it holds for each embodiment that centre of the filter at least substantially coincides with a centre of that part of the foil which forms a boundary of the inner space. Alternatively, possibly it holds for each embodiment that a centre of the filter layer is offset with a centre of that part of the foil which forms a boundary of the inner space in a direction parallel to the foil. A centre is in this case defined as a centre of gravity of a flat product having the same circumferential shape as the filter or the shape

of that part of the foil which forms a boundary of the inner space respectively.

In a preferred embodiment an outer boundary of the surface area of the foil wherein the plurality of exit openings are distributed lays at least substantially completely or completely at a distance from the circumferential side wall.Optionally, in order to optimise the quality of the beverage on the one hand and the brewing time on the other hand the filter layer fills c% of the volume of the inner space of the capsule wherein c lays within the range of 0.1-8, preferably within the range of 0.1-6.5, more preferably within the range of 0.1-3. By reserving an volume of the inner space of the capsule which is filled by the filter layer provides, in use, a volume of the capsule in which a preferred flow may be established and/or through which a preferred flow may flow.

Preferably the volume that the filter layer fills is located adjacent to the foil, or at least in the vicinity of the foil.

Optionally, a flow resistance of the filter layer is higher than a flow resistance of the extractable product. Preferably a flow resistance of the filter layer is smaller than a flow resistance of the extractable product when being extracted with a fluid under a pressure of 9-18 bar.. Possibly a flow resistance of the filter layer is G times smaller than a flow resistance of the extractable product when being extracted with a fluid under a pressure of 9-18 bar wherein G lays in the range of 10-30, preferably in the range of 15-25 more preferably in the range of 18-22. G is estimated on the basis of modelling.

During brewing, as the liquid under pressure enters the capsule via the bottom in order to interact with the extractable product, the extractable product is compacted. Choosing the filter layer to have a flow resistance smaller than the compacted bed may allow a preferred flow to form and/or to continue. Influencing the preferred flow leads to more controllable brewing conditions. In this way an improved beverage can be

obtained reliably. It has been estimated with the aid of modelling that a filter layer having a flow resistance of approximately 20 times smaller than a flow resistance of the extractable product when being extracted is desirable. This also applies to such values provided elsewhere in this application

It will be clear that, when being extracted, implies supplying a fluid under a pressure of G bar wherein G lays in the range of 4-20, preferably in the range of 9-18. The fluid may be water. In this case the water under pressure may be supplied at a temperature higher than, for example, 70-90 degrees Celsius.

A flow resistance of the filter layer is preferably characterized by T wherein, while using a filter paper test device of the Herzberg design from Schroder Pruftechnik, T is the time in seconds for 100 ml of water to flow through an area of 10 cm2 of a sample of the filter layer in a direction perpendicular to a plane wherein the sample lays, with a starting water column of 33 cm, wherein the water temperature is at 20 degree C, wherein T lays in the range of 4-150, preferably 4-30, more preferably 5-20, for example in the range of 4-15 for filtering paper, for example in the range of 60-150 for white non woven and for example in the range of 45-80 for blue non woven. Preferably the density of the extractable product is D gr/cm3, wherein D lays in the range of 0.278-0.5, preferably within the range of 0.313-0.455, more preferably in the range of 0.379-0416. In that case the filter layer may influence the flow path of the fluid in the capsule.

Preferably the extractable product is ground coffee and wherein an average particle size of the extractable product is E micro meter wherein E lays in the range of 100-1000, preferably within the range of 200-750, more preferably in the range of 250-500.

Preferably the particles of the extractable product comprises L% fines in volume wherein L lays in the range of 7-60, preferably within the range of 8-30, more preferably in the range of 10-20. Fines are understood to

be particles smaller than 100 µm. In this application the measurement of the amount of fines is carried out with an Sympatec laser diffraction apparatus with a r6 lens.

By providing a filter layer, the applicant found that more possibilities regarding the coffee parameters of the capsule for brewing coffee are available. Different densities, average particle sizes, and/or percentages of fines of the extractable product may be used, while maintaining a brewing process that is reproducible and/or controllable. Additionally, an improved cup of coffee may be obtained having desired dry matter amount, crema layer and an acceptable brewing time for the user.

In the discussed embodiments the exit area of the foil (24) may for example comprises 50-250 openings (25), preferably 70-190, more preferably 100-160 openings. Also preferably an average open area of the exit opening is z mm2 per exit opening, wherein z lays in the range of 0.008-0.2, preferably in the range of 0.03-0.13, more preferably in the range of 0.05-0.1. A average largest diameter of each exit opening may be d µm per exit opening, wherein d lays in the range of 100-500, preferably in the range of 200-400, more preferably in the range of 250-350.

In a practical embodiment the filter layer has the shape of a ring wherein an outer circumferential boundary of the filter layer lays adjacent the circumferential wall and wherein preferably the centre area has a cross section of S mm wherein S lays in the range of 45-85c, preferably in the range of 50-80 and more preferably within the range of 60-75 and wherein preferably the outer diameter of the portion of the filter layer which forms a boundary of the inner space has a cross section of about 28-30mm and/or wherein preferably the diameter of the inner space near the foil is about 28-30mm .

The filter layer may have for example a thickness of T mm wherein T is in the range of 0.05-0.01 excluding 0.01, or 0.01-1 or 1-10 excluding 1, preferably 0.05 - 0.5 , more preferably 0.05-0.2. The thickness of the filter

may influence a preferred path through the filter, as well as increase the amount of fines caught by the filter. Additional filter material provides an additional volume of the inner space of the capsule in which a preferred flow may be established and/or through which a preferred flow may flow.

Optionally, the filter layer comprises a stack of sub filter layer wherein each sub filter layer is sheet shaped. Through the stacking of sub filter layers a desired filter thickness may be achieved. The stack may for example comprise 2-10 sub filer layers.

Optionally, the extractable product comprises or consists of H grams of ground coffee wherein H is in the range of 4-11, preferably in the range of 5-8 more preferably in the range of 5.3-6. Due to the filter layer more ground coffee can be provided in the capsule without an increased risk that the foil is blocked by fines during brewing.

Also by providing a filter layer, the applicant found that more possibilities regarding the coffee parameters of the capsule for brewing coffee are available. Different amounts of ground coffee and/or finer coffee may be used, while maintain a brewing process that is reproducible and/or controllable. Additionally, an improved cup of coffee may be obtained having desired dry matter amount, crema layer and an acceptable brewing time for the user.

For each of the embodiments he bottom comprise a plurality of slits forming entrance openings of the capsule.

The invention also relates to a system for preparing a predetermined quantity of beverage suitable for consumption using an extractable product, comprising the above described exchangeable capsule, and an apparatus comprising a receptacle for holding the exchangeable capsule, and a fluid dispensing device for supplying an amount of a fluid, such as water, under pressure to the exchangeable capsule, wherein the fluid dispensing device is arranged for supplying the fluid to the extractable

product through the bottom for forming the beverage, wherein the receptacle comprises a support surface, and wherein the capsule is arranged to at least partly abut against the support surface for draining the prepared beverage from the capsule through the lid and through the support surface, wherein the lid comprises a flexible foil having a plurality of exit openings defining an exit area for draining of the prepared beverage, wherein inside the capsule between the extractable product and the lid a substantially sheet shaped filter layer is provided that does not cover any of the exit openings in the foil, wherein the system comprises an outlet which, in use, is in fluid communication with the lid for draining the prepared beverage from the capsule and supplying the beverage to a container such as a cup. When using the capsule according to the invention in the apparatus of the system, the same effects and advantages are obtained as described with the capsule. The support surface of the apparatus of the system may comprise lid piercing means intended for piercing an exit area of for instance a hermetically sealed, closed capsule, when the exit area of such capsule is sufficiently pressed against the lid piercing means under the influence of the pressure of the fluid and/or beverage in the capsule for creating at least one exit opening through which the beverage can drain from said hermetically sealed capsule. In case the capsule according to the invention is used in such an apparatus, the foil with exit openings and the filter layer provided between said foil and the roast and ground coffee provided inside the capsule body will stay in tact. However, the lid may deform against the lid piercing means. Consequently, the roast and ground particles will remain inside the capsule during brewing and during removing of the capsule from the apparatus after finishing of the beverage. To be able to retain the fines before reaching the exit openings of the foil, the filter layer may have an air permeability of 0-2000 mm/second measured at a pressure of approximately 200 Pascal. By means of the system the beverage prepared in a cup, for example about 35-50vml, having a cylindrical inner space with

a diameter of 6 cm comprises a crema layer with a height R mm wherein R lays within the range of 2-16, preferably within the range of 4-12, and more preferably within the range of 5-8.5.

The invention also relates to a method for preparing a predetermined quantity of beverage suitable for consumption using an extractable product, using a system (1) according to invention and/or an exchangeable capsule (2) according to the invention.

The invention will now be further elucidated by means of, non-limiting, examples referring to the drawing, in which

Fig. 1 shows an example of a system with a capsule for preparing a beverage according to a first embodiment of the invention;

Fig. 2 shows a second example of a system with a capsule according to a second embodiment of the invention;

Fig. 3 shows a third embodiment of the capsule according to the invention;

Fig. 4 shows an example of the filter layer of a capsule according to the invention;

Fig. 5 shows another example of the filter layer of a capsule according to the invention;

Fig. 6 shows a further example of the filter layer of a capsule according to the invention;

Fig. 7 shows another example of the filter layer of a capsule according to the invention;

Fig. 8 also shows an example of the filter layer of a capsule according to the invention;

Fig. 9 shows an alternative example of the additional filter layer of a capsule according to the invention;

Fig. 10A shows a schematic cross section view of a capsule according to the invention;

Fig. 10B shows a schematic view from inside the capsule of Fig. 10A viewed in a direction B;

Fig. 11A shows a schematic cross section view of a capsule according to the invention;

Fig. 11B shows a schematic view from inside the capsule of Fig. 11A viewed in a direction B;

Fig. 12A shows a schematic cross section view of a capsule according to the invention;

Fig. 12B shows a schematic view from inside the capsule of Fig. 12A viewed in a direction B;

Fig. 13A shows a schematic cross section view of a capsule according to the invention;

Fig. 13B shows a schematic view from inside the capsule of Fig. 13A viewed in a direction B;

Fig. 14A shows a schematic cross section view of a capsule according to the invention;

Fig. 14B shows a schematic view from inside the capsule of Fig. 14A viewed in a direction B;

Fig. 15A shows a schematic cross section view of a capsule according to the invention; and

Fig. 15B shows a schematic view from inside the capsule of Fig. 15A viewed in a direction B.

It is noted that identical or corresponding elements in the different drawings are indicated with identical or corresponding reference numerals. The exemplary embodiments shown should not be construed to be limitative in any manner and serve merely as illustration.

Figure 1 shows an example of a first embodiment of a system 1 for preparing a predetermined quantity of beverage suitable for consumption

using an extractable product according to the invention. The system 1 comprises an exchangeable capsule 2 and an apparatus 4. The apparatus 4 comprises a receptacle 6 for holding the exchangeable capsule 2. In Figure 1, a gap is drawn between the capsule 2 and the receptacle 6 for clarity. It will be appreciated that, in use, the capsule 2 may lie in contact with the receptacle 6. In this example the receptacle 6 has a shape at least partly complementary to the shape of the capsule 2. In this example the receptacle 6 comprises an upper part 8 and a support surface 10. The apparatus 4 further comprises lid piercing means 30 that are provided for piercing a lid of a hermetically sealed capsule when the pressure inside the capsule 2 is built up high enough. The apparatus 4 also comprises a fluid dispensing device 5 for supplying an amount of a fluid, such as hot water, under a high pressure to the exchangeable capsule 2. The fluid dispensing device 5 is operatively connected to bottom piercing means 12 that are also intended for piercing a hermetically sealed capsule. In Figure 1, the bottom piercing means 12 are shown in an extended position. Since the capsule 2 according to the invention is an open capsule that need not be pierced, the end of the bottom piercing means 12 is positioned at a short distance from the capsule 2. However, in an alternative embodiment of the invention, the fluid dispensing device 5 may comprise a fluid supply that extends adjacent the bottom piercing means 12 into the receptacle inner space. With such a construction, the fluid is supplied to the inner space of the receptacle 6 above the capsule instead of via the bottom piercing means. In a further embodiment, the capsule 2 may comprise a closed bottom that in use is pierced by the lid piercing means 12 to provide a supply opening in the capsule such that the fluid can enter the capsule and come into contact with the extractable product.

In the system 1 shown in Figure 1, the exchangeable open capsule 2 according to the invention comprises a circumferential wall 14, a bottom

16 closing the circumferential wall 14 at a first end 18, and a lid 20 closing the circumferential wall 14 at a second end 22 opposite the bottom 16. The circumferential wall 14, the bottom 16 and the lid 20 enclose an inner space 23 comprising the beverage ingredient such as roast and ground coffee. The capsule body may be filled with approximately 4-11 grams, preferably 5-8 grams, more preferably 5.3-6 grams of roast and ground coffee. The average particle size may be between 100-1000µm, preferably between 200-750µm, more preferably between 250-500µm. The capsule may be suitable for preparing a single portion of the beverage, preferably a single cup of the beverage, e.g. 20 ml- 30 ml excluding 30 ml or 30-200ml of the prepared beverage. Dependent on the desired strength of the prepared beverage the amount of extractable product may vary. For preparing a cup of coffee, the capsule 2 may have an inner space 23 of approximately 11-18 ml. For instance, the inner space 24 may have a volume of approximately 12 ml. To be suitable for preparation of different kinds of coffee, the capsule 2 may comprise an amount of roast and ground coffee with a density of 0.278 gr/cm^3 – 0.5 gr/cm^3, preferably a density of 0.313gr/cm^3 – -0.455 gr/cm^3, more preferably a density of 0.357gr/cm^3 – 0.434gr/cm^3, most preferably a density of 0.379gr/cm^3 – -0.416 gr/cm^3. The pouring volume of the roast and ground coffee may be between 500-900cc/250gr, preferably between 550-800cc/250gr, more preferably between 575-700cc/250gr, most preferably between 600-660cc/250gr coffee. According to a further embodiment of the invention, the roast and ground coffee may comprise an average particle size of 100-1000µm, preferably an average particle size of 200-750µm, more preferably an average particle size of 250-500µm.With such an average particle size a coffee with a relatively large amount of dry matter and thus a good quality is obtained.

In the example of Figure 1, the circumferential first wall 14 is substantially rigid. The circumferential first wall 14 may e.g. comprise a

plastics material and may be formed by e.g. injection moulding, vacuum-forming, thermoforming or the like. In this example the bottom 16 is integral with the circumferential first wall 14. In this example the second wall 16 is substantially rigid and comprises a plurality of entrance openings 17, possibly slits, for allowing the fluid to enter the capsule 2. The bottom 16 provides an entrance filter of the capsule 2.

The lid 20 of the capsule 2 comprises a multilayer foil 24 with a plurality of exit openings 25, through which the beverage can drain from the capsule 2. The multilayer foil 24 comprises two layers 27, 28. The two layers 27, 28 are bonded together so they can act on each other and/or strengthen each other. A physical and/or a chemical bond may be provided over approximately the entire surface of the layers. In this example, the first layer 27 has a higher tear strength than the second layer 28, and the second layer 28 has a higher stiffness than the first layer 27. The stiffness and the tear strength of the layers 27, 28 is such that the layers bonded together will not tear, rupture or deform too much such that the multilayer foil 24 may have a relatively constant flow resistance for a pressure built up in the capsule 2, which may thus become more reproducible and/or more controllable. The first layer 27 preferably comprises a layer of polyethylene terephthalate (PET-P) and the second layer 28 preferably comprises a layer of co-polymer polypropylene (CPP). The first layer 27 of PET-P has a thickness of approximately 15µm and the second layer 28 of CPP has a thickness of approximately 30µm. The exit area of the multilayer foil 24 preferably comprises 50-250 openings 25, preferably 70-190, more preferably 100-160 openings, wherein an average opening diameter may be between 0.1mm and 0.5 mm. Thus, the fluid can drain from the capsule 2 over a large area. Hence, a very homogeneous drain of beverage from the extractable product is obtained. Thus, the risk of occurrence of preferential paths via which the fluid flows through the extractable product is greatly reduced.

In the example of Figure 1, the capsule 2 further comprises an outwardly extending rim 15 at the second end 22, wherein the lid 20 is attached to the outwardly extending rim 15, e.g. by gluing, welding or the like. Hence, in this example the multilayer foil 24, is attached to the outwardly extending rim 15.

Between the extractable product in the inner space 23 of the capsule 2 and the multilayer foil 24 a substantially sheet shaped filter layer 26 is provided According to a first aspect of the invention, the substantially sheet shaped filter layer 26 does not cover any of the exit openings 25 in the foil 24. This is depicted in Figure 1. The filter layer 26 may be a layer of paper filtering material or a layer of non-woven material. The filter layer 26 may catch the smallest particles of the roast and ground coffee, i.e. the fines contained in the inner space 23. The fines will spread in the filter layer 26 before said particles will reach the exit openings 25 in the foil 24. Since at least not all fines will reach the exit openings, a desired flow restriction, thus not restricting the water flow too much, is obtained. Additionally, without wishing to be bound by any theory, the applicant has found that the filter layer 26 may also establish a preferred flow and/or allow a preferred flow to flow through the filter layer 26. During brewing, the filter layer 26 has a lower flow resistance than the compacted bed of coffee inside the capsule 2 in an area adjacent to the foil 24. It is noted a preferred path through the filter layer may include a preferred path extending parallel to the circumferential wall as well as a preferred path extending radially inward from the circumferential wall parallel to the foil. A preferred flow may also positively influences the brewing time of a beverage. Also excessive compression of the coffee bed is minimized. Thus brewing time is improved. . Therefore, the filter layer 26 may be of paper filtering material having a weight of approximately 1-250 grams/m2, more preferably between 10-100 grams/m2, preferably approximately 15-50 grams/m2. Alternatively, the filter layer 26 may be of a non-woven or woven material, such as a synthetic

material like for instance high density polyethylene (HDPE). In an example of the capsule, the material of the filter layer may be calendered. The filter layer 26 may comprise a fine structured network of fibers and/or meshes. An example of such a material may be Tyvek. In a different embodiment, the filter layer may comprise a screen, for instance a plastic or metal screen. Such a material layer may comprise a similar thickness and weight as above indicated with the paper filtering material. To be able to retain the fines before reaching the exit openings 25 of the multilayer foil 24, the filter layer 26 may have an air permeability of 0-550 or 550-2000 excluding 500 mm/second measured at a pressure of approximately 200 Pascal. As is visible in Figure 1, the filter layer 26 extends substantially parallel to the multilayer foil 24 and does not cover any of the exit openings 25 provided in the multilayer foil 24.

In order not to cover any of the exit openings 25, the filter layer may for instance comprise an opening provided in the central area of the filter layer (see for instance Figure 5). This is the case in the capsule 2 according to Figure 1. A first surface P of the filter layer 26 may abut against the multilayer foil 24, at least to a surface S opposing the filter layer 26 and may be pressed between the roast and ground coffee and the multilayer foil 24 to keep the filter layer 26 in place. In this case, the filter layer 26 in not connected to other parts of the capsule 2. Alternatively, the filter layer 26 may be connected to the multilayer foil 24 along the entire surface S thereof. The filter layer 26 may for instance be sealed to the multilayer foil 24 or glued. To enhance the sealing properties between said filter layer 26 and the multilayer foil 24, the filter layer 26 may be provided with polyethylene (PE). Instead of connecting the filter layer 26 along its entire surface to the multilayer foil 24, only the circumferential edge of the filter layer 26 may be connected to the multilayer foil 24.

The combination of the multilayer foil 24 and the filter layer 26 prevents extractable product from leaving the capsule 2 for instance during

or after preparing of the beverage or during removing of the used capsule 2 from the apparatus 4, thereby preventing soiling of the apparatus 4 and at the same time preventing fines entering the container together with the prepared beverage.

The multilayer foil 24 is arranged to having sufficiently high tear strength not to be pierced by the lid piercing means 30 under the influence of the pressure inside the capsule 2. The filter layer 26 may be configured to contribute to the strength of the lid 9.

Alternatively, or additionally, the multilayer foil 24 forms a sufficiently low flow resistance for the beverage exiting the capsule 2, such that the lid 20 is not pressed against the lid piercing means 30 with sufficient force to be pierced by the lid piercing means 30 and the lid 20 stays intact. More in general it applies that the multiple layer foil 24 and the lid piercing means 30 are adapted to each other such that the capsule 2, in use, is not pierced by the lid piercing means 30 and the lid 20 stays intact. Since the multilayer foil 24 stays intact, also the filter layer 26 will stay intact. It will be appreciated that the lid 20 however may deform against the lid piercing means 30.

The system 1 shown in Figure 1 is operated as follows for preparing a cup of coffee.

The capsule 2 is placed in the receptacle 6. The lid 20 is brought into abutment with the support surface 10. The fluid, here hot water under pressure, is supplied from the fluid dispensing device 5, via the bore 13 in the bottom piercing means 12, to the extractable product in the inner space 23 through the entrance openings 17 provided in the bottom 16 of the capsule 2. In a different embodiment (not shown) the water may be supplied via a water supply that is arranged separately from the bottom piercing means 12. The hot water may be supplied to the roast and ground coffee under a pressure of approximately 4-20 bars, preferably 9-15 bars. The

water will wet the coffee grounds and extract the desired substances to form the coffee beverage. The prepared coffee will drain from the capsule 2 through the lid 20 comprising the multilayer foil 24 and the filter layer 26. The coffee beverage is further drained from the receptacle 6 via a plurality of outlets 32, and may be supplied to a container (not shown) such as a cup. During the supply of the water to the roast and ground coffee in the inner space 23 of the capsule 2, coffee particles are redistributed in the inner space 24 of the capsule 2. The relatively small particles, i.e. the fines, are displaced together with the water towards the lid 20 and some fines will be caught by the filter layer 26 and spread in said layer 26. Consequently, accumulation at the exit openings 25 by said fines is reduced. . Additionally, it is believed that a preferred flow, which has formed along the circumferential wall 14 may enter the filter layer 26 because the flow resistance through the filter layer 26 is preferably 10-30 times smaller than the flow resistance through the compacted roasted ground coffee product. The preferred flow may continue flowing in an inwardly radial direction and exit the capsule 2 through the exit openings 25 provided in foil 24. Thus brewing time is improved.

In Figure 2 another example of a system 1 comprising a capsule 2 according to a second embodiment of the invention is shown. For the sake of clarity only the differences with respect to the system 1 according to the first example will be discussed. The apparatus 4 of the system 1 according to Figure 2 does not comprise bottom piercing means 12. In use, fluid is supplied from the fluid dispensing device 5 via a supply opening 13 to the entrance openings 17 provided in the bottom 16 of the capsule 2. In the example of Figure 2 the plurality of entrance openings 17 is distributed over substantially the entire bottom 16. Thus, the fluid is supplied to the extractable product via the plurality of entrance openings 17, which causes the extractable product to be wetted over substantially the entire cross

section of the capsule 2. Hence, a very homogeneous supply of fluid to the extractable product is obtained.

The capsule 2 according to the second embodiment of the invention only differs with respect to the capsule 2 of the first embodiment in that the lid 20' has a different construction. The filter layer 26 does not cover any of the exit openings 25 in the foil 24.The filter layer 26, comprising an opening provided in the central area of the filter layer (see for instance Figure 5) has substantially the same outer diameter as the multilayer foil 24 of the lid. The filter layer 26 is connected, with the circumferential edge thereof, to the rim 15, at least to the surface of the rim 15 facing the lid 20'. To be able to seal the filter layer 26 directly to the rim 15, the filter layer 26 may comprise plastic, such as PE content. Alternatively, the filter layer 26 may be coated. The multilayer foil 24 may be sealed against the filter layer 26, either along the entire surface or only along the circumferential edge. If the filter material of the filter layer 26 is thin enough, melting the multilayer foil 24 and the rim 15 together, will suffice to enable keeping the filter layer 26 in place. In that case the filter material of the filter layer 26 does not have to comprise the additional sealing properties such as plastic or a coating.

It will be appreciated that in other not shown embodiments of the system, the apparatus may be different than the apparatus as described in the first or second example of the system according to the invention. For instance, the apparatus can be provided with a hollow space between the lid 20 of the capsule 2 and the outlet openings 28 of the apparatus 4. Also the lid piercing means 30 may be omitted. Thus it is noted that the capsule according to the invention can be used in any suitable apparatus for preparing a beverage by using high pressure.

In Figures 3 a further embodiment of the capsule 2 according to the invention is shown. The capsule 2 may be used in an apparatus 4 as shown in Figure 1 or an apparatus 4 as shown in Figure 2 or any other suitable apparatus.

The capsule 2 in Figure 3 differs from the capsules 2 in Figures 1 and 2 in that the bottom 16 and the lid 20''' are configured differently. For the sake of clarity only the differences will be discussed here in detail. The description of the features that have been described before with reference to Figures 1 and/or 2 is omitted here.

The lid 20'' of the capsule 2 as shown in Figure 3 comprises a multilayer foil 24 with the first material layer 27 and the second material layer 28. The filter layer 26 comprises a filtering paper, comprising an opening provided in the central area of the filter layer (see for instance Figure 5), that is positioned between the roast and ground coffee provided in the inner space 23 of the capsule 2 and the multilayer foil 24. The circumferential edge of the filter layer 26 is enclosed between the lid 20'' and the outwardly extending rim 15. The filter layer 26 may remain in the desired position by means of the seal that connects the lid 20'' to the rim 15 at an outer part of the rim 15. The entrance filter 19 comprises a porous sheet, for instance of filter paper, that is connected to the bottom 16 to extend along the bottom opening 17'. The entrance filter is connected to the circumferential edge of the bottom 16 of the capsule 2.

Figures 4-9 show further examples of filter layers 26 that may be provided on top of the respective flexible foil layer, such as the multilayer foil 24. Such a filter layer 26 may be comprised in a capsule 2 according to the invention. In Figure 4 a paper or non-woven filter layer is shown that comprises multiple substantially circular holes. Exit openings provided in the foil 24 correspond to the substantially circular holes such that when the filter layer 26 is placed between the foil 24 and the extractable product contained in the inner space none of the exit openings are covered by the

filter layer 26. Thus the material that extends in between the respective holes does not cover any of the exit openings 25 in the foil 24 of the capsule 2.

In Figure 5, the filter layer 26 may comprise a single opening that preferably is located above a centre area of the foil 24. In this embodiment, as the capsules 2 described in Figures 1-3, when the filter layer 26 is placed between the foil 24 and the extractable product contained in the inner space none of the exit openings are coved by the filter layer 26. In Figure 6, the filter layer 26 covers approximately half of the flexible foil 24. Exit opens may be provided on the other half of the flexible foil 24 not covered by the filter layer 26. This also holds for the example of the foil layer 26 as shown in Figure 7. The filter layer 26 may be formed out of an elongate strip of filter layer material. Figure 8 shows a filter layer 26 having openings with a substantially rectangular shape. According to the invention, the exit openings in the foil 24 correspond to the openings of the filter layer 26, such that when the filter layer 26 is placed between the foil 24 and the extractable product contained in the inner space none of the exit openings are coved by the filter layer 26. In other examples, the openings may have other shapes such as triangular openings. The filter layers 26 as shown in Figures 4-8 may for instance be of paper or non woven material. In Figure 9, the filter layer 26 is has a similar shape to that of the filter layer 26 depicted in Figure 5 and is of a gauze having a multitude of small openings.

In Figures 10A/B-15A/B, different embodiments of the capsules 2 according to the invention are shown. In each of the capsules 2, the substantially sheet shaped filter layer 26 does not cover any of the exit openings 25 in the foil 24. This means that each opening is completely uncovered by the filter layer 26.

The capsules 2 of Figures 10A/B-15A/B may be brewed using an apparatus similar to the apparatus 4 described in reference to Figure 1, resulting in a coffee beverage. Hot water is supplied to the capsule from the

fluid dispensing device 5 to the extractable product in the inner space 23 through the entrance openings 17, possibly slits, provided in the bottom 16 of the capsule 22P. The hot water was supplied at an average temperature of 92-98 degrees Celsius and preferably is supplied to the capsules under an average pressure of 14-16 bar. The prepared coffee may be drained from the capsule 2 through the lid 20. The coffee beverage may be further drained from the receptacle 6 via a plurality of outlets 32, into for example a container such as a cup. During the supply of the water to the roast and ground coffee in the inner space 23 of the capsule 2, coffee particles are redistributed in the inner space 23 of the capsule 2. The relatively small particles, i.e. the fines, are displaced together with the water towards the lid 20.

The brewing properties of the beverage brewed by the capsule may be measured. Brewing time is measured in seconds. The crema layer of the beverage is measured in millimetres, and the amount of dry matter (DMA) is measured in g/100 g and is expressed in percent.

In Figures 10A-15A, a capsule 2 is shown. In the Figures 10B-15B, the surface area of that part of the foil 24 which forms a boundary of the inner space 23 of the respective capsule is shown viewed in a direction B indicated in Figures 10A-15A, respectively. The second open end 22 of the capsule 2 has a diameter D, in these examples equal to 29mm. The surface area of the foil 24 seen in a direction B and defined by the second open end 22 of the capsule has a diameter D which corresponds to the diameter of the inner space 23 of the capsule 2 at the second open end 22 of the capsule 2 measured along the foil 24. In all the capsules 2 shown in Figures 10A/B-15A/B an exit opening has a diameter of 300 µm. Furthermore, the inner space 23 of the capsules 2 of Figures 10A/B – 15A/B have a volume of approximately 12 ml.

Figure 10A shows a capsule 2 according to the invention. In the area adjacent to the foil 24, a filter layer 26 is provided. The filter layer 26 is

positioned between the extractable product in the inner space 23 and the lid 20, which comprises a multilayer foil 24 with a plurality of exit openings 25. In this example, the multilayer foil 24 has 141 exit openings 25 distributed in a pattern within an area defined by a circle 50 having a diameter of D' equal to 22.5 mm. The circle 50 is concentric with the surface area of the foil 24 defined by the second open end 22.

The filter layer 26, in this example, is ring-shaped and comprises one opening 100. The outer diameter F is equal to 28.5 mm, and the inner diameter F' is equal to 24 mm. As the outer diameter is slightly smaller than the inner diameter D of the capsule 2 at the second open end 22, the filter 26 may be placed in the capsule 2 between the extractable product in the inner space 23 and foil 24. In this case the outer diameter of the filter F, is approximately 2% smaller than the inner diameter D of the capsule 2 at the second open end 22 measured along the foil 24. The filter layer 26 is formed from filter paper having a density of 22 g/m2, an air permeability of 517 mm/s at 200Pa and a thickness of 0.1 mm.

As the inner diameter F' of the filter is larger than 22.5mm none of the exit openings 25 are covered by the filter layer 26. The plurality of exit openings 25 directly face the extractable product contained in the inner space 23. The first surface P of the filter layer 26 abuts against the multilayer foil 24, at least to the surface S opposing the filter layer 26 and may be pressed between the roast and ground coffee and the multilayer foil 24 to keep the filter layer 26 in place. A second surface P' of the filter layer 26, which is opposite the first surface P of the filter layer 26, directly faces the extractable product contained in the inner space 23.

The surface of the foil 24 which is not covered by the filter layer 26 comprises 72% of the total surface area of the foil 24 which forms a boundary of the inner space 23 of the capsule 2. The surface area of the foil 24 which is not covered by the filter layer 26 and which is provided with the exit openings 25 is 60% of the total surface area of the foil 24 which forms a

boundary of the inner space 23 of the capsule 2. In this example, the surface area of the foil which is not covered by the filter layer and which is provided with the exit openings is f*72% wherein f is 0.83.

In this example the full outer boundary 126 of the filter layer 26, which is an outer circumferential boundary of the ring-shaped of the filter layer 26, extends to the circumferential wall 14 of the capsule 2. Therefore a first portion 101 of the surface area of the foil 24 which is covered by the filter layer 26 lays at least substantially completely adjacent the circumferential wall 14. It will be appreciated that adjacent to the circumferential wall, measured along the surface area of the foil 24 which forms a boundary of the inner space 23 of the capsule 2, is understood to be at a distance smaller than 3% of the diameter of the surface area of the foil 24 which forms a boundary of the inner space 23 of the capsule 2 at the second open end 22. As the outer diameter F of the ring-shaped filter layer 26 is equal to 28.5 mm, the outer boundary 126 of the filter layer 26 is within 3% of the diameter D. Furthermore, 100% of an outer boundary 121 of the first portion 101 of the foil 24 lays adjacent to the circumferential wall 14. The outer boundary 121 of the first portion 101 of the foil coincides with the outer boundary 126 of the filter layer 26. Therefore the filter layer 26 extends to each position of the circumferential wall 14 adjacent the foil 24.

As the inner diameter F' of the filter layer 26 is 24 mm and the diameter of the exit openings 25 is approximately 300µm, the opening 100 of the filter layer 26 has a surface area which is greater than a surface area of an exit opening 25 having the largest surface area. Additionally, the centre opening 100 of the ring-shaped filter layer 26 has a largest diameter F', in this example 24 mm, which is approximately 83% of D. D is the inner diameter of the capsule 2 at the second open end 22.

A second portion 102 of the surface area of the foil 24 wherein the plurality of exit openings 25 are distributed lays at least substantially completely at a distance from the circumferential wall. In this example, the

141 exit openings 25 are distributed within the area defined by a circle 50 having a diameter of D' equal to 22.5 mm. As the circle 50 is concentric with the surface area of the foil 24 defined by the second open end 22, the exit openings are at least D/2-D'/2, or 3.25 mm from the circumferential wall 14 measured along the surface area of the foil 24.

Additionally, a third portion 103 of the surface area of the foil 24 which is not covered by the filter layer 26 lays at least substantially completely at a distance from the circumferential wall 14. In this example 100%, of a outer circumferential boundary 123 of the third portion 103 of the surface are of the foil 24 lays at a distance from the circumferential wall 14. Here the third portion is an island. Furthermore, the filter layer 26 is substantially centred on the foil 24 such that a centre of the filter layer 26 coincides with a centre of the part of the foil 24 which forms a boundary of the inner space 23 at the second open end 22.

When the capsule 2 is brewed, coffee particles inside the capsule may move towards the foil 24 during supply of the fluid inside the capsule. The filter layer 26 between the extractable product, i.e. roast and ground coffee, and the foil, catches some of the fines in the coffee. In this way, at least not all fines will reach the exit openings 25, while a flow restriction is still formed. Additionally, it is believed that a preferred flow, which has formed along the circumferential wall 14 may enter the filter layer 26 covering the first portion 101 of the foil 24, because the flow resistance through the filter layer 26 is approximately estimated by modelling 20 times smaller than the flow resistance through the compacted roasted ground coffee product. The preferred flow may continue flowing in an inwardly radial direction towards the third portion 103 of the surface area of the foil 24 and exit the capsule 2 through the exit openings 25 provided in the second portion 102 of the surface area of the foil 24. Thus brewing time is improved.

In this example, the inner space 23 of the capsule 2 is filled with 5.8 gm of ground roasted Profondo coffee. The coffee has a pouring volume of 705-710 ml/250g, a particle density X50 of 262.21 µm, and a particle density X10 of 40.34 µm. The percentage of fines, i.e. particles smaller than 100 µm is 20.22%. With capsules filled with coffee having the above properties, the brewing time for a lungo coffee was between 66-73 seconds. The crema layer was 5.8 mm -6.5 mm. DMA was between 1.44% and 1.46%.

In Figure 11A/B a capsule 2 according to the invention similar to the capsule 2 of Figure 10A/B is shown. The capsule 2 of Figure 11A/B differs from the capsule 2 of Figure 10A/B in that the filter layer 26 of the capsule 2 of Figure 11A/B comprises 3 sub-layers 26.1-26.3. Each sub filter 26.i is sheet shaped, and also, in this example, each sub layer 26.i is ring-shaped. The ring has a 24 mm inner diameter, F', and an outer diameter F, is equal to 28.5 mm, which is approximately 2% smaller than the diameter D of the inner space 23 of the capsule measured along the inside surface of the foil 24. Furthermore, each sub layer 26.i is formed from filter paper having a density of 22 g/m2, and air permeability of 517 mm/s at 200Pa and a thickness of 0.1 mm.

Through stacking filter layer 26.i, the resulting filter layer 26 of the capsule 2 of Figure 11A/B provides 3 times more volume for a preferred path to flow through. In this example, the resulting filter layer 26 fills approximately 0.6% of the volume of the inner space 23 of the capsule 2. The capsule 2 using a filter layer 26 comprising sub layer 26.i has also shown a reliable reduction of brewing time, relatively high DMA percentages, and an acceptable crema layer.

It is also conceivable that the filter layer 26 in the capsules 2 according to the invention is formed from a non-woven material. For example a 300 µm thick non-woven mesh filter layer 26 with a ring-shape having an inner diameter F' of 24 mm fills approximately 4.6% of the volume of the inner space of the capsule 23. In this example, the volume of

the inner space 23 is 12 ml. By reserving an volume of the inner space of the capsule which is filled by the filter layer 23 provides, in use, a volume of the capsule in which a preferred flow may be established and/or through which a preferred flow may flow. Preferably, as in this example, a flow resistance of the filter layer 26 is 10-30 times smaller than a flow resistance of the extractable product in the inner space 23, when being extracted with a fluid under a pressure of 4-20 bar and preferably 9-18 bar.

Figure 12A shows a capsule 2 according to the invention. In the area adjacent to the foil 24, a filter layer 26 is provided. The filter layer 26 is positioned between the extractable product in the inner space 23 and the lid 20, which comprises a multilayer foil 24 with a plurality of exit openings 25. In this example, the multilayer foil 24 has 141 exit openings 25 distributed in a pattern within an area defined by a circle 50 having a diameter of D', 22.5 mm. The circle 50 is concentric with the surface area of the foil 24 defined by the second open end 22.

The filter layer 26, in this example, comprises one opening 100 which is shaped as the DE-brand. The outer diameter F is equal to D, which is the inner diameter of the capsule 2 at the second open end 22. The filter 26 is placed in the capsule 2 between the extractable product in the inner space 23 and the foil 24. The filter layer is formed from filter paper having a density of 22 g/m2, an air permeability of 517 mm/s at 200Pa and a thickness of 0.1 mm.

In this example, the smallest inner diameter F' of the filter is 23 mm and is therefore larger than the 22.5 mm circle in which the exit openings 25 are distributed. Therefore none of the exit openings 25 are covered by the filter layer 26. The plurality of exit openings 25 directly face the extractable product contained in the inner space 23.

The surface of the foil 24 which is not covered by the filter layer 26 comprises at least 63% of the total surface area of the foil 24 which forms a boundary of the inner space 23 of the capsule 2. The surface area of the

foil 24 which is not covered by the filter layer 26 and which is provided with the exit openings 25 is 60% of the total surface area of the foil 24 which forms a boundary of the inner space 23 of the capsule 2. In this example, the surface area of the foil which is not covered by the filter layer and which is provided with the exit openings is f*63% wherein f is 0.95.

In this example the full outer boundary 126 of the filter layer 26 extends to the circumferential wall 14 of the capsule 2. Therefore a first portion 101 of the surface area of the foil 24 which is covered by the filter layer 26 lays at least substantially completely adjacent the circumferential wall 14. Furthermore, 100% of an outer boundary 121 of the first portion 101 of the foil 24 lays adjacent to the circumferential wall 14. The outer boundary 121 of the first portion 101 of the foil coincides with the outer boundary 126 of the filter layer 26. Therefore the filter layer 26 extends to each position of the circumferential wall 14 adjacent the foil 24.

The inner diameter F' is at least 23 mm, and therefore the area of the opening 100 of the filter layer 26 has a surface area which is greater than a surface area of an exit opening 25 having the largest surface area.

A second portion 102 of the surface area of the foil 24 wherein the plurality of exit openings 25 are distributed lays at least substantially completely at a distance from the circumferential wall because the exit openings 25 are distributed within the area defined by a circle 50 concentric with the surface area of the foil 24 defined by the second open end 22 and having a diameter of D' equal to 22.5 mm.

Additionally, a third portion 103 of the surface area of the foil 24 which is not covered by the filter layer 26 lays at least substantially completely at a distance from the circumferential wall 14. In this example 100%, of a outer circumferential boundary 123 of the third portion of the surface are of the foil 24 lays at a distance from the circumferential wall 14. The outer boundary 123 of the third portion is shaped as the DE-brand.

Owing to the similarities of the filter layer 26 of the capsule 2 of Figure 12A/B to the filter layer 26 of the capsule 2 of Figure 11A/B similar brewing properties were achieved. It is noted that the filter layer 26 allows the properties of the extractable product to be varied. Hence providing the appropriate filter may allow for additional ground roasted coffee to be brewed.

A capsule 2 according to the invention is shown in Figure 13A. In the area adjacent to the foil 24 a filter layer 26 is provided. The filter layer 26 is positioned between the extractable product in the inner space 23 and the lid 20. The filter layer 26, in this example, is a strip. The width F' of the filter layer 26 is 6mm and the length F of the filter layer strip 26 is 28.5 mm. The filter layer is formed from filter paper having a density of 22 g/m2, an air permeability of 517 mm/s at 200Pa and a thickness of 0.1 mm. The strip-shaped filter layer 26 is provided with two opposite ends 130, 131 laying adjacent the circumferential wall and two opposite sides 132, 133 each laying at a distance from the circumferential wall.

In this example, the multilayer foil 24 has 100 exit openings 25 distributed in a pattern within an area defined by a circle 50 and excluding the surface area of the foil 24 covered by the strip-shaped filter layer 26. In this way none of the exit openings 25 are coved by the filter layer 26. The diameter of the circle 50 is D', which is equal 22.5 mm. The circle 50 is concentric with the surface area of the foil 24 defined by the second open end 22.

The plurality of exit openings 25 directly face the extractable product contained in the inner space 23. The first surface P of the filter layer 26 abuts against the multilayer foil 24, at least to the surface S opposing the filter layer 26 and may be pressed between the roast and ground coffee and the multilayer foil 24 to keep the filter layer 26 in place. A second surface P' of the filter layer 26, which is opposite the first surface P

of the filter layer 26, directly faces the extractable product contained in the inner space 23.

The surface of the foil 24 which is not covered by the filter layer 26 comprises approximately 74% of the total surface area of the foil 24 which forms a boundary of the inner space 23 of the capsule 2. The surface area of the foil 24 which is not covered by the filter layer 26 and which is provided with the exit openings 25 is approximately 45% of the total surface area of the foil 24 which forms a boundary of the inner space 23 of the capsule 2. In this example, the surface area of the foil which is not covered by the filter layer and which is provided with the exit openings is f*74% wherein f is approximately 0.61.

In this example, the two opposite ends 130, 131 of the strip-shaped filter lay adjacent to the circumferential wall 14 of the capsule 2. Therefore, the outer boundary 126 of the filter layer 26 extends to the circumferential wall 14 of the capsule 2. A first portion 101 of the surface area of the foil 24 which is covered by the filter layer 26 and lays at least substantially completely adjacent the circumferential wall 14. In this example, 17% of an outer boundary 126 of the filter layer lays adjacent to the circumferential wall 14.

A second portion of the surface area of the foil 24 wherein the plurality of exit openings 25 are distributed comprises two discrete portions 102A and 102B. Both second portions 102A/B lay at least substantially completely at a distance from the circumferential wall.

During brewing, coffee particles inside the capsule may move towards the foil 24 during supply of the fluid inside the capsule. The filter layer 26 between the extractable product, i.e. roast and ground coffee, and the foil 24, catches some of the fines in the coffee. As a result at least not all fines will reach the exit openings 25. Additionally, it is believed that a preferred flow, which has formed along the circumferential wall 14 may enter the filter layer 26 covering the first portion 101 of the foil 24 adjacent

to the circumferential wall 14. Since the flow resistance through the filter layer 26 is approximately estimated by modelling 20 times smaller than the flow resistance through the compacted roasted ground coffee product. The preferred flow may continue flowing in an inwardly radial direction and eventually exit the capsule 2 through the exit openings 25 provided in the second portion 102 of the surface area of the foil 24.

The inner space 23 of the capsule 2 is filled with 5.8 gm of ground roasted Profondo coffee. The coffee has a pouring volume of 705-710 ml/250g, a particle density X50 of 262.21 µm, and a particle density X10 of 40.34 µm. The percentage of fines, i.e. particles smaller than 100 µm is 20.22%. With capsules filled with coffee having the above properties, the brewing time for a lungo coffee was more than 73 and less than 90 seconds. The crema layer was more 5.8 mm, and the DMA was more than 1.44%.

Another capsule 2 according to the invention is shown in Figure 14A. In the area adjacent to the foil 24, a filter layer 26 is provided. The filter layer 26 is positioned between the extractable product in the inner space 23 and the lid 20, which comprises a multilayer foil 24 with a plurality of exit openings 25. The filter layer 26, in this example, comprises a ring and a strip. The width F" of the strip portion of the filter layer 26 is 6mm and the ring has an inner diameter F' equal to 24 mm.

The filter layer is formed from filter paper having a density of 22 g/m2, an air permeability of 517 mm/s at 200Pa and a thickness of 0.1 mm.

In this example, the multilayer foil 24 has 100 exit openings 25 distributed in a pattern within an area defined by a circle 50 and excluding the surface area of the foil 24 covered by the strip-shaped portion of the filter layer 26. In this way none of the exit openings 25 are coved by the filter layer 26. The diameter of the circle 50 is D' is equal 22.5 mm and the circle 50 is concentric with the surface area of the foil 24 defined by the second open end 22.

The plurality of exit openings 25 directly face the extractable product contained in the inner space 23. The first surface P of the filter layer 26 abuts against the multilayer foil 24, at least to the surface S opposing the filter layer 26 and may be pressed between the roast and ground coffee and the multilayer foil 24 to keep the filter layer 26 in place. A second surface P' of the filter layer 26, which is opposite the first surface P of the filter layer 26, directly faces the extractable product contained in the inner space 23.

The surface of the foil 24 which is not covered by the filter layer 26 comprises approximately 52% of the total surface area of the foil 24 which forms a boundary of the inner space 23 of the capsule 2. The surface area of the foil 24 which is not covered by the filter layer 26 and which is provided with the exit openings 25 is 45% of the total surface area of the foil 24 which forms a boundary of the inner space 23 of the capsule 2. In this example, the surface area of the foil which is not covered by the filter layer and which is provided with the exit openings is f*52% wherein f is approximately 0.87.

In this example the full outer boundary 126 of the filter layer 26 extends to the circumferential wall 14 of the capsule 2. Additionally, the outer boundary 126 is an outer circumferential boundary. A first portion 101 of the surface area of the foil 24 which is covered by the filter layer 26 lays at least substantially completely adjacent the circumferential wall 14. Furthermore, 100% of an outer boundary 121 of the first portion 101 of the foil 24 lays adjacent to the circumferential wall 14. The outer boundary 121 of the first portion 101 of the foil coincides with the outer boundary 126 of the filter layer 26. Therefore the filter layer 26 extends to each position of the circumferential wall 14 adjacent the foil 24.

In this example, the filter layer 26 comprises a plurality of openings 100A and 100B. Therefore a second portion of the surface area of the foil 24 wherein the plurality of exit openings 25 are distributed

comprises two discrete second portions 102A and 102B. Both second portions 102A/B lay at least substantially completely at a distance from the circumferential wall. Each opening 100A/B has a surface area which is greater than surface area of exit opening having the largest surface area.

Additionally, a third portion of the surface area of the foil 24 which is not covered by the filter layer 26 comprises two discrete third portions 103A and 103B. The third portions 103A/B lay at least substantially completely at a distance from the circumferential wall 14. In this example 100%, of both outer circumferential boundary 123A/B of the third portion 103A/B of the surface are of the foil 24 lay at a distance from the circumferential wall 14. Here the third portion is formed by two islands. Furthermore, the filter is substantially centred on the foil 24 such that a centre of the filter layer 26 coincides with a centre of the part of the foil 24 which forms a boundary of the inner space 23 at the second open end 22.

When brewing, coffee particles inside the capsule may move towards the foil 24 during supply of the fluid inside the capsule. The filter layer 26 between the extractable product, i.e. roast and ground coffee, and the foil 24, catches some of the fines in the coffee. As a result at least not all fines will reach the exit openings 25. In this example 100% the outer boundary 121 of the first portion 101 is adjacent to the circumferential wall 14 at the boundary formed by the foil 24 and the inner space 23. Therefore, it is believed that a preferred flow, which has formed along the circumferential wall 14 may enter the filter layer 26 covering the first portion 101 of the foil 24 adjacent to the circumferential wall 14. Since the flow resistance through the filter layer 26 is preferably estimated by modelling 20 times smaller than the flow resistance through the compacted roasted ground coffee product. The preferred flow may continue flowing in an inwardly radial direction and exit the capsule 2 through the exit openings 25 provided in the second portion 102 of the surface area of the foil 24.

Another capsule 2 according to the invention is shown in Figure 15A. In the area adjacent to the foil 24, a filter layer 26 is provided. The filter layer 26 has the shape of a disc. The disc-shaped filter layer 26 has a diameter F equal to, in this example, 18 mm. The filter layer is formed from filter paper having a density of 22 g/m2, an air permeability of 517 mm/s at 200Pa and a thickness of 0.1 mm.

In this example, the multilayer foil 24 has 90 exit openings 25 distributed in on the foil 24 outside an circle having a diameter D', which is in this embodiment equal to F, which is equal to 18mm.

The plurality of exit openings 25 directly face the extractable product contained in the inner space 23. The first surface P of the filter layer 26 abuts against the multilayer foil 24, at least to the surface S opposing the filter layer 26 and may be pressed between the roast and ground coffee and the multilayer foil 24 to keep the filter layer 26 in place. A second surface P' of the filter layer 26, which is opposite the first surface P of the filter layer 26, directly faces the extractable product contained in the inner space 23.

The surface of the foil 24 which is not covered by the filter layer 26 comprises approximately 61% of the total surface area of the foil 24 which forms a boundary of the inner space 23 of the capsule 2. The surface area of the foil 24 which is not covered by the filter layer 26 and which is provided with the exit openings 25 is also 61% of the total surface area of the foil 24 which forms a boundary of the inner space 23 of the capsule 2. In this example, the surface area of the foil which is not covered by the filter layer and which is provided with the exit openings is f*61% wherein f is 1.

In this example, the filter layer 26 does not extend to the circumferential wall 14. The disc-shaped filter layer 26 forms an island.

During brewing, the filter layer 26 catches fines of the coffee. The fines will spread in the filter layer 26 before reaching the exit openings 25 in the foil 24. In this way, at least not all fines will reach the exit openings 25,

while a flow restriction is still formed. Additionally, the presence of a filter layer 26 may allow a preferred flow to form through the filter layer 26, because the flow resistance through the filter layer is smaller than the flow resistance through the compacted extractable product.

The inner space 23 of the capsule 2 was filled with 5.8 gm of ground roasted Ristreto coffee. The coffee has a pouring volume of 684 ml/250g and a particle density X50 of 400 µm. The percentage of fines, i.e. particles smaller than 100 µm is 13,8%.

When the capsules were filled with coffee having the above properties, the brewing time for a coffee was between 15-36 seconds. The crema layer was between 2 mm and 5,35 mm. DMA was between 3.14% and 3.49%.

When the filter layer 26 forms a ring, it is also conceivable that the filter layer does not extend to the circumferential wall. Preferably the area of the foil adjacent the circumferential wall and which is not covered by the ring is x% of the total area of the foil which forms a boundary of the inner space wherein x lays in the range of X1-X2, preferably in the range of X3-X4. Additionally, a centre opening of the ring may have a largest diameter lays within the range of 15%-60% of the largest diameter of the inner space at the foil.

The flow resistance of the discussed filter layers 26 may be F times smaller than a flow resistance of the extractable product wherein F lays in the range ofF1-F2, preferably in the range of F2-F3 more preferably in the range of F4-F5.

The flow resistance of the filter layers 26 may be G times smaller than a flow resistance of the extractable product when being extracted with a fluid under a pressure of 9-18 bar wherein G lays in the range of 10-30, preferably in the range of 15-25 more preferably in the range of 18-22.

The flow resistance of the discussed filter layers 26 may for example be characterized by T wherein, while using a filter paper test

device of the Herzberg design from Schroder Pruftechnik, T is the time in seconds for 100 ml of water to flow through an area of 10 cm2 of a sample of the filter layer in a direction perpendicular to a plane wherein the sample lays, with a starting water column of 33 cm, wherein the water temperature is at 20 degree C, wherein T lays in the range of 4-150, preferably 4-30, more preferably 5-20, for example in the range of 4-15 for filtering paper, for example in the range of 60-150 for white non woven and for example in the range of 45-80 for blue non woven. It will be clear that a filter layer as shown in the capsules according to the invention may be embodied a plurality of discrete filter layers. The discrete filter layers may be secured to the foil and/or held in place by the foil and the extractable product in the inner space of the capsule. The layout of the discrete filter layers may be considered a filter layer.

Furthermore, it will be appreciated that the figures are schematic. The depiction of the exit opening is purely schematic. Different sizes of exit openings, different distribution patterns, for example a hexagonal patter, and densities are all considered to fall under the scope of this invention.

It is also noted that brewing properties, such as brew time, crema layer, and DMA also depend on the extractable product contained in the inner space 23 of the capsule 2 and the obtained volume of the beverage.

In the foregoing specification, the invention has been described with reference to specific examples of embodiments of the invention. It will, however, be evident that various modifications and changes may be made therein without departing from the broader spirit and scope of the invention as set forth in the appended claims.

It is for instance possible that the capsule is contained in an air tight wrapping prior to use to improve shelf-life.

It is for instance possible that the capsule 2 has different dimensions or different shapes. In the examples the circumferential first

wall 14 is substantially cylindrical. It will be appreciated that the capsule according to the invention is not limited to this shape. The circumferential first wall 14 may e.g. be frustoconical, hemispherical, or polygonal, such as hexagonal, octagonal, etc.

However, other modifications, variations and alternatives are also possible. The specifications, drawings and examples are, accordingly, to be regarded in an illustrative rather than in a restrictive sense.

In the claims, any reference signs placed between parentheses shall not be construed as limiting the claim. The word 'comprising' does not exclude the presence of other features or steps then those listed in a claim. Furthermore, the words 'a' and 'an' shall not be construed as limited to 'only one', but instead are used to mean 'at least one', and do not exclude a plurality. The mere fact that certain measures are recited in mutually different claims does not indicate that a combination of these measures cannot be used to advantage.

For the purpose of clarity and a concise description features are described herein as part of the same or separate embodiments, however, it will be appreciated that the scope of the invention may include embodiments having combinations of all or some of the features described.

Claims

1. Capsule (2) for preparing a predetermined quantity of beverage suitable for consumption using an extractable product, for instance roast and ground coffee, comprising:

a substantially rigid circumferential wall (14),

a bottom (16) closing the circumferential wall at a first end (18), and

a lid (20, 20', 20",20"") closing the circumferential wall at a second, open, end (22) opposite the bottom, wherein the circumferential wall, the bottom and the lid enclose an inner space (23) comprising the extractable product, wherein the lid (20, 20', 20",20"") comprises a flexible foil (24), said foil having a plurality of exit openings (25) defining an exit area for draining of the prepared beverage, wherein inside the capsule (2) between the extractable product and the lid (20, 20', 20",20"") a substantially sheet shaped filter layer (26) is provided that does not cover any of the exit openings in the foil.

2. Capsule according to claim 1, wherein the substantially sheet shaped filter layer (26) comprises a layer of paper filtering material, a layer of non-woven material, or a layer of woven material.

3. Capsule according to claim 1 or 2, wherein the filter layer (26) extends substantially parallel along the lid (20, 20', 20",20"") preferably at least across the maximal transversal cross section of the second open end (22) of the capsule (2).

4. Capsule according to any one of the preceding claims, wherein the filter layer covers all openings (25) provided in the foil (24).

5. Capsule according to any one of claims 1-3, wherein in a centre area of said filter layer an opening is provided.

6. Capsule according to any one of the preceding claims, wherein the filter layer (26) abuts against the lid (20, 20', 20", 20"').

7. Capsule according to any one of the preceding claims, wherein only a circumferential edge of the filter layer (26) is connected to the lid (20, 20', 20",20"'), preferably adjacent a circumferential edge of said lid (20, 20', 20",20"').

8. Capsule according to any one of claims 1-6, wherein the filter layer (26) is connected to the lid (20, 20', 20",20"') along an entire surface of the filter layer (26).

9. Capsule according to any one of the preceding claims, wherein the capsule (2) comprises an outwardly extending rim (15) at the second end (22), wherein the lid (20, 20', 20", 20"') is attached to the outwardly extending rim (15).

10. Capsule according to claim 9, wherein a circumferential edge of the filter layer (26) is enclosed between the lid (20, 20', 20", 20"') and the outwardly extending rim (15).

11. Capsule according to any one of claims 2-10, wherein the layer of paper filtering material is of paper having a weight of approximately 1-250 grams/m2, more preferably between 10-100 grams/m2, preferably approximately 15-50 grams/m2.

12. Capsule according to any one of claims 2-10, wherein the layer (26) of non-woven material comprises a synthetic material comprising a structured network of fibers and/or meshes, for instance high density polyethylene (HDPE) fibres.

13. Capsule according to any one of the preceding claims, wherein the filter layer (26) has an air permeability of maximal 550 mm/second or maximal within the range of 550-2000 mm/second excluding 550 mm/second, measured at a pressure of approximately 200 Pascal.

14. Capsule according to any one of claims 11-13, wherein the filter layer (26) is provided with a plastic such as polyethylene (PE) or is coated to enhance the sealing properties for sealing the filter layer (26) to the foil (24).

15. Capsule according to any one of the preceding claims, wherein the capsule body is filled with approximately 4-11 grams, preferably 5-8 grams, more preferably 5.3-6 grams of roast and ground coffee, with an average particle size of approximately of 100-1000μm, preferably an average particle size of 200-750μm, more preferably an average particle size of 250-500μm.

16. Capsule according to any one of the preceding claims, wherein the foil of the lid is configured to stay intact when being used in an apparatus that comprises lid piercing means intended for piercing a lid of a closed capsule.

17. Capsule according to any one of the preceding claims, wherein the foil (24) is a multilayer foil that comprises a first material layer (27) and a second material layer (28), wherein the tear strength of the second layer is higher than the tear strength of the first layer and wherein the first layer has a higher stiffness than the second layer.

18. Capsule according to claim 17, wherein the first material layer (27) is a layer of polyethylene terephthalate (PET-P) and the second material layer (28) is a layer of co-polymer polypropylene (CPP).

19. Capsule according to claim 18, wherein the layer (27) of PET-P has a thickness of approximately 15µm and the layer (28) of CPP has a thickness of approximately 30µm.

20. Capsule according to any one of the preceding claims, wherein the exit area of the foil (24) comprises 50-250 openings (25), preferably 70-190, more preferably 100-160 openings, wherein an average opening diameter is between 0.1mm and 0.5 mm.

21. Capsule according to any one of the preceding claims, wherein an open surface of the foil (24) formed by a total surface of the exit openings (25) is between 0.4-49.1mm^2.

22. Capsule according to any one of the preceding claims, wherein the bottom (16) comprises an entrance filter (19, 19', 19"), for instance a substantially rigid bottom (16) comprising a plurality of entrance openings (17) or for instance a porous sheet, such as a sheet of paper or the like non-woven material, or a perforate sheet, such as a polymeric film provided with a plurality of entrance openings, for supplying the fluid to the extractable product there through.

23. Capsule according to any one of the preceding claims, wherein the inner space of the capsule has a volume of the capsule is 10-20 ml, preferably 11-18 ml, more preferably 10-13 ml excluding approximately 12 ml or more preferably approximately 12 ml.

24. Capsule according to any one of the preceding claims, the exit openings directly face the extractable product.

25. Capsule according to any one of the preceding claims, wherein the surface of the foil which is not covered by the filter layer comprises p% of the total surface area of the foil which forms a boundary of the inner space of the capsule wherein p lays in the range of 29-99.5, preferably in the range of 44-99.5, more preferably in the range of 54-99.5.

26. Capsule according to claim 25, wherein the surface area of the foil which is not covered by the filter layer and which is provided with the exit openings is f*p% wherein f lays in the range of 0.5-1.

27. Capsule according to any preceding claim wherein the filter layer extends to the circumferential wall, more particularly wherein the full outer boundary of the filter layer extends to the circumferential wall.

28. Capsule according to any one of the preceding claims wherein a first portion of the surface area of the foil which is covered by the filter layer lays at least substantially completely adjacent the circumferential wall.

29. Capsule according to claim 28 wherein c% an outer boundary of the first portion of the foil lays adjacent to the circumferential wall, wherein c is greater than 50, preferably greater than 85, more preferably greater than 95 and wherein c is most preferably 100.

30. Capsule according to any preceding claim 1-27, 29 wherein the filter layer extends to each position of the circumferential wall adjacent the

foil.

31. Capsule according to any preceding claim 1-26 wherein the filter layer does not extend to the circumferential wall.

32. Capsule according to any preceding claim whereon the filter layer comprises one opening.

33. Capsule according to claim 32 wherein the opening has a surface area which is greater than a surface area of exit opening having the largest surface area.

34. Capsule according to any preceding claim 1- 31 wherein the filter layer comprises a plurality of openings.

35. Capsule according to claim 34 wherein each opening has a surface area which is greater than surface area of exit opening having the largest surface area.

36. Capsule according to any one of the preceding claims , wherein a second portion of the surface area of the foil wherein the plurality of exit openings are distributed lays at least substantially completely at a distance from the circumferential wall.

37. Capsule according to any one of the preceding claims, wherein a third portion of the surface area of the foil which is not covered by the filter layer lays at least substantially completely at a distance from the circumferential wall.

38. Capsule according to claim 37 wherein a'% of an outer circumferential boundary of the third portion of the surface area of the foil lays at a distance from the circumferential wall, wherein a is greater than 50, preferably greater than 85, more preferably greater than 95 and wherein a is most preferably 100 and wherein a distance is defined as 5-30% from a diameter of the inner space adjacent the foil.

39. Capsule according to any preceding claim, wherein the filter layer has the shape of a ring.

40. Capsule according to claim 27 and 39 or claim 30 and 39 wherein a centre opening of the ring has a largest diameter lays within the range of 25%-75% of the largest diameter of the inner space at the foil.

41. Capsule according to claims 31 and 39 wherein the area of the foil adjacent the circumferential wall and which is not covered by the ring is x% of the total area of the foil which forms a boundary of the inner space wherein x lays in the range of 10-50, preferably in the range of 15-40.

42. Capsule according to claim 41 wherein a centre opening of the ring has a largest diameter lays within the range of 15%-60% of the largest diameter of the inner space at the foil.

43. Capsule according to claim 39 wherein an outer circumferential boundary of the filter layer lays adjacent the circumferential wall and wherein preferably the centre area has a cross section of S mm wherein S lays in the range of 12-26, preferably in the range of 14-25 and more preferably within the range of 16-24 and wherein preferably the outer diameter of the portion of the filter layer which forms a boundary of the

inner space has a cross section of about 28-30mm and/or wherein preferably the diameter of the inner space near the foil is about 28-30mm .

44. Capsule according to any preceding claim 1-38, wherein the filter layer has the shape of a strip.

45. Capsule according to claim 44 wherein the filter layer having the shape of a strip is provided with two opposite ends laying adjacent the circumferential wall and two opposite sides each laying at a distance from the circumferential wall.

46. Capsule according to any preceding claim 1-38, wherein the filter layer has the shape of a disc.

47. Capsule according to any preceding claim 1-38, wherein the filter layer has the shape of the DE-brand as shown in figure 12A/B.

48. Capsule according to any preceding claim, characterised that a centre of the filter at least substantially coincides with a centre of that part of the foil which forms a boundary of the inner space.

49. Capsule according to any of the preceding claims wherein filter layer fills c% of the volume of the inner space of the capsule wherein c lays within the range of 0.1-8, preferably within the range of 0.1-6.5, more preferably within the range of 0.1-3.

50. Capsule according to any of the preceding claims wherein a flow resistance of the filter layer is larger than a flow resistance of the extractable product

51. Capsule according to any of the preceding claims wherein a flow resistance of the filter layer is smaller than a flow resistance of the extractable product when being extracted with a fluid under a pressure of 9-18 bar.

52. Capsule according to any of the preceding claims wherein a flow resistance of the filter layer is characterized by T wherein, while using a filter paper test device of the Herzberg design, T is the time in seconds for 100 ml of water to flow through an area of 10 cm2 of a sample of the filter layer in a direction perpendicular to a plane wherein the sample lays, with a starting water column of 33 cm, wherein the water temperature is at 20 degree C, wherein T lays in the range of 4-150, preferably 4-30, more preferably 5-20, for example in the range of 4-15 for filtering paper, for example in the range of 60-150 for white non woven and for example in the range of 45-80 for blue non woven.

53. Capsule according to any of the preceding claims wherein the density of the extractable product is D gr/cm3, wherein D lays in the range of 0.278-0.5, preferably within the range of 0.313-0.455, more preferably in the range of 0.379-0416.

54. Capsule according to any of the preceding claims wherein the extractable product is ground coffee and wherein an average particle size of the extractable product is E micro meter wherein E lays in the range of 100-1000, preferably within the range of 200-750, more preferably in the range of 250-500.

55. Capsule according to any of the preceding claims wherein the particles of the extractable product comprises L% fines in volume wherein L

lays in the range of 7-60, preferably within the range of 8-30, more preferably in the range of 10-20.

56. Capsule according to any one of the preceding claims, wherein the exit area of the foil (24) comprises 50-250 openings (25), preferably 70-190, more preferably 100-160 openings.

57. Capsule according to any one of the preceding claims wherein an average open area of the exit opening is z mm2 per exit opening, wherein z lays in the range of 0.008-0.2, preferably in the range of 0.03-0.13, more preferably in the range of 0.05-0.1.

58. Capsule according to any one of the preceding claims wherein an average diameter of the exit opening is d µm per exit opening, wherein d lays in the range of 100-500, preferably in the range of 200-400, more preferably in the range of 250-350.

59. Capsule according to any preceding claim wherein the filter layer has a thickness of T mm wherein T is in the range of 0.05-0.01, excluding 0.01, or 0.01-1 or 1-10 excluding 1, preferably 0.05 - 0.5 , more preferably 0.05-0.2.

60. Capsule according to any preceding claim wherein the filter layer comprises a stack of sub filter layer wherein each sub filter layer is sheet shaped.

61. Capsule according to claim 60 wherein the stack comprises 2-6 sub filter layers

62. Capsule according to any preceding claim wherein the extractable comprises or consists of H grams of ground coffee wherein H is in the range of 4-11, preferably in the range of 5-8 more preferably in the range of 5.3-6.

63. Capsule according to any preceding claims wherein the bottom comprise a plurality of slits forming entrance openings of the capsule.

64. System for preparing a predetermined quantity of beverage suitable for consumption using an extractable product, comprising:

an exchangeable capsule (2) according to any one of the preceding claims, and

an apparatus (4) comprising a receptacle (6 for holding the exchangeable capsule, and a fluid dispensing device (5) for supplying an amount of a fluid, such as water, under pressure to the exchangeable capsule,

wherein the fluid dispensing device (5) is arranged for supplying the fluid to the extractable product through the bottom (16) for forming the beverage,

wherein the receptacle (6) comprises a support surface (10), and wherein the capsule (2) arranged to at least partly abut against the support surface (10) for draining the prepared beverage from the capsule (2) through the lid (20, 20', 20",20"') and through the support surface (10),

wherein the lid (20, 20', 20", 20"') comprises a flexible foil (24) having a plurality of exit openings (25) defining an exit area for draining of the prepared beverage, wherein inside the capsule (2) between the extractable product and the lid (20, 20', 20", 20"') a substantially sheet shaped filter layer (26) is provided that does not cover any of the exit openings in the foil,

wherein the system comprises an outlet (32) which, in use, is in fluid communication with the lid (20, 20', 20", 20"') for draining the prepared

beverage from the capsule (2) and supplying the beverage to a container such as a cup.

65. System according to claim 64 wherein the fluid is supplied under a pressure of 4-20 bar, preferably under 9-18 bar.

66. System according to claim 64 or 65, wherein the extractable product comprise or consists of ground coffee wherein the pouring volume of roast and ground coffee is U cc/250 gr wherein U lays within the range of 500-900, preferably in the range of 575-700, more preferably in the range of 600-660.

67. System according to claim 64,65 or 66, wherein the V ml of fluid is supplied to the capsule wherein V lays within the range of 20-200, preferably within the range of 25-140, more preferably within the range of 25-110.

68. System according to any one of claims 64-67 wherein the beverage prepared in a cup, having a cylindrical inner space with a diameter of 6 cm comprises a crema layer with a height R mm wherein R lays within the range of 2-16, preferably within the range of 4-12, and more preferably within the range of 5-8.5.

69. System according to any one of claims 64-68 wherein the beverage prepared, for example an espresso, comprises a DMA of K gr/100 gr expressed in percent (%) wherein K is in the range of 2-7, preferably in the range of 2.5-5 more preferably in the range of 2.8-4.5 or

wherein the beverage prepared, for example a lungo, comprises a DMA of K gr/100 gr expressed in percent (%) wherein K is in the range of 0.5-3, preferably in the range of 0.8-2 more preferably in the range of 1-1.6.

70. System according to any one of claims 64-69 wherein the beverage, for example a lungo, is prepared in J sec wherein J is in the range of 30-70, preferably in the range of 38-55 more preferably in the range of 42-48 and wherein the amount of beverage prepared is L ml wherein L is in the range of 100-120, preferably in the range of 105-115 more preferably in the range of 108-112.

71. System according to any one of claims 64-69 wherein the beverage, for example an espresso, is prepared in J sec wherein J is in the range of 10-45, preferably in the range of 15-35 more preferably in the range of 18-32 and wherein the amount of beverage prepared is L ml wherein L is in the range of 35-45, preferably in the range of 38-42 more preferably in the range of 39-40.

72. System according to any of the preceding claims 64-71 wherein a flow resistance of the filer layer is smaller than a flow resistance of the extractable product when being extracted with a fluid under a pressure of 5-19 bar. .

73. Method for preparing a predetermined quantity of beverage suitable for consumption using an extractable product, using a system (1) according to claim 64-72 and/or an exchangeable capsule (2) according to any one of claims 1-63.

74. Method according to claim 73 wherein the fluid is supplied under a pressure of 4-20 bar, preferably under 9-18 bar.

75. Method according to claim 73 or 74, wherein the extractable product comprise or consists of ground coffee wherein the pouring volume of

roast and ground coffee is U cc/250 gr wherein U lays within the range of 500-900, preferably in the range of 575-700, more preferably in the range of 600-660.

76. Method according to claim 73, 74 or 75, wherein the V ml of fluid is supplied to the capsule wherein V lays within the range of 20-200, preferably within the range of 25-140, more preferably within the range of 25-110.

77. Method according to any one of claims 73-76, wherein the beverage prepared in a cup having a cylindrical inner space with a diameter of 6 cm comprises a crema layer with a height R mm wherein R lays within the range of 2-16, preferably within the range of 4-12, more preferably within the range of 5-8.5.

78. Method according to any one of claims 73-77, wherein the beverage prepared, for example an espresso, comprises a DMA of K gr/100 gr expressed in percent (%) wherein K is in the range of 2-7, preferably in the range of 2.5-5 more preferably in the range of 2.8-4.5 or

wherein the beverage prepared, for example a lungo, comprises a DMA of K gr/100 gr expressed in percent (%) wherein K is in the range of 0.5-3, preferably in the range of 0.8-2 more preferably in the range of 1-1.6.

79. Method according to any one of claims 73-78 wherein the beverage, for example a lungo, is prepared in J sec wherein J is in the range of 30-70, preferably in the range of 38-55 more preferably in the range of 42-48 and wherein the amount of beverage prepared is L ml wherein L is in the range of 100-120, preferably in the range of 105-115 more preferably in the range of 108-112.

80. Method according to any one of claims 73-78 wherein the beverage, for example espresso, is prepared in J sec wherein J is in the range of 10-45, preferably in the range of 15-35 more preferably in the range of 18-32 and wherein the amount of beverage prepared is L ml wherein L is in the range of 35-45, preferably in the range of 38-42 more preferably in the range of 39-40.

81. Method according to any of the preceding claims 73-80, wherein a flow resistance of the filer layer is G smaller than a flow resistance of the extractable product when being extracted with a fluid under a pressure of 9-18 bar .

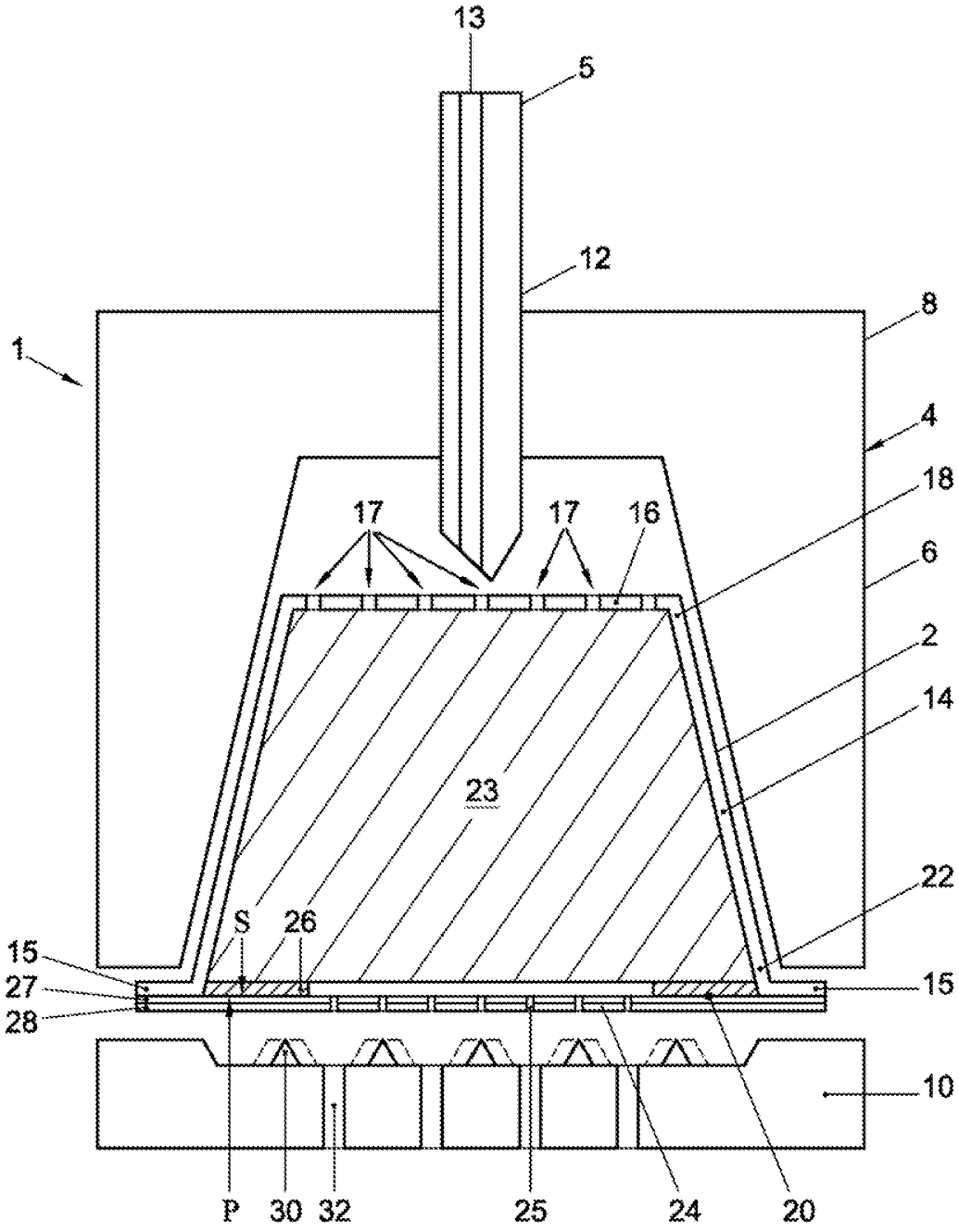

FIG. 1

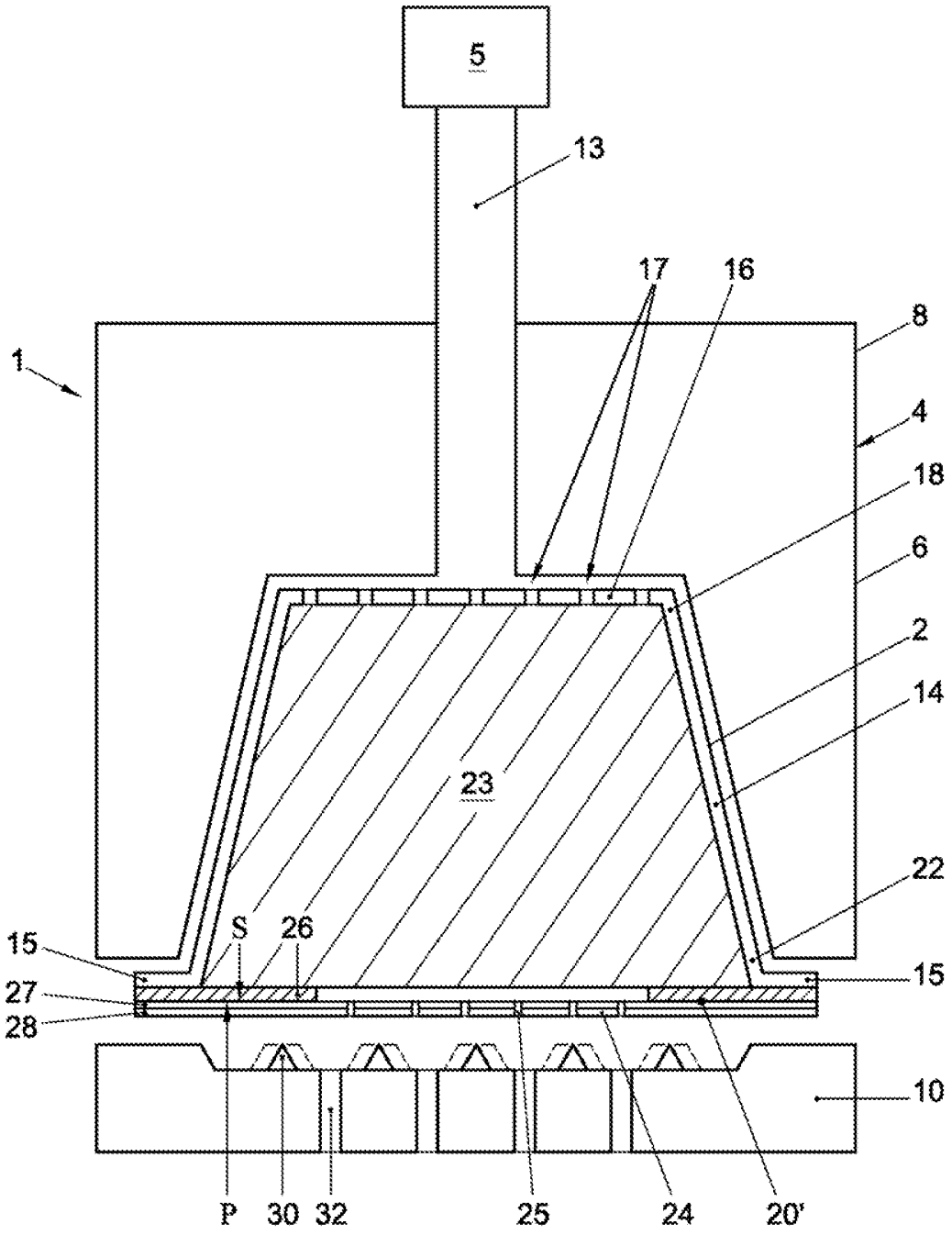

FIG. 2

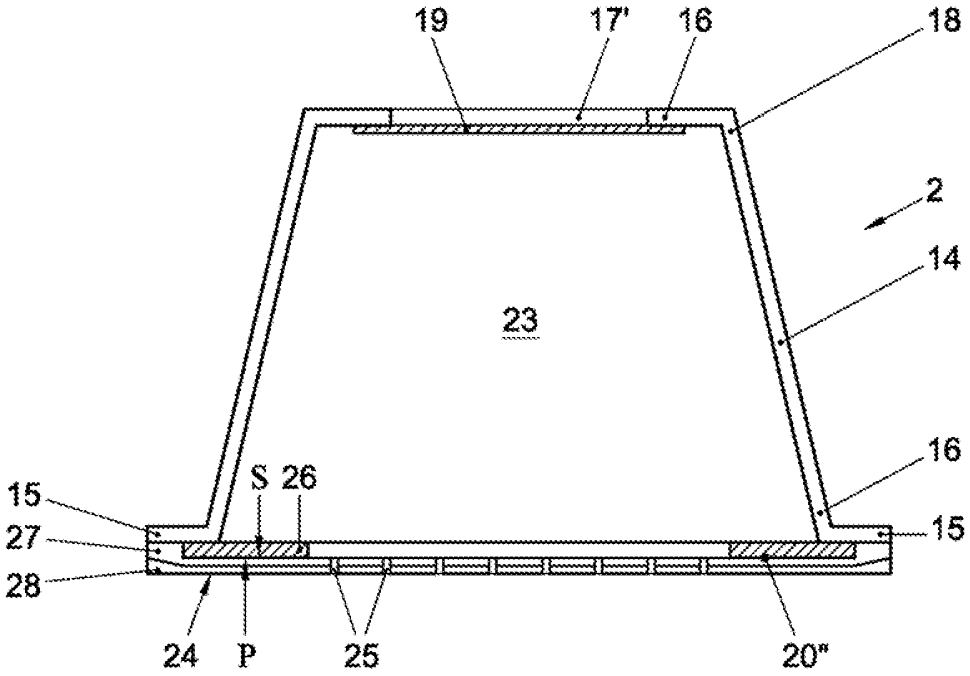

FIG. 3

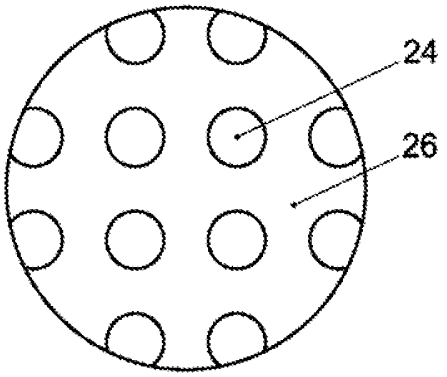

FIG. 4

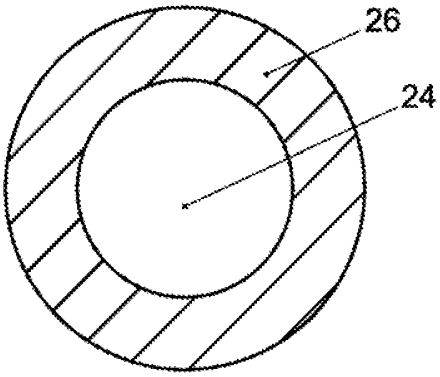

FIG. 5

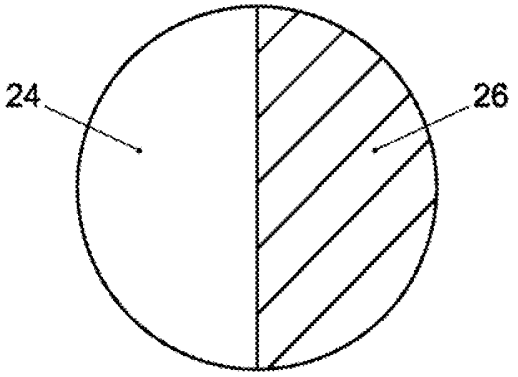

FIG. 6

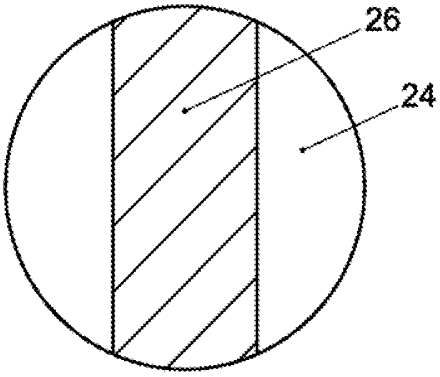

FIG. 7

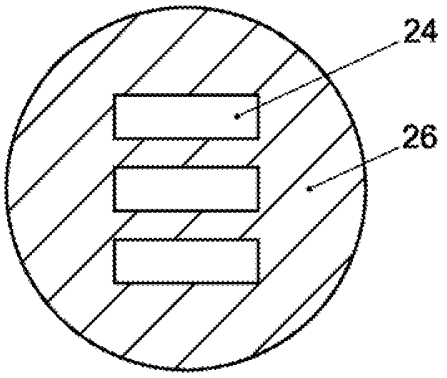

FIG. 8

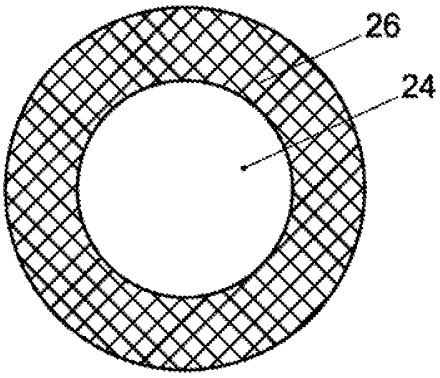

FIG. 9

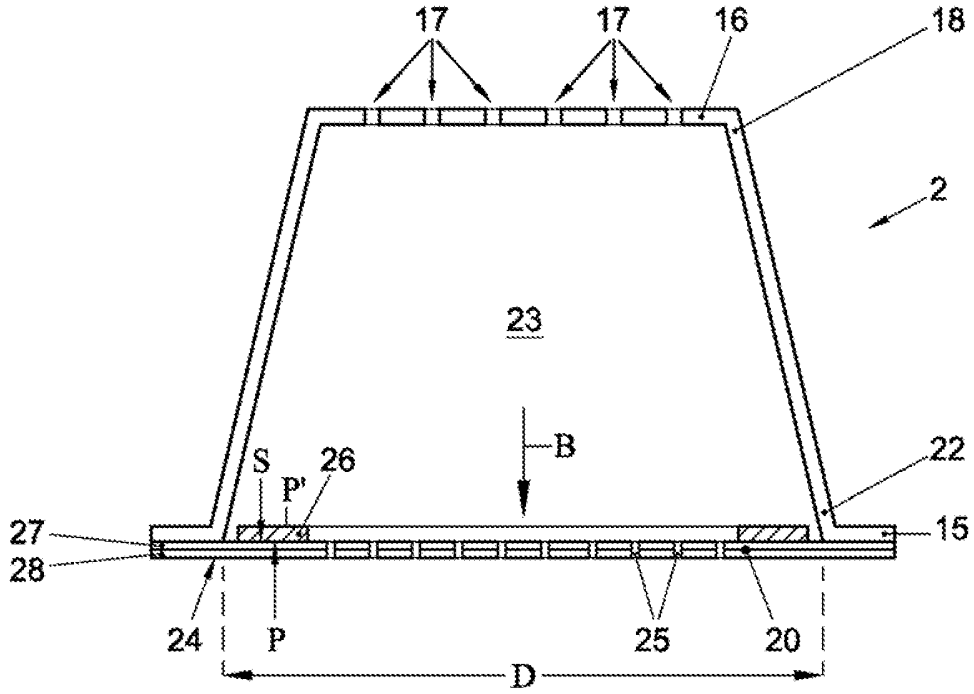

FIG. 10A

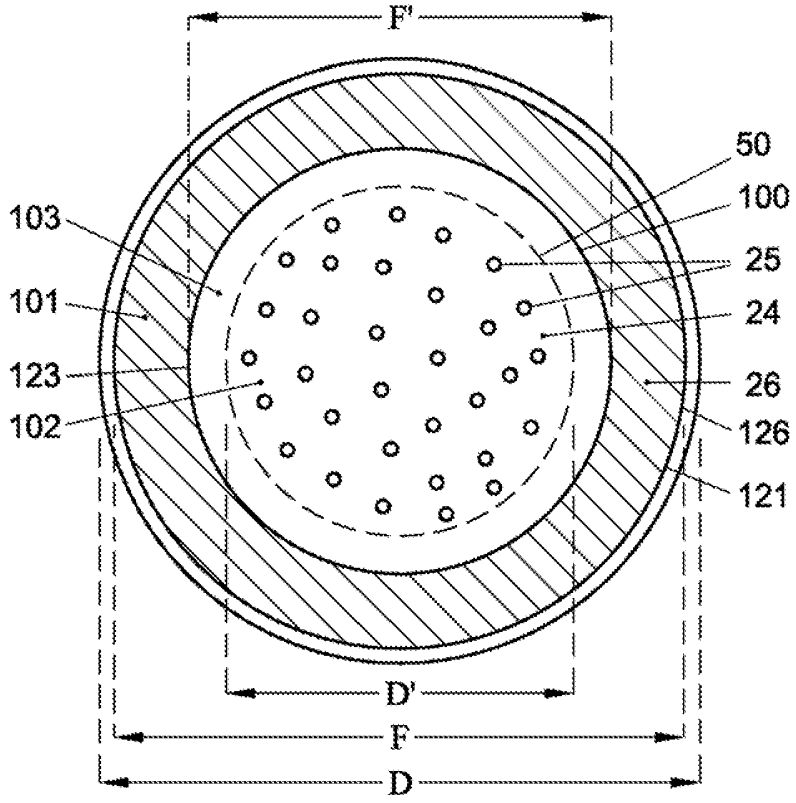

FIG. 10B

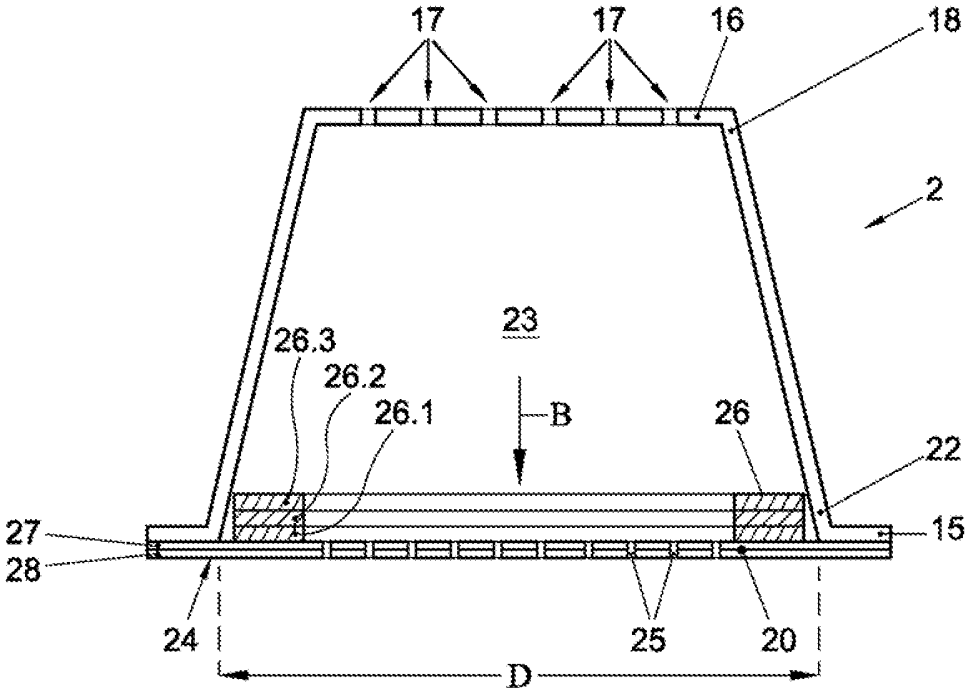

FIG. 11A

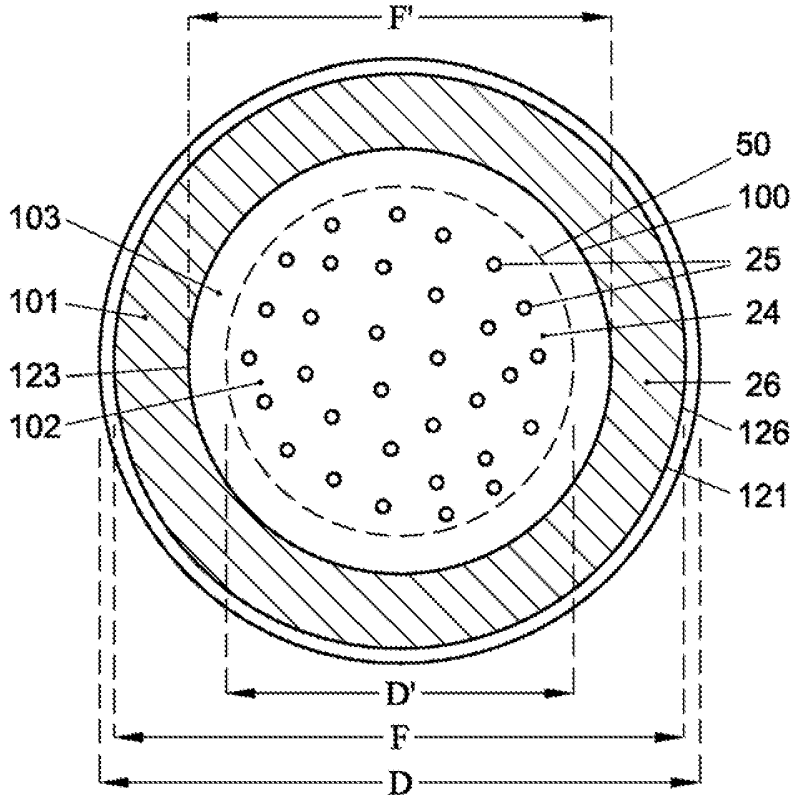

FIG. 11B

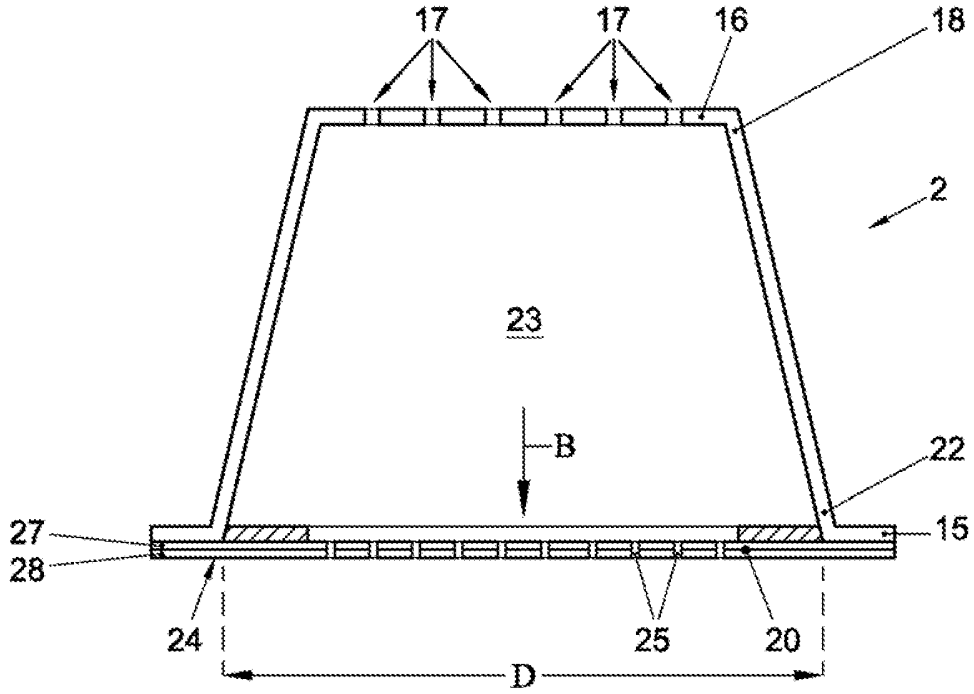

FIG. 12A

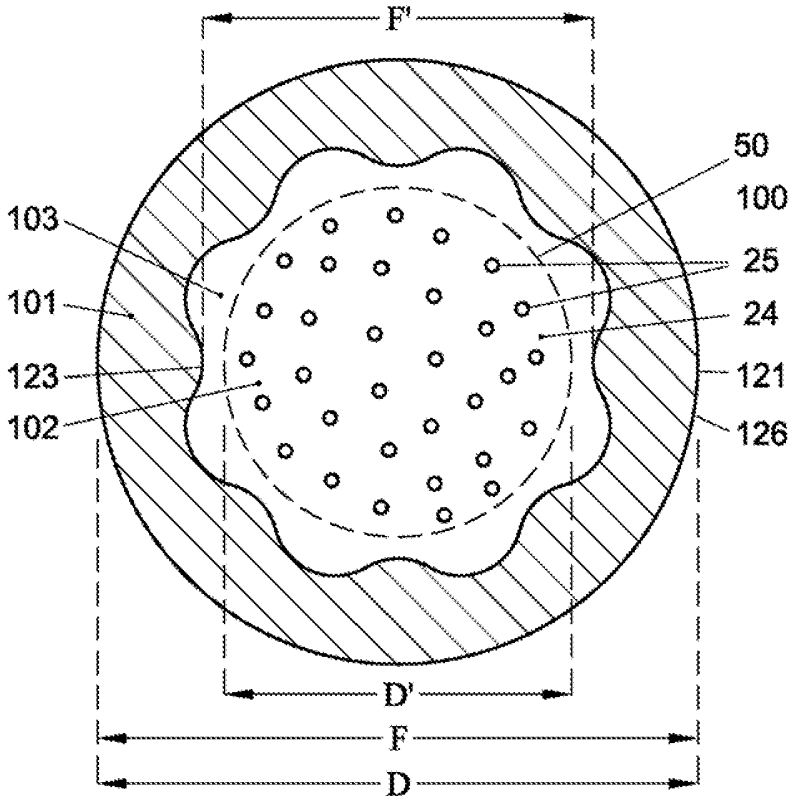

FIG. 12B

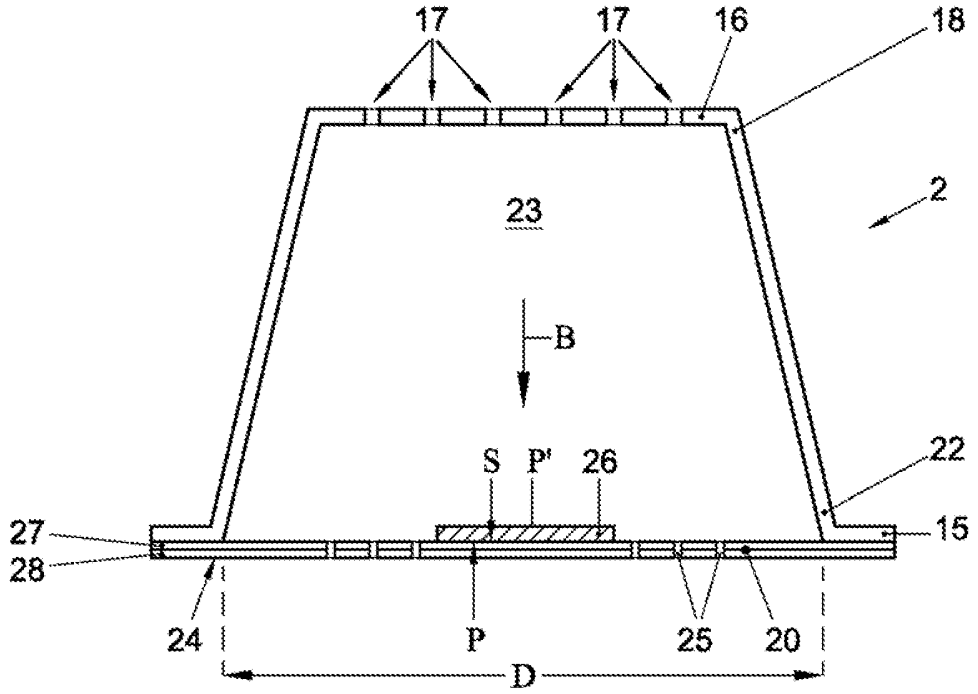

FIG. 13A

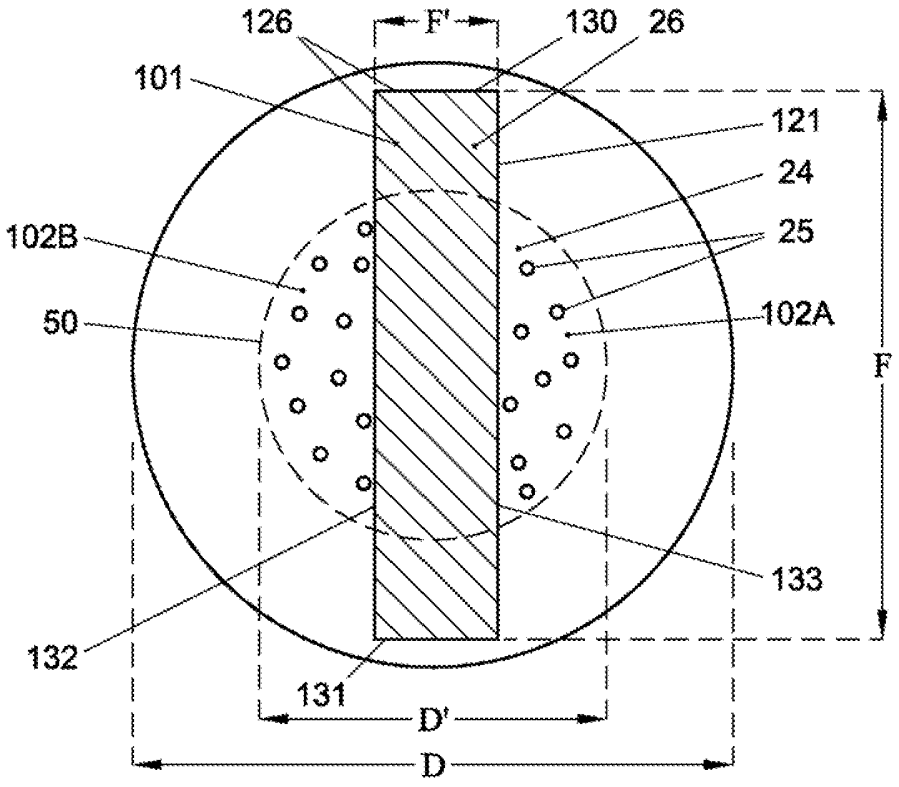

FIG. 13B

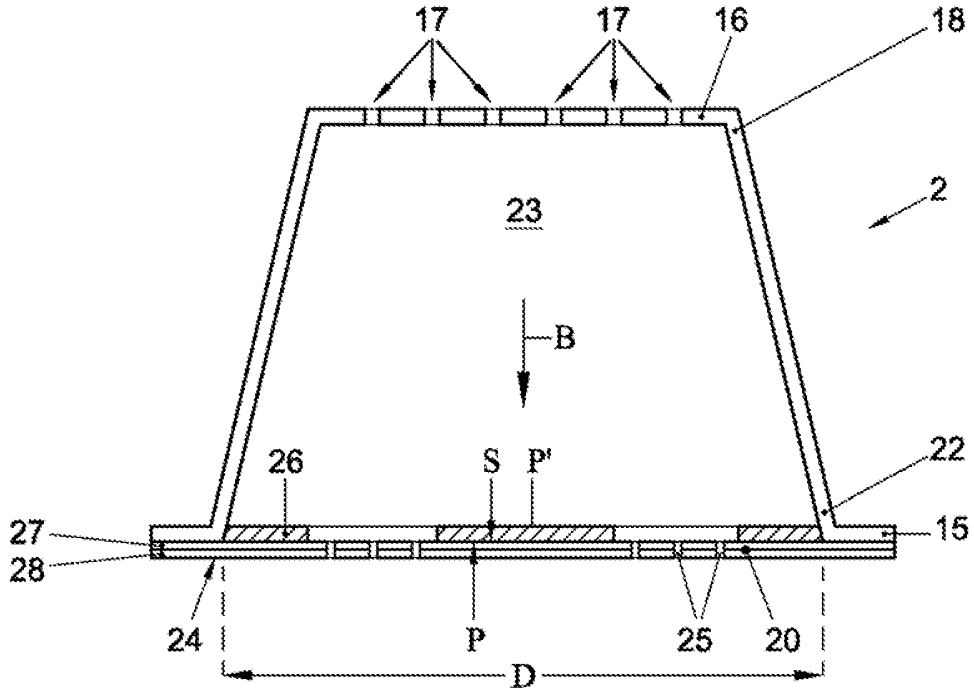

FIG. 14A

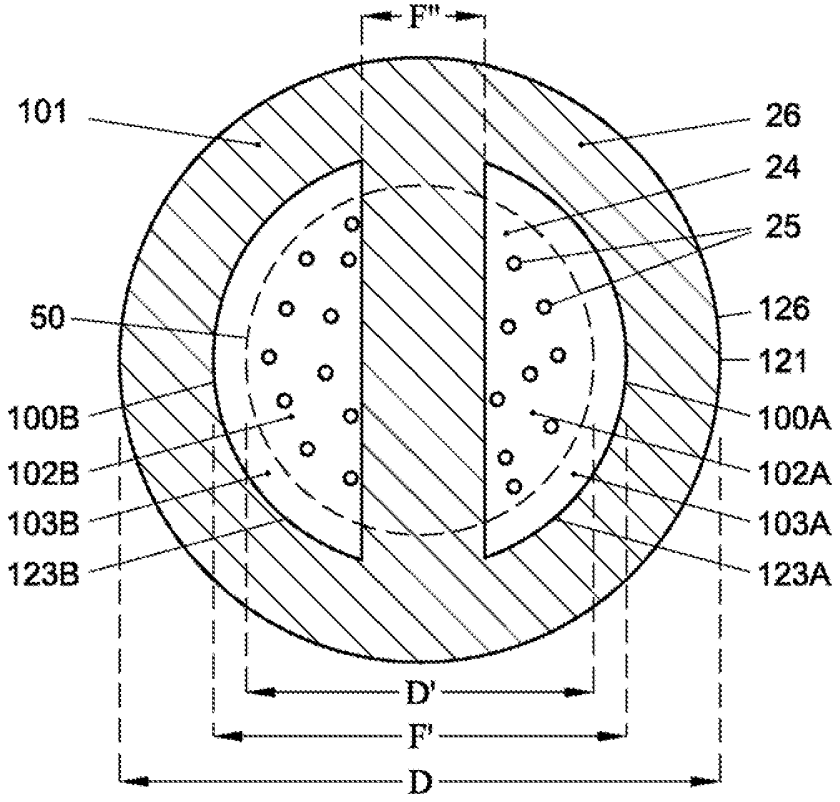

FIG. 14B

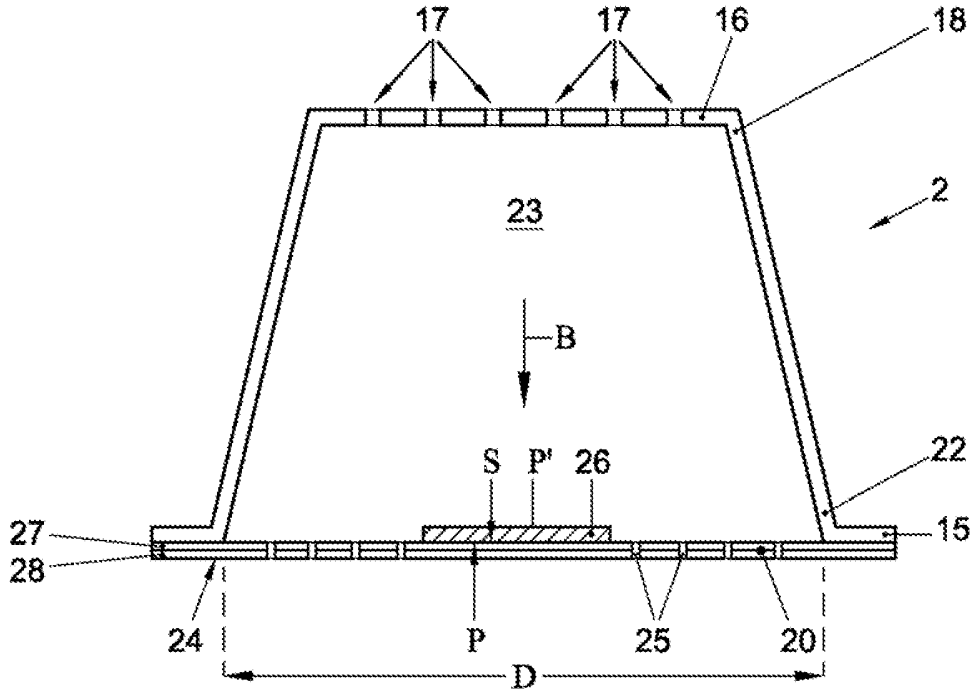

FIG. 15A

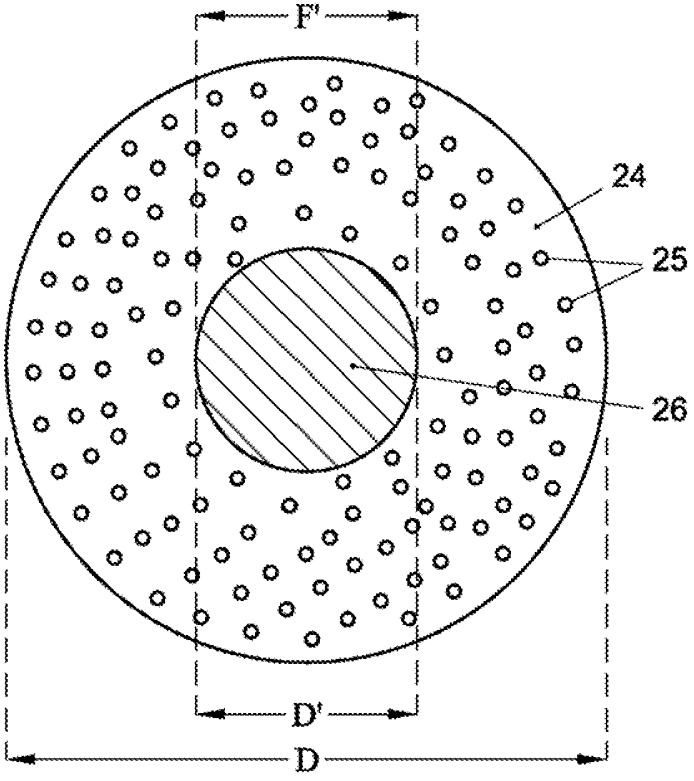

FIG. 15B