(117;204) surrounding the opening out of the path of the beverage which subsequently emerges through the outlet opening.

2. A method as claimed in Claim 1, characterised in that the package (10;200) has a sealed outlet (38;202), the tool (49;248) piercing the sealing material (117;204) at said outlet to form said opening.

3. A method as claimed in Claim 2, characterised in that the sealed outlet (38) has a counterbore (120) and the piercing action of the tool (49) folds inwardly the material (117) surrounding the opening formed by the tool whereby the material lies within the counterbore of the outlet.

4. A method as claimed in Claim 3, characterised in that, prior to introducing the aqueous medium, the piercing tool (49) is withdrawn both from the outlet opening (38) and out of the path of the beverage which emerges through the outlet.

5. A method as claimed in Claim 2, characterised in that the sealed outlet (202) has a trough (258) adjacent the outlet, and the piercing action of the tool (248) folds the material (204) covering the outlet into the trough thereby moving the material out of the path of the beverage which emerges through the outlet.

6. A method as claimed in any one of the preceding claims, characterised in that the package (10;200) is pierced by the tool from below.

7. A method as claimed in any one of the preceding claims, characterised in that the package (10;200) is engaged at a point of entry (16;209) of the package into the machine, and conveyed to the brewing station.

8. A method as claimed in any one of the preceding claims, characterised in that the package (10;200) is clamped at the brewing station prior to the package being pierced to form the outlet opening.

9. A method as claimed in any one of the preceding claims, characterised in that hot water is the aqueous medium which is passed through the package (10;200).

10. A method as claimed in any one of the preceding claims, characterised in that the passage of the aqueous medium is followed by a burst of compressed air through the package (10;200).

11. A method as claimed in any one of the preceding claims, characterised in that the used package (10;200) is ejected from the brewing station.

12. A method as claimed in Claim 10, characterised in that the used package (10;200) is ejected into a waste bin (87) within the beverage preparing machine.

13. A method as claimed in any one of the preceding claims, characterised in that as a preliminary step the user selects the package (10;200) from a storage portion of the beverage preparing machine.

14. A machine for preparing a beverage by employing a package (10;200) containing at least one beverage ingredient comprising means (35;243) for locating the package at a brewing station, a tool (49;248) for piercing the package to form an outlet opening (38;202) in the package, and means (48;237) for introducing an aqueous medium into the package to enable the aqueous medium to commingle with the beverage ingredient to form a beverage, the beverage so formed being collected through the outlet opening formed in the package, characterised in that the piercing tool is adapted to fold the material (117;204) surrounding the outlet opening out of the path of the beverage from the outlet opening.

15. A machine as claimed in Claim 14, characterised in that the package (10;200) has a sealed outlet (38;202) and the tool is adapted to pierce the sealing material (117;204) at said outlet to form said opening.

16. A machine as claimed in Claim 15, characterised in that the sealed outlet (38) has a counterbore (120) and the tool (49) has a shank (55) for insertion into the counterbore to fold inwardly the material (117) surrounding the opening formed by the tool whereby the material lies within the counterbore of the outlet.

17. A machine as claimed in Claim 16, characterised in that means are provided to reciprocate the piercing tool (48) to form the outlet (38) and to withdraw the tool from the outlet, and then to pivot the tool out of the path of the beverage from the outlet opening.

18. A machine as claimed in Claim 17, characterised in that the piercing tool (48) is carried by a frame (50) having a cam follower (57) for engagement by a cam (24), rotation of the cam effecting pivotal movement of the frame and the piercing tool thereon.

19. A machine as claimed in Claim 18, characterised in that the means for withdrawing the piercing tool (48) from the outlet opening (38) is a mechanical link (59) between the cam (24) and the frame (50) which when released allows the tool to pierce the package (10) under spring pressure (56) to form the outlet opening therein.

20. A machine as claimed in Claim 14 or Claim 15, characterised in that the piercing tool (248) is tubular and has an end surface (253) to pierce the sealing material (204) around a part of the outlet, without removing any material, and in that the tool is adapted to fold the cut material externally of the outlet (202).

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21. A machine as claimed in Claim 20, characterised in that the piercing tool (248) is of D cross-section, the arcuate portion (253) of the end surface being serrated to pierce and eventually to cut the sealing material (204), and the straight portion (254) at the same end serving to fold the cut material whereby the material lies externally of the outlet (202).

22. A machine as claimed in any one of Claims 14 to 21, characterised in that the piercing tool (49;248) is positioned beneath the package (10;200) when disposed at the brewing station.

23. A machine as claimed in any one of Claims 14 to 22, characterised in that means (30;230) are provided for engaging the package at a point of entry (16;209) of the package (10;200) into the machine, and for conveying the package to the brewing station.

24. A machine as claimed in any one of Claims 14 to 23, characterised in that means (33, 41; 233, 236) are provided for clamping the package (10;200) at the brewing station.

25. A machine as claimed in any one of Claims 14 to 24, characterised in that there is provided a supply of hot water (65) as the aqueous medium, and means (64) for feeding hot water from the supply to means (48;237) for introducing water into the package.

26. A machine as claimed in any one of Claims 14 to 25, characterised in that means (69) are provided for passing compressed air through the package (10;200).

27. A machine as claimed in Claim 26, characterised in that the means (69) for passing compressed air to the package (10;200) are connected to the means (48;237) for introducing the aqueous medium.

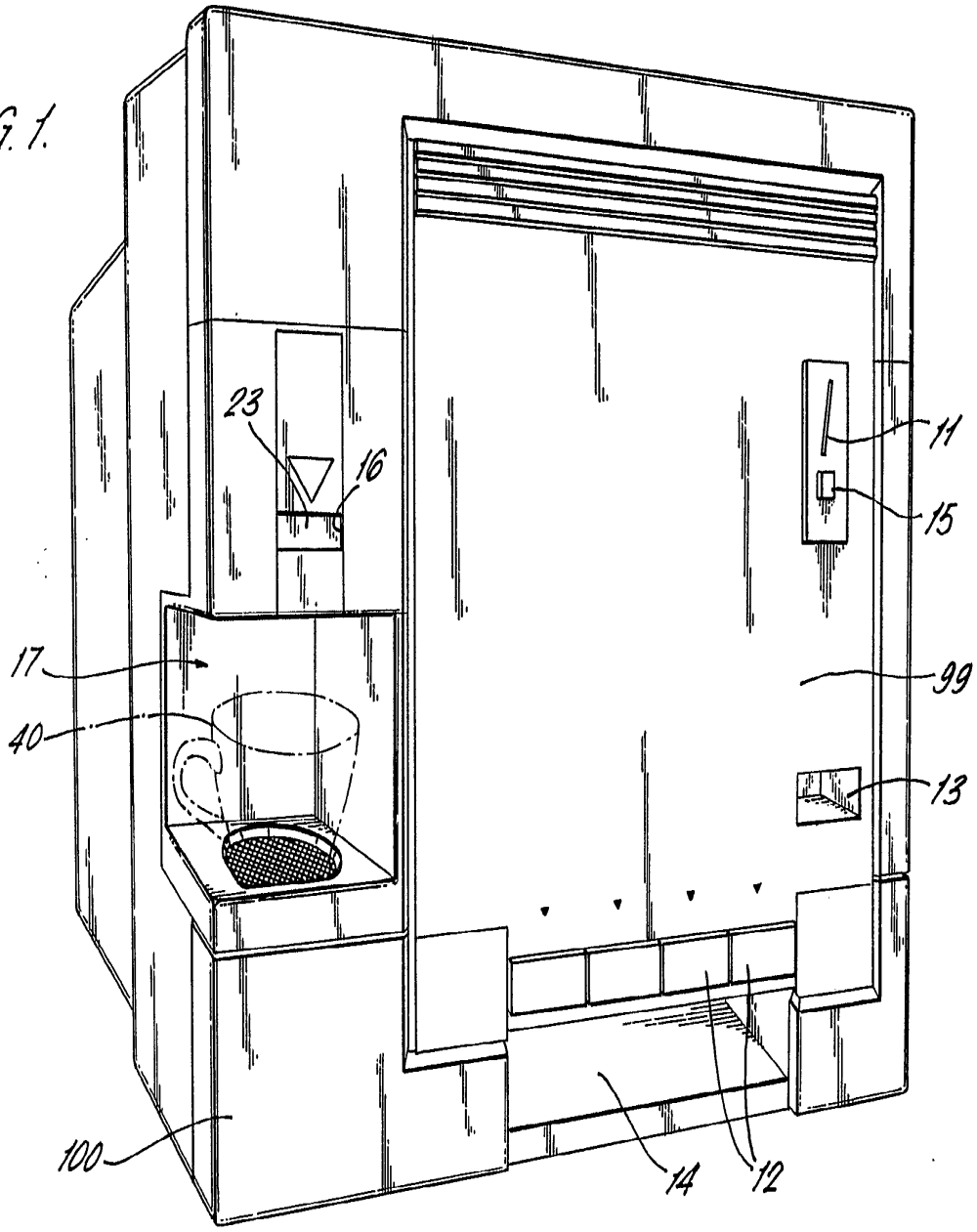
28. A machine as claimed in any one of Claims 14 to 27, characterised in that means (75;231) are provided for ejecting the used package (10;200) from the brewing station.

29. A machine as claimed in Claim 28, characterised in that a waste bin (87) is provided for collecting the used packages (10;200).

30. A machine as claimed in any one of Claims 14 to 29, characterised in that there are provided means for storing a plurality of packages (10;200), and means for the user to select a required package from the storage means.

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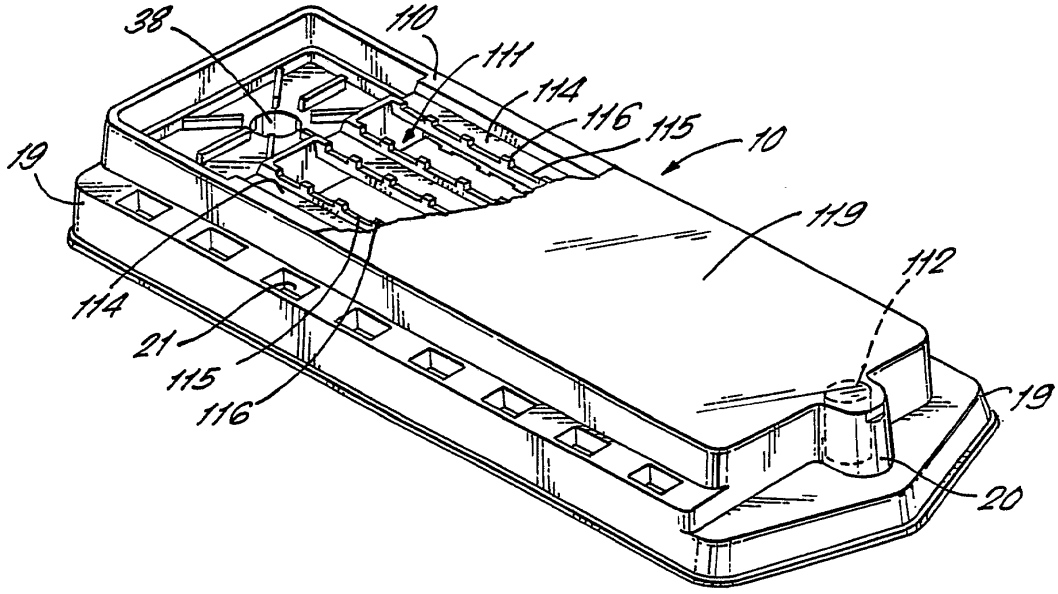
FIG. 1.



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FIG. 2.


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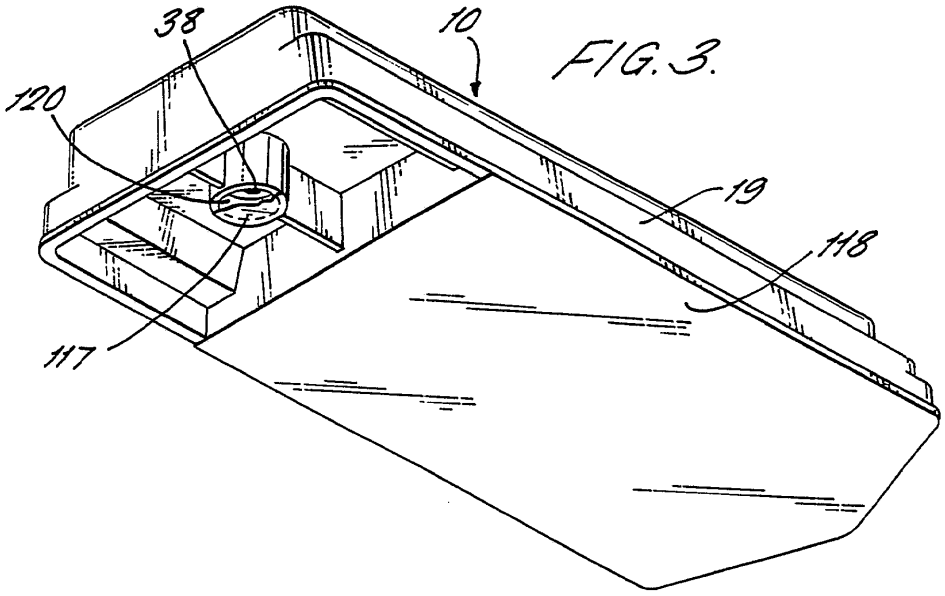

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FIG. 3.

FIG. 4.

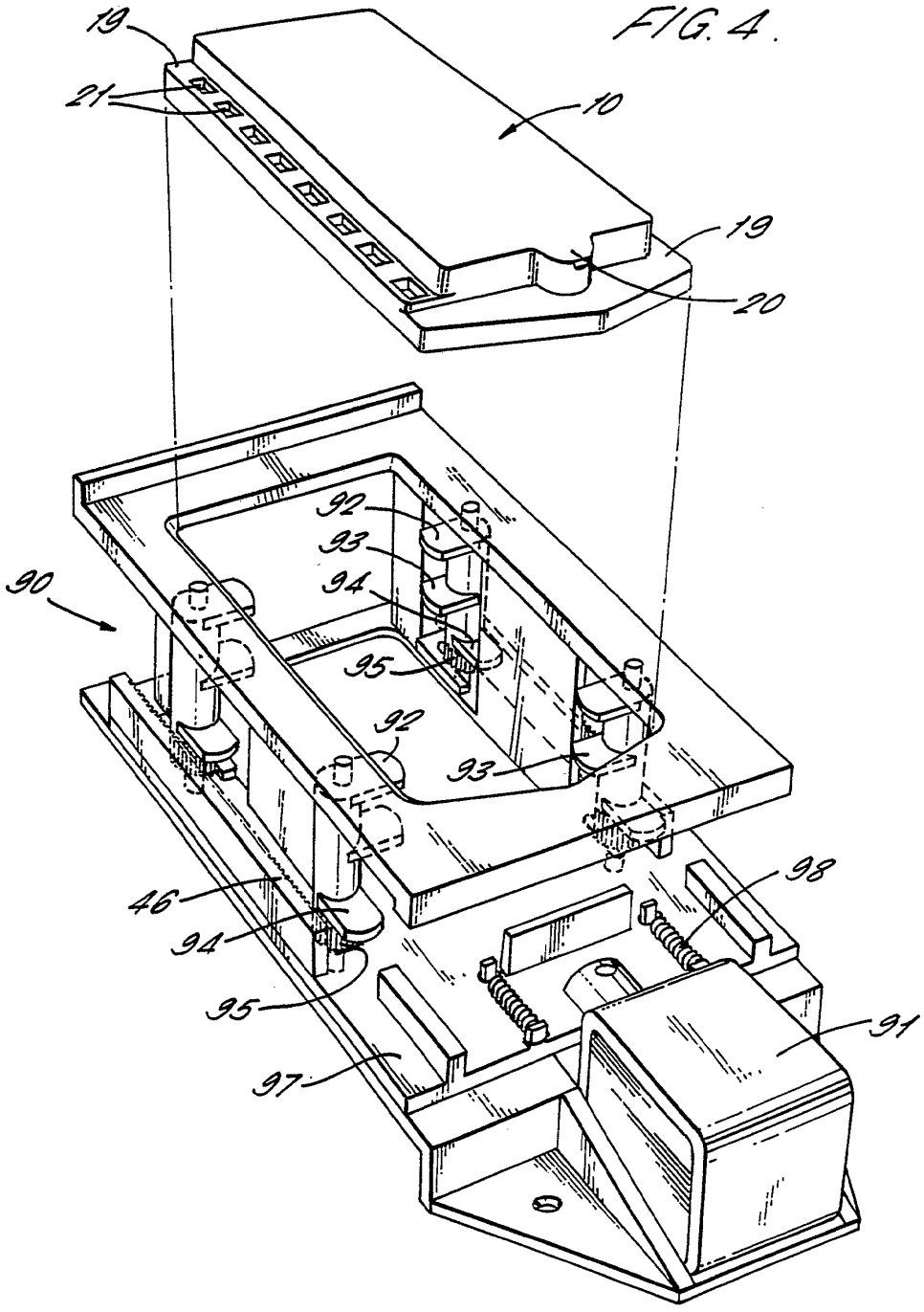
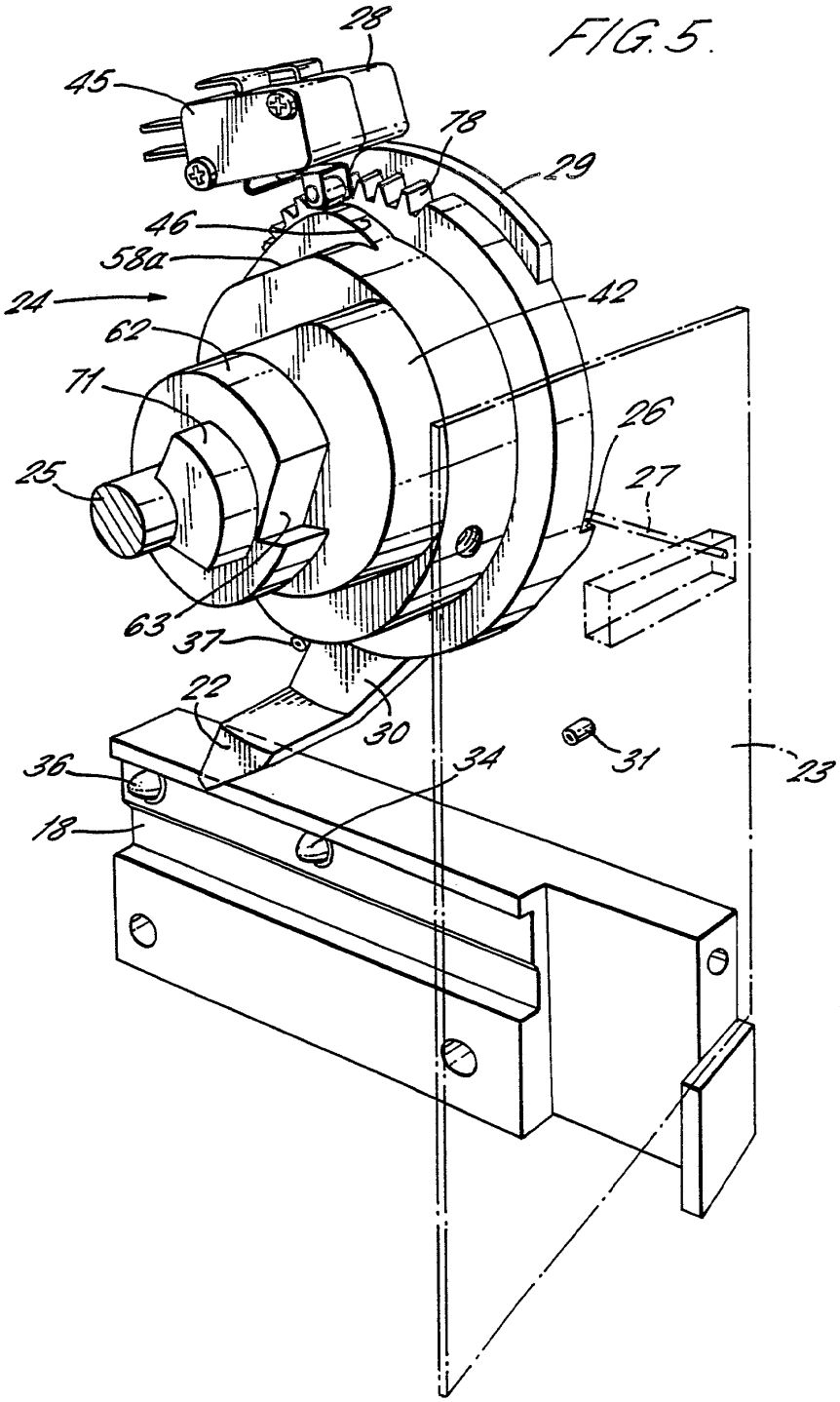
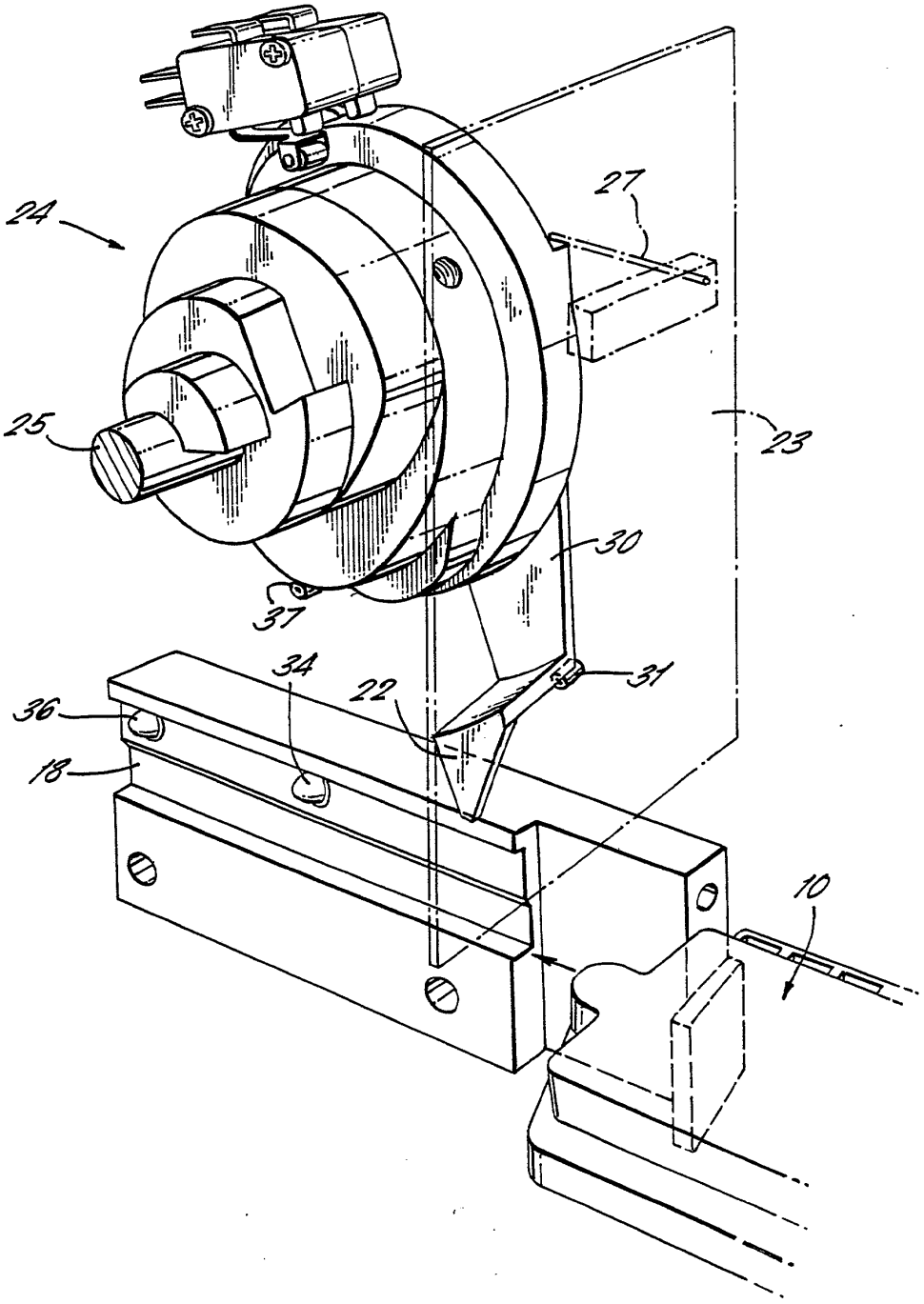


FIG. 5.



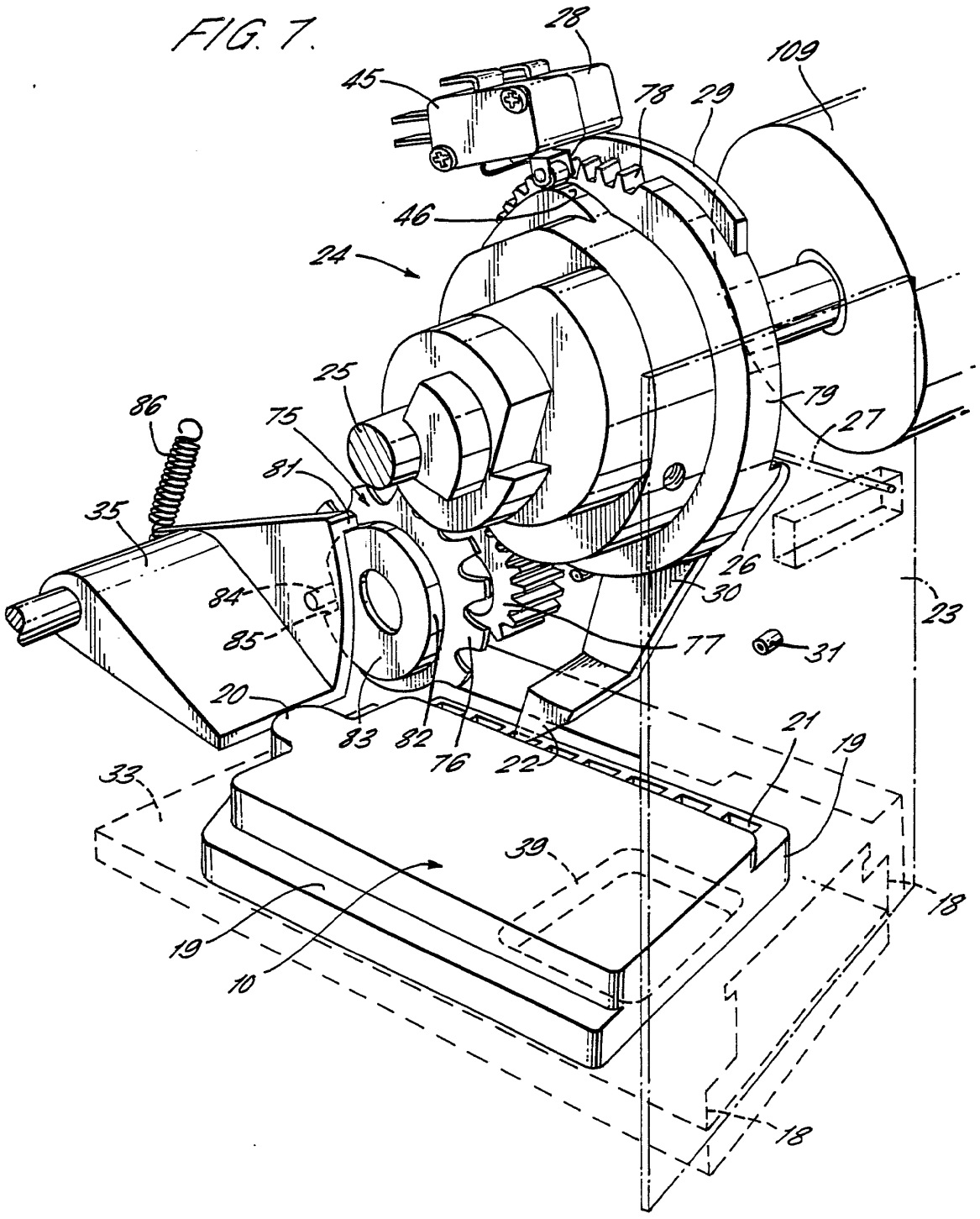
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FIG. 6.



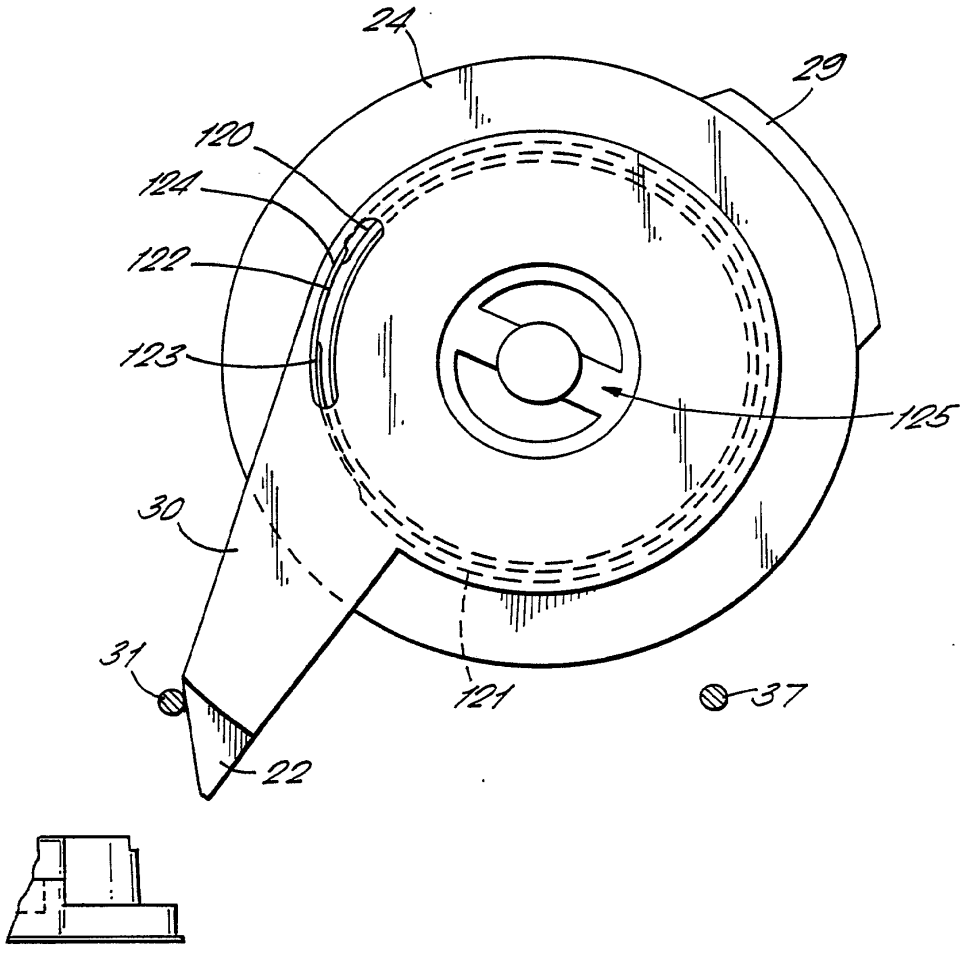
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FIG. 7.



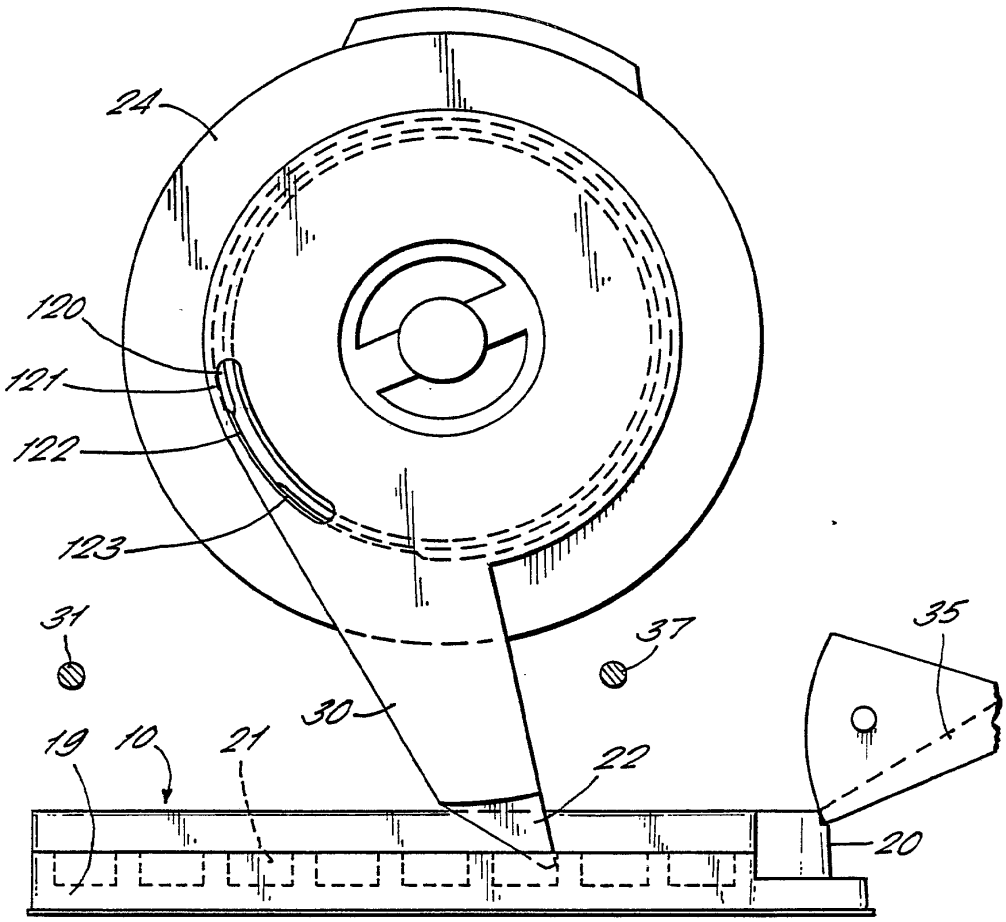
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FIG.8.



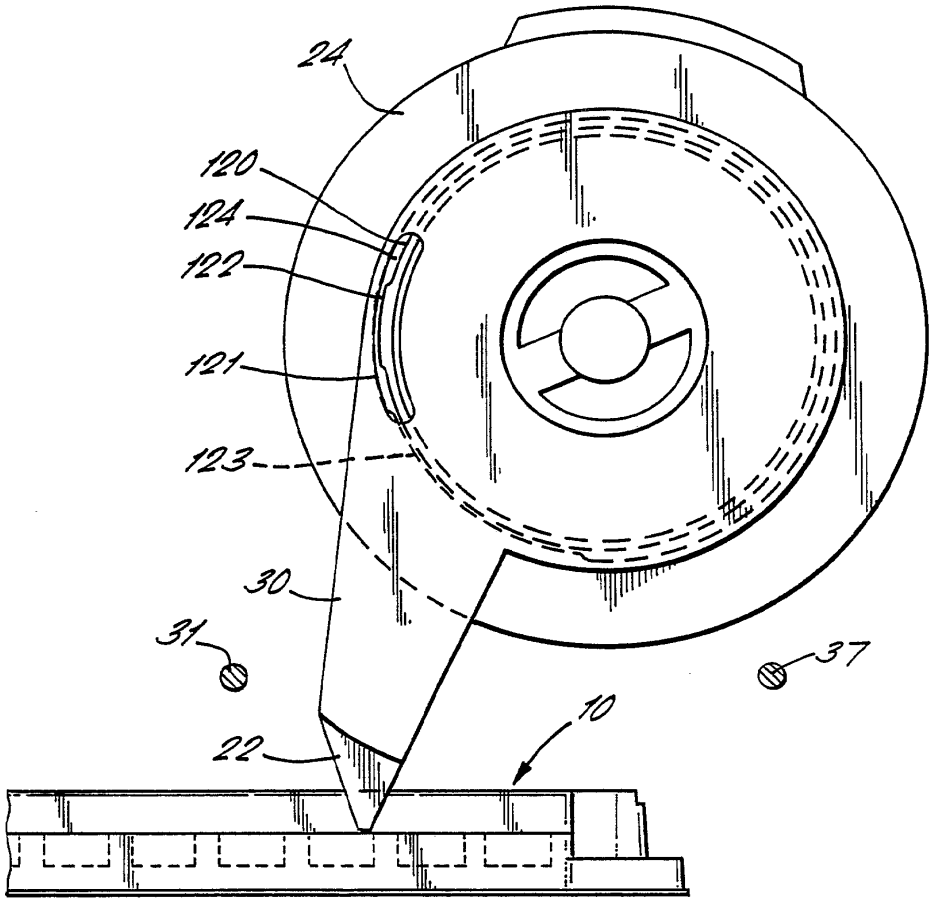
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FIG. 9.



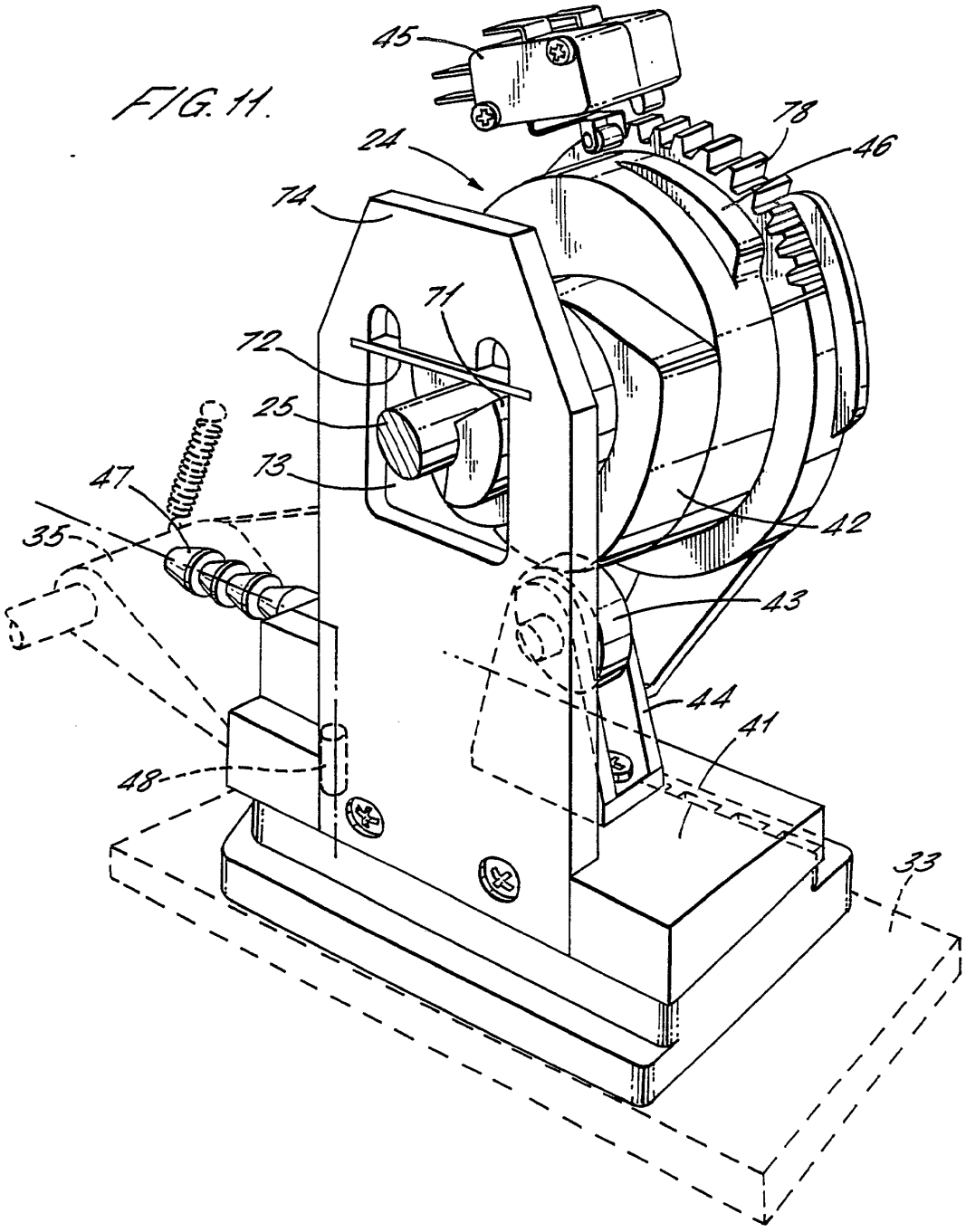
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FIG. 10.



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FIG. 11.



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FIG. 12.

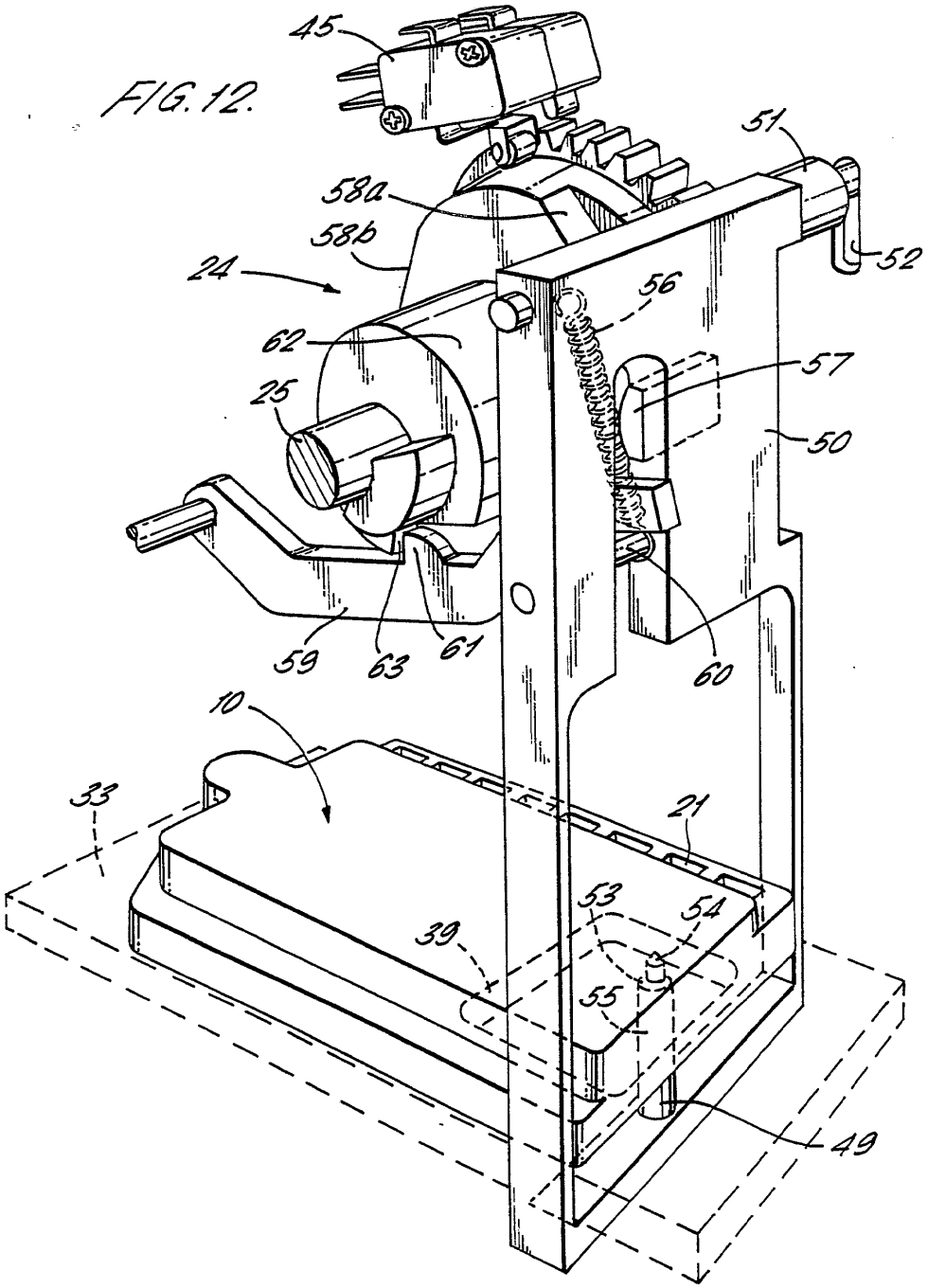
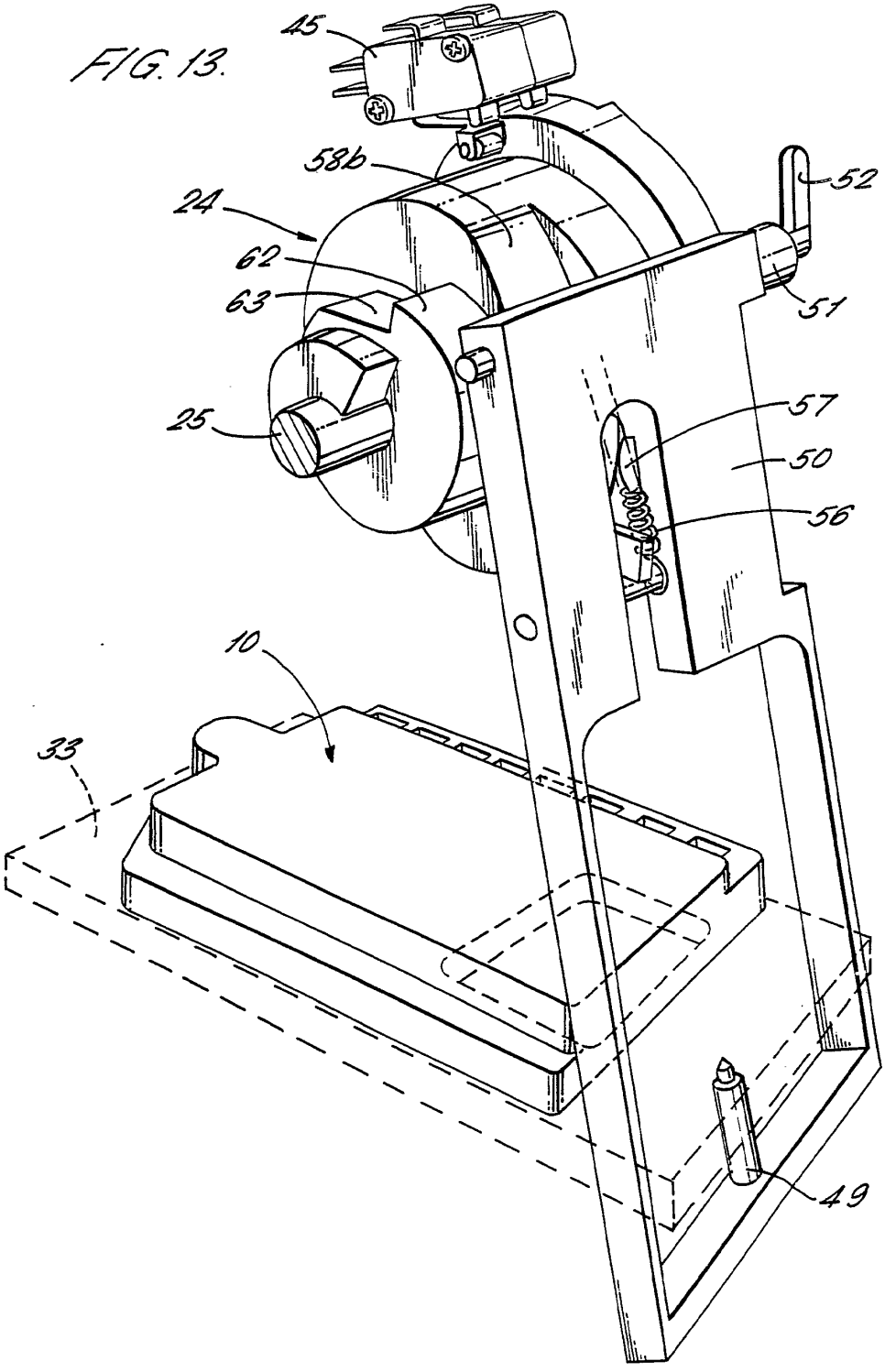
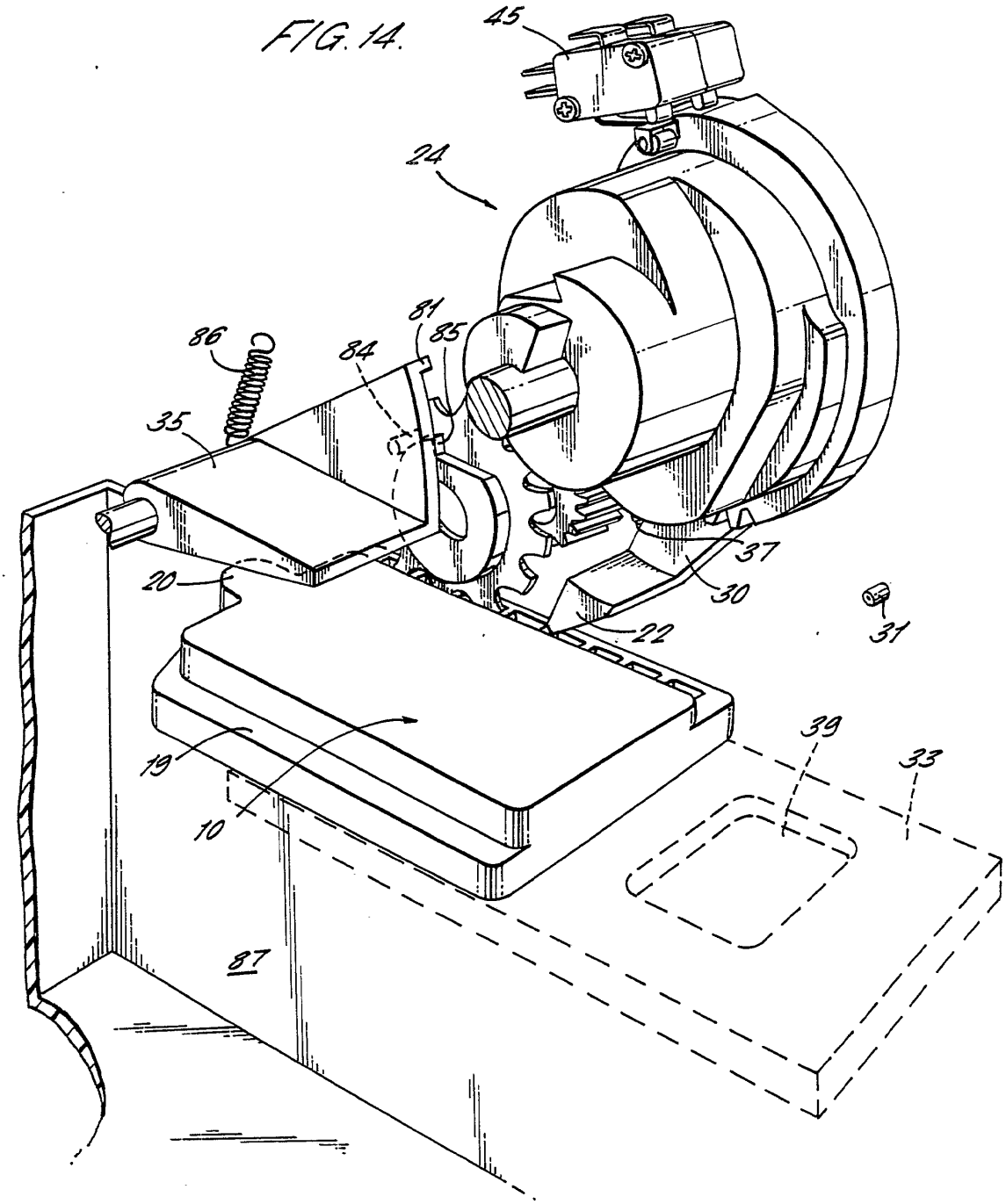


FIG. 13.



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FIG. 14.



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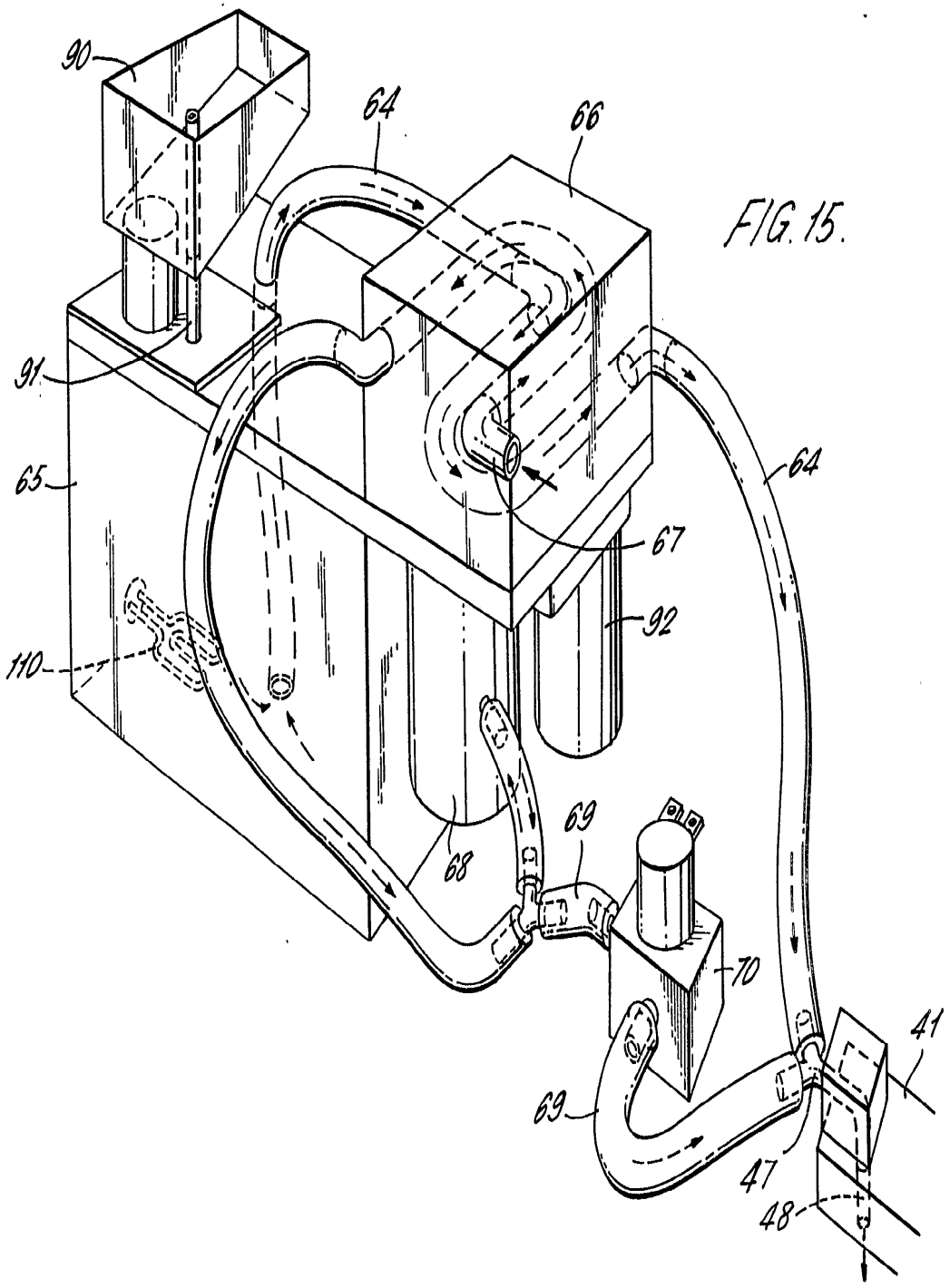


FIG. 15.

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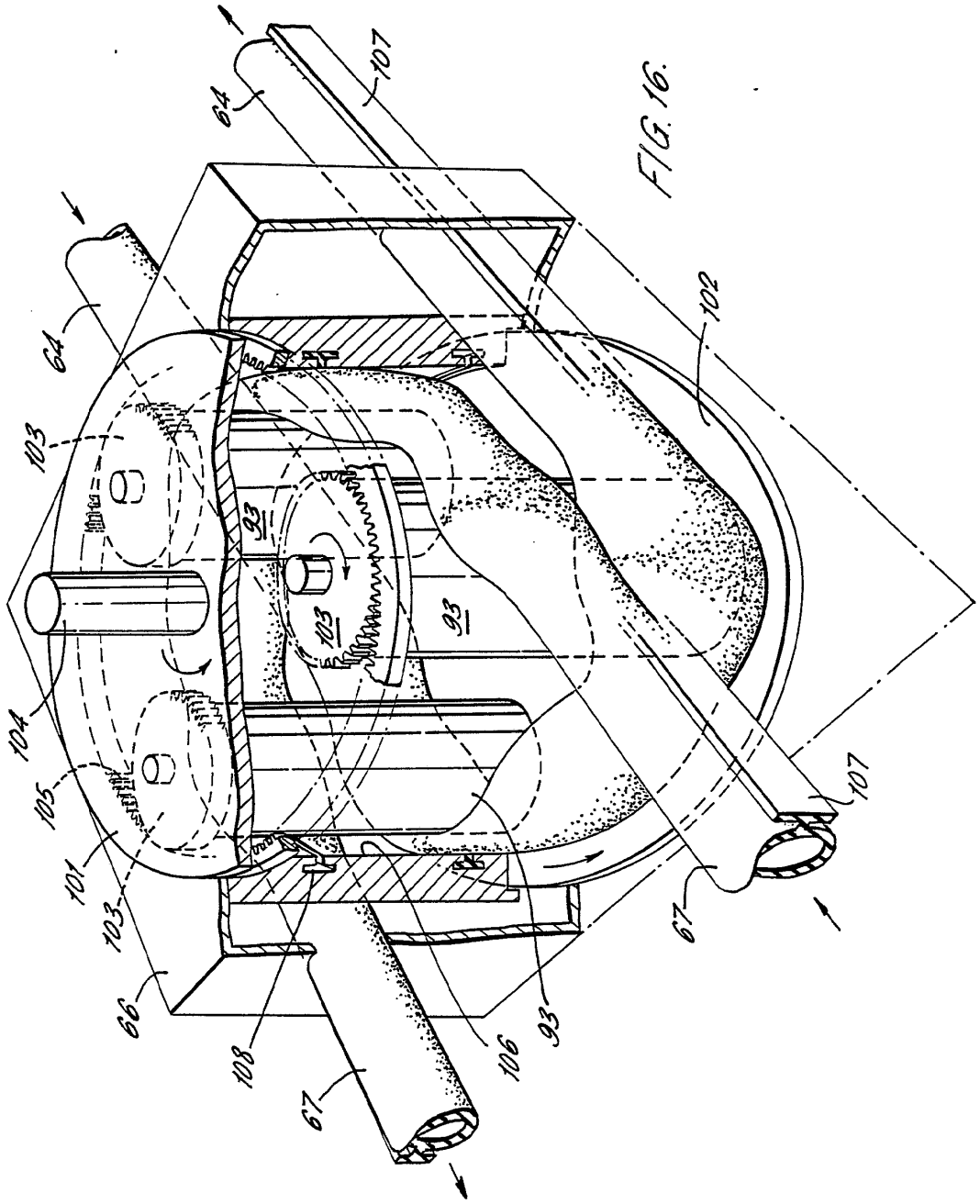


FIG. 16.

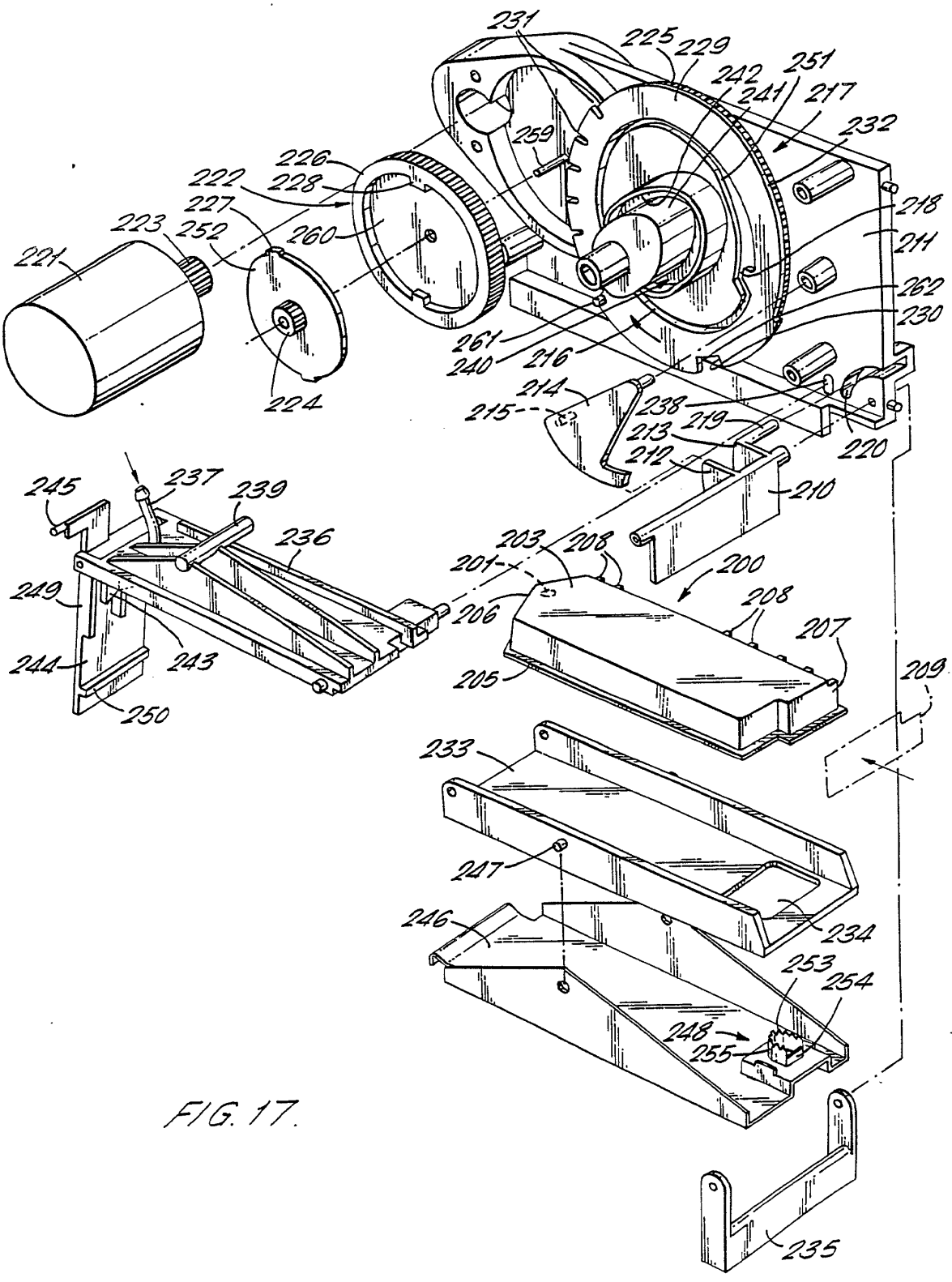

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FIG. 17.

FIG. 18.

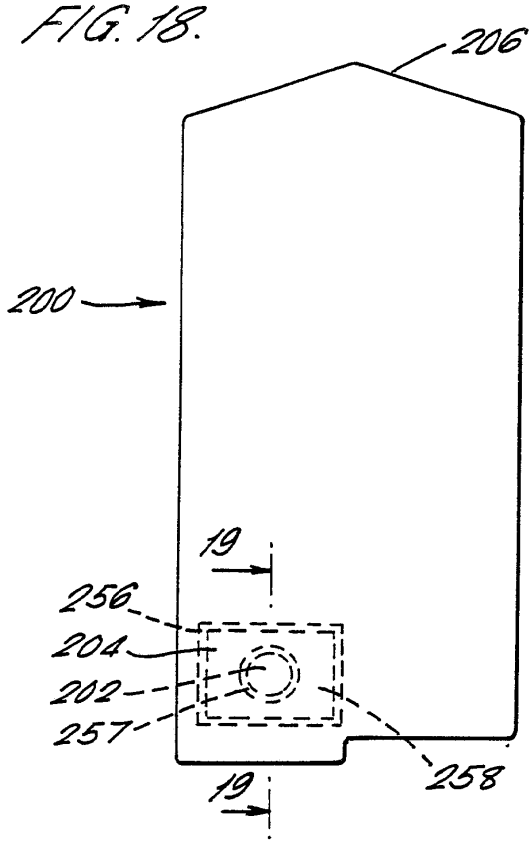
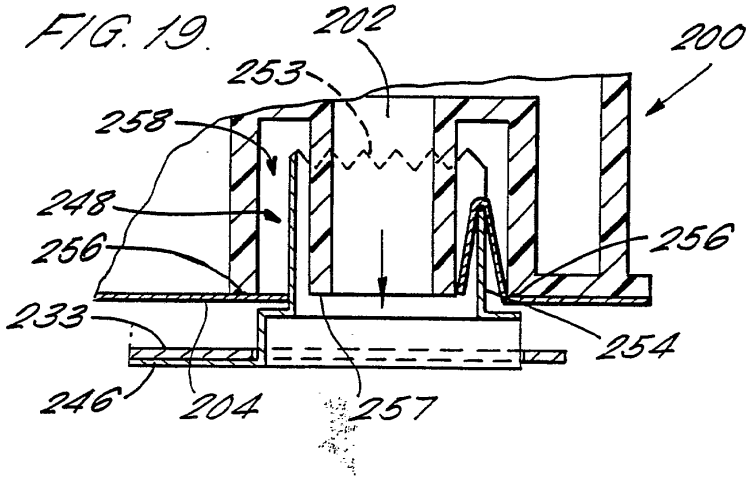

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FIG. 19.


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European Patent Office

EUROPEAN SEARCH REPORT

Application Number

EP 89 30 2708

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.4)
X	DE-U-7430910 (BOSCH-SIEMENS GMBH) * figure 1 *	1-3, 8, 9, 14-16, 20, 24, 25	A47J31/40
X	FR-A-2140619 (JOH.JACOBS & CO.) * page 4, line 30 - page 5, line 11; figure 3 *	1, 2, 4, 6-9, 11, 12-15, 17, 20 23-25, 28-30	
X	US-A-2778739 (J.J.RODTH) * the whole document *	1-3, 6, 14-16	
A	US-A-3295998 (GOROS) * the whole document *	1, 6-9, 11-14, 22-25, 28-30	
A	GB-A-2123685 (MARS LTD) * page 5, line 9 - line 39; figure 2 *	10, 26	TECHNICAL FIELDS SEARCHED (Int. Cl.4) A47J
A	EP-A-041931 (UNOPER S.R.L.) * figures 3, 6-8 *	7-9, 11, 12, 23-25, 28, 29	B65D

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	26 JUNE 1989	SCHARTZ J.

CATEGORY OF CITED DOCUMENTS

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(54) **Process for preparation of organofunctional siloxanes.**

(57) The present invention is a process for the preparation of organofunctional-terminated polydiorganosiloxane polymers and organofunctional polydiorganosiloxane copolymers. The process comprises reacting a chlorine-terminated polydiorganosiloxanepolymer with : (1) an organofunctional chlorosiane end-blocker to form an lorganofunctional terminated polydiorganosiloxane polymer and (2) a mixture of organochlorosilane end-blocker and organofunctional dichlorosilane to form an organofunctional polydiorganosiloxane copolymer. The process is conducted in the presence of an aqueous solution of hydrogen chloride, where the water is present in stoichiometric excess in relation to the hydrolyzable silicon-bonded chlorine.

The present process is particularly useful for producing 5-hexenyl-terminated polydimethylsiloxane polymers and for producing siloxane copolymers comprising randomly distributed poly-5-hexenylmethylsiloxy and polydimethylsiloxy blocks.

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The present invention is a process for the preparation of organofunctional-terminated polydiorganosiloxane polymers and organofunctional polydiorganosiloxane copolymers. The process comprises reacting a chlorine-terminated polydiorganosiloxane polymer with: (1) an organofunctional chlorosilane end-blocker to form the organofunctional-terminated polydiorganosiloxane polymer or (2) a mixture of an organochlorosilane end-blocker and an organofunctional dichlorosilane to form a organofunctional polydiorganosiloxane copolymer. The process is conducted in the presence of an aqueous solution of hydrogen chloride, where the water is present in a stoichiometric excess in relation to the hydrolyzable silicon-bonded chlorine.

Organofunctional-terminated polydiorganosiloxane polymers and organofunctional polydiorganosiloxane copolymers, particularly where the organofunctional group is an alkenyl, are finding increasing use as paper coatings. However, the use of these materials is limited by the costs of production associated with current processes. The present process is a simple one-step process using readily available materials, thus reducing the cost of production of these organofunctional siloxane polymers and siloxane copolymers.

Several methods for the production of chlorine-terminated polydiorganosiloxane polymers are known. For example, it is known that the hydrolysis and condensation of organodichlorosilanes can result in a mixture of cyclicdiorganosiloxanes and short-chained chlorine end-terminated polydiorganosiloxanes, with the concurrent formation of hydrogen chloride.

Typically, these chlorine-terminated polydiorganosiloxane polymers are further hydrolyzed with excess water to form hydroxy-terminated polydiorganosiloxane polymers. These hydroxy-terminated siloxanes can then be condensed and end-blocked with trimethylsiloxy groups to form stable polydiorganosiloxane polymers.

In a first embodiment of the present process, a chlorine-terminated polydiorganosiloxane polymer is reacted with a organochlorosilane end-blocker containing at least one organofunctional substituent. The resultant product is an organofunctional-terminated polydiorganosiloxane polymer.

In a second embodiment of the present process, a chlorine-terminated polydiorganosiloxane polymer is reacted with a mixture comprising an organochlorosilane end-blocker and an organofunctional dichlorosilane. The resultant product is a randomly distributed block copolymer comprising diorganosiloxy blocks and organofunctionalsiloxy blocks.

The prior art does not recognize that chlorine terminated polydiorganosiloxane polymers can be reacted, as described in the present process, to form organofunctional terminated polydiorganosiloxanes and organofunctional polydiorganosiloxane copolymers.

The present process is particularly useful for producing 5-hexenyl-terminated polydimethylsiloxane polymers and for producing siloxane copolymers comprising randomly distributed poly-5-hexenylmethylsiloxy and polydimethylsiloxy blocks.

The present invention is a process for the preparation of organofunctional-terminated polydiorganosiloxane polymers of formula

$$R^1_aR_bSiO(R_2SiO)_xSiR^1_aR_b, \quad (1)$$

and organofunctional polydiorganosiloxane copolymers of formula

$$R^1_eR_fSiO\{(R_2SiO)_x\}_y\{(R^1_cR_dSiO)_q\}_zSiR^1_eR_f, \quad (2)$$

where each R is a radical selected from a group consisting of alkyls of one to 20 carbon atoms, cycloalkyls of four to 20 carbon atoms and aryls; R^1 is an organofunctional radical selected from a group consisting of alkenyls of two to 20 carbon atoms and haloalkyls of one to 20 carbon atoms; a=1, 2 or 3; b=0, 1 or 2; a+b=3; c=1 or 2; d=0 or 1; c+d=2; e=0, 1, 2 or 3; f=0, 1, 2 or 3; e+f=3; x is an integer from n+1 to 1,000; n is an integer from one to 1,000; q is an integer from one to 1,000; y is the number of randomly distributed diorganosiloxy blocks contained in the copolymer and y is an integer from one to 1,000; and z is the number of randomly distributed organofunctionalsiloxy blocks contained in the copolymer and z is an integer from one to 1,000.

To form the organofunctional-terminated polydiorganosiloxane polymers described by formula (1), a first embodiment of the present process comprises:

(A) forming a mixture comprising chlorine-terminated polydiorganosiloxane polymers of formula

$$Cl(R_2SiO)_nSiR_2Cl, \quad (3)$$

and an organofunctional chlorosilane end-blocker of formula

$$R^1_aR_bSiCl; \quad (4)$$

(B) contacting the mixture with a stoichiometric excess of water containing 5 to 36 weight percent hydrogen chloride; and

(C) isolating organofunctional-terminated polydiorganosiloxane polymers described by formula (1); where R, R^1, a, b and n are as previously described.

To form the organofunctional polydiorganosiloxane copolymers described by formula (2), a second embodiment of the present process comprises:

(A) forming a mixture comprising chlorine-terminated polydiorganosiloxane polymers of formula (3), that is

$$Cl(R_2SiO)_nSiR_2Cl,$$

an organofunctional dichlorosilane of formula

$$R^1_cR_dSiCl_2, \quad (5)$$

and an organochlorosilane end-blocker of formula

$$R^1_eR_fSiCl; \quad (6)$$

(B) contacting the mixture with a stoichiometric

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excess of water containing 5 to 36 weight percent hydrogen chloride; and

(C) isolating organofunctional polydiorganosiloxane copolymers comprising diorganosiloxy blocks of formula $(R_2SiO)_x$ and organofunctionalsiloxy blocks of formula $(R^1_cR_dSiO)_q$ randomly distributed to form organofunctional polydiorganosiloxane copolymers as described by formula (2); where R, R^1, c, d, e, f, x, q and n are as previously described.

The present process can be run in any standard reactor suitable for hydrolyzing chlorosilanes and chlorine-terminated polydiorganosiloxane polymers. The present process can be run as a continuous, semi-continuous or batch process. The present process employs chlorine-terminated polydiorganosiloxane polymers, as described by formula (3), as the basic building unit for the process. The chlorine terminated polydiorganosiloxane polymers contain substituents R where each R is a radical independently selected from the group consisting of alkyls of one to 20 carbon atoms, cycloalkyls of four to 20 carbon atoms and aryls. R can be, for example, methyl, ethyl, propyl, butyl, isobutyl, tert-butyl, pentyl, hexyl, cyclopentyl, cyclohexyl, phenyl, tolyl and xylyl. Preferred is when R is methyl. More preferred is when R is methyl and n is an integer from 1 to 50.

In the embodiment of the present process where the product is an organofunctional-terminated polydiorganosiloxane polymer as described by formula (1), a mixture of the chlorine-terminated polydiorganosiloxane polymer is formed with an organofunctional chlorosilane end-blocker as described by formula (4). The organofunctional chlorosilane end-blocker can have one, two or three organofunctional radical substituents R^1. R^1 is selected from a group consisting of alkenyls of two to 20 carbon atoms and haloalkyl radicals of one to 20 carbon atoms. R^1 can be, for example, vinyl, allyl, 1-methylvinyl, 4-pentenyl, 2-pentenyl, 5-hexenyl, bromomethyl, chloromethyl, iodomethyl, fluoromethyl, 3,3,3-trifluoropropyl and perfluoropropyl. Preferred is where R^1 is selected from a group consisting of alkenyls of two to 10 carbon atoms. More preferred is where R^1 is vinyl or 5-hexenyl. The organofunctional chlorosilane end-blocker can have zero, one or two radicals R, where R is as previously described. The preferred organofunctional chlorosilane end-blocker is one containing two substituents R, where R is methyl and R^1 is an alkenyl of two to 10 carbon atoms. The most preferred organofunctional chlorosilane end-blockers are 5-hexenyldimethylchlorosilane and dimethylvinylchlorosilane.

In the second embodiment of the present process where the product is an organofunctional polydiorganosiloxane copolymer as described by formula (2), a mixture of the chlorine-terminated polydiorganosiloxane polymer with an organochlorosilane end-blocker as described by formula (6) is formed. The organochlorosilane end-blocker can have zero, one, two or three substituents R^1, where R^1 is as previously described. The organochlorosilane end-blocker can have zero, one, two or three substituents R, where R is as previously described. The total of R substituents and R^1 substituents bonded to the silicon atom of the organochlorosilane end-blocker must equal three. Preferred is when the organochlorosilane end-blocker is selected from a group consisting of trimethylchlorosilane, 5-hexenyldimethylchlorosilane and dimethylvinylchlorosilane.

A useful concentration of the organofunctional chlorosilane end-blocker of formula (4) and the organochlorosilane end-blocker of formula (6) is where the mole ratio of the chlorine-terminated polydiorganosiloxane polymer described by formula (3) to end-blocker is within a range of about 0.5 to 999. A preferred concentration for end-blocker is where the mole ratio of chlorine-terminated polydiorganosiloxane polymer to end-blocker is in a range of about 0.5 to 10.0. The mole ratio at which the chlorine terminated polydiorganosiloxane polymer and end-blocker are controlled in the mixture will depend upon the desired chain length for the product polymers and copolymers. Generally, the larger the ratio of chlorine-terminated polydiorganosiloxane polymer to end-blocker, the larger the molecular weight of the product polymers and copolymers.

In the second embodiment of the present process, where the product is an organofunctional polydiorganosiloxane copolymer as described by formula (2), the mixture of chlorine-terminated polydiorganosiloxane polymer and organochlorosilane end-blocker also contains an organofunctional dichlorosilane as described by formula (5). The organofunctional dichlorosilane can contain one or two substituents R^1, where R^1 is an organofunctional radical as previously described; and zero or one substituent R, where R is as previously described. The preferred organofunctional dichlorosilane is where R^1 is an alkenyl of two to 10 carbon atoms and R is methyl. Even more preferred is when the organofunctional dichlorosilane is 5-hexenylmethyldichlorosilane or methylvinyldichlorosilane.

A useful concentration of the organofunctional dichlorosilane, as described by formula (5), is where the mole ratio of the chlorine-terminated polydiorganosiloxane polymers described by formula (1), to organofunctional dichlorosilane, is within a range of about 0.5 to 1000. It is preferred that the mole ratio of chlorine-terminated polydiorganosiloxane polymer to organofunctional dichlorosilane be within a range of about 0.5 to 5.0.

The mixture comprising either (1) the chlorine terminated polydiorganosiloxane polymer and the organofunctional chlorosilane end-blocker; or (2) the chlorine-terminated polydiorganosiloxane polymer, the organofunctional dichlorosilane and the organo-

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chlorosilane end-blocker; is contacted with a stoichiometric excess of water containing 5 to 36 weight percent hydrogen chloride.

The described mixtures are immiscible with the aqueous hydrogen chloride. Therefore, it is desirable to facilitate contact between the mixture phase and the aqueous phase by a dispersive means. The dispersive means can be, for example, mechanical stirring, sonification, agitation of the reactor, high pressure injection or impingement mixing.

The mixtures are contacted with a stoichiometric excess of water. By "stoichiometric excess", it is meant that the mole ratio of water to total silicon-bonded chlorine is greater than 0.5. Generally, the greater the excess of water the faster the reaction, however, excess water may cause formation of cyclosiloxanes. Therefore, in practice, the mole ratio of water to silicon-bonded chloride is dictated by the size of the reaction vessel, desired reaction rate and acceptable levels of cyclosiloxanes. A useful mole ratio of water to silicon-bonded chlorine is within a range of greater than about 0.5 to 200. A preferred mole ratio of water to silicon-bonded chlorine is within a range of about one to 100. The most preferred molar ratio of water to silicon-bonded chloride is within a range of about 4 to 40.

Hydrogen chloride, present in aqueous solution, acts as a catalyst for the present process. Therefore, it is desirable to maintain the aqueous concentration of hydrogen chloride in the present process within a range of about 5 to 36 weight percent. The water added to the process may contain 5 to 36 weight percent hydrogen chloride as added or alternatively water may be added to the process and the 5 to 36 weight percent hydrogen chloride be provided by the hydrolysis of silicon-bonded chlorine. A preferred range for the concentration of hydrogen chloride in water is about 10 to 32 weight percent. The most preferred range for the concentration of hydrogen chloride in water is about 25 to 32 weight percent.

The temperature at which the process is conducted can be any temperature within a range where the lower limit is defined by the freezing point of the aqueous hydrogen chloride solution and the upper limit determined by the point where significant cleavage of organic substituents from silicon occurs. In general, a temperature within a range of about 0°C. to 100°C. may be used. A preferred temperature for conducting the process is within a range of about 20°C. to 50°C.

The pressure within the reactor in which the process is run can be within a range of about 0.1 to ten atmospheres (Pa). About one atmosphere (Pa) is a preferred pressure.

The time of contact of the mixtures with the aqueous hydrogen chloride is not critical to the present process. In general, any contact time within a range of about 0.1 hour to 18 hours is considered useful. A preferred contact time is within a range of about 0.5 hour to four hours.

Isolation of the organofunctional-terminated polydiorganosiloxane polymers and isolation of the organofunctional polydiorganosiloxane copolymers can be achieved by standard means. The siloxane polymers and the siloxane copolymers can be separated from the aqueous hydrogen chloride by, for example, stripping, gravitational settling, centrifugation, coalescence or membrane separation.

Typically, the recovered product siloxane polymers and product siloxane copolymers are contaminated with materials containing silicon-bonded to chlorine. To ensure the stability of the recovered products, it is desirable to wash the recovered products with one or more portions of water to hydrolyze and remove the residual chlorine.

The following examples are offered to illustrate the present invention.

Example 1

A 5-hexenyl-terminated polydimethylsiloxane polymer was prepared. The preparation apparatus was a one-liter, three-necked flask, containing a bottom drain. The flask was fitted with a thermometer and an externally driven stirring blade. A charge of 500 g $Cl(Me_2SiO)_nSiMe_2Cl$ (where n is an average value of 37.7), 24 g of 5-hexenyldimethylchlorosilane and 72 g of 8.4 weight percent (Wt%) aqueous hydrogen chloride were placed in the flask. The content of the flask was stirred for one hour at 25°C.

At the end of one hour, stirring was stopped and the content of the flask allowed to separate. The bottom aqueous acid layer was drained off. An additional 170 g of water were added to the siloxane polymers remaining in the flask, to hydrolyze the residual silicon-bonded chlorine and effect chlorine removal. The resulting dispersion was heated to about 120°C. to remove the water. The siloxane polymers were washed with two, 30 g, portions of water. The resulting siloxane polymers were heated to 155°C. at about 20 mmHg (2.66 kPa) to remove volatile species. The product was analyzed for residual chlorine by acid/base titration, for vinyl content by Fourier Transform Infrared (FTIR) analysis and the viscosity determined. The product contained 3.5 ppm chlorine, 0.68 weight percent (Wt%) vinyl and had a viscosity of about 290 cs (μm^2/sec).

Example 2

A 5-hexenyl-terminated polydimethylsiloxane polymer was prepared. The procedure was similar to that described for Example 1. A charge of 300 g of $Cl(Me_2SiO)_nSiMe_2Cl$ (where n is an average value of 37.7), 7.1 g of 5-hexenyldimethylchlorosilane and 43 g of 11.1 Wt% aqueous hydrogen chloride were placed in the flask. The content of the flask was stir-

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red vigorously for one hour at 25°C. The resultant product was separated, washed and analyzed as described for Example 1. The product contained 17.6 ppm chlorine, 0.33 Wt% vinyl and had a viscosity of 682 cs (μm^2/sec).

Example 3

A 5-hexenylfunctional polydimethylsiloxane copolymer was prepared. The apparatus was the same as described for Example 1. A charge of 500 g of $Cl(Me_2SiO)_nSiMe_2Cl$ (Where n is an average value of 37.7), 27 g of 5-hexenylmethyldichlorosilane, 16.1 g of 5-hexenyldimethylchlorosilane and 85 g of a 3.6 Wt% aqueous hydrogen chloride solution were placed in the flask. The content of the flask was stirred vigorously for one hour at 25°C. The resultant product siloxane copolymers were washed with 105 g of water, followed by five additional washings with 50 g portions of water. The washed product was stripped of volatiles and analyzed as described in Example 1. The product contained 27.9 ppm chlorine, 1.03 Wt% vinyl and had a viscosity of 238 cs (μm^2/sec).

Example 4

A 5-hexenylfunctional polydimethylsiloxane copolymer was prepared. The apparatus was the same as described for Example 1. A charge of 1386 g of $Cl(Me_2SiO)_nSiMe_2Cl$ (where n is an average value of 37.7), 71.6 g of 5-hexenylmethyldichlorosilane and 42.9 g of 5-hexenyldimethylchlorosilane were added to the flask and mixed for 10 minutes. Then, 300 g of a 25 Wt% aqueous hydrogen chloride solution were added to the flask and mixing continued for an additional five minutes. After five minutes, 300 g of water were added to the flask and stirring continued for about three hours at 25°C. The resultant product was separated, washed, stripped and analyzed as described in Example 1. The product contained 3 ppm chlorine, 0.84 Wt% vinyl and had a viscosity of 369 cs (μm^2/sec). The product contained 119 ppm SiOH, as determined by FTIR analysis after substituting deuterium for hydrogen in the SiOH.

Claims

1. A process for preparation of organofunctional terminated polydiorganosiloxane polymers, the process comprising:
   (A) forming a mixture comprising a chlorine-terminated polydiorganosiloxane polymer of formula
   $$Cl(R_2SiO)_nSiR_2Cl,$$
   where each R is a radical independently selected from a group consisting of alkyls of one to 20 carbon atoms, cycloalkyls of 4 to 20 carbon atoms and aryls and n is an integer from one to 1,000; and an organofunctional chlorosilane end-blocker of formula
   $$R^1_aR_bSiCl,$$
   where R^1 is an organofunctional radical selected from the group consisting of alkenyls of two to 20 carbon atoms and haloalkyl radicals of one to 20 carbon atoms, R is as previously described, a=1, 2 or 3, b=0, 1 or 2 and a+b=3;
   (B) contacting the mixture with a stoichiometric excess of water containing 5 to 36 weight percent hydrogen chloride; and
   (C) isolating organofunctional-terminated polydiorganosiloxane polymers of formula
   $$R^1_aR_bSiO(R_2SiO)_xSiR^1_aR_b,$$
   where R, R^1, a and b are as previously described and x is an integer from n+1 to 1,000.

2. A process for preparation of organofunctional polydiorganosiloxane copolymers, the process comprising:
   (A) forming a mixture comprising a chlorine-terminated polydiorganosiloxane polymer of formula
   $$Cl(R_2SiO)_nSiR_2Cl$$
   where each R is a radical independently selected from a group consisting of alkyls of one to 20 carbon atoms, cycloalkyls of four to 20 carbon atoms and aryls and n is an integer from one to 1,000; an organofunctional dichlorosilane of formula
   $$R^1_cR_dSiCl_2,$$
   where R^1 is an organofunctional radical selected from a group consisting of alkenyls of two to 20 carbon atoms and haloalkyls of one to 20 carbon atoms, R is as previously described, c=1 or 2, d=0 or 1 and c+d=2; and an organochlorosilane end-blocker of formula
   $$R^1_eR_fSiCl,$$
   where R and R^1 are as previously described, e=0, 1, 2 or 3, f=0, 1, 2 or 3 and e+f=3;
   (B) contacting the mixture with a stoichiometric excess of water containing 5 to 36 weight percent hydrogen chloride; and
   (C) isolating organofunctional polydiorganosiloxane copolymers comprising diorganosiloxy blocks of formula $(R_2SiO)_x$ and organofunctionalsiloxy blocks of formula $(R^1_cR_dSiO)_q$ randomly distributed to form organofunctional polydiorganosiloxane copolymers of formula $R^1_eR_fSiO\{(R_2SiO)_x\}_y\{(R^1_cR_dSiO)_q\}_zSiR^1_eR_f$, where R, R^1, c, d, e and f are as previously described, x is an integer from n+1 to 1,000, q is an integer from one to 1,000, y is the number of randomly distributed diorganosiloxy blocks contained in the copolymer and y is an integer from one to 1,000 and z is the number of randomly distributed organofunctionalsiloxy

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blocks contained in the copolymer and z is an integer from one to 1,000.

3. A process according to claims 1 or 2 where R is methyl.

4. A process according to claims 1 or 2 where n is an integer from 1 to 50.

5. A process according to claims 1 or 2 where R^1 is selected from a group consisting of alkenyls of two to 10 carbon atoms.

6. A process according to claims 1 or 2 where R^1 is selected from a group consisting of vinyl and 5-hexenyl.

7. A process according to claims 1 or 2 where the organochlorosilane end-blocker is selected from a group consisting of 5-hexenyldimethylchlorosilane, dimethylvinylchlorosilane and trimethylchlorosilane.

8. A process according to claims 1 or 2 where the mole ratio of the chlorine-terminated polydiorganosiloxane polymer to the organofunctional chlorosilane end-blocker is in a range of about 0.5 to 10.0.

9. A process according to claims 1 or 2 where the mole ratio of the water to silicon-bonded chlorine is within a range of greater than about 0.5 to 200.

10. A process according to claims 1 or 2 where the mole ratio of the water to silicon-bonded chlorine is within a range of about 4 to 40.

11. A process according to claims 1 or 2 where the water contains about 25 to 32 weight percent hydrogen chloride.

12. A process according to claims 1 or 2 where the process is conducted at a temperature within a range of about 20°C. to 50°C.

13. A process according to claims 1 or 2 where contact of the mixture with the stoichiometric excess of water containing 5 to 36 weight percent hydrogen chloride is for a time period within a range of about 0.1 to 18 hours.

14. A process according to claims 1 or 2 where contact of the mixture with the stoichiometric excess of water containing 5 to 36 weight percent hydrogen chloride is for a time period within a range of about 0.5 to four hours.

15. A process according to claims 1 or 2 where the isolated organofunctional polydiorganosiloxane copolymers are washed with one or more portions of water.

16. A process according to claim 2 where the mole ratio of the chlorine-terminated polydiorganosiloxane to organofunctional dichlorosilane is within a range of about 0.5 to 5.0.

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EUROPEAN SEARCH REPORT

Application Number
EP 93 30 3492

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
X	DE-B-1 257 435 (DR. ELFRIEDE HUSEMANN) * claim 1 * * column 1, line 39 - column 3, line 3 * * examples 6,7 * ---	1,3-10, 12,15,16	C08G77/20 C08G77/24 C08G77/06
A	US-A-2 507 316 (MCGREGOR AND AL.) * claims * -----	1,2	
			TECHNICAL FIELDS SEARCHED (Int. Cl.5)
			C08G

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	09 AUGUST 1993	HOLLENDER C.J.F

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
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Espacenet

EP0844195A1 Closed container containing a pulverized substance

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Closed container containing a pulverized substance

Abstract

The capsule is made from a material which is impermeable to oxygen and water vapour and is designed to hold roast and ground coffee of which 5-15% of the fine particles are at least 90 mu m in size. The capsule is made from two identical layers of a supple material, circular, oval, or polygonal in shape, or with a round or truncated conical dome (11). It can be made, for example, from aluminium, plastics or a multilayered material, incorporating an oxygen-proof barrier of EVOH or PVDC (vinylidene polychloride), or paper and polyethylene, metallised polyester. Composite materials can also include polypropylene and polyamide.

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DESCRIPTION EP0844195A1

[0001]

The present invention relates to a closed chamber, containing a pulverulent substance for the preparation of a drink chosen from roasted and ground coffee, a mixture of ground coffee and soluble coffee, intended to be extracted under pressure, the material used for said chamber. is impermeable to oxygen and to water vapor for the preservation of said pulverulent substance and said enclosure being open under the effect of the only increase in pressure during the injection of the extraction fluid.

[0002]

There are already many patents mentioning capsules or cartridges intended to be extracted under pressure.

Mention may in particular be made of patent application WO 94/01344 in the name of the applicant. In this patent application, no mention is made of the grain size of roasted and ground coffee used: any grain size is possible. However, it may happen that for certain reasons it is preferable to aim more specifically at a certain particle size.

[0003]

The aim of the present invention is to find a closed chamber, provided for the extraction under pressure, in which the extraction speed is increased, while ensuring a good rate of extraction of the pulverulent substance used.

[0004]

The invention relates to a closed enclosure according to the preamble of claim 1, wherein the roasted and ground coffee has a particle size such that it comprises between 5 and 15% of fines having a size of less than 90 microns respectively for a D (4.3) between 650 and 300 microns and it is compacted or packed.

[0005]

There are several types of grinding possible in the field of coffee.

The most common grinding is done with mills with axial fluted rollers, such as a mill from the Probat Company.

Particles are obtained having a particle size distribution with a higher fines content (more than 10% of fines having a size of less than 90 microns for a D (4.3) of between 650 and 300 microns).

It is therefore contemplated to make a grinding to obtain particles having a particle size distribution reducing the content of fines. This is achieved by grinding on mills with radial fluted rollers, such as a mill from the Matsubo Company. A Gaussian-shaped distribution is obtained in which there is a decrease in the content of fines for D (4.3) as mentioned above.

[0006]

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By D (4.3) is meant the average size of particles based on their diameter according to the Rosin Rammler diagram.

[0007]

The coffee used in the enclosure according to the invention is compacted or packed.

Therefore, if we want to keep a fairly high extraction speed and a good extraction rate, it becomes advantageous to work with a particle size distribution as mentioned in claim 1.

The term "packed" is understood to mean compression under a pressure of the order of one kg to a few tens of kg / cm2. By compacted is meant compression under a pressure of the order of a few hundred kg / cm 2.

[0008]

The particle size is determined with a Malvern Mastersizer-S device with a focal length of 4 to 3500 microns, which works with a laser beam: the particles whose size we want to determine are placed in butanolic suspension, we stir and we passes a laser beam through it.

The reflected beam is studied and the data processing system leads to a statistical distribution of the particle sizes.

[0009]

The closed enclosure according to the invention can be of two types.

The first solution consists in considering a flexible capsule made up of two identical flexible sheets of circular, oval or polygonal shape leaving between them a space for the pulverulent substance and welded on their periphery so that said sachet is substantially symmetrical with respect to its welding plane. The second solution consists in considering a cartridge comprising a cup with a bottom and a side wall having substantially the shape of a truncated cone or of a dome and a circular rim of greater diameter at the bottom and a seal welded to the periphery of the rim of the capsule.

[0010]

In the case of the second solution, the cup, of frustoconical shape and semi-rigid in nature, can be made of aluminum with a thickness of the order of 20 to 100 microns, of pure or multi-layered plastic with optionally an oxygen barrier layer such as EVOH or PVDC, of a multi-layer film such as cardboard, aluminum, plastic or cardboard, plastic with optionally an oxygen barrier layer such as EVOH or PVDC. The capsule cover, which is flexible in nature, can be made of aluminum with a thickness of the order of 15 to 60 microns, or of a multi-layer film comprising either paper of 20 to 60 g / m2 , plastic such as PE with a thickness of the order of 20 to 60 microns and aluminum with a thickness of 5 to 20 microns, or EVOH or PVDC with a thickness of 5 to 30 microns and plastic (PP, PE, PA) of the order of 20 to 100 microns, either PET (5 to 30 microns) and plastic (PP, PE) from 20 to 100 microns, or metallized PET or a high barrier layer such as SiO2.

[0011]

In the case of the first solution, the sheets can be made of flexible material such as aluminum with a thickness of the order of 5 to 40 microns or plastic such as PET. Preferably, the sheets will be made of a flexible multi-layer material suitable for welding by the usual methods while constituting sufficient protection of the product against oxygen and water vapor.

The following combination of materials is recommended:

outer layer: PET (normal, woven, or non-woven), PE, PP, PA, PS or paper

high barrier central layer: aluminum with a thickness of around 5 to 20 microns, EVOH, PVDC, PET or PVA

inner layer: plastic, preferably PE or PP or OPP. The following multi-layer combinations can be considered: PET-EVOH-PE or PET-aluminum-PE.

[0012]

For the first and second solution, the coffee is tamped or compacted.

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Preferably, for the first solution, the coffee is compacted and for the second solution, it is compacted.

[0013]

The remainder of the description is made with reference to the drawings, in which

Fig. 1 is a representation of the amount of fines for a certain average particle size D (4.3),

Fig. 2 is a global representation of particle sizes with a Matsubo mill,

Fig. 3 is a global representation of particle sizes with a Probat mill,

Fig. 4 is a schematic representation of the flexible capsule that can be used and

Fig. 5 is a schematic representation of the usable cartridge.

[0014]

The aim of the present invention is to have a capsule or a cartridge ready for use, in which, on a basis of capacity of 4 to 12 g of roasted and ground coffee, it is possible to obtain a cup of coffee of given volume. in less time than with a Probat grind while maintaining the same extraction rate.

[0015]

To do this, it is necessary to limit the content of fines.

This result is achieved for enclosures containing fines according to curve C in figure 1.

This grain size is obtained with a Matsubo mill.

On the abscissa, we represent the D (4.3), that is to say the average size of the particles in microns: each point corresponds to a grind.

The ordinate shows the content of fines, that is to say the content of particles having a dimension of less than 90 microns.

By way of comparison, we see on curve D the particle size distribution with a Probat mill: For identical D (4.3) values, we have a higher fines content.

[0016]

FIG. 2 represents on the one hand the particle size distribution from a logarithmic scale on the abscissa: it is the Gaussian A, the left ordinate indicating the content in% for each particle size.

The maximum can be seen at 410 microns and the average particle size D (4.3) is 383 microns.

[0017]

Curve B sums the different grain sizes to go from 0 to 100%: right ordinate.

[0018]

For comparison, Figure 3 shows the same particle size distribution, but with a Probat mill.

Curve E indicates the Gaussian on the same scale as the previous figure, from which the higher content of fines clearly emerges.

Curve F sums the different particle sizes and if we compare with curve B, we can clearly see a higher content at 100 microns.

In this case, on curve E, the maximum is at 409 microns and the D (4.3) at 380 microns.

[0019]

Figure 4 shows a flexible capsule containing roasted and ground coffee with the grain sizes according to Figures 1 (C) and 2 above.

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The bag (1) of circular shape comprises two sheets of flexible material (2) and (3) welded on their periphery (4) by heat sealing and containing ground roasted coffee (5) compacted for the preparation of a drink.

The compacted coffee has convex faces (35), the general shape of its section being circular, as well as that of the bag.

The purpose of the cylindrical blank (38) of the wafer is to avoid the undesirable presence of grains in the welding zone.

[0020]

With regard to FIG. 5, the cartridge (11) comprises a cup (12) with a bottom (15) and a side wall of frustoconical shape (16).

The cup is made of 50 micron thick aluminum.

The cartridge contains roasted coffee (13) and it is closed by a cover (14) made of aluminum / paper composite.

This cover is welded to the periphery (17) of the rim of the cup.

[0021]

The remainder of the description is given with reference to the examples.

Examples 1 to 3

[0022]

The tests are carried out with a capsule according to FIG. 4 successively containing 4.6, 5 and 5.2 g of roasted and ground coffee having a D (4.3) of 355 microns.

[0023]

An extraction is carried out on a machine according to patent application WO 94/02059.

We prepare a cup of coffee of 50 g.

For the first capsule, the cup is obtained in 22 seconds with a Matsubo grind, while it takes 28 seconds. to get the same amount with a Probat grind.

If we now look at the extraction rate, we see that they are identical.

[0024]

For the 5 g capsule, with the grind according to the invention, a 50 g cup is obtained in 21 sec. whereas with a Probat grind it takes 24 seconds.

Again, the extraction rates are identical.

[0025]

Finally, for the 5.2 g capsule, we obtain in 20 sec. a 50 g cup of coffee with a grind according to the invention, while 26 sec. with Probat ground coffee.

The extraction rates are always the same.

[0026]

It is therefore possible to obtain, with an enclosure according to the invention, a more rapid extraction of the coffee.

Abbreviations.

[0027]

PVDC

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= Polyvinylidene chloride

EVOH

= Ethylene vinyl alcohol copolymer

PP

= Polypropylene

PE

= Polyethylene

PET

= Polyester

PA

= Polyamide

PVA

= polyvinyl alcohol

OPP

= Oriented polypropylene

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CLAIMS EP0844195A1

1.

Closed enclosure, containing a pulverulent substance for the preparation of a drink chosen from roasted and ground coffee, a mixture of ground coffee and soluble coffee, intended to be extracted under pressure, the material used for said enclosure is impermeable to water. oxygen and water vapor for the preservation of said pulverulent substance and said enclosure being open under the effect of the sole increase in pressure during the injection of the extraction fluid, characterized in that the roasted and ground coffee to a particle size such that it comprises between 5 and 15% of fines having a size of less than 90 microns respectively for a D (4.3) of between 650 and 300 microns and it is compacted or packed.

2.

Closed enclosure according to claim 1, said enclosure being a flexible capsule made up of two identical flexible sheets of circular, oval or polygonal shape leaving between them a space for the pulverulent substance and welded on their periphery so that said bag is substantially symmetrical compared to its welding plan.

3.

Closed enclosure according to claim 1, said enclosure being a cartridge comprising a cup with a bottom and a side wall having substantially the shape of a truncated cone or a dome and a circular rim of greater diameter than the bottom and a welded cover around the edge of the capsule.

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(54) Enceinte fermée contenant une substance pulvérulente

(57) L'invention concerne une enceinte fermée,contenant une substance pulvérulente pour la préparation d'une boisson choisie parmi le café torréfié et moulu, un mélange de café moulu et de café soluble, prévue pour être extraite sous pression, ladite enceinte étant ouverte sous l'effet de la seule montée en pression lors de l'injection du fluide d'extraction, dans laquelle le café torréfié et moulu à une dimension particulaire telle qu'il comprend entre 5 et 15 % de fines ayant une taille de moins de 90 microns respectivement pour un D(4,3) compris entre 650 et 300 microns (courbe C) et il est compacté ou tassé.

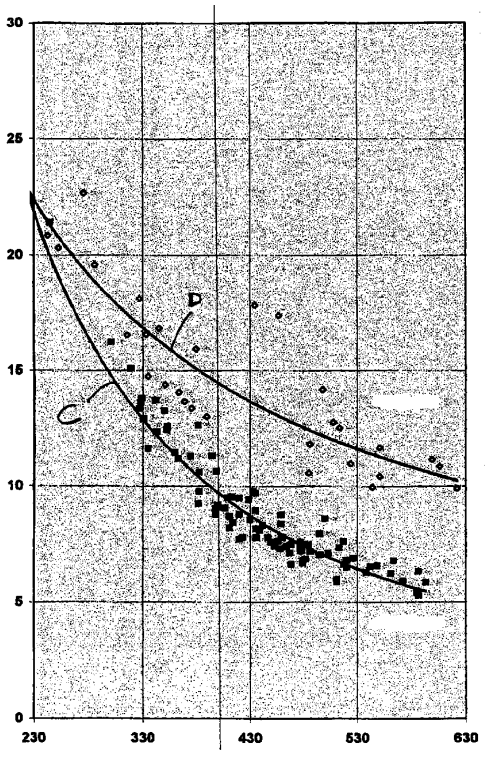


FIG. 1

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Description

La présente invention concerne une enceinte fermée, contenant une substance pulvérulente pour la préparation d'une boisson choisie parmi le café torréfié et moulu, un mélange de café moulu et de café soluble, prévue pour être extraite sous pression, le matériau utilisé pour ladite enceinte est imperméable à l'oxygène et à la vapeur d'eau pour la conservation de ladite substance pulvérulente et ladite enceinte étant ouverte sous l'effet de la seule montée en pression lors de l'injection du fluide d'extraction.

Il existe déjà de nombreux brevets mentionnant des capsules ou des cartouches prévues pour être extraites sous pression. On peut citer notamment la demande de brevet WO 94/01344 au nom de la demanderesse. Dans cette demande de brevet, il n'est fait aucune mention de la granulométrie de café torréfié et moulu utilisé : toute granulométrie est possible. Il peut arriver cependant que pour certaines raisons, il soit préférable de viser plus spécifiquement une certaine granulométrie.

Le but de la présente invention est de trouver une enceinte fermée, prévue pour l'extraction sous pression, dans laquelle on augmente la vitesse d'extraction , tout en garantissant un bon taux d'extraction de la substance pulvérulente utilisée.

L'invention concerne une enceinte fermée selon le préambule de la revendication 1, dans laquelle le café torréfié et moulu à une dimension particulaire telle qu'il comprend entre 5 et 15 % de fines ayant une taille de moins de 90 microns respectivement pour un D(4,3) compris entre 650 et 300 microns et il est compacté ou tassé.

Il existe plusieurs types de mouture possible dans le domaine du café. Le mouturage le plus répandu se fait avec des moulins avec rouleaux à cannelures axiales, comme par exemple un moulin de la Société Probat. On obtient des particules ayant une distribution granulométrique avec une teneur en fines plus élevée (plus de 10 % de fines ayant une taille de moins de 90 microns pour un D(4,3) compris entre 650 et 300 microns). On envisage par conséquent de faire un mouturage pour obtenir des particules ayant une distribution granulométrique réduisant la teneur en fines. On arrive à ce résultat en faisant le mouturage sur des moulins avec rouleaux à cannelures radiales, comme par exemple un moulin de la Société Matsubo. On obtient une distribution en forme de gaussienne dans laquelle on a une diminution de la teneur en fines pour le D(4,3) tel que mentionné ci-dessus.

Par D(4,3) on entend la grandeur moyenne de particules basée sur leur diamètre selon le diagramme de Rosin Rammler.

Le café utilisé dans l'enceinte selon l'invention est compacté ou tassé. De ce fait,si on veut conserver une vitesse d'extraction assez élevée et un bon taux d'extraction, il devient avantageux de travailler avec une distribution granulométrique comme mentionnée dans la revendication 1. Par tassé, on entend une compression sous une pression de l'ordre du kg à quelques dizaines de kg/cm2. Par compacté, on entend une compression sous une pression de l'ordre de quelques centaines de kg/cm2.

La détermination de la taille des particules se fait avec un appareil Malvern Mastersizer-S avec une focale de 4 à 3500 microns, qui travaille avec un faisceau laser : on met en suspension butanolique les particules dont on veut déterminer la taille, on agite et on y fait passer un rayon laser. On étudie le faisceau réfléchi et le système de traitement de données conduit à une distribution statistique des tailles de particules.

L'enceinte fermée selon l'invention peut être de deux types. La première solution consiste à envisager une capsule souple constituée de deux feuilles souples identiques de forme circulaire, ovale ou polygonale ménageant entre elles un espace pour la substance pulvérulente et soudées sur leur périphérie de manière à ce que ledit sachet soit sensiblement symétrique par rapport à son plan de soudage. La seconde solution consiste à envisager une cartouche comprenant une coupelle avec un fond et une paroi latérale ayant sensiblement la forme d'un tronc de cône ou d'un dôme et un rebord circulaire de diamètre supérieur au fond et un opercule soudé sur le pourtour du rebord de la capsule.

Dans le cas de la seconde solution, la coupelle, de forme tronconique et de nature semi-rigide, peut être constituée d'aluminium d'une épaisseur de l'ordre de 20 à 100 microns, de plastique pur ou multi-couches avec éventuellement une couche barrière à l'oxygène telle que l'EVOH ou le PVDC, d'un film multi-couches tel que carton, aluminium, plastique ou carton, plastique avec éventuellement une couche barrière à l'oxygène telle que l'EVOH ou le PVDC. L'opercule de la capsule , de nature souple, peut être constitué d'aluminium d'une épaisseur de l'ordre de 15 à 60 microns, ou d'un film multi-couches comprenant soit du papier de 20 à 60 g/m2, du plastique tel que le PE d'une épaisseur de l'ordre de 20 à 60 microns et de l'aluminium d'une épaisseur de 5 à 20 microns, soit de l'EVOH ou du PVDC d'une épaisseur de 5 à 30 microns et du plastique (PP,PE, PA) de l'ordre de 20 à 100 microns, soit du PET (5 à 30 microns) et du plastique (PP,PE) de 20 à 100 microns, soit du PET métallisé ou d'une couche haute barrière telle que SiO2.

Dans le cas de la première solution, les feuilles peuvent être faites de matériau souple tel que de l'aluminium d'une épaisseur de l'ordre de 5 à 40 microns ou du plastique tel que le PET. Préférentiellement les feuilles seront constitués d'un matériau multi-couche souple se prêtant au soudage par les méthodes usuelles tout en constituant une protection suffisante du produit face à l'oxygène et à la vapeur d'eau. La combinaison suivante de matériaux est recommandée :

couche extérieure : PET (normal,tissé, ou non tissé),PE, PP, PA, PS ou papier

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couche centrale haute barrière : aluminium d'une épaisseur de l'ordre de 5 à 20 microns, EVOH, PVDC, PET ou PVA

couche intérieure : plastique, , de préférence PE ou PP ou OPP. On peut envisager les combinaisons multi-couches suivantes : PET-EVOH-PE ou PET-aluminium-PE.

Pour la première et la seconde solution, le café est tassé ou compacté. De préférence, pour la première solution, le café est compacté et pour la seconde solution, il est tassé.

La suite de la description est faite en référence aux dessins, sur lesquels

Fig. 1 est une représentation de la quantité de fines pour une certaine taille moyenne de particules D(4,3),

Fig. 2 est une représentation globale des tailles de particules avec un moulin Matsubo,

Fig. 3 est une représentation globale des tailles de particules avec un moulin Probat,

Fig. 4 est une représentation schématique de la capsule souple utilisable et

Fig. 5 est une représentation schématique de la cartouche utilisable.

Le but de la présente invention est d'avoir une capsule ou une cartouche prête à l'emploi, dans laquelle sur une base de contenance de 4 à 12 g de café torréfié et moulu, on arrive à obtenir une tasse de café de volume donné en moins de temps qu'avec une mouture Probat tout en maintenant le même taux d'extraction.

Pour ce faire, il faut limiter la teneur en fines. Ce résultat est atteint pour des enceintes contenant des fines selon la courbe C de la figure 1. Cette granulométrie est obtenue avec un moulin Matsubo. En abscisse, on représente le D(4,3), c'est-à-dire la taille moyenne des particules en microns : chaque point correspond à une mouture. En ordonnées, on représente la teneur en fines, c'est-à-dire la teneur en particules ayant une dimension inférieure à 90 microns. A titre de comparaison, on voit sur la courbe D la distribution granulométrique avec un moulin Probat : Pour des valeurs de D(4,3) identiques, on a une teneur en fines plus élevée.

La figure 2 représente d'une part la répartition granulométrique à partir d'une échelle logarithmique en abscisse : c'est la gaussienne A, l'ordonnée de gauche indiquant la teneur en % pour chaque granulométrie. On voit bien le maximum à 410 microns et la taille moyenne de particules D(4,3) est de 383 microns.

La courbe B somme les différentes granulométries pour passer de 0 à 100 % : ordonnée de droite.

A titre de comparaison, le figure 3 montre la même répartition granulométrique, mais avec un moulin Probat. La courbe E indique la gaussienne à la même échelle que la figure précédente, d'où il ressort bien la teneur plus élevée en fines. La courbe F somme les différentes granulométries et si on compare avec la courbe B, on voit bien une teneur plus élevée à 100 microns. Dans ce cas, sur la courbe E, le maximum est à 409 microns et le D(4,3) à 380 microns.

La figure 4 montre une capsule souple contenant du café torréfié et moulu avec les granulométries selon les figures 1 (C) et 2 ci-dessus. Le sachet (1) de forme circulaire comporte deux feuilles de matière souple (2) et (3) soudées sur leur périphérie (4) par thermoscellage et contenant du café torréfié moulu (5) compacté pour la préparation d'une boisson. La café compacté présente des faces convexes (35), la forme générale de sa section étant circulaire , ainsi que celle du sachet. Le flan cylindrique (38) de la galette a pour but d'éviter la présence indésirable de grains dans la zone de soudage.

S'agissant de la figure 5, la cartouche (11) comporte une coupelle (12) avec un fond (15) et une paroi latérale de forme tronconique (16). La coupelle est en aluminium d'épaisseur 50 microns. La cartouche contient du café torréfié (13) et elle est fermée par un opercule (14) en composite aluminium/papier. Cet opercule est soudé sur le pourtour (17) de rebord de la coupelle.

La suite de la description est faite en référence aux exemples.

Exemples 1 à 3

On effectue les essais avec une capsule selon la figure 4 contenant successivement 4,6 , 5 et 5,2 g de café torréfié et moulu ayant un D(4,3) de 355 microns.

On fait une extraction sur une machine selon la demande de brevet WO 94/02059. On prépare une tasse de café de 50 g. Pour la première capsule, on obtient la tasse en 22 secondes avec une mouture Matsubo, alors qu'il faut 28 sec. pour obtenir la même quantité avec une mouture Probat. Si on regarde maintenant le taux d'extraction, on constate qu'ils sont identiques.

Pour la capsule de 5 g, avec la mouture selon l'invention, on obtient une tasse de 50 g en 21 sec. alors qu'avec une mouture Probat il faut 24 secondes.Là également, les taux d'extraction sont identiques.

Finalement, pour la capsule de 5,2 g, on obtient en 20 sec. une tasse de café de 50 g avec une mouture selon l'invention, alors qu'il faut 26 sec. avec du café à mouture Probat. Les taux d'extraction sont toujours identiques.

On arrive donc à obtenir avec une enceinte selon l'invention une extraction plus rapide du café.

Abréviations.

PVDC = Polychlorure de vinylidène

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EVOH = Copolymère d'éthylène et d'alcool de vinyle
PP = Polypropylène
PE = Polyéthylène
PET = Polyester
PA = Polyamide
PVA = alcool polyvinylique
OPP = Polypropylène orienté

Revendications

1. Enceinte fermée,contenant une substance pulvérulente pour la préparation d'une boisson choisie parmi le café torréfié et moulu, un mélange de café moulu et de café soluble, prévue pour être extraite sous pression, le matériau utilisé pour ladite enceinte est imperméable à l'oxygène et à la vapeur d'eau pour la conservation de ladite substance pulvérulente et ladite enceinte étant ouverte sous l'effet de la seule montée en pression lors de l'injection du fluide d'extraction, caractérisée en ce que le café torréfié et moulu à une dimension particulaire telle qu'il comprend entre 5 et 15 % de fines ayant une taille de moins de 90 microns respectivement pour un D(4,3) compris entre 650 et 300 microns et il est compacté ou tassé.

2. Enceinte fermée selon la revendication 1, ladite enceinte étant une capsule souple constituée de deux feuilles souples identiques de forme circulaire, ovale ou polygonale ménageant entre elles un espace pour la substance pulvérulente et soudées sur leur périphérie de manière à ce que ledit sachet soit sensiblement symétrique par rapport à son plan de soudage.

3. Enceinte fermée selon la revendication 1, ladite enceinte étant une cartouche comprenant une coupelle avec un fond et une paroi latérale ayant sensiblement la forme d'un tronc de cône ou d'un dôme et un rebord circulaire de diamètre supérieur au fond et un opercule soudé sur le pourtour du rebord de la capsule.

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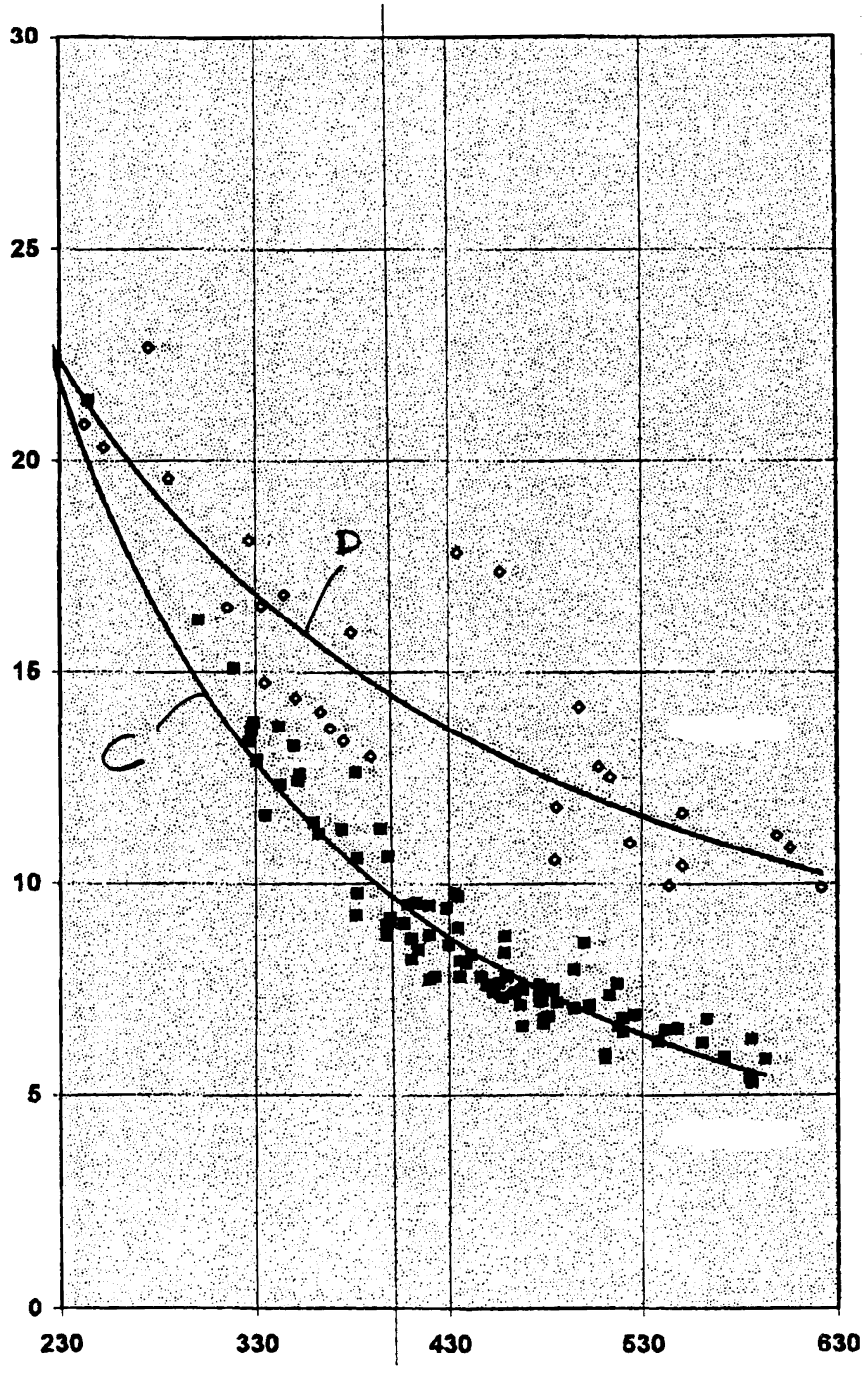


FIG. 1

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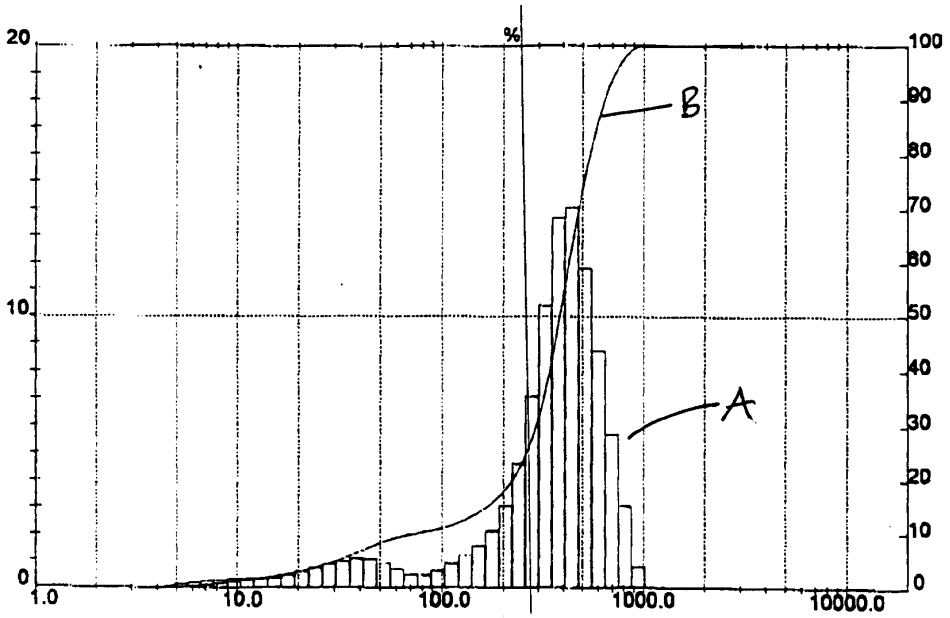


FIG. 2.

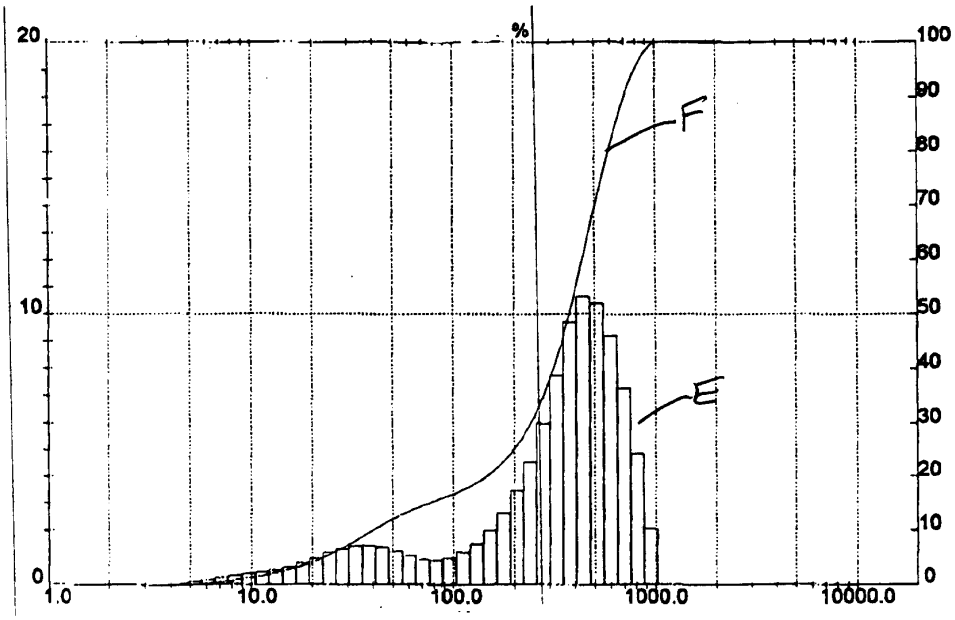


FIG. 3

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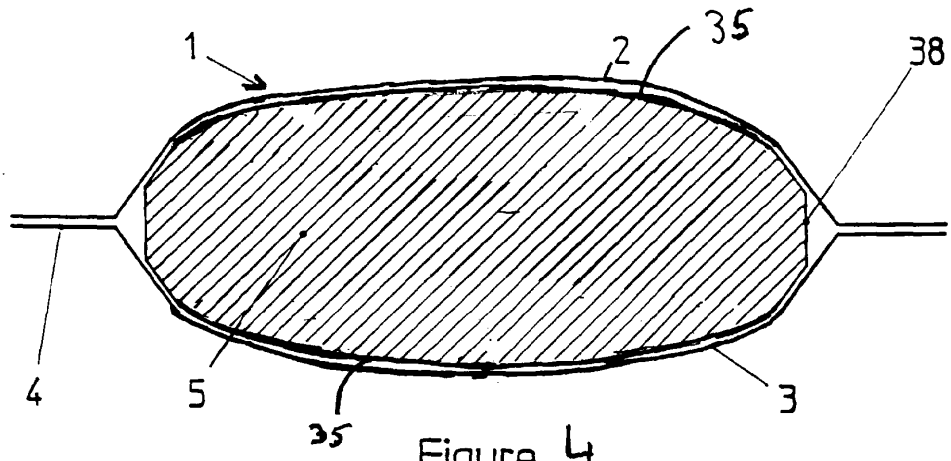


Figure 4

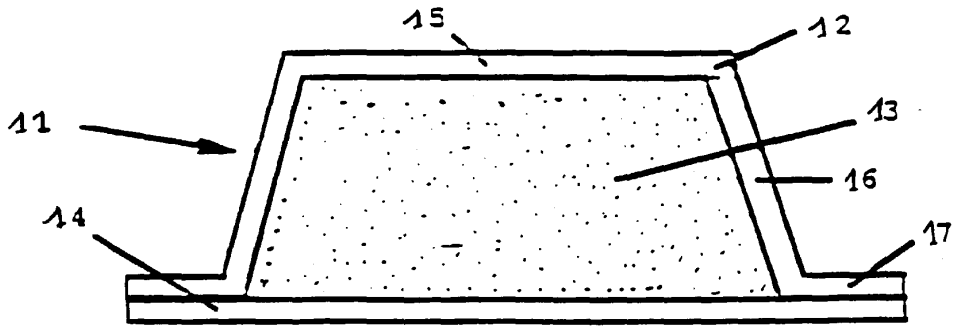


FIGURE 5

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RAPPORT DE RECHERCHE EUROPEENNE

Numero de la demande
EP 96 20 3230

DOCUMENTS CONSIDERES COMME PERTINENTS

Catégorie	Citation du document avec indication, en cas de besoin, des parties pertinentes	Revendication concernée	CLASSEMENT DE LA DEMANDE (Int.Cl.6)
X,D	WO 94 01344 A (SOC D PRODUITS NESTLE S A ;FOND OLIVIER (CH); PLEISCH JEAN PIERRE) 20 Janvier 1994 * abrégé * * page 2, dernier alinéa - page 3, alinéa 2 *	1,2	B65D81/00
X	EP 0 512 468 A (NESTLE SA) 11 Novembre 1992 * abrégé * * colonne 2, ligne 50 - ligne 31; figures *	1,3	
A	EP 0 398 524 A (HAG AG) 22 Novembre 1990 * page 1, ligne 36 - page 2, ligne 15 *	1-3	
A	EP 0 398 530 A (HAG AG) 22 Novembre 1990 * abrégé * * page 4, ligne 17 - ligne 27; exemples *	1-3	
A	EP 0 554 469 A (NESTLE SA) 11 Août 1993 * page 3, ligne 29 - page 4, ligne 36 *	1-3	DOMAINES TECHNIQUES RECHERCHES (Int.Cl.6) B65D
A	US 4 254 694 A (ILLY ERNESTO) 10 Mars 1981 * colonne 4, ligne 19 - ligne 46 *	1-3	

Le présent rapport a été établi pour toutes les revendications

Lieu de la recherche	Date d'achèvement de la recherche	Examinateur
BERLIN	20 Mars 1997	Olsson, B

CATEGORIE DES DOCUMENTS CITES

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(54) Brewing device for capsule with closure mechanism of variable transmission ratio

(57) Brewing device for the brewing of a capsule containing a beverage ingredient comprising
- a main frame (2),
- a first capsule holding part (5),
- a second capsule holding part (6; 66) for at least partially holding the capsule mobile relative to the first capsule holding part (5) in the frame (2) and linked to the frame by a closing mechanism (23, 31) comprising knuckle joint means or equivalent means;
- a manual handle (21) forming lever to activate via the closing mechanism the second holding part from the open position to the closed position and vice versa.

The closing mechanism (23, 31) comprises additional force transmission means (31) associated to the handle arranged to de-multiply the force applied by the handle (21; 69) on the knuckle joint means that compensates for the increase of the force needed for closing the holding parts on the capsule.

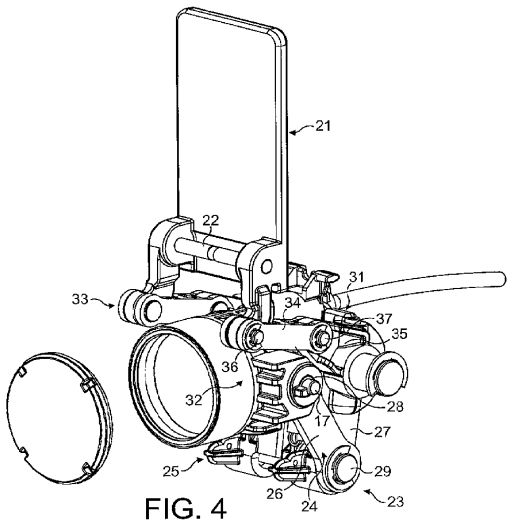


FIG. 4

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Description

[0001] The invention generally relates to a brewing device of a beverage or a liquid comestible adapted to handle a capsule containing ingredient(s) which is able to produce a beverage or liquid comestible when interacting with a liquid, such as for example, hot pressurized water, introduced into the volume of the capsule.

[0002] Especially in the field of coffee machines, machines have been widely developed in which a capsule containing beverage ingredients is inserted in a brewing device. The brewing device is tightly closed about the capsule, water is injected at the first face of the capsule, the beverage is produced in the closed volume of the capsule and a brewed beverage can be drained from a second face of the capsule and collected into a receptacle such as a cup or glass.

[0003] Brewing devices have been developed to facilitate insertion of a "fresh" capsule and removal of the waste one.

[0004] WO 2005/004683 relates to such a brewing device which comprises:

- a frame,
- a fixed holding part for the capsule,
- a mobile holding part; said part being mounted relative to the frame in a sliding relationship,
- a knuckle joint mechanism that provides a mechanical system which enables to close in a steady and fluid-tight manner the holding parts about the capsule while also resisting to the counter-force acting in re-opening and generated by the internal brewing pressure; and
- a handle for directly levering the knuckle joint mechanism.

[0005] Such a device provides a simple assembly enabling insertion of the capsule by vertical fall through a passage in the frame and removal of the waste capsule in the same direction as the insertion direction.

[0006] Although such device is easy to use and reliable, there are still a few disadvantages. In particular, the device may be relatively hard to close by the lever and/or may not be compact enough. Compactness depends on several technical factors and constraints which are necessary for a proper functioning of the device. The closure cinematic is such that a relatively long lever is needed to transfer a force sufficient to close the knuckle joint mechanism from the manual force exerted by the user on the lever. The manual force depends on the setting of the closing forces of the knuckle joint mechanism which depends on the tightening force exerted about the capsule to provide a fluid tight and pressure resistant system. Therefore, in order for the manual force to remain acceptable, the lever arm must be increased so to exert the necessary torque on the knuckle mechanism. Furthermore, the length of the lever necessitates to position the lever at the rear of the device which is so not optimal since it requires the user to extend his arm to grab the lever from a point relatively remote from the front of the machine and to describe a large arc of circle to close the device. The available room might not be sufficient (in particular in cramped kitchens) to accommodate such design of device or to carry out a comfortable operation of the machine.

[0007] In certain systems, the closure forces must also be sufficient to enable a side of the capsule to be perforated. For instance, the entry side of the capsule is perforated during closure to allow the introduction of the injection fluid in the capsule after closure. The forces required to pierce the capsule can be relatively important when the ingredient is in a compacted form in the capsule rather than in a loose form. The material the capsule is made of also influences on the required closure forces of the device. Therefore, the increase of the force required for piercing the capsule, in particular, those containing a compacted substance, imposes a greater effort on the handle by the user at a level which is not acceptable. Therefore, there is a need for reducing the effort on the handle while providing the required force to pierce the capsule correctly during closure of the device about the capsule.

[0008] Furthermore, the known device is linked to a water line that needs to be both flexible and long enough to compensate for the displacement of the mobile holding part during closure/opening cycles. The water line extension thus requires a relatively large internal volume of the frame to avoid the line to be squeezed or bent which could cause water flow disruption or flow rate control issues.

[0009] In view of the above problems, it is an object of the present invention to propose a device that, according to several possible embodiments, requires relatively less manual closure force for a same lever arm or requires a smaller lever arm for a same force for closing the brewing parts in a steady way about the capsule.

[0010] There is a need for a device that provides also high closure forces on the capsule to pierce and/or provide a sufficiently tight seal engagement in the device while not impacting on the ease of closing and at a level of manual effort which remains acceptable for the user.

[0011] There is also a need for a simple and low cost device without affecting the technical constraints, in particular, the need for relatively high closing forces.

[0012] There is a need for a device that can be built in a more compact design while keeping the closing efficiency and reliability of the existing brewing device, in particular, while providing a fluid-tight and pressure resistant closure.

[0013] These objects are achieved by means of the features of the independent claims. The dependent claims develop further the central idea of the present in-

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vention.

[0014] A first aspect of the invention so relates to a brewing device for the brewing of a capsule containing a beverage ingredient comprising:

- a main frame,
- a first capsule holding part,
- a second capsule holding part for at least partially holding the capsule; said capsule holding part being mobile relative to the first capsule holding part in the frame and linked to the frame by a closing mechanism comprising knuckle joint means to move from an open position at which the two parts are distant one another to enable the insertion of the capsule between the two parts and a closed position at which the first and second holding parts are closed about the capsule;
- a handle forming a lever means arranged to activate via the closing mechanism the second holding part from

the open position to the closed position and vice versa, characterized in that:

the closing mechanism comprises additional force transmission means associated to the handle arranged to de-multiply the force applied by the handle on the
knuckle joint means that compensates for the increase of the force needed for closing the holding parts on the capsule.

[0015] In a first mode, the force transmission means comprise additional force levers adapted to demultiply the force of the handle onto the knuckle joint means.

[0016] This configuration offers the opportunity for a more compact design. Since less force is required for a same lever arm, the manual handle can be shortened and positioned in a more effective and convenient manner.

[0017] In a possible mode, the knuckle joint means is composed of at least one pair of rods, preferably, two pairs of rods placed in parallel, which are linked on a first end to the mobile holding part and the other end fixed in rotation to the frame. The second end of the said at least one pair of rods is also linked in rotation to the force transmission means instead of being linked in rotation to the handle directly. As a result, an angle unit (i.e., a delta A of 1 degree) in the angular course of the lever will transfer the effort to a smaller displacement of the knuckle joint means at the end of the angular course of the handle; (i.e., where the "hard point" of the knuckle joint means must be overcome), than at the beginning of the angular course. This results in less manual efforts to be engaged on the handle when the hard point is overcome; therefore, providing the opportunity of reducing the lever arm as compared to the existing systems of given torque.

[0018] In a mode, the handle is placed in a position relatively above and forward the rear transmission point that is fixed to the frame. This configuration has been found more efficient for the proper transmission of the efforts via the force transmission means while participating at the same time to a compact brewing design. Indeed, the force transmission means extends substantially above the knuckle joint means between it and the handle; therefore, acting by force demultiplication on the knuckle joint means without taking too much additional space. The handle describes a smaller arc-shaped path during operation and it also becomes more accessible to the user.

[0019] Preferably, the handle is also articulated to the upper of the frame. Again this participates to the effectiveness of the engaged forces and to the ergonomics of the device.

[0020] Furthermore, the handle can be shorter in length than the length of the assembly formed by the second holding part and the knuckle joint means when in extension in the closing position. In particular, the handle can be shorter than the length of the assembly without detriment to the ease of closing the device by an adult user. For instance, the handle can be 25% shorter or more.

[0021] For instance, the force transmission means are configured in relation to the handle and knuckle joint means so that the at least 50 last percent of the handle's course is utilized to displace the course of the knuckle joint means of about or less than the last 20%, more preferably less than the last 10%.

[0022] The course of the knuckle joint means is determined hereby as being the transversal or "vertical" distance travelled by the knee point with respect to a centre line passing through the two axis of the rotating ends of the rod means.

[0023] Preferably, the brewing device of the invention is oriented for being able to perform easy insertion and removal or ejection of the capsule. For this, the second holding part is arranged to slide in a substantially horizontal direction within the frame. The device can further comprise a passage adapted for the vertical fall of the capsule between the two holding parts. Therefore, the insertion of the capsule can be carried out in a manner similar to a moneybox. Capsule retaining means are also provided between the two holding parts to retain the capsule in a predefined position before closure. These retaining means can be identical to the solutions described in WO 2005/004683.

[0024] In another preferred embodiment of the invention, the brewing unit for the brewing of a capsule containing beverage ingredients comprises a frame and a first and second capsule holding members for at least partially enclosing the capsule during brewing. The first holding member can be mobile along the frame between an open and a closed position in relation to the second

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holding member. A closing mechanism is provided to actuate the first holding member between the two positions comprising an actuation member. The closing mechanism comprises gear means able to transfer the torque provided by the actuation member into translational closure forces on the first holding member.

[0025] Preferably, the gear means is arranged so that the transmission rate varies progressively during rotation therefore enabling to compensate for the increase of the force required to pierce and/or tightly enclose the capsule by the holding parts.

The gear means can comprise a pair of spur gears having non-circular transversal sections. In particular, each spur gear has a longer transversal radius and the respective transversal radiuses are positioned in intermeshing relationship at about 90 degrees one another.

[0026] The actuation member is preferably a handle or, alternatively, can be motor with a drive shaft. Another advantage of the invention can be indeed to offer the opportunity to reduce the effort to be exerted by a motor for a motorized brewing device; therefore making significant savings on the motor cost and/or energy consumption.

[0027] In another aspect of the invention, the brewing device for the brewing of a capsule containing a beverage ingredient comprises:

- a main frame,
- a first capsule holding part,
- a second capsule holding part for at least partially holding the capsule; said capsule holding part being mobile relative to the first capsule holding part,
- water supply means connected to second holding part configured to inject water in the said part,

characterized in that:

the water supply means comprises a length compensatory tube portion which is fixed relatively to the frame whereas the second holding part can move with respect to said length compensatory tube portion.

[0028] Therefore, the length compensatory tube portion of the water supply means, that is necessary to compensate for the relative movement of the holding portion from the closed to the opening position of the device, is meant to remain in a relatively static configuration. Such a configuration of the water supply means enables to eliminate the volume necessary to absorb the displacement of the tube during opening of the device. The length of the tube may also be significantly reduced. The water tube is less submitted to mechanical stresses such as repeated flexure bending or torsions that may affect the brewing conditions (pressure, flow rate, temperatures,...) and therefore its lifetime is improved.

[0029] More particularly, the length compensatory tube portion is mounted relatively to the second holding part so that it inserts itself at least partly in the holding part as the holding part moves to the open position. The length compensatory tube portion can slide at least partially in a passage of the capsule holding part as said holding part moves toward its opening position. The passage can be formed of a hollow metal tube that is part of or connected to the holding part and can guide the portion of tube in sliding engagement while reducing the mechanical stresses on the portion of tube itself. In a possible mode, a portion of the compensatory tube moves inside the holding part to assist in ejecting the capsule from the holding part when the holding parts are opened.

Further advantages, features and objects of the present invention will become evident from the following detailed description of preferred embodiments of the present invention in conjunction with the figures of the enclosed drawings.

Fig. 1 shows in perspective a brewing device for a beverage production machine according to a first mode of the present invention,
Fig. 2 shows a cross sectional and longitudinal view of the brewing device of Fig. 1,
Fig. 3 shows in perspective the brewing device of Figs. 1 and 2 but in open position,
Fig. 4 shows a simplified perspective view of the brewing device without the frame and in open position,
Fig. 5 is a side view of Fig. 4,
Fig. 6 shows a simplified perspective view of the brewing device in intermediate position,
Fig. 7 is a side view of Fig. 6,
Fig. 8 shows a simplified perspective view of the brewing device in closed position,
Fig. 9 is a side view of Fig. 8,
Fig. 10 shows a cross sectional view of a variant of the invention comprising the fixed compensatory tube means,
Fig. 11 shows a perspective view of a brewing device according to another embodiment of the invention in the open position for inserting a capsule therein,
Fig. 12 shows the embodiment of Fig. 11 in perspective view with the sidewall removed,
Fig. 13 shows a perspective view with the sidewall removed of the brewing device of Fig. 11 in closed position,
Fig. 14 shows a side view taken along a median vertical plane of the brewing device of Fig. 11,
Fig. 15 shows a side view taken along a median vertical plane of the brewing device of Fig. 11 in closed position,
Fig. 16 shows a schematic view of the variable transmission rate of the gear means of the embodiment of Figs 12 to 15.

[0030] Before referring in detail to the figures of the enclosed drawings, the following definitions are given for clarity:

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- The term "beverage" encompasses both drinkable liquids and liquid comestibles such as (but not limited to) soups and the like.
- The term "capsule" is any receptacle enclosing a beverage ingredient in dry, liquid, solid or other form. The capsule can have a hard envelope or a soft envelope. It can be made of a same material or of different materials. It can be hermetically sealed (e.g., an aluminium body and membrane) or not (e.g., partially or totally porous) .
- The term "brewing" and "brewing device" refers to, respectively, all kind of interactions between a liquid and ingredients, such as pressure extraction, mixing, dissolving, infusing, etc., and technical modules as part of a beverage machine capable of handling a capsule to provide the brewing process.
- The spatial relationship of the brewing device can also be changed without departing from the scope of the invention. In particular, although the brewing device is described in a horizontal arrangement and references are made to "front" and "rear directions" for the ease of comprehension; the device could be arranged in other spatial configuration, i.e., vertical or inclined.

[0031] Figs. 1 and 2 show an overview of a first embodiment of the brewing device or module of the present invention.

[0032] The brewing device for a capsule can be integrated in different beverage production machines, especially coffee machines. It can constitute an independent module, which only needs to be connected to a supply and for pressurized water (supplied e.g. from a pump connected to a thermoblock, boiler or another type of heater).

[0033] The brewing device 1 of the invention comprises a main frame 2 generally made of a durable material such as aluminium, stainless steel, copper or hard plastic or combinations thereof. The frame extends on the front of the device by a beverage delivery outlet 3 and on the rear of the device by a housing 4 of substantially tubular configuration. The frame thus extends substantially horizontally along median horizontal plane I. The delivery outlet includes an internal channel that is configured for collecting the beverage and for delivering it downwards in direction A.

[0034] The device further comprises capsule holding portions, respectively, a first or front holding portion 5 and a rear holding portion 6; both of which cooperate together to hold the capsule in place during the brewing process. The holding portions 5,6 are further configured to form an enclosure at the water injection side of the capsule; thereby allowing water entering the enclosure to interact with the ingredient in the capsule. The enclosure is preferably fluid tight along the peripheral edges 7 of the portions; fluid tightness being obtained by a sufficient force of the rear holding portion 6 abutting on a rim of the capsule and pressing it toward the edge of the front holding portion. For proper sealing, a joint 8 can be provided on the rear holding portion 6 or as part of the capsule itself as described in pending European patent application No. 04025320.5.

[0035] The rear holding portion can be a plate having protruding elements that tears or punctures a membrane of the capsule when a sufficient pressure has been built inside the enclosure. The beverage can be drained through channels and holes performed in the plate itself and/or at the surface and/or side of the plate. Other brewing principles are possible such as pre-opening the delivery side of the capsule and filtering the beverage via a filter in the plate, for instance.

[0036] The front holding portion 5 is preferably fixed in the frame, for instance, it is fixedly inserted in a ridge 9 formed between the delivery outlet 3 and the housing 4.

[0037] The rear holding portion 6 has the form of a cage with an internal cavity 10 that encompasses the body of the capsule and is associated with water supply means 11 arranged to inject water in the cavity and consequently in the capsule forming with the cavity, the fluid tight enclosure. In the bottom of the cavity 10, are lodged piercing elements 12 such as blades for opening the capsule and allowing pressurized water to enter the capsule. Water can be injected at any point in the cavity such as on a side or in the bottom via a water inlet 13. The water supply means further include tube means 14 to transport water from a heater to the inlet, a backpressure valve 15 to control the pressure in the device and avoid backflow and a sealed connector 16.

[0038] The rear holding portion 6 is mobile in the frame 2 to be able to move from an opening position allowing the capsule to be inserted between the two portions 5, 6 and a closed position for brewing the capsule. The holding portion can move along a closing path from the opening to the closed position that is not necessarily fully linear. Preferably, the path is not fully linear. In particular, the closing path has a first portion that is slightly offset in respect to the centre line O that passes through the centre of the front holding portion. It has a second portion that is centred along centre line O. The variation to a pure linear movement of the closing path has the function to move the capsule from an off-centred position of insertion to a brewing position. The capsule is retained in pre-position via retaining means that can be forced during closure of the holding portions. When the holding parts are re-opened, the capsule being no longer retained by the retaining means can fall down by gravity. Such a mode of insertion and pre-positioning of the capsule has been already described in full detail in WO 2005/004683 A1; the content of which is part of the present description, at least concerning the description of the solution for retaining the capsule during closing (i.e., page 2, lines 36 to page 7, lines 26).

[0039] For guiding the holding portion in the closing path, the holding portion includes, for instance, side pins 17 protruding outwards and being guided along longitudinally oriented grooves 18 provided along the side of

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the housing. The grooves are formed with a first (rear) and second (front) portions; with the first portion being slightly offset relative to the centre line of the holding portions in the closed state of the device.

[0040] As also apparent in Fig. 3, the frame is provided with an upper passage 19 arranged to receive the capsule. The profile of the passage 19 can be adapted to the capsule shape to be received in the correct insertion side. As apparent in Fig. 2, the frame also comprises a lower passage 20 for discarding of the waste capsule once the brewing process is over and the rear holding portion is re-opened. As already mentioned, the capsule falls down by gravity as it is no longer retained by capsule retaining means when the rear holding portion re-opens.

[0041] The kinematic closing arrangement of the brewing device that constitutes a central idea of the invention will now be described in relation to Figs. 4 to 9.

[0042] First of all, the brewing device is intended to be closed manually by a handle 21 that is positioned on the upper side of the device and is articulated in rotation along an axle 22 fixed to the upper side of the frame.

[0043] The rear holding portion is associated to a knuckle joins mechanism 23 which is known 'per se'. Such a mechanism enables to move the holding portion 6 and to lock it steadily in place by a "knee" effect once a "hard point" has been overcome which corresponds to the extension of the mechanism in a slightly reversed angular configuration relative to the its folded position. For this, this mechanism comprises preferably two pairs 24, 25 of rods 26, 27. The two pairs are placed in parallel on each side of the holding portion in order to offer a high resistance to the torsion efforts. The first or front rods 26 are attached on the front end axle 28 on the side of the rear holding portion 6 and on the other end at a free pivot axle 29 to the second or rear rods 27 of the knuckle joins mechanism. The second rear rod 27 is then attached by a rear end axle 30 to a force transmission means whose structure and function will be described just next. The two rods 26, 27 are so attached along a free pivot axle 29 which has the ability to move vertically and horizontally as the front and rear axles 28, 30 are moved away during closing of the brewing device. It can be noticed that both front and rear axles 28, 30 are, respectively, guided and linked to the frame whereas pivot axle 29 is not. Front axle 28 protrudes by the side pin 17 in the side groove 18. Rear axle 30 is static relative to the frame enabling to take the reaction forces when the holding portion is pushed forward to the front holding portion.

[0044] As apparent in Fig. 2, a force control system of the knuckle means is provided to enable to compensate for the manufacturing tolerances and precisely control its closure force. For this, the two rods 26, 27 are attached by a connection axle 50/oblong 51. A needle 53 is provided to control the position of the axle 50 in the oblong 51 in order to adjust the necessary force to close the knuckle mechanism. The position of the needle 53 is adjustable longitudinally along a complementary threading 54 and can be moved by means of screwdriver or a spanner. A coil 52 can be further provided to prevent the needle from unscrewing during use of the brewing device which would otherwise affect the closure force of the brewing device. According to the invention, the handle is not directly articulated to the rear axle 30 of the knuckle joint mechanism 23 but is linked to an intermediate force transmission means 31 whose function is to de-multiply the force from the handle to the knuckle joint mechanism. This mechanism is formed of at least two second pairs 32, 33 of rods 34, 35 connected respectively to each side of the handle and knuckle joint mechanism. Each pair of rods comprises an upper rod 34 linked via an upper free pivot axle 36 to the handle and a lower shorter rod 35 linked to the upper rod via an intermediate free pivot axle 37 and linked fixedly to knuckle joint mechanism 23 at a certain fixed angle B ,e.g., of about 110-130 degrees.

[0045] Therefore, the movement of the handle 21 in rotation from the opening position (Figs 4-5) toward the closing direction (Figs 7-8 and finally Figs. 8-9) will force transmission means 31 to fold at the intermediate pivot axle 37 therefore transferring a force to the knuckle joint mechanism that increases while the folding angle A of the means 31 diminishes. As a result, the force exerted by the force transmission means on the knuckle mechanism to pass the "hard point", between the intermediate positions of Fig. 7 to the closing position of Fig. 9, is higher than the force at the beginning of the closing operation (i.e., between the opening of Fig. 5 to the intermediate of Fig. 7). Comparatively also, The vertical displacement $\Delta d2$ of the knuckle joint mechanism at the end of the closing process, when passing from an open "V" shape to the inverted "V" shape (Fig. 9), is greatly smaller than the displacement $\Delta d1$ from the opened to the intermediate position (Fig. 7). The displacement $\Delta d2$ exerts itself along an operational angular range A2 of the handle that is still relatively important (Fig. 7). Therefore, the ratio of the rotation angle of the handle to the displacement of the knuckle joint mechanism (or in manner equivalent to the relative displacement of the holding portions) $\Delta A/\Delta d$ tends to increase as the handle is actuated down to the closing position.

[0046] Of course, the force transmission means could be replaced by equivalent means that may differ in their form but which exerts the same force demultiplying function (i.e., the same primary effect).

[0047] Fig. 10 refers to a variant of the brewing device regarding another aspect of the invention. The improvement lies in the water supply means to the capsule's brewing device. The water supply means 11 comprises a length compensatory tube portion 38 which is non-moveable relative to the frame whereas the rear holding portion 6 moves during opening and closing against the front holding part. The length compensatory tube portion is, for instance, a portion of tube which extends preferably rearwardly in a straight configuration. The tube can be flexible or semi-rigid but its rigidity should be determined to enable to the tube to insert itself in the holding portion 6 while the portion is opened (i.e., moved rearwardly) but

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not too rigid to avoid blocking the opening of the device.

[0048] On its front end 39, the portion of tube 38 can be mounted in sliding relationship in the holding portion 6. More particularly, the holding portion can include a tubular passage 40, such as a flared portion in a rigid sleeve. The connection of the front end 39 in the passage is a fluid-tight but sliding connection; therefore, necessitating one or more sealing elements 41 inserted in the interior of the passage such as o-rings and the like.

[0049] The rear end 42 of the compensatory portion of tube can be attached fixedly to a redirecting connecting portion 49 having the function to change the direction of the tube as needed. In the present case, the compensatory portion of tube 38 can be a rigid, hollow casing with an inlet 42 for receiving an upstream fluid supply tube 43 that brings the fluid from the water heater and an outlet 44 for receiving the rear attached end of the compensatory tube means. The casing can encompass the usual backpressure valve 45, if needed, which is normally provided further downstream of the water supply means, i.e., just before the brewing cavity. Proper sealing elements 46, 47, fittings 48, are provided for ensuring a proper fluid tight connection through the casing.

[0050] When the rear holding portion 6 is moved backwards, the compensatory portion of tube which is fixed by its rear end 42 but free by its front end 39 will insert itself in the passage and eventually in the brewing cavity 10. The front end of the portion can be reinforced with plastic, metal and/or fibres to improve its durability. The whole portion can also be made or reinforced in these materials. The end can also be slightly flared to improve the sealing effort in radial direction when back in place in sealing engagement with the passage for the water supply.

[0051] The front end 39 of the compensatory portion of tube 38 can protrude inside the internal cavity 10 of the holding part 6 when the holding part is moved backwards during re-opening of the brewing device. The compensatory portion of tube can thus help remove the capsule from the cavity. When the holding part 6 is moved backwards, the capsule may still be in engagement by the piercing elements 12 thus causing the capsule to remain stuck in the cavity. Therefore, the compensatory portion of tube can push the capsule to become disengaged from the piercing elements as the holding part is sliding backwards.

[0052] Another possible mode of the invention is now described in relation to Figs. 11 to 16.

[0053] The device comprises a main frame 60 which can be composed of a left frame portion 61, a right frame portion 62, an upper frame portion 63 (e.g., for stability) and a front beverage outlet portion 64.

[0054] The frame can be manufactured in full plastic or metal or a combination of plastic and metal. The portions can be made of injected or extruded pieces.

[0055] The device in Figs 11 to 13 comprises two holding members, respectively a first and second holding members 65, 66; which are positioned in spaced apart relationship in the open position of Fig. 12 for enabling insertion of a capsule 9 in the device.

[0056] According to an aspect of the invention, a capsule retaining member 67 is provided in the open gap between the holding members to receive and guide the capsule in its descent and hold it in a pre-position in the brewing device. The retaining member 67 is arranged to maintain the capsule during closing of the brewing device and allow the capsule's ejection during re-opening of the brewing device.

[0057] A detailed description of the principle for holding and ejecting the capsule in the brewing device is given in co-pending European patent application filed on the same day as the present application and entitled: "Brewing device with a capsule holder for facilitating insertion and removal of capsule".

[0058] In the disclosed embodiment, the first holding member is slidably mounted along the frame, i.e., the two side portions 65, 66 to be capable of reciprocating along a substantially longitudinal median axis I. The second holding member 66 is placed in the frame in a non-movable position, i.e., fixed position. Therefore, for closure of the holding members 65, 66 about the capsule 67, the first holding member 65 is forced to come closer to the second holding member 66 up to a position where it can form a fluid tight engagement with the second holding member in the closed position of Fig. 13.

[0059] According to an aspect of the invention, the brewing device has a closing mechanism 68 comprising an actuation member 69 and force transmission means 70 which transfer the force exerted by or on the actuation member 69 to the first holding member. The actuation member 69 can be a manual lever. The lever transfers torque as applied by the user directly to the force transmission means 68. The force transmission means comprises spur gear means which are designed to transfer the torque of the lever into translation forces to the holding member 65.

[0060] More particularly, the spur gear means 70 consists of a pair of gears 71, 72 which engage into intermeshing and are connected in rotation to the frame, i.e., the left and right portions 61, 62 of the frame, respectively to a rear axle 73, and front axle 74. The rear gear 71 represents the master gear receiving the torque of the lever and which forces the front gear or slave gear 72 in rotation. The front gear 72 is connected to rod means 75 at a pivot point 76 transversally mounted on the front gear which is offset from the axial centre 74 of the front gear. The rod means 75 may be a pair of side rods connected respectively to the front gear 72 via said pivot point 76 and to the first holding member 65 via a front pivot point 77. As a result of the angular course on the lever, e.g., a course of about 90 degrees, the gears are driven in rotation thereby transferring translational forces via the rod means 75 onto the first holding member 65. The rod means and the front gear forms a knuckle joint means that fold at pivot point 76. Furthermore, according to a preferred mode, the spur gear means are designed to

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provide a variable transmission rate. The rate of transmission expresses the ratio between the entry speeds of the master gear and the exit speed of the slave gear as illustrated in Fig. 16. The rate of transmission is directly obtained by the ratio of the radiuses (r1/r2) at the pitch point. According to the invention, the ratio of radiuses, r1/r2, varies progressively during the angular courses of the gear means, consequently, also during the angular course of the lever, therefore, providing a variable exit speed on the slave gear which is transferred as a variable translational closure speed onto the first holding member.

[0061] Preferably, the spur gear is designed such that the transmission rate provides progressively increasing output torque and conversely a decreasing rotational output speed. This increasing output torque transfer increasing translational forces onto the first holding member and conversely a reduction of the speed of closure of the first holding member toward the second holding member.

[0062] Therefore, higher closure forces are delivered when they are desired the most, i.e., at the end of the closure motion. The modification of the output forces are also obtained without significantly modifying the input force exerted on the lever; therefore, facilitating manual closure of the device.

[0063] For this, the radius r1 (at the intermeshing point) of the master gear becomes smaller and the radius r2 (at the intermeshing point) of the slave gear becomes greater during the angular course of the closing mechanism toward the direction of closure (Direction A in Fig. 16). The relation is such that r1 is greater than r2 at the beginning of the closure motion and r1 is smaller than r2 at the end of the closure motion.

[0064] For instance, the transmission rate r1/r2 can vary of from 5:1 to 1:5.

[0065] In order to obtain variable transmission rates, the gears can have a non-circular transversal section with a longer longitudinal axis and a shorter transversal axis.

[0066] For instance, the gears have an ellipsoidal transversal section. For this, each spur gear has a longer transversal radius. The respective longer transversal radiuses of the spur gears are thus positioned at about 90 degrees one another.

[0067] Figs 14 and 15 illustrate respectively the open state and the closing state of the device. In the open state, the lever 69 is substantially positioned in upright position and the first holding member 65 is distant from the second (fixed) holding member 66. The radius r1 of the master gear is maximal whereas the radius r2 of the slave gear is minimal. At least one of the gears, e.g., the slave gear may also comprise a inward curvature in the region of its smaller dimension in order to reduce the distance between the pivot points and have a more compact design. When the lever is actuated down for closing the device, the transmission rate will vary causing a progressive increasing force and a deceleration of the closing speed at the holding member. At the end of the angular course of the lever (Fig. 15), i.e., about a 90-degree angular path, the transmission rate of the gear means is inverted and the force becomes maximal and so the speed becomes minimal.

[0068] The brewing device further comprises an ejection assisting means 78 in the form of a punch applying an ejection force to unstick the capsule from the internal surface of the first holding member. The capsule can remain stuck to the surface, for example, by the perforating elements being engaged in the capsule. Therefore, the ejection assisting means 78 is coordinated with the opening of the holding members about the capsule to ensure that it applies the ejection force as the holding member re-opens. For this, the ejection assisting means is guided by the gear means. The punch of the ejection assisting means has a rear end directly engaged by the slave gear and is pushed in translation by the gear.

Claims

1. Brewing device for the brewing of a capsule containing a beverage ingredient comprising:

   - a main frame (2; 60),
   - a first capsule holding part (5; 65),
   - a second capsule holding part (6; 66) for at least partially holding the capsule; said second capsule (6; 66) holding part being mobile relative to the first capsule holding part (5; 65) in the frame (2) and linked to the frame by a closing mechanism (23, 31; 68) comprising knuckle joint means or equivalent means to move from an open position at which the two parts are distant one another to enable the insertion of the capsule between the two parts and a closed position at which the first and second holding parts are closed about the capsule;
   - a manual handle (21; 69) forming lever to activate via the closing mechanism the second holding part from the open position to the closed position and vice versa,

   characterized in that:

   the closing mechanism (23, 31; 68) comprises additional force transmission means (31; 71, 72) associated to the handle arranged to de-multiply the force applied by the handle on the knuckle joint means that compensates for the increase of the force needed for closing the holding parts on the capsule.

2. Brewing device according to claim 2, **characterized in that** the additional force transmission means are configured to link the handle to the knuckle joint means.

3. Brewing device according to claim 2, **characterized in that** the additional force transmission means com-

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prise force levers applying a demultiplication of the force of the handle to the knuckle joint means during closure.

4. Brewing device according to claim 3, **characterized in that** the knuckle joint means comprises a pair of two rods; one end of which being connected to the second holding part, the other end of which being connected to the said additional force transmission means.

5. Brewing device according to claim 4, **characterized in that** the additional force transmission means are formed of at least a pair of connecting rods attached to the handle on one end and to the knuckle joint means on the other end.

6. Brewing device according to claims 3, 4 or 5, **characterized in that** the force transmission means are configured in relation to the handle and knuckle joint means to increase the ratio of the angular course of the handle (21; 69) to the closure course of the at least second holding part (6; 66) when the handle is actuated in the closure direction.

7. Brewing device according to claim 6, **characterized in that** the at least 40 last degrees of the handle's course is utilized to displace the course of the knuckle joint means of about or less than the last 20%.

8. Brewing device according to claim 1, **characterized in that** the force transmission means comprises gear means able to transfer the torque provided by the handle into translational closure forces on the first capsule holding part.

9. Brewing device according to claim 8, **characterized in that** the gear means comprise a pair of spur gears having non-circular transversal sections.

10. Brewing device according to claim 9, **characterized in that** each spur gear has a longer transversal radius and
wherein the respective transversal radiuses are positioned at about 90 degrees one another.

11. Brewing device according to any one of claims 1 to 7, **characterized in that** the handle is attached to the upper of the frame.

12. Brewing device according to claim 11, **characterized in that** the handle is shorter in length than the length of the assembly formed by the second holding part and the knuckle joint means when extended in the closing position.

13. Brewing device according to any of the preceding claims, **characterized in that**
the second holding part is arranged to slide in a substantially linear direction within the frame.

14. Brewing device according to claim 13, **characterized in that** it further comprises a passage adapted for the positioning of the capsule between the two holding parts.

15. Brewing device according to claim 14, **characterized in that** a capsule retaining means is provided between the two holding parts to retain the capsule in a predefined position before closure.

16. Brewing unit (1, 1A, 1B) for the brewing of a capsule containing beverage ingredients comprising:

a frame (2),
a first and second capsule holding members (7, 8) for at least partially enclosing the capsule (9) during brewing;
wherein the first holding member (7) is mobile along the frame (2) between an open and a closed position in relation to the second holding member (8);
a closing mechanism (3) to actuate the first holding member between the two positions comprising an actuation member (11);
characterized in that
the closing mechanism (3) comprises gear means (12) able to transfer the torque provided by the actuation member (11) into translational closure forces on the first holding member (7).

17. Brewing unit according to claim 16, **characterized in that**
the gear means (12) is arranged so that the transmission rate varies progressively during rotation.

18. Brewing unit according to claim 17, **characterized in that** the gear means (12) comprise a pair of spur gears (14, 15) having non-circular transversal sections.

19. Brewing unit according to claim 18, **characterized in that** each spur gear (14, 15) has a longer transversal radius and wherein the respective transversal radiuses are positioned in intermeshing relationship at about 90 degrees one another.

20. Brewing unit according to any one of claims 16 to 19, **characterized in that** the actuation member is a handle.

21. Brewing unit according to any one of claims 16 to 19, **characterized in that** the actuation member is a motor with drive shaft.

22. Brewing device for the brewing of a capsule contain-

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ing a beverage ingredient comprising:

- a main frame,
- a first capsule holding part,
- a second capsule holding part for at least partially holding the capsule; said capsule holding part being mobile relative to the first capsule holding part,
- water supply means connected to second holding part configured to injected water in the said part,

characterized in that:

the water supply means comprises a length compensatory tube portion which is fixed relatively to the frame whereas the second holding part can move with respect to said compensatory tube portion.

23. Brewing device according to claim 22, **characterized in that** the compensatory tube portion is mounted relatively to the second holding part so that it inserts itself at least partly in the holding part as the holding part moves to the open position.

24. Brewing device according to claim 23, **characterized in that** the compensatory tube portion slides at least partially in a passage of the capsule holding part as said holding part moves toward its opening position.

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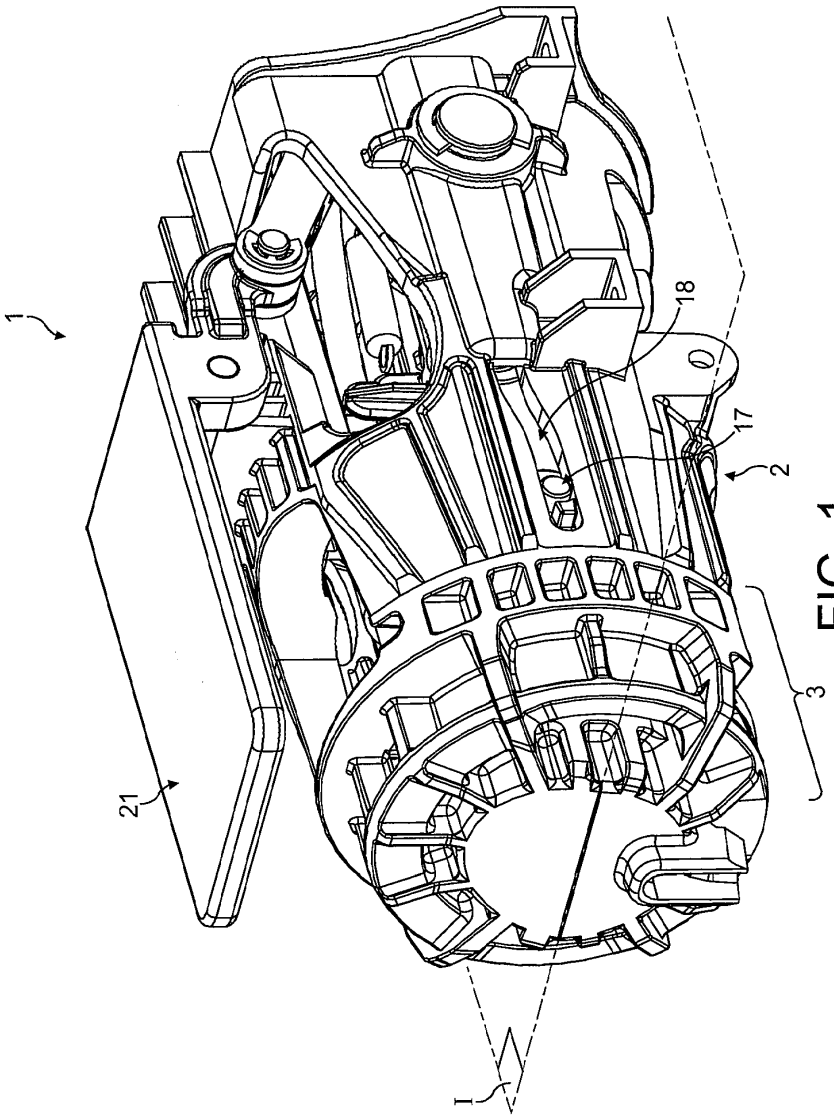


FIG. 1

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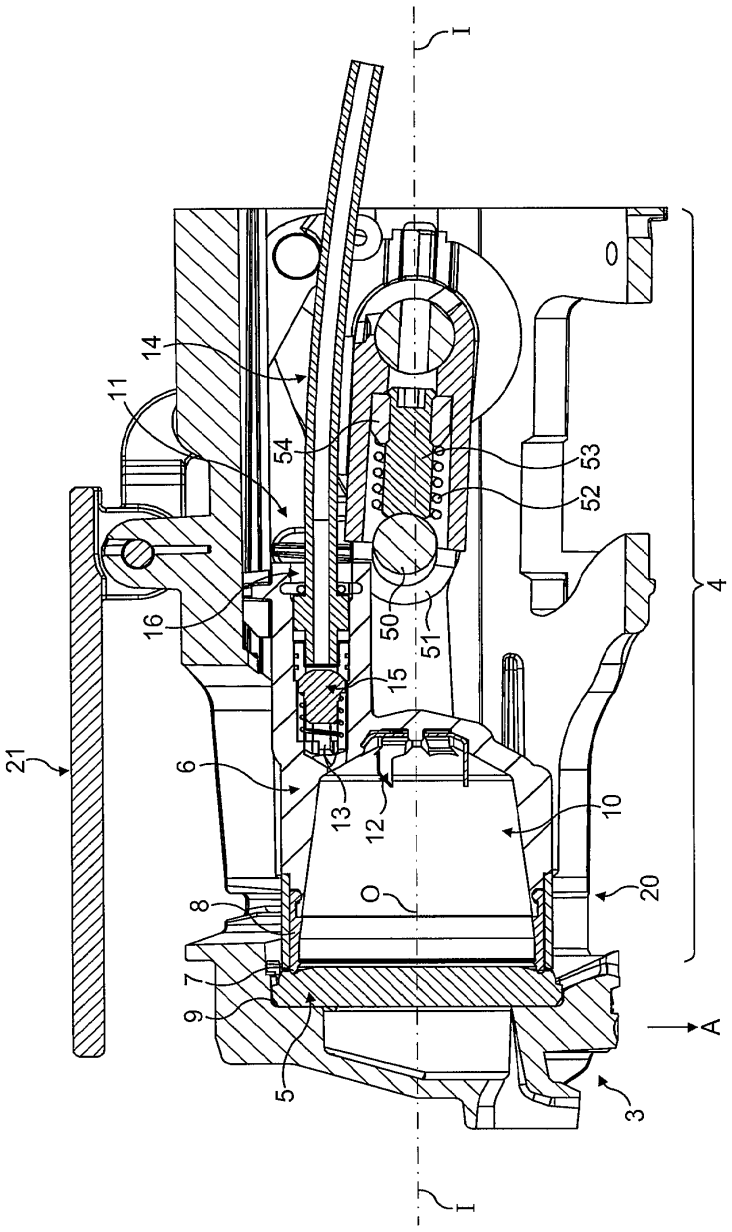


FIG. 2

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NESPRESSO USA, INC. v. K-FEE SYSTEM GMBH
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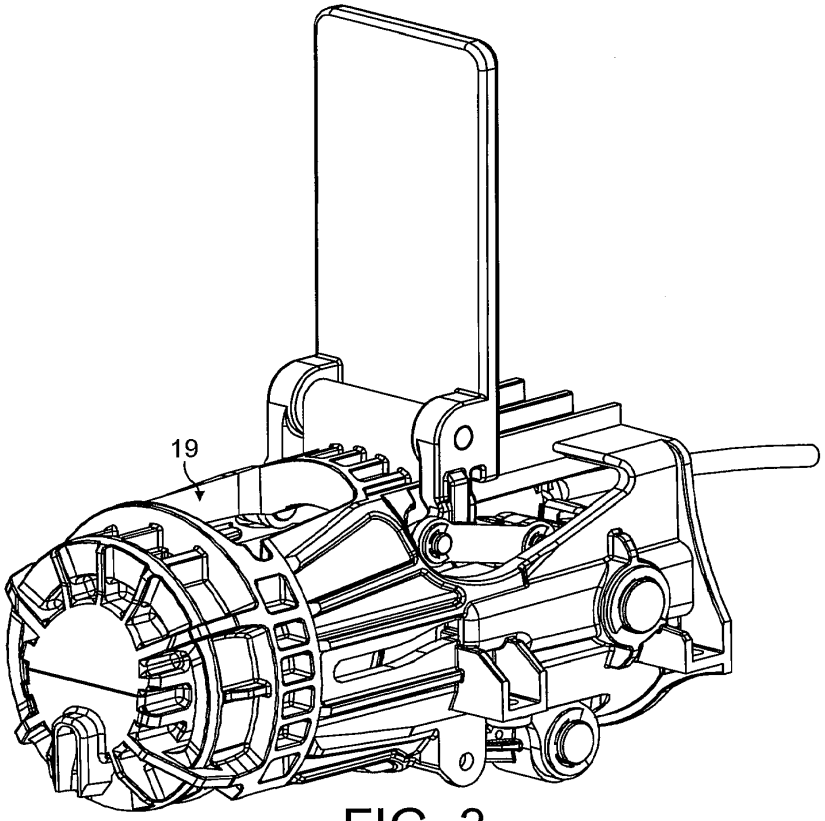


FIG. 3

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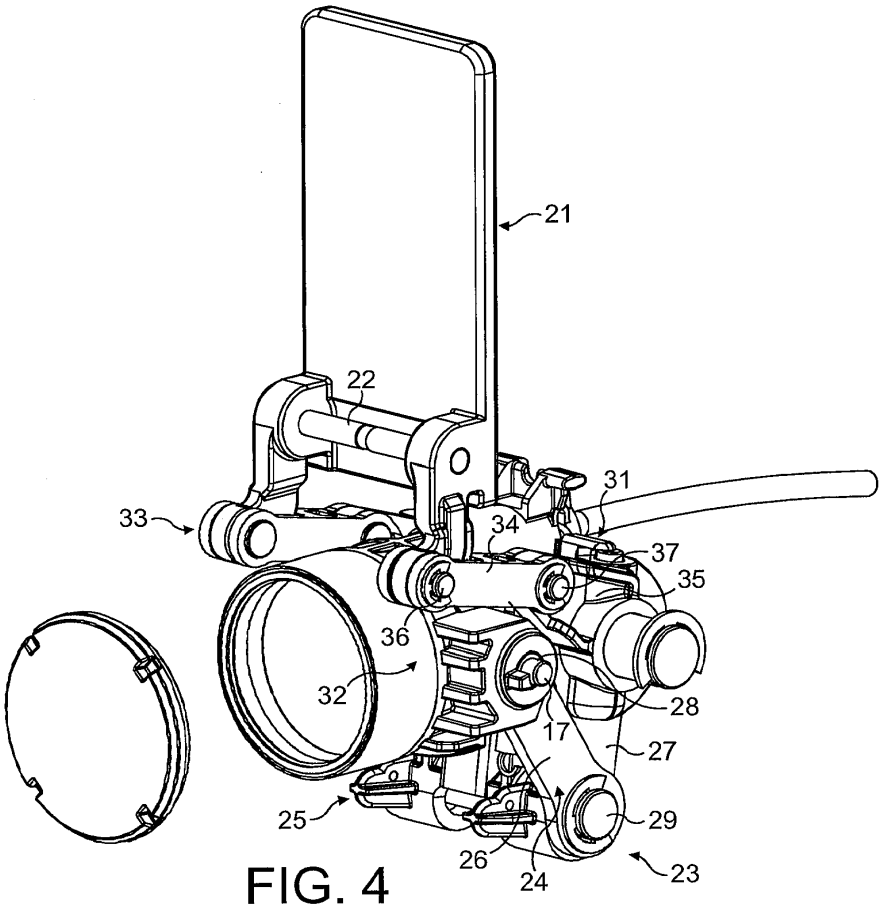


FIG. 4

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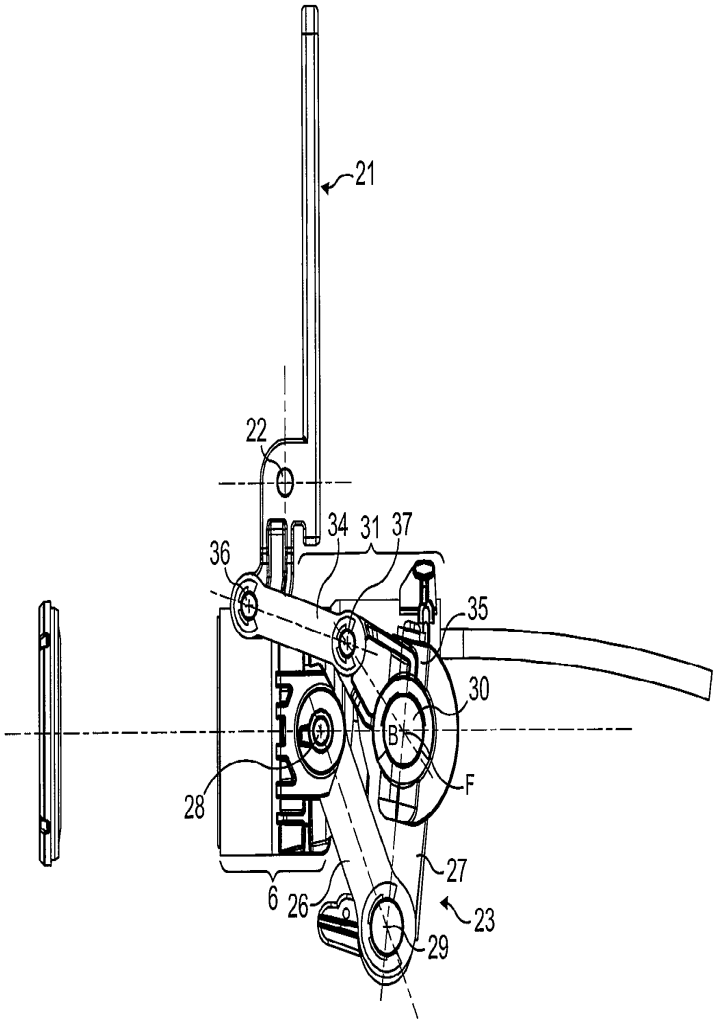


FIG. 5

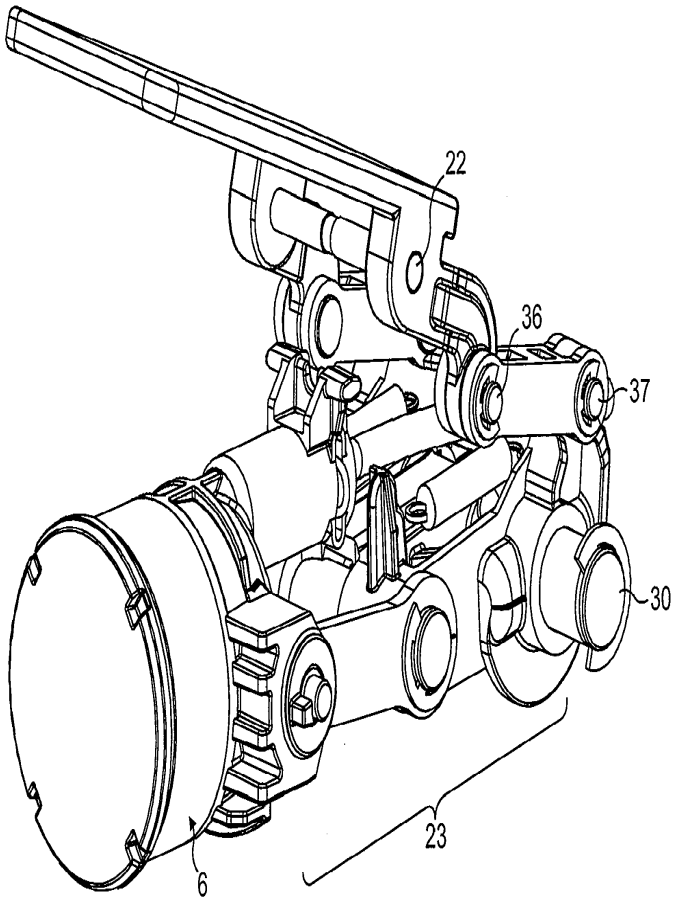


FIG. 6

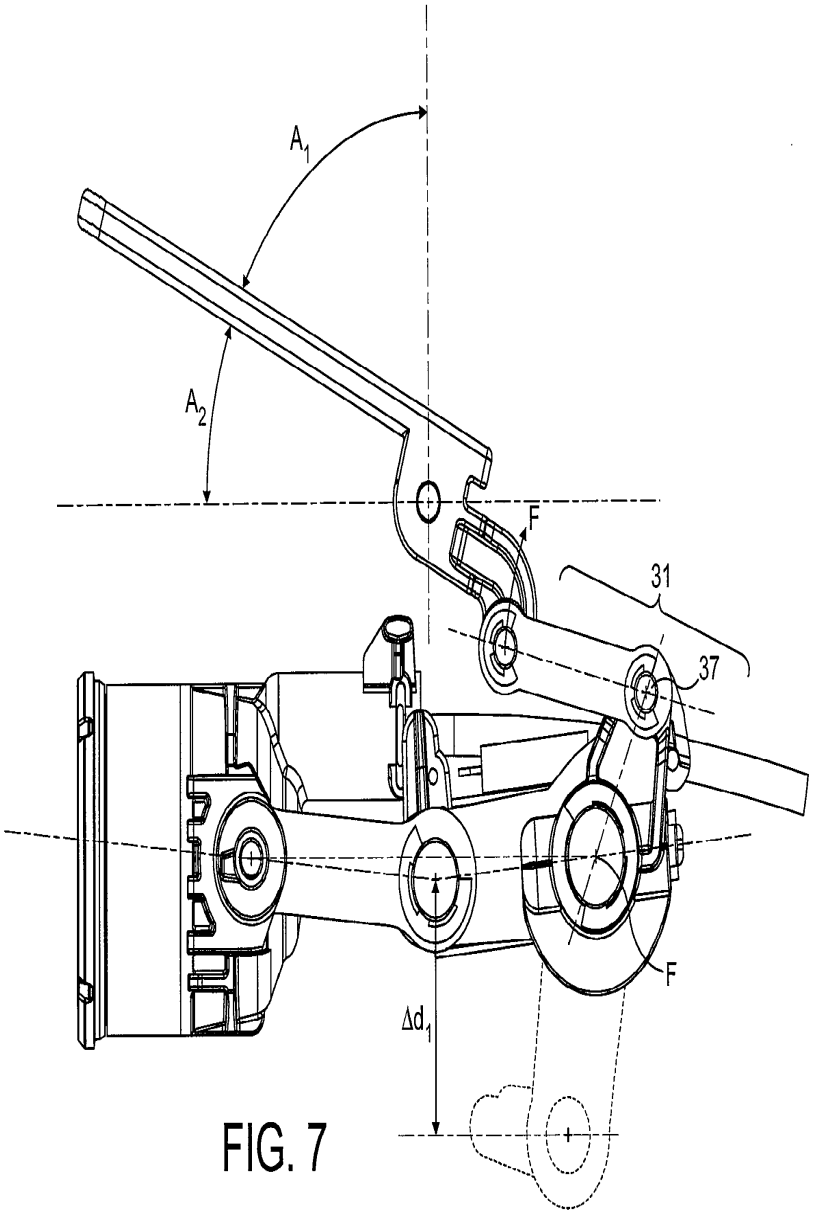


FIG. 7

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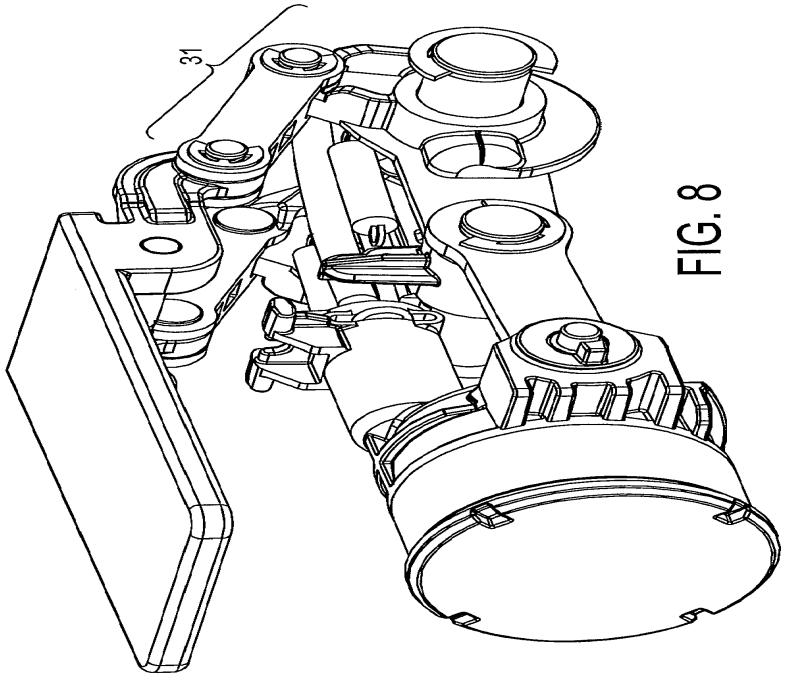


FIG. 8

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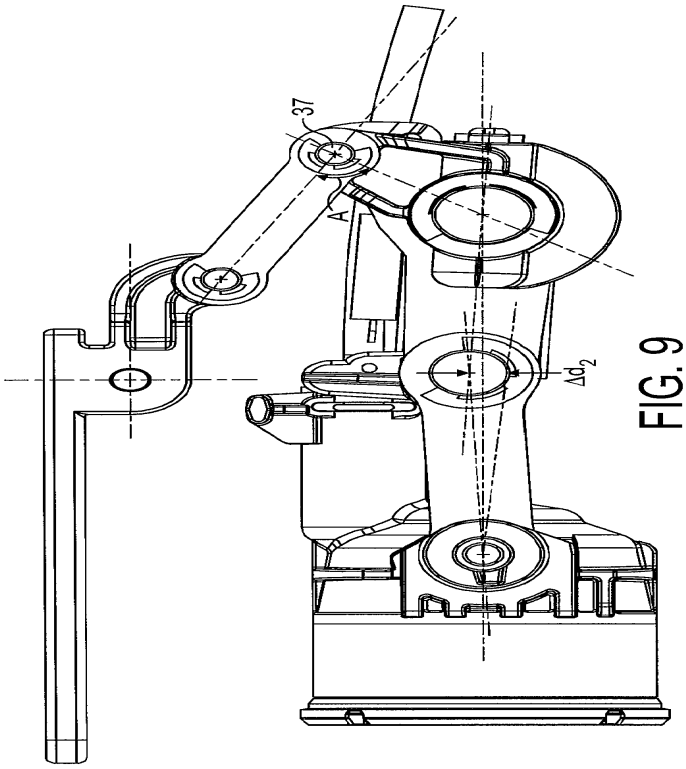


FIG. 9

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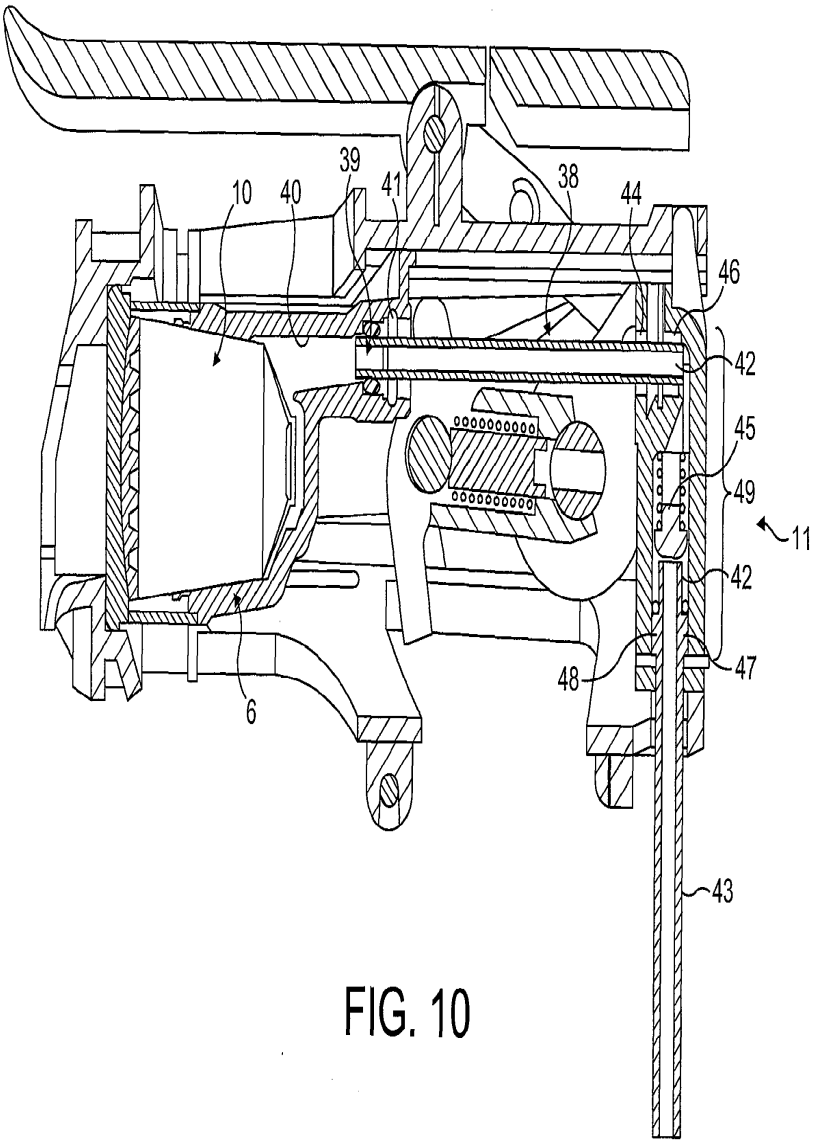


FIG. 10

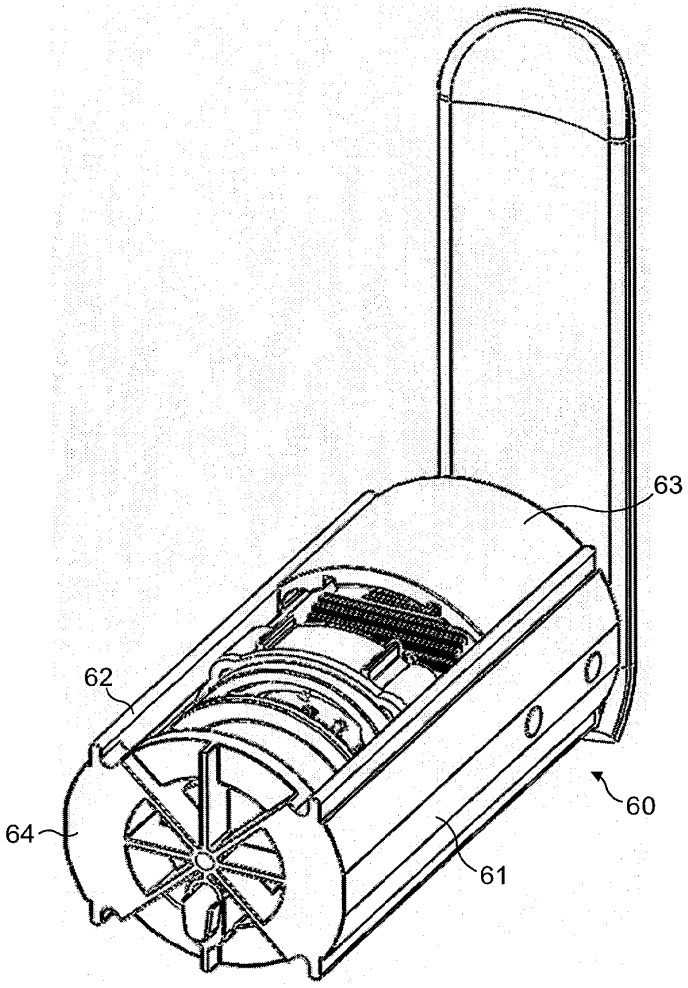


FIG. 11

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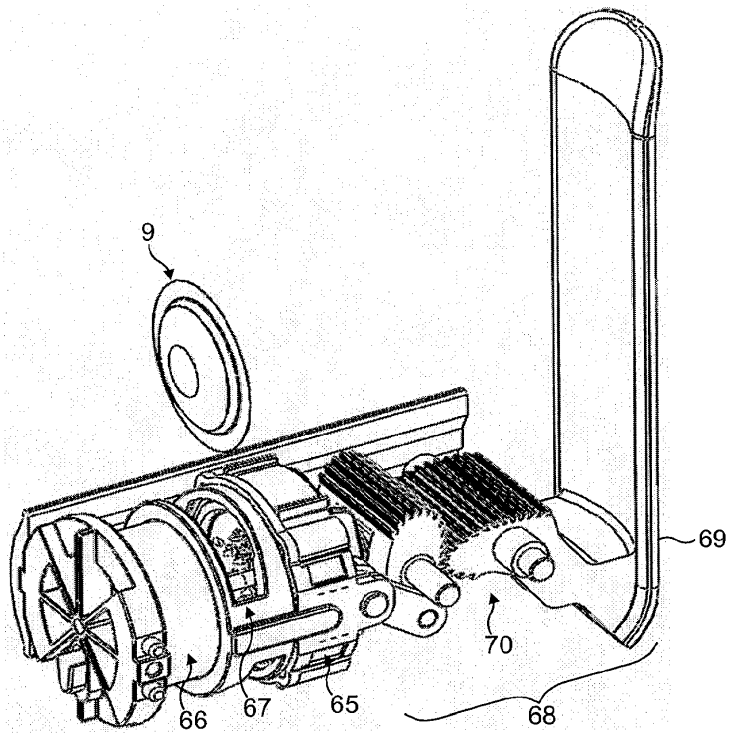


FIG. 12

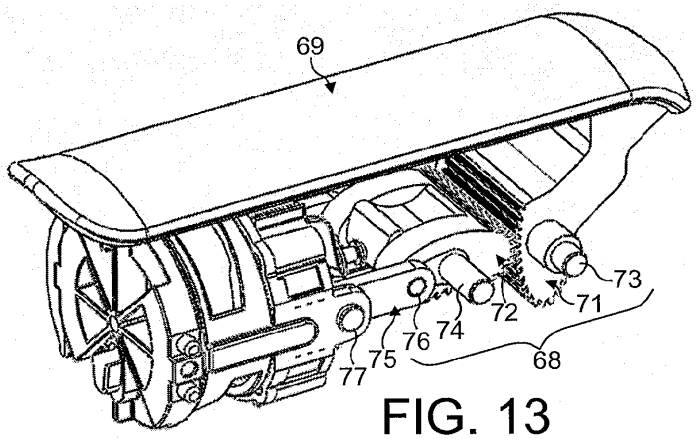


FIG. 13

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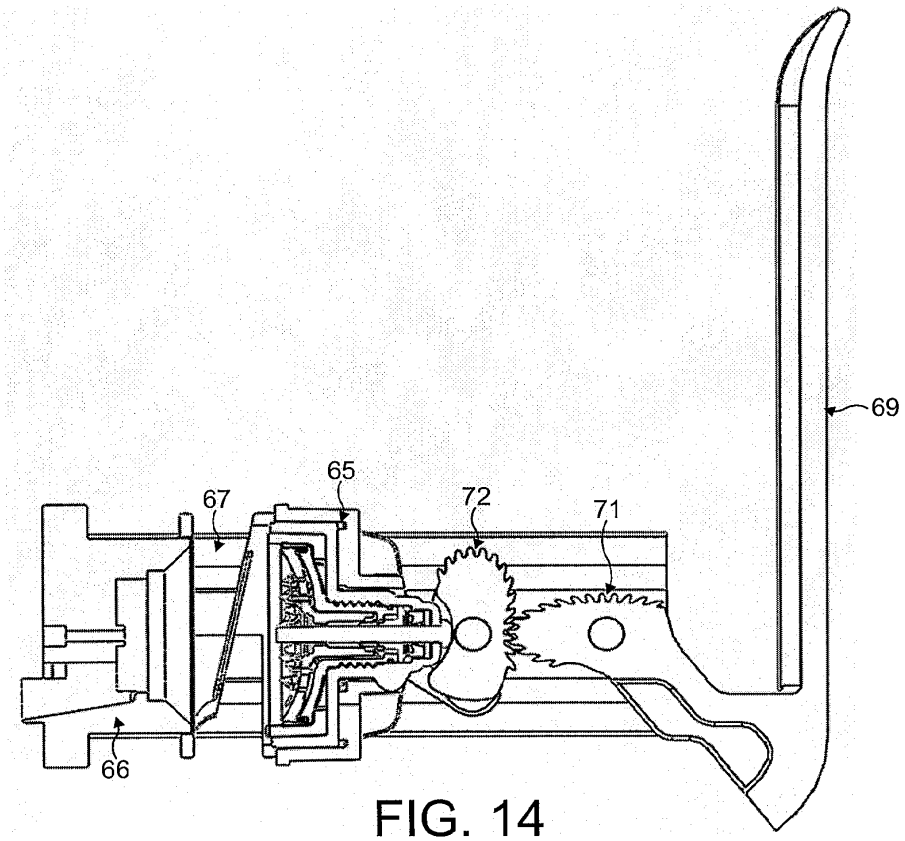


FIG. 14

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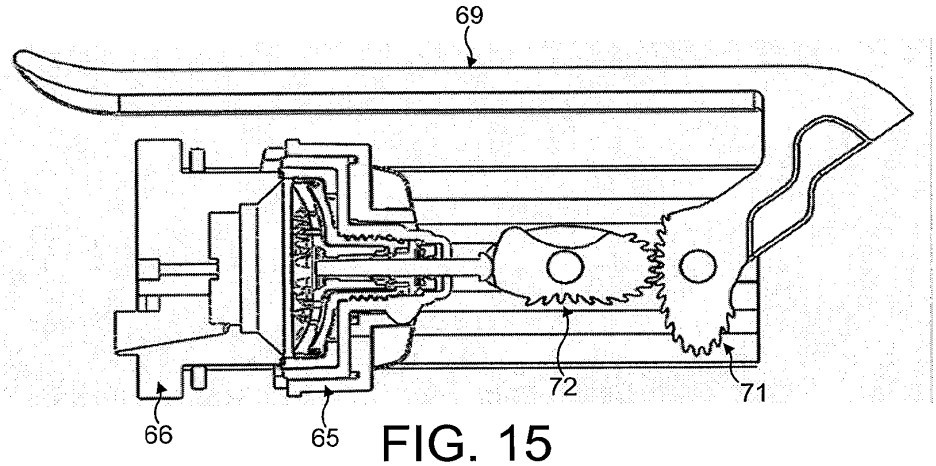


FIG. 15

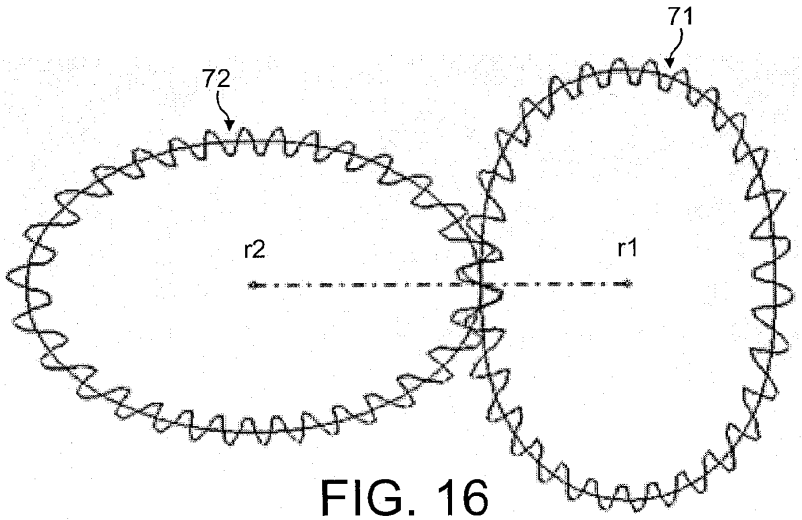


FIG. 16

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EUROPEAN SEARCH REPORT

Application Number
EP 06 11 4446

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	US 2005/106288 A1 (BLANC JEAN-PIERRE ET AL) 19 May 2005 (2005-05-19) * paragraphs [0039] - [0090]; figures *	1-7, 11-17,20	INV. A47J31/40 A47J31/46
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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	5 January 2007	De Terlizzi, Marino

CATEGORY OF CITED DOCUMENTS

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EUROPEAN SEARCH REPORT

Application Number
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DOCUMENTS CONSIDERED TO BE RELEVANT

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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	5 January 2007	De Terlizzi, Marino

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CLAIMS INCURRING FEES

The present European patent application comprised at the time of filing more than ten claims.

☐ Only part of the claims have been paid within the prescribed time limit. The present European search report has been drawn up for the first ten claims and for those claims for which claims fees have been paid, namely claim(s):

☐ No claims fees have been paid within the prescribed time limit. The present European search report has been drawn up for the first ten claims.

LACK OF UNITY OF INVENTION

The Search Division considers that the present European patent application does not comply with the requirements of unity of invention and relates to several inventions or groups of inventions, namely:

see sheet B

☒ All further search fees have been paid within the fixed time limit. The present European search report has been drawn up for all claims.

☐ As all searchable claims could be searched without effort justifying an additional fee, the Search Division did not invite payment of any additional fee.

☐ Only part of the further search fees have been paid within the fixed time limit. The present European search report has been drawn up for those parts of the European patent application which relate to the inventions in respect of which search fees have been paid, namely claims:

☐ None of the further search fees have been paid within the fixed time limit. The present European search report has been drawn up for those parts of the European patent application which relate to the invention first mentioned in the claims, namely claims:

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LACK OF UNITY OF INVENTION
SHEET B

Application Number
EP 06 11 4446

The Search Division considers that the present European patent application does not comply with the requirements of unity of invention and relates to several inventions or groups of inventions, namely:

1. claims: 1-21

Brewing device whose closing mechanism comprises force transmission means arranged to de-multiply the force applied by the handle on the knuckle joint means that compensates for the increase of the force needed for closing the holding parts on the capsule

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2. claims: 22-24

Brewing device whose water supply means comprises a length compensatory tube portion which is fixed relatively to the frame whereas the second holding part can move with respect to said compensatory tube portion

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(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
19 October 2006 (19.10.2006)

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(54) Title: COFFEE PRODUCT

(57) Abstract: A coffee product comprises (i) a first portion consisting of unroasted coffee, in an amount of from 1 to 90% by weight based on the total weight of the ground coffee composition, and (ii) a second portion consisting of ground coffee which has been roasted to a higher degree of roast than said first portion, in an amount of from 99 to 10% by weight based on the total weight of the ground coffee composition in a weight ratio of (i) to (ii) is from 10:90 to 80:20 wherein the coffee product comprises at least 4g of chlorogenic acids per 100g of product.

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COFFEE PRODUCT

Field of the Invention

The present invention relates to a coffee product comprising roasted and unroasted portions, a method of preparing such a coffee product as well as the use of the product to provide certain desirable consumer benefits.

Background of the Invention

It is known that coffee is a complex mixture of many hundreds of compounds, which, in combination, form a unique and pleasing aroma and taste desired by many consumers. Furthermore, coffee is consumed not only for its desirable flavour but often for other reasons, such as to increase short term mental alertness. The positive health impact of coffee has been studied over many decades and, for a long time, it has been known that certain of these coffee compounds are capable of providing benefits to the consumer, especially greater mental alertness through the ingestion of caffeine. However, it is less well known to consumers that certain coffee compounds are excellent anti-oxidants and that, weight for weight, coffee can potentially provide significantly more antioxidants to the consumer than, for example, a well known source of antioxidants such as green tea.

A very important source of anti-oxidants that has been identified in coffee is the class known as chlorogenic acids.

Chlorogenic acids in coffee are mainly mono- and di-esters of quinic acid and phenolic groups (e.g. caffeic, ferulic, coumaric, methoxycinnamic) attached to different positions. These chlorogenic acids have been shown to have antioxidant activity *in vitro* (e.g. radical scavenging, LDL oxidation resistance, DNA damage protection) and antimutagenic effect *in vivo* on large intestine, liver and tongue in rats and hamsters. Additionally chlorogenic acids are able to reduce systemic acid secretion in the stomach protecting the gastric mucosa against irritations possibly responsible for heartburn.

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From the health and nutritional perspective, it is desirable that consumers should be able to benefit from the positive health aspects of coffee identified above and so it would be highly advantageous to maximise the amount of chlorogenic acids available in coffee products.

Conventional coffee process methods, where all of the beans that contribute to an end product are roasted, are well known. However, it has been found that the roasting process degrades a significant amount of the chlorogenic acids present prior to roasting. Nevertheless, the achievement of desirable "roasty" coffee flavour is of such importance to consumers, that it has hitherto been necessary to roast the beans to a significant degree with the knowledge that this will cause undesirable degradation of certain beneficial compounds.

In particular, it has been found that the natural chlorogenic acid content of green coffee can be reduced by as much as about 40 to 90% by weight during conventional roasting processes.

Therefore, it is highly desirable to provide a coffee product, which both retains a much higher level of chlorogenic acids than traditionally associated with roasted coffee but which nevertheless provides an acceptable or even more desirable roasted coffee flavour. Ideally, the coffee product should at least provide organoleptic properties desired by the consumer and/or avoid or minimise any undesirable organoleptic properties.

In WO-A1-02/41700, the mixing of roasted and green coffee beans is discussed. However, the green and roasted coffee batches are ground together and processed in such a way as to deliver a product not having significantly increased levels of chlorogenic acids.

In view of the foregoing, the present invention seeks to provide one or more of the abovementioned benefits and/or to address one or more of the abovementioned problems.

Summary of the Invention

Accordingly, the present invention provides a coffee product comprising:

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(i) a first portion consisting of unroasted ground and/or unground coffee, in an amount of from 1 to 90% by weight based on the total weight of the coffee product, and

(ii) a second portion consisting of ground coffee which has been roasted to a higher degree of roast than said first portion, in an amount of from 99 to 10% by weight based on the total weight of the coffee product,

wherein the chlorogenic acids are present in an amount of at least 4g per 100g of the coffee product.

The invention also provides a coffee beverage product, such as (a) a roast and ground coffee product, (b) a soluble coffee product, (c) a single portion coffee pad, tablet or capsule (d) a ready to drink coffee product or (e) any other suitable coffee product, comprising the coffee product as defined herein as an ingredient.

In a further aspect the invention provides the use of a coffee product as defined herein to provide increased amount of natural bio-available antioxidants to the body when consumed.

The invention further provides a method (hereinafter referred to as "method 1") of preparing a soluble coffee product comprising the steps of:

(A) providing a first portion consisting of unroasted coffee, in an amount of from 1 to 90% by weight based on the total weight of the coffee product,
(B) optionally grinding the first portion,
(C) providing a second portion consisting of coffee which has been roasted to a higher degree of roast than said first portion, in an amount of from 99 to 10% by weight based on the total weight of the coffee product,
(D) grinding the second portion,
(E) optionally stripping the aroma from the second portion to provide a first aroma portion and a stripped second portion,

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(F) mixing the first portion together with the second ground portion or optionally the stripped second portion,

(G) co-extracting the first and second portions to form an extract, and

(H) optionally stripping the aroma from the extract,

(I) optionally adding the first aroma portion to the optionally stripped, combined extract

(J) optionally drying the extract,

so as to provide a soluble coffee composition having a content of chlorogenic acids of at least 8g per 100g of the coffee product, based on an extraction level providing a Total solids (Ts) content of 50% by weight of the coffee product.

It has been found that such a process provides the desired high levels of chlorogenic acids and a much improved aroma in the final product.

Although stripping of the various extracts is optional, it is highly desirable to perform these steps since this allows significantly greater control over the final aroma than hitherto has been achievable. Thus, it can advantageously enable the provision of a coffee product, which is more readily tailored to the different taste and aroma profiles desired by consumers in different markets.

In a further aspect, the invention provides a method (hereinafter referred to as "method 2") of preparing a soluble coffee product comprising the steps of:

(A) providing a first portion consisting of unroasted coffee,

(B) optionally grinding the first portion,

(C) extracting the first portion to provide a first extract,

(D) optionally drying the first portion,

(E) providing a second portion consisting of coffee which has been roasted to a higher degree of roast than said first portion,

(F) grinding the second portion,

(G) optionally stripping the aroma from the second portion to provide a first aroma portion and a stripped second portion,

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(H) extracting the optionally stripped second portion to provide a second extract,

(I) optionally drying the second portion,

(J) combining the first and second portions in the stoechiometric proportions of extracts so that the initial combined coffee blend would have been composed of 1 to 90% by weight of unroasted ground or/and unground coffee and 99 to 10% by weight of roasted ground coffee,

(K) optionally stripping the aroma from the combined extract,

(L) optionally adding the first aroma portion to the, optionally stripped, combined extract, and

(M) optionally drying the extract,

so as to provide a soluble coffee product having a content of chlorogenic acids in an amount of at least 8g per 100g of the coffee product, based on an extraction level of 50% by weight of Total solids (Ts).

Whilst optional, the stripping steps are highly desirable for the reasons given above.

In yet a further aspect, the invention provides a method (hereinafter referred to as "method 3") of preparing a fully or partially decaffeinated soluble coffee product comprising the steps of:

(A) providing a first portion consisting of unroasted decaffeinated coffee, in an amount of from 1 to 90% by weight based on the total weight of the coffee product composition,

(B) optionally grinding the first portion

(C) providing a second portion consisting of coffee, optionally decaffeinated which has been roasted to a higher degree of roast than said first portion, in an amount of from 99 to 10% by weight based on the total weight of the coffee product composition,

(D) grinding the second portion,

(E) carrying out steps (E) to (J) of method 1 or steps (F) to (M) of method 2.

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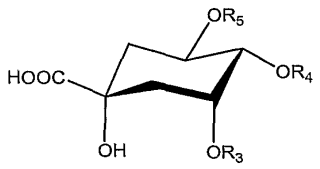
It has been found that such a process provides the desired high levels of chlorogenic acids, a reduction or removal of caffeine level and a much improved aroma in the final product.

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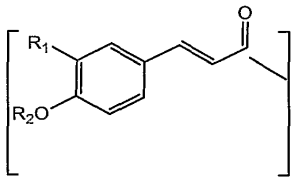
Detailed Description of the Invention

The present invention provides a coffee product which depends upon the blending of coffee beans, a portion of which are roasted and portion of which are unroasted or green so as to provide a coffee beverage, which, when reconstituted with water and consumed, has a pleasing taste and aroma and which delivers a significantly higher level of antioxidants, in the form of chlorogenic acids, to the body.

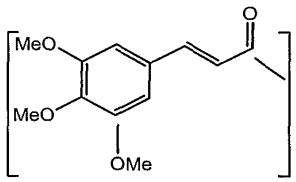
Chlorogenic acids have the general formula:



R3, R4, R5 acyl groups



R1=H, R2=H Coumaroyl
R1=OH, R2= H Caffeoyl
R1=OMe, R2=H Feruloyl
R1=OMe, R2=Me Dimethoxycinnamoyl



Sinapoyl

The most prevalent chlorogenic acids are given in the following table.

Name	Structure	R3	R4	R5
Chlorogenic acids				
5-*O*- caffeoyl-D-quinic acid (5CQA)	C	H	H	caffeoyl
4-*O*- caffeoyl-D-quinic acid (4CQA)	C	H	caffeoyl	H
3-*O*- caffeoyl-D-quinic acid (3CQA)	C	caffeoyl	H	H

Other isomers exist which also fall within the definition of the structure given above. Therefore, in the context of the present invention, the phrase "chlorogenic acids" denotes all chlorogenic acid isomers, which are defined by the aforementioned structure.

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In one aspect of the present invention, the coffee product is derived from a mixture of green and roasted coffee beans in which the weight ratio of the green portion and roasted portion in the coffee product is from 1:99 to 90:10, preferably from 30:70 to 50:50, more preferably from 35:65 to 45:55, most preferably from 37:63 to 42:58.

Where the ratio is below 1:99, the amount of chlorogenic acid present in the product is found to be insufficient to provide an effective amount of bio-available antioxidants.

Where the weight ratio of green bean to roasted bean in the product exceeds 60:40, it has been found that the product may be perceived as having an undesirable organoleptic profile, mainly due to a weakening of the roasted notes. Of course, it may be possible to compensate for this by darkening the roast level of the roasted portion. In this case, the weight ratio of the green bean portion to the roasted bean portion is less critical and could potentially be as high as 90:10.

Nevertheless, in order to provide a balance of acceptable taste with sufficiently high levels of chlorogenic acid in the product, the inventors have found that the weight ratio is most preferably between 35:65 to 45:55, or even 37:63 to 42:58 because, when moving away from these ratio ranges, there is considered to be a disproportionate reduction in one of the desirable benefits when compared to the improvement in the other benefit.

The content of chlorogenic acids in the coffee product is at least at least 4g per 100g of product, more preferably at least 5g, even more preferably at least 6g, most preferably at least 8g, e.g. at least 9g.

The green coffee portion may be a blend of green Arabica and green Robusta beans. However, it is particularly preferred that the green coffee portion is substantially or wholly derived from Robusta coffee beans.

Thus, preferably at least 65%, more preferably 75%, even more preferably 85%, most preferably 95%, e.g. 100% by weight of the green coffee beans are Robusta. This is because it has been found that Robusta coffee beans provide a greater level of chlorogenic acid per gram of bean than Arabica beans.

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The roasted coffee portion may be a blend of Arabica and Robusta, although it is particularly preferred that the roasted portion is substantially or wholly derived from Arabica beans. This is because Arabica provides a richer taste and aroma profile, which is associated with coffee of higher quality.

The green coffee portion and/or the roasted coffee portion may be at least partially decaffeinated. This is to provide products the caffeine level of which can be modulated from caffeine-free to regular caffeine level. However, it is particularly preferred that the green coffee portion is from decaffeinated coffee.

Preferably the coffee product is used to provide a soluble coffee product.

Soluble coffee, or instant coffee as it is otherwise known, is very well known and has been produced commercially for many decades. It is produced from roast and ground coffee in a variety of ways, all of which are well known to the person skilled in the art.

Typically a first, though optional, step involves the stripping of the most volatile aroma components from coffee, which has previously been roast and ground.

Any suitable method for stripping can be used, though a particularly preferred method is disclosed in EP-A-1078576.

Following stripping, the less volatile components are then subjected to an "extraction" step. Extraction is a term common in the art of processing soluble coffee and indicates a process where water and/or steam are used to extract a complex mixture of coffee components from the roasted, ground coffee bean.

After extraction, the product may undergo a concentration step, following which, if a stripping step has taken place, the stripped aroma is reintroduced into the resulting extract.

Finally, the aromatised extract is usually dried according to any standard procedure, such as freeze-drying, spray-drying or agglomerating.

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This produces a solid soluble product which may suitably be in the form of a powder or granules.

The soluble coffee mixture may be produced by co-extraction of the green portion and the roasted portion.

Alternatively, the soluble coffee product can be produced by separately providing a roasted coffee portion and a green coffee portion and then extracting them individually before combining the resultant extracts. This is advantageous as the extraction conditions can be adapted to suit roasted and unroasted beans respectively.

It is to be understood that where the coffee product of the invention is used in a soluble coffee product, the extraction process, explained herein, will increase the concentration of chlorogenic acids present. Therefore, in such a product, the content of chlorogenic acids is defined at a notional extraction level of 50% total solids extracted since, at higher or lower extraction levels, the content of chlorogenic acid will increase or decrease respectively.

Thus, in a soluble coffee product, the content of chlorogenic acid is at least 8g per 100g of the coffee product, based on an extraction level of 50% by weight of total solids, more preferably 10g, most preferably 12g per 100g of soluble coffee product.

It has also been found that the coffee product of the invention has other benefits. For instance, arabinogalactans are present in green coffee.

Arabinogalactans are a family of polysaccharides (proteoglycans) involved in plant growth and development. They are found in higher plants and occur in many different tissues, such as on the plasma membrane, in the cell wall and in the extracellular matrix.

Arabinogalactans typically have molecular weights, which vary from 10 kDa to 4000 kDa. They typically contain less than 10wt% protein, which is normally composed mainly of proline/hydroxyproline, alanine, serine, and threonine. More than 90wt% of arabinogalactans consists of polysaccharides, composed mainly of β-(1–3)-galactan chains with β-(1–6)-galactosyl side chains terminated primarily with arabinosyl residues.

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Importantly, arabinogalactans deliver prebiotic benefits to the body when ingested.

In order to make the arabinogalactans available to the body, the green coffee portion is preferably ground, since this allows the arabinogalactans to be extracted therefrom.

It may also be desirable to incorporate into the coffee product additional arabinogalactans that have been isolated from green or roasted coffee. Suitable processes for isolating arabinogalactans are set out in WO 2005/116083, incorporated herein by reference.

Thus, in the present invention, arabinogalactans present in the ground green coffee portion, optionally together with arabinogalactans incorporated from another source into the coffee product, can be used to provide prebiotic benefits to the body when the coffee product is consumed.

The present invention is particularly suitable for use as a soluble coffee product or any product, which is based on or derived from a soluble coffee product.

For instance, the coffee product may also be used in so-called ready-to-drink beverages. Examples of ready-to-drink beverages for which the product of the present invention are suited include two-in-one beverages which comprise a coffee component together with a natural or artificial sweetener component, the components optionally being pre-diluted with a liquid such as water or milk. In this case, the coffee component can comprise the coffee product of the present invention.

Three-in-one beverages, which comprise coffee, a sweetener and a whitener such as milk, a liquid creamer or a solid (e.g. powdered) creamer, may comprise the coffee product of the present invention.

Furthermore, any beverage, which comprises soluble coffee as an ingredient, may comprise the coffee product of the present invention.

Additionally, the present invention can be used as an ingredient for standard brew, espresso, coffee-based beverage preparations to be used as bulk or in single beverage portion for in-home preparation.

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Examples

In the following examples, all amounts are percentage by weight unless otherwise stated.

Example 1

Soluble coffee products were produced as follows:

Arabica and/or Robusta beans were medium roasted (CTN 80) and mixed with green Arabica and/or green Robusta beans. The beans were then ground and extracted according to standard methods. The resulting product was then dried to provide a soluble coffee product. These products were compared to traditional soluble coffee products derived wholly from either roasted Arabica and/or Robusta beans. See table 1.

The chlorogenic acid isomers were separated by high pressure liquid chromatography and detected by UV photometry. Antioxidant activity of chlorogenic acid isomers was evaluated in sequence by measuring the radical scavenging ability of the product using stable free radicals (ABTS). The total antioxidant activity was obtained from the summation of antoxidative activity of individual chlorogenic acid isomers. The antioxidant activity is given in "chlorogenic acid equivalents" (g/100g of the powdered product). The results are given in Table 1.

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Table 1

Sample	Coffee Product (weight ratio of green:roasted)	Green coffee	Roasted Coffee (CTN 80)	Chlorogenic acids equivalent
1	0:100	-	Arabica	3.4
2	20:80	Arabica	Arabica	5.3
3	35:65	Arabica	Arabica	7.8
4	50:50	Arabica	Arabica	9.4
5	0:100	-	Robusta	2.2
6	35:65	Robusta	Robusta	7.2
7	0:100	-	50/50 Mix	*2.9*
8	35:65	77/23 Mix*	50/50 Mix	7.2
9	35:65	Robusta	Robusta	8.3

* denotes 77% Arabica / 23% Robusta.

Example 2

Soluble coffee products were prepared as follows:

Arabica and/or Robusta beans were roasted to various degrees and mixed with green Arabica and/or green Robusta beans. The beans were then ground and extracted using conventional techniques. The resulting products were dried to provide a soluble coffee product. These products were then compared to soluble coffee samples derived wholly from either roasted Arabica and/or Robusta beans. See table 2.

The chlorogenic acid isomers were separated by high pressure liquid chromatography and detected by UV photometry. The antioxidant activity is given in "chlorogenic acid equivalents" (g/100g of the powdered product). The results are given in Table 2.

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Table 2

Sample	Coffee Product (weight ratio of green:roasted)	Green coffee	Roasted Coffee	Colour (CTN)	Chlorogenic acids equivalent
10	0:100	-	Arabica	80	*2.9*
11	35:65	Arabica	Arabica	60	6.8
12	35:65	Arabica	Arabica	80	7.8
13	35:65	Arabica	Arabica	100	8.6
14	0:100	-	35/65 Mix*	80	*3.7*
15	35:65	Robusta	Arabica	60	8.2
16	35:65	Robusta	Arabica	80	8.8
17	35:65	Robusta	Arabica	100	10.6

* denotes 35% Arabica / 65% Robusta.

Example 3

Soluble coffee products were prepared as follows:

Arabica and/or Robusta beans were roasted to various degrees and mixed with green Arabica and/or green Robusta beans. The roasted beans were then ground whereas green coffee beans were used in an unground form. The ground roasted coffee and the unground green coffee were blended and extracted using conventional techniques. The resulting products were dried to provide a soluble coffee product. These products were then compared to soluble coffee samples derived wholly from either roasted Arabica and/or Robusta beans.

The chlorogenic acid isomers were separated by high pressure liquid chromatography and detected by UV photometry. The antioxidant activity is given in "chlorogenic acid equivalents" (g/100g of the powdered product). The results are given in Table 3.

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Table 3

Sample	Coffee Product (weight ratio of green:roasted)	Green coffee	Roasted Coffee	Colour (CTN)	Chlorogenic acids equivalent
18	0:100	-	35/65 Mix*	80	*3.7*
19	35:65	Robusta	Arabica	80	8.5
20	35:65	Robusta	Arabica	90	9.7
21	35:65	Robusta	Robusta	80	2.2
22	35:65	Robusta	Robusta	85	7.6

* denotes 35% Arabica / 65% Robusta.

Although the invention has been described with reference to specific embodiments, this description is not meant to be construed in a limited sense. Various modifications of the disclosed embodiments, as well as alternative embodiments of the inventions will become apparent to persons skilled in the art upon the reference to the description of the invention. It is, therefore, contemplated that the appended claims will cover such modifications that fall within the scope of the invention.

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Claims

1. A coffee product comprising:

(i) a first portion consisting of unroasted ground or/and unground coffee, in an amount of from 1 to 90% by weight based on the total weight of the coffee product, and

(ii) a second portion consisting of ground coffee which has been roasted to a higher degree of roast than said first portion, in an amount of from 99 to 10% by weight based on the total weight of the coffee product,

wherein the content of chlorogenic acids is at least 4g per 100g of the coffee product.

2. A coffee product as claimed in claim 1 in which the weight ratio of (i) to (ii) is from 30:70 to 50:50.

3. A coffee product according to claim 1 in which the weight ratio of (i) to (ii) is from 37:63 to 42:58.

4. A coffee product according to any one of the preceding claims wherein the first portion is derived from decaffeinated coffee and the second portion is derived from, optionally decaffeinated, coffee.

5. A coffee product comprising a liquid or solid coffee composition derived from the coffee product as claimed in any one of the preceding claims.

6. A method of preparing a soluble coffee product comprising the steps of:

(A) providing a coffee product comprising

(i) a first portion consisting of unroasted ground or/and unground coffee, in an amount of from 1 to 90% by weight based on the total weight of the ground coffee composition, and

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(ii) a second portion consisting of ground coffee which has been roasted to a higher degree of roast than said first portion, in an amount of from 99 to 10% by weight based on the total weight of the ground coffee composition,

(B) optionally stripping the aroma from the second portion to provide a first aroma portion and a stripped second portion,

(C) combining and co-extracting portion (i) and optionally stripped portion (ii)

(D) optionally stripping the aroma from the extract,

(E) optionally adding the first aroma portion to the, optionally stripped extract,

(F) optionally drying the extract,

so as to provide a soluble coffee composition having a content of chlorogenic acids of at least 8g per 100g of the soluble coffee product, based on an extraction level of 50% Ts.

7. A method of preparing a soluble coffee product comprising the steps of:

(A) providing a first portion consisting of unroasted coffee,

(B) optionally grinding the first portion,

(C) extracting the first portion to provide a first extract,

(D) Optionally drying the first extract

(E) providing a second portion consisting of coffee which has been roasted to a higher degree of roast than said first portion,

(F) grinding the second portion,

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(G) optionally stripping the aroma from the second portion to provide a first aroma portion and a stripped second portion,

(H) extracting the optionally stripped second portion to provide a second extract,

(I) Optionally drying the second extract,

(J) combining the first and second extracts in the stoechiometric proportions of extracts so that the initial combined coffee blend would have been composed of 1 to 90% by weight of unroasted ground or/and unground coffee and 99 to 10% by weight of roasted ground coffee,

(K) optionally stripping the aroma from the combined extract, and

(L) optionally adding the first aroma portion to the, optionally stripped, combined extract

(M) optionally drying the extract

so as to provide a soluble coffee product having a content of chlorogenic acids of at least 8g per 100g of the soluble coffee product, based on an extraction level of 50% Ts.

8. Use of a coffee product as defined in any one of claims 1 to 5 which, when reconstituted to provide a coffee beverage, provides an increased amount of natural bio-available antioxidants to the body when consumed.

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INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2006/003209

A. CLASSIFICATION OF SUBJECT MATTER
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According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
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Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal, WPI Data, PAJ, FSTA, BIOSIS, COMPENDEX

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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A	claims 1,15,16; example 1	1-4,6,7
X	EP 0 299 106 A (CODE KAFFEE-HANDELSGESELLSCHAFT MBH) 18 January 1989 (1989-01-18)	5,8
A	page 2, lines 1-30; examples	1-4,6,7
X	CH 523 023 A (HAG AKTIENGESELLSCHAFT BREMEN) 31 May 1972 (1972-05-31) examples 1,2	5,8

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[X] Further documents are listed in the continuation of Box C.

[X] See patent family annex.

* Special categories of cited documents :

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"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

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Date of the actual completion of the international search	Date of mailing of the international search report
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International application No
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C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
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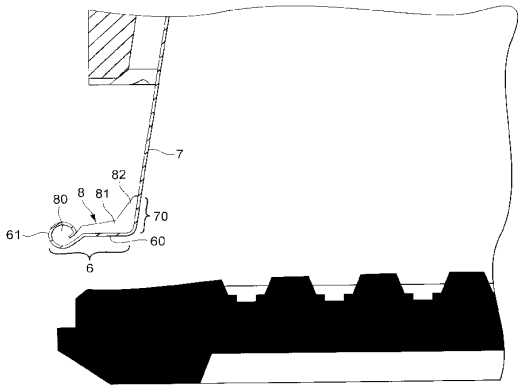
(74) Agent: **BORNE, Patrice**; Nestec S.A., Avenue Nestlé 55, CH-1800 Vevey (CH).

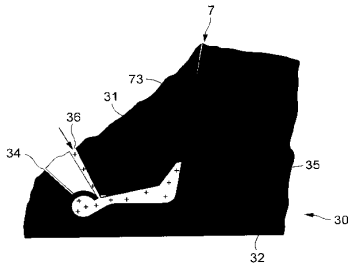
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[Continued on next page]

(54) Title: CAPSULE FOR PREPARING A BEVERAGE WITH A SEALING MEMBER FOR WATER TIGHTNESS ATTACHED THERETO AND METHOD OF PRODUCING THE SAME





(57) Abstract: Method for producing a capsule (1) containing beverage ingredients designed for insertion in a beverage production device in which a liquid under pressure enters the capsule in order to interact with the ingredients in the capsule and to drain a beverage from the capsule, wherein the capsule comprises a body (4) with a sealing member attached thereto. The method comprises providing a body (4) with a main cavity, injecting at least one sealing material by injection-moulding onto at least a portion of the external surface of the body (4) to mould a sealing member (8) sealingly attached to the body, filling the cavity with food ingredients and imperviously closing the cavity with a membrane (5) to provide a closed capsule containing the food ingredients.

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PT, RO, SE, SI, SK, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Declarations under Rule 4.17:

— *as to applicant's entitlement to apply for and be granted a patent (Rule 4.17(ii))*

— *as to the applicant's entitlement to claim the priority of the earlier application (Rule 4.17(iii))*

— *of inventorship (Rule 4.17(iv))*

Published:

— *with international search report*

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

Capsule for preparing a beverage with a sealing member for water tightness attached thereto and method of producing the same.

The present invention generally relates to capsules for containing beverage ingredients to a beverage producing system for use in connection with such capsules as well as to a method for producing such capsules.

The background of the present invention is the field of capsules which contain beverage ingredients (e.g., coffee ground, milk powder) or other comestible ingredients (e.g. dehydrated soup). By means of an interaction of these ingredients with a liquid, a beverage or other comestibles can be produced. The interaction can be for example an extraction, brewing or dissolution process. Such a capsule is particularly adapted to contain ground coffee in order to produce a coffee beverage by having hot water under pressure enter the capsule and draining a coffee beverage from the capsule.

Systems and methods for obtaining fluid comestibles from substances containing capsules are for example known from EP-A-512470.

The general principle of this extraction process can be summarized as follows:

- An initially closed capsule is inserted between capsule holder means which are closed in a water tight manner about the capsule;
- Water injection means of the machine inject water in the capsule;
- Water interacts with the ingredients contained in the capsule while traversing the interior of the capsule

and is then made to leave the capsule through at least one opening/perforation created in the second wall.

The ingredients in the capsule constitute the „bottleneck„ of the flow path of the water and will therefore cause a pressure drop between the upstream and the downstream side of the liquid flow through the capsule, which pressure drop will even increase during the interaction between the liquid and the ingredients for example due to a swelling of the ingredients. Correspondingly it has to be assured that the only water flow is actually taking place through the interior of the capsule and that no water can flow from the water injector into the interstice between the annular enclosing member and the exterior of the capsule and then to the draining bore of the device. In other words, any water flow exterior to the capsule has to be stopped by a sealing engagement between an annular enclosing member of the holder means and the capsule and in the flow path between the water injector and the beverage-draining bore.

Such sealing engagement can be achieved at least to a certain degree by the pinching engagement between the capsule holder means (i.e., annular enclosing member and capsule holder) and the flange-like rim of the body in-between.

In case the sealing engagement is not working properly and water is flowing outside the capsule, no pressure sufficient to cause the tearing of the tear face will be built up inside the capsule or, alternatively, the pressure will be causing no complete tearing of the tear face and therefore a poor extraction of the substance. In

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such a scenario water will be drained from the beverage production device without having interacted or fully interacted under sufficient pressure conditions, with the ingredients contained in the capsule.

An improvement could be thought of according to which this sealing engagement is further improved by lining the inner wall of the annular member with a rubber-elastic material. In other words, according to said approach the sealing engagement is assured by structures fixed to or attached with the beverage-producing device. This has disadvantages in that after the use of a substantial number of capsules a wearing off of the fixed sealing means can take place such that the quality of the produced beverage is increasingly deteriorated by water passing the no longer properly efficient sealing. Furthermore, the sealing means can become dirty with organic residues sticking to it which is not very hygienic and may affect the sealing and pressure conditions as well during extraction.

Any "leak" at the exterior of the capsule reduces the pressure build-up inside the capsule. On the other hand, it is well known that a sufficient extraction pressure is a key factor for the quality of espresso-style coffee. European co-pending patent application No. 04025320.5 entitled "Capsule with sealing means" aims at an improvement of the sealing engagement positioned between the liquid inlet and the beverage draining side of such a beverage production system. The invention aims at transferring a resilient part of the sealing engagement from the beverage production device to the capsule. The advantage is that any resilient sealing member is only used once (i.e. only with the associated capsule) such

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that a proper functioning of the sealing can be assured and no hygienic problems can occur at the sealing member.

The present invention aims at another improvement of European co-pending patent application No. 04025320.5 in order to improve the sealing conditions between the capsule and the seal so to ensure water tightness during brewing. Indeed, it is of importance to avoid any potential liquid leakage between the sealing member and the rest of the capsule in particular thanks to a good bond created between the two.

Furthermore, it is also of importance that the sealing member is integrated to the capsule using a process that can be implemented on a large industrial scale, be highly reliable with minimal defective products and be also cost effective.

The object is achieved by means of the features of the independent claims. The depending claims further develop the central idea of the present invention.

For this, the method of the invention is for providing a sealing member on the body of a capsule containing beverage ingredients designed for insertion in a beverage production device in which a liquid under pressure enters the capsule in order to interact with the ingredients in the capsule and to drain a beverage from the capsule,

characterized in that it comprises providing a body and injecting at least one sealing material by injection-moulding onto at least a portion of the external surface of the body to mould a sealing member sealingly attached to the body.

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More particularly, the injection of a sealing material (or sealant) to form the sealing member offers many advantages. First of all, the adhesion of the sealing member can be very much improved compared to attaching a prefabricated sealing member. As a result, liquid leakage can be prevented between the sealing member and the capsule's body and the conditions of extractions can be better guaranteed and maintained from capsule to capsule (better brewing conditions repeatability). The sealing member being more solidly attached as a part of the capsule, there is less risk for the sealing member to detach or be removed for use in beverage brewing machines which are not intended for receiving capsules without the sealing member and consequently also to reduce the risk of malfunctioning.

Furthermore, this offers more opportunities for producing the capsule's body with simpler or more varied shapes. The method is also quicker, more cost effective than adding and attaching a sealing member by mechanical, welding and/or adhesive means and can be implemented in effective manner, at high throughput and large industrial scale.

Preferably, the sealing material is made of a different material from the material of the body. More preferably, the sealing material is softer than the material of the body.

In a preferred mode, the body is formed with a flange-like rim and the injection step comprises injecting the sealing member onto the flange-like rim. The flange-like rim represents the region at which the capsule is pinched by the enclosing members (e.g., a bell member and a capsule holder hermetically closing about the capsule) of

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the beverage production device. The injected sealing member being of softer material than the body at the flange-like rim, it can be compressed to compensate for the irregularities, tolerance plays or gaps and so on, to maintain water tightness under the brewing pressure in the enclosure for the capsule.

The flange-like rim can further comprise an anchoring portion and a support portion. The anchoring portion is arranged so that, during injection, the material of the sealing member can flow in the anchoring portion to improve the connection between the sealing member and the body.

The anchoring portion can be formed of a partially curled portion. The curled portion can comprise an opening, e.g., an annular opening, for plastic to flow therein during injection. The curled portion can be formed during a deep drawing operation of the body that precedes the injection of the sealing member or alternatively is formed in a separate forming operation of the flange-like rim after deep drawing the cavity of the capsule's body. The operation for injecting the sealing member is preferably a high-pressure plastic injection. The capsule body is clamped both internally, i.e., on the cavity side, and externally, i.e., on the external side of the sidewall of the body, by injection dies and an injecting enclosure is defined by the dies for delimiting the volume to be filled in for the sealing material. The sealing material can be injected at a pressure that exceeds 500 bar, preferably between 500 and 2000 bar, more preferably between 800 and 1500 bar. The injection time is very quick and does typically not exceed more than a second. Just after injection, the sealing material

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is allowed to cool down for solidifying during a few seconds, in general, between 3 to 8 seconds.

The material for the seal member should be chosen amongst thermoplastic elastomer having ability to be resilient, heat and pressure resistant and injectable. Preferably, the thermoplastic material is typically a Thermoplastic Elastomer ("TPE"). More preferably, the TPE is a polypropylene based elastomer.

As mentioned, in a preliminary production step, the capsule body can be preformed by deep drawing of a metal or metal-plastic sheet. The capsule body can be deep drawn during one step or during sequential steps to form a final main open cavity enabling filling of the food ingredients. The flange-like rim, anchoring means in particular the curled end of the rim or other important functional shapes may be formed during the deep drawing operation(s).

Furthermore, at least one localized deformation of the body sidewall can be carried out to create further anchoring means for the sealing member, in particular, at a collar portion of the sealing member that extends along the sidewall body. The localized deformation(s) can be formed in the sidewall of the body so to create, for instance, one or more arc-shaped protrusions of body's wall rising inside the material of the sealing member. Said localized deformation(s) can be carried out during injection or cooling down of the injected sealing member. In another subsequent step, the body is filled with the food ingredient such as roast and ground coffee.

The capsule body can comprise aluminium. It can be a single ply of aluminium or a multi-ply of plastic and aluminium such as polypropylene and aluminium.

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The invention also relates to producing a capsule containing beverage ingredients designed for insertion in a beverage production device, i.e., between capsule enclosing members, in which a liquid under pressure enters the capsule in order to interact with the ingredients in the capsule and to drain a beverage from the capsule. The capsule comprises a body with a sealing member attached thereto. The sealing member is intended to provide water tightness between the capsule and at least a pressing surface of the production device, i.e., of one of the enclosing members of the device. The method comprises providing a body, filling the body with food ingredients and imperviously closing the body. The method also comprises injecting at least one sealing material by injection-moulding onto at least a portion of the external surface of the body to form a sealing member sealingly attached to the body.

In a subsequent step following the food ingredient filling step, a membrane is welded along a portion of the external face of the flange-like rim to close the capsule. The seal membrane can also be aluminium or a laminate of plastic and aluminium.

The invention also relates to a particular injection layout for injecting sealing material onto the surface of capsule bodies produced according to the method of the invention.

The layout comprises:

- a first injection die member comprising at least a first and second injection sides for receiving a plurality of capsule bodies,

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- at least a second injection die member configured for closing against the first injection die member and for engaging the pluralities of capsule bodies;

- at least first body's replacing means configured for replacing capsule bodies in one of the first or second injection sides while injection-moulding of sealing material is carried out on the capsule bodies of the at least one other injection side of the first die member,

wherein the first and at least second injection die members are mobile relative one another to enable the closing of the second die member against alternatively the first and second sides of the first injection die member.

Therefore, injection-moulding of the capsule bodies can be achieved at a high throughput and in an automated manner according to this particular layout.

More particularly, the first and second sides of the first die member comprises series of cavities for receiving the capsule bodies whereas the second die member comprises a series of mandrels for engaging the capsule bodies in closure of the die members.

The other depending claims develop further this particular layout for carrying out the method of the invention.

Further advantages, features and objects of the present invention will become apparent for the man skilled in the art when reading the following detailed description of embodiments of the present invention taking in conjunction with the figures of the enclosed drawings.

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Fig. 1 shows a first embodiment of the capsule system of the present invention in which a capsule is placed on the capsule holder but has not yet reached its closing position in the beverage production device,
Fig. 2 shows an enlarged of Fig. 1,
Fig. 3 the first embodiment in a state, in which a capsule has reached its closing position between the capsule enclosing parts, i.e., a bell member and the capsule holder,
Figs. 4 and 5 show schematically the injection operation of the sealing member on the capsule body,
Figs. 6 to 10 show detail of the male injection die that holds the capsule body and provides a deformation 'in situ' during the injection operation,
Fig. 6 shows the male die without the capsule body being positioned thereon,
Fig. 7 shows the male die with the capsule body being positioned after injection of the sealing member,
Fig. 8 shows the male die with the capsule body being positioned but with the sealing member being removed for showing the localized deformations being formed on the body by the die,
Fig. 9 shows a cross sectional view of the male die without capsule body,
Fig. 10 shows a detail cross sectional view of the male die with the capsule body being positioned and the sealing member being injected,
Figs 11 to 13 show views of the injection device layout at the manufacturing site enabling high throughput of injected capsule parts,
Fig. 14 is a chart illustrating steps according to a mode of the method of the invention,

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Fig. 15 is a chart illustrating steps according to a variant of the method of the invention.

Note that in the following the invention will be explained referring to a certain design of a capsule, i.e. a design according to which the capsule comprises a cup-like base body and a closing foil member. However, it is to be understood than other designs of the capsule are viable, such as e.g. capsules having a lenticular form with two essentially matching and opposing walls (e.g. foils) being sealed at the e.g. ring-shaped edge. Generally a capsule according to the present invention comprises at least two opposing wall members (faces) which are connected to each other at their respective edges to form a sealed flange-like rim area, thus enclosing a sealed interior.

The embodiment shows a capsule holder 13 having relief elements 12 which are designed to tear and perforate a foil member 5 closing off a cup-like base body 4 of the capsule 1. This tearing of the foil member 5 can occur as soon as the pressure inside the capsule exceeds a threshold value. Note that the relief elements can have any protruding shape able to cause a controlled tearing of the foil member. As an example only pyramids, needles, bumps, cylinders, elongated ribs are cited. The relief element can also be single.

Fig. 1 shows a state in which such a capsule has been placed on a capsule holder 13, the foil member 5 resting on the relief elements 12 of the capsule holder 13 and the cup-like base body 4 of the capsule 1 being already partly surrounded by the circumferential wall 25 of an enclosing member 9 of the beverage production device. The shown enclosing member can have the shape of a bell.

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Other shapes are viable, wherein the design of the interior contours (recess) of the enclosing member is generally adapted to substantially match the contours of the capsule 1.
The capsule holder 13 (also representing an enclosing member) and the enclosing member 9 thus can selectively enclose a capsule enclosure space 22 when transferred from an opened position into a capsule-enclosing position.
Note that the foil member 5 as shown is not necessarily exactly flat due to a defined over pressure inside the capsule, which over pressure is generated by introducing e.g. a protective gas when producing the filled capsule and during delayed degassing of the food ingredients after sealing, for instance, carbon dioxide from coffee.

The enclosing (bell) member 9 furthermore comprises an annular pressing surface 18 and a water inlet opening 20 for feeding a liquid such as for example hot water under pressure to a water injection system 14 which is releasable mounted (e.g., screwed) to the bell member 9.

The water injection system can comprise one or more perforation elements (blades, pins, etc.) 24 designed to produce one or more openings in the top wall 17 of the capsule 1 when the capsule holder 13 and the bell member 9 are moved close together e.g. by a manually operated or an automatic closing mechanism. A channel 19 traverses the injection system and leads to the enclosure 22 of the enclosing member 9 such that water can be fed to the interior of the capsule 1 once the perforation elements 24 protrude into the interior of the capsule 1.

The capsule 1 comprises said top wall 17, a side wall 7 and a flange-like rim 6, wherein the foil member 5 is

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sealed to said flange-like rim 6 to close-off hermetically the cup-like base body 4 of the capsule 1. Again, other designs for the capsule are possible as long as the capsule can be sealed and contain the mentioned ingredients.

According to the present invention the outer surface of the capsule 1 presents a dedicated water tightness sealing member (made of sealing material) 8 thereafter called "sealing member". The sealing member 8 can be compressible, more preferably resilient.

The material for the sealing member can be an injectable thermoplastic elastomer.

As more apparent in Fig. 2, the capsule of the invention comprises a flange-like rim 6 with a support portion 60 for the sealing member and a partially curled end portion 61 forming an anchoring portion for the sealing member. The support portion 60 merges with the sidewall 7 of the body 4 at a certain angle (i.e., slightly more than 90 degrees when the body has a truncated form). The flange like rim as well as the base surface 70 of the sidewall receives the annular sealing member 8. In order for the sealing member to be affixed to the flange-like rim in a reliable manner, the sealing member extends toward the partially curled portion 61 by a connection portion 80 which is injected in the partially curled portion 61 of the rim. The curled ends forms a "hook" for the sealing material which so increases the connection and also the water tightness between the sealing member and the rim. Outside the partially curled portion 61, the sealing member 8 extends along the support portion 60 of the flange-like rim by a sealing portion 81 that can extend by collar portion 82 applied against the base surface 70

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of the body's sidewall 7. The sealing portion 81 and collar portion 82 can form surfaces of different slopes or can merge in a single continuous concave or flat inclined surface. The form of the sealing member 8 into a wedge profile is chosen to provide a sufficient mass of material for compensating for the irregularities, tolerances, gaps or other interstices (e.g., due to wearing of the mechanical surfaces) between the capsule and the enclosing or bell member. As the watertight sealing may also be obtained dynamically, i.e., by effect of the water under pressure forcing on the sealing member, the shape, dimension and overall mass of the sealing member should be sufficient to deform, thus resiliably "flow" and fill correctly the left openings when the pressure builds up during brewing.

Fig. 3 shows the state in which the enclosing member 9 and the capsule holder 13 are brought in closing pressure engagement at the rim and due to the water entering the interior of the capsule and building up a pressure there the pyramidal relief members 12 of the capsule holder 13 produce openings in the foil member 5 of the capsule 1. Upon insertion of the capsule the blade elements 24 of the water injector 14 have previously created perforations 16 in the top wall 17 of the capsule 1. When a sufficient pressure of fluid has been built inside the capsule, the beverage produced from the ingredients contained in the capsule can be drained in small interstices or perforations created by tearing of the foil member 5 by the relief elements 12.

In a first step of the method (not illustrated), the body 4 of the capsule is produced. The body can be produced with a preform of the flange-like rim 6 which remains open for injection of material of the sealing member in

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the subsequent injection step. The body 4 can be preformed by deep drawing of a metal sheet or an assembly of multiple plies including metal, e.g., aluminium and plastic, e.g., polypropylene and eventually binders and/or lacquers. Depending on the complexity of the shape of the body and the depth of the cavity, the sheet can be deep drawn in more than a single step. Also, the cavity of the body and the flange-like rim can be formed in a same operation or, alternatively, in separate operations.

Figs. 4 and 5 show the injection operation of the sealing member 8 on the preformed body 7. The body can thus be placed between an injection die assembly 30. The die assembly typically comprises two die members, a female die member 31 and a male die member 32 which are assembled tightly about the capsule body and leave an injection room 35 for the sealing material to be injected in to form the sealing member. The female die member 31 surrounds the external sidewall 7 and top wall 17 of the body, and usually also delimits the volume 35 for the sealing member to be injected on the flange-like rim 6 and further extends to a parting line 34 which can be situated, for instance, substantially at the end of the partially curled portion 61 of the rim therefore to enable easy removal of the body from the die after injection. The male die member 32 is inserted inside the cavity of the body and matches the external form of the flange-like rim (e.g., lower surface of the rim) up to the parting line 34.

Advantageously, the die assembly 30 extends along the whole side 7 of the body and imposes a relatively high mechanical pressure on the sidewall 7. The advantages are two fold.

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Firstly, the injection is carried out a relatively high pressure-short time therefore a pressure tight injection seal arrangement must be obtained in particular at the junction line 34 between the external sidewall of the body and the uppermost point of the sealing member.

Secondly, the pressure can also be effective to smooth the external surface 73 of the body's sidewall. The former deep drawing operation tends to create wrinkles on the surface of the sidewall due to the general truncated form of the body. Therefore, the mechanical pressure exerted by the male and female dies directly at the whole opposed surfaces of the sidewall 7 enables to flatten the wrinkles and eliminate or at least significantly reduces this visual defect.

The injection takes place through at least one small injection gate 36. The opening of the gate at the entry of the injection room can be in the order of 0.5-1 mm. The injection is carried out at a high pressure, i.e., an average of between 700 to 1500 bar during less than 1.01 second, typically 0.01 second. The plastic is injected in at a temperature above glass transition. Preferred thermoplastic elastomer is a TPE. The sealing member 8 that is obtained is allowed to cool down for at least a few seconds, typically, 5-10 seconds, before the die assembly is reopened and the body is extracted. Cooling can be assisted with a coolant that circulates inside a cooling circuit of the die assembly to diminish the hardening cycle for the sealing member.

Figs. 6 to 10 show in detail, the injection male die arrangement 40 according to a possible embodiment. The male die arrangement 40 can be mounted in an impervious manner on a frame 41. It comprises a mandrel 42 with an

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end which substantially matches the internal cavity of the capsule's body as illustrated in Fig. 8. Inside the mandrel is provided a moveable eccentric punching assembly 43 as illustrated by Figs. 9 and 10. The eccentric assembly comprises two punching members 44, 45 mounted slidably along radially oriented slots 37, 38 of the mandrel (Fig. 9). The punching members 44, 45 are activated in extension/retraction through the slots by a longitudinal pusher 46 which is moved back and forth along the longitudinal axis of the mandrel. The central pusher has portions of ramp 47, 48 which activate the punching members 44, 45 in opposed radial sliding motions along the slots.

As illustrated in Fig. 10, when the central pusher is pushed upwards, the punching members 44, 45 are moved radially against the sidewall 7 of the body 4 and thus cause the sidewall of the capture body to deform outwardly according to arc-shaped indentations 71, 72 (Fig. 8) that protrude inside the sealing member 8 (Fig. 10). The indentations can be formed at any time after the capsule body is inserted on the mandrel and before the injection material has hardened. Preferably, the indentations are created just after the injection, e.g., 0.5-1 sec. after injection stopped.

The indentations 71, 72 improve the anchoring of the sealing member on the sidewall at a base region which is critical and where the sealing member tends to come unstuck from the body. As a consequence, it also provides to some extent a more water impervious sealing by preventing risk of leakage at the interface between the sealing member and the body.

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It must be noted that the indentation(s) may be formed in many ways a man skilled in the art can think of and that the present invention only refers to an industrial possible way for matter of illustration only. Also, the indentations may have different forms such as pins, bumps, etc.

Figs. 11 to 14 illustrate a possible layout for the injection station for handling injection cycles at a high throughput. The general principle will now be explained.

Fig. 11 represents the general injection lay out which can handle two series of injection assemblies running simultaneously on opposed sides. The principle is based on a cubic injection female die member 60 that comprises four injection die sides 61, 62, 63, 64 and can rotate at 90 degrees along a central axis 65 to move the sides of a 90-degree incremental path. Each female side includes a series of injection die cavities 600 for individual insertion of capsule bodies therein. The cavities are usually distributed on the die side according to a predefined pattern, preferably, along a number of lines and columns, for example, in a square pattern, 7 lines times 7 columns giving thus a total of 49 individual injection sites. The pattern and the number of lines and columns in the pattern can vary depending on the required throughput.

The cubic injection female die 60 is associated to two male dies 66, 67 facing opposite sides 61, 63 of the cubic female die member. The male dies 66, 67 can reciprocate relative to the cubic die 60 to be able to open and close against the cavity sides of the cubic injection die. The male dies 66, 67 further comprise male mandrels 42 in number and according to a distribution

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matching the number and distribution of the injection sides.

In the direction orthogonal to the "injection direction I" (i.e., the direction at which the die assemblies are closing simultaneously on the cubic die), are positioned facing the two other opposed sides 62, 63 of the cubic die, stock and transport means 68, 69 for automatically loading/unloading the bodies in the cavities 600 of said sides. This stock and transport means can comprise loading areas 680, 681 arranged for comprising "naked" capsule bodies (bodies without injected sealing members) arranged in square patterns and bodies' stock areas 682, 683 arranged for receiving the "sealed" capsule bodies (i.e., bodies with the injected sealing members thereon). In between are arranged multidirectional robots 684, 685 configured in at least three directions to, respectively: a) unload the sealed bodies of a given pattern at once from the full injection sides, b) transport the sealed bodies of a given pattern to the bodies' stock areas 682, 683, c) take the naked bodies of a given pattern at once from the loading area 680, 681 and d) transport and place them in the empty cavities of the injection sides moved for facing the stock and transport means.

The multidirectional robots 684, 685 may comprise individual suction means, for example, vacuum assisted suction means, to take, transport and release the bodies all at once.

Fig. 12 illustrates, a cycle of injection of two series of patterns J1, J2 being simultaneously injected. The other loading/unloading operations can be run simultaneously during the injection at these sides 61, 63. In step A, the robotic means remove the sealed bodies

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from the full sides 62, 63. In step B, the robotic means then transport and unload the sealed bodies in the unloading area 682, 683. In step C, the robotic means take a new waiting pattern of naked capsule bodies (e.g., 49 bodies arranged in a 7 X 7 square pattern) from the bodies' stock areas 680, 681. Then in step D in Fig. 13, the robotic means transport and load the captured series of naked bodies in the empty injection sides 62, 64 of the cubic die member 60. The steps A-D can be implemented while two other series of bodies in the two contiguous sides 61, 63 are injected with the sealing members. Therefore, a much higher throughput can be achieved since almost every about 10 seconds, two series of 49 (so 98 bodies in total) can be injected with sealing members.

The injection layout of Figs 11 to 13 can be simplified to form only one loading/unloading station with only one male injection die.

As illustrated in Fig. 14, the method encompasses one or more steps 100 of deep drawing the capsule's body, injection-moulding 110 of the sealing member (or "ring"). In a next step 120, the body is filled with food ingredients and finally, in step 130, the membrane 5 is welded. e.g., by heat or ultrasonic welding, on the external face of support portion 60 of the flange-like rim. Additional steps can be envisaged at any suitable time during the production process such as positioning and affixing of filters inside the body and/or the membrane 5 before or after deep drawing of the body.

The present invention encompasses other possible variants. For example, the sealing member can be formed of two or more injection materials having different hardness. For instance, an inner layer of a first

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material can be firstly injected on the body. An outer layer of a second material softer than the material of the inner layer can be then overmoulded on the inner layer. The inner layer can be to improve the bonding for the second material. The outer material can be softer for reducing the closing efforts necessary to close the enclosing members of the beverage production device on the capsule.

In another possible variant illustrated in Fig. 15, the capsule body can be formed of plastic material. The body is also preferably injection-moulded. The body and the sealing member can be so co-injected (step 140). The body can be in plastic of higher Young modulus than the sealing member but the two materials should be compatible to adhere to each other. Example of a suitable material for the body and sealing member is a TPE. The body may also be provided with injected multi-layers comprising one or more gas barrier layer such as EVOH (Ethylene-Vinyl-Alcohol-Copolymer) which is embedded between an inner and outer layers made of TPE.

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Claims:

1. Method for providing a sealing member on the body (4) of a capsule (1) containing beverage ingredients designed for insertion in a beverage production device in which a liquid under pressure enters the capsule in order to interact with the ingredients in the capsule and to drain a beverage from the capsule,
characterized in that it comprises providing a body (4) and injecting at least one sealing material by injection-moulding onto at least a portion of the external surface of the body (4) to mould a sealing member (8) sealingly attached to the body.

2. Method according to claim 1, characterized in that the injected material for the sealing member (8) is different from the material forming the body.

3. Method according to claim 2, characterized in that the injected material for the sealing member (8) is softer than the material forming the body (4).

4. Method according to any one of claims 1 to 3, characterized in that the body (4) is formed with a flange-like rim (6) and the injection step comprises injecting the sealing member (8) onto the flange-like rim (6).

5. Method according to claim 2, characterized in that the flange-like rim (6) comprises an anchoring portion (61) and a support portion (60); wherein the injection step comprises injecting the sealing member (8) both in the anchoring portion (61) and support portion (60).

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6. Method according to claim 5, characterized in that the anchoring portion is formed of a partially curled portion comprising an opening for plastic to flow therein during injection.

7. Method according to any of the preceding claims, characterized in that injection is made under a pressure of about 500 to 2000 bar and during less than or about a second.

8. Method according to any of the preceding claims, characterized in that after injection, the body (4) with its injected sealing member (8) is allowed to cool down during a few seconds in the injection dies (31, 32).

9. Method according to any of the preceding claims, characterized in that the injected material is a Thermoplastic Elastomer.

10. Method according to any of the preceding claims, characterized in that the capsule body (4) is preformed by deep drawing of a metal or metal-plastic sheet.

11. Method according to claim 10, characterized in that the capsule body (4) comprises aluminium.

12. Method according to claims 10 or 11, characterized in that at least one localized deformation (71, 72) of the body sidewall (7) is carried out to create anchoring means for the sealing member (8).

13. Method according to claim 12, characterized in that the at least one localized deformation (71, 72) is

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carried out during injection or cooling down of the injection-moulded sealing member (8).

14. Method according to claim 12, characterized in that the at least one localized deformation is carried out by the deep drawing operation.

15. Method according to any one of claims 1 to 9, characterized in that the body (4) is injection-moulded.

16. Method according to any one of claim 15, characterized in that the body (4) is co-injected with the sealing member (8).

17. Method for producing a capsule containing beverage ingredients designed for insertion in a beverage production device in which a liquid under pressure enters the capsule in order to interact with the ingredients in the capsule and to drain a beverage from the capsule; wherein the capsule comprises a body with a sealing member attached thereto, wherein it comprises providing a body (4), filling the body with food ingredients and imperviously closing the body;
characterized in that:
it comprises providing a body (4) and injecting at least one sealing material by injection-moulding onto at least a portion of the external surface of the body (4) to mould a sealing member (8) sealingly attached to the body.

18. Method according to claim 17, characterized in that it comprises welding a membrane (5) to hermetically close the body (4).

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19. Method according to claim 17, characterized in that it comprises deep drawing the body before the sealing member is injected on it.

20. A capsule for containing beverage ingredients, the capsule (1) being designed for insertion in a beverage production device in which a liquid under pressure enters the capsule in order to interact with the ingredients in the capsule and to drain a beverage from the capsule,

the capsule comprising a sealing member (8) on the outer surface of the capsule, the sealing member being geometrically arranged to be in sealing engagement with at least a matching pressing surface (18) of the beverage production device,

wherein the capsule comprises a body (4) extending by a flange-like rim (6) with the sealing member (8) attached thereto;
characterized in that

the sealing member (8) is made of injection-moulded material.

21. Capsule according to claim 20, characterized in that sealing member (8) is of softer material than the material of the body (4).

22. Injection layout for injecting sealing material onto the surface of capsule bodies produced according to the method of any one of claims 1 to 19, comprising:

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- a first injection die member (60) comprising at least a first (61, 63) and second injection sides (62, 64) for receiving a plurality of capsule bodies,

- at least a second injection die member (66, 67) configured for closing against the first injection die member (60) and for engaging the pluralities of capsule bodies;

- at least first replacing means (68, 69) configured for replacing bodies in one of the first or second injection sides (62, 64) while injection-moulding of sealing material is carried out on the bodies of the at least one other injection side (61, 63) of the first die member (60),

wherein the first (60) and at least second injection die members (66, 67) are mobile relative one another to enable the closing of the second die member (66, 67) against alternatively the first (61, 63) and second sides (62, 64) of the first injection die member.

23. Layout according to claim 22, characterized in that

the first and second sides of the first die member (60) comprises series of cavities (600) for receiving the capsule bodies whereas the at least one second die member (66, 67) comprises a series of mandrels (42) for engaging the capsule bodies in closure of the die members (60, 66, 67).

24. Layout according to claim 23, characterized in that it comprises:

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a first cubic die (60) comprising four injection sides (61, 62, 63, 64) and is configured for rotating incrementally of 90 degrees,

two second die members (66, 67) configured to selectively engage two (61, 63) of the four injection sides of the cubic die (60) as the cubic die rotates in injection position of two of the four injection sides (61-64) and,

two replacing means (68, 69) configured for replacing the bodies of two other sides (62, 64) which are not in injection-moulding position in relation to the second die members (66, 67).

25. Layout according to claim 23 or 24, characterized in that the replacing means comprises robotic means (684, 685) for replacing the bodies of the injection sides at once.

26. Layout according to claim 23, 24 or 25 characterized in that the series of cavities (600) and mandrels (42) are distributed according to a substantially square pattern.

27. Layout according to claim 26 characterized in that the substantially square pattern comprises at least 7 lines and 7 columns of cavities (600) and mandrels (42).

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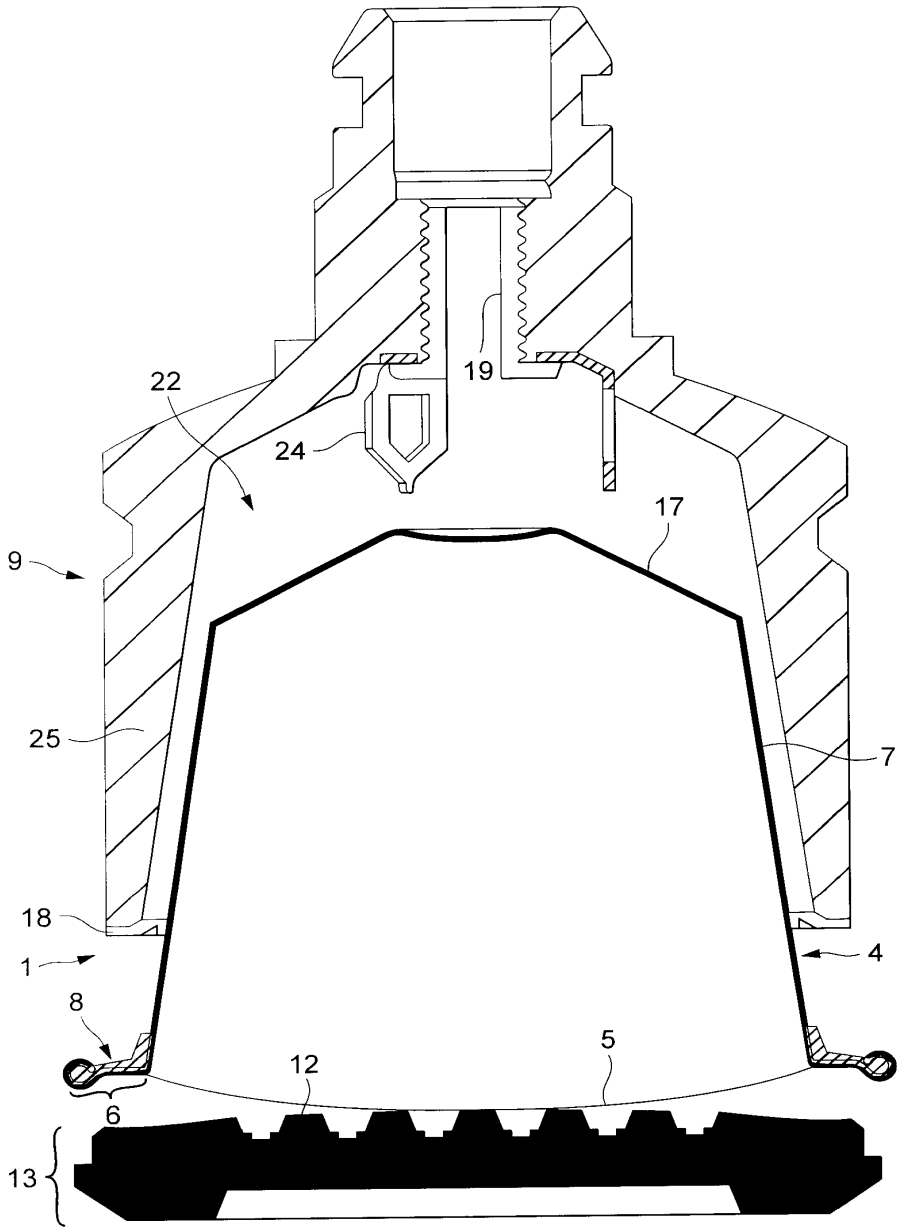


FIG. 1

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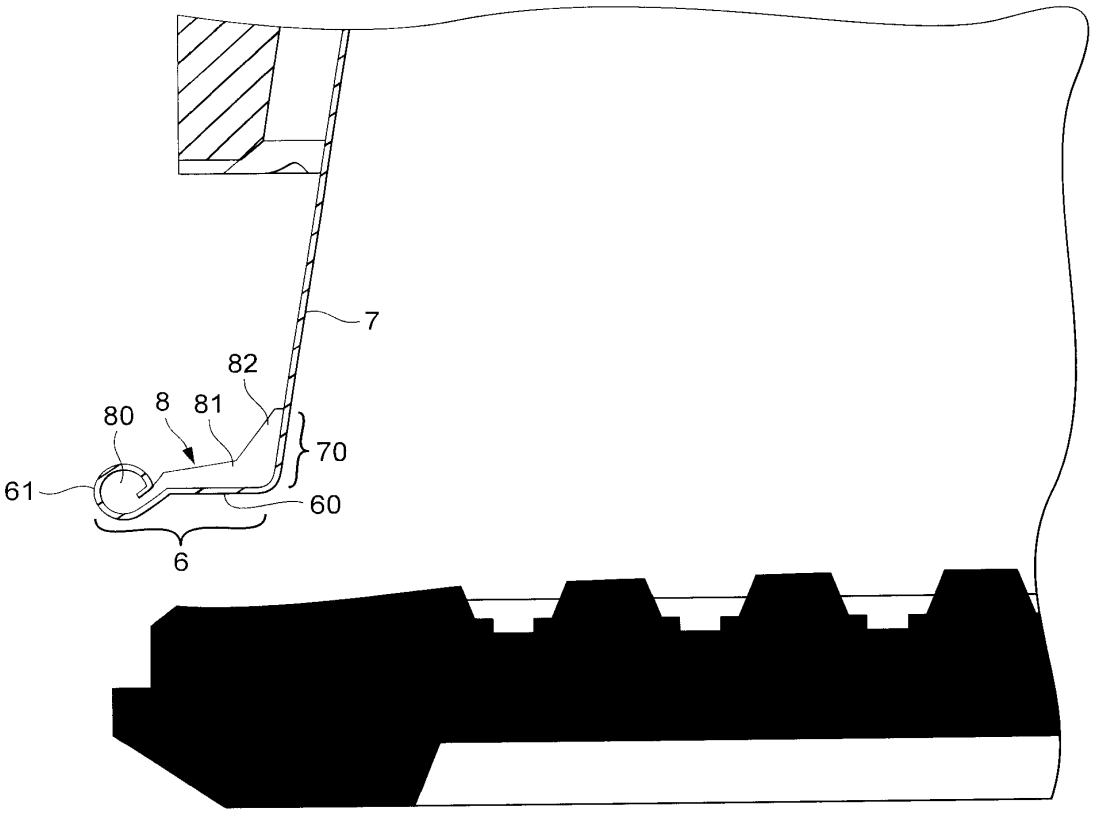


FIG. 2

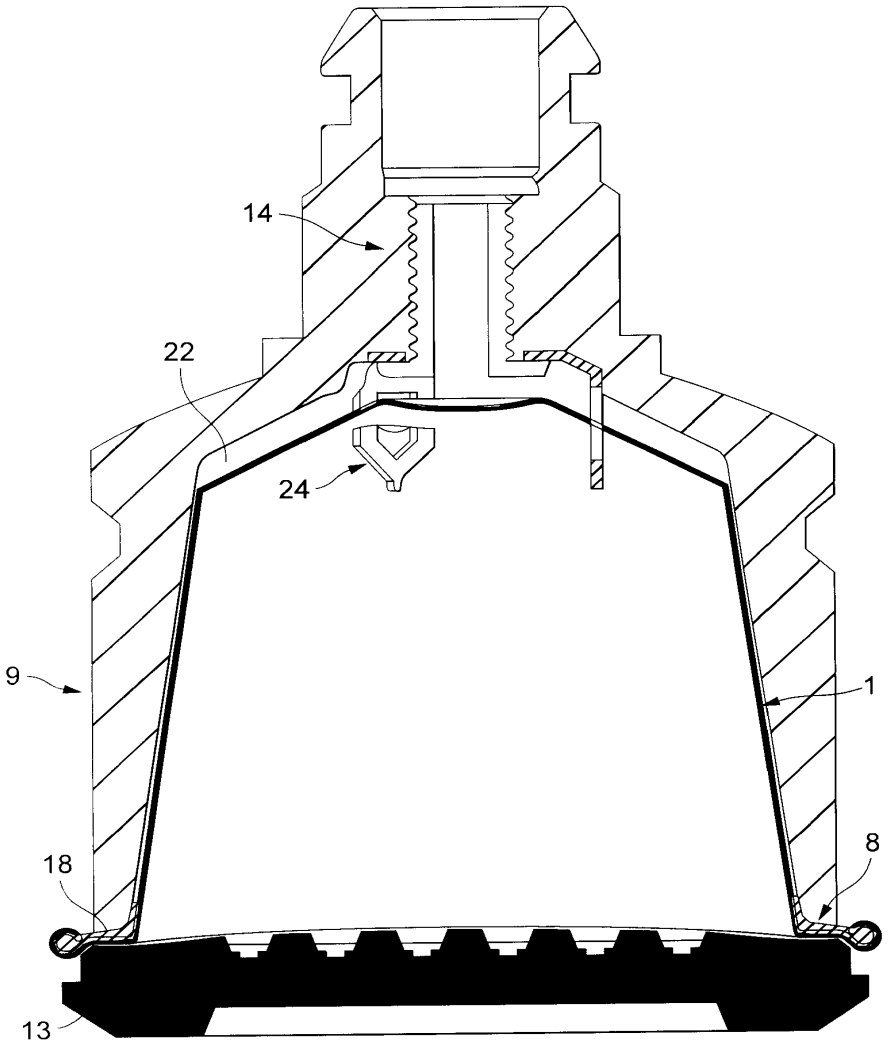


FIG. 3

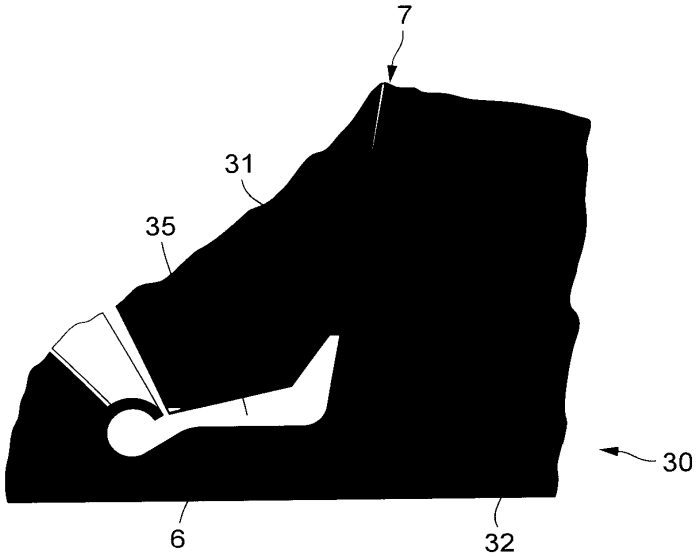


FIG. 4

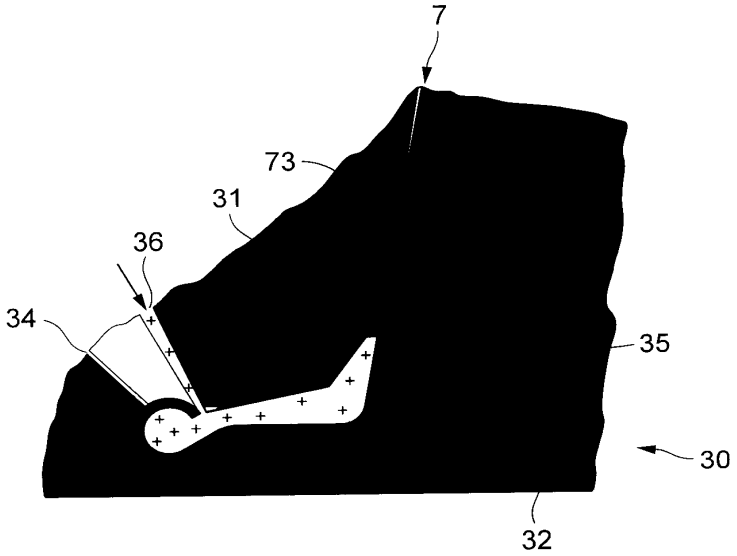


FIG. 5

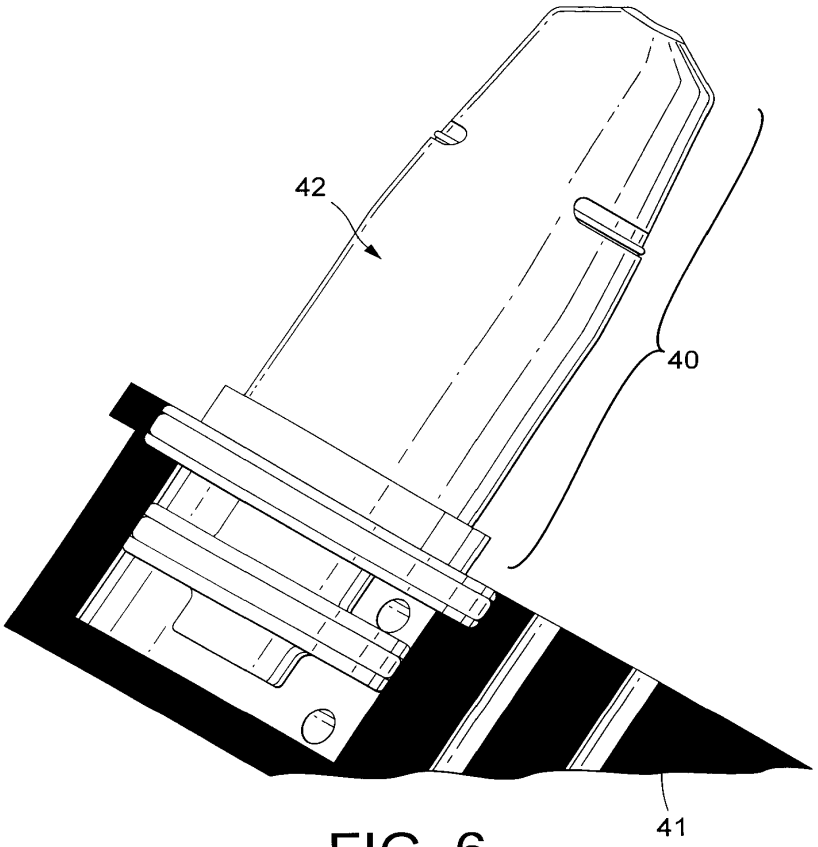


FIG. 6

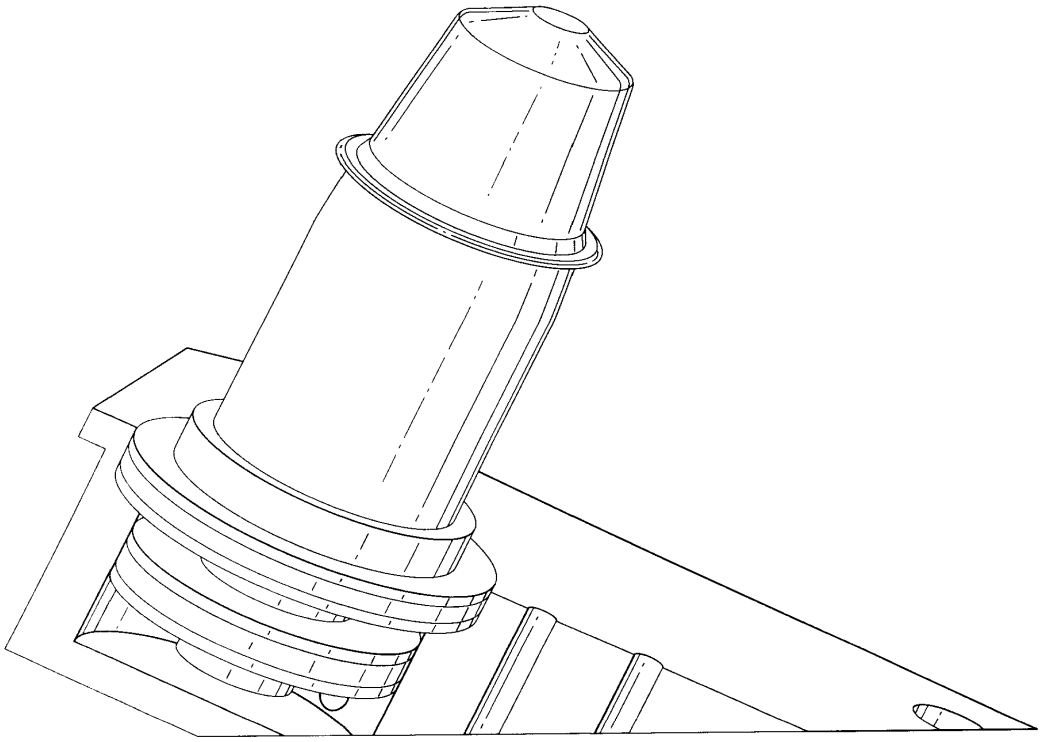


FIG. 7

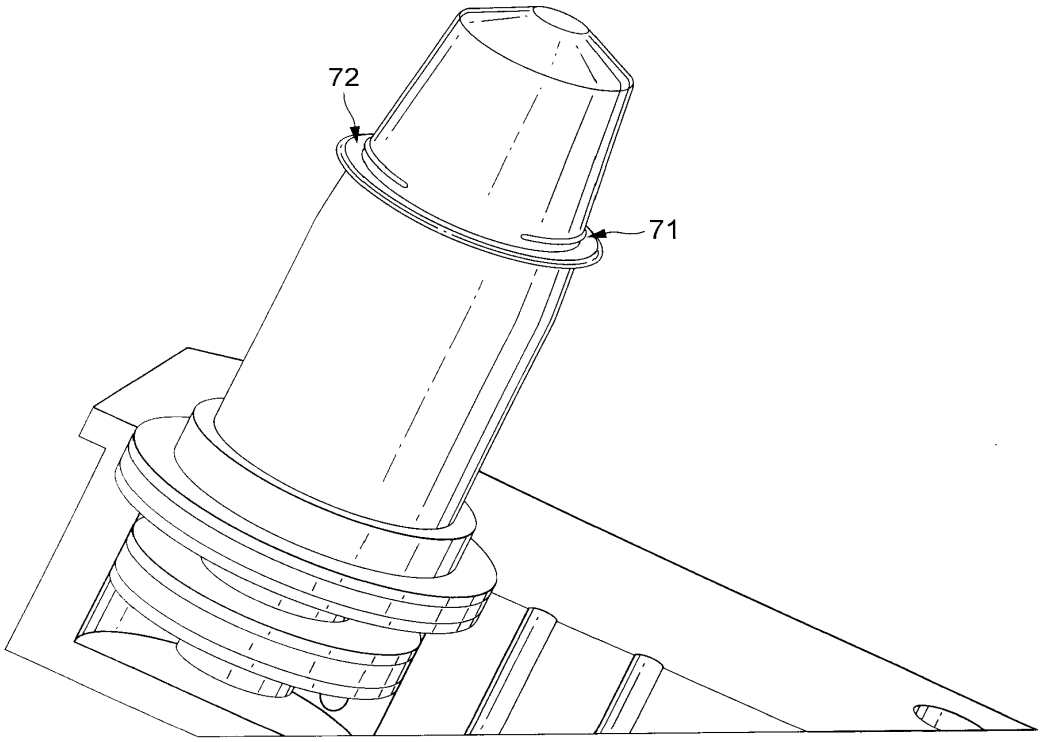


FIG. 8

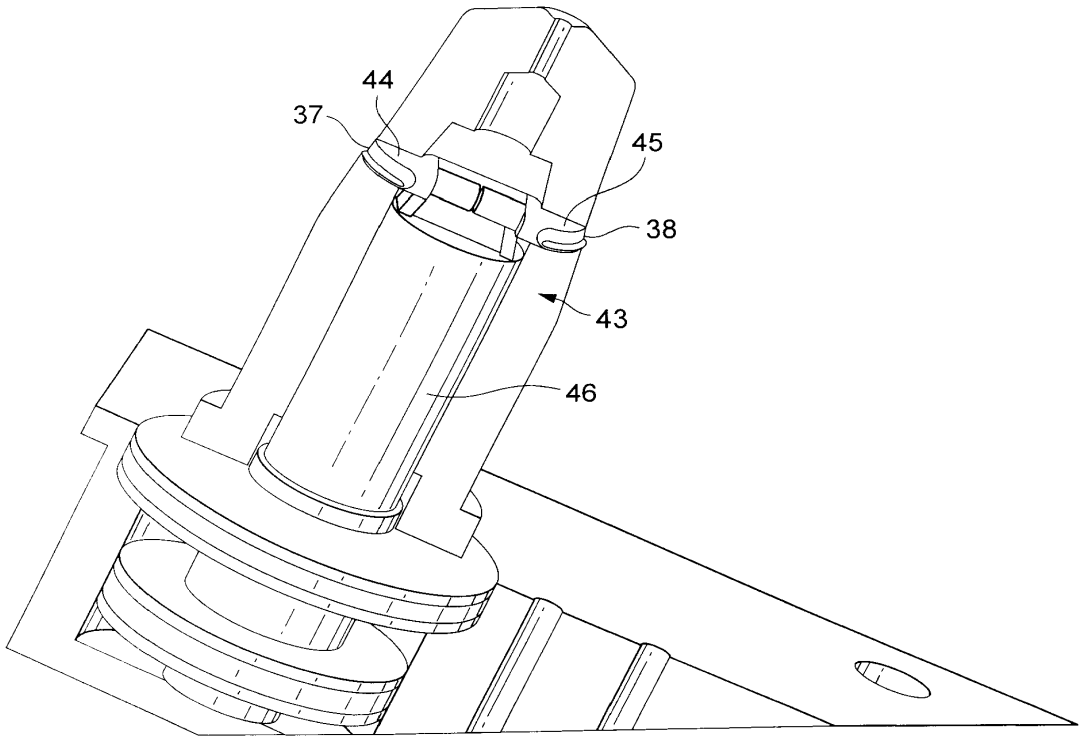


FIG. 9

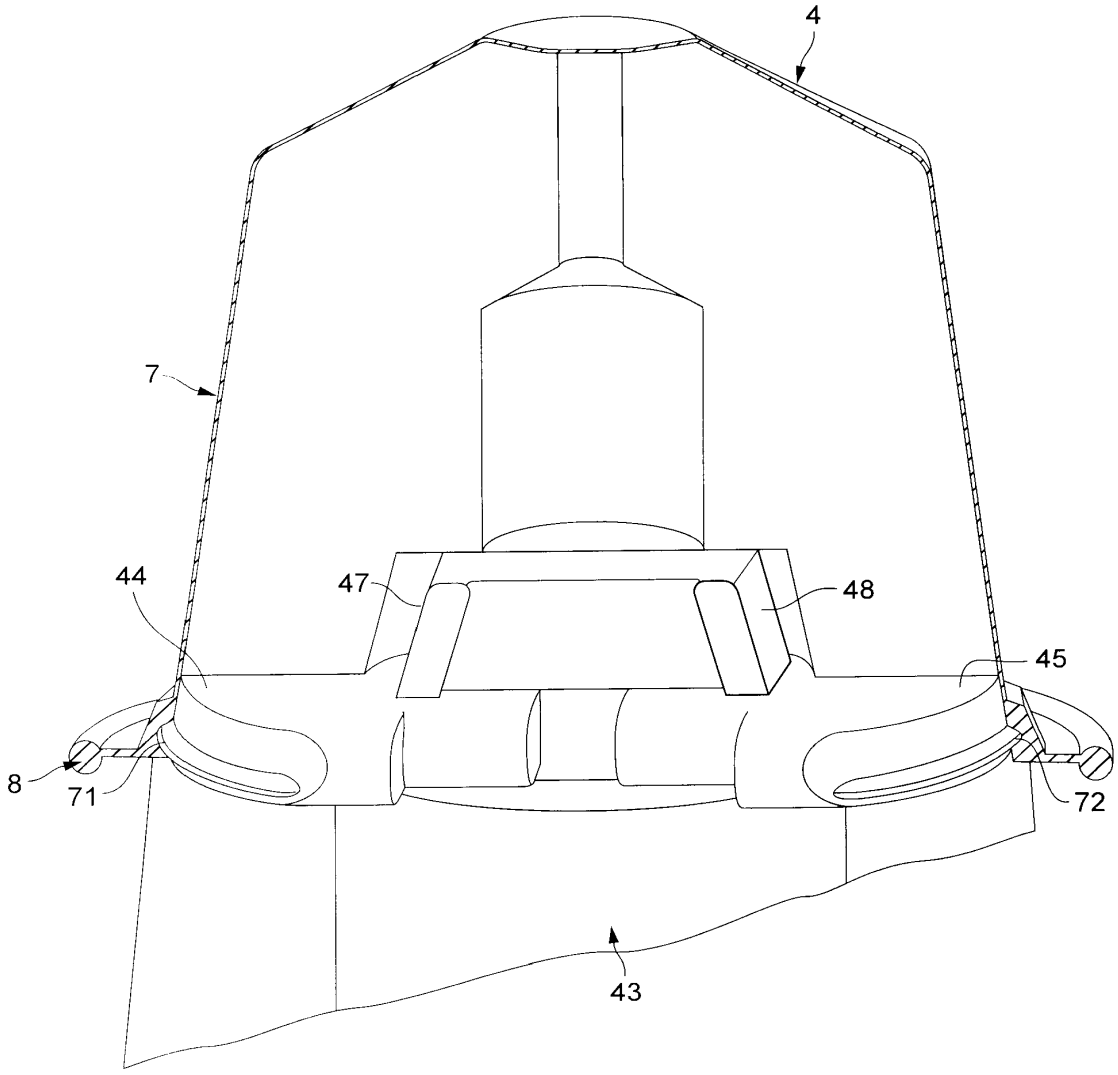


FIG. 10

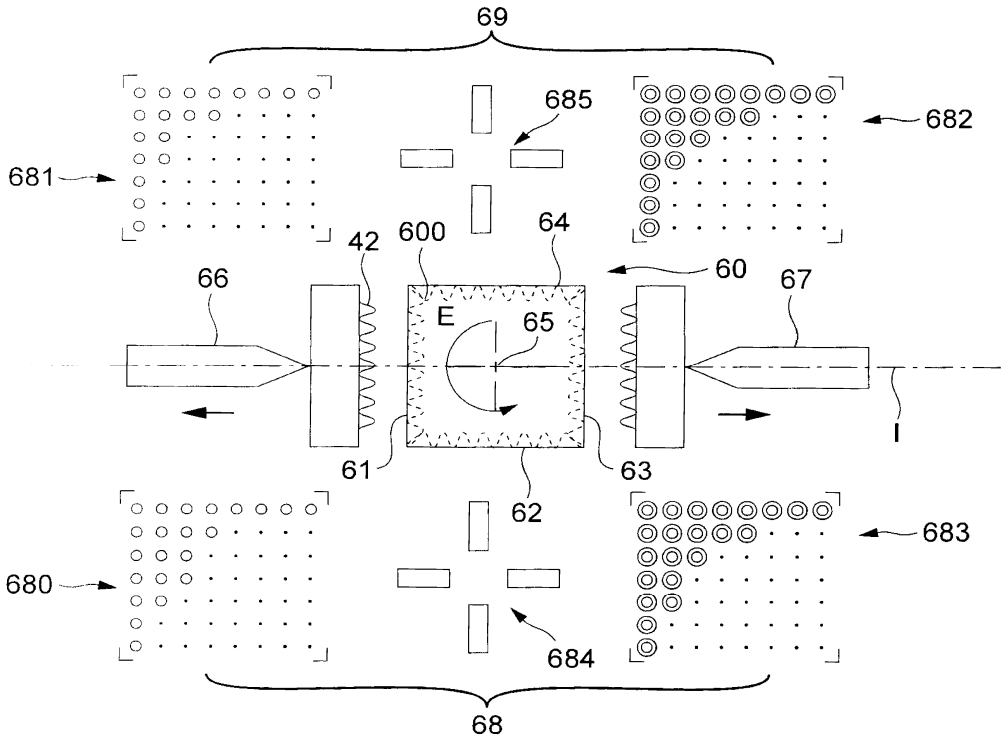

69
685
682
681
42
600
64
60
66
67
E
65
I
61
63
62
683
680
684
68

FIG. 11

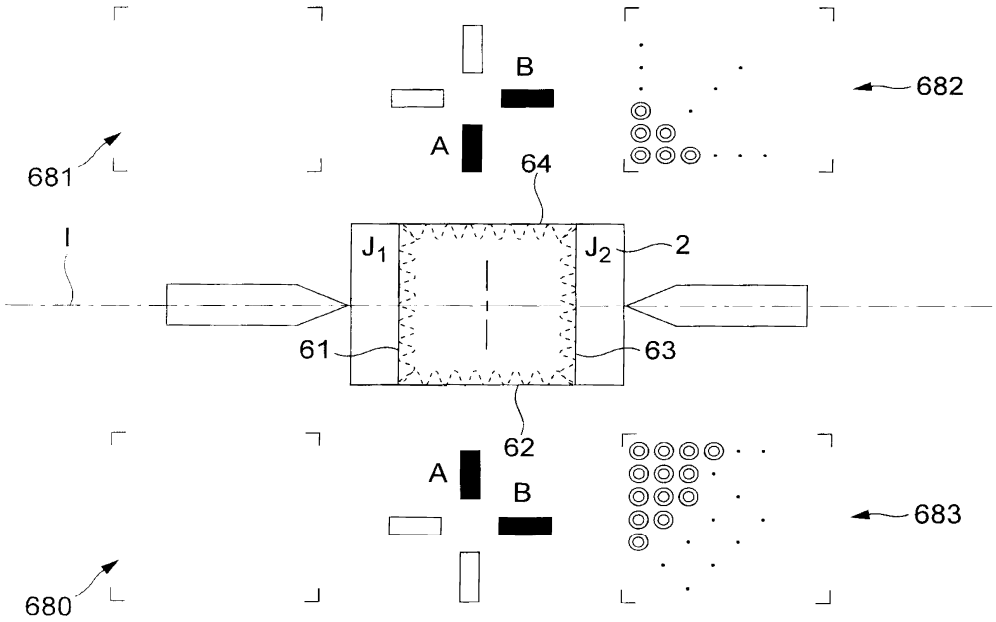

B
682
A
681
64
I
J1
J2
2
61
63
62
A
B
683
680

FIG. 12

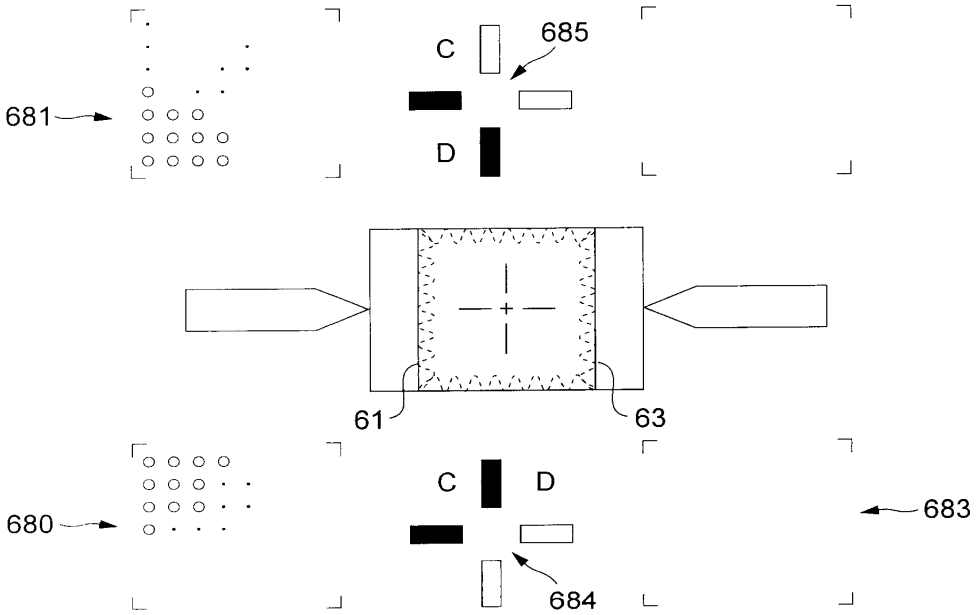


FIG. 13

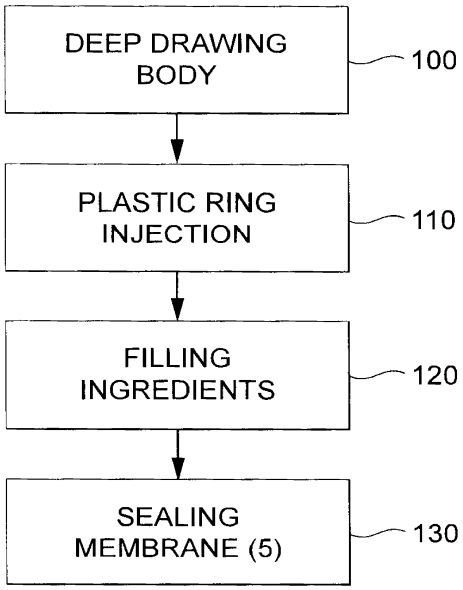

DEEP DRAWING BODY
100
PLASTIC RING INJECTION
110
FILLING INGREDIENTS
120
SEALING MEMBRANE (5)
130

FIG. 14

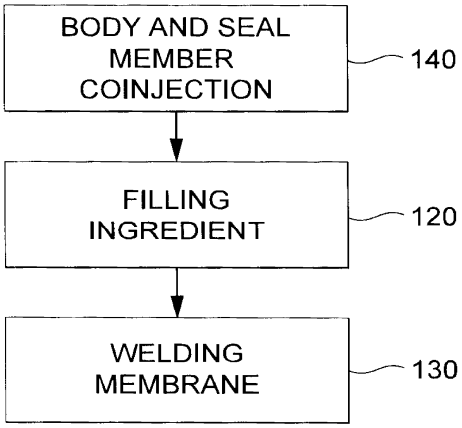

BODY AND SEAL MEMBER COINJECTION
140
FILLING INGREDIENT
120
WELDING MEMBRANE
130

FIG. 15

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2007/053926

A. CLASSIFICATION OF SUBJECT MATTER
INV. B29C45/14 B65D85/804
ADD. B29C45/16 B29C45/04

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
B29C B65D

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

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X Y	EP 1 247 756 A (SOCIETE DES PRODUITS NESTLE S.A) 9 October 2002 (2002-10-09) column 5, line 5 - line 24 paragraph [0011] -----	1-5,8, 10,15 22,25
X Y A	FR 2 617 389 A (DESALTERA) 6 January 1989 (1989-01-06) -----	20 21 1,17
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[X] Further documents are listed in the continuation of Box C. [X] See patent family annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance
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Date of the actual completion of the international search	Date of mailing of the international search report
18 July 2007	25/07/2007

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Zattoni, Federico

Form PCT/ISA/210 (second sheet) (April 2005)

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2007/053926

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
P,X	EP 1 654 966 A (NESTEC S.A) 10 May 2006 (2006-05-10) cited in the application paragraph [0018] - paragraph [0027] paragraph [0044] - paragraph [0048]	20,21
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Form PCT/ISA/210 (continuation of second sheet) (April 2005)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/EP2007/053926

Box II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This International Search Report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claims Nos.:
because they relate to parts of the International Application that do not comply with the prescribed requirements to such an extent that no meaningful International Search can be carried out, specifically:

3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

see additional sheet

1. ☒ As all required additional search fees were timely paid by the applicant, this International Search Report covers all searchable claims.

2. ☐ As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.

3. ☐ As only some of the required additional search fees were timely paid by the applicant, this International Search Report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this International Search Report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

☐ The additional search fees were accompanied by the applicant's protest.

☐ No protest accompanied the payment of additional search fees.

K-FEE SYSTEM GMBH, EX2012, page 2055
NESPRESSO USA, INC. v. K-FEE SYSTEM GMBH
IPR2023-00485, U.S. PATENT 11,230,430

FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

This International Searching Authority found multiple (groups of) inventions in this international application, as follows:

1. claims: 1-21

Method for providing a sealing member on the body of a capsule and capsule thereof.

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2. claims: 22-27

Injection moulding layout.

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2007/053926

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NESPRESSO USA, INC. v. K-FEE SYSTEM GMBH
IPR2023-00485, U.S. PATENT 11,230,430

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Declarations under Rule 4.17:

— *as to applicant's entitlement to apply for and be granted a patent (Rule 4.17(ii))*

— *as to the applicant's entitlement to claim the priority of the earlier application (Rule 4.17(iii))*

— *of inventorship (Rule 4.17(iv))*

Published:

— *with international search report (Art. 21(3))*

WO 2010/076263 A1

(54) **Title**: PROCESS OF BREWING TEA LEAVES CONTAINED IN A CAPSULE

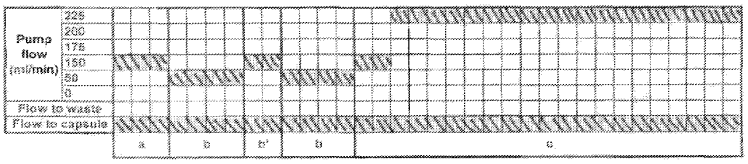


Figure 4

(57) **Abstract**: The invention concerns a process for the preparation of a beverage in a beverage machine with a capsule comprising an enclosure containing tea leaves comprising the steps of : a) introducing water in the capsule to submerge the tea leaves in the capsule enclosure, then b) introducing water at a soaking flow of at most 80 ml/min, then c) introducing water in the capsule until the required volume of beverage is delivered, wherein during at least one period of step b), water is introduced in the capsule at least once at a stirring flow superior the soaking flow to stir tea leaves.

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PROCESS OF BREWING TEA LEAVES CONTAINED IN A CAPSULE

The present invention relates to a process for brewing tea leaves or other kinds of herbal leaves contained in a beverage producing capsule.

Different beverage capsules for brewing beverages in a suitable beverage machine are known. One commercially successful capsule system for extracting beverage from capsules consists in placing an air- and water-impermeable capsule into an extraction device, injecting hot water into the capsule and releasing the liquid extract out of the capsule. Most of the beverages produced by these capsules are coffee or beverages issued from the dissolution of soluble liquid or powder ingredients.

Concerning the production of tea beverage, WO 2007/042414 describes capsules more particularly suited for tea beverages produced from a capsule containing leaf tea product and the like. Quality of a tea beverage is highly dependent on the quality of the leaf tea ingredients, i.e., the tea origin used (soil, drying, blending, etc.) and their storage conditions. For instance, tea ingredients are usually sensitive to oxygen and light. Preferred tea ingredients are taken from loose leaves, chiselled or broken in small fragments. However, brewing conditions are also important to take full advantage of the quality of the ingredients used.

Usually beverage machines process all the capsules the same way because they process always the same product, coffee for example. Other machines have also been developed for producing different kinds of beverages : they are able to produce either coffee or chocolate or tea or cappuccino. For example EP 1 440 640 describes such a type of machine. This machine enables the production of different beverages (coffee, chocolate, milk, ...). It mentions that the operational parameters of the machine are adjusted according to the nature of the ingredients, yet no information are given concerning these parameters

Concerning the particular preparation of beverage from capsules comprising tea leaves, it has been noticed that the usual brewing steps used for coffee and other beverages could not lead to optimal preparation of a tea beverage. In particular it is known that the time for extracting tea leaves is quite longer than for extracting coffee from roast and ground coffee because tea leaves must hydrate and open themselves before extraction occurs. Then the process of extraction of roast and ground coffee does not lead to optimal brewing of tea leaves.

Besides, there exists a large variety of different tea leaves : black, green, white, red, herbal teas perfumed with a lot of different aromas. Each of these leaves can require specific extraction. On the contrary, roast and ground coffees of different origins are all extracted according to the same process.

Lastly the long time for extraction of tea leaves can be perceived as a disadvantage when a tea beverage is prepared by a machine compared to the classical preparation in a tea pot. Yet shorter preparation of tea beverage leads to lower quality of extraction. Then is there a need to

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optimize the tea extraction length time while maintaining the quality of the extraction.

The present invention aims at solving the problem of quality by improving the brewing process of tea leaves in a process of preparation of tea beverage from a capsule containing tea leaves.

The present invention aims also at solving the problem of brewing tea leaves in a process of preparation of tea beverage from a capsule containing tea leaves in the shortest time as possible while maintaining an optimal extraction of the tea extract from the tea leaves.

The present invention aims also at solving the problem of brewing tea leaves of very different types enclosed in a capsule with the same beverage machine by proposing a process adaptable to each type of tea leaves.

According to a first aspect, the invention concerns a process for the preparation of a tea beverage in a beverage machine with a capsule comprising an enclosure containing tea leaves comprising the steps of :

a) introducing water in the capsule to submerge the tea leaves in the capsule enclosure, then

b) introducing water at a soaking flow of at most 80 ml/min, then

c) introducing water in the capsule until the required volume of beverage is delivered,

wherein during at least one period of step b), water is introduced in the capsule at a stirring flow superior to the soaking flow to stir tea leaves.

The process of the present invention is adapted for the preparation of a tea beverage by introduction of hot water in a capsule containing tea leaves, the capsule presenting an inlet for introducing water and an outlet for evacuating the extracted tea beverage. The inlet and/or the outlet can be preformed or produced by puncturing means of the machine.

According to the invention, in the first step a), water is introduced in the capsule to at least submerge all the tea leaves in the capsule enclosure. According to a preferred embodiment of the invention, during step a), a volume equivalent to the volume tea leaves enclosure of the capsule is introduced so as to be sure that the leaves are submerged by water. During this step a), the tea leaves are wetted. Preferably, during step a), water is introduced at a flow of at least 150 ml/min. Such a flow value enables the rapid filling of the capsule to manage optimal beverage preparation time length. The value of this flow can also depend from the type of heater used to heat the water and its ability to provide hot water at high flow rates.

Immediately after step a) and the wetting of the leaves, step b) starts during which water is introduced at a soaking flow of at most 80 ml/min, preferably at most 50 ml/min, generally comprised between 20 and 80 ml/min. Such a soaking flow aims at leaving tea leaves quiet so that they can unfold. According to a specific mode, the soaking flow can be null. If this soaking flow is not null, the introduction can either complete the filling of the tea leaves enclosure or leads to the

overflow of this enclosure ; in this last case, it produces a drip flow in the container or cup placed at the outlet of the capsule. During this step b), the extraction of tea begins. Generally the time length of step b) is at least 5 seconds, preferably at most 50 seconds. According to the invention, during step b) water is briefly introduced during at least one period (b') in the capsule at a stirring flow superior to the soaking flow to stir tea leaves. During this soaking step b) that corresponds to a quiet period during which tea leaves are at rest on account of no introduction of water or introduction of water at low flow, the short introduction of water at a stirring flow superior to the soaking flow creates a turbulent jet of water able to move and stir the tea leaves and to redistribute the leaves in the capsule before they are again left at rest. Due to this stirring and redistribution of the tea leaves, extraction of tea leaves is boosted because immobilization of tea leaves after step a) creates places where tea extract concentration is high and then inhibition of further extraction in the area near from these places. In order to provide a jet of water sufficient to stir tea leaves, the stirring flow is preferably at least greater than 150 ml/min. Several stirring jets of water can occur separated by rest periods during which the water flow rate stays inferior or equal to 80 ml/min or null. In step b), the number of periods during which water is introduced in the capsule to stir tea leaves, the time length of this/these period(s) and the total time length of step b) can be adjusted in function of at least :

- the nature of brewed tea leaves, in particular their size, their dryness, their flavour, and
- the desired strength of the final beverage.

Preferably in step b) of the process of the present invention, water is introduced in the capsule to stir tea leaves one or two times (corresponding to two stirring periods (b')). Generally, the time length of each period during which water is introduced in the capsule to stir tea leaves is inferior to 5 seconds. The time length between two periods during which tea leaves are stirred preferably lasts during 5 and 15 seconds.

Lastly during step c), the rest of the water necessary to provide the desired volume of beverage is introduced in the capsule. Preferably during step c) water is introduced at a flow of at least 150 ml/min in order to match the shortest beverage delivery time.

The different flow rates of water according to the different steps of the process can be set so that the total time for implementing steps a) to c) is comprised between 40 seconds and 2 min.

Generally water is introduced in the capsule with a temperature comprised between 30 and 95°C.

According to the preferred embodiment of the present invention, the process is implemented with a capsule comprising :

- an enclosure containing tea leaves,
- a filtering wall delimiting at least one filtering side of the enclosure,
- an overflow wall that is positioned in the path of the brewed liquid after the filtering wall and which

comprises at least one overflow aperture or is associated with at least one puncture means or, respectively, puncture indication means capable of producing or, respectively, indicating at least one overflow aperture. Preferably the filtering wall extends from below a median horizontal plane passing through the enclosure when the capsule is oriented so that at least one overflow aperture or puncture means or, respectively the puncture indicating means, is placed above said plane. Such a capsule is more specifically described in WO 2007/042414.

According to a second aspect, the invention concerns a beverage production system comprising :

- beverage ingredient containing capsules comprising an identification member, and
- a beverage production machine for receiving said capsules, said machine comprising reading means for reading the capsule identification member in order to read information thereof and control means connected to the reading means and designed to control the operation of the beverage production machine in response to the read information,

characterized in that the identification member provides instructions to the machine for brewing tea leaves according to the process such as described above.

This identification member can be of any nature like bar code, colour code (identified by a visual sensor), RFID tag (identified by a RF sensor), indents, cut outs, protrusions, holes (identified by a mechanical sensor), magnetic code, electronic code, induction code, conduction code … Preferably, the identification member is designed for being physically contacted from outside and is covered by a deformable, displaceable, removeable and/or puncturable cover. Capsules presenting this kind of identification member are described in EP 1 950 150. Generally, the machine-readable information are selected in the list of : the temperature of the water, the values of the water flows of steps a), b) and/or c), the number of stirring periods in step b), the time length of the steps a), b) and/or c) and combinations thereof. The beverage machine in which is used said capsule comprises control means designed to control : the values of the water flows of steps a), b) and c), the number of stirring periods in step b), the time length of the different steps in response to the read information. Based on the information provided by the identification member, the control unit can then vary the brewing parameters especially the water flow of steps a), b) and c), the number of stirring periods in step b), the time length of the different steps flow rate for the brewing of different tea beverages according to capsules containing leaf tea ingredients having different characteristics and/or origins.

In the present application, the terms "capsule" means also "cartridge" or "package". The term "capsule" will be preferentially used. The words "brewing" or "infusion" are used as synonymous. The term "brewing fluid" generally refers to the liquid that serves to infuse the beverage ingredients, more generally, hot water.

In the present application, the term "tea" encompasses all type of leaf tea such as green tea, black tea, white tea, chai tea, flavoured tea and herbal or fruit tea. The term "leaf tea/tea leaves" or "leaf ingredient" refers to brewable tea or other ingredients in whatever form such as complete, cut or chiselled leaves, small fragments of leaves, powder or dust.

Brief description of the drawings

The characteristics and advantages of the invention will be better understood in relation to the figures which follow :

- Figure 1 is a diagram presenting the hot water flow introduced in the capsule according to each step of the brewing process according to a first embodiment of the invention ;
- Figure 2 is a diagram presenting the hot water flow introduced in the capsule according to each step of the brewing process according to a second embodiment of the invention ;
- Figure 3 is a schematic illustration of a capsule brewing system before brewing ;
- Figure 4 is a schematic illustration of a the capsule brewing system of figure 3 during brewing of the capsule.

Detailed description of the drawings

Figure 1 illustrates the values of the hot water flows introduced in a capsule for each step of the process and the time length of introduction of these different flows according to a first embodiment of the invention.

As illustrated in Figure 1, in **step a)**, the capsule is filled with hot water with a flow of water of 150 ml/min. The volume of water that is introduced in the capsule corresponds to the capsule teal leaves enclosure volume.

In **step b)** :

- the capsule is first filled with hot water again but at a lowest flow of 50 ml/min so as to not stir the tea leaves and let the leaves unfold,
- then capsule is filled with hot water at a greater flow of 150 ml/min (step b') during a short time of 3 seconds to stir the leaves in order to redistribute them,
- then capsule is finally filled with hot water again but at the lowest flow of 50 ml/min so as to not stir the tea leaves an let the redistributed leaves unfold.

During step b), when the volume of injected water overlaps the capsule tea leaves enclosure volume, water gently drips through the capsule outlet inside a final cup or container.

In **step c)**, the capsule is filled with hot water firstly at a flow of 150 ml/min and then rapidly at a flow of 225 ml/min until the total desired volume of tea beverage flows through the capsule outlet and fills the cup.

The process of preparation and dispensing of the tea beverage ready to be drunk lasts 51 seconds.

Figure 2 illustrates the values of the hot water flows introduced in the capsule for each step of the process and the time length of introduction of these different flows according to a second embodiment of the invention.

In **step a)**, the capsule is filled with hot water with a flow of water of 150 ml/min. The volume of water that is introduced in the capsule corresponds to the capsule volume.

In **step b)** :

- no hot water is introduced in the capsule so that the tea leaves can stay at rest and unfold. Yet, the pump is not stopped during this short period to avoid the stagnation of water in the pump and the development of scale ; hot water flow is just derived from capsule inlet and sent to waste.
- then capsule is filled with hot water at a flow of 150 ml/min (step b') during 3 seconds to stir the leaves and redistribute them,
- then the flow of hot water is derivated to waste so that no flow enters the capsule and that the redistributed leaves can stay at rest and unfold.

In **step c)**, the capsule is filled with hot water firstly at a flow of 150 ml/min and then rapidly at a flow of 225 ml/min until the total desired volume of tea beverage flows through the capsule and fills the cup.

The process of preparation and dispensing of the tea beverage ready to be drunk lasts only 51 sec.

Figures 3 and 4 illustrate a capsule system of which construction is particularly adapted for the implementation of the process of the present invention.

A capsule system 1 is provided that comprises a capsule 2 and a beverage brewing device 10. For simplicity, the beverage brewing device is only schematically depicted and may, in reality, comprise additional technical features within the normal knowledge of the person skilled in the art. The capsule comprises an enclosure 20 containing beverage ingredients such as leaf tea and the like. The enclosure is demarcated by a cup-shaped housing 21 and a filtering wall 22 that is fixedly attached to peripheral inner step 23 of the housing 21. The enclosure is preferably impermeable to gas and light. The housing may encompass different cross sections such as a circular, ellipsoid, square, rectangular or polygonal section that determine as a matter of fact the general profile of the filtering wall 22. The enclosure is sized to accommodate a dose of leaf beverage ingredient of typically about between 1 to 10 grams, preferably 2 to 5 grams. The dose of leaf ingredient may depend on the final volume of beverage to produce. For an individual cup of tea, a typical dose can be of about 2 grams whereas for a tea pot, a typical dose can be of about 8 to 10 grams. As clearly

apparent in figure 3, the capsule is positioned relative to the brewing device so that the filtering wall 22 extends substantially vertical and from substantially the bottom of the enclosure. For this, the capsule is preferably positioned in a "vertical" arrangement in the brewing device 1. The cup-shaped housing 21 can be so oriented with its large opening and its bottom oriented in a vertical position.

Importantly, the capsule comprises an overflow wall 3 with an overflow aperture 25 placed at least above the median horizontal plane P of the enclosure. The filtering wall 22 and the overflow wall 3 are spaced apart a short distance sufficient to create an interstitial space "s" that is supposed, without being bound by theory, to work as a sort of "siphon" that can promote the upward motion of the denser beverage portion that is predominantly localized in the bottom of the enclosure.

Both the sealing wall and the housing can be made of oxygen barrier materials and the enclosure can be substantially free of oxygen so that the freshness of the beverage ingredients can be preserved during an extended period of time. The sealing wall can be a flexible membrane or a semi-rigid plastic part. A puncturable sealing membrane is preferred such as a monolayer or a multi-layer membrane, typically, laminates of PET/Aluminium/PP, PE/EVOH/PP, PET/Metallised/PP, aluminum/PP. The enclosure is preferably oxygen free and may contain flushed inert gas such as N_2, N_2O or CO_2.

The capsule can further comprise a cover 4 that is also attached to the rim 24 of the housing 21 and overlaps the sealing wall 3. The cover forms an internal channel 40. An identification member 51 can be present on the cover (or even under the cover). This identification member contains information about the brewing parameters to be implemented to get the better brewing for the tea leaves present inside the capsule.

The shape of the housing of the capsule is not very critical. Preference is given to a trunconical, ellipsoidal or hemispherical shapes for different reasons. This allows a larger surface for the exit of the beverage through the sealing wall when perforated and a reduction of the inside pressure. The housing can also be manufactured industrially at lower cost by plastic thermoforming or aluminium deep drawing. This shape with smoother corners also favours the removal of the handling members and so ejection of the capsule.

Turning to the brewing device 10, it comprises capsule handling members 30, 31 that are configured to hold the capsule in the "vertical" arrangement as defined. These handling members 30, 31 can be machine jaws or any suitable mechanical enclosing means that can open and close about the capsule and can maintain it firmly in place. There is no need for providing high closing forces since the involved fluid pressure in the capsule remains relatively low and, preferably, as close as possible to the atmospheric pressure. Also, since the capsule can withstand the low brewing pressure therefore the capsule does not necessarily need to be entirely enclosed but

simply held water tightly in place during brewing. This participates to a simplification of the machine and it reduces machine costs.

The brewing device comprises a water supply 32, such as a water tank, a water pump 33, a heater 34 and a hot water injection line 35 that is managed through the handling member 30. The brewing device may also comprise a controller 39 and a user interface board (not shown) to manage the beverage preparation cycles as known in the art. A backpressure valve 36 can be provided to lower the pressure at the entry side of injection member 38 such as a needle(s) or blade(s) creating a water inlet in the capsule. Of course, the backpressure valve could be omitted and a low pressure pump could be used that delivers fluid at low pressure. Medium to high pressure pump may however be preferred because of their robustness and reliability and so used in combination with a backpressure valve.

The brewing device may further comprise a means 37 for perforating the cover 4 and creating a beverage outlet. As shown in figure 3, the perforating means 37 can be activated after closing of the handling members 30, 31 about the capsule. The perforating means is forced or guided through the cover 4. The perforator can be driven by a solenoid or any other equivalent drive means or even manually.

The brewing device may further comprise a detection unit 50 to convert the information of the identification member 51 of the capsule into brewing instructions through the controller 39. In the present the invention, the information especially varies according to the tea leaves present inside the capsule. The information provide to the control unit 39 instructions so that the steps a), b) and c) of the process of the present invention is implemented with specific features adapted for each type of tea leaves that are : the values of water flow of steps a), b) and c), the number of stirring periods in step b), the time length of the different steps.

Preferably the information can be read from the capsule 1 in a non-optical manner, as the optical reading e.g. using a bar code has the disadvantages of having a negative impact on the aesthetic impression of the outer appearance of the capsule and of being prone to failure due to the legibility of the bar code in the environment of the beverage production process. Preferably the information is coded in a digital manner. The information can be coded by a modulation of the surface structure of a face of the capsule 1. E.g. a hole or a recession can represent one logical sate (e.g. "0"), while another surface state ("no recession" or "no hole") can represent the other logical state (e.g. "1"). Replacing the bar code by a surface modulation which can then be detected in a non-optical manner (or even in an optical manner) enhances the reliability of the information reading from the capsule.

In relation to figure 4, the method of the invention works as follows. A capsule is inserted in the brewing device and the capsule handling members 30, 31 are closed about the capsule to position it with the sealing wall being substantially vertically oriented. An outlet aperture is created

by the perforating means 37 that punctures the cover 4 and is withdrawn to leave the aperture opened. On the opposite side of the capsule, the fluid injection member 38 is introduced in the capsule's enclosure. Hot water is thus injected in the capsule at relatively low pressure, preferably, at a pressure not exceeding 0,2 bar. Hot water slowly fills the capsule in and submerges the beverage ingredients in the enclosure. The brewed beverage is filtered through the filtering wall 22. A denser portion 5 of the beverage may tend to settle in the bottom of the enclosure ; which portion is also filtered through the filtering wall since it is properly placed adjacent this portion. The denser beverage is evacuated through the interstitial space "s" as caused by the variation of pressure between the lower part of the space and the upper part of said space therefore acting similarly to a "siphon". The rest of the beverage is also filtered also by passing through the filtering wall at different vertical levels up to the upper level of the fluid in the enclosure and is evacuated to the overflow aperture 25.

It should be noted that the overflow aperture should preferably be placed above the 3/4 of the total height of the enclosure and even preferably be placed above the 4/5 of the total height of the enclosure ; thus ensuring a more complete submergence of the beverage ingredients and a slower evacuation of the beverage from the enclosure which favours a better infusion process.

The "total height" of the enclosure is meant to be the total distance separating the lowermost point of the enclosure to the uppermost point of the enclosure when the capsule is positioned in the beverage machine ready for the brewing operation. In a possible mode, the filtering wall can be substantially equal to the total height of the enclosure.

The principle of the brewing method according to figures 3 and 4 encompasses different variants and equivalences.

For instance, the overflow wall 3 may not be perforated but may be pre-opened by a pre-cut overflow aperture. The pre-cut overflow aperture means an aperture which has already been made at the manufacturing stage of the capsule. Freshness of the beverage ingredients may so be preserved by different means such as by an airtight closed cover with a sealed outlet that is unsealed just before brewing or by the use of an airtight overwrap package that encloses the capsule.

The capsule may also be conceived without the cover 4 and its channelling function. In which case, the front handling member 31 may be designed to collect the brewed liquid as it passes the overflow wall 3 and travels down to the recipient.

CLAIMS

1. Process for the preparation of a beverage in a beverage machine with a capsule comprising an enclosure containing tea leaves comprising the steps of :

a) introducing water in the capsule to submerge the tea leaves in the capsule enclosure, then

b) introducing water at a soaking flow of at most 80 ml/min, then

c) introducing water in the capsule until the required volume of beverage is delivered,

wherein during at least one period of step b), water is introduced in the capsule at a stirring flow superior to the soaking flow to stir tea leaves.

2. Process according to claim 1 wherein during step a), water is introduced at a flow of at least 150 ml/min.

3. Process according to claim 1 or 2, wherein during step b), the soaking flow is null.

4. Process according to any of the precedent claims, wherein the time length of the at least one period during which water is introduced in the capsule at a stirring flow superior to the soaking flow to stir tea leaves is inferior to 5 seconds.

5. Process according to any of the precedent claims, wherein the time length of step b) is at least 5 seconds, preferably at most 50 seconds.

6. Process according to any of the precedent claims, wherein during step b) the stirring flow is at least greater than150 ml/min.

7. Process according to any of the precedent claims, wherein during step c), water is introduced at a flow of at least 150 ml/min.

8. Process according to any of the precedent claims, wherein water is introduced with a temperature comprised between 30 and 95°C.

9. Process according to any of the precedent claims characterized in that it is implemented with a capsule (2) comprising :

- an enclosure (20) containing tea leaves,
- a filtering wall (22) delimiting at least one filtering side of the enclosure,
- an overflow wall (3) that is positioned in the path of the brewed liquid after the filtering wall and

which comprises at least one overflow aperture (25).

10. Process according to the precedent claim characterized in that the filtering wall extends from below a median horizontal plane (P) passing through the enclosure (20) when the capsule is oriented so that the overflow aperture (25) is placed above said plane (P).

11. A beverage production system comprising :
- beverage ingredient containing capsules (1) comprising an identification member (6) and
- a beverage production machine for receiving said capsules, said machine comprising reading means (50) for reading the capsule identification member (6) in order to read information thereof and control means connected to the reading means and designed to control the operation of the beverage production machine (11) in response to the read information,
characterized in that the identification member provides instructions to the machine for brewing tea leaves according to the process of any of claims 1 to 10.

12. A beverage production system according to claim 11 wherein the machine-readable information are selected in the list of : the temperature of the water, the values of the water flows of steps a), b) and/or c), the number of stirring periods in step b), the time length of the steps a), b) and/or c) and combinations thereof.

13. A beverage production system according to claim 11 or 12 wherein the capsules (1) comprise :
- an enclosure (20) containing tea leaves,
- a filtering wall (22) delimiting at least one filtering side of the enclosure,
- an overflow wall (3) that is positioned in the path of the brewed liquid after the filtering wall and which comprises at least one overflow aperture (25).

14. A beverage production system according to claim 13 wherein the filtering wall extends from below a median horizontal plane (P) passing through the enclosure (20) when the capsule is oriented so that the overflow aperture (25) is placed above said plane (P).

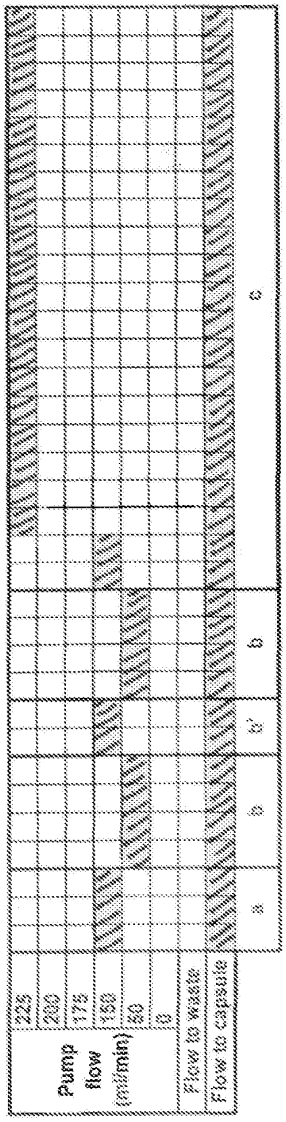


Figure 1

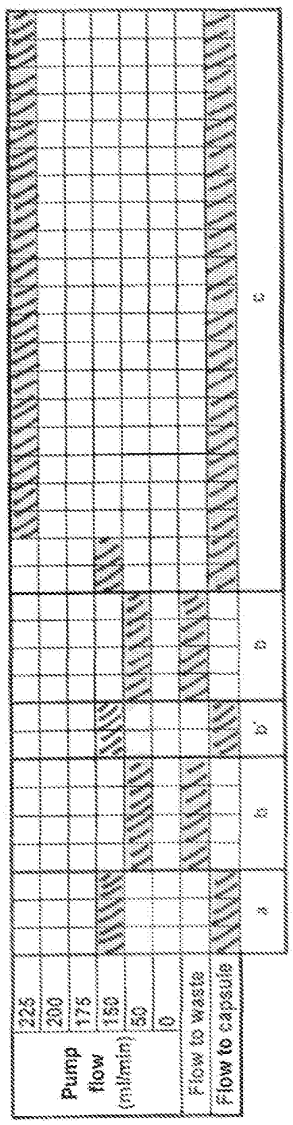


Figure 2

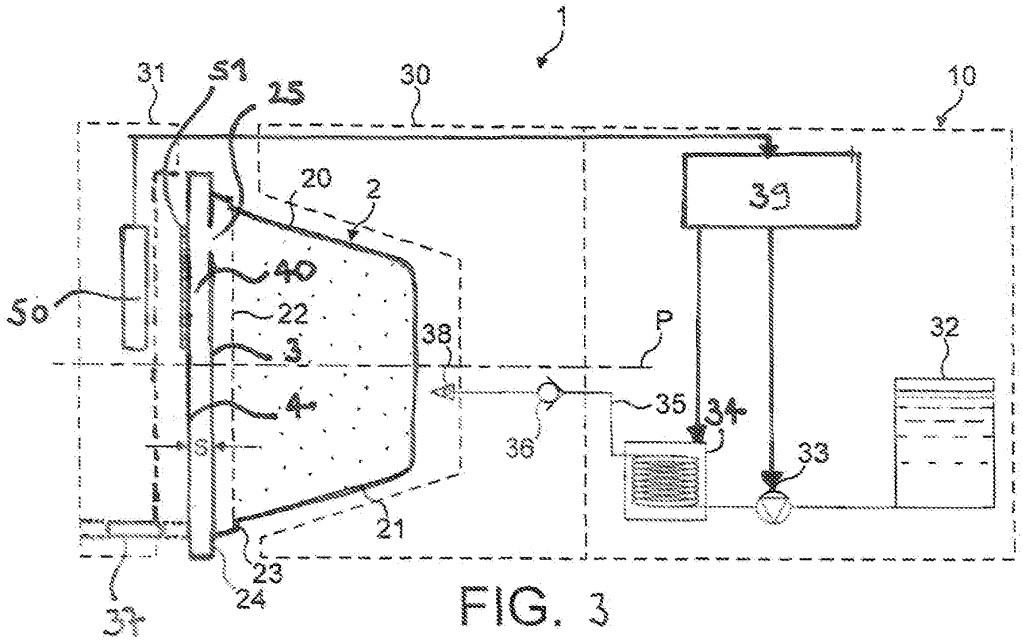

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FIG. 3

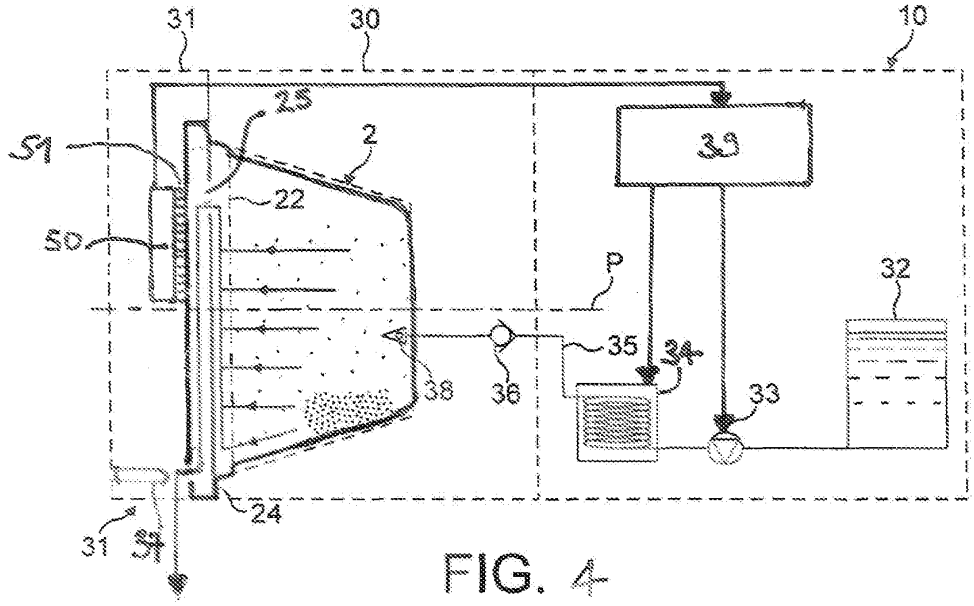

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FIG. 4

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2009/067728

A. CLASSIFICATION OF SUBJECT MATTER
INV. A47J31/36 A47J31/06

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
A47J B65D

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

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal, WPI Data, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	EP 1 440 640 A (KRAFT FOODS R & D INC [DE]) 28 July 2004 (2004-07-28) cited in the application	1-10
X	the whole document	11-14
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-/--

[X] Further documents are listed in the continuation of Box C.

[X] See patent family annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

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

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Date of the actual completion of the international search	Date of mailing of the international search report
2 February 2010	02/03/2010

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL – 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Fritsch, Klaus

Form PCT/ISA/210 (second sheet) (April 2005)

K-FEE SYSTEM GMBH, EX2012, page 2072
NESPRESSO USA, INC. v. K-FEE SYSTEM GMBH
IPR2023-00485, U.S. PATENT 11,230,430

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2009/067728

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	GB 2 447 024 A (KRAFT FOODS R & D INC [DE]) 3 September 2008 (2008-09-03) the whole document	1-10

Form PCT/ISA/210 (continuation of second sheet) (April 2005)

K-FEE SYSTEM GMBH, EX2012, page 2073
NESPRESSO USA, INC. v. K-FEE SYSTEM GMBH
IPR2023-00485, U.S. PATENT 11,230,430

INTERNATIONAL SEARCH REPORT

International application No.
PCT/EP2009/067728

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

see additional sheet

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.

2. ☒ As all searchable claims could be searched without effort justifying an additional fees, this Authority did not invite payment of additional fees.

3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.

☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.

☐ No protest accompanied the payment of additional search fees.

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NESPRESSO USA, INC. v. K-FEE SYSTEM GMBH
IPR2023-00485, U.S. PATENT 11,230,430

FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

This International Searching Authority found multiple (groups of) inventions in this international application, as follows:

1. claims: 1-10

Process for the preparation of a beverage comprising different steps of introducing water at different flow rates into the capsule.
This feature solves the objectively determinated problem of improving the quality of the beverage and brewing the beverage in the shortest time as possible.

---

2. claims: 11-14

Beverage production system comprising an identification member including machine-readable information.
This feature solves the objectively determinated problem of brewing different types of beverages with the same machine.

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/EP2009/067728

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A47J 31/06 (2006.01)

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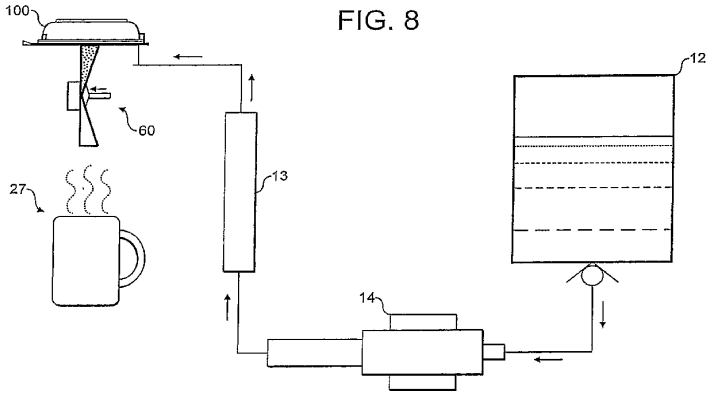
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Published:

— *with international search report (Art. 21(3))*

(54) **Title**: BEVERAGE PREPARATION MACHINES

FIG. 8



(57) **Abstract**: The present invention relates to improvements in methods of preparing beverages using a beverage preparation machines and in particular to a beverage preparation machine (10) of the type which uses pre-packaged containers (100) of beverage ingredients. The method is characterised by controlling the volume of air resident in at least a part of a delivery system of the machine to produce predetermined characteristics in a prepared beverage.

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BEVERAGE PREPARATION MACHINES

The present invention relates to improvements in beverage preparation machines and in particular to a beverage preparation machine of the type which uses pre-packaged containers of beverage ingredients.

Coffee houses have been a part of the "coffee culture" since the 17th century. Throughout the years methods of making coffee have been refined and skilled people trained to produce the best coffee beverages. The first coffee machines were developed in the early 1800s and an automatic espresso machine was invented in the 1930s. The automation of the coffee making process has, in turn, lead to a rapid growth, particularly in the last ten years, in the number of coffee houses/shops with more specialist drinks, such as espresso and cappuccino, being in high demand. These types of beverages have historically been regarded as luxury items because of the need for expensive, complex machines capable of producing the high pressures necessary for making them, which had to be properly operated and maintained by a trained barista to produce good quality. Coffee aficionados agree that an espresso can be spoiled by a badly trained operator despite the use of a good quality machine and good quality coffee. This trend, however, has not only lead to an increased demand from consumers for luxury top quality beverages, but also a desire for a greater variety of speciality beverages, and the ability to make such beverages in the comfort of one's own home.

Although there is no agreed technical definition, it is generally understood that, compared to drip coffee, barista quality espresso has a thicker consistency, due to a higher amount of dissolved solids and fine oil droplets suspended throughout the drink. It has a smooth, yet thick, dark reddish brown crema making up 10 to 30% of the beverage. The crema is a polyphasic emulsion of air and the oils, proteins and sugars extracted from the coffee which is produced at a high pressure, traditionally in the region of 9 to 10 bar. The higher pressures increase the rate of coffee wetting and improve extraction as well as being responsible for the development of the crema.

It is acknowledged, by discerning espresso drinkers, that espresso produced using water which is cooler than the optimum temperature tastes sour and that produced with water which is hotter than this temperature tastes bitter. The optimum temperature is claimed to be between 92 and 96°C. Other factors which affect the quality of the espresso include the roasting and age of the coffee beans, the grind size, the compaction of the grinds prior to brewing, and the brew time. The "best" espresso is achieved by balancing these key elements of the brewing process.

Domestic coffee machines have also developed significantly since the first filter machines were invented in the 1960s and coffee machines are now essential pieces of kitchen equipment in many households. Some such machines dispense individual servings of a beverage directly into a drinking receptacle, and derive the beverage from a bulk supply of beverage ingredients or from individual packages

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of beverage ingredients such as pods, pads or cartridges. In the following specification such packages will be referenced by the general term cartridges. Machines which use such cartridges eliminate the need for cleaning and can enable the user to make a selection of beverages. An example of one type of such cartridge is described in EP-A-1440903. The beverages are formed from brewing, mixing, dissolving or suspending the beverage ingredients in water. For example, for coffee beverages, heated water is forced through the cartridges to form the extracted solution. The use of cartridges in such machines has become increasingly popular due to their convenience and the quality of the beverage produced.

An example of a machine for preparing beverages using this type of cartridge is described in EP-A-1440644. This type of machine provided, inter alia, an improvement over the prior art known at the time in that it operated at a lower pressure than the previously known machines, which were designed for the commercial or industrial markets rather than the domestic market. Hence it was more suitable for the domestic market in terms of cost, reliability and performance. However, the problem that faces systems that operate at a lower pressure is that they are generally not capable of producing barista quality espressos, which require a significantly higher pressure.

With the change in consumer trends, however, there is a desire for domestic machines which are capable of producing barista quality espresso and a range of other beverages, for

which no training is necessary, which are affordable and which require little or no cleaning.

Some machines available on the market claim to produce higher quality beverages but for various reasons, they are comparatively expensive machines. Examples of such machines are the Gaggia L'Amante ™, the Gaggia Evolution ™, the Nespresso Delonghi Latissimma 660 ™, and the Krups XN2101 ™.

Most of these machines require specially designed cartridges of increased complexity and a particular specification of materials to cope with the high pressures involved in the brewing process for espresso. These cartridges generally incorporate filters and the process uses the geometry of the cartridge to enable the desired quality of the beverage to be produced under high pressure. This constrains the use of the cartridges in the machine for which it is designed.

It is, however, desirous to provide an improved beverage preparation machine capable of making a selection of beverages, including a premium quality espresso as well as non-espresso beverages, preferably using pre-packed beverage cartridges. The machine may also be a bulk brewer or other non-cartridge machine

It is also desirous to provide a machine which is backwardly compatible with existing cartridges, such as those described in EP-A-1440903, which are used in existing low pressure beverage preparation machines.

Accordingly, the present invention provides a method of preparing beverages using a beverage preparation machine for preparing beverages from one or more beverage ingredients, characterised by controlling the volume of gas in at least a part of a delivery system of the machine to produce predetermined characteristics in a prepared beverage.

The volume of gas is preferably actively controlled by increasing the volume to increase the gas:liquid ratio in the beverage produced, decreasing the volume to decrease the gas:liquid ratio or maintaining the volume.

Preferably the volume of gas in the delivery system is controlled by inducting additional gas into the delivery system, venting gas from the delivery system and/or purging the delivery system.

The method preferably further comprises the step of measuring the actual volume of gas resident in the delivery system.

An actual volume of gas resident in the delivery system may be calculated from stored parameters relating to a volume of gas remaining in the delivery system after a last operation of the machine.

Control of the volume of gas is preferably effected on a beverage by beverage basis and is preferably effected automatically according to the type of beverage being produced.

Alternatively the control of the volume of gas is effected manually.

The volume of gas upstream and/or downstream of the beverage ingredients may be controlled.

Preferably the volume of gas is controlled by selectively opening and/or closing valve means in the delivery system prior to and/or during beverage preparation.

The invention also provides a beverage preparation machine for preparing a beverage from one or more beverage ingredients, characterised by the provision of means for controlling the volume of gas in at least a part of a delivery system of the machine to produce predetermined characteristics in a prepared beverage.

The machine preferably comprises means for determining the actual volume of gas resident in the delivery system.

The means for determining the actual volume of gas resident in the delivery system may comprise means for calculating the actual volume from stored parameters relating to a volume of gas remaining in the delivery system after a last operation of the machine.

Preferably the stored parameters comprise a basic volume parameter stored in the control means, said basic volume being the actual volume of gas which resides in the delivery system of an unused machine or a machine after a purging cycle has been run.

The stored parameters may comprise parameters relating to the actual volume of gas remaining in the delivery system after each type of beverage which the machine is programmed to prepare.

The means for determining the actual volume of gas resident in the delivery system preferably comprise means for measuring the actual volume of gas in the delivery system.

Parameters relating to predetermined volumes of gas required to be present in the delivery system for preparing a predetermined range of beverages are preferably stored in the control means, said control means being programmed to calculate the difference between the predetermined volume required for a beverage in preparation and the actual volume present.

The means for controlling the actual volume of gas may comprise valve and/or purge means for venting gas and/or pump means for injecting additional gas into the delivery system.

Preferably the valve means comprise an outlet valve downstream and/or a valve upstream of the beverage ingredients.

Operation of the valve means is preferably controlled relative to the beverage preparation cycle to vary the actual volume of gas present in the delivery system.

Preferred embodiments of the present invention will now be described, by way of example only, with reference to the accompanying drawings in which:

Figure 1 is a front perspective view of a prior art beverage preparation machine with the cartridge head in a closed position;

Figure 2 is a front perspective view of the machine of Figure 1 with the cartridge head in an open position;

Figure 3 is a rear elevation of the machine of Figure 1 with some parts omitted for clarity;

Figure 4 is a front perspective view of a cartridge head of the machine of Figure 1 with some parts omitted for clarity;

Figure 5 is another front perspective view of the cartridge head of Figure 4, with some parts omitted for clarity;

Figure 6 is a cross-sectional view of the cartridge head of Figure 4 in a closed position accommodating a version of a beverage cartridge;

Figure 7 is a cross-sectional side elevation of the cartridge head of Figure 4 in an open position accommodating the beverage cartridge;

Figure 7a is a plan view of a rubber seal for the cartridge head of Figure 4;

Figure 8 is a schematic showing the various component parts of the machine of Figure 1 incorporating a new variable outlet valve;

Figure 9 is a section of schematic of an outflow from the cartridge head incorporating the variable outlet valve of Figure 8;

Figures 10-12 are cross-sectional front elevations of one embodiment of the variable valve in the outflow of Figure 9 showing it's closed, open and restricted positions respectively;

Figures 13a and 13b are cross-sectional end elevations of an alternative variable outlet valve used in the outflow of Figure 9 in its open and closed position respectively;

Figures 14 and 15 are cross-sectional side elevations of the valve of Figures 13a and 13b;

Figure 16a is a side elevation of a beverage receptacle containing a coffee beverage having a large volume of crema produced using an improved gas management system;

Figure 16b is a chart showing the brew parameters used in producing the beverage illustrated in Figure 16a;

Figure 17a is a side elevation of a beverage receptacle containing a coffee beverage having a small volume of crema produced using the improved gas management system;

Figure 17b is a chart showing the brew parameters used in producing the beverage illustrated in Figure 17a;

Figure 18 is a plan view of a beverage cartridge suitable for use in the beverage preparation machine of Figure 1;

Figure 19 is cross-sectional side elevation of an outer member of the cartridge of Figure 18;

Figure 20 is a cross-sectional side elevation of a detail of the outer member of Figure 19 showing an inwardly directed cylindrical extension;

Figure 21 is a cross-sectional side elevation of a detail of the outer member of Figure 19 showing a slot;

Figure 22 is a perspective view from above of the outer member of Figure 19;

Figure 23 is a perspective view from above of the outer member of Figure 19 in an inverted orientation;

Figure 24 is a plan view from above of the outer member of Figure 19;

Figure 25 is a cross-sectional drawing of an inner member of the cartridge;

Figure 25a is a cross-sectional drawing of a detail of the inner member of Figure 25 showing an aperture;

Figure 26 is a perspective view from above of the inner member of Figure 25;

Figure 27 is a perspective view from above of the inner member of Figure 25 in an inverted orientation;

Figure 28 is another cross-sectional drawing of the inner member of Figure 25;

Figure 28a is a cross-sectional drawing of another detail of the inner member of Figure 25 showing an air inlet;

Figure 29 is a cross-sectional side elevation of the cartridge in an assembled condition; and

Figure 30 is a cross-sectional side elevation of another version of cartridge.

In order to cater for the desired wide selection of good quality beverage types, having different characteristics, the present invention involves one or more significant improvements to known beverage preparation machines. These improvements enable sufficiently high pressures to be generated and maintained for the production of good quality espressos, and the pressure to be varied in a manner which is invisible to the user and requires no

manual intervention. Furthermore they enable the crema to be improved in a way not previously possible.

These improvements, which will be described in more detail below, include:-

1. providing a variable geometry valve downstream of the beverage cartridge to enable the beverage preparation machine to operate at a range of pressures; and

2. providing greater control over the end appearance of the dispensed beverage, in particular beverages with crema, by controlling the volume of gas passed through the beverage ingredients.

The aforementioned improvements will be described with reference to a known beverage preparation machine 10 which is illustrated in Figures 1 to 7 of the accompanying drawings. It should be noted, however, that the improvements find application in a wide range of beverage preparation machines capable of using a wide range of cartridges which, as noted above, include pods, pads, rigid and semi-rigid cartridges.

The beverage preparation machine 10 of Figures 1 to 3 generally comprises a housing 11, a tank 12, a water heater 13, a control processor (not shown), a user interface 16 and a cartridge head 17. The cartridge head 17 in turn generally comprises a cartridge holder 18 for holding, in use, a beverage cartridge 100 and cartridge recognition means 20. The cartridge head 17 further comprises inlet and outlet

piercers 21,22 for forming in the beverage cartridge 100, in use, an inlet 107 for liquid to enter the cartridge 100 and an outlet 108 for the prepared beverage to exit the beverage cartridge 100.

Although water is likely to be the most common liquid used in preparing beverages such as coffee, the machine 10 is also capable of handling other liquids, such as milk or milk preparations, for mixing with the beverage ingredients 200. Any references herein to water should also be taken to include any form of liquid used in preparing beverages.

The housing 11 is preferably made in whole or in part from a suitable plastics material or metal. The housing 11 preferably comprises a clam-shell design having a front half 25 and a rear half 26 which allow access during assembly for fitting of the machine 10 components.

The front half 25 of the housing 11 defines a dispensing station 27 where dispensation of the beverage takes place, which includes a cupstand 23 with a drip tray located beneath. The machine user interface 16 is also located on the front of the housing 11 and comprises a plurality of control switches, for example, a start/stop button 28, and a number of status indicators 29-32. The status indicators 29-32 are preferably light emitting diodes (LED) which, for example, indicate readiness of the machine 10, whether an error has occurred in the machine 10 operation, and the mode of operation of the machine 10. The LEDs 29-32 may be controlled to illuminate at a constant intensity, to flash intermittently, or both depending on the

status of the machine 10. The LEDs 29-32 may have a variety of colours including green, red and yellow. The start/stop button 28 controls commencement of the dispense cycle and is preferably a manually operated push-button, switch or similar.

The tank 12 is located to the rear of the housing 11 and is preferably incorporated in, or connected to, the rear half 26 of the housing 11. The tank 12 has an inlet for filling the tank 12 with water, or other liquid, which is closed off when the tank 12 is in position in the machine 10. An outlet is provided towards a lower end of the tank 12 which communicates with the pump 14. The tank 12 may be made from a transparent or translucent material to allow a consumer to view the quantity of water remaining in the tank 12. Alternatively, the tank 12 may be made from an opaque material but have provided a viewing window therein. In addition, or in place of the above, the tank 12 may be provided with a low level sensor which prevents operation of the pump 14 and optionally triggers a warning indicator, such as an LED, when the liquid level in the tank descends to a preselected level. The tank 12 preferably has an internal capacity of approximately 1.5 litres.

The pump 14 is operatively connected between the tank 12 and the water heater 13, as shown schematically in Figure 8, and is controlled by the control processor. A suitable pump provides a flow rate of 900 ml/min of water at a pressure of 6 bar. The flow rate of water through the machine 10 can be controlled by the control processor to be a percentage of the maximum flow rate of the pump 14 by

cycle chopping the electrical supply to the pump. Preferably the pump can be driven at any of 10%, 20%, 30%, 40%, 50%, 60%, 70%, 80%, 90% or 100% of the maximum rated flow rate. The accuracy of the volume of water pumped is preferably + or - 5% leading to a + or - 5% accuracy in the final volume of the dispensed beverage. A volumetric flow sensor (not shown) is preferably provided in the flow line either upstream or downstream of the pump 14. Preferably, the volumetric flow sensor is a rotary sensor.

The heater 13 is located in the interior of the housing 11. One suitable heater 13 has a power rating of 1550 W and is able to heat water received from the water pump 14 from a starting temperature of approximately 20 °C to a nominal operating temperature of around 85°C in under 1 minute. Preferably the dwell time between the end of one dispense cycle and the heater 13 being able to commence a subsequent dispense cycle is less than 10 seconds. The heater maintains the selected temperature to within + or - 2 °C during the dispense cycle. The water for the dispense cycle is delivered to the cartridge head 17 at a predetermined temperature. The heater 13 is able to quickly adjust the delivery temperature to the required temperature, generally between 80°C and 98°C and possibly higher from the incoming water temperature. Where desired, the machine 10 can incorporate a steam purge. The preferred means of generating the steam purge is to utilise a water heater 13 in the form of a flash (also known as an instantaneous or flow) heater. Typically such flash heaters comprise a tube through which the water passes wherein the tube is heated by one or more resistive elements. The flash heater can be used not only

for heating water for forming beverages but also, at higher power settings, for generating a steam purge by boiling off water remaining with the flash heater tube after the beverage has been formed. An advantage of flash heaters is that there is no significant delay whilst water in a boiler heats up. Flash heaters heat water on demand and switch off immediately after each brewing cycle and are therefore very energy efficient.

Water output from the heater 13 is fed via a suitable delivery system to the cartridge head 17 and cartridge 100 by means of a valve. If the pressure of the water flow is acceptable, the water is passed to the cartridge 100. If the pressure is below or above predetermined limits then the water is diverted by means of the valve to a waste recovery receptacle.

The delivery system comprises conduits which connect the tank 12, the water pump 14, the water heater 13 and the cartridge head 17 (as shown in Figure 8) to transport the water from the tank 12 to the cartridge 100.

The cartridge holder 18 is designed to be capable of handling the opening forces generated by the pressure inside the cartridges 100, which is around 250kg for espresso beverages. During operation of the machine 10 the cartridges 100 attempt to expand, but the integrity of the cartridges 100 must be maintained. In addition the user must not be able to open the holder 18 whilst the system is pressurised and suitable locking mechanisms are provided to achieve this.

One suitable design of cartridge head 17, as described in WO-A-2006/014936, is shown in Figures 4 to 7. The cartridge holder 18 of the cartridge head 17 comprises a fixed lower part 43, a rotatable upper part 44 and a pivotable cartridge mount 45 positioned between the fixed lower part 43 and the rotatable upper part 44. The upper part 44, lower part 43 and cartridge mount 45 are rotated about a common hinge axis 46. Figures 4 to 7 show the holder 18 with some components of the machine 10 omitted for clarity.

The rotatable upper part 44 and pivotable cartridge mount 45 are moved relative to the fixed lower part 43 by means of a clamping mechanism. The clamping mechanism comprises a clamping lever having first and second members or parts 47 and 48. The first part 47 of the clamping lever comprises a U-shaped arm which is pivotably mounted to the upper part 44 at two first pivot points 48, one on each side of the holder 18.

The second part of the clamping lever comprises two over-centre arms 49, one on each side of the holder 18 which are each pivotably mounted to the upper part 44 at a second pivot point 50 located on the hinge axis 46 coupling the upper part 44 to the fixed lower part 43. Each over-centre arm 49 is a reciprocal member comprising a cylinder 49a, a stem 49b and a resilient sleeve 49c. The cylinder 49a has an internal bore and is rotatably mounted at one end at the hinge axis 46. A first end of the stem 49b is slidingly received in the bore of the cylinder 49a. The opposite end of the stem 49b is rotatably mounted to the U-shaped arm 47

at a third pivot point 51. The third pivot points 51 are unconnected to, and freely moveable relative to, the upper part 44 and lower part 43. The resilient sleeve 49c is mounted externally on the stem 49b and extends, in use, between abutment surfaces on the cylinder 49a and stem 49b. The resilient sleeve 49c accommodates shortening of the over-centre arm 49 but biases the over-centre arm 49 into an extended configuration. Movement of the third pivot points 51 towards and away from the hinge axis 46 is thus possible by relative movement of the stems 49b in the cylinders 49a. The resilient sleeves 49c are preferably formed from silicone. Whilst the illustrated embodiment uses two over-centre arms 49, it will be apparent that the closure mechanism may be configured with only one over-centre arm 49.

The U-shaped arm 47 extends around the front of the holder 18 and comprises two downwardly dependant hook members 52, one on each side of the holder 18, each comprising a cam surface facing the hinge axis 46. The fixed lower part 43 of the holder 18 is provided with two bosses 53, or detents, located one on each side of the lower part 43 at or near a front edge 54 thereof aligned generally with the hook members 52.

As shown in Figure 4, the U-shaped arm 47 may be formed from a one piece plastics moulding comprising an ergonomic hand grip and the hook members 52 integral to the arm 47.

The cartridge mount 45 is rotatably mounted between the upper and lower parts 43, 44 of the holder 18. The mount 45

is provided with a substantially circular recess 55 which receives in use the beverage cartridge 100 (which is described in greater details below). The recess 55 includes an irregularity 56 for accommodating the handle portion 24 of the beverage cartridge 100 which also acts to prevent rotation of the beverage cartridge 100 in the holder 18. The cartridge mount 45 is sprung relative to the fixed lower part 43 such that in the open position, as shown in Figure 7, the cartridge mount 45 is biased out of contact with the fixed lower part 43 so that the cartridge mount 45 is moved out of contact with the outlet and inlet piercer members 21, 22. The cartridge mount 45 is provided with an aperture 57 for receiving there through the inlet and outlet piercers 21, 22 and a head of the cartridge recognition means 20 when the cartridge mount 45 is moved into the closed position.

The upper part 43 comprises a generally circular body 58 housing a circular viewing window 59 through which a consumer can view the beverage cartridge 100 during a dispense cycle and also visually confirm whether a cartridge 100 is loaded in the machine 10. The viewing window 59 is cup-shaped having a downwardly directed rim. In addition, the viewing window 59 is provided with a clamping member in the form of an inwardly directed tubular extension 61 as shown in Figure 7. The extension 61 is directed towards the lower part 44 and lies within the volume of the cartridge head when in the closed position as shown in Figure 6. The viewing window 59 is able to move axially relative to the housing 58 of the upper part 43. One arrangement of accomplishing the relative movement is to provide a wave spring (not shown), or similar resilient means such as a

rubberised ring, positioned between the viewing window 59 and the circular housing 58. In an alternative arrangement, a series of helical compression springs (not shown) are provided extending between the viewing window 59 and the housing 58. In both cases the resilient means allows the viewing window 59 to move axially relative to the circular housing 58 by a small degree.

When the holder 18 is in the closed position, a distal end 62 of the tubular extension 61 of viewing window 59 bears against the clamping surface 18a of the beverage cartridge 100 biasing it against the lower part 44 as shown in Figure 6 (in which the arrangement is illustrated containing a cartridge having a greater depth). The pressure exerted by the tubular extension 61 on the outer member 102 ensures a fluid tight seal between the cartridge 100 and the holder 18. It should be noted that the height of the viewing window 59, and hence also the cartridge head 17, is such that cartridges 100 of various depths can be inserted. In Figure 6 the arrangement is shown with a relative deep cartridge. The same cartridge head 17 can also accommodate shallower cartridges. In this case there will be a gap between the upper surface 11 of the cartridge 100 and the window 59. However the cartridge 100 is fully sealed at inlet and outlet by the pressure applied by the tubular extension 61.

The lower part 43 comprises the inlet and outlet piercers 21, 22 and the head of the cartridge recognition means 20. The inlet piercer 21 comprises a hollow needle-like tube 63 having a sharpened end 64 for perforating the

laminate 108 of the beverage cartridge 100 in use. The inlet piercer 21 is in fluid communication with a water conduit 65, as shown in Figure 7, which passes through the lower part 43 and is connected to an outlet conduit 66 of the water heater 13. The outlet piercer 22 is similar in type to the outlet piercer described in the EP-A-0389141 and EP-A-0 334572 and comprises an open ended cylinder of circular or D-shaped cross-section having dimensions larger than the beverage discharge spout 109. An arcuate portion 67 of the upper end of the outlet piercer 22 is serrated to pierce and eventually cut the laminate of the beverage cartridge 100. The remainder of the upper end is cut back longitudinally of the cylinder at least to the base of the teeth 68 of the serrated portion to fold or pull the cut laminate 108 away from the outlet aperture before the beverage is dispensed there through. The outlet piercer 22 pierces the laminate 105 externally of the discharge spout 143 and when the cartridge mount 45 is in the closed position, rests in the annulus between the discharge spout 143 and the outer wall 42 of the discharge funnel 140. The outlet piercer 22 folds back the cut laminate 105 into the annulus. Thereby both the outlet piercer 22 and the cut laminate 105 are held out of the way of the discharged beverage.

The outlet piercer 22 is surrounded by a ledge which is raised relative to its surroundings by 0.5mm.

Advantageously, the outlet piercer 22 is removable from the lower part 43 to enable it to be thoroughly cleaned, for example, in a dishwasher. The removable outlet piercer 22 is received in a recess in the lower part 43 where it is

seated. The inlet piercer 21 and/or the outlet piercer 22 may be made of a metal, such as stainless steel, or from a plastics material. Advantageously, the use of plastic cutting elements is enabled by use of a laminate 105 which is able to be punctured and cut by a non-metallic material. Consequently, the piercers 21, 22 can be made less sharp which lowers the risk of injury to the consumer. In addition, plastic piercing elements are not prone to rust. Preferably, the inlet piercer 21 and the outlet piercer 24 are formed as a single, integral unit which is removable from the lower part 43.

In use, the upper part 44 of the holder 18 is movable from an open position in which it is orientated vertically or towards the vertical as shown in Figure 2, to a closed position in which it is orientated substantially horizontally and in interengagement with the fixed lower part 43 and cartridge mount 45. The upper part 44 is moved from the open to the closed positions by operation of the clamping lever. To close the upper part 44 a user takes hold of the clamping lever by the U-shaped arm 47 and pulls downwards. Consequently, the upper part 44 rotates which first brings the tubular extension 61 of the viewing window 59 into contact with the clamping surface 118a of the beverage cartridge 100. Continued rotation of the upper part 44 rotates the upper part 44 and cartridge mount 45 down into contact with the lower part 43. Further rotation of the U-shaped arm 47 causes the U-shaped arm 47 to rotate relative to the upper part 44 and the lower part 43 resulting in the hook members 52 of the upper part 44 engaging the bosses 53 of the lower part 43 with the cam

surface riding over the bosses 53. During this last stage of rotation the cartridge 100 is compressed between the cartridge mount 45 and the viewing window 59. As a result, the viewing window 59 is moved axially slightly relative to the circular housing 58 of the upper part 44 against the bias of the wave spring or helical springs. This movement allows for a take up of tolerances in the beverage cartridge 100 and beverage preparation machine 10 and ensures that the amount of compressive force applied to the cartridge 100 is kept within an acceptable range. The clamping force of the mechanism as moderated by the action of the wave spring or helical springs ensures a clamping pressure on the cartridge 100. It has been found that a force of between 150N and 400N is required to counter the pressure in the cartridge 100. During closure of the cartridge head the laminate 105 of the cartridge 100 is tensioned as it is brought into contact with the ledge surrounding the outlet piercer 22 which causes the laminate 105 to flex out of plane as the distal end of the outer tube 42 of the cylindrical funnel is moved upwardly by 0.5mm relative to the flange 147. This movement also ensures that the great majority of the compressive force applied to the cartridge 100 acts through the central region of the cartridge 100 through the load-bearing inner member 103. These clamping forces help prevent failure of the cartridge 100 during pressurisation and also ensure that the inner member 103 and outer member 102 are fully seated relative to one another and thus that all internal passageways and apertures remain at their intended dimensions even during internal pressurisation.

In the closed position, the separation of the distal end 62 of the tubular extension 61 and the lower part 44 is shown by reference D in Figure 6. This distance is fixed by the dimensions of the viewing window 59, housing 58 and lower part 44. The distance D is chosen to be the same or marginally smaller than the distance d between the clamping surface 118a and laminate 105 under surface of the cartridges 100. In this way, on closure of the cartridge head 17 the cartridges 100 are subjected to a fixed, known degree of compression. In addition, both the first and second embodiments of cartridge can be clamped with the same degree of compression since distance D is the same for both cartridge types.

An imaginary datum line can be drawn between the first and second pivot points 48, 50 of the holder 18. As can be seen in Figure 7, in the open position the third pivot points 51 are located on the side of the datum line nearest the fixed lower part 43. As the upper part 44 reaches the closed position, the third pivot points 51 of the clamping lever pass through the datum line joining the first and second pivot points 48, 50 to the opposite side of the line, furthest from the fixed lower part 43. Consequently, the U-shaped arm 47 'snaps through' from a first stable position to a second stable position. The snap through action is accommodated by shortening of the over-centre arms 49 and consequential compression of the resilient sleeves 49c. Once the third pivot points 51 are past the imaginary datum line, the recovery of the resilient sleeves 49c acts to continue the motion of the third pivot points 51 away from the imaginary datum line. The clamping lever thus has a bi-

stable operation in that the lever is stable in the open or closed positions but unstable at the point when the third pivot points 51 lie on the imaginary datum line joining the first and second pivot points 48, 50. Thus, the snap-through action of the clamping lever provides a positive closure mechanism which leads to a definite closure action wherein in the final stages of the clamping lever's rotation, the snap-through action of the U-shaped arm 47 and second arms forces the hook members 52 firmly into engagement with the bosses 53. In addition, the resilient sleeves 49c provide a resistance to re-opening of the upper part 44 since a minimum force is required to compress the sleeves 49c sufficiently to move the third pivot points 51 back into line with the datum line joining the first and second pivot points 48, 50. Advantageously, the interengagement of the hook members 52 and the bosses 53 prevents separation of the upper and lower parts other than by rotation of the clamping lever. This is useful in preventing opening of the cartridge head 17 during operation when the cartridge head 17 is subject to internal pressurisation.

The pressure exerted by the upper section 44 ensures a full fluid tight seal between the cartridge 100 and the cartridge holder 18. The clamping forces help prevent failure of the cartridge 100 during pressurisation and also ensure that all of the internal passageways and apertures within the cartridge 100 remain at their intended dimensions even during internal pressurisation. To improve the seal with the cartridges 100 the applicant has now found that lining the recess 55 of the cartridge mount 45 with a rubber seal 55a (see Figure 7a) improves the machine's ability to

withstand the significantly higher pressures generated during the brewing cycle.

Control of the brew cycle is effected by the control processor of the beverage preparation machine 10, which comprises a processing module and a memory. The control processor is operatively connected to, and controls operation of, the heater 13, pump 14, user interface 16, and other components described below.

The operational behaviour of the machine 10 is determined by software embedded in the control processor, for example as described in EP-A-1440644. The memory of the control processor includes one or more variables for one or more operational parameters for the beverage preparation machine 10. In the prior art machines these are generally the temperature of the liquid passed through the beverage cartridge 100 during the operating stage, the speed of charging the beverage cartridge 100, the presence or otherwise of a soak step, the total dispensed volume of the beverage, the flow rate of the liquid during the discharge stage, and the period of the purge stage.

One purpose of the cartridge recognition means 20 is, inter alia, to allow the machine 10 to recognise the type of beverage cartridge 100 that has been inserted and to adjust one or more operational parameters accordingly. The variables for the operational parameters are stored in the memory. The cartridge 100 comprises a code 120 provided on or in the cartridge 100 representing the operational parameters required for optimal dispensation of the beverage

in that cartridge 100. An example of the code is described in EP-A-1440644.

The control processor memory further stores information on the type of beverage dispensed so that the operating cycle of the machine 10 may be adjusted for the next cartridge 100. This is especially advantageous where two or more beverage cartridges 100 are used sequentially to form a beverage. For example a coffee cartridge may be dispensed followed by a milk cartridge to form a cappuccino beverage. Alternatively a chocolate cartridge could be used followed by a milk cartridge to produce a creamy hot chocolate beverage. By using a memory that stores information on the first beverage dispensed, the manner of dispensing the second cartridge, say a milk cartridge, may be altered to achieve an optimum beverage. In the above example the milk dispensed for hot chocolate may, typically, be diluted less than the milk added to the coffee. In addition, the milk dispensed for chocolate may be dispensed at a slower flow rate to lessen the degree of foaming of the beverage. Many combinations of cartridges are possible and operating parameters as will be obvious to the skilled person. In addition, the memory may be used to allow the machine 10 to 'predict' the type of beverage that a user will next want to dispense. For example, if a user predominantly drinks one beverage type then the machine can instruct the water heater to remain at the optimum temperature for that beverage type.

Operation of the known prior art machines 10 comprises insertion of a beverage cartridge 100 into the cartridge head 17, carrying out a dispense cycle in which the beverage

is dispensed and removal of the cartridge 100 from the machine.

To insert the cartridge 100 the cartridge holder 18 is opened as described above to expose the cartridge mount 45. The cartridge 100 is then placed on the cartridge mount 45 received within the recess 46. The cartridge holder 18 is then closed by operation of the clamping handle 51 as described above. During closure the inlet and outlet piercers pierce the cartridge 100 to form the cartridge inlet 107 and outlet 108.

To commence the operating cycle the user operates the start/stop button 28. The operating cycle comprises the steps of cartridge recognition and the beverage preparation cycle.

Cartridge recognition is performed by the optical cartridge recognition means 20 as described above assuming that the outputs from the cartridge sensor and lock sensor are satisfactory. Once the barcode 40 has been decoded the operational parameters of the machine 10 are adjusted by the control processor. The preparation cycle is then automatically commenced. The preparation cycle has four main stages, although not all of these are used for all beverage types:

1. Pre-wet
2. Pause
3. Brew stage
4. Purge

In the pre-wet stage the cartridge 100 is charged with liquid from the storage tank 12 by means of the pump 14. The charging with water causes the beverage ingredients 200 in the chamber 160 to be wetted. The charging may take place at a "fast" flow rate of 600 ml/min or a "slow" flow rate of 325 ml/min. The slow charging rate is particularly useful for cartridges 100 containing viscous liquid beverage ingredients where the ingredients require some dilution before they are able to be pumped at a higher volume flow rate. The volume of liquid injected into the cartridge 100 is selected to ensure that liquid or beverage does not drip out of the cartridge outlet 108 during this stage.

The pause stage allows the beverage ingredients 200 to soak in the liquid injected during the pre-wet stage for a predetermined period of time. Both the pre-wetting and soaking stages are known to increase the yield of the extractibles from the beverage ingredients 200 and to improve the end flavour of the beverage. Pre-wetting and soaking are particularly used where the beverage ingredients are roast and ground coffee.

In the brew stage liquid is passed through the cartridge 100 in order to produce the beverage from the beverage ingredients 200. The temperature of the liquid is determined by the control processor which sends instructions to the heater 13 to heat the liquid passing from the tank 12 to the cartridge head 17. Liquid enters the cartridge holder 18 via an inlet valve and the inlet piercer and then passes into the inlet chamber 126 of the beverage cartridge 100.

Brewing and/or mixing of the beverage in the beverage cartridge 100 occurs, as described in EP-A-1440644, before the prepared beverage exits the cartridge outlet 104, enters the outlet valve 37 and is directed into a suitably placed receptacle in the dispensing station 27.

During the purge cycle the temperature of the water heater 13 is raised sufficiently high to convert the water remaining in the system to steam and blowing the pressurised steam through the beverage preparation machine 10 and the beverage cartridge 100. This ensures that all beverage is dispensed and that the flow path is cleared ready for dispensing another beverage. The purge cycle may not commence immediately on cessation of the brew/mixing stage to allow for the majority of the fluid to clear the flow path.

Once the operating cycle has been completed, the machine automatically stops and the consumer removes the cartridge 100 by opening the cartridge holder 18 and manually removing and disposing of the cartridge 100. Alternatively, the machine 10 may be provided with an automatic ejection mechanism for removing the cartridge automatically on opening the cartridge holder 18.

The first of the significant improvements to the known beverage preparation machines 10 referred to above is the provision of variable geometry valve 60 (see Figures 9 to 15) provided adjacent the cartridge outlet 108 to provide post-cartridge pressure control. This enables the machine 10 to produce a wide variety of beverages, as it allows the

cartridges 100 to be selectively brewed at either high or low pressure or a varying pressure during the brew cycle, depending on the type of brew cycle required for the beverage ingredients in the cartridge as identified by the cartridge recognition means 20, thus providing an automated variable pressure system. The modified machine is capable of producing beverages at a range of pressures, for example from 0 to 9 bar, and more preferably from 0 to 6 bar.

The variable geometry valve 60 is positioned downstream of the cartridge 100, and preferably positioned in the beverage outlet 37, which is partially housed in, and extends from, the lower section 43 of the cartridge head 17 (see Figures 6 and 7). The valve 60 has at least an open and a restricted state, and more preferably all of the states identified below:-

1. Open (Figure 11)
2. Restricted (Figure 12)
3. Closed (Figure 10)
4. Cleaning/purging.

Various types of valve may be used for the outlet valve 60, such as ball valves, pinch valves, sleeve valves, seat valves or disc valves. The embodiment illustrated in Figures 10 to 12 is a ball type valve which has a rotating element 69 located in a chamber 70 in the beverage outlet 37. The rotating element 69 is rotatable between preset positions to provide the required states. The diameter of the bore of the valve 60 in the unrestricted position is preferably at least

5mm which is required, for example, for cartridges 100 providing low pressure filter beverages.

An alternative suitable valve is a pinch valve illustrated in Figures 13 to 15 which comprises a flexible tube 71, preferably made of silicon rubber or an elastomeric material, and a clamping mechanism 72. In the unrestricted position (Figures 13a and 14) the beverage flows freely through the tube 71. The clamping mechanism 72 is activated to provide a restricted position (Figures 13b and 15) and closed position.

The valve 60 is controlled automatically by the control processor of the machine 10. Once the type of cartridge 100 inserted into the machine 10 has been identified, by the decoding the barcode 40, the control processor selects the correct initial setting and, if appropriate, any subsequent operation of the valve 60 for the relevant beverage type.

The machine 10 can operate in a range of modes, with the valve 60 in one or more positions, some examples of which are:-

1. Valve Open Throughout The Brewing Cycle

When the valve 60 is in its open position the operating pressure is below 2 bar allowing a steady state through flow rate of up to 400 ml/min. The beverage is dispensed under similar conditions to those described in EP-A-1440644. This mode is particularly useful as it renders the machine 10 backwardly compatible with existing cartridges for preparing

low pressure beverages, such as tea, foamed milk or chocolate.

2. Valve Restricted Throughout The Brewing Cycle

When the valve 60 is in its restricted position it creates a relatively high back pressure within the cartridge 100, which results in an operating pressure of up to 4, 6 or even 9 bar and provides a steady state through flow rate of 60 to 300 ml/min. This is sufficient to obtain the necessary solids extraction and emulsification of oils in the beverage ingredients 200 for an espresso beverage. The consequential restriction in the beverage outlet 37 provides a shearing and mixing action in the beverage flowing through the valve 60, giving rise to good air/liquid emulsification and resulting in an improved crema. This mode can advantageously be used for preparing higher pressure beverages, such as espressos and cappuccinos, from cartridges 100 which do not have means for entraining air to effect the mixing action, i.e. so called non-eductor cartridges.

3. Valve Closed Then Restricted

If the valve 60 is closed immediately at the start of the brewing cycle (before the pump 14 commences and during the pre-wet cycle), this enables a higher pressure to be developed within the cartridge 100 than when the valve 60 is in it's restricted position.

Further combinations may be appropriate, such as valve closed then open or valve closed then restricted then open according to the desired effect to be achieved.

If required, the valve 60 can be pulsed between various positions during the brewing cycle, or a part thereof. This manner of valve operation during the delivery cycle enables beverages with a crema having a graduated colour and/or bubble size to be produced.

During the purge cycle the valve 60 is controlled by the control processor to divert the steam to a drain area rather than to the dispensing station 27 to preserve the appearance of the beverage and prevent contamination.

The second of the significant improvements to the known beverage preparation machines 10 referred to above is the addition to the brew control system of gas management. Surprisingly the applicant has now discovered that the characteristics of beverages prepared in this type of beverage preparation machine 10 can be modified beyond boundaries hereto seen in prior art machines. The surprising effect is enacted by controlling the volume of gas in the delivery system during the preparation of the beverage to prescribe the amount of high quality crema resulting in a controlled amount of crema on a beverage varying from a delicate layer up to a surprisingly deep layer in the final beverage. The applicant has found a way to successfully use gases within the beverage preparation machine to modify the gas:liquid ratio to produce a surprising volume of good stable crema in prepared beverages never seen before in

prior art machines. Maintaining a greater volume of gas resident in the delivery system enables a much larger gas:liquid ratio to be achieved during brewing and dispensing and this produces a correspondingly larger volume of crema. Decreasing the volume of gas enables the ratio to be decreased to reduce the crema volume. The bubble size is also influenced by the gas:liquid ratio, so a lower ratio can be used to provide a tight and creamy crema and a higher ratio used to provide a more loose and bubbly crema. This improvement therefore provides the ability to optimise the crema volume and bubble size for each beverage dispensed. It has been found that by manipulating the gas good quality espressos can be brewed with a crema volume greater than 25% of the beverage volume whilst minimising the occurrence of bubbles having a diameter of more than 172 microns which is not previously seen to be possible in known beverage preparation machines of this type.

The improvement is achieved by adapting the control of the brew cycle to provide means for managing the volume of gas within the delivery system which conveys the water from the tank 12 to the beverage ingredients 200 and to the dispensing outlet. All further references in this specification to the delivery system are intended to include any predetermined section thereof, for example the section extending from the water heater 13 to the cartridge 100 and may also include, if relevant, some gas contained within a headspace of the cartridge 100.

The "basic volume" of gas which can reside within the delivery system of any given machine 10 is dependant on its