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(54) **A device for the manufacture of self-sustaining cups of thin paper**

Vorrichtung zum Herstellen von Bechern aus dünnem Papier

Dispositif pour la fabrication de gobelets autoportants en papier mince

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• **Francesco, Ferri**  
**10133 Torino (IT)**

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(74) Representative: **Spandonari, Carlo, Dr. Ing.**  
**Spandonari & Modiano s.r.l.**  
**corso Duca degli Abruzzi 16**  
**10129 Torino (IT)**

(73) Proprietor: **Ecopack S.p.A.**  
**10040 Piobesi (Torino) (IT)**

(56) References cited:  
**US-A- 2 447 855**                      **US-A- 3 001 683**

(72) Inventors:  
• **Luigi, Ferri**  
**10133 Torino (IT)**

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## Description

**[0001]** This invention is concerned with a device for the manufacture of self-sustaining cups of thin paper according to the preamble of claim 1, suitable for containing foodstuffs and particularly cakes, pies, plumcakes and the like, during the steps of baking, automatic or manual manipulation, exposure and sale.

**[0002]** It is known to accommodate certain foodstuffs such as mentioned above in drawn metal baking-pans that, during the baking step, possibly with insertion of paper cups ("pirottini"), in order to avoid direct contact with metal.

**[0003]** Such cups, comprising radially plaited paper sheets having a frustoconical shape, are not self-sustaining, so that, without an embanking structure, they tend to buckle, both because of the tendency of the raw batter to become flabby and because of the natural expansion of the batter itself during the baking stage.

**[0004]** To this purpose, containers of corrugated paper are sometimes used which comprise two parts, namely a bottom and a lateral band to make a wall. Aluminium containers are also used.

**[0005]** It is also known to support plaited-paper cups in seats made in cardboard trays, so that the cup is laterally contained with the seat profile, while being easily withdrawn after baking.

**[0006]** However, since the above products are to be distributed industrially, the practice has developed of using cups which, while having an adequate sturdiness, can nevertheless be easily and unexpensively manufactured. This condition is not satisfactorily met by the above-mentioned approaches.

**[0007]** Due to the above reasons, substantially frustoconical cups have been made in different sizes, not only from aluminium sheet, but also from cardboard (sometimes coupled to other materials). US-A-5 184 995 and US-A-6 093 460, for instance, show how to mould cardboard cups having a curled lip to build a peripheral containing bead, which imparts the structure a good resistance to its coming apart. The bead is formed by a beading member or by a molding in the die, which bends the lip of the cup to make a curl.

**[0008]** US-A-2 447 855 discloses a die for forming paper caps, wherein the cap blank is pushed between a diaphragm draw block and a diaphragm plunger of a complementary shape, and the latter are then depressed into a draw ring so that a cylindrical wall is formed on the blank, between the external wall of the plunger and the internal wall of the draw ring. The outer portion of the cap is then downwardly folded by a cylindrical member lowering over the draw ring, while a sizing ring compacts said outer portion by entering the gap, with close running fit, between the cylindrical member and the draw ring.

**[0009]** However, the approaches of US-A-5 184 995, US-A-6 093 460 and US-A-2 447 855 are suitable for handling cardboard of considerable thickness, say hav-

ing a basic weight of 200 g/sq.m. or more, and therefore having a good inherent stiffness, and are not suitable, on the other hand, for the manufacture of thin-paper cups, i.e. made of paper of 50 g/sq.m. or less, corresponding to a thickness of a few hundredths of a millimeter. As a person skilled in the art will appreciate, the degree of dimensional accuracy required for the different parts of the die increases as the paper thickness is reduced: in fact, if the gap between the movable and the stationary portions of the die is smaller than the thickness of the paper, the latter is liable to be torn, while, on the other hand, if the gap is too large, the paper is liable to be creased and be wedged between the parts of the die, thus jamming it. It is difficult to achieve so small dimensional tolerances and even more difficult to maintain them during the operation of the die machine, particularly in consideration of the circumstance that the die is also subject to heating, on the one hand because of friction, on the other hand because of deliberate heating for the purpose of thermoforming the paper.

**[0010]** Furthermore, the peripheral bead made of a single curl, as provided for in US-A-5 184 995 and US-A-6 093 460 with reference to cardboard, is not sufficient in the case of thin paper, on the one hand because it is unpracticable to build the required curl in the paper, on the other hand because anyway the curl is not stiff enough to impart the desired solidity to the cup.

**[0011]** Finally, wear of the dies due to operation would cause a quick decay of the accuracy of the die in any case, and would force replacement after a very short life period.

**[0012]** A main object of the invention is therefore to provide a device for the inexpensive mass-production of self-sustaining thin paper cups.

**[0013]** Another purpose is to extend the useful life of the dies used for thermoforming the cups.

**[0014]** The above objects and advantages are achieved by the invention, together with other advantages which will appear below, by providing a device for manufacturing self-sustaining cups, having the features set out in claim 1. The dependent claims recite other advantageous features.

**[0015]** The inventive device will now be described in more detail, with reference to a preferred embodiment shown, by way of non limiting example, in the attached drawings, wherein:

Fig. 1 shows, in an axial, vertical cross-section, a device for the manufacture of paper cups according to a preferred embodiment of the invention;

Figs. 2, 3, 4, 5, 6 are partial cross-sections, to an enlarged scale, similar to Fig. 1, showing successive steps in the operation of the device;

Fig. 7 is a perspective view of a finished cup, made by the device of Figs. 1 to 6.

**[0016]** With reference to the Figures, a device 1 according to the preferred embodiment comprises a die matrix 2, axially slidable with respect to a base 8. Matrix 2 has a cavity 17 and is peripherally defined by a cylindrical wall 20. A punch 3, having a complementary shape to matrix 2, is coaxially arranged in front of matrix 2. Punch 3 is attached to a piston 4, which is itself axially slidable in a main block 5, opposite to base 8. Block 5 has circular shoulder 22, preferably of brass, which projects frontally and coaxially to punch 3, thus defining a pit 7 having a cylindrical inside wall.

**[0017]** Both matrix 2 and piston 4 are normally biased to a position extended from base 8 and the main block 5 respectively, by means of first and second elastic means 9 and 10, advantageously compressed air springs, acting in opposition, wherein elastic means 10 have a stiffness characteristic lower than elastic means 9.

**[0018]** A beading member 6 comprising a thin cylindrical foil coaxial to base 8 and integral with it, is arranged coaxially and slidably, in close running fit, on the cylindrical outside surface of matrix 2. Beading member is adapted to axially enter an annular gap 15 (Fig. 4) between the cylindrical internal wall of pit 7 and the cylindrical external surface of matrix 2, when they are in axially overlapping mutual positions, according to the sequence of operational steps as described in detail below.

**[0019]** A knockout pan 11 extends from the bottom of matrix 2, being biased by a third compressed-air cylinder 12, acting as an elastic means, having a stiffness lower than the other elastic means on the average.

**[0020]** The bottom of matrix 2 has a depression 13 to receive knockout pan 11, the latter being adapted to completely withdraw within it.

**[0021]** Driving means known and not shown in the drawings, for instance hydraulic double-action actuators or electric motors connected to means for converting motion from rotatory to linear motion, such as linkages or cam devices, are provided to move base 8 axially relative to main block 5, although the latter might be movable and the former be stationary.

**[0022]** Electric resistances 16 are wound around main block 5 to heat the block, which resistances are powered by an external voltage source (not shown), by the intermediary of a voltage regulator shown diagrammatically as 24, controlled by a temperature probe 26 mounted on shoulder 22, so that the pit is maintained at a desired temperature which is suitable for thermoforming the paper, the temperature being typically chosen in a range of 140 to 200°C.

**[0023]** The device of Fig. 1 is designed so that, when it is inactive and electric resistances 16 are off, i.e. when the device is cool, the internal diameter of pit 7 is slightly smaller than the external diameter of beading member 6, i.e. so that there is interference between the side wall of pit 7 and the external surface of beading member 6. When block 5 is heated by resistances 16, the pit ex-

pands and, when its temperature attains a predetermined nominal value (say 180°C), a condition of close running fit prevails between the wall of pit 7 and beading member 6.

**[0024]** In a first embodiment, the manufacture of the self-sustaining cup starts from a cup or "pirottino" 28 (Fig. 2), i.e. a disk of thin paper which has been palited radially to take a frustoconical shape and having a peripheral edge exceeding the desired depth of the finished cup. After pre-heating block 5 to a predetermined temperature, say 180°C, cup 28 is brought to the position shown on Fig. 2, between matrix 2 and punch 3 by means of manipulator means, obvious for a person skilled in the art, such as are conventionally used for transferring workpieces being processed on automatic-production lines or plants.

**[0025]** The operating steps now follow as shown on Figs. 2 to 6, as described below.

**[0026]** When cup 28 has been placed between matrix 2 and punch 3 (Fig. 2), base 8 is moved vertically toward main block 5, until cup 28 is squeezed between punch 3 and pan 11, the latter withdrawing to flatness after matrix 2 has coupled with punch 3 and has trapped cup 28 therebetween (Fig. 3).

**[0027]** At this point, as the approaching stroke continues, piston 4 starts to withdraw, the stiffness of second elastic means 10 being smaller than first elastic means 9, and eventually the piston reaches its limit.

**[0028]** During this step, peripheral edge 14 abuts against shoulder 22 and is first bent to make a flap at right angles to the axis of the die (Fig. 3) and then is bent again along the lateral wall of pit 7, substantially lying as a cylinder within the annular gap 15 which is formed between lateral wall of pit 7 and external wall of the matrix (Fig. 4).

**[0029]** After piston 4 has reached its limit, matrix 2 also starts to withdraw so that beading member 6 enters annular gap 15, thus squeezing and compacting peripheral edge 14, the latter being securely contained within annular gap 15, due to the close running fit between the beading member and both sliding walls inside and outside (Fig. 5).

**[0030]** The device is maintained in the condition of Fig. 5 for a short predetermined time, such that the paper material of the cup, and particularly the material that has been compacted in a ring 14 undergoes a thermal processing with a partial molecular alteration having a consolidating effect, which is sufficient to stabilize the shape forced by the die. At this point, the die is opened (Fig. 6) and the finished cup is unloaded, while a fresh "pirottino" is placed as on Fig. 2, for a fresh operating cycle.

**[0031]** A person skilled in the art will appreciate that the temperature can be regulated with accuracy to a value that will provide the close running fit between the parts of the die, and the dwelling time of the device in closed condition can then be chosen so that the thermal processing of the paper is optimized. As known, the

thermoforming temperature of the paper can vary within a broad range, provided that the dwelling time is changed to compensate for it. This circumstance makes it practicable to compensate for the wear of the pit and of the beading member, whereby the working temperature is progressively reduced (and therefore also the expansion of the pit), while the dwelling time is simultaneously increased, within reasonable bounds.

**[0032]** By the teachings of the invention it is possible to thermoform paper of a thickness of a few hundredths of a millimeter, which, in a conventional die, would inevitably penetrate within the interfaces between the sliding parts, with an ease that would increase as the die is worn down, causing not only misshapen products, but also jamming and downtime of the equipment.

**[0033]** In practice, it has been found that the invention fully achieves the appointed object by providing a device allowing self-sustaining cups of thin paper to be mass-produced without jamming, by taking advantage of the thermal expansion of the main block in an attempt to compensate for the clearances between the parts sliding relative to each other.

**[0034]** Another advantage of the invention is that the life of the dies used for thermoforming the cups is considerably extended, so that frequent replacements of the parts subjected to wear are avoided.

**[0035]** Moreover, all the details could be replaced with other technically equivalent parts. For instance, the elastic means could be simple wound springs or similar devices.

**[0036]** Similarly, although an embodiment where the base is movable with respect to a stationary main block is preferred, it is possible to choose the opposite approach, or even to make both parts movable so that, under appropriate circumstances, the productivity is increased.

**[0037]** Although the dies and the containers usually have a shape of a truncated cone with circular base, dies and containers with different shapes could be used, for example having an oval base.

**[0038]** Furthermore, the heating means which have been suggested could be replaced with other technically equivalent means; for example, it is possible to implant electrically heatable filaments within the wall of the main block.

**[0039]** In practice, the materials used and their sizes and shapes could be different, depending on requirements, provided that they are compatible with the specified purpose.

**[0040]** Finally, although for convenience the example disclosed refers to a starting product consisting of a preformed cup or "pirottino", it is also possible to start from a flat sheet, which is preliminarily or simultaneously punched to a disk.

## Claims

1. A device for the manufacture of self-sustaining cups of thin paper, comprising a matrix (2) having a frustoconical inner surface and a punch (3) of a complementary shape and coaxial to the former, the matrix and the punch being adapted to be brought together to shape an inserted sheet of said thin paper, and the matrix (2) having a cylindrical peripheral surface (20) along which a beading member (6) comprising a cylindrical foil is slidable with a close running fit, **characterized in that**
  - a shoulder (22) extends coaxially to the punch (3) to define a pit (7) having a cylindrical internal wall having a diameter, when the device is cool, which is smaller than the outside diameter of the beading member (6); and
  - heating means (16) are controllable to heat the shoulder (22) to a predetermined temperature such that the pit (7) is expanded to a diameter of close running fit between its internal wall and the beading member (6).
2. The device of claim 1, **characterized in that** the matrix (2) is supported on a base (8) through the intermediary of first elastic means (9) axially biasing the matrix to an extended position.
3. The device of claim 2, **characterized in that** the shoulder (22) is supported on a main block (5) and the punch (3) is movably supported axially with respect to said block between a withdrawn position and an extended position, whereby second elastic means (10) bias the punch (3) to its extended position and the matrix when coming in contact with the punch pushes it to its withdrawn position.
4. The device of claim 3, **characterized in that** said first elastic means (9) have a stiffness characteristic such that their resistance to compression is higher than said second elastic means (10).
5. The device of any of claims 1 to 4, **characterized in that** the matrix comprises a knockout pan (11) which is outwardly biased by third elastic means (12) having a stiffness characteristic that is lower than said first and second elastic means (9, 10).
6. The device of any of claims 2 to 5, **characterized in that** said first elastic means (9) are a compressed-air cylinder.
7. The device of any of claims 3 to 6, **characterized in that** said second elastic means (10) are a compressed-air cylinder.

8. The device of any of claims 5 to 7, **characterized in that** said third elastic means (12) are a compressed-air cylinder.
9. The device of any of claims 5 to 8, **characterized in that** said knockout pan (11) is receivable within a seat (13) in the bottom of the matrix (2).
10. The device of any of claims 3 to 9, **characterized in that** said main block (5) is stationary and said base (8) is axially movable by the action of motor means.
11. The device of claim 10, **characterized in that** said motor means are electric motors connected to means for converting a rotatory motion to an axial motion.
12. The device of claim 11, **characterized in that** said means for converting motion are linkages.

#### Patentansprüche

1. Vorrichtung zum Herstellen selbsttragender Becher aus dünnem Papier mit einer Matrize (2) mit einer kegelstumpfförmigen Innenfläche und einem Stempel (3), der eine komplementäre Form zur Matrize hat und koaxial zu dieser angeordnet ist, wobei die Matrize und der Stempel so ausgeführt sind, dass sie zusammengebracht werden können, um einen dazwischen eingeführten Bogen aus dünnem Papier zu verformen, und wobei die Matrize (2) eine zylindrische Umfangsfläche (20) hat, entlang der ein Bördelement (6) mit einer zylindrischen Folie mit engem Spielsitz gleitbar ist, **dadurch gekennzeichnet, dass**
- sich koaxial zum Stempel (3) eine Schulter (22) erstreckt, um eine Vertiefung (7) mit einer zylindrischen Innenwand zu begrenzen, deren Durchmesser bei kühler Vorrichtung kleiner ist als der Außendurchmesser des Bördelements (6); und dass
  - Heizmittel (16) zum Erwärmen der Schulter (22) auf eine vorgegebene Temperatur so steuerbar sind, dass sich die Vertiefung (7) auf einen Durchmesser mit engem Spielsitz zwischen der Innenwand und dem Bördelement (6) ausdehnt.
2. Vorrichtung nach Anspruch 1, **dadurch gekennzeichnet, dass** die Matrize (2) über erste elastische Mittel (9) auf einem Fuß (8) gelagert ist, die die Matrize in eine ausgefahrene Position axial vorspannen.
3. Vorrichtung nach Anspruch 2, **dadurch gekenn-**

**zeichnet, dass** die Schulter (22) von einem Hauptblock (5) getragen und der Stempel (3) bezüglich dieses Blocks zwischen einer eingefahrenen und einer ausgefahrenen Position axial beweglich gelagert ist, wodurch zweite elastische Mittel (10) den Stempel (3) in seine ausgefahrene Position vorspannen und die Matrize bei Kontakt mit dem Stempel ihn in seine eingefahrene Position schiebt.

4. Vorrichtung nach Anspruch 3, **dadurch gekennzeichnet, dass** die ersten elastischen Mittel (9) eine charakteristische Steifigkeit haben, so dass ihr Widerstand gegen Zusammendrücken höher ist als der der zweiten elastischen Mittel (10).
5. Vorrichtung nach einem der Ansprüche 1 bis 4, **dadurch gekennzeichnet, dass** die Matrize eine Auswerferplatte (11) aufweist, die durch dritte elastische Mittel (12) nach außen vorgespannt und deren charakteristische Steifigkeit geringer ist als die der ersten und zweiten elastischen Mittel (9, 10).
6. Vorrichtung nach einem der Ansprüche 2 bis 5, **dadurch gekennzeichnet, dass** die ersten elastischen Mittel (9) Druckluftzylinder sind.
7. Vorrichtung nach einem der Ansprüche 3 bis 6, **dadurch gekennzeichnet, dass** die zweiten elastischen Mittel (10) Druckluftzylinder sind.
8. Vorrichtung nach einem der Ansprüche 5 bis 7, **dadurch gekennzeichnet, dass** die dritten elastischen Mittel (12) Druckluftzylinder sind.
9. Vorrichtung nach einem der Ansprüche 5 bis 8, **dadurch gekennzeichnet, dass** die Auswerferplatte (11) in einem Sitz (13) im Boden der Matrize (2) aufgenommen werden kann.
10. Vorrichtung nach einem der Ansprüche 3 bis 9, **dadurch gekennzeichnet, dass** der Hauptblock (5) feststehend ist und der Fuß (8) durch die Wirkung von Motormitteln axial beweglich ist.
11. Vorrichtung nach Anspruch 10, **dadurch gekennzeichnet, dass** die Motormittel Elektromotoren sind, die mit Mitteln zum Wandeln einer Rotationsbewegung in eine lineare Bewegung verbunden sind.
12. Vorrichtung nach Anspruch 11, **dadurch gekennzeichnet, dass** die Mittel zur Bewegungswandlung Gestänge sind.

#### Revendications

1. Dispositif pour la fabrication de coupelles autopor-

- tantes de papier mince, comportant une matrice (2) ayant une surface intérieure tronconique et un poinçon (3) d'une forme complémentaire et coaxiale à celle-ci, la matrice et le poinçon étant adaptés pour être amenés ensemble afin de former une feuille insérée dudit papier mince, et la matrice (2) ayant une surface périphérique cylindrique (20) le long de laquelle un élément de formation de bourrelet (6) comportant une feuille cylindrique peut coulisser avec un agencement serré, **caractérisé en ce que**
- un épaulement (22) s'étend coaxialement au poinçon (3) pour définir une cavité (7) ayant une paroi interne cylindrique ayant un diamètre, lorsque le dispositif est froid, qui est plus petit que le diamètre extérieur de l'élément de formation de bourrelet (6), et
  - des moyens de chauffage (16) peuvent être commandés pour chauffer l'épaulement (22) jusqu'à une température prédéterminée, de telle sorte que la cavité (7) est étendue jusqu'à un diamètre d'agencement serré entre sa paroi intérieure et l'élément de formation de bourrelet (6).
2. Dispositif selon la revendication 1, **caractérisé en ce que** la matrice (2) est supportée sur une base (8) par l'intermédiaire de premiers moyens élastiques (9) rappelant la matrice axialement vers une position étendue.
3. Dispositif selon la revendication 2, **caractérisé en ce que** l'épaulement (22) est supporté sur un bloc principal (5), et le poinçon (3) est supporté de manière mobile axialement par rapport audit bloc entre une position retirée et une position étendue, de sorte que les deuxièmes moyens élastiques (10) rappellent le poinçon (3) vers sa position étendue, et la matrice, lorsqu'elle vient en contact avec le poinçon, le pousse vers sa position retirée.
4. Dispositif selon la revendication 3, **caractérisé en ce que** lesdits premiers moyens élastiques (9) ont une caractéristique de rigidité, de telle sorte que leur résistance à la compression est plus élevée que lesdits deuxièmes moyens élastiques (10).
5. Dispositif selon l'une quelconque des revendications 1 à 4, **caractérisé en ce que** la matrice comporte un bac d'éjection (11) qui est rappelé vers l'extérieur par des troisièmes moyens élastiques (12) ayant une caractéristique de rigidité qui est inférieure auxdits premiers et deuxièmes moyens élastiques (9, 10).
6. Dispositif selon l'une quelconque des revendications 2 à 5, **caractérisé en ce que** lesdits premiers moyens élastiques (9) sont un vérin à air comprimé.
7. Dispositif selon l'une quelconque des revendications 3 à 6, **caractérisé en ce que** lesdits deuxièmes moyens élastiques (10) sont un vérin à air comprimé.
8. Dispositif selon l'une quelconque des revendications 5 à 7, **caractérisé en ce que** lesdits troisièmes moyens élastiques (12) sont un vérin à air comprimé.
9. Dispositif selon l'une quelconque des revendications 5 à 8, **caractérisé en ce que** ledit bac d'éjection (11) peut être reçu dans un siège (13) situé dans le fond de la matrice (2).
10. Dispositif selon l'une quelconque des revendications 3 à 9, **caractérisé en ce que** ledit bloc principal (5) est stationnaire, et ladite base (8) est mobile axialement par l'intermédiaire de l'action de moyens formant moteur.
11. Dispositif selon la revendication 10, **caractérisé en ce que** lesdits moyens formant moteur sont des moteurs électriques connectés à des moyens pour transformer un mouvement rotatif en un mouvement axial.
12. Dispositif selon la revendication 11, **caractérisé en ce que** lesdits moyens pour transformer un mouvement sont des biellettes.

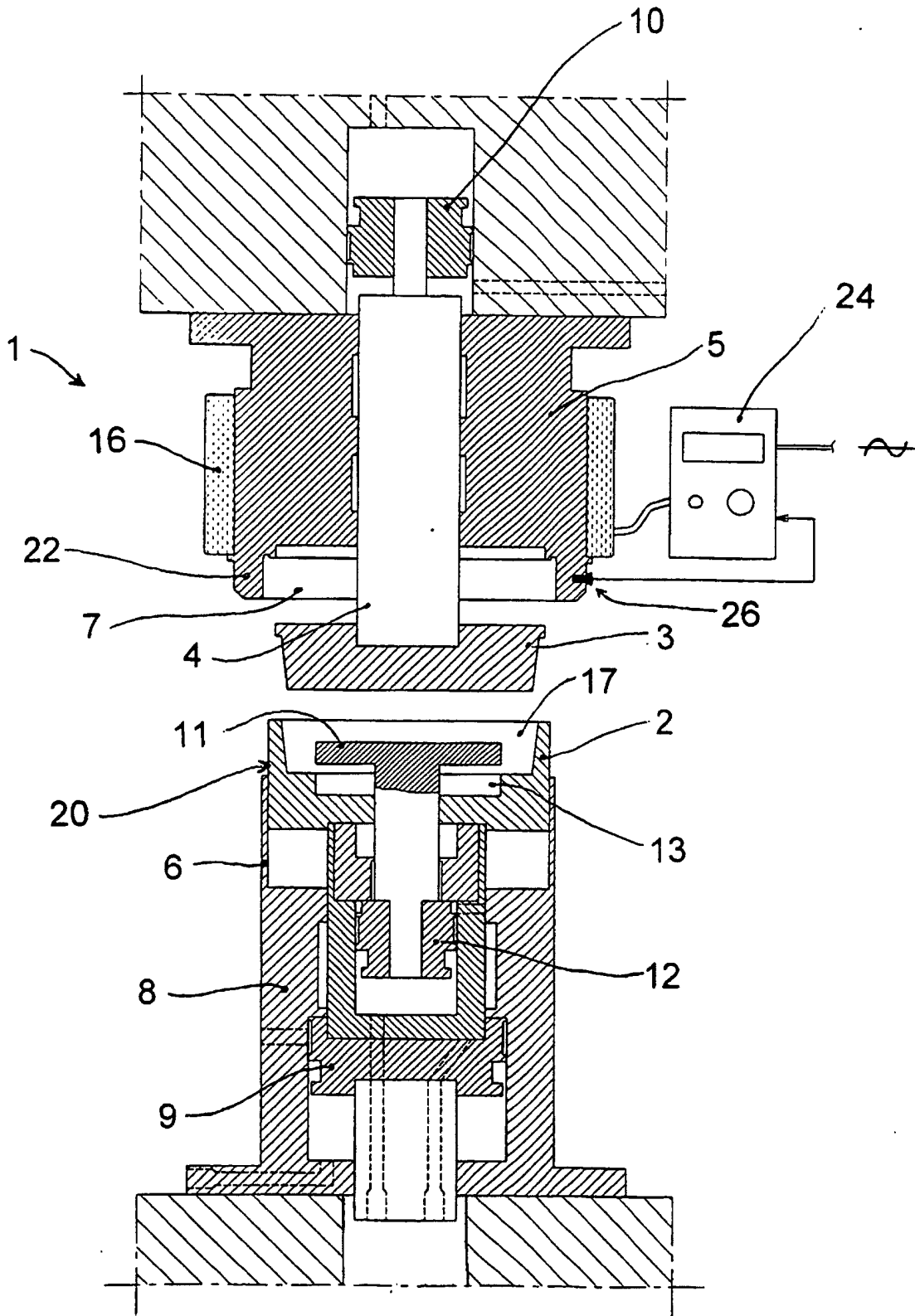


Fig.1

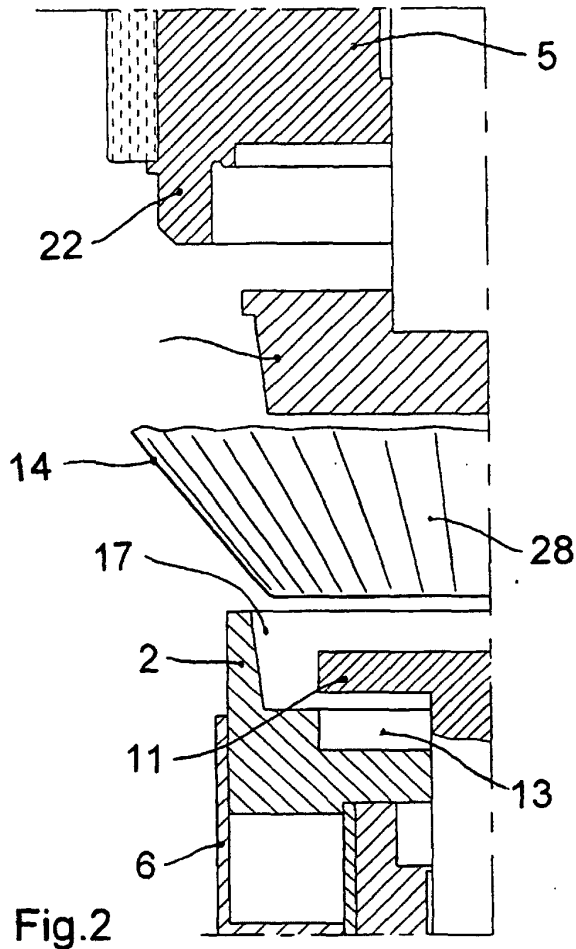


Fig.2

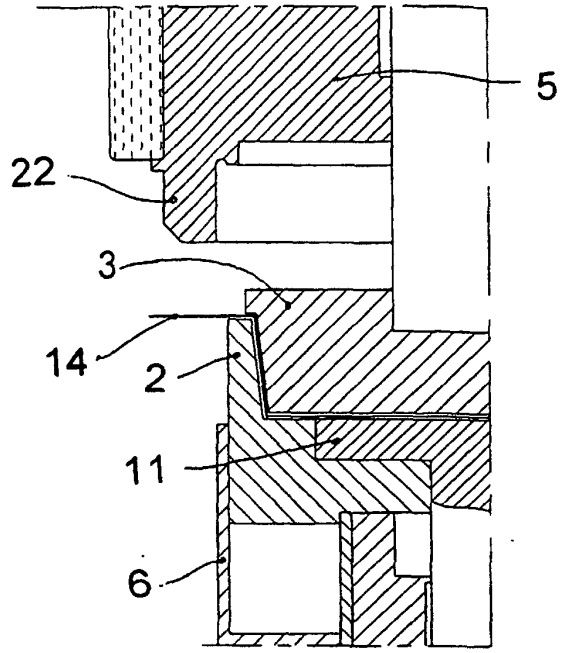


Fig.3

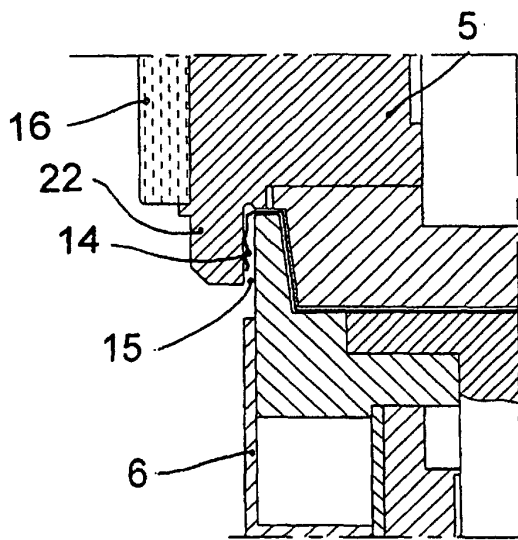


Fig.4

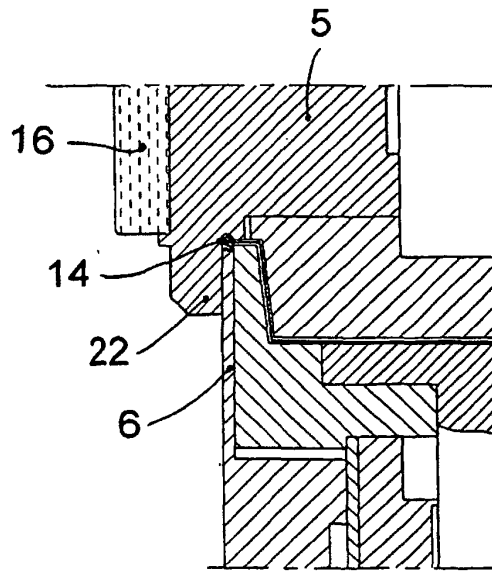


Fig.5



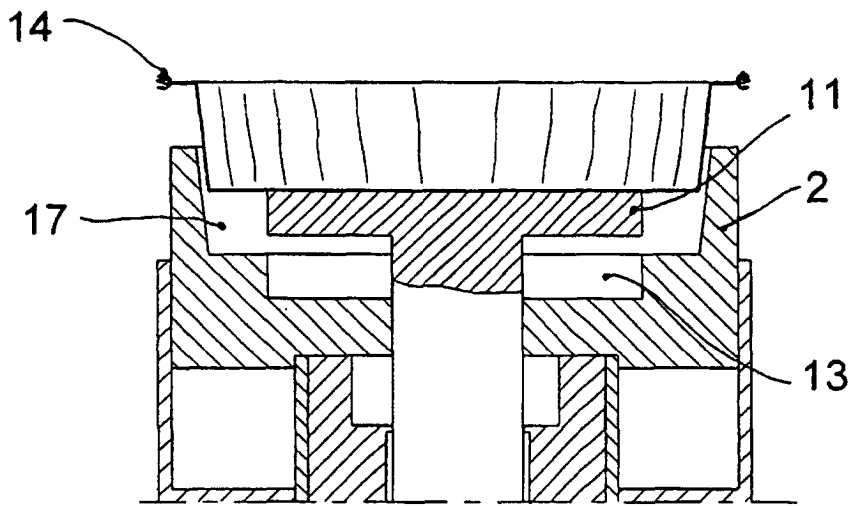
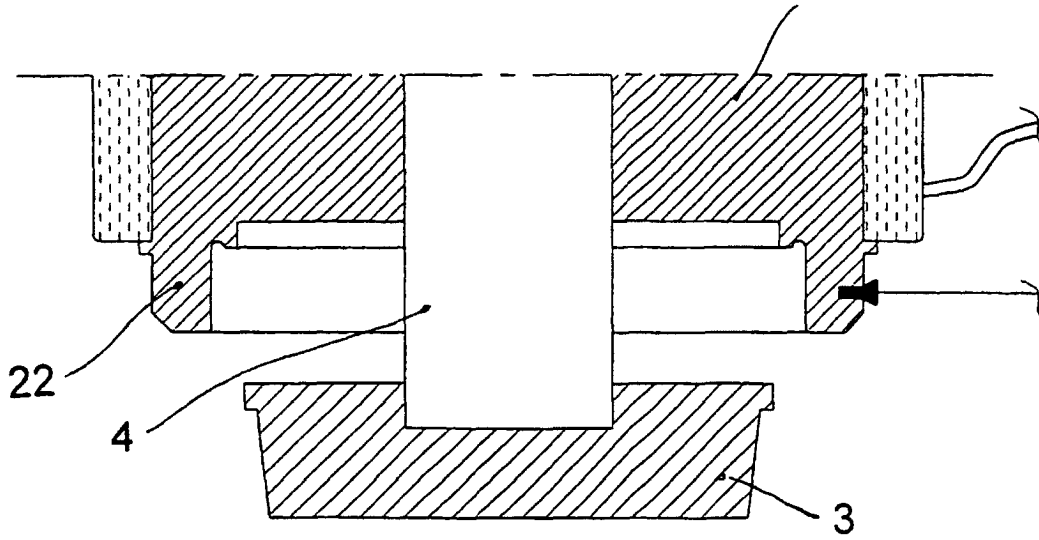


Fig.6

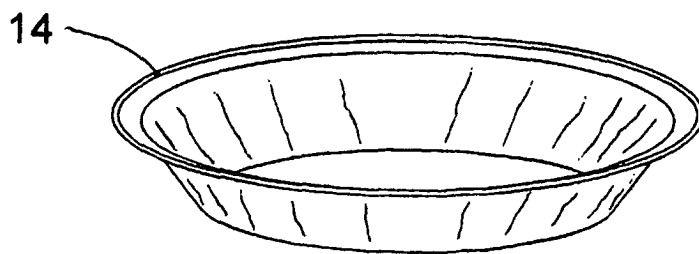


Fig.7