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(54) **METHOD AND APPARATUS FOR PACKAGING A PRODUCT IN A PACKAGE WITH TRAY AND SLEEVE**

VERFAHREN UND VORRICHTUNG ZUM VERPACKEN EINES PRODUKTS IN EINE VERPACKUNG MIT SCHALE UND HÜLLE

PROCEDE ET DISPOSITIF POUR EMBALLER UN PRODUIT DANS UN EMBALLAGE A BARQUETTE ET ENVELOPPE

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US-A- 4 221 320 **US-A- 6 092 664**
US-B1- 6 183 790

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Description

[0001] This invention relates to a packaging system and in particular to a method of packaging prepared food.

BACKGROUND TO THE INVENTION

[0002] It is known from the prior art for prepared meals ("ready meals") to be packaged in a plastics tray with a covering membrane of transparent plastics. The covering membrane is sealed to the plastics tray, for example with an adhesive. The sealed tray is generally enclosed in a cardboard sleeve on which the details of the contents and instructions for preparation are printed. Figure 1 depicts such a conventional food tray arrangement comprising a conventional food tray 1 made from an appropriate plastics material, which after filling with product 3 is covered and sealed with a suitable plastic film 2. A cardboard outer cover 4 is slid over the sealed tray to provide the outer covering. Such an arrangement is disclosed in 4 221 320 A.

[0003] There are a number of problems with such packaging arrangements. Firstly, as the overall package is made up of at least two different materials, the recycling of the packaging is relatively complicated.

[0004] Secondly, it is desirable for the customer to be able to see the product they are buying through the transparent membrane and customers will often slide aside the cardboard sleeve to view the product. While the cardboard outer sleeve could be provided with a window, or an aperture could be cut in the sleeve to provide viewing of the contents, this adds to the cost of production. The cardboard outer is itself relatively expensive and it is an expensive process by which it is fitted to the food tray, usually involving manual labour. Printing of product specific data such as date and batch number is typically carried out before the cardboard sleeve is brought to the food tray for fitting, which can result in errors and waste.

[0005] Finally, the cardboard outer is easily removed in the supermarket or any store, and the enclosed plastic tray with its transparent cover can be inserted into the cardboard outer of a lower cost product which has the same physical dimensions, in order to defraud the retailer. If this is not noticed at the check-out, a lower price will be paid than the product should command. There is also the risk that important food allergy information that appears on the cardboard sleeve may not be available to the customer if the cardboard sleeve is removed or substituted, which could be potentially life-threatening.

[0006] The present invention at least in its presently preferred embodiments seeks to address at least some of these problems. US 6,092,664, EP 619244 and GB 2323836 each disclose further prior art packaging containers.

SUMMARY OF THE INVENTION

[0007] The present invention provides a method for packaging a product according to claim 1. The method of the invention provides a package for a product, such as pre-prepared food. The package comprises a plastics tray for containing the product. The tray is sealed by a transparent plastics membrane. A plastics sleeve encloses the tray. The plastics sleeve covers the plastics membrane substantially completely in the assembled package.

[0008] The package made according to the method of the invention has the advantage that it can be made less expensive, more recyclable and with enhanced visibility of the contained product than for existing packaging.

[0009] The product to be packaged may be a pre-prepared food product, such as a "ready meal". However, the packaging of the invention may be applied to a wide range of products, including cosmetics or paint, for example.

[0010] The plastics sleeve may be, at least partially, transparent. In this way, the plastics sleeve can allow the customer to view the content of the package, for example through a window defined in the sleeve. The plastics sleeve may be printed. Typically, the printing on the plastics sleeve will obscure some of the product that would otherwise be visible through the transparent membrane.

[0011] Typically, the plastics sleeve is formed as a loop of plastics film material joined at its two ends. The amount of the overlap between the two ends may be selected according to the desired characteristics of the package.

[0012] Conveniently, the ends of the loop of plastics sheet material may be ultrasonically bonded together. Alternatively, other bonding methods may be used, such as adhesive bonding or heat sealing. However, ultrasonic bonding is preferred as it is quick and has only a minimal effect on the appearance of the film.

[0013] Typically, the tray may be generally rectangular in plan, but this is not intended to be restrictive. For example, the tray may be circular, hemispherical or generally bowl-shaped. In the presently preferred embodiment, the tray is of plastics material, as this facilitates recyclability. However, the tray may be formed of other material, such as metal foil, molded paper pulp or cardboard.

[0014] Typically, the mandrel will be approximately the same size and shape as the tray in order that the plastics sleeve is a good fit around the tray.

[0015] The step of forming the plastics sleeve about the mandrel may comprise wrapping a film of plastics material around the mandrel and bonding the film material to itself. The bonding step may involve ultrasonic bonding of the film material to itself. Conveniently, the plastics film may be provided on a continuous roll.

[0016] In embodiments of the invention, the step of wrapping the film around the mandrel may include rotating the mandrel relative to the film to wind the film around the mandrel. Conveniently, the plastics sleeve may be held on the mandrel during forming by a vacuum system.

Similarly, the plastics sleeve may be removed from the mandrel during forming by a vacuum system.

[0017] Advantageously, removing the plastics sleeve from the mandrel and sliding the plastics sleeve onto the sealed tray may include transferring the plastics sleeve directly from the mandrel to the sealed tray.

[0018] The invention further provides a packaging machine as defined in claim 10.

BRIEF DESCRIPTION OF THE DRAWINGS

[0019] Embodiments of the invention are further described by way of example only hereinafter with reference to the accompanying drawings, in which:

Figure 1 is a schematic view of a food tray arrangement according to the prior art;

Figure 2 is a schematic view of a food tray arrangement made according to an embodiment of the invention;

Figure 3 is a schematic plan view of a packaging line in accordance with the present invention;

Figure 4 is a schematic representation of a mandrel for use in a method according to the invention;

Figures 5, 6 and 7 are schematic representations of the mandrel of Figure 4 in use; and

Figure 8 is a schematic representation of the transfer of a plastics sleeve from the mandrel of Figure 4 to a food tray in accordance with the invention.

DETAILED DESCRIPTION

[0020] Figure 2 depicts a packaging product made according to an embodiment of the present invention. The product comprises a food tray 1 made from an appropriate plastics material. The food tray 1 is filled with a food product 3 and covered and sealed with a suitable plastic film 2. A complete loop of a further plastic film 5 with a joint 6 to form the loop is slid over the sealed food tray 1 to provide the outer covering.

[0021] The packaging product made according to the present invention provides a means by which the packaging for prepared meals and similar products can be constructed from materials which can be recycled together. The outer plastic sleeve 5 is also much cheaper to apply than a cardboard sleeve and can provide sight of the product contents via a window, if a transparent plastics film is used. The security of the overall product is also enhanced because such an outer sleeve 5 is much more difficult to remove and to replace as it collapses and loses its shape when removed from the inner tray 1.

[0022] As a feedstock, the process according to an embodiment of the invention uses a supply of plastic trays 1 of the requisite size, complete with contents 3 and sealed with a plastic film 2 in the conventional way. The plastics film 2 may be sealed to the tray by ultrasonic welding.

[0023] Figure 3 depicts the overall machine arrange-

ment according to an embodiment of the present invention. In Figure 3 a conveyor arrangement 7 brings filled sealed food trays 1 in readiness for the outer sleeve 5 to be applied. The food tray 1 which is ready for the outer sleeve 5 to be applied is manoeuvred into position opposite a mandrel 8 on which the continuous printed film 9 is wound to form a complete loop. After jointing, the loop which forms the outer sleeve 5 is slid onto the waiting food tray 1, which is then manoeuvred to the exit conveyor 10 to join food trays which have already had the outer sleeve 5 applied. Printing, date stamping and data logging can occur at this point prior to the completed product being taken away for bulk packing and distribution. The application of product specific data by printing at this point removes the possibility of incorrect marking, and reduces waste. However, the bulk of branding and generic product information will have been pre-printed on the continuous film material which is supplied to the mandrel 8.

[0024] Figure 4 depicts the mandrel 8 which has appropriate dimensions for the food tray 1 to be covered, and is mounted on a rotational shaft 11. The mandrel 8 is secured to the shaft 11 at one end, so that the mandrel 8 can rotate about the axis of the shaft 11, which is generally aligned with the longer dimension of the plastic tray 1 (where the plastic tray is rectangular). A plastic tray 1, filled with product and sealed, is aligned with the axis of rotation of the mandrel 8.

[0025] A plastics film 9, printed to suit the packaging requirements for the product is fed in continuous form in a direction perpendicular to the rotation shaft. A retaining mechanism 12, 13 is provided such that the leading edge of the film 9 can be secured to the mandrel 8. The continuous film 9 may be similar or even identical to the film 2 which is used to cover and seal the tray 1. In the presently preferred example, the plastics film 9 is 48 micron clear oriented polypropylene (OPP) film. However, the film thickness may range from 20 to 100 microns.

[0026] Figure 5 shows the mandrel 8 onto which the continuous film 9 is fed. The film 9 is retained in place by a vacuum system 12 which applies a partial vacuum along the length of the leading edge of the film 9 by way of a number of apertures 13 such that the film is retained in position while the mandrel 8 is rotated by the rotational shaft 11 so that a complete loop of film is formed around the mandrel 8.

[0027] The mandrel 8 is rotated about its axis of rotation, such as to completely wrap the mandrel 8 in the film 9. The film 9 is marked with an indexing point which is typically identified by optical means. The indexing point ensures that when the film 9 is wrapped around the mandrel 8, the printing on the film and any viewing window are correctly located relative to their final position on the tray 1. In this way, when the film is transferred to the food containing tray 1 from the mandrel 8, the printing and window are correctly positioned for illustrating the product and viewing the contents 3.

[0028] Figure 6 shows the mandrel 8 with a complete

turn of film 9 around it. The base plate 14 of an ultrasonic horn 15 is fitted to the mandrel 8 so that it is inside the loop of film 5. The ultrasonic horn 15 is moved to make contact with the loop of film 5 and by the application of ultrasonic energy a joint is formed in the film so that it becomes a permanent continuous loop. At the same time a cutter blade 16 cuts the film at the feed point so that the continuous loop remains on the mandrel 8. Thus, the ultrasonic horn 15 moves up to the film 9 which is resting on a base blade 14. The ultrasonic horn 15 and the base blade 14 coming together forms an ultrasonic weld 6 so that the film forms a complete loop 5. As the horn 15 is withdrawn, the blade 16 cuts the film 9 so that a complete bonded turn of film 5 is left on the mandrel and the surplus film is withdrawn ready for the next time that it is required. The film clamping mechanism 12, 13 is then released.

[0029] Figure 7 depicts a vacuum arrangement 17 whereby a partial vacuum is applied through a series of apertures 18 to the top and the two side leading edges of the film loop 5, which is in a continuous loop around the mandrel 8. The set of vacuum devices 17 is presented to the film wrapping of the mandrel 8 along the upper and two sides, at the end of the mandrel furthest from the rotation shaft 11, and nearest to the tray 1 filled with product. Mandrel 8 is aligned in the same orientation as the food tray 1. The arm 17 positions itself over the mandrel 8 and collects the sleeve 5. Application of a partial vacuum pulls the film 5 clear of the surfaces of the mandrel 8 such that when the vacuum device 17 is moved in the direction of the food tray 1, the film 5 slides along the mandrel 8 and on to the food tray 1, in such a manner that the food tray 1 is enclosed, and the orientation of the film loop 5 on the tray is maintained.

[0030] Figure 8 depicts the continuous loop of film 5 sliding from the mandrel 8 on to the food tray 1 to complete the product.

[0031] In summary, a package for pre-prepared food comprises a plastics tray 1 for containing a pre-prepared food product 3. The tray 1 is sealed by a transparent plastics membrane 2. A plastics sleeve 5 encloses the tray 1. The plastics sleeve 5 covers the plastics membrane 2 substantially completely in the assembled package.

[0032] A method for packaging pre-prepared food comprises: providing a plastics tray 1 for containing a pre-prepared food product 3, the tray being sealed by a transparent plastics membrane 2; forming a plastics sleeve 5 about a mandrel 8; removing the plastics sleeve 5 from the mandrel 8; and sliding the plastics sleeve 5 onto the sealed plastics tray 1.

[0033] The package is more recyclable and less expensive than know equivalent packaging.

[0034] Throughout the description and claims of this specification, the words "comprise" and "contain" and variations of them mean "including but not limited to", and they are not intended to (and do not) exclude other components, integers or steps. Throughout the description and claims of this specification, the singular encom-

passes the plural unless the context otherwise requires. In particular, where the indefinite article is used, the specification is to be understood as contemplating plurality as well as singularity, unless the context requires otherwise.

Claims

1. A method for packaging a product (3), the method comprising:

providing a tray (1) containing the product (3), the tray (1) being sealed by a transparent plastics membrane (2),

forming a plastics sleeve (5) about a mandrel (8), removing the plastics sleeve (5) from the mandrel (8); and

sliding the plastics sleeve (5) onto the sealed tray (1).

2. A method as claimed in claim 1, wherein the step of forming the plastics sleeve (5) about the mandrel (8) comprises wrapping a film of plastics material around the mandrel (8) and bonding the film material to itself.

3. A method as claimed in claim 2, wherein the bonding step involves ultrasonic bonding of the film material to itself.

4. A method as claimed in claim 2 or 3, wherein the plastics film is provided on a continuous roll.

5. A method as claimed in claim 4, wherein the plastics sleeve is cut from the continuous roll after the bonding step.

6. A method as claimed in any of claims 2 to 5, wherein the step of wrapping the film around the mandrel (8) includes rotating the mandrel (8) relative to the film to wind the film around the mandrel (8).

7. A method as claimed in any preceding claim, wherein the plastics sleeve (5) is held on the mandrel (8) during forming by a vacuum system.

8. A method as claimed in any preceding claim, wherein the plastics sleeve (5) is removed from the mandrel (8) after forming by a vacuum system.

9. A method as claimed in any preceding claim, wherein removing the plastics sleeve (5) from the mandrel (8) and sliding the plastics sleeve (5) onto the sealed tray (1) includes transferring the plastics sleeve directly from the mandrel (8) to the sealed tray (1).

10. A packaging machine comprising:

a mandrel (8);

- means for providing a tray (1) containing a product (3), the tray (1) being sealed by a transparent plastics membrane (2);
 means for forming a plastics sleeve (5) about the mandrel (8);
 means for removing the plastics sleeve (5) from the mandrel (8); and
 means for sliding the plastics sleeve (5) onto the sealed tray (1)
11. A packaging machine as claimed in claim 10, wherein the means for forming the plastics sleeve (5) about the mandrel (8) comprises means for wrapping a film of plastics material around the mandrel (8) and means for bonding the film material to itself.
12. A packaging machine as claimed in claim 11, wherein the bonding means comprises means for ultrasonic bonding of the film material to itself.
13. A packaging machine as claimed in claim 11 or 12, wherein the plastics film is provided on a continuous roll.
14. A packaging machine as claimed in claim 13 comprising means for cutting the plastics sleeve from the continuous roll after bonding.
15. A packaging machine as claimed in any of claims 11 to 14, wherein the means for wrapping the film around the mandrel (8) includes means for rotating the mandrel (8) relative to the film to wind the film around the mandrel (8).
16. A packaging machine as claimed in any of claims 10 to 15 comprising a vacuum system arranged to hold the plastics sleeve (5) on the mandrel (8) during forming.
17. A packaging machine as claimed in any of claims 10 to 16 comprising a vacuum system arranged to remove the plastics sleeve (5) from the mandrel (8) after forming.
18. A packaging machine as claimed in any of claims 10 to 17, wherein the means for removing the plastics sleeve (5) from the mandrel (8) and the means for sliding the plastics sleeve (5) onto the sealed tray (1) are arranged to transfer the plastics sleeve directly from the mandrel (8) to the sealed tray (1).
- Produkt (3) enthält, wobei die Schale (1) durch eine transparente Kunststoffmembran (2) verschlossen ist;
 das Ausbilden einer Kunststoffhülle (5) um einen Dorn (8);
 das Entfernen der Kunststoffhülle (5) von dem Dorn (8); und
 das Schieben der Kunststoffhülle (5) auf die verschlossene Schale (1).
2. Verfahren nach Anspruch 1, wobei der Schritt des Ausbildens der Kunststoffhülle (5) um den Dorn (8) das Wickeln eines Plastikfolienmaterials um den Dorn (8) und das Bonden des Folienmaterials an sich selbst umfasst.
3. Verfahren nach Anspruch 2, wobei der Schritt des Verbindens das Ultraschall-Bonden des Folienmaterials an sich selbst umfasst.
4. Verfahren nach Anspruch 2 oder 3, wobei die Plastikfolie auf einer Endlosrolle bereitgestellt wird.
5. Verfahren nach Anspruch 4, wobei die Kunststoffhülle nach dem Schritt des Bondens von der Endlosrolle geschnitten wird.
6. Verfahren nach einem der Ansprüche 2 bis 5, wobei der Schritt des Wickelns der Folie um den Dorn (8) das Drehen des Dorns (8) im Verhältnis zu der Folie umfasst, so dass die Folie um den Dorn (8) gewickelt wird.
7. Verfahren nach einem der vorstehenden Ansprüche, wobei die Kunststoffhülle (5) während dem Formen durch ein Vakuumsystem an dem Dorn (8) gehalten wird.
8. Verfahren nach einem der vorstehenden Ansprüche, wobei die Kunststoffhülle (5) nach dem Formen durch ein Vakuumsystem von dem Dorn (8) entfernt wird.
9. Verfahren nach einem der vorstehenden Ansprüche, wobei das Entfernen der Kunststoffhülle (5) von dem Dorn (8) und das Schieben der Kunststoffhülle (5) auf die verschlossene Schale (1) das direkte Übertragen der Kunststoffhülle von dem Dorn (8) auf die verschlossene Schale (1) aufweist.
10. Verpackungsmaschine, die folgendes umfasst:

Patentansprüche

1. Verfahren zum Verpacken eines Produkts (3), wobei das Verfahren folgendes umfasst:
- das Bereitstellen einer Schale (1), welche das
- einen Dorn (8);
 Mittel zum Bereitstellen einer Schale (1), die ein Produkt (3) enthält, wobei die Schale (1) durch eine transparente Kunststoffmembran (2) verschlossen wird;
 Mittel zum Ausbilden einer Kunststoffhülle (5)

- um den Dorn (8);
Mittel zum Entfernen der Kunststoffhülle (5) von dem Dorn (8); und
Mittel zum Schieben der Kunststoffhülle (5) auf die verschlossene Schale (1). 5
11. Verpackungsmaschine nach Anspruch 10, wobei die Mittel zum Ausbilden der Kunststoffhülle (5) um den Dorn (8) Mittel zum Wickeln einer Folie aus einem Plastikmaterial um den Dorn (8) sowie Mittel zum Bonden des Folienmaterials an sich selbst umfassen. 10
12. Verpackungsmaschine nach Anspruch 11, wobei die Mittel zum Bonden Mittel zum Ultraschall-Bonden des Folienmaterials an sich selbst umfassen. 15
13. Verpackungsmaschine nach Anspruch 11 oder 12, wobei die Plastikfolie auf einer Endlosrolle bereitgestellt wird. 20
14. Verpackungsmaschine nach Anspruch 13, die Mittel umfasst, um die Kunststoffhülle nach dem Bonden von der Endlosrolle zu schneiden. 25
15. Verpackungsmaschine nach einem der Ansprüche 11 bis 14, wobei die Mittel zum Wickeln der Folie um den Dorn (8) Mittel zum Drehen des Dorns (8) im Verhältnis zu der Folie umfassen, um die Folie um den Dorn (8) zu wickeln. 30
16. Verpackungsmaschine nach einem der Ansprüche 10 bis 15, wobei diese ein Vakuumsystem umfasst, das so angeordnet ist, dass es die Kunststoffhülle (5) während dem Ausbilden an dem Dorn (8) hält. 35
17. Verpackungsmaschine nach einem der Ansprüche 10 bis 16, wobei diese ein Vakuumsystem umfasst, das so angeordnet ist, dass es die Kunststoffhülle (5) nach dem Ausbilden von dem Dorn (8) entfernt. 40
18. Verpackungsmaschine nach einem der Ansprüche 10 bis 17, wobei die Mittel zum Entfernen der Kunststoffhülle (5) von dem Dorn (8) und die Mittel zum Schieben der Kunststoffhülle (5) auf die verschlossene Schale (1) so angeordnet sind, dass sie die Kunststoffhülle direkt von dem Dorn (8) auf die verschlossene Schale (1) übertragen. 45
- Revendications**
1. Procédé de conditionnement d'un produit, le procédé comprenant les étapes consistant à : 50
- fournir une barquette (1) contenant le produit (3), la barquette (1) étant fermée hermétiquement par une membrane plastique transparente 55
- (2),
former un manchon en plastique (5) autour d'un mandrin (8),
retirer le manchon en plastique (5) du mandrin (8) ; et
faire coulisser le manchon en plastique (5) sur la barquette (1) fermée hermétiquement.
2. Procédé selon la revendication 1, dans lequel la formation du manchon en plastique (5) autour du mandrin (8) comprend les étapes consistant à entourer un film en matière plastique autour du mandrin (8) et à fixer la matière du film sur elle-même.
3. Procédé selon la revendication 2, dans lequel la fixation comprend l'étape consistant à fixer par ultrasons la matière du film sur elle-même.
4. Procédé selon la revendication 2 ou 3, dans lequel le film plastique est fourni sur un rouleau continu.
5. Procédé selon la revendication 4, dans lequel le manchon en plastique est découpé du rouleau continu après la fixation.
6. Procédé selon l'une quelconque des revendications 2 à 5, dans lequel l'enroulement du film autour du mandrin (8) comprend l'étape consistant à faire tourner le mandrin (8) par rapport au film pour enrouler le film autour du mandrin (8).
7. Procédé selon l'une quelconque des revendications précédentes, dans lequel le manchon en plastique (5) est maintenu sur le mandrin (8) pendant la formation par un système à vide.
8. Procédé selon l'une quelconque des revendications précédentes, dans lequel le manchon en plastique (5) est retiré du mandrin (8) après la formation par un système à vide.
9. Procédé selon l'une quelconque des revendications précédentes, dans lequel le retrait du manchon en plastique (5) du mandrin (8) et le coulisser du manchon en plastique (5) sur la barquette (1) fermée hermétiquement comprend l'étape consistant à transférer le manchon en plastique directement du mandrin (8) à la barquette (1) fermée hermétiquement.
10. Machine de conditionnement (300), comprenant :
- un mandrin (8) ;
des moyens pour fournir une barquette (1) contenant un produit (3), la barquette (1) étant fermée hermétiquement par une membrane plastique transparente (2) ;
des moyens pour former un manchon en plas-

- tique (5) autour du mandrin (8) ;
des moyens pour retirer le manchon en plastique (5) du mandrin (8) ; et
des moyens pour faire coulisser le manchon en plastique (5) sur la barquette (1) fermée hermétiquement. 5
- 11.** Machine de conditionnement selon la revendication 10, dans laquelle les moyens pour former le manchon en plastique (5) autour du mandrin (8) comprennent des moyens pour enrouler un film en matière plastique autour du mandrin (8) et des moyens pour fixer la matière du film sur elle-même. 10
- 12.** Machine de conditionnement selon la revendication 11, dans laquelle les moyens de fixation comprennent des moyens pour la fixation par ultrasons de la matière du film sur elle-même. 15
- 13.** Machine de conditionnement selon la revendication 11 ou 12, dans laquelle le film plastique est fourni sur un rouleau continu. 20
- 14.** Machine de conditionnement selon la revendication 13, comprenant des moyens pour couper le manchon en plastique du rouleau continu après la fixation. 25
- 15.** Machine de conditionnement selon l'une quelconque des revendications 11 à 14, dans laquelle les moyens pour enrouler le film autour du mandrin (8) comprennent des moyens pour faire tourner le mandrin (8) par rapport au film pour enrouler le film autour du mandrin (8). 30
- 35
- 16.** Machine de conditionnement selon l'une quelconque des revendications 10 à 15, comprenant un système à vide conçu pour maintenir le manchon en plastique (5) sur le mandrin (8) pendant la formation. 40
- 17.** Machine de conditionnement selon l'une quelconque des revendications 10 à 16, comprenant un système à vide conçu pour retirer le manchon en plastique (5) du mandrin (8) après la formation. 45
- 18.** Machine de conditionnement selon l'une quelconque des revendications 10 à 17, dans laquelle les moyens pour retirer le manchon en plastique (5) du mandrin (8) et les moyens pour faire coulisser le manchon en plastique (5) sur la barquette (1) fermée hermétiquement sont conçus pour transférer le manchon en plastique directement du mandrin (8) à la barquette (1) fermée hermétiquement. 50
- 55

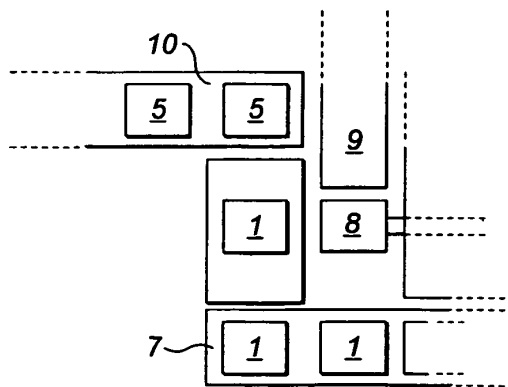
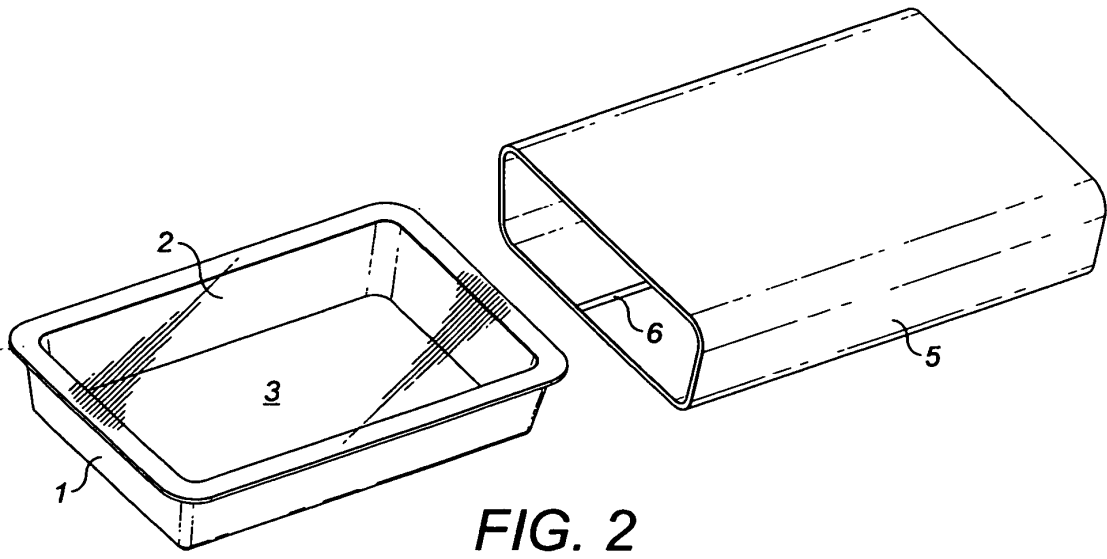
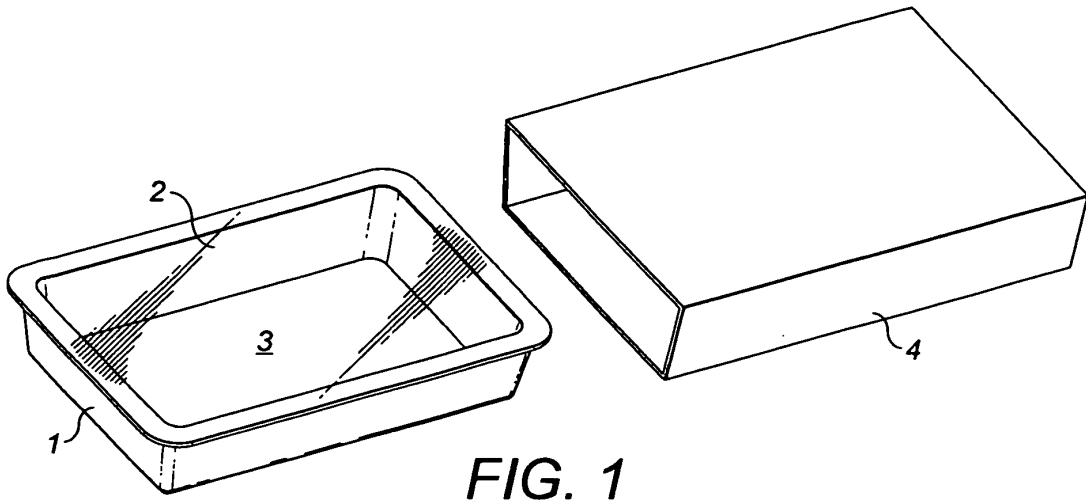


FIG. 3

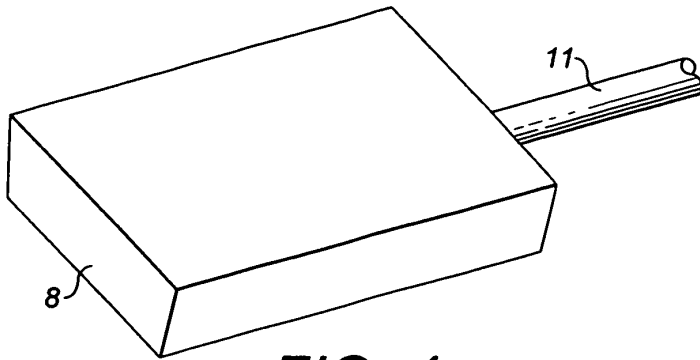


FIG. 4

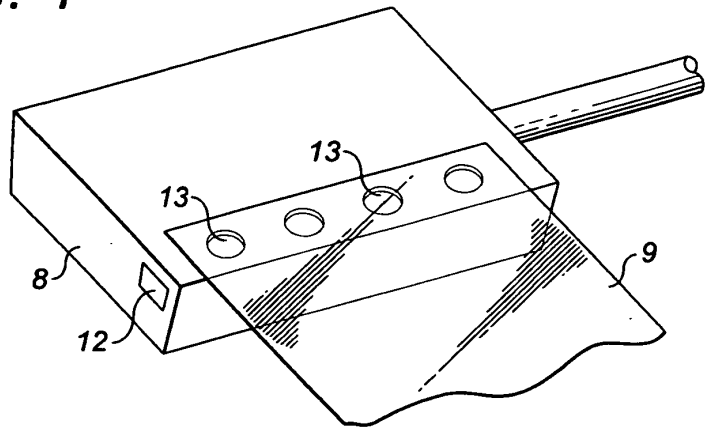


FIG. 5

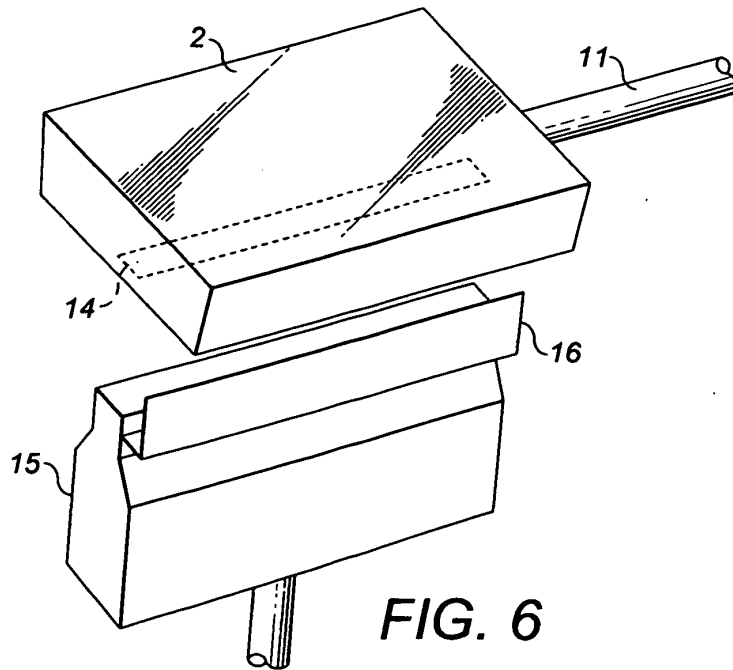


FIG. 6

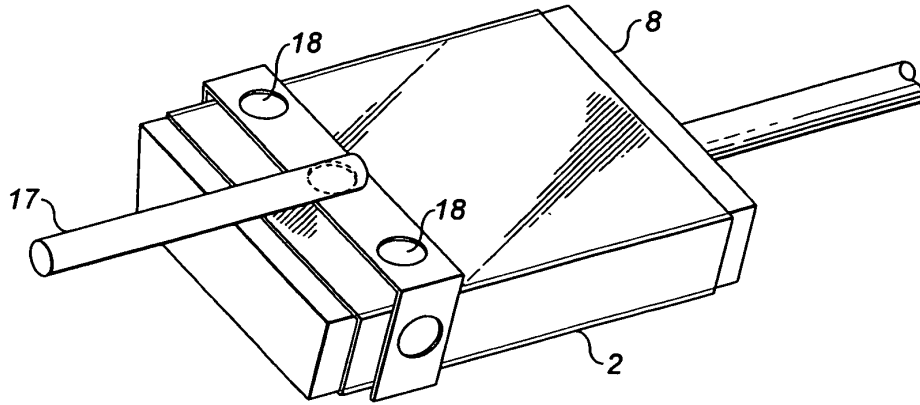


FIG. 7

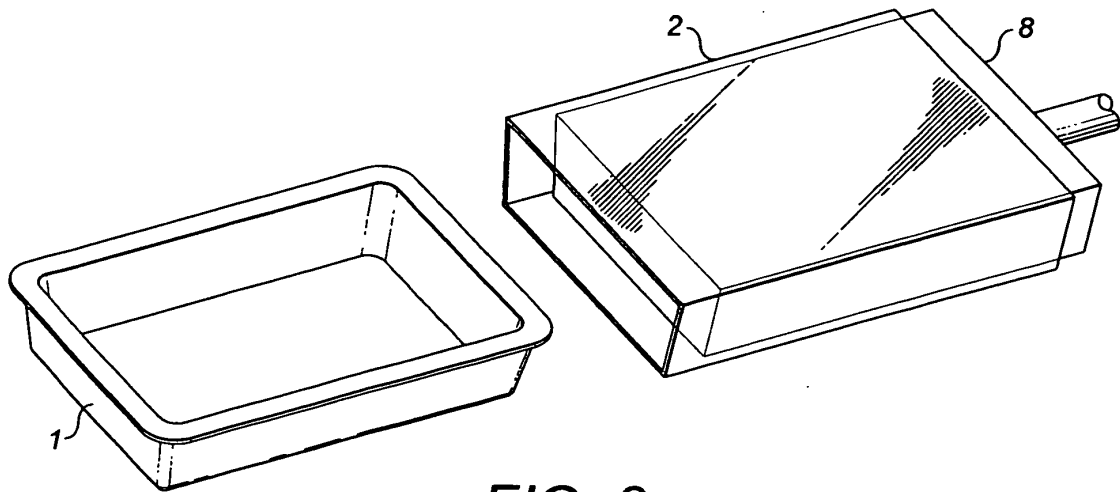


FIG. 8

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

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