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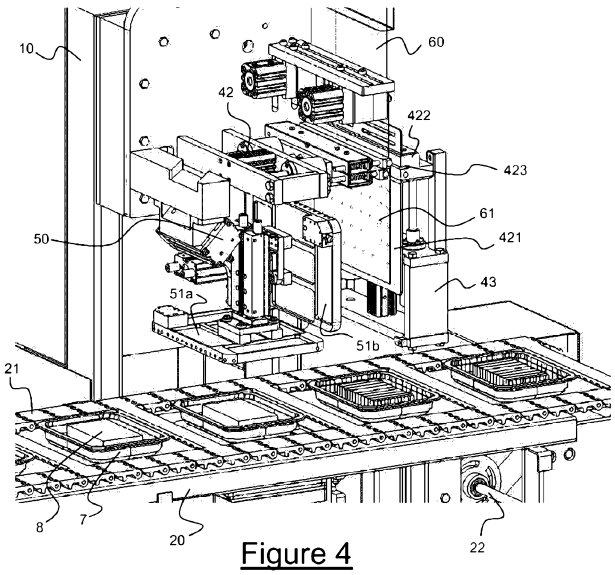

Figure 4

(57) **Abstract**: It is disclosed a machine (1) for vacuum skin packaging a product arranged on a support (7). The support has a sidewall with at least one hole (70). The machine comprises a first film transfer plate (51a) configured for holding a film sheet (61), heating the film sheet, bringing the film sheet to a position above the support with the product arranged thereon and air tightly fixing the film sheet to the support. The machine also comprises a vacuum arrangement (9) for removing air from within the support underneath the film sheet through the at least one hole. The first film transfer plate is configured to release the film sheet thereby allowing the film sheet to be drawn into the support while the vacuum arrangement is removing air from within the support.

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VACUUM SKIN PACKAGING OF A PRODUCT ARRANGED ON A SUPPORT

Technical field

The present invention generally relates to vacuum skin packaging of products. In particular, the present invention relates to a machine and a method for vacuum skin packaging of a product arranged on a support.

Background art

Vacuum packaging is a well known process for packaging a wide variety of products, in particular food products.

Among the known vacuum packaging processes, vacuum skin packaging is commonly employed for packaging food products such as fresh and frozen meat and fish, cheese, processed meat, ready meals and the like. Vacuum skin packaging is described for instance in FR 1 258 357, FR 1 286 018, AU 3 491 504, US RE 30 009, US 3 574 642, US 3 681 092, US 3 713 849, US 4 055 672, and US 5 346 735.

Vacuum skin packaging is basically a thermoforming process. In particular, the product is typically placed on a rigid or semi-rigid support (such as a tray, a bowl or a cup). The support with the product placed thereon is put in a vacuum chamber, where a film of thermoplastic material, held by vacuum in a position above the product placed on the support, is heated to soften it. The space between the support and the film is then evacuated and finally vacuum above the film is released to cause the film to drape down all around the product and seal to the surface of the support not covered by the product, thus forming a tight skin around the product and on the support.

US 2007/0022717 discloses a machine for gastight packaging an object using a film material. The machine has a lower tool for supporting two trays and an upper tool having cutting devices and facing the lower tool. A film is interposed between the upper tool and the lower tool. The film is firstly cut to the size of the peripheral rims of the trays, and is applied subsequently and/or simultaneously to the peripheral rim in a gastight manner. A vacuum is situated in the surrounding region of the tray to cause deep-drawing of the

film in response to the formation of a pressure drop.

US 2005/0257501 discloses a machine for packaging a product arranged in a tray. The machine has a lower tool for supporting the tray and an upper tool with a cutting device. During operation, the film is clamped along an edge surrounding the tray and is deformed by the upper tool in a direction extending away the product. The space surrounding the product is then evacuated, the film and the edge of the tray are sealed and the film is then cut by the cutting device.

US 3481101 discloses a method for making skin packages using a support provided with a plurality of apertures in a lip thereof. According to this method, after the tray is filled, a heated cover film is draped upon the tray and vacuum is applied so that the air within the package is drawn from the package and the film is drawn into heat sealing condition with the tray to form a hermetic seal of the cover to the tray lip. Additional apertures may be provided in the upper sidewalls of the tray whereupon the heated film is not only drawn into sealing contact with the lip of the tray, but also is drawn down partially into the cavity.

EP 320294 discloses a skin packaging method wherein a product loaded tray provided with a vent in its sidewall is placed on a vacuum platen, an excess of the thermoplastic film is held over the tray by a frame and heated until it starts to sag over the product, then vacuum is applied from below the tray to pull the film to conform to the surface of the product and over and around the rim of the tray in a thermally set crimp seal. The excess film is then trimmed.

Summary of the invention

The Applicant has noticed that the above known solutions for vacuum skin packaging have some drawbacks.

As to the machines disclosed by US 2007/0022717 and US 2005/0257501, the film is cut to the size of the support within the chamber formed by the upper tool and the lower tool, by means of the cutting devices provided on the upper tool.

First of all, this disadvantageously requires providing a rather complex and bulky upper tool, comprising means for holding the film above the product loaded supports positioned within the vacuum chamber.

Besides, this disadvantageously requires providing an excess film with respect to the size of the support, which excess film is cut from the package and scrapped during or at the end of the packaging process. Indeed, the film is in the form of a continuous sheet wound on a roll (as shown e.g. in Figure 3 of US 2005/0257501). Therefore, an excess film is required to allow the film to be pulled from the roll and to be held in place above the supported product. Further, in US 2007/0022717 more than one product loaded support (namely two) is packaged at each cycle, so that an excess film is also present between adjacent supports. The Applicant has estimated that the excess film cut from the package and scrapped may be 30% to 40% of the total amount of film pulled from the roll.

Further, in the machines disclosed by US 2007/0022717 and US 2005/0257501 removal of air from the interior of the support is possible only as long as the film is held above the support and the product. As soon as the film contacts the surface of the support along a closed line, air can no longer be removed from within the support. Thus, particularly when a deep tray is used as a support for the product, air pockets may disadvantageously remain entrapped between the film and the bottom surface of the support. The air pockets may disadvantageously negatively influence the shelf-life of the product as well as the impression that the consumer has of the package.

In the skin packaging methods of US 3481101 and EP 0320294, the apertures of the support allow removal of air from within the support even after the film has contacted the support, thus reducing the risk of leaving air pockets in the package.

Accordingly, the Applicant has faced the problem of providing a machine for vacuum skin packaging of a product arranged on a support that (similarly to the skin packaging methods of US 3481101 and EP 0320294) reduces the risk of leaving air pockets in the package and that at the same time overcomes at least one of the aforesaid drawbacks of the machines of US

2007/0022717 and US 2005/0257501, i.e.: it is simpler and more compact than these machines and minimizes excess film that is cut from the package and scrapped during or at the end of the packaging process.

According to a first aspect, the present invention provides a machine for vacuum skin packaging a product arranged on a support, the support having a sidewall with at least one hole, the machine comprising:

- a first film transfer plate configured for holding a film sheet, heating the film sheet, bringing the film sheet to a position above the support with the product arranged thereon and air tightly fixing the film sheet to the support; and
- a vacuum arrangement for removing air from within the support underneath the film sheet through the at least one hole,

the first film transfer plate being configured to release the film sheet thereby allowing the film sheet to be drawn into the support while the vacuum arrangement is removing air from within the support.

Preferably, the machine further comprises a second film transfer plate, the first film transfer plate and the second film transfer plate being arranged so that:

- during a first operating step of the machine, the first film transfer plate holds a first film sheet and heats the first film sheet, while the second film transfer plate releases a second film sheet thereby allowing the second sheet to be drawn into a first support; and
- during a second operating step of the machine, the second film transfer plate holds a third film sheet and heats the third film sheet, while the first film transfer plate releases the first film sheet thereby allowing the first film sheet to be drawn into a second support.

Preferably, the machine further comprises a rotating cylinder suitable for rotating about its axis X, the first film transfer plate and the second film transfer plate being connected to the rotating cylinder so that, when the rotating cylinder rotates about its axis X, the positions of the first film transfer plate and the second film transfer plate are exchanged.

Profitably, the machine further comprises a roll supporting assembly

configured to support a film roll from which the film sheet is cut.

Preferably, the machine further comprises a cutting device having a cutting blade suitable for cutting the film sheet from the film roll and a backing plate suitable for retaining the film sheet after it has been cut.

Preferably, the backing plate has a number of holes suitable for drawing vacuum allowing retaining the film sheet.

Preferably, the first film transfer plate is configured to rest against the backing plate with the film sheet arranged between them and to move the film sheet away from the backing plate by adhesion.

Preferably, the first film transfer plate has a opening connected to the vacuum arrangement, the opening allowing drawing vacuum while the first film transfer plate is holding the film sheet and allowing reintroducing air thereby inducing the first film transfer plate to release the film sheet.

Preferably, the machine further comprises a base unit suitable for supporting the support while the film sheet is drawn into the support.

According to a first preferred variant, the base unit comprises an outer fixed element and an inner slidable element, the inner slidable element being suitable for supporting the support, the outer fixed element having one or more vacuum conduits formed in the thickness thereof and connected to the vacuum arrangement, the vacuum conduits being in connection with the at least one hole when the support rests on the inner slidable element and the inner slidable element engages a cavity of the outer fixed element.

According to a second preferred variant, the base unit comprises an outer element, a fixed baseplate and an adapter with a number of levelling feet, the adapter being suitable for supporting the support and leaning on the fixed baseplate with the number of levelling feet projecting on a lower side of the fixed baseplate, the outer element having a base and a sidewall defining a central cavity, the central cavity of the outer element being dimensioned to allow the fixed baseplate and the adapter to slide in the central cavity.

According to a second aspect, the present invention provides a method for vacuum skin packaging of a product arranged on a support, the method comprising:

- providing at least one hole on a sidewall of the support;
- providing a film sheet;
- by means of a first film transfer plate, holding the film sheet, heating the film sheet, bringing the film sheet to a position above the support with the product arranged thereon and air tightly fixing the film sheet to the support;
- removing air from within the support underneath the film sheet through the at least one hole; and
- while the air is removed from within the support, releasing the film sheet from the first film transfer plate thereby allowing the film sheet to be drawn into the support.

Preferably, the method comprises:

- during a first operating step, by means of the first film transfer plate, holding a first film sheet and heating the first film sheet while, by means of a second film transfer plate, releasing a second film sheet thereby allowing the second sheet to be drawn into a first support; and
- during a second operating step, by means of the second film transfer plate, holding a third film sheet and heating the third film sheet while, by means of the first film transfer plate, releasing the first film sheet thereby allowing the first film sheet to be drawn into a second support.

Preferably, the method comprises releasing the film sheet from the first film transfer plate after a predefined low pressure is reached within the support, the predefined low pressure being lower than 50 mBar, preferably comprised between 3 mBar and 40 mBar, more preferably comprised between 5 mBar and 30 mBar, and even more preferably comprised between 10 mBar and 20 mBar.

Preferably, the method comprises releasing the film sheet from the first film transfer plate when a predefined time has expired, the predefined time being comprised between 0.5 s and 2.5 s, preferably between 1 s and 2 s.

Brief description of the drawings

The present invention will become clearer by reading the following detailed description, given by way of example and not of limitation, to be read with

reference to the accompanying drawings, wherein:

- Figures 1a and 1b are a side view and an axonometric view, respectively, of a machine according to a preferred embodiment of the present invention;
- Figure 2 is a side view of a portion of the machine of Figures 1a and 1b;
- Figure 3 is an enlarged view of a detail of Figure 2;
- Figure 4 is a perspective view of a portion of the machine during operation;
- Figures 5a to 5h show various steps of the vacuum skin packaging performed by the machine, according to a first variant; and
- Figures 6a to 6h show various steps of the vacuum skin packaging performed by the machine, according to a second variant.

Detailed description of preferred embodiments of the invention

Figures 1a, 1b, 2, 3, and 4 show a machine 1 for vacuum skin packaging of a product arranged on a support according to a preferred embodiment of the present invention. Corresponding parts shown in the various Figures are indicated with the same reference numeral through the Figures. The Figures are not in scale.

The machine 1 preferably comprises a frame 10, a support transport assembly 2, a roll supporting assembly 3, a film cutting assembly 4, a packaging assembly 5 and a vacuum arrangement such as a vacuum pump (not shown in the drawings) or the like.

The support transport assembly 2 preferably comprises a sliding plane 20 and a conveyor belt 21 arranged in slidable contact with the sliding plane 20. The support transport assembly 2 is fixed to the frame 10 so that the sliding plane 20 is substantially horizontal and the conveyor belt 21 slides in contact with the sliding plane 20 in the horizontal direction indicated by the arrow A1 shown in Figure 1a. Next to the frame 10, the sliding plane 20 has an aperture 20a (visible e.g. in Figures 5a to 5h) suitable for being engaged by the packaging assembly 5, as it will be described in further detail hereinafter. The support transport assembly 2 further comprises a stepping motor unit 22 for operating the conveyor belt 21 step-by-step.

The roll supporting assembly 3 preferably comprises two rotating cylinders 31, 32 horizontally projecting from an upper part of the frame 10 and suitable for supporting a film roll 6. Preferably, the roll supporting assembly 3 further comprises an arm 33 fixed to the frame 10 and suitable for preventing axial movement of the film roll 6. Further, the roll supporting assembly 3 preferably comprises film punching devices 34 configured essentially to provide the correct profile to the film edges to match, when transversally cut in the cutting assembly 4, the shape of the tray mouth with rounded corners. The punching devices 34 may also help to keep an unrolled portion of film 60 pulled from the film roll 6 substantially vertically aligned. Alternatively, the film may be unwound from the film roll 6 and moved to a first pinch roll horizontally, instead of vertically as illustrated in the figures. In such a case the punching devices 34 may be positioned closer to the film roll 6, in the space between the film roll 6 and said first pinch roll, and rotated by 90° to punch the film while it is horizontal.

Preferably, the film rolled on the film roll 6 is made of a flexible multi-layer material comprising at least a first outer heat-sealable layer, an optional gas barrier layer and a second outer heat-resistant layer. The outer heat-sealable layer preferably comprises a polymer capable of welding to the inner surface of the supports carrying the products to be packaged, such as for instance ethylene homo- or co-polymers, like LDPE, ethylene/alpha-olefin copolymers, ethylene/acrylic acid copolymers, ethylene/methacrylic acid copolymers, and ethylene/vinyl acetate copolymers, ionomers, co-polyesters, e.g. PETG. The optional gas barrier layer preferably comprises oxygen impermeable resins like PVDC, EVOH, polyamides and blends of EVOH and polyamides. The outer heat-resistant layer is preferably made of ethylene homo- or co-polymers, ethylene/cyclic-olefin copolymers, such as ethylene/norbornene copolymers, propylene homo- or co-polymers, ionomers, (co)polyesters, (co)polyamides. The film may also comprise other layers such as adhesive layers or bulk layers to increase thickness of the film and improve its mechanical properties. Preferably, one or more layers of the film are cross-linked to improve the strength of the film and/or its heat resistance. Cross-

linking may be achieved by using chemical additives or by subjecting the film layers to an energetic radiation treatment. The film preferably has a thickness comprised between 50 microns and 200 microns, more preferably between 60 and 180 microns and even more preferably between 70 microns and 150 microns. The film preferably has a width substantially equal to the width of the support carrying the product to be packaged.

The film cutting assembly 4 preferably comprises a cutting device 40 with a cutting blade 401 and a first piston 41. The first piston 41 may be replaced by any other kind of electric, pneumatic or hydraulic linear actuator. The first piston 41 is preferably fixed to the frame 10 underneath the roll supporting assembly 3 and is connected to the cutting device 40 so as to push and pull it in the horizontal direction indicated by the double arrow A2 shown in Figure 3. The film cutting assembly 4 further comprises a backing block 42 and a second piston 43. The second piston 43 may be replaced by any other kind of electric, pneumatic or hydraulic linear actuator. The second piston 43 is preferably fixed to the frame 10 and is connected to the backing block 42 so as to push and pull it in the vertical direction indicated by the double arrow A3 shown in Figure 3. The backing block 42 preferably comprises a backing plate 421 having a number of holes and a backing element 422 having a slit 423. The cutting device 40 and the backing block 42 are preferably arranged so that the unrolled portion of film 60 pulled from the film roll 6 lies between them.

The packaging assembly 5 preferably comprises a rotating cylinder 50 mounted on the frame 10 and suitable for rotating about its axis X as indicated by the double arrow A4 shown in Figure 3. The axis X preferably forms an angle of about 45° with the vertical direction. The rotating cylinder 50 may be replaced by any other kind of electric, pneumatic or hydraulic rotating actuator. Further, the packaging assembly 5 comprises two film transfer plates 51a, 51b and two third pistons 52a, 52b. The third pistons 52a, 52b may be replaced by any other kind of electric, pneumatic or hydraulic linear actuator. The third pistons 52a, 52b are connected to the rotating cylinder 50 so as to form a substantially right angle between them, i.e. one of

the two third pistons (e.g. 52a) has its axis vertically oriented and the other one (e.g. 52b) has its axis horizontally oriented, as shown in Figure 3. Each of the third pistons 52a, 52b is connected to a respective film transfer plate 51a, 51b so as to push and pull it along the direction indicated by the double arrows A5 and A6, respectively. By rotation of the rotating cylinder 50 about the axis X of an angle of about 180° (either in the clockwise or counter-clockwise direction), the position of the two pistons 52a, 52b and the respective film transfer plates 51a, 51b may be exchanged. Each film transfer plate 51a, 51b is preferably provided with a heatable surface 510 and with at least one opening 520 (visible in Figures 5a to 5j) connected to the above mentioned vacuum pump. The transfer plates 51a and 51b are illustrated in the drawings as flat surfaces, according to a preferred embodiment of the present invention. It can however also be foreseen to use shaped transfer plates, having an inner concavity with around flat edges corresponding to the rim of the support carrying the product to be packaged. This would have the advantage to allow also the packaging of products protruding from the support.

The packaging assembly 5 further preferably comprises a base unit 53 and a fourth piston 54. The fourth piston 54 may be replaced by any other kind of electric, pneumatic or hydraulic linear actuator. The fourth piston 54 is fixed to the frame 10 underneath the sliding plane 20 and is connected to the base unit 53 so as to push and pull at least a part thereof in the vertical direction indicated by the double arrow A7 shown in Figure 3 through the aperture 20a of the sliding plane 20.

With reference to Figures 5a to 5h, the base unit 53 according to a first preferred variant will be described in further detail.

According to the first preferred variant, the base unit 53 preferably comprises an outer fixed element 530 and an inner slidable element 531. The outer fixed element 530 has a base and a sidewall defining a central cavity. The outer fixed element 530 is preferably provided with vacuum conduits 532 connected to the above mentioned vacuum pump. They may be positioned e.g. on the bottom of the outer fixed element 530 or, as illustrated in Figures

5a to 5h, in the thickness of the sidewall of the outer fixed element 530. In particular, in the embodiment of Figures 5a to 5h, the vacuum conduits 532 are configured for matching with holes placed on sidewalls of a tray supported by the inner slidable element 531 resting on the base of the outer fixed element 530. The inner surface of the sidewall of the outer fixed element 530 is preferably conformed to fit the contour of the support on which the product to be packaged is arranged. The base of the outer fixed element 530 has a central hole. The outer fixed element 530 is preferably fixed to the frame 10 underneath the sliding plane 20. The inner slidable element 531 preferably has a baseplate and a stem connected to the fourth piston 54 (not shown in Figures 5a to 5h) and engaging the central hole of the base of the outer fixed element 530. The inner slidable element 531 is slidable in the central cavity of the outer fixed element 530 by the fourth piston 54 between a first position (shown in Figures 5a, 5b and 5h) in which its baseplate engages the aperture 20a of the sliding plane 20 and is substantially aligned with the sliding plane 20, and a second position (shown in Figures 5c to 5g) in which its baseplate rests on the base of the outer fixed element 530.

The operation of the machine 1 with the base unit 53 according to the first variant will be now described in detail.

Firstly, the heatable surface 510 of the film transfer plates 51a, 51b is heated to a predefined temperature. The predefined temperature is preferably between 140 °C and 200 °C. It is assumed that the third pistons 52a, 52b with the film transfer plates 51a, 51b are initially in the configuration shown in Figure 3, i.e. the third piston 52a has its axis vertically oriented and the third piston 52b has its axis horizontally oriented.

Then, the film cutting assembly 4 preferably starts cutting film sheets 61 from the unrolled portion of film 60 that is vertically aligned between the cutting device 40 and the backing block 42. In particular, before each cut the second piston 43 preferably pushes the backing block 42 in the vertical direction indicated by the double arrow A3 shown in Figure 3, until the backing element 422 faces the cutting device 40. Then, the unrolled portion of film 60 is drawn until it has a predefined length, preferably corresponding to

the length of the supports 7. This can be done by any conventional method such as for instance by means of an encoder, knowing the angular position of the rotating cylinder 31 and suitably controlling its movement to provide the predefined length of unrolled film. When the unrolled portion of film 60 has the predefined length, the first piston 41 preferably pushes the cutting device 40 in the horizontal direction indicated by the double arrow A2 of Figure 3, until the cutting device 40 rests against the backing element 422 and the cutting blade 401 engages the slit 423, thus cutting a film sheet 61 whose width and length are equal to the width and length, respectively, of the support 7. After the film sheet 61 has been cut, the first piston 41 preferably pulls the cutting device 40 in the horizontal direction indicated by the double arrow A2 of Figure 3, thereby moving the cutting device 40 away from the film sheet 61 and the backing element 422. Substantially at the same time, the second piston 43 preferably pulls the backing block 42 downwardly in the vertical direction indicated by the double arrow A3 shown in Figure 3, until the backing plate 421 faces the film transfer plate 51b (as shown in Figure 3). Substantially at the same time, vacuum is drawn through to the holes of the backing plate 421.

While the backing block 42 is pulled downwardly, the film sheet 61 is also pulled downwardly, since vacuum drawn through the holes of the backing plate 421 keeps the film sheet 61 integral therewith.

Further, while the backing block 42 is pulled downwardly, the third piston 52b pushes the film transfer plate 51b in the horizontal direction indicated by the double arrow A6 until the film transfer plate 51b rests against the backing plate 421, with the film sheet 61 arranged between them.

Then, vacuum is applied between the heatable surface 510 of the film transfer plate 51b and the film sheet 61 by the vacuum pump through the at least one opening 520 of the film transfer plate 51b, while vacuum through the holes of the backing plate 421 is released. In this way, the film transfer plate 51b holds the film sheet 61 by adhesion, i.e. the film sheet 61 adheres to the heatable surface 510 of the film transfer plate 51b. As the film sheet 61 enters into contact with the heatable surface 510 (that, as mentioned above, is

heated to the predefined temperature) it advantageously starts to heat and soften.

Then, while continuing to apply vacuum between the heatable surface 510 and the film sheet 61, the third piston 52b with its axis horizontally oriented preferably pulls the film transfer plate 51b along the direction indicated by the double arrows A6 of Figure 3, so as to move it away from the backing plate 421. Due to vacuum, the film sheet 61 advantageously still adheres to the heatable surface 510.

In the meanwhile, products 8 to be packaged are arranged on respective supports 7, such as for instance trays. Each support 7 preferably has a base, a sidewall and one or more holes 70 on the sidewall. The support 7 preferably has a number n of holes comprised between 2 and 12. The diameter of the holes 70 is preferably comprised between 0.5 mm and 3.0 mm, more preferably between 0.75 mm and 3.0 mm. Preferably the number and size of the hole(s) is such that $nA \geq 4\ mm^2$, more preferably $nA \geq 7\ mm^2$, wherein A the area of a single hole 70. Preferably, the holes 70 have the same size and shape. The holes 70 are preferably positioned close to the rim of the sidewall, in order to reduce the risk of spillage of liquid products and/or the clogging of the holes 70. The holes 70 are preferably evenly distributed across the sidewall area. The holes 70 are preferably positioned at the corners of the sidewall. This further reduces the risk of having residual air pockets in the final package.

The supports 7 are preferably made of a single-layer or a multi-layer thermoplastic material having gas barrier properties. Exemplary gas barrier single-layer thermoplastic materials are (co)polyesters, (co)polyamides and the like. Preferably, in case a multi-layer thermoplastic material is used, the multi-layer thermoplastic material preferably comprises at least one gas barrier layer and at least one heat-sealable layer to allow welding of the film sheet 61 to the surface of the support 7. Exemplary gas barrier polymers that can be employed for the gas barrier layer are PVDC, EVOH, (co)polyamides, (co)polyesters and blends thereof. Preferably, the heat-sealable layer is made of a polyolefin, such as ethylene homo- or co-polymers, e.g., in particular

polyethylene, ethylene-α-olefin copolymers, and ethylene-vinyl acetate co-polymers, propylene homo- or co-polymers, such as ethylene-propylene copolymers and ethylene-propylene-α-olefin terpolymers, and ionomers, or of homo- or co-polyesters, e.g. PETG (a glycol-modified polyethylene terephthalate). The multi-layer thermoplastic material may also comprise adhesive layers, to better adhere the gas-barrier layer to the adjacent layers. It may also comprise bulk layers to provide the structure with a sufficient thickness and/or with the desired mechanical properties. Chemically or physically foamed layers may be present in the support 7 particularly for use as bulk layers. Other layers may also be present – as known in the art - to provide the support 7 with certain desired properties, e.g., layers suitable to make the end package easy-to-open or to make it reclosable. The overall thickness of the single-layer or multi-layer thermoplastic material is preferably lower than 10 mm, more preferably comprised between 0.2 mm and 8.0 mm and even more preferably between 0.3 mm and 7.0 mm.

The supports 7 with the products 8 arranged thereon are then leaned on the sliding plane 20, so that the conveyor belt 21 makes them slide step-by-step along the sliding plane 20 in the direction indicated by the arrow A1 of Figure 1a. As shown in Figure 5a, one of the supports 7 with a product 8 arranged thereon is sliding step-by-step along the sliding plane 20 under effect of the conveyor belt 21 (not shown in Figure 5a), until it reaches the aperture 20a engaged by the base unit 53 and is accordingly arranged on the baseplate of the inner slidable element 531.

While the conveyor belt 21 is bringing the support 7 on the baseplate of the inner slidable element 531, the rotating cylinder 50 preferably rotates by 180° about is axis X, so that the positions of the film transfer plates 51a, 51b are exchanged. Accordingly, the third piston 52b has now its axis vertically oriented and the film transfer plate 51b holding the film sheet 61 is now above the support 7 and the product 8 (see Figure 5b). Vacuum applied between the heatable surface 510 of the film transfer plate 51b and the film sheet 61 is symbolically represented by the arrow A8.

The inner slidable element 531 is then moved downwardly by the fourth

piston 54 in the vertical direction indicated by the arrow A7 of Figure 3, until its basement rests on the base of the outer fixed element 530 (see Figure 5c).

Then, while continuing to apply vacuum between the heatable surface 510 and the film sheet 61, the third piston 52 pushes downwardly the film transfer plate 51b along the vertical direction indicated by the arrow A5 of Figure 3, until the heatable surface 510 engages the rim of the support 7 carried by the outer fixed element 530 of the base unit 53 and the film sheet 61 covers the aperture of the support 7, as shown in Figure 5d. Preferably, the edges of the film sheet 61 are fixed to the rim of the support 7 in an airtight manner by the pressure of the film transfer plate 51b.

Then, air is removed from within the support 7 by means of the vacuum pump, through the holes 70 and the vacuum conduits 532, as schematically indicated by the arrows A9 in Figure 5e. This advantageously creates vacuum (i.e. it lowers pressure) within the support 7 underneath the film sheet 61. It can be noticed that, even if vacuum is created underneath the film sheet 61, the film sheet 61 still adheres to the heatable surface 510. This is due to the fact that the low pressure created between the heatable surface 510 and the film sheet 61 is lower than the low pressure created underneath the film sheet 61.

After a predefined low pressure is reached within the support 7 underneath the film sheet 61 (typically in the range of up to 50 mBar, preferably comprised between 3 and 40 mBar, more preferably between 5 and 30 mBar and even more preferably in the range of 10-20 mBar), air is reintroduced between the heatable surface 510 and the film sheet 61 through the at least one opening 520 of the film transfer plate 51b, as indicated by the arrow A8' of Figure 5f. Air may be reintroduced either immediately after the predefined low pressure is reached, or after a predefined extra-time. Alternatively, air is reintroduced when a predefined time has expired (typically between 0.5 and 2.5 s and preferably between 1 and 2 s). The film sheet 61 then ceases to adhere to the heatable surface 510 and is drawn downwardly by the vacuum within the support 7. While the film sheet 61 is drawn downwardly, the vacuum pump preferably continues removing air from the support 7 through

the holes 70. Advantageously, the film sheet 61 moving downwards in the support 7 helps air exiting from the support 7 through the holes 70. Since the film sheet 61 is heated (and then softened), under effect of the vacuum within the support 7 it deforms so as to adhere to the product 8 and to the inner surface of the support 7, as shown in Figure 5f. Removal of air from within the support 7 may advantageously continue until the holes 70 are not closed by the film sheet 61. As soon as the film sheet 61 closes the holes 70 by adhering to the inner surface of the support 7 along a closed line encircling such holes 70, removal of air from within the support 7 is prevented. When removal of air from within the support 7 is prevented, evacuation of the package ends.

The film transfer plate 51b is then pulled in the vertical direction indicated by the arrow A5 of Figure 3 by the third piston 52b, thereby moving it away from the base unit 53 (see Figure 5g).

Vacuum is released from below the support 7 and then the fourth piston 54 preferably pushes the inner slidable element 531 of the base unit 53 in the vertical direction indicated by the arrow A7 of Figure 3, until the inner slidable element 531 is again substantially aligned with the sliding plane 20 (see Figure 5h). In this way, the support 7 may continue sliding step-by-step along the sliding plane 20 in the horizontal direction indicated by the arrow A1 under effect of the conveyor belt 21.

The operation of a single film transfer plate 51b has been taken into account in the above description. However, in the machine 1 the two film transfer plates 51a, 51b are operated simultaneously. Their operation is preferably synchronized as follows.

While the film transfer plate 51b is involved in the operations of Figures 5d to 5f (i.e. it is in contact with the base unit 53), the film cutting assembly 4 cuts a further film sheet as described above (the backing block 42 is pushed upwardly until the backing element 422 faces the cutting device 40, the cutting device 40 is horizontally pushed against the backing element 422 thus cutting the further film sheet, the cutting device 40 is moved away from the backing element 422 and the backing block 42 is pulled downwardly until the

backing plate 421 faces the film transfer plate 51a), the film transfer plate 51a is pushed against the backing plate 421 with the further film sheet arranged between them, vacuum is applied between the heatable surface of the film transfer plate 51a and the further film sheet so that the film transfer plate 51a holds the further film sheet, and the film transfer plate 51a holding the further film sheet is moved away from the backing plate 421.

Successively, the film transfer plate 51b is preferably moved away from the base unit 53 (Figure 5g) and the support 7 is raised at the level of the sliding plane 20 (Figure 5h). Then, with a single step of the stepping motor unit 22, the conveyor belt 21 removes the support 7 from the base unit 53 and brings a further support with a further product on the inner slidable element 531 of the base unit 53. The further support is brought on the inner slidable element 531 and said element 531 is lowered, while the rotating cylinder 50 preferably rotates by an angle of about 180° about its axis X, thereby exchanging the positions of the film transfer plates 51a, 51b. The heating surface 510 is then lowered to engage the rim of the support 7 carried by the outer fixed element 530 of the base unit 53. Consequently, the film transfer plate 51a holding the further film sheet is now above the further support. The operations shown in Figures 5d to 5h are then repeated to provide for a further product packaged according to the vacuum skin package technique.

The operation of the machine 1 cyclically repeats according to the above synchronism, thereby implementing vacuum skin packaging on a number of supports 7 with respective products 8 loaded thereon that are sequentially provided onto the sliding plane 20.

The above described machine has a number of advantages.

First of all, providing the holes 70 in the support 7 advantageously allows removing air from within the support 7 underneath the film sheet 61 even after the paper film 61 is brought into airtight contact with the rims of the support 7. This advantageously allows removing more air from within the support 7, thereby minimizing the amount of residual air left in the support 7 at the end of the vacuum skin packaging process, and accordingly minimizing the risk of forming air pockets.

Further, this allows continuing removing air from the support 7 even after the film sheet 61 is released from the heatable surface 510 of the film transfer plate 51b. This advantageously allows reducing the residual amount of air inside the package at the end of the vacuum skin packaging process.

Further, this allows providing a much simpler and compact machine, since the vacuum chamber required for allowing extraction of air from within the support 7 is very simple. Indeed, thanks to the holes 70, the film sheet 61 may be air tightly fixed to the rims of the support 7 before starting extracting air from within the support 7. In other words, the film transfer plate 51 and the outer fixed element 530 form a "vacuum chamber".

Besides, the film transfer plates 51a, 51b advantageously allows firstly cutting the film sheet 61 and subsequently transferring the film sheet 61 into the position above the product 8 and the support 7. In this way, no excess film is required to allow the film to be pulled from the film roll 6 and to be held in place above the product 8. Further, this advantageously allows providing a film cutting assembly 4 separated from the packaging assembly 5. The film cutting assembly 4 is advantageously very simple, since it performs the cuts at environment temperature and pressure. No complicated solutions are required for performing the cuts in extreme conditions such as very high temperatures or very low pressures. Also the packaging assembly 5 is advantageously very simple and compact, since it does not have to integrate any cutting device. The resulting machine 1 is therefore simpler and more compact then the known machines.

Furthermore, thanks to the presence of two alternating film transfer plates 51a, 51b, processing of consecutive supports 7 is partially overlapped in time, giving a higher productivity.

Further, advantageously, the presence of two alternating film transfer plates 51 increases the heating time of the film sheet 61 (i.e. the time during which the film sheet 61 is in contact with the heatable plate of a film transfer plate 51a, 51b). Indeed, heating of the film sheet 61 starts when a film transfer plate (e.g. 51b) holds the film sheet 61 by adhesion, it continues while the film transfer plate 51b is moved away from the backing plate 421,

while the rotating cylinder 50 rotates thus exchanging position of the film transfer plates 51a, 51b, while the film transfer plate 51b is pushed into contact with the base unit 53 and while air is extracted from within the support 7. This time is much longer than the heating time allowed by the known machines. Therefore, advantageously, the predefined temperature at which the heatable surfaces 510 of the film transfer plates 51a, 51b are heated may be lower than in prior art machines.

With reference to Figures 6a to 6h, the base unit 53' according to a second preferred variant will be described in further detail.

According to the second preferred variant, the base unit 53' preferably comprises an outer element 530', a fixed baseplate 531' and an adapter 532' with four levelling feet 533'. The fixed baseplate 531' is connected to a fixed stem 540 of the third piston 54 and has four passing holes (not visible in the drawings). The adapter 532' leans on the fixed baseplate 531' with the four levelling feet 533' engaging the passing holes and projecting on the lower side of the fixed baseplate 531'. In an alternative embodiment not shown in the drawings, the adapter 532' may be configured so that, when it leans on the fixed baseplate 531', the four levelling feet 533' are external to the fixed baseplate 531' and they project on the lower side of the fixed baseplate 531'. The fixed baseplate 531' and the adapter 532' engage the aperture 20a of the sliding plane 20 so that upper surface of the adapter 532' is aligned with the sliding plane 20. The outer element 530' has a base and a sidewall defining a central cavity. The base has one or more vacuum holes (not shown in the drawings) suitable for connecting the central cavity with the vacuum pump. The central cavity of the outer element 530' is preferably dimensioned to allow the fixed baseplate 531' and the adapter 532' to slide in the central cavity. The base of the outer element 530' is preferably connected to a movable cylinder 541 of the third piston 54.

The operation of the machine 1 with the base unit 53' according to the second variant will be now described in detail. Since the operations that do not involve the base unit 53' are substantially the same as the corresponding operations performed by the machine with the base unit 53 according to the

first variant, such operations will be only briefly summarized, while a detailed description thereof will not be repeated.

Firstly, the hateable surface 510 of the film transfer plates 51a, 51b is heated to a predefined temperature. Then, the film cutting assembly 4 preferably starts cutting film sheets 61 from the unrolled portion of film 60 as described above (before each cut, the backing block 42 is pushed upwardly until the backing element 422 faces the cutting device 40, the cutting device 40 is horizontally pushed against the backing element 422 thus cutting a film sheet 61, the cutting device 40 is moved away from the backing element 422 and the backing block 42 is pulled downwardly until the backing plate 421 faces the film transfer plate 51b). Then, the film transfer plate 51b is pushed against the backing plate 421 with the film sheet 61 arranged between them, vacuum is applied between the heatable surface of the film transfer plate 51b and the film sheet 61 so that the film transfer plate 51b holds the film sheet 61, and the film transfer plate 51a holding the film sheet 61 is moved away from the backing plate 421.

In the meanwhile, products 8 to be packaged are arranged on respective supports 7 with one or more holes 70 on their sidewalls. The supports 7 with the products 8 arranged thereon are then leaned on the sliding plane 20, so that the conveyor belt 21 makes them slide step-by-step along the sliding plane 20 in the direction indicated by the arrow A1 of Figure 1a.

As shown in Figure 6a, one of the supports 7 with a product arranged thereon (not visible in Figure 6a) is sliding along the sliding plane 20 under effect of the conveyor belt 21 (not shown in Figure 6a), until it reaches the aperture 20a engaged by the base unit 53' and is accordingly arranged on the adapter 532'.

While the conveyor belt 21 is bringing the support 7 on the adapter 532', the rotating cylinder 50 preferably rotates by 180° about is axis X, so that the positions of the film transfer plates 51a, 51b are exchanged. Accordingly, the third piston 52b has now its axis vertically oriented and the film transfer plate 51b holding the film sheet 61 is now above the support 7 and the product 8 (see Figure 6b).

The outer element 530' is then moved upwardly in the vertical direction indicated by the arrow A7 of Figure 3 by the moving cylinder 541 of the fourth piston 54, until the outer element 530' touches the rim of the support 7 and the levelling feet 533' of the adapter 532' rests on the base of the outer element 530' (see Figure 6c).

Then, the outer element 530' is further moved upwardly in the vertical direction indicated by the arrow A7 of Figure 3 by the moving cylinder 541 of the fourth piston 54, thus raising the adapter 532' (and the support 7 resting on it) and detaching it from the fixed baseplate 531'. The stroke of the outer element 530' ends when the fixed baseplate 531' leans against the base of the outer element 530' (see Figure 6d).

Then, the film transfer plate 51b holding the film sheet 61 is pushed downwardly until the film sheet 61 covers the aperture of the support 7 (as shown in Figure 6e), the edges of the film sheet 61 being fixed to the rim of the support 7 in a airtight manner.

Then, air is removed from within the support 7 through the holes 70 and the vacuum holes of the outer element 530' for creating vacuum within the support 7 underneath the film sheet 61. When a predefined low pressure is reached within the support 7 underneath the film sheet 61, the film sheet 61 is released and is drawn downwardly by the vacuum within the support 7. Since the film sheet 61 is heated (and then softened), under effect of the vacuum within the support 7 it deforms so as to adhere to the product 8 and to the inner surface of the support 7 (not shown in the Figures).

Following reventing through the film transfer plate 51b, the film transfer plate 51b is pulled in the vertical direction indicated by the arrow A5 of Figure 3 by the third piston 52b, thereby moving it away from the base unit 53 (see Figure 6f), and vacuum in the outer element 530' is released.

Then, the outer element 530' is moved downwardly in the vertical direction indicated by the arrow A7 of Figure 3 by the moving cylinder 541 of the fourth piston 54, thus lowering the adapter 532' (and the support 7 resting on it) and bringing it again into contact with the fixed baseplate 531' (see Figure 6g).

The outer element 530' is then further moved downwardly in the vertical

direction indicated by the arrow A7 of Figure 3 by the moving cylinder 541 of the fourth piston 54, until the outer element 530' disengages the aperture 20a of the sliding plane 20 and the support 7 (see Figure 6h). In this way, the support 7 may continue sliding along the sliding plane 20 in the horizontal direction indicated by the arrow A1 under effect of the conveyor belt 21.

Also according to this second variant, the two film transfer plates 51a, 51b. may be operated according to the synchronism described above.

The machine 1 incorporating the base unit 53' according to the second variant has the same advantages as the machine 1 incorporating the base unit 53' according to the first variant, i.e.: minimization of the risk of forming air pockets, minor amount of residual air inside the pack at the end of the vacuum skin packaging process, the use of a simpler vacuum chamber, no excess film required to allow the film to be pulled from the film roll 6 and to be held in place above the product 8, simplicity of the film cutting assembly 4 and of the packaging assembly 5, increased productivity, and increased heating time of the film sheet 61.

In addition to the above advantages, the base unit 53' according to the second variant advantageously allows adapting the machine 1 to the use with a variety of supports of different types in a very simple way.

Indeed, as it can be noticed in Figures 6c to 6g, the packaging assembly 5 incorporating the base unit 53' properly operates if the overall height of the adapter 532' with the levelling feet 533' and the support 7 equals the height of the central cavity of the outer element 530'. Therefore, in case the machine is firstly used for packaging first products on a first type of supports having a first height, and successively the machine should be used for packaging second products on a second type of supports having a second height, the machine 1 can be adapted to the use with the supports of the second type by simply changing the adapter 532' with a new adapter having levelling feet with the suitable height. If the levelling feet 533' of the adapter 532' are adjustable, adaptation is performed by simply adjusting the levelling feet 533'. Both operations (changing the adapter or adjusting the levelling feet thereof) are advantageously very simple, since the adapter is merely resting on the fixed

baseplate 531', and accordingly may be removed from the base unit 53' and mounted in the base unit 53' in a very easy way.

Alternatively, instead of a continuous film of the suitable width which is cut in film sheets to the predefined length matching the tray mouth, it is also possible to use pre-cut film sheets of the suitable dimensions (width and length). Said pre-cut film sheets may be stacked and taken up, one at a time, by the film transfer plates 51a and 51b and used in the packaging process described above. In such a case a suitable configuration of the packaging assembly 5 (not shown in the dr awings) may foresee that the film transfer plates 51a, 51b are arranged parallel to the base unit 53 and they are moved vertically by relative pistons that allow said film transfer plates 51a, 51b to be raised and lowered as needed. The pistons may be connected to a cylinder rotating about a vertical axis, so as to horizontally displace the pistons with the film transfer plates 51a, 51b. This alternative packaging assembly may run the following steps: lowering a first film transfer plate (designed as 51a above) over the stack of pre-cut film sheets, applying vacuum through the first film transfer plate 51a to take up the top film sheet of the stack, raising the first film transfer plate 51a with the pre-cut film sheet adhered thereto, rotating the cylinder by a suitable angle to bring said first film transfer plate 51a over a base unit 53 and at the same time a second film transfer plate 51b above the stack of pre-cut film sheets, and lowering the first film transfer plate 51a to carry out a vacuum skin packaging process as described above.

Throughout this specification and the claims which follow, unless the context requires otherwise, the word "comprise", and variations such as "comprises" and "comprising", will be understood to imply the inclusion of a stated integer or step or group of integers or steps but not the exclusion of any other integer or step or group of integers or steps.

The reference in this specification to any prior publication (or information derived from it), or to any matter which is known, is not, and should not be taken as an acknowledgment or admission or any form of suggestion that that prior publication (or information derived from it) or known matter forms part of the common general knowledge in the field of endeavour to which this specification relates

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CLAIMS

1. A machine for vacuum skin packaging a product arranged on a support, said support having a sidewall with at least one hole, said machine comprising:

- a first film transfer plate configured for holding a film sheet, heating said film sheet, bringing said film sheet to a position above said supportwith said product arranged thereon and air tightly fixing said film sheet to said support; and
- a vacuum arrangement for removing air from within said support underneath said film sheet through said at least one hole,

said first film transfer plate being configured to release said film sheet thereby allowing said film sheet to be drawn into said support while said vacuum arrangement is removing air from within said support.

2. The machine according to claim 1, further comprising a second film transfer plate, said first film transfer plate and said second film transfer plate being arranged so that:

- during a first operating step of said machine, said first film transfer plate holds a first film sheet and heats said first film s heet, while said second film transfer plate releases a second film sheet thereby allowing said second sheet to be drawn into a first support; and
- during a second operating step of said machine, said second film transfer plate holds a third film sheet and heats said third film sheet, while said first film transfer plate releases said first film sheet thereby allowing said first film sheet to be drawn into a second support.

3. The machine according to claim 2, further comprising a rotating cylinder suitable for rotating about its axis X, said first film transfer plate and said second film transfer plate being connected to said rotating cylinder so that, when said rotating cylinder rotates about its axis X, the positions of said first film transfer plate and said second film transfer plate are exchanged.

4. The machine according to any one of the preceding claims, further comprising a roll

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supporting assembly configured to support a film roll from which said film sheet is cut.

5. The machine according to claim 4, further comprising a cutting device having a cutting blade suitable for cutting said film sheet from said film roll and a backing plate suitable for retaining said film sheet after it has been cut.

6. The machine according to claim 5, wherein said backing plate has a number of holes suitable for drawing vacuum allowing retaining said film sheet.

7. The machine according to claim 6, wherein said first film transfer plate is configured to rest against said backing plate with said film sheet arranged between them and to move said film sheet away from said backing plate by adhesion.

8. The machine according to claim 4, further comprising a film cutting assembly configured for cutting film sheets from an unrolled portion of film.

9. The machine according to claim 5 or 8, wherein said first film transfer plate is configured for holding a film sheet which has been cut to have a predefined length and width matching a mouth of said support and then bringing said film sheet from a position not above said support to the position above said support.

10. The machine according to any one of the preceding claims, wherein said first film transfer plate has a opening connected to said vacuum arrangement, said opening allowing drawing vacuum while said first film transfer plate is holding said film sheet and allowing reintroducing air thereby inducing said first film transfer plate to release said film sheet.

11. The machine according to any one of the preceding claims, further comprising a base unit suitable for supporting said support while said film sheet is drawn into said support.

12. The machine according to claim 11, wherein said base unit comprises an outer

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fixed element and an inner slidable element, said inner slidable element being suitable for supporting said support, said outer fixed element having one or more vacuum conduits formed in the thickness thereof and connected to said vacuum arrangement, said vacuum conduits being in connection with said at least one hole when said support rests on said inner slidable element and said inner slidable element engages a cavity of said outer fixed element.

13. The machine according to claim 11, wherein said base unit comprises an outer element, a fixed baseplate and an adapter with a number of levelling feet, said adapter being suitable for supporting said support and leaning on said fixed baseplate with the number of levelling feet projecting on a lower side of said fixed baseplate , said outer element having a base and a sidewall defining a central cavity, said central cavity of said outer element being dimensioned to allow said fixed baseplate and said adapter to slide in said central cavity.

14. A method for vacuum skin packaging of a product arranged on a support, said method comprising:

- providing at least one hole on a sidewall of said support;
- providing a film sheet;
- by means of a first film transfer plate, holding said film sheet, heating said film sheet, bringing said film sheet to a position above said support with said product arranged thereon and air tightly fixing said film sheet to said support ;
- removing air from within said support underneath said film sheet through said at least one hole; and
- while said air is removed from within said support, releasing said film sheet from said first film transfer plate thereby allowing said film sheet to be drawn into said support.

15. The method according to claim 14, the method comprising:

- during a first operating step, by means of said first film transfer plate, holding a first film sheet and heating said first film sheet while, by means of a second film transfer plate, releasing a second film sheet thereby allowing said second sheet to be drawn into a first support; and

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- during a second operating step, by means of said second film transfer plate, holding a third film sheet and heating said third film sheet while, by means of said first film transfer plate, releasing said first film sheet thereby allowing said first film sheet to be drawn into a second support.

16. The method according to claim 14 or 15, the method comprising releasing said film sheet from said first film transfer plate after a predefined low pressure is reached within said support, said predefined low pressure being lower than 50 mBar.

17. The method according to any one of claims 14 to 16, the method comprising releasing said film sheet from said first film transfer plate when a predefined time has expired, said predefined time being comprised between 0.5 sand 2.5 s,.

18. The method according to any one of claims 14 to 17, wherein the support is a tray which has a base, a sidewall and one or more holes on the side wall.

19. The method according to any one of claims 14 to 18, wherein the step of providing a film sheet comprises:

- providing a predefined length of unrolled film drawing the unrolled portion of film;
- cutting said film sheet from the unrolled portion of said film.

20. The method according to claim 19 wherein bringing said film sheet to a position above said support takes place after cutting the film sheet and includes bringing said film sheet from a position not above said support to said position above said support.

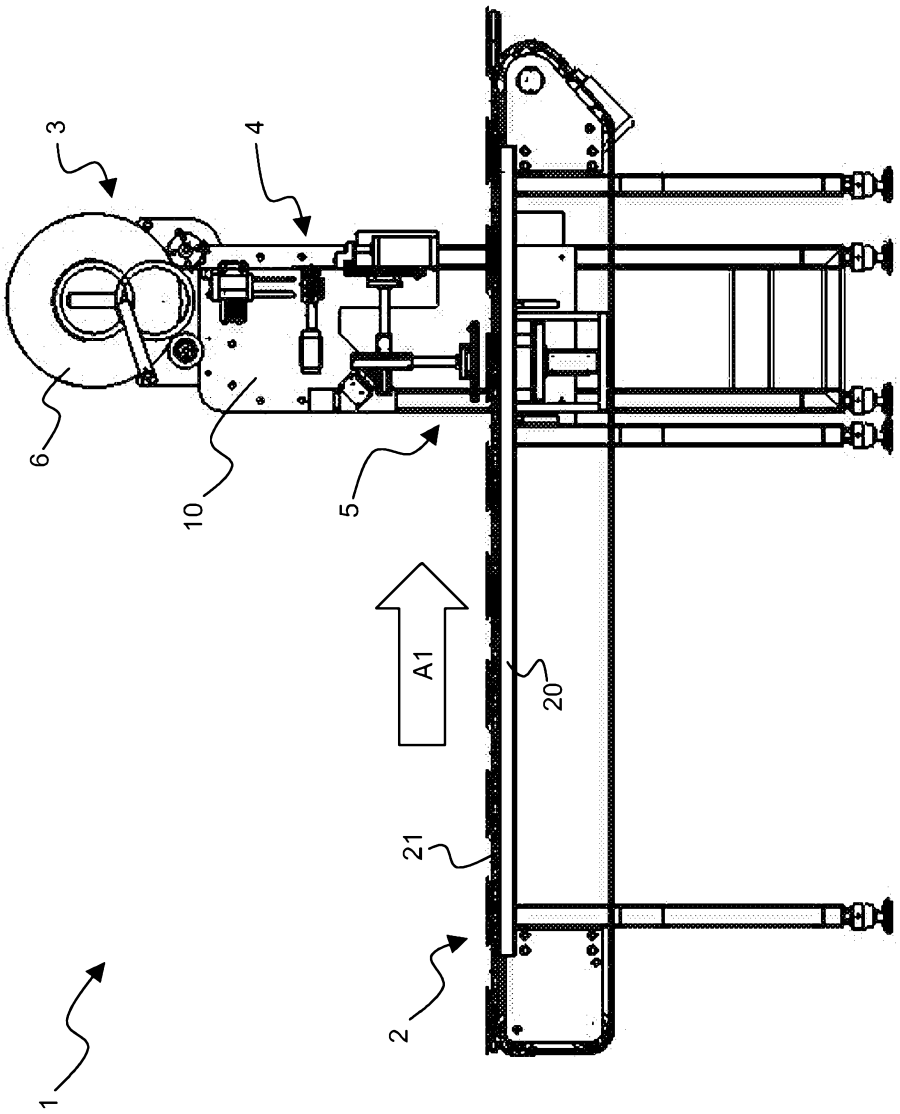


Figure 1a

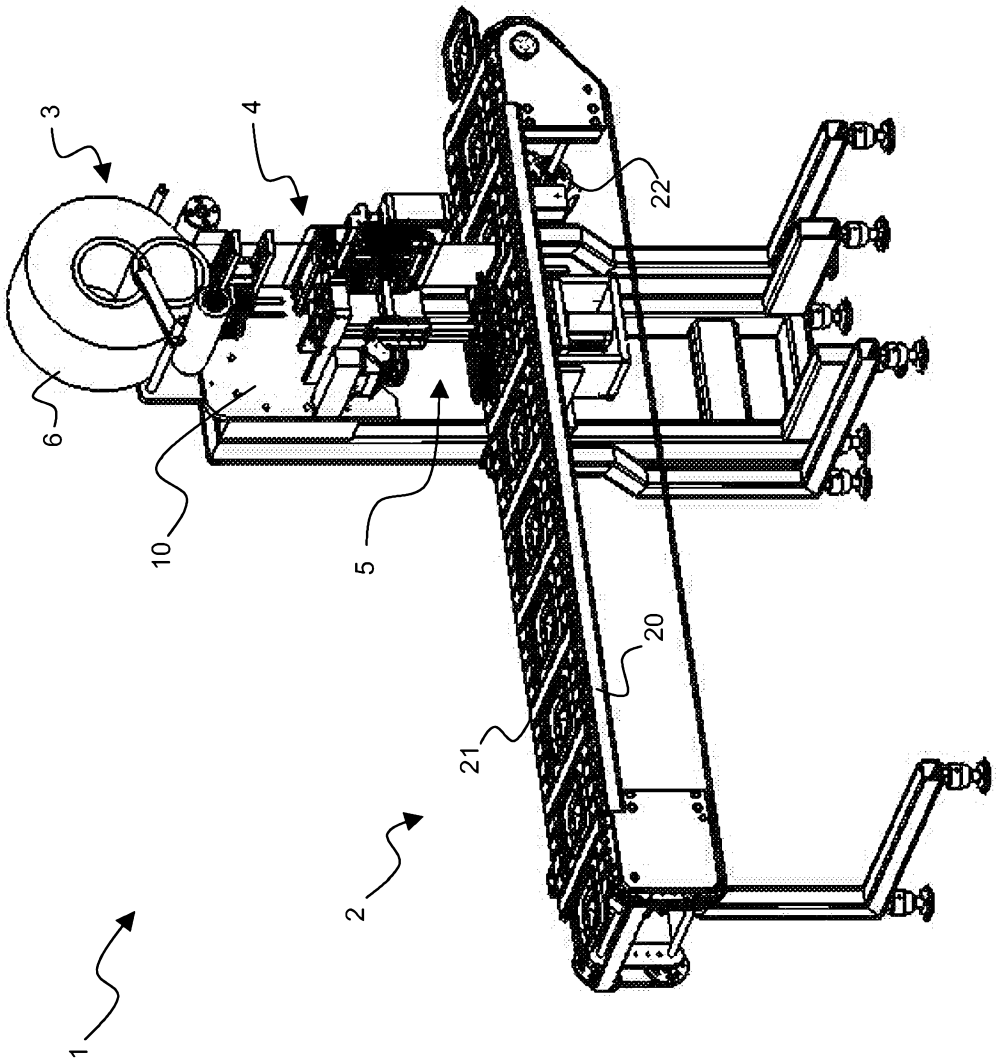


Figure 1b

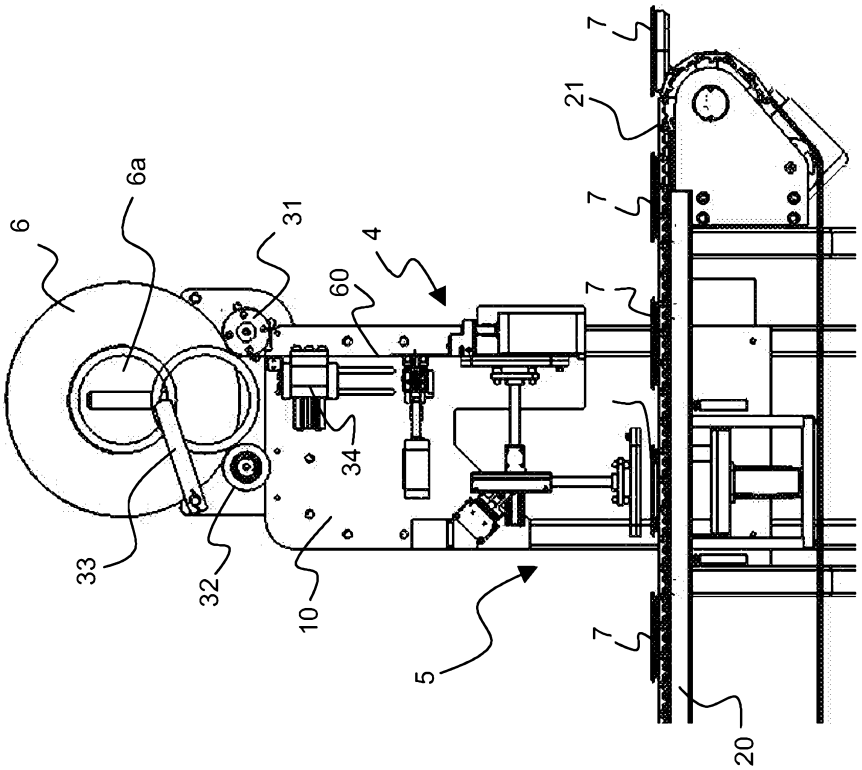
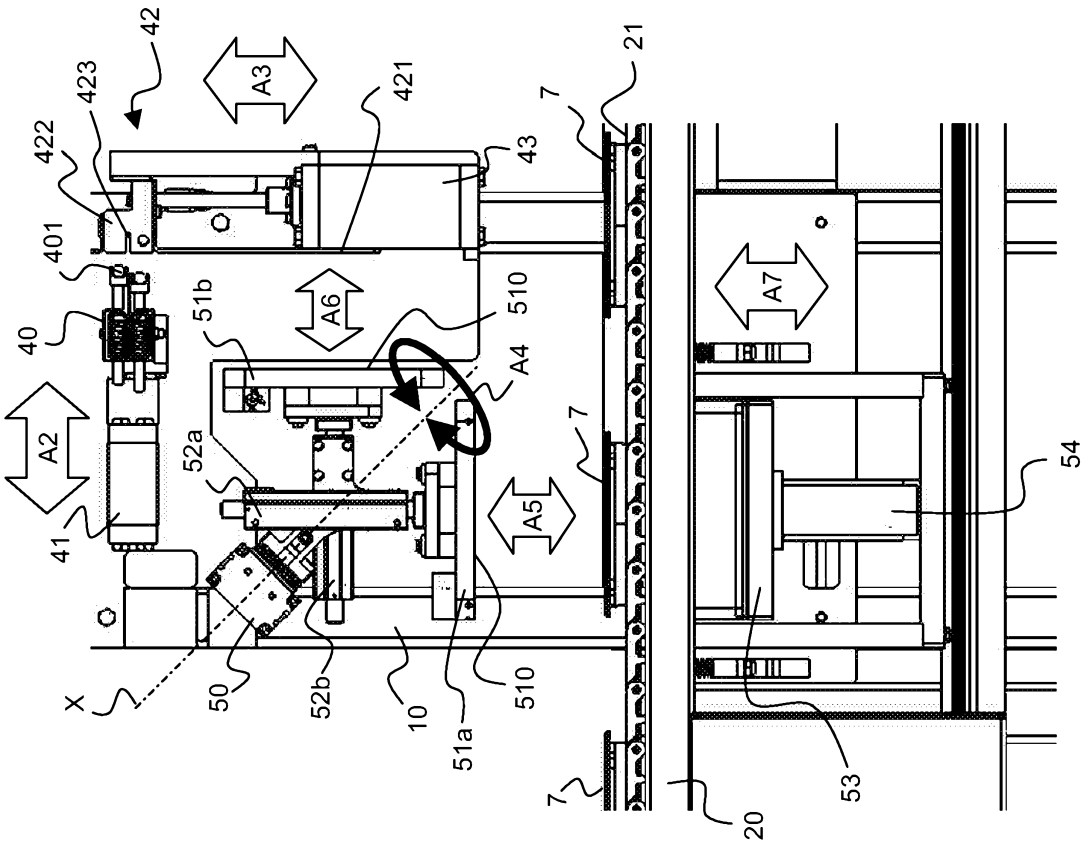


Figure 2

Figure 3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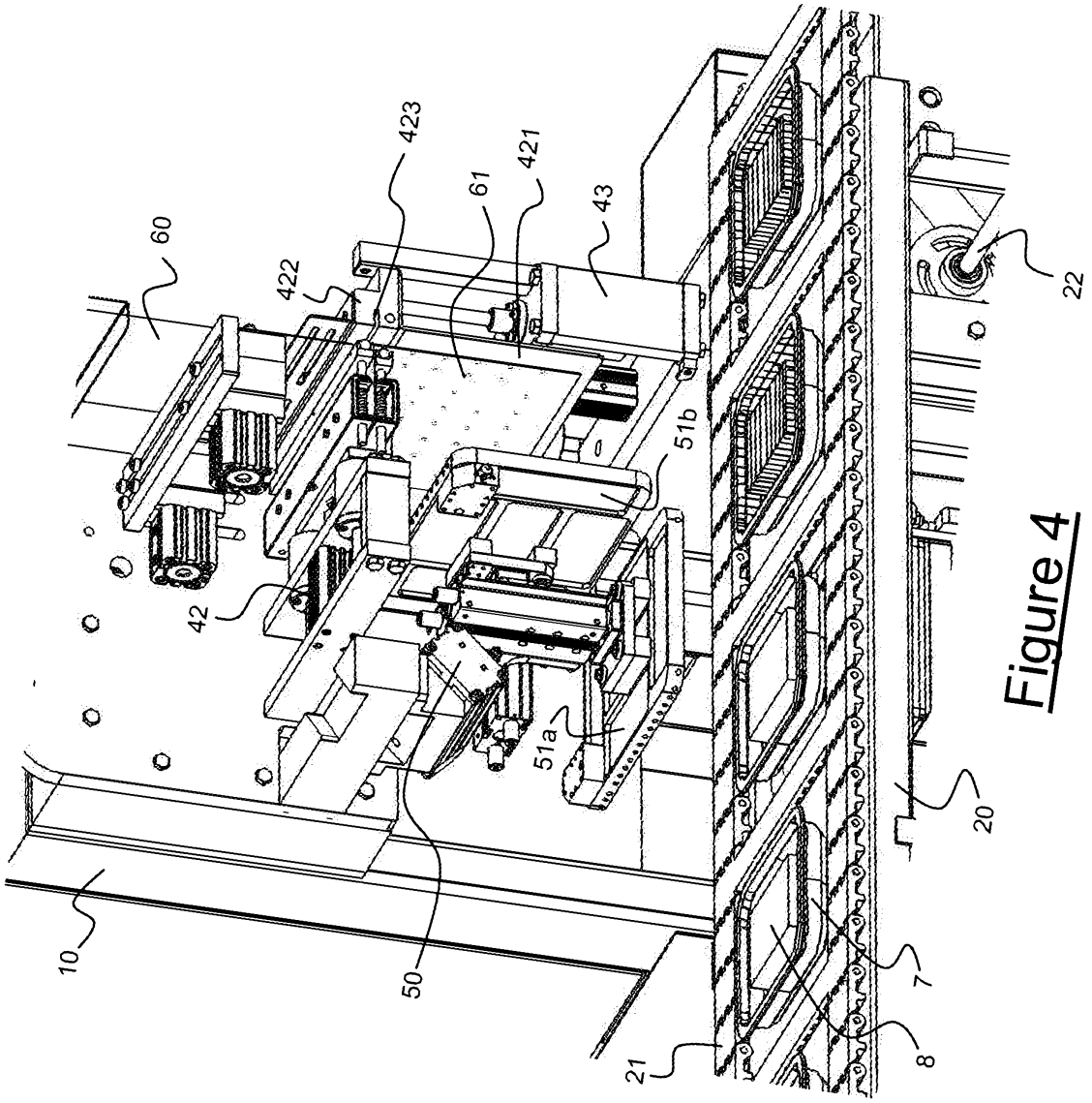

Figure 4

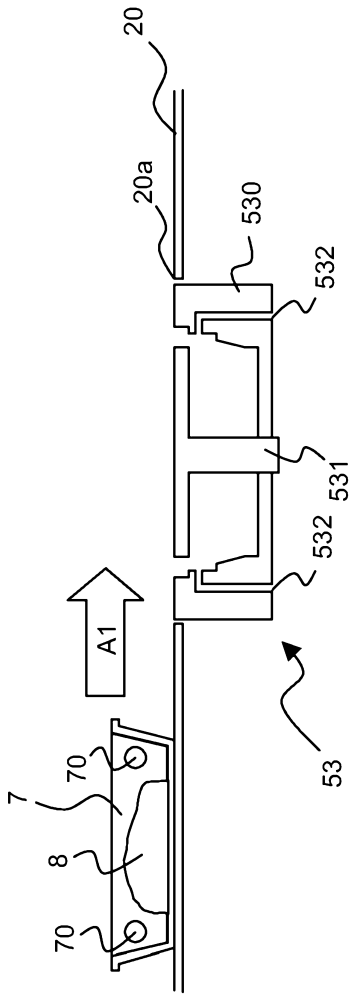

Figure 5a

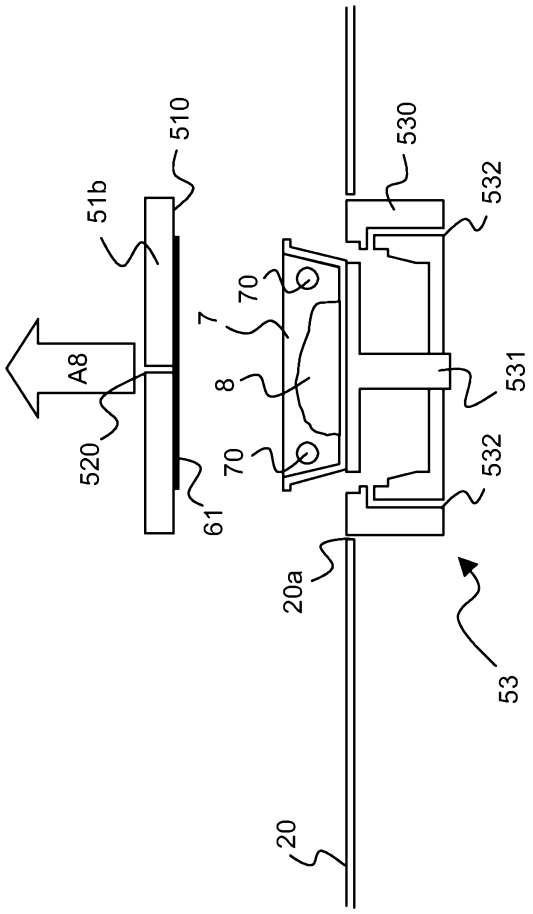

Figure 5b

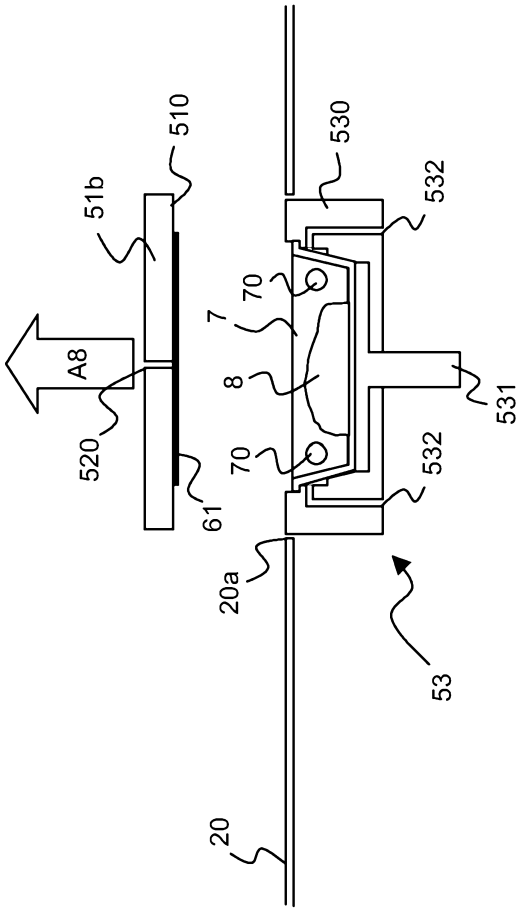

Figure 5c

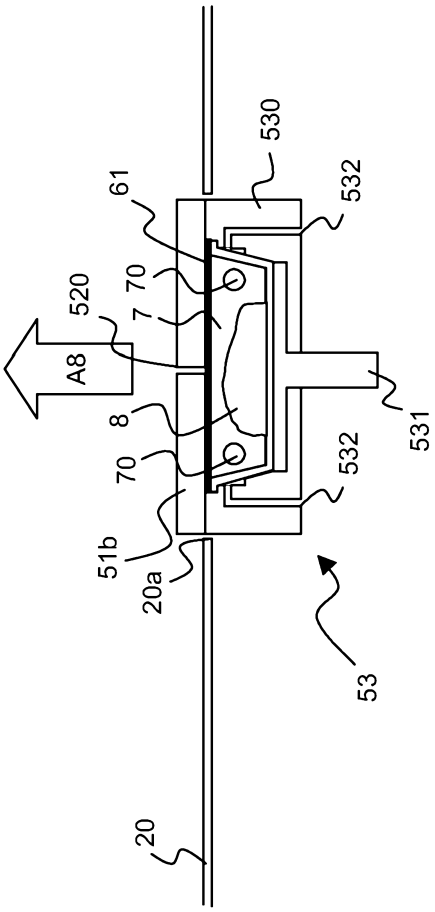

Figure 5d

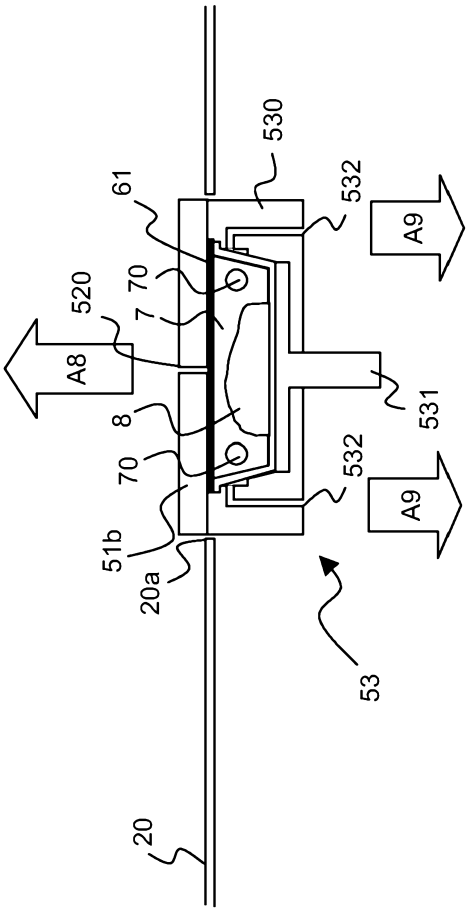

Figure 5e

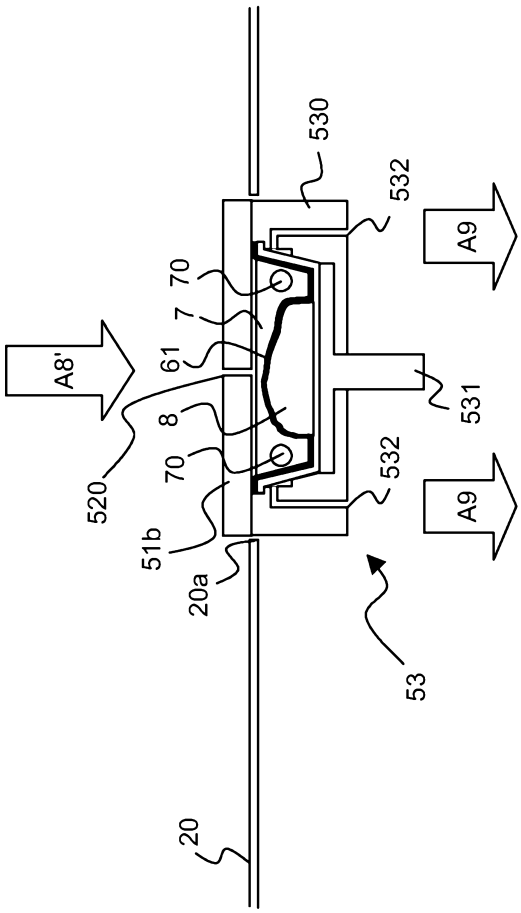

Figure 5f

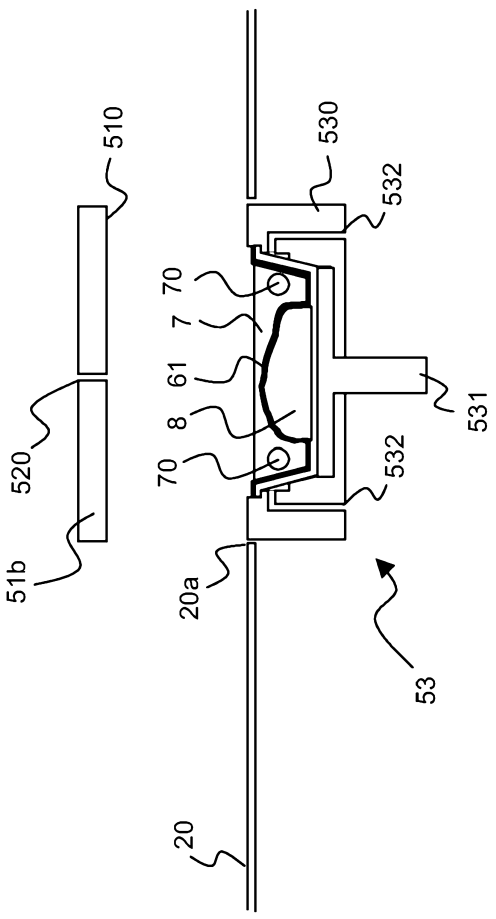

Figure 5g

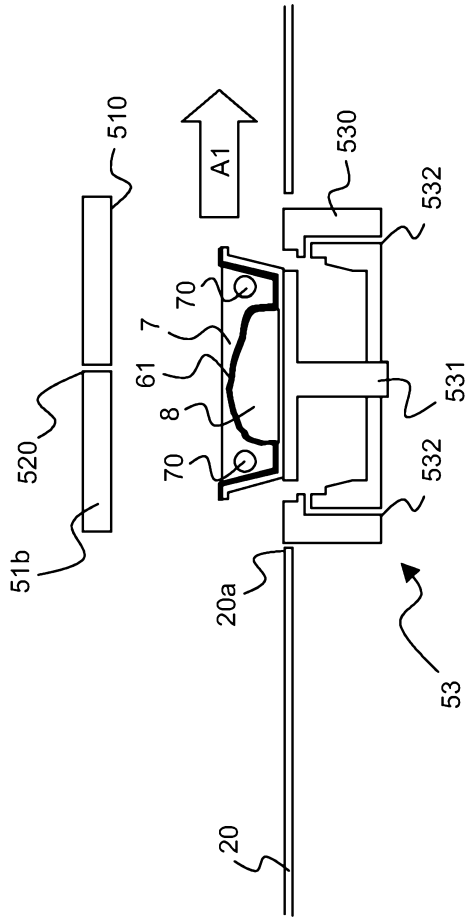

Figure 5h

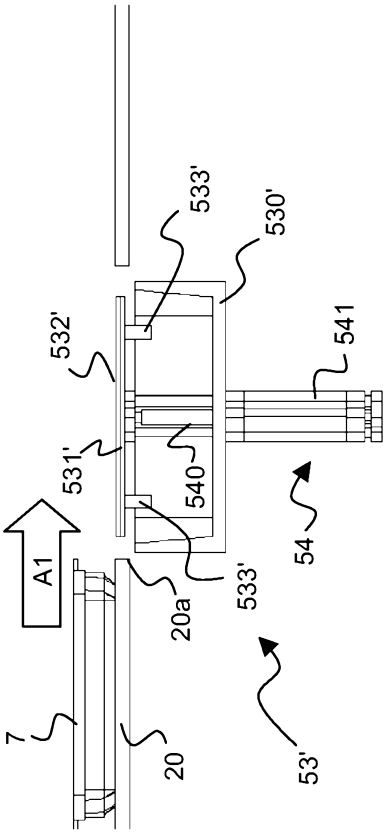

Figure 6a

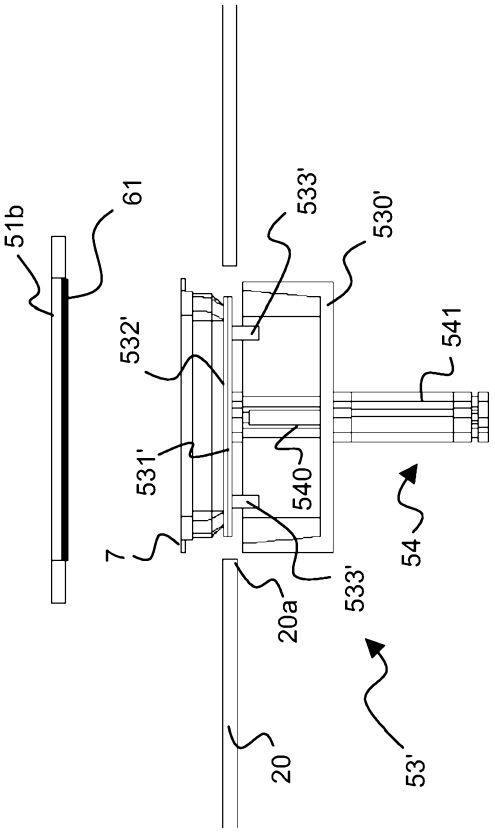

Figure 6b

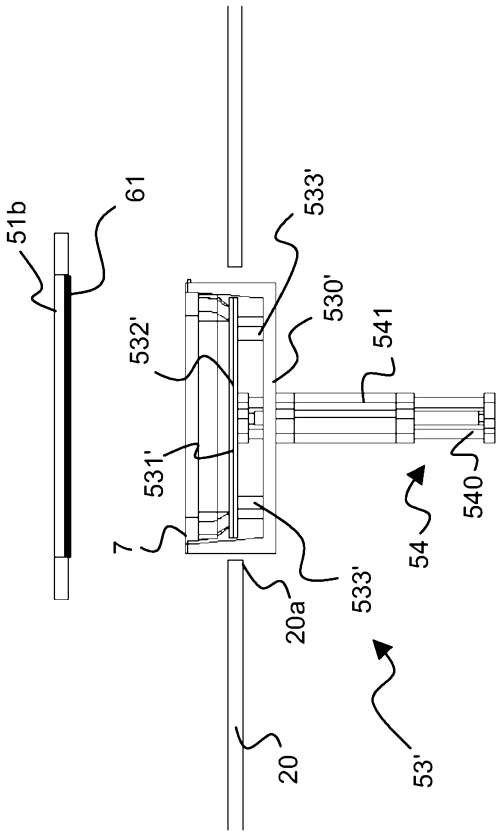

Figure 6c

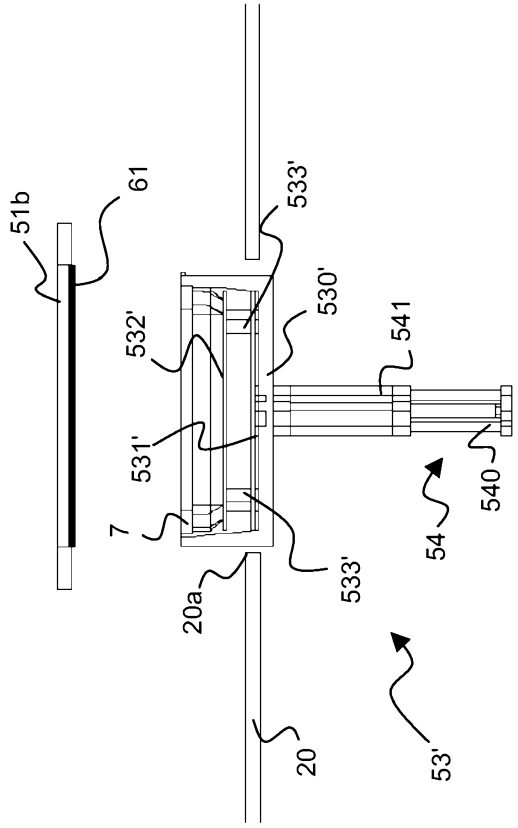

Figure 6d

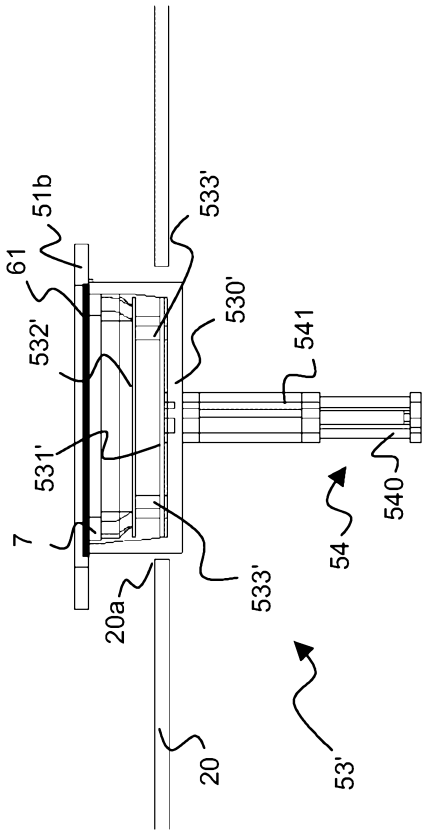

Figure 6e

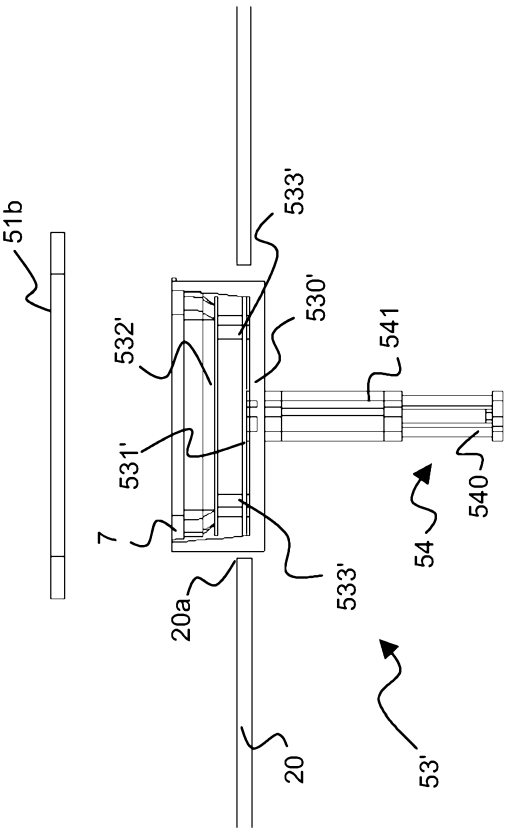

Figure 6f

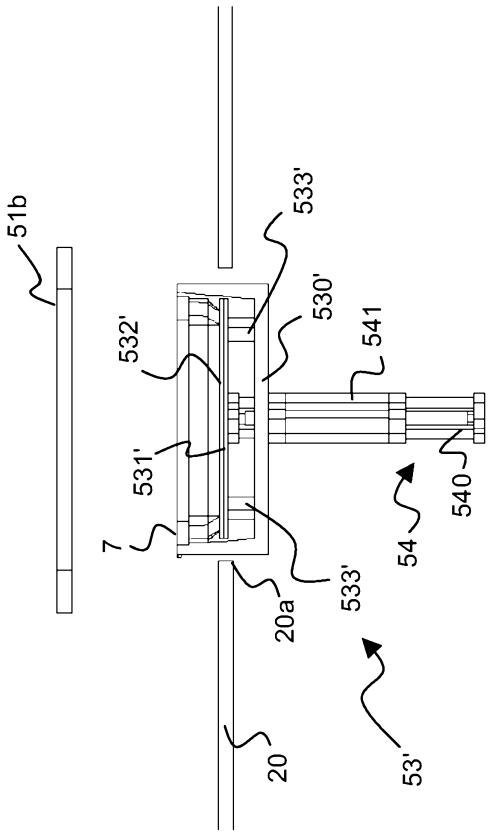

Figure 6g

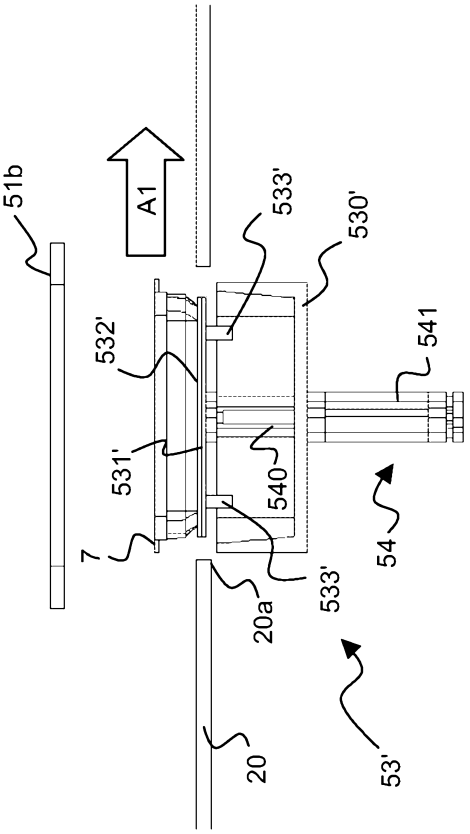

Figure 6h