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APPARATUS FOR DEEP DRAWING A THERMOPLASTIC FOIL

The invention relates to an apparatus for deep drawing a thermoplastic foil, having an upper tool and a lower tool that are movable relative to each other and to a foil plane extending between them.

Such an apparatus is known from EP 1,297,943 where the lower tool can be moved by a first actuator. An upper tool is provided with an extender on a rod that is mounted on another actuator. Finally, there is in the upper tool a separate seal piston that also has its own actuator. With this apparatus the foil extending between the upper tool and the lower tool is first gripped by moving the lower tool and then is stretched by advance of the extender, and finally is given its final shape by movement of the seal piston. The numerous independent drives complicates this apparatus and makes it expensive and cost inefficient.

It is an object of the invention to provide an apparatus of the above-described type where in spite of simple construction one is assured of a qualitatively uniform high-quality deformation of the foil.

This object is achieved according to the invention in an apparatus of the above-described type wherein the upper tool is formed by a base plate, a punch plate fixed on the base plate, and a hold-down plate movable relative to the punch plate and formed

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with a hole through which engages a punch of the punch plate.

This system has the advantage that a separate punch drive is not needed, since the punch plate moves together with the upper tool because it forms part of the upper tool.

Preferably according to the invention a frame has an upper transverse beam holding the upper tool and a lower transverse beam holding the lower tool and a drive for moving the upper beam. It is worth noting that an apparatus according to the invention as a rule is used as a shaper of a thermoshaping system in which as a rule a thermoplastic synthetic-resin is shaped, filled, sealed, and cut into individual blister packs. The drive of the shaper is typically used to move the upper beam and to first prepare the plastic foil for shaping by arresting it with the hold-down plate and then shifting the base plate and the punch plate relative to the hold-down plate to deform the plastic foil. When the upper and lower beams are connected by vertical frame elements, there is the further advantage that it is possible achieve very accurate positioning and accurately guide the parts. In addition to the possibility of making the lower beam stationary, in a preferred embodiment the lower beam is movable to prevent the foil from sticking to the lower tool and only bring the upper and lower tools into engagement with the foil during the shaping operation.

Since the punch plate is secured centrally in the base plate, thermal expansion is possible from the center out and the punch plate is accurately positioned

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even when as a result of the different treatment temperatures required by the different types of foils it is heated more or less. To this end it is preferable when a guide between the base plate and the punch plate comprises pins engaged in slots and preferably the guide slots are on the punch plate and the pins are on the base plate at the outer edges thereof so that maximum possible movement is possible.

Furthermore according to the invention thermally insulating spacer plates are provided between the base plate and the punch plate so that on heating of the punch plate the base plate is not heated also.

In accordance with a particular feature of the invention a coolant connection is provided on the hold-down plate that serves to control the temperature of the hold-down plate independently of the punch plate, so that the foil is cooled below the deformation temperature in the regions that are not being shaped. Since the hold-down plate is movable relative to the punch plate, a flexible coolant hose with a loop is connected to the connection to compensate for position changes.

In accordance with a preferred embodiment of the invention the lower tool is formed as a cavity plate with cavities, and the punch plate has an array of the punches corresponding to the cavities. In this manner with a single shaping cycle it is possible to form any desired array of blisters in the foil, the format being changeable by switching the chamber plate, punch plate, and hold-down plate without affecting the positioning accuracy since this is a function of mounting on the

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upper and lower beams and their mounting on the shaper frame.

One of the hold-down plate or punch plate is provided with a seal engageable with the other plate allowing the foil to be preshaped by the punch plate and then given its final shape by pressurization of the chamber defined within the seal between the punch plate and the hold-down plate. When a very small chamber is used, the pressurization can be effected with a small amount of pressurizing medium.

According to the invention it is further recommended that the punch plate is made of a heat conducting material, in particular a metal, preferably aluminum.

It is further preferred according to the invention that a spacer disk is provided to limit movement of the punch plate 11 relative to the hold-down plate so as to be able to customize the penetration depth, normally in a step-wise manner, when spacer disks of different thicknesses are provided.

It is particularly advantageous when the spacer disk is mounted in the guide slots that are particularly accessible, the spacer disk being constructed and oriented to limit the penetration of at least one of the guide pins into the respective guide slot.

When format parts are used that can be changed for different applications, it is advisable when the spacer disk is unitarily formed with the base plate so as to eliminate various assembly and adjustment

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operations when the base plate is exchanged for a different application.

It is also recommended when the spacer disk forms an annular rim of the base plate projecting into the guide slot and acting as abutment for the respective guide pin.

The invention is more closely described in the following with reference to the embodiment shown in the drawing wherein:

FIG. 1 is a front view of an apparatus according to the invention at the start of a shaping cycle;

FIG. 2 is a view like FIG. 1 with the upper and lower tools engaging the foil;

FIG. 3 is a view like FIG. 1 with the upper beam advanced to make blisters in the foil;

FIG. 4 is a perspective view of the upper tool;

FIG. 5 is a perspective view of the insulated lower hold-down plate of the upper tool;

FIG. 6 is a perspective view of the insulated punch plate of the upper tool;

FIG. 7 is a section through the upper tool of FIG. 4 in pushed-together condition;

FIG. 8 is a top view of the punch plate with the guide pins of the base plate engaged in their guides;

FIG. 9 is a schematic representation of the connection formed by two hose loops between the hold-down plate and the base plate;

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FIG. 10 is a schematic representation of the connection of the coolant hose between the hold-down plate and the base plate with a torque-responsive hose guide;

FIG. 11 is a schematic representation of the static seal between the hold-down plate and the punch plate; [[and]]

FIG. 12 is a view like FIG. 11 showing a dynamic seal between the punch plate and the hold-down plate;

FIG. 13 is a perspective view of another embodiment; and

FIG. 14 is the detail shown at XIV in FIG. 13.

Thermoshaping machines serve for the packaging of measured numbers of capsules, pills, tablets, or the like in a foil 1, to which end blisters 2 are formed in the foil, are filled with the product in a downstream filler, and then in a sealer further downstream in the foil-travel direction are sealed by a cover foil. Then a downstream stamper separates the filled and sealed blister packs from one another. An important part of such a thermoshaping machine is a shaper with an apparatus 3 for deep drawing the thermoplastic foil, having an upper tool 4 and a lower tool 5 that are movable relative to each other and to a foil plane 6 between them. As shown in FIGS. 1 to 3, the upper tool 4 is mounted on an upper transverse beam 7 and the lower tool 5 on a lower transverse beam 8, the upper beam 7 and lower beam 8 being connected by vertical frame elements 9. The upper beam 7 and the lower beam 8 are

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moved by respective drives provided in the thermoshaper.

The upper tool 4 is comprised of a base plate 10, a punch plate 11 fixed on the base plate 10, and a hold-down plate 12 movable relative to the punch plate 10 and formed with a hole 14 through which the punch plate 11 engages with at least one punch 13. The punch plate 11 is made of a heat-conducting material, preferably aluminum, and can be heated as shown schematically by the variable heater 15 in FIGS. 1 and 3. Since the punch plate 11 is fixed by the base plate 10 to the upper beam 7, it is not necessary to provide the apparatus 3 with a flexible cable to feed an electric resistance heater, instead a rigid cable and plug suffice.

Between the hold-down plate 12 and the punch plate 11 there are spacer plates 16 (FIG. 6) that are thermally insulating in order to reduce heating of the base plate 10. The punch plate 11 is fixed centrally at 19 to the base plate 10 and thus is very accurately positioned in the machine frame via the base plate 10 and the upper beam. Such mounting allows the punch plate 11 to thermally expand out from the center (FIG. 8), to which end pins 18 engaged in respective guide slots 17 are provided for guiding. FIGS. 6 and 7 show that the guide slots 17 are in the punch plate 11 and the guide pins 18 are on the base plate 10 at the outer edges thereof.

A coolant connection 26 (FIG. 5) is mounted on the hold-down plate 12 and a flexible coolant hose 20 forming a loop 21 is connected to the connection 26 in order to compensate for the relative movement of the

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hold-down plate 12 and the base plate 10. FIGS. 9 and 10 show two alternative hose arrangements, one (FIG. 9) with bending of the coolant hose 20 and the other (FIG. 10) with twisting.

The lower tool 5 is formed as a cavity plate 22 with an array of cavities 23 and the punch plate 11 has an array of punches 13 corresponding to the cavities 23 and engaging through respective holes 14 in the hold-down plate 12.

FIG. 5 shows that the face of the hold-down plate 12 turned toward the punch plate 11 has a seal 24 and a pressure line 25 opens into the chamber defined within the seal 24 between the punch plate 11 and the hold-down plate 12 so that in the FIG. 3 position it is possible once the preshaping of the foil 1 has been done by the punches 13 to effect the final shaping by pressurization. To this end it is significant that the chamber be of limited volume so it can be pressurized rapidly. FIG. 5 shows a static seal between the punch plate 11 and the hold-down plate as also illustrated in FIG. 11. It is also possible to effect the sealing dynamically as shown in FIG. 12 with a wear-resistant seal 24.

As shown in FIGS. 13 and 14, a spacer disk 17 limits displacement of the punch plate 11 relative to the hold-down plate 12, this spacer disk 27 being so constructed and oriented that the extent of insertion of at least one of the guide pins 18 in the respective guide slot 17 is limited. In the embodiment shown in the drawing this is effected in that the spacer disk 27 is made unitarily with the base plate 10 and forms an

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annular rim of the base plate 10 projecting into the
guide slot 17 and forming an abutment for the guide pin
18.

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Patent claims:

1. An apparatus for deep drawing a thermoplastic foil (1), having an upper tool (4) and a lower tool (5) that are movable relative to each other and to a foil plane (6) extending between them, the upper tool (4) being formed by a base plate (10), a punch plate (11) fixed on the base plate (10), and a hold-down plate (12) movable relative to the punch plate (11) and formed with a hole (14) through which engages a punch (13) of the punch plate (11), characterized in that the heatable punch plate (11) is secured centrally (at 19) in the base plate (10), whereby thermal expansion is possible from the center out and a guide between the base plate (10) and the punch plate (11) comprises pins (18) engaged in slots (17).

2. The apparatus according to claim 1, characterized in that a frame has an upper transverse beam (7) holding the upper tool (4) and a lower transverse beam (8) holding the lower tool (5) and a drive for moving the upper beam (7).

3. The apparatus according to claim 2, characterized in that the upper beam (7) and the lower beam (8) are connected by vertical frame elements (9).

4. The apparatus according to claim 3, wherein the lower beam (8) can move on the elements (9).

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5. The apparatus according to claims 1 to 4, characterized in that the guide slots (17) are on the punch plate (11) and the pins (18) are on the base plate (10) at the outer edges thereof.

6. The apparatus according to one of claims 1 to 5, characterized in that thermally insulating spacer plates (16) are provided between the base plate (10) and the punch plate (11).

7. The apparatus according to one of claims 1 to 7, characterized in that a coolant connection (26) is provided on the hold-down plate (12).

8. The apparatus according to claim 7, characterized in that a flexible coolant hose (29) with a loop (21) is connected to the connection (26).

9. The apparatus according to one of claims 1 to 8, characterized in that the lower tool (5) is formed as a cavity plate (22) with cavities (23), and the punch plate (11) has an array of the punches (13) corresponding to the cavities (23).

10. The apparatus according to one of claims 1 to 9, characterized in that one of the hold-down plate (12) or punch plate (11) is provided with a seal (24) engageable with the other plate.

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11. The apparatus according to claim 10, characterized in that a pressure line (25) opens into a chamber defined within the seal (24) between the punch plate (11) and the hold-down plate (12).

12. The apparatus according to one of claims 1 to 11, characterized in that the punch plate (11) is made of a heat conducting material, in particular a metal, preferably aluminum.

13. The apparatus according to one of claims 1 to 12, characterized in that a spacer disk 27 is provided to limit movement of the punch plate 11 relative to the hold-down plate 12.

14. The apparatus according to claim 13, characterized in that the spacer disk 27 is constructed and oriented to limit the penetration of at least one of the guide pins 18 into the respective guide slot 17.

15. The apparatus according to claim 14, characterized in that the spacer disk 27 is unitarily formed with the base plate 10.