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REFERENCIA: SOLICITUD DE PATENTE DE MODELO DE UTILIDAD
TITULO: PARED DE ENVASES PLASTICOS TERMOFORMADOS
RESISTENTES AL FORMAMIENTO POR EFECTOS DE
CAMBIOS EN LA PRESION BAROMETRICA
SOLICITANTE: CARVAJAL S. A.
EXPEDIENTE No. 00-53.003
ASUNTO: COMPLEMENTO DE INFORMACION

Yo, MONICA WOLF WASSERMAN, identificada con cédula de ciudadanía No. 51.711.267 de Bogotá y T.P.A. No. 46.034 del Consejo Superior de la Judicatura, obrando en mi condición de apoderada de la sociedad MULTIDIMENSIONALES S.A., organizada y existente de conformidad con las leyes colombianas y con domicilio en Bogotá D.C., por medio del presente escrito acompaño información clara y suficiente que desvirtúa la novedad del Modelo de Utilidad en referencia.

PETICIONES

1. Aunar a la solicitud de patente las presentes pruebas que desvirtúan la novedad absoluta que debe guardar el Modelo de Utilidad en referencia.
2. Se niegue el privilegio de patente al Modelo de Utilidad citado en referencia.

FUNDAMENTOS JURIDICOS

De acuerdo con los siguientes análisis procederemos a demostrar que la solicitud objeto de esta oposición en realidad no solo carece de novedad sino que además por sus propias características de diseño, carece de aplicación industrial por cuanto el diseño propuesto y mostrado en las figuras de dicha solicitud no es posible de lograr por el método de termoformado que propone la solicitante CARVAJAL S.A.

Quiero llamar su atención a las figuras 1B, 2B, 3A, 3B, 3C en donde se muestra el objeto de la solicitud objeto de esta oposición. En estas figuras se pueden observar unos cortes hechos a los envases para poder visualizar la sección de los anillos que supuestamente cumplen el objeto de dar refuerzo al envase de manera que no se colapse con los cambios de presión. Se ve a partir de las figuras que dichos anillos de refuerzo tienen una sección de corte transversal perfectamente triangular. Este tipo de figura no se puede lograr por el proceso de termoformado que se utiliza para obtener el envase en cuestión.

Tomando como referencia un libro técnico especializado en termoformado, titulado "Thermoforming" A practical guide, editado por Adolf Illig y publicado por Hanser Publishers, Munich Alemania, páginas 102 y 103, las cuales adjunto aquí como prueba, se muestra la influencia que tiene el contorno o forma del contramolde o preformador y la carrera o avance del

contramolde, entre otras variables que afectan el termoformado. Del libro se puede concluir que dependiendo de la magnitud del radio de la base se forma una acumulación del material plástico en la porción de arriba del envase si el radio es grande o en la porción de abajo del envase si el radio es pequeño (Ver Fig 4.48, en la página 102).

En la página 103, la figura 4.50 muestra un incremento de espesor en la pared lateral del envase con una disminución en el fondo aunque más gruesa que en la porción superior. Es interesante que estos sucesos mostrados en las figuras mencionadas del libro son causados por "error" en el diseño del molde o del contramolde y otros factores que afectan el termoformado.

La solicitante CARVAJAL S.A. logró en la realidad lo que se muestra en la figura 4.50. Es decir, como expertos en la técnica y conocedores de la teoría del termoformado simplemente diseñaron el molde o el contramolde para obtener los efectos de lo mostrado por la figura 4.50 de la página 103 de este libro. Lo reivindicado en la solicitud objeto de esta oposición difiere sustancialmente de lo obtenido en la práctica por la solicitante. La razón de la diferencia es que lo propuesto en la solicitud no puede lograrse por termoformado, mientras que lo obtenido en la práctica es el producto de un error en termoformado que cualquier experto en esta técnica puede lograr variando las dimensiones del contramolde y otras variables como temperatura, la carrera del contramolde y la velocidad de entrada. En la página 104 bajo el subtítulo "Influencia ejercida por la secuencia de formado, o el inicio temporizado del aire de formado y el movimiento del contramolde" dice: El material sujetado está siendo preformado con el contramolde por medio de preformado mecánico, tan pronto como la herramienta se cierra. Si el movimiento del contramolde se inicia temprano, es decir, justo después de que el material ha sido sujetado (Fig. 4.51), puede ser muy posible procesar una pequeña cantidad de nuevo material de desperdicio por los lados. Se advierte en contra de esto, por razones de repetitibilidad precisa y buena distribución en el espesor de la pared. Si el material ha sido formado estando relativamente caliente, muy prontamente un movimiento del contramolde puede resultar en marcar de enfriado y espesores de pared irregulares en la zona de borde del artículo completado (Fig. 4.51). Si el aire formador del artículo se deja fluir muy rápido, este separará el material caliente del contramolde muy pronto. Por lo tanto el contramolde es incapaz de llevar a cabo su tarea completamente, a pesar de la continuidad de su movimiento. Entonces la base se vuelve muy delgada. Si el aire formador se coloca muy tarde, el contramolde empuja mucho material en la base: esta entonces será muy gruesa y las paredes del artículo serán muy delgadas. De esta manera, al combinar y variar los factores que afectan el termoformado, se pueden lograr diferentes perfiles de distribución de material en las paredes y el fondo del artículo. Esto es lo que ha utilizado la solicitante del modelo de utilidad objeto de la oposición para lograr un producto que no se parece a lo que muestra en los dibujos y la descripción como se puede ver en la muestra física de lo que comercia bajo dicha solicitud de patente de modelo de utilidad. Junto con el presente escrito presento una muestra de uno de los envases que produce y vende la solicitante supuestamente de acuerdo con la invención. A simple vista o mejor tacto con los dedos se puede apreciar lo discutido aquí.

Igualmente, de acuerdo con lo anterior la solicitud objeto de esta oposición carece de novedad puesto que se basa en una verdad ya conocida en la técnica del termoformado, además de falta de aplicación industrial puesto que el diseño como se muestra en las figuras de la solicitud de patente de modelo de utilidad es imposible de lograrse por termoformado. Adicionalmente, manifiesto que esta teoría del termoformado se menciona en varios otros libros que describen esta técnica.

Por ejemplo, menciono el libro "Thermoforming on RDM Machines" edición del 5 de abril de 1999, en donde se analizan las pautas técnicas para el diseño de los moldes y la utilización de la maquinaria en donde se puede corroborar lo analizado anteriormente.

De otro lado, se adjunta la siguiente información de patentes estadounidenses relacionadas con el tema y que muestran lo conocido en el estado de la técnica.

- Patente Estadounidense No. US 4.220.683 de Septiembre 2, 1980 ✓
- Patente Estadounidense No. US 4.443.401 de Abril 17, de 1984 ✓
- Patente Estadounidense No. US 4.608.009 de Agosto 26 de 1986 ✓
- Patente Estadounidense No. US 5.290.490 de Marzo 1 de 1994 ✓
- Patente Estadounidense No. US 5.795.535 de Agosto 18 de 1998 ✓
- Patente Estadounidense No. US 5.571.473 de Noviembre 5 de 1996 ✓
- Patente Estadounidense No. US 5.591.463 de Enero 7 de 1997 ✓
- Patente Estadounidense No. US 5.650.110 de Julio 22 de 1997 ✓

Cada una de las citas anteriores y de las cuales adjunto una copia están relacionadas con el tema del termoformado de artículos como el de la solicitud objeto de la oposición. En ellas se resuelven los problemas comunes al termoformado. En particular quiero destacar la patente estadounidense No. 4.443.401 en cuanto menciona justamente el problema de los errores del termoformado (Ver pags. 3 y 4).

Este análisis e información adicional le aportan a su Despacho herramientas para analizar si la solicitud de patente de modelo de utilidad cumple con los requisitos de ley para ser otorgada o no. La información suministrada dice que no.

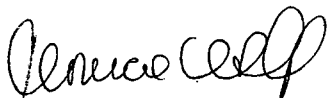
ANEXOS

Lo indicado.

NOTIFICACIONES

Recibiré notificaciones en la secretaría de ese despacho y en nuestras oficinas localizadas en la Diag. 83A No. 23-90 de Bogotá.

De Usted, Cordialmente



MONICA WOLF WASSERMAN
C.C. 51.711.267 DE BOGOTA
T.P.A. No. 46.034 del C. S. de la J.

109 46

Traducción oficial del idioma alemán no.: 26-151

En todas las hojas: sellos de autenticación en español

Hoja 1:

Günther Kiefer / Peter Schwarzmann

Moldeado térmico en la práctica

Editado por Adolf Illig

Editorial Carl Hanser Munich Viena

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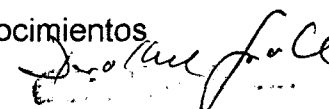
Hoja 3:

Prefacio

El procedimiento de fabricación del modelado térmico se aplica en la producción industrial en una medida considerada imposible hace pocas décadas.

Aparte de las áreas tradicionales, es decir, el moldeado de placas para displays, refrigeradores y partes de automóviles, el moldeado térmico conquistó en el moldeado de aire comprimido de empaques una importante participación en el mercado. Materiales termoplásticos constantemente mejorados permiten con las máquinas y herramientas más modernas un incremento del rendimiento de cantidades con, al mismo tiempo, una más alta precisión de las piezas moldeadas.

El moldeado térmico inicialmente más artesanal, se estableció como procedimiento de fabricación, que utiliza consecuentemente conocimientos


Traducción oficial de la Oficina de
Resolución No. 2301 de Minjusticia
1994

científicos de la ciencia de materiales y de la técnica de medición y regulación. La reproducibilidad de los parámetros de procedimientos permite la aplicación del procedimiento en instalaciones de alto rendimiento para el uso industrial.

Aparte de múltiples revistas, ... (ilegible) publican los fundamentos del moldeo térmico en ... (ilegible) de la ADOLF ILLIG Maschinenbau GmbH & Co. Pero falta una presentación resumida de los fundamentos y procedimientos que puede transmitirles tanto a los estudiantes como también a los ingenieros y técnicos ya en la práctica, una introducción en la especialidad y los conocimientos básicos para un tratamiento profundo de cuestiones particulares.

El objetivo del libro "Moldeo térmico en la práctica" es él de cerrar los huecos indicados.

Aparte de materiales termoplásticos se describen todos los pasos del procedimiento del moldeo térmico, los tipos esenciales de máquinas y las bases para la construcción de formas y herramientas y todo eso se aclara con ejemplos de la práctica. La historia de la evolución de este libro es estrictamente relacionada con la historia de 50 años de la empresa ILLIG. Por lo tanto, en él influyeron una cantidad de estímulos y experiencias, para cuya amplia descripción le doy especialmente gracias a los autores, el señor Peter Schwarzmann y el señor Günther Kiefer.

Le doy las gracias al señor Prof. Dr. Günther Harsch por la revisión crítica del manuscrito y de los complementos. El editor y los autores esperan que el "Moldeo térmico en la práctica" facilite la iniciación en el moldeo térmico y sea una ayuda útil para la solución de problemas.

Heilbronn, mayo 1997

Adolf Hillig *Adolf Hillig*
Produktion ...
Erscheinung Nr. 2.01 de ...
1994

4.8 Moldeo térmico con herramientas de moldeo y de estampado combinadas

4.8.1 Herramientas de modelado y de estampado con corte de cizallar

El gráfico 4.46 muestra una herramienta de moldeo y de estampado combinada con corte de cizallar. *Proceso de moldeo /estampado:*

- Transportar la lamina calentada en la herramienta abierta.
- Cerrar la herramienta (la mitad de la herramienta con el inserto de herramienta esta móvil la otra mitad fija.) Mientras la herramienta se cierra, la lámina es cortada por la placa de corte y el macho de corte y el borde de la pieza a moldear es sostenida por el sujetador.
- Mover el macho hacia la parte baja de la mitad de la herramienta; así, la lámina sujeta es preformada por el preestiramiento mecánico. Durante el movimiento del macho se adiciona el aire moldeador y, con una presión entre 500 kPa y 700 kPa (5 hasta 7 bar), la pieza a moldear se moldea completamente.
- Enfriar hasta que la pieza moldeada baja, con su parte más gruesa que es, en la mayoría de los casos, el borde, por debajo de la temperatura de reblandecimiento para que la pieza moldeada pueda sacarse sin reposición del molde.
- Apagar el aire moldeador

- Estampar mediante el *movimiento estampador*, con un movimiento vertical de la parte inferior de la herramienta de aproximadamente 0,8 mm la pieza moldeada acabada es recortada.
- Abrir la herramienta de moldeo moviendo la mitad inferior de la herramienta.
- Expulsar la pieza moldeada estampada mediante un movimiento vertical del fondo expulsador hacia arriba.

Ventajas de la combinación de moldeo y estampado con corte de cizallar en una herramienta:

- corte perfectamente céntrico hacia la pieza moldeada ("pérdida de corte" igual a cero)
- borde de corte limpio, liso, es decir, no se necesitan contrates de sustento, no hay puntos de rotura ni polvo de estampado ni rebada
- alta durabilidad de las herramientas: (1,5 hasta 3,5) millones de carreras de estampado hasta el primer reafileado de la placa de corte

Posibilidades de influencia en la *distribución del espesor de las paredes* de la pieza moldeada:

- contorno del macho (el macho sirve como macho prelamador)
- recorrido del macho
- material del macho
- temperatura del macho
- punto del inicio del aire moldeador en relación con el movimiento del macho

- temperatura del producto semiacabado en el momento de la deformación, con lo cual tanto la temperatura de la parte superior como de la parte inferior del producto semiacabado pueden ser de importancia
- suma de los cortes transversales del aire evacuado en relación con el volumen del aire suprimido durante el tiempo de deformación.

Hoja 5:

Moldeado térmico con herramientas de moldeo y de estampado combinadas 101

Hay un gráfico:

Gráfico 4.46

Herramienta de moldeo y de estampado con corte de cizallar

1. placa de cabeza
2. aire comprimido para el sujetador
3. placa intermedia, parte superior de la herramienta (camisa de enfriamiento)
4. aire moldeador (aire comprimido para el proceso de moldeo)
5. macho prelamador
6. sujetador
7. agua de enfriamiento para la placa de corte
8. placa de corte (matriz)
9. producto semiacabado
10. macho de corte (patrón)
11. agua de enfriamiento para la mitad inferior de la herramienta
12. inserto de la herramienta
13. pieza moldeada
14. fondo expulsor

15. bloque de enfriamiento, mitad inferior de la herramienta (camisa de enfriamiento)

16. placa básica

En la siguiente parte se mostrarán los *factores de influencia* con el ejemplo de una pieza moldeada redonda (gráfico 4.47)

Hay un gráfico

Gráfico 4.47

Contorno de macho para una herramienta de moldeo y estampado

Hoja 6:

102 4 Procedimientos con el moldeo térmico

Influencia del contorno del macho

El contorno del macho (gráfico 4.47) puede determinarse con los siguientes *valores de experiencia*:

Para la *distancia a* del macho hasta la herramienta puede valer:

$$a = 1,5 \cdot \text{espesor de la lámina } s + (1 \text{ mm hasta } 3 \text{ mm})$$

El *diámetro exterior* D_5 del macho prelamador se orienta en el *diámetro interior*

D_N del sujetador y resulta en

$$D_5 = D_N - (2 \text{ mm hasta } 4 \text{ mm})$$

Los *radios de fondo* R se orientan en el producto semiacabado a moldear. Se

selecciona un *pequeño* radio de fondo R_1 para productos semiacabados con

escasa fricción deslizante como PS, PS-HI, PET, PVC y un *gran* radio de fondo R_2

para productos semiacabados con alta fricción deslizante como PP:

$$R_1 = (5 \text{ mm hasta } 6 \text{ mm})$$

$$R_2 = (10 \text{ mm hasta } 20 \text{ mm}) \text{ y más}$$

A observar: Lo más pequeño que es el radio de fondo R del macho, lo más grueso es el fondo y viceversa. El área del fondo se vuelve más delgado cuando se aumenta el radio R del macho. El punto más delgado de una pieza moldeada está, al utilizar un macho con un radio de fondo R, muy pequeño en la pared lateral abajo (gráfico 4.48) y, al utilizar un macho con un gran radio de fondo R en la esquina de fondo de la pieza moldeada (gráfico 4.48) o en el área del piñón tensor.

Hay dos gráficos

Gráfico 4.48 Distribución del espesor de las paredes en el área del fondo

a) radio del macho demasiado pequeño, b) radio del macho demasiado grande
1 macho, 2 pieza moldeada, 3 herramienta

Influencia del recorrido del macho

En posición retractada con la herramienta cerrada el macho no debe tocar la lámina sujeta antes de iniciar su movimiento. En el momento en que el macho alcanza su posición final (punto más bajo), la distancia a hacia el fondo (gráfico 4.47) debería corresponder aproximadamente al siguiente valor

$$a = 1,5 \cdot \text{espesura de la lámina } s + (1\text{mm hasta } 2 \text{ mm}).$$

En ningún caso el macho puede inmergir de la manera que atasque la lámina en el fondo. Una posibilidad de determinar esta distancia con plastilina se muestra en el gráfico 4.49. Cuando la profundidad de inmersión se reduce demasiado para así lograr una placa de fondo más delgado, el resultado pueden ser espesores no iguales de las paredes laterales (gráfico 4.50).

Hoja 7:

Moldeado térmico con herramientas de moldeo y de estampado combinadas 103

Hay un gráfico

Gráfico 4.49

Determinación de la distancia exacta del macho del fondo de la herramienta utilizando plastilina (distancia del macho a = espesor de la plastilina espichada)

Hay un gráfico:

Gráfico 4.50

Engrosamiento I en la pared lateral, cuando el radio R es pequeño y la distancia b del macho grande.

Influencia del material del macho

En la tabla 2.4 se recomiendan materiales para el macho prelamador aptos para productos acabados sintéticos. Hay que evitar combinaciones de herramientas *desfavorables*. Cuando, por ejemplo, se utiliza para el moldeo térmico de PP un macho prelamador de fieltro, el fondo del vaso será demasiado grueso, porque el fieltro es muy áspero para PP. Cuando se utiliza para el moldeo de PS-HI un macho prelamador de PTFE (por ejemplo teflon), el fondo de un vaso será muy delgado, también cuando el aire moldeador se prende, después de que el macho haya alcanzado su posición final. La tabla 4.1 da para los sintéticos utilizados principalmente en autómatas de cilindros, indicaciones para materiales aptos para macho prelamadores

Tabla 4.1 Materiales para machos prelamadores para autómatas de cilindros

	Materiales para macho superiores		
lámina	POM	fieltro endurecido	espuma sintáctica ¹⁾
PS-HI		x	x
estirolux, K-resin	x		x
PP	x		x

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 Profesor Dr. Dr. habil. Dr. habil. Dr. habil.
 Dr. habil. Dr. habil. Dr. habil. Dr. habil.
 Dr. habil. Dr. habil. Dr. habil. Dr. habil.

PP transparente	x		
PVC		x	x
PVC transparente			x
PET (PETG, APET)	x		x
PET transparente	x		

Hoja 8:

104

4 Procedimientos con el moldeado térmico

1) Nota la pie acerca de la tabla 4.1: Esferas huecas de micro-vidrio combinado en resina epoxi

Para láminas de capas múltiples con una capa exterior de PE deberían utilizarse machos de PTEE, cuando el lado PE es tocado por el macho superior.

Características de los diferentes materiales para machos prelaminares

Polioximetileno POM, por ejemplo (DuPont), Ultraform (BASF) Hostaform (Hoechst)

- material económico para machos prelaminares
- puede ser procesado sin problemas
- mejor material para piezas transparentes
- no es apto para PVC
- escasa carga continua, max. 110°C hasta 120°C
- la superficie se vuelve más lisa, adquiere un color café y forma hendiduras
- después de 30 hasta 100 horas de trabajo la superficie tiene que ser relijada en la mayoría de los casos, con excepción de los machos pulidos para piezas transparentes

- en conexión con láminas PS existen dificultades de arranque por el choque térmico cuando los machos prelamadores son fríos.

Fieltro endurecido (endurecido según la fórmula 647, empresa Filzfabrik Fulda, en el comercio en placas hasta 88 mm de espesor, placas de fieltro no endurecidas con espesores por encima de 80 mm pueden ser endurecidas superficialmente con Clou fondo de admisión):

- sin problemas de arranque con láminas PS y PVC
- no apto para materiales transparentes por fuertes marcaciones en la pieza a estirar
- no apto para PP porque se pega en la lámina
- unión fácil con la barra del macho prelamador
- entre las materiales propuestas aquí, el fieltro es el más costoso

Espuma sintáctica (por ejemplo Syntac 350 de la empresa Emerson & Cumming/USA)

- universalmente aplicable con escasas limitaciones para piezas moldeadas transparentes
- al trabajar por arranque de material se produce polvo
- bajo el nombre 351 también en el comercio como modificación para colar; pero la colación es muy dispendiosa.

Influencia del proceso de moldeo, o sea, de la utilización temporal del aire moldeador y del movimiento del macho

Tan pronto que la herramienta esté cerrada, el producto semiacabado sujetado es preformado mediante el estiramiento mecánico. En el caso de que el movimiento

del macho empieza poco antes de que la lámina esté sujeta (gráfico 4.51), un poco del material sintético del área de residuos puede también ser estirada pero, por razones de una buena reproducibilidad y para una buena distribución de los espesores de las paredes, no debería moldearse de esta manera. En el caso de que la lámina fuera moldeada con temperaturas relativamente altas, pueden darse, por un movimiento temprano del macho, marcas de choque térmico y espesores irregulares de las paredes en la parte marginal de la pieza acabada (gráfico 4.51). En el caso de que el aire moldeador para el moldeo se prende muy temprano, éste desprende el material sintético muy temprano del macho.

Hoja 9:

Moldeado térmico con herramientas de moldeo y de estampado combinadas 105

Así, el macho no puede cumplir con su tarea, a pesar de su siguiente movimiento; el fondo se vuelve muy delgado. Si, por el contrario, el aire moldeador se prende muy tarde, el macho empuja demasiado material en el fondo; el fondo se vuelve muy grueso y las paredes laterales de la pieza moldeada se vuelven muy delgadas.

Hay un gráfico

Gráfico 4.51

Distribución no reproducible del espesor de las paredes en el área marginal, cuando el movimiento del macho se da antes de que la herramienta esté cerrada.

Influencia de la temperatura de formación de la pieza semiacabada en la distribución del espesor de las paredes

Se aspira a alcanzar con la más baja temperatura moldeadora posible una exactitud de moldeo todavía justificable. Con temperaturas de moldeo más

altas, el fondo de la pieza moldeada se vuelve con el mismo proceso de moldeo más grueso; y eso porque con temperaturas más altas se da menos tensión en la lámina y, al mismo tiempo, la fricción entre el macho y la lámina se incrementa.

Influencia de la suma de los cortes laterales del aire evacuado en la distribución de los espesores de las paredes

En el caso de que en una herramienta negativa la suma de los cortes laterales del aire evacuado es muy pequeña, se da una contrapresión al inmergir el macho en el molde que incrementa la fuerza de fricción entre la lámina y el macho y retarda el desprendimiento de la lámina por el aire moldeador; como resultado hay una pieza moldeada con un fondo más grueso.

4.8.2 Herramienta de moldeo y estampado combinada para piezas moldeadas sin borde

En diferencia de una herramienta de moldeo y estampado estándar con corte de cizallar, aquí lo que se mueve es la placa de corte y el macho de corte está fijo (gráfico 4.52)

Hay un gráfico:

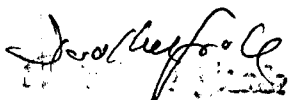
Gráfico 4.52

Herramienta de moldeo y estampado para piezas moldeadas sin borde

a) herramienta, b) pieza moldeada

1 macho de corte, 2 macho prelamador, 3 sujetador, 4 pieza acabada antes de la expulsión, 5 placa de corte, 6 expulsador

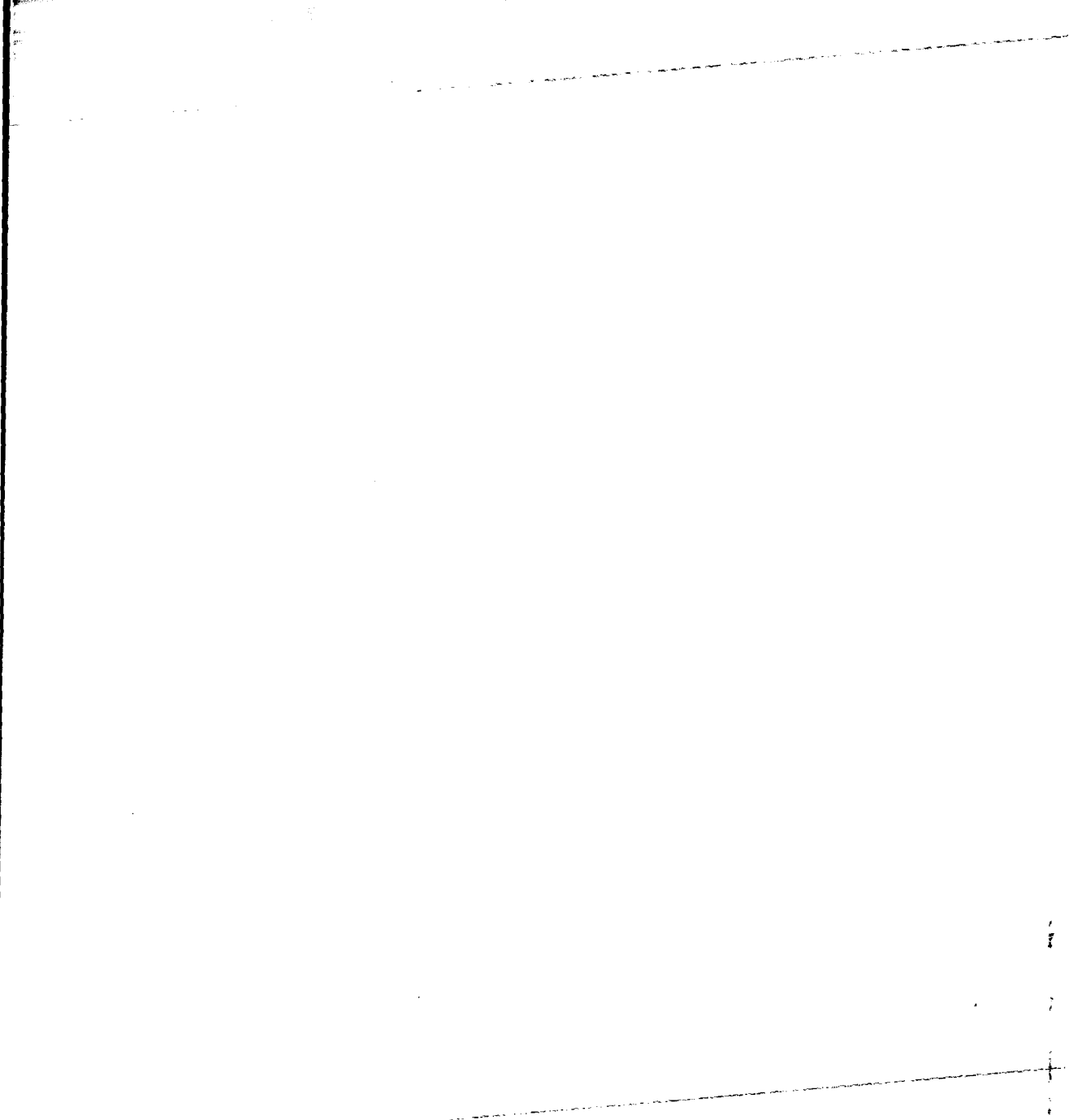
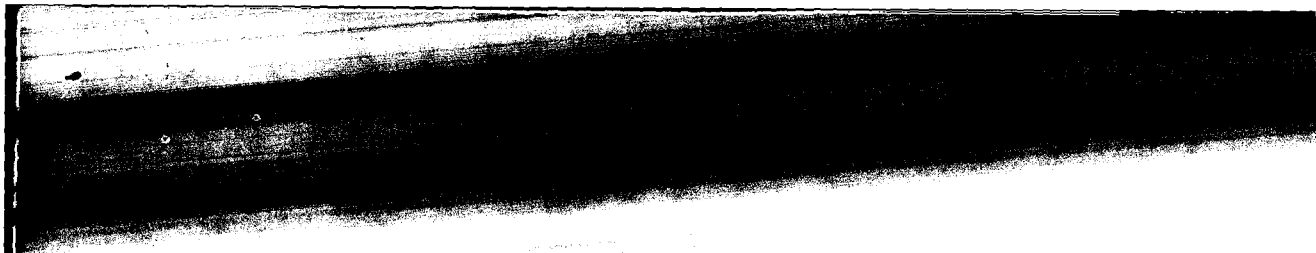
Es traducción fiel y completa del original



Dorothee Grote, traductora e intérprete oficial

Traducción Fiel y Completa
Resolución no. 2501 del Ministerio de Justicia
1994

Resolución no. 2501 del Ministerio de Justicia 1994



Günther Kiefer / Peter Schwarzmann

Thermoformen in der Praxis

Herausgegeben von

Adolf Illig

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Herausgeber

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Vorwort

Die Fertigungsverfahren der Thermoformung werden in der industriellen Produktion in einem vor wenigen Jahrzehnten noch nicht für möglich gehaltenen Ausmaß angewandt.

Neben den traditionellen Gebieten, der Vakuumformung von Platten für Displays, Kühlschränke oder Automobilteile hat sich das Thermoformen bei der Druckluftformung von Verpackungen einen bedeutenden Marktanteil erobert. Ständig verbesserte Thermo-
plaste erlauben mit modernsten Maschinen und Werkzeugen eine Steigerung der Mengenleistung bei gleichzeitig erhöhter Präzision der Formteile.

Das ursprünglich mehr handwerkliche Thermoformen hat sich als Fertigungsverfahren etabliert, das wissenschaftliche Erkenntnisse der Werkstoffkunde, der Meß- und Regelungstechnik konsequent nutzt. Die Reproduzierbarkeit der Verfahrensparameter erlaubt den Einsatz des Verfahrens in Hochleistungsanlagen für den industriellen Einsatz.

Neben zahlreichen Zeitschriftenveröffentlichungen werden die Grundlagen des Thermoformens seit Jahrzehnten in Lehrgängen der **ADOLF ILLIG Maschinenbau GmbH & Co** vermittelt. Es fehlt jedoch eine zusammenfassende Darstellung der Grundlagen und Verfahren, die gleichzeitig den Studierenden und den bereits in der Praxis stehenden Ingenieuren und Technikern eine Einführung in das Fachgebiet ist und das Grundwissen zur vertieften Behandlung von Einzelfragen vermitteln kann.

Die aufgezeigte Lücke mit der genannten Zielsetzung zu schließen, ist das Anliegen des Buches „Thermoformen in der Praxis“.

Neben den Thermoplasten werden alle Verfahrensschritte beim Thermoformen, die wesentlichen Maschinentypen und Grundlagen für den Bau von Formen und Werkzeugen umfassend geschildert und mit Praxisbeispielen erläutert. Die Entstehungsgeschichte dieses Buches ist eng mit der 50-jährigen Firmengeschichte der Firma **ILLIG** verbunden. Dementsprechend sind eine Vielzahl von Anregungen und Erfahrungen eingeflossen, für deren umfassende Darstellung den Autoren Herrn **Peter Schwarzmann** und Herrn **Günther Kiefer** mein besonderer Dank gilt.

Für die kritische Durchsicht des Manuskriptes, zahlreiche Verbesserungsvorschläge und Ergänzungen danke ich Herrn Prof. Dr. **Günther Harsch**. Herausgeber und Autoren hoffen, daß „Thermoformen in der Praxis“ die Einarbeitung in das Thermoformen erleichtert und bei der Lösung von Problemen eine nützliche Hilfe ist.

Heilbronn, im Mai 1997

Adolf Illig

17

4.8 Thermoformung mit kombinierten Form- und Stanzwerkzeugen

4.8.1 Form- Stanz-Werkzeug mit Scherschnitt

Bild 4.46 zeigt ein kombiniertes Form- und Stanzwerkzeug mit Scherschnitt. Ablauf des Form- und Stanzvorgangs:

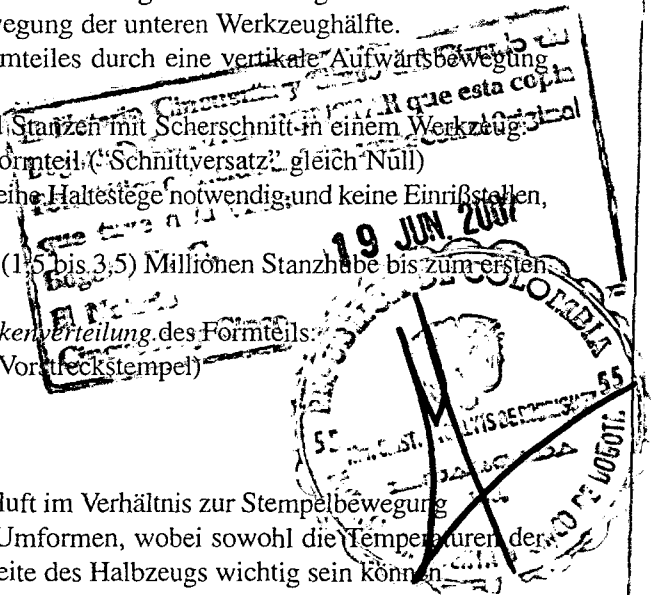
- Aufgeheizte Folie in das geöffnete Werkzeug transportieren.
- Werkzeug schließen (die Werkzeughälfte mit dem Werkzeugeinsatz ist beweglich, die andere Hälfte ist feststehend). Während des Schließens wird die Folie von der Schnittplatte und dem Schnittstempel angeschnitten und der Formteilrand vom Niederhalter festgehalten.
- Stempel in die untere Werkzeughälfte fahren; dadurch wird die eingespannte Folie durch mechanisches Vorstrecken vorgeformt. Während der Stempelbewegung wird die Formungsluft zugeführt und mit einem Druck zwischen 500 kPa und 700 kPa (5 bar bis 7 bar) wird das Formteil ausgeformt.
- Kühlen bis die Temperatur des Formteils an der dicksten Stelle, meist im Randbereich, unter die Erweichungstemperatur sinkt, damit das Formteil ohne Rückstellung entformt werden kann.
- Formungsluft abschalten.
- Stanzen durch die *Stanzbewegung*; mit einer vertikalen Bewegung der unteren Werkzeughälfte von ca. 0,8 mm wird das fertige Formteil ausgeschnitten.
- Formwerkzeug öffnen durch Bewegung der unteren Werkzeughälfte.
- Ausstoßen des ausgestanzten Formteiles durch eine vertikale Aufwärtsbewegung des Auswerferbodens.

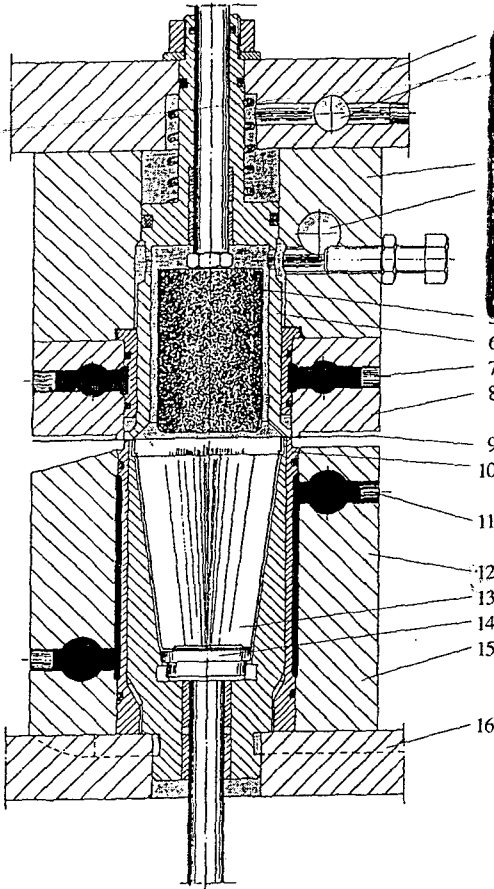
Vorteile der Kombination Formen und Stanzen mit Scherschnitt in einem Werkzeug:

- perfekt zentrischer Schnitt zum Formteil („Schnittversatz“ gleich Null)
- sauberer, glatter Schnitttrand, d.h. keine Haltestege notwendig, und keine Einrißstellen, kein Stanzstaub und kein Grat
- hohe Standzeiten der Werkzeuge: (1,5 bis 3,5) Millionen Stanzhube bis zum ersten Nachschliff der Schnittplatte.

Einflußmöglichkeiten auf die Wanddickenverteilung des Formteils:

- Stempelkontur (Stempel dient als Vorstreckstempel)
- Stempelweg
- Stempelwerkstoff
- Stempeltemperatur
- zeitliches Einsetzen der Formungsluft im Verhältnis zur Stempelbewegung
- Temperatur des Halbzeugs beim Umformen, wobei sowohl die Temperaturen der Oberseite, als auch die der Unterseite des Halbzeugs wichtig sein können
- Summe der Abluftquerschnitte in Bezug zum während der Umformzeit verdrängten Luftvolumen.





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- Bild 4.46
- Form- und Stanzwerkzeug mit Scherschnitt
- 1 Kopfplatte
 - 2 Druckluft für Niederhalter
 - 3 Zwischenplatte, Werkzeugoberteil (Kühlmantel)
 - 4 Formungsluft (Druckluft, Formvorgang)
 - 5 Vorstreckstempel
 - 6 Niederhalter
 - 7 Kühlwasser für Schnittplatte
 - 8 Schnittplatte (Matrize)
 - 9 Halbzeug
 - 10 Schnittstempel (Patrize)
 - 11 Kühlwasser für untere Werkzeughälfte
 - 12 Werkzeugeinsatz
 - 13 Formteil
 - 14 Auswerferboden
 - 15 Kühlblock, untere Werkzeughälfte (Kühlmantel)
 - 16 Grundplatte

Nachfolgend werden die *Einflußgrößen* am Beispiel eines runden Formteils (Bild 4.47) aufgezeigt.

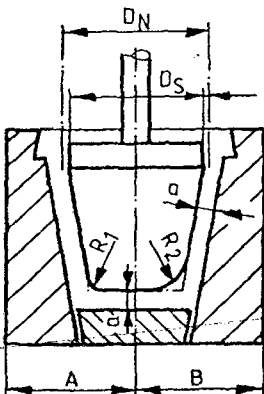


Bild 4.47
Stempelkontur für ein Form- und Stanz-Werkzeug

Einfluß der Stempelkontur

Es kann mit nachstehenden Erfahrungswerten die Stempelkontur (Bild 4.47) festgelegt werden:

Für den Abstand a Stempel bis Werkzeug kann gelten:

$$a = 1,5 \cdot \text{Foliendicke } s + (1 \text{ mm bis } 3 \text{ mm})$$

Der Außendurchmesser D_S des Vorstreckstempels richtet sich nach dem Innendurchmesser D_N des Niederhalters und ergibt sich zu

$$D_S = D_N - (2 \text{ mm bis } 4 \text{ mm})$$

Die Bodenradien R richten sich nach dem umzuformenden Halbzeug. Es wird gewählt ein kleiner Bodenradius R_1 für Halbzeuge mit kleiner Gleitreibung wie PS, PS-HI, PET, PVC und ein großer Bodenradius R_2 für Halbzeuge mit hoher Gleitreibung wie PP:

$$R_1 = (5 \text{ mm bis } 6 \text{ mm})$$

$$R_2 = (10 \text{ mm bis } 20 \text{ mm}) \text{ und höher.}$$

Beachte: Je kleiner der Bodenradius R des Stempels, um so dicker wird der Boden und umgekehrt. Der Bodenbereich wird dünner, wenn der Stempelradius R vergrößert wird. Die dünnste Stelle in einem Formteil liegt beim Einsatz eines Stempels mit sehr kleinem Bodenradius R in der Seitenwand unten (Bild 4.48 a) und beim Einsatz eines Stempels mit großem Bodenradius R in der Bodenecke des Formteils (Bild 4.48 b) oder im Bereich des Spannrandes.

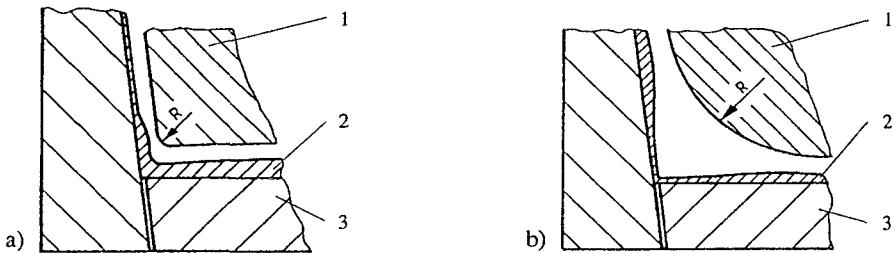


Bild 4.48 Wanddickenverteilung im Bodenbereich
a) Stempelradius zu klein, b) Stempelradius zu groß
1 Stempel, 2 Formteil, 3 Werkzeug

Einfluß des Stempelwegs

Der Stempel darf in zurückgefahrener Position, bei geschlossenem Werkzeug, die eingespannte Folie nicht berühren, bevor er seine Bewegung beginnt. Erreicht der Stempel seine Endposition (tiefste Stelle), sollte der Abstand a zum Boden (Bild 4.47) in etwa folgendem Wert entsprechen

$$a = 1,5 \cdot \text{Foliendicke } s + (1 \text{ mm bis } 2 \text{ mm})$$

Der Stempel darf keineswegs so tief einfahren, daß er die Folie im Boden festklemmt. Eine Möglichkeit, diesen Abstand mit "Knetmasse" (Plastilin) zu ermitteln, zeigt Bild 4.49. Wird die Eintauchtiefe zu stark verringert, um eine dünnere Bodenpartie zu erreichen, kann dies zu ungleichen Seitenwanddicken führen (Bild 4.50).

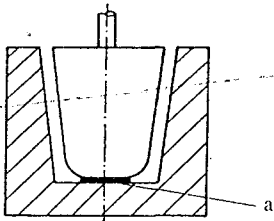


Bild 4.49

Feststellen des genauen Stempelabstandes vom Boden des Werkzeuges mit Hilfe von Plastilin: (Stempelabstand a = Dicke des verquetschten Plastilins)

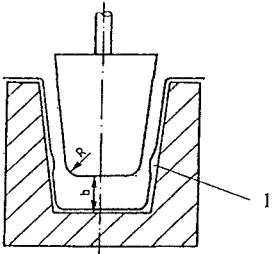


Bild 4.50

Verdickung l in der Seitenwand, wenn Radius R klein und Stempelabstand b zu groß

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Einfluß des Stempelwerkstoffes

In Tabelle 2.4 werden für die Kunststoffhalbzeuge geeignete Werkstoffe für Vorstreckstempel empfohlen. *Ungünstige* Werkstoffkombinationen sind zu vermeiden. Wird z.B. bei der Thermoformung von PP ein Vorstreckstempel aus Filz verwendet, dann wird der Boden eines Bechers zu dick, weil Filz für PP zu rau ist. Wird bei der Thermoformung von PS-HI ein Vorstreckstempel aus PTFE (z.B. Teflon) eingesetzt, wird der Boden eines Bechers zu dünn, auch wenn die Formungsluft einsetzt, nachdem der Stempel seine Endposition erreicht hat. Tabelle 4.1 gibt für die hauptsächlich in Rollenautomaten eingesetzten Kunststoffe Hinweise für geeignete Vorstreckstempelwerkstoffe.

Tabelle 4.1 Vorstreckstempelwerkstoffe für Rollenautomaten

	Oberstempelwerkstoffe		
Folie	POM	Filz gehärtet	Syntaktischer Schaum ¹⁾
PS-HI		X	X
Styrolux, K-Resin	X		X
PP	X		X
PP "glasklar"	X		
PVC		X	X
PVC "glasklar"			X
PET (PETG, APET)	X		X
PET "glasklar"	X		

¹⁾ siehe Seite 104 oben

b) Fußzeile zu Tabelle 4.1: Mikro-Glas-Hohlkugeln, gebunden in Epoxidharz
Für Mehrschichtfolien mit einer PE-Außenschicht sollten PTFE-Stempel eingesetzt werden, wenn die PE-Seite vom Oberstempel berührt wird.

Eigenschaften der einzelnen Vorstreckstempel-Werkstoffe

Polyoxymethylen POM, z.B. Delrin (DuPont), Ultraform (BASF), Hostaform (Hoechst)

- preisgünstiger Vorstreckstempelwerkstoff
- problemlos verarbeitbar
- bestes Material für Glasklarteile
- nicht für PVC geeignet
- geringe Dauertemperaturbelastung max. 110 °C bis 120 °C
- Oberfläche glättet nach, wird bräunlich und bildet Risse
- nach jeweils 30 bis 100 Arbeitsstunden muß in den meisten Fällen die Oberfläche wieder aufgeraut werden, mit Ausnahme der polierten Stempel für Glasklarteile
- in Verbindung mit PS-Folien gibt es Anfahrschwierigkeiten durch Abschreckung, wenn die Vorstreckstempel kalt sind.

Gehärteter Filz (gehärtet mit Rezeptur 647, Firma Filzfabrik Fulda; erhältlich in Platten bis 80 mm Dicke, ungehärtete Filzplatten mit Dicken über 80 mm können mit Einlaßgrund "oberflächengehärtet" werden):

- keine Anfahrprobleme bei PS- und PVC-Folien
- für Klarsichtmaterialien wegen starken Markierungen am Ziehteil ungeeignet
- für PP wegen Kleben an der Folie ungeeignet
- einfache Verbindung mit der Vorstreckstempelstange
- Filz ist unter den hier vorgeschlagenen der teuerste Werkstoff.

Syntaktischer Schaum (z.B. Syntac 350 der Firma Emerson & Cumming/USA):

- universell einsetzbar mit geringen Einschränkungen für glasklare Formteile
- beim Zerspanen fällt Staub an
- unter der Bezeichnung 351 auch als gießbare Modifikation erhältlich; das Gießen selbst ist aber sehr aufwendig.

Einfluß des Formungsablaufes, bzw. des zeitlichen Einsatzes der Formluft und der Stempelbewegung

Sobald das Werkzeug geschlossen ist, wird das eingeklemmte Halbzeug mit dem Stempel durch mechanisches Strecken vorgeformt. Beginnt die Stempelbewegung schon kurz bevor die Folie festgeklemmt ist (Bild 4.51), kann zwar geringfügig Kunststoff aus dem Abfallbereich mitverstreckt werden, aber aus Gründen einer guten Reproduzierbarkeit und für eine gute Wanddickenverteilung, sollte so nicht geformt werden. Wurde die Folie relativ heiß verformt, kann es durch eine zu früh einsetzende Stempelbewegung zu Abschreckmarken und unregelmäßigen Wanddicken im Randbereich des Fertigteils kommen (Bild 4.51). Wird die Formungsluft für das Ausformen des Formteils zu früh eingeschaltet, löst sie den heißen Kunststoff zu früh vom Stempel ab. Der

Stempel kann dadurch seine Aufgabe, trotz Weiterbewegung, nicht erfüllen; der Boden wird zu dünn. Wird die Formungsluft dagegen zu spät eingeschaltet; drückt der Stempel zu viel Material in den Boden; der Boden wird zu dick und die Seitenwände des Formteils werden zu dünn.

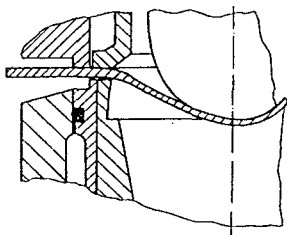


Bild 4.51

Nicht reproduzierbare Wändickenverteilung im Randbereich, wenn Stempelbewegung einsetzt, bevor Werkzeug geschlossen ist

Einfluß der Umformtemperatur des Halbzeugs auf die Wändickenverteilung

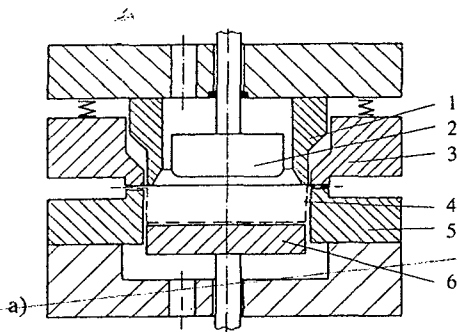
Angestrebt wird, mit der niedrigst-möglichen Umformtemperatur eine noch vertretbare Ausformschärfe zu erreichen. Bei höheren Umformtemperaturen wird bei gleichem Formungsablauf der Boden des Formteils dicker; das liegt daran, daß bei höherer Temperatur geringere Spannungen in der Folie bestehen und gleichzeitig die Reibung zwischen Stempel und Folie erhöht wird.

Einfluß der Summe der Abluftquerschnitte auf die Wändickenverteilung

Ist in einem Negativwerkzeug die Summe der Abluftquerschnitte zu klein, entsteht beim Eintauchen des Stempels in die Form ein Gegendruck, der die Reibkraft zwischen Folie und Stempel erhöht und das Ablösen der Folie vom Stempel durch die Formungsluft zeitlich verzögert; es ergibt sich ein Formteil mit dickerem Boden.

4.8.2 Kombiniertes Form- und Stanzwerkzeug für randlose Formteile

Im Unterschied zu einem Standard-Form-Stanz-Werkzeug mit Scherschnitt wird hier die Schnittplatte bewegt und der Schnittstempel steht fest (Bild 4.52).



b)



Bild 4.52

Form- und Stanzwerkzeug für randlose Formteile

a) Werkzeug, b) Formteil

1 Schnittstempel, 2 Vorstreckstempel, 3 Niederhalter, 4 Fertigteil vor dem Ausstoßen, 5 Schnittplatte, 6 Auswerfer

20

USPTO PATENT FULL-TEXT AND IMAGE DATABASE

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View Cart		Add to Cart		
Images				

(1 of 1)

United States Patent
Sauer

4,034,054
July 5, 1977

Process for thermoforming hollow articles

Abstract

There is disclosed a novel process for using a pressure box assembly associated with a thermoplastic thermoforming assembly. The pressure box assembly is provided with a diaphragm formed of a resilient material, such as synthetic rubber and the like, disposed across the entrance into a cavity of the pressure box of the pressure box assembly. The pressure box assembly is associated with thermoforming molding apparatus to cause a heat thermoplastic sheet or web to be drawn about a male mold provided on a male mold assembly during insertion of the male mold into the cavity in a hollow article of more uniform wall thickness.

Inventors: **Sauer; Donald G.** (Harwinton, CT)

Assignee: **National Can Corporation** (Chicago, IL)

Appl. No.: **507788**

Filed: **September 20, 1974**

Current U.S. Class:

264/313; 264/322

Intern'l Class:

B29C 017/04; B29F 005/00

Field of Search:

264/316,87,93,322,313,292

References Cited [Referenced By]

U.S. Patent Documents			
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<u>2648099</u>	Aug., 1953	Dunmire	264/93.
<u>2962757</u>	Dec., 1960	Slemmons et al.	264/93.
<u>3342915</u>	Sep., 1967	Wanderer	264/93.
<u>3608055</u>	Sep., 1971	Long	264/316.

Primary Examiner: Hoag; Willard E.

Attorney, Agent or Firm: Marn & Jangarathis

Claims

What is claimed is:

1. In a process for thermoforming a hollow plastic article from a sheet of heated thermoplastic material over a male mold contained to a desired internal shape of said article, wherein said sheet of thermoplastic material is firmly held between a pressure box assembly and a male mold assembly including said male mold, the improvement comprising:

(a) closing an entrance to a chamber of said pressure box by disposing a resilient diaphragm of elastomeric material across said entrance, between said sheet and said entrance;

(b) stretching and forming said sheet by moving and pressing said male mold against a side of said sheet

occupied by said diaphragm so that said resilient diaphragm causes said sheet to be drawn about said male mold, and maintaining chamber at a positive pressure with a compressible fluid during said stretching and forming.

Description

FIELD OF THE INVENTION

This invention relates to a process and apparatus for molding hollow plastic articles from a sheet or strip of thermoplastic material, and more particularly to a novel pressure box assembly and process and apparatus for the thermoforming of hollow plastic articles utilizing such assembly. This application relates to co-pending application U.S. Ser. No. 506,333, filed Sept. 16, 1974 and assigned to the same assignee as the present invention.

BACKGROUND OF THE INVENTION

This invention is particularly concerned with thermoforming operations in which a web or sheet of thermoplastic material is first softened by heat and then formed or shaped while in this stretchable plastic state by being drawn or pressed against the contours of a mold or die under the influence of a fluid pressure differential. The former may be exemplified by the application of pressure within a pressure box produced by compressed air or the like, to press the softened material against the contours of a male mold or core pin. Alternately, a vacuum may be applied from within a female mold while allowing atmospheric pressure to shape the heat softened thermoplastic material against the surface of the female mold. For many purposes, a combination of these two techniques is preferred with the softened sheet material being subjected to vacuum on the face as such combination provides greater versatility and better control in the forming operation.

Recently, a process has been advanced utilizing a preformed liner which produces a barrier container, i.e., a semi-rigid plastic container provided with a liner or inner layer of another material or materials having properties different than the outer layer thereof. In accordance with such process, the preformed liner or sleeve (manufactured, for example, by thermoforming techniques) is positioned over a core rod with a parison being subsequently formed about the liner in an injection station of an injection blow molding machine. The lined or composite parison is expanded in a blow molding station of the machine with the resulting lined container being removed from the core rod in a product receiving station. As a result of the creasing tendency of the liner during the formation of the preform due to orientation and/or size variations of the thermoformed liner, many barrier containers are formed which have poorly fitted liners.

OBJECTS OF THE INVENTION

An object of the present invention is to provide an improved process and apparatus for thermoforming hollow plastic articles which overcome the problems of the prior art.

Still another object of the present invention is to provide an improved process and apparatus for forming hollow plastic articles whereby creasing of the liner of a barrier container is substantially eliminated.

Another object of the present invention is to provide a novel pressure box assembly for a thermoforming process and apparatus.

Various other objects and advantages of the present invention will become apparent from the following detailed description of an exemplary embodiment thereof with the novel features thereof being particularly pointed out in the appended claims.

SUMMARY OF THE INVENTION

In accordance with one embodiment of the present invention, there is provided a pressure box assembly provided with a diaphragm formed of a resilient material, such as synthetic rubber and the like, disposed across the entrance into a cavity of the pressure box of the pressure box assembly, as more fully hereinafter described.

Another embodiment of the present invention is directed to the use of the hereinabove described pressure box assembly in a process and apparatus for thermoforming hollow articles, and in particular, such use for the production of liners of more uniform thickness to be used in the subsequent manufacture of barrier containers. Accordingly, such a pressure box assembly is associated with

mold provided on a male mold assembly during the formation of the hollow article. In this manner, the hollow article, e.g., a liner, is formed with more uniform wall thickness.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention will be more clearly understood by reference to the following detailed description of an exemplary embodiment thereof in conjunction with the accompanying drawings wherein like reference numerals designate like parts in all figures in which:

FIG. 1 is a vertical view, partially in section, of a thermoforming molding machine embodying the principles of the present invention with some accessories omitted for greater clarity; and

FIGS. 2 to 4 are schematic vertical side sections of the thermoforming machine of FIG. 1 sequentially illustrating the formation of a hollow article.

DETAILED DESCRIPTION OF THE DRAWINGS

It will be appreciated that the type of thermoplastic or thermoelastically deformable material employed in the present process is generally determined by the economics and duty to which the hollow article will eventually be placed. Among the many thermoplastic resins suitable for various purposes and adaptable to thermoforming are high-impact polystyrene, polybutadiene, styrene-butadiene blends or copolymers, polyvinylchloride and related vinyl polymers, polyallomers, nylon, formadehyde polymers, polyethylene, polypropylene, nitrocellulose, cellulose acetate, cellulose propionate, cellulose acetate butyrate, polymethylmethacrylate, ethyl cellulose, benzyl cellulose and ester-esters of cellulose.

Referring now to FIG. 1, a portion of a molding machine, generally indicated as 10, such as that manufactured by the Brown Machine Co. of Beavertown, Mich., is shown with a pressure box assembly, generally indicated as 12, and a male mold assembly, generally indicated as 14. While the particular disposition of apparatus elements depicted in FIG. 1 does not correspond with any stage of the actual forming cycle, this view illustrates the construction and arrangement of various parts of the equipment. The pressure box assembly 12 includes a pressure box 16 which is rigidly attached to an upper platen 18 and which may be provided with passageways (not shown) to permit the circulation of a heat transfer medium to cool, heat or maintain a constant temperature in the pressure box 16. The pressure box assembly 12 is constructed and arranged for vertical movement in the molding machine by suitable mechanism (not shown) as known to those skilled in the art.

The pressure box 16 is formed with a top wall 20 and side walls 22 defining a main cavity 24 of the pressure box 16. The pressure box 16 is provided with a clamping grid 26 rigidly mounted to the pressure box, such as by bolts 28, a flexible diaphragm 30 across the entrance to the cavity 24. The flexible diaphragm is formed of a resilient material, such as natural or synthetic rubber or the like of a thickness to cause the thermoplastic material to be drawn about the male mold, generally a thickness of from 1/16 to 3/32. It will be apparent to one skilled in the art that the resilient material must be carefully selected to accomplish the desired purpose with minimal turn around requirements. A side wall 22 of the pressure box 16 is provided with an orifice 32 to permit the introduction of a compressed fluid into the cavity 24 of the pressure box 16 by placing the orifice 32 in fluid communication by line 34 with the compression side of a pump, generally indicated as 36.

The male mold assembly 14 is comprised of a male mold 38 mounted, such as by screws 40, to a male mold support assembly, generally indicated as 42. The male mold 38 may be formed of a porous material (i.e., having a multiplicity of discrete passageways formed during the fabrication thereof), such as a two (2) micron stainless steel, such as disclosed in co-pending application U.S. Ser. No. 506,333, filed Sept. 16, 1974 assigned to the same assignee as the present invention. The male mold support assembly 42 may be provided with passageways not shown for the passage of an intermediate heat transfer fluid.

The male mold assembly 14 is provided with fluid cylinders 44 including piston rods 46 mounted on a lower platen 48. The male mold support assembly 42 is positioned about the upper ends of the fluid cylinders 44 by mounting brackets 50 formed on the side walls of the male mold support assembly 42. A clamp support assembly 52 including a clamp grid 54 is mounted, such as by bolts 56, to the ends of the piston rods 46, such as by brackets 58, formed on the clamp support assembly 52.

In FIG. 1 there is also illustrated a feed mechanism, generally indicated as 60, for advancing the thermoplastic web or sheet 62, after being heated to a softened state by suitable means (not shown), such as radiant heaters, infrared lamps, etc. The following description in conjunction with FIGS. 1 to 4 illustrates the sequence of steps in the formation of a hollow article in accordance with the present invention. As is known to those skilled in the art, the pressure box assembly 12, at the beginning of a

24
129

subsequent unimpeded horizontal passage of the formed article upon advancement of the thermoplastic sheet 62 by the mechanism 64.

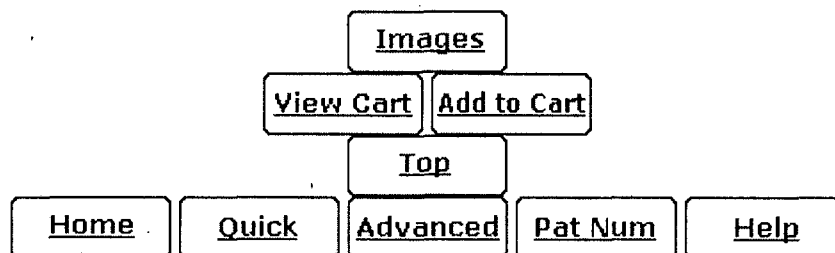
The strip of thermoplastic sheet 62 softened to an optimum forming temperature (i.e., to a stretchable plastic condition) is advanced by the feed mechanism 60 into position between the upper and lower assemblies 12 and 14. The upper platen 16 is caused to be moved downwardly to the point at which the clamp grid 26 is proximate to the sheet 62 with the lower platen 48 being raised to the position shown in FIG. 2 whereby the clamp grid 54 is pressed against the lower surface of the sheet 62 thus trapping the sheet or web of thermoplastic material around the entrance to the cavity 24 of the pressure box 16 between the grids 26 and 54. Positive pressure is continuously maintained on the fluid cylinders 44 to retain the grip about the grids 26 and 54 on the plastic sheet 62 during the remainder of the forming operation.

The male mold 38 is caused to be moved through the original plane of the sheet of thermoplastic material 62 by the continued upward movement of the lower platen 48 thereby stretching and drawing the material through the resilient diaphragm 30 and into the cavity 24 of the pressure box to control the wall thickness and uniformity of the wall thickness of the shaped article. During initial upward movement of the male mold 38 through the resilient material 30, the cavity 24 is placed under a positive pressure by placing the cavity 24 in fluid communication with the compression side of the pump 36 by orifice 32 via line 46 to control the wall thickness and uniformity of wall thickness of the shaped article.

Upward movement of the lower platen 48 is continued until the male mold support assembly 42 is fully disposed within the clamping support member 52, as illustrated in FIG. 4, thereby arresting further upward movement of the male mold support assembly 38. The flow of compressed fluid into the cavity 24 is discontinued and the pressure box assembly 12 is thereafter caused to be moved vertically upwardly to an initial position to a point when the formed hollow article 64 may readily pass during subsequent advancement of the thermoplastic sheet 62 by the drive means 60. The male mold assembly is caused to be downwardly displaced to the position illustrated in FIG. 1. The feed mechanism 62 is actuated to move the section of web 64 having the shaped article 66 projecting thereabove out of the machine 10 (not shown), and to position a fresh section of heated plastic sheet between the mold assemblies 12 and 14 in preparation for the next molding cycle. The shaped article 66 is trimmed with the excess material being usually returned to an extruder or other auxiliary equipment for re-use in the preparation of the thermoplastic sheet from which the article is formed. Hollow articles formed in accordance with the present invention may be conveyed to a liner feeder apparatus, such as disclosed in copending application Ser. No. 448,191 filed Mar. 5, 1974, and assigned to the same assignee as the present invention.

While the invention has been described in connection with an exemplary embodiment thereof, it will be understood that many modifications will be apparent to those of ordinary skill in the art and that this application is intended to cover any adaptations or variations thereof. Therefore, it is manifestly intended that this invention be only limited by the claims and the equivalents thereof.

* * * * *



85
130



U.S. Patent July 5, 1977

Sheet 1 of 2

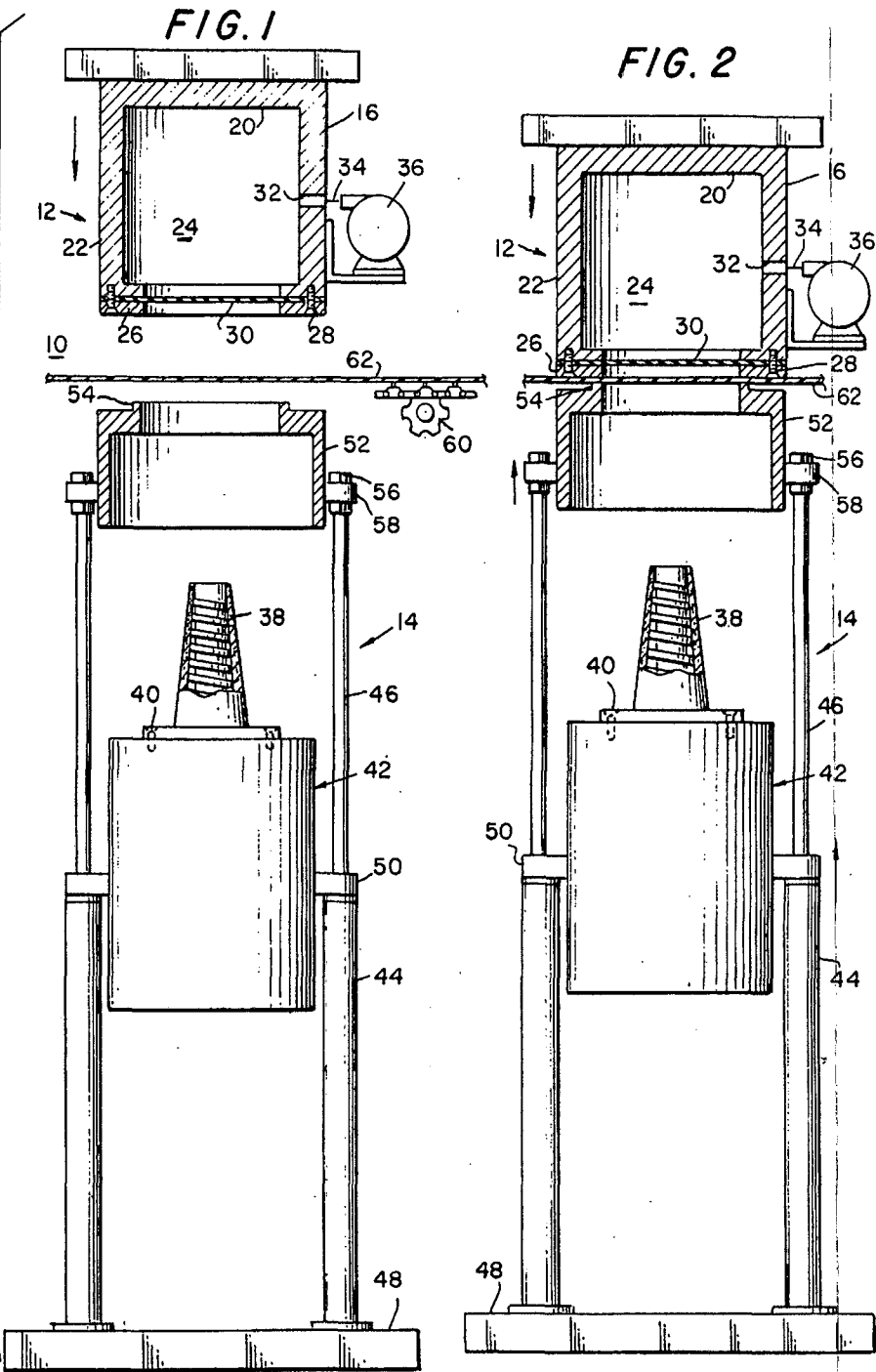
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^ Full Text
? Help

Go to Page:



- Sections:
- [Front Page](#)
 - [Drawings](#)
 - [Specifications](#)
 - [Claims](#)



26
131



U.S. Patent July 5, 1977

Sheet 2 of 2

4,034,054

Full Text
Help

Go to Page:

Go



Sections:

- Front Page
- Drawings
- Specifications
- Claims

FIG. 3

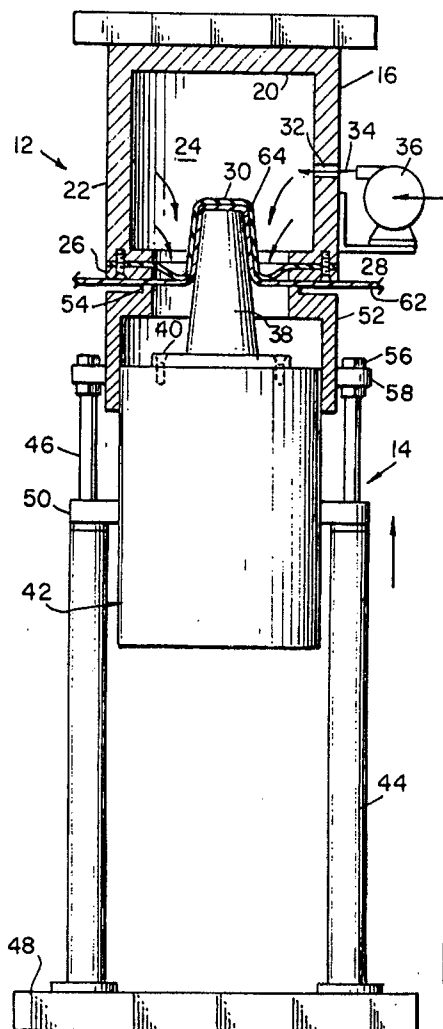
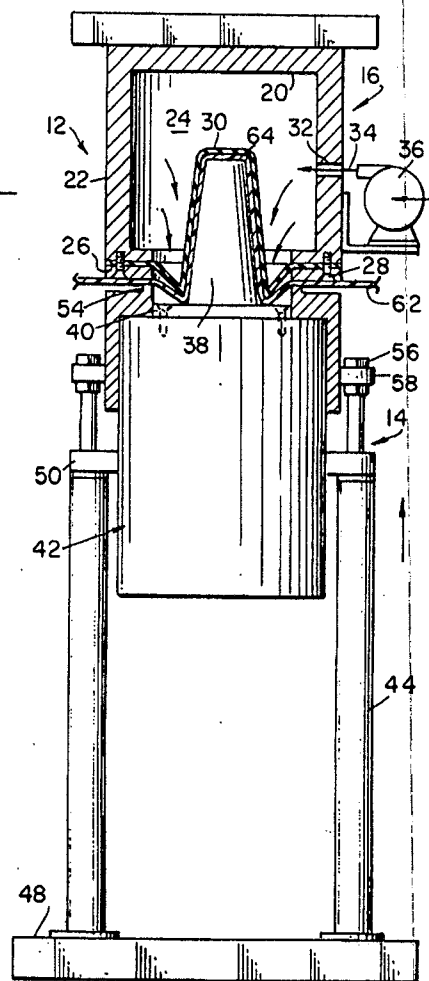


FIG. 4



49
132

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(1 of 1)

United States Patent
Barker , et al.

4,220,683
September 2, 1980

Method of thermoforming and product made therefrom

Abstract

A method of thermoforming a thermo-plastics sheet carrying a protective layer of polyethylene on at least one of the surfaces of the sheet comprising heating the assembly of sheet together with its protective layer to above the softening point of the thermoplastic and subsequently stretching the assembly to a desired shape.

Inventors: **Barker; Peter J.** (Royston, GB2); **Cheal; Gerald R.** (Welwyn, GB2)
Assignee: **Imperial Chemical Industries Limited** (London, GB2)
Appl. No.: **957195**
Filed: **November 2, 1978**

Foreign Application Priority Data

Apr 28, 1976[GB]

17255/76

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Intern'l Class:

B32B 007/00; B65D 007/00; A47K 001/00

Field of Search:

428/516,520,35 156/222 4/166,167,187 R 264/241

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Primary Examiner: Robinson; Ellis P.

Attorney, Agent or Firm: Cushman, Darby & Cushman

Parent Case Text

This is a division of application Ser. No. 785,301 filed Apr. 6, 1977, and now U.S. Pat. No. 4,141,771.

Claims

We claim:

1. A shaped article which has been shaped from a sheet of poly(methyl methacrylate) having a thickness of at least 3.0 mm, a reduced viscosity of at least 1.5 and carrying an adhered protective layer of polyethylene having a melt flow index as measured by ASTM Method 1238-70 of between 1 and 4 and having a thickness of at least 40 microns wherein the polyethylene is in intimate contact with at least one surface of the shaped article.
2. A shaped article according to claim 1 in which the reduced viscosity of the poly(methyl methacrylate) is at least 3.0.
3. A shaped article according to claim 1 in which the article is an article of sanitaryware such as a bath, shower-tray or wash basin.

Description

This invention relates to a method of shaping thermoplastics sheets and in particular to a method of shaping poly(methyl methacrylate) sheets to give shaped articles, particularly articles of sanitaryware, carrying a protective covering which can remain in place to protect the surface of the shaped article up to the time that it is to be used by the consumer.

It is known to protect the surfaces of thermoplastics sheets from damage during transport and handling of the sheets prior to thermoforming the sheets by adhering various protective materials to the sheets which are removed before thermoforming. Paper has been commonly used as a protective material because of its cheapness. The adhesives which have been used to adhere the paper to the thermoplastic are either water soluble adhesives applied as solutions, such as gelatin or hydrolysed polyvinyl acetate or are rubber based, pressure-sensitive adhesives. The former system has been preferred because of its cheapness and the ease with which the paper can be removed from the sheet even after the protected sheet has been stored for long periods. The use of water based adhesives suffers from the disadvantage that for applications in which the surface quality of the thermoplastics sheet is critical imperfections can be introduced unless the adhesive is applied uniformly to the surface of the sheet. These imperfections become noticeable when the sheet is subsequently stretched in a thermoforming operation. The apparently simple operation of applying the adhesive uniformly, in practice requires a high standard of process control.

As an alternative to the use of paper polyethylene film is also used. This is normally applied using hot rolls which adhere the film to the thermoplastics sheet so that additional adhesive is not usually necessary. This process overcomes any problem associated with residual adhesive or uneven application of adhesive to the sheet but gives rise to further problems as a result of the high level of static charge present on the sheet after removing the protective polyethylene film. This static charge is sufficiently high to give a substantial shock to any operator discharging the sheet by manual contact and additionally attracts dust strongly and is a potential fire hazard. It is sometimes necessary to wash the sheet after the polyethylene film has been removed and prior to thermoforming the sheets. It has now been found that polyethylene film protected thermoplastics sheets can be thermoformed without encountering the aforesaid problems arising from static electricity.

A disadvantage of these methods of protecting and shaping sheets is that the resulting shaped article is in an unprotected state after the shaping operation and it is inconvenient and expensive to provide a further protective layer to the shaped article. With some shaped articles, particularly sanitaryware, the article is subjected to considerable further handling before the article is finally installed for use by the consumer. During this period the surface of the shaped article is at risk from accidental damage. A method of

the extent of the aforementioned problems.

Accordingly there is provided a method of thermoforming a sheet of poly(methyl methacrylate) having a reduced viscosity as hereinbefore defined of at least 1.5, preferably at least 3.0, carrying a protective layer of polyethylene in intimate contact with at least one surface of the sheet comprising heating the assembly of sheet and its protective layer to a temperature of at least 140.degree. C., preferably at least 150.degree. C., until the sheet is in a heat softened condition but insufficiently long for the surface of the sheet to be marred by changes arising in the polyethylene due to the thermal treatment received, subsequently stretching the assembly to a desired shape whilst the polyethylene remains in intimate contact with the sheet.

The changes which can arise in the polyethylene if an excessive thermal treatment is received and which can give rise to loss of intimate contact and marring of the surface of the poly(methyl methacrylate) sheet are various. Shrinkage of the polyethylene relative to the sheet when the sheet is in the softened condition can cause marring but more particularly an increase in adhesion between the polyethylene film and the sheet can result in damage to the sheet surface which is apparent when the polyethylene is eventually removed from the shaped article. Excessive heating can result in degradation of the polyethylene and consequent difficulty in removing the film without surface damage to the shaped article.

By "poly(methyl methacrylate) sheet" is meant a sheet material in which at least the surface which is to form the exposed surface of the shaped article consists of a homopolymer of methyl methacrylate or a copolymer of methyl methacrylate containing a major proportion, and preferably at least 90% by weight of units of methyl methacrylate. The sheet may be, for example, a laminate in which the surface to be used as the exposed surface is a polymer of methyl methacrylate of the required reduced viscosity and the underside of the sheet is of a different thermoplastic material.

The reduced viscosity (RV) of the poly(methyl methacrylate) (as hereinbefore defined) is determined at 25.degree. C. on a solution in chloroform containing 1 g of polymer in 1000 cm.³ of solution. Poly(methyl methacrylate) for sanitary ware applications frequently contains small amounts of cross-linking agents. Such polymer cannot be readily characterised by solution viscometry but for the purpose of the invention the backbone molecular weight of the polymer when prepared in the absence of cross-linking agent should still be at least 1.5 and preferably greater than 3.0. The most suitable sheet is that prepared by the known polymerisation casting techniques either in closed cells or between continuous double bands.

Surprisingly, in view of the low softening point and relatively low thermal stability of polyethylene the assembly of sheet and film may be given a sufficient heat treatment to render the high molecular weight sheet readily thermoformable without the polyethylene either shrinking or becoming so well adhered to the poly(methyl methacrylate) that it either damages the sheet surface or is not readily removable after the shaping operation.

In the method of the invention the protective layer remains in place throughout the thermoforming operation and may be readily removed when desired leaving an undamaged surface on the thermoplastics shaped article. The protective layer may be removed immediately after cooling the shaping or optionally is allowed to remain in place as protection until the shaped article is finally in use. For example when the sheet has been shaped into a bath shell which requires the application of glass fibre and polyester resin to the underside of the bath to increase the strength and rigidity of the shaping, it is advisable to leave the protective layer in position at least until the reinforcement process has been completed. This prevents the glass fibre and resin from coming into contact with the downturned rim of the bath and avoids subsequent cleaning of the rim to remove any deposited material. It can be advantageous, to reduce the risk of accidental damage to the minimum, to leave the protective film in position until the bath has been fully installed and the water services connected. The film may then be stripped off at the same time serving to collect debris such as bathroom tile fragments, brick or plaster which may have dropped into the bath during construction work.

In addition to the protection conferred by leaving the film in position the advantages which the method of the invention confers are various. Although a static charge will still be present when the film is eventually removed it will normally be less after thermoforming due to decay of the charge. In addition, the removal of the polyethylene film can be carried out at the optimum convenient time. For example, removal prior to the normal inspection of the shaped articles ensures that the static discharge can be carried out in a low fire-risk area and at a time when the article would normally be wiped clean to remove any dust or debris, thus avoiding any extra operations.

The provision of a protective layer is particularly important in the case of poly(methyl methacrylate) sheet because the excellent surface qualities of this material are relatively easily damaged by abrasion.

surface damage up to the time when the article is in use.

As a further embodiment of the invention there is provided a shaped article of poly(methyl methacrylate) having an RV of at least 1.5, preferably at least 3.0 carrying a protective layer of poly(ethylene) film in intimate contact with at least one surface of the shaped article.

This aspect of the invention is particularly useful when the shaped article is an article of sanitaryware such as a bath, shower-tray or wash basin because such articles run the risk of damage during building and installation operations.

In most applications it is only necessary that one surface of the sheet is protected because in use only one surface is exposed to view. In the method of the invention it is therefore only necessary to use a thermoplastics sheet protected on one of its surfaces, that is the surface which is eventually to be exposed to view. It is, in fact, advantageous in the method of the invention to operate with only one surface protected because this allows more latitude in the method of thermoforming. It is inadvisable to allow a polyethylene protected surface to come into contact with any hot forming surface when the temperature of the polyethylene is above about 150.degree. C. because the polyethylene may become so firmly adhered to the thermoplastics sheet that it is difficult to remove after the thermoforming operation.

In methods of thermoforming in which a hot metal surface is urged against a softened sheet to produce the desired shape it is essential that the polyethylene is present only on the surface of the sheet not contacted by the metal surface because it has been found that if a hot metal surface is pressed against the polyethylene it becomes so firmly adhered to either the softened sheet or the metal surface that it is either difficult to remove from the metal surface or the surface of the sheet.

In a preferred method of shaping a sheet of poly(methyl methacrylate) having a reduced viscosity of at least 1.15, preferably at least 3.0 and carrying an adhered protective layer of polyethylene on one surface of the sheet is heated to at least 140.degree. C. until it is in a thermoformable condition, is removed from the source of heat before changes in the nature of the polyethylene cause marring of the sheet surface and is subsequently thermoformed by stretching the softened sheet together with the adhered layer of polyethylene until the unprotected surface makes contact with a mould surface of a desired shape.

The sheets may be stretched to form the shaped article by any of the conventional methods such as the application of vacuum or pressure to stretch the sheet without contact with mould surfaces or by the application of pressure or vacuum to blow or draw the sheet onto a mould surface.

In order to obtain a satisfactory product from the process it is necessary that the heating cycle should give a sufficient heat treatment to enable the sheet to be thermoformed into a good quality moulding but not of such intensity to cause the intimate contact between the polyethylene film and the poly(methyl methacrylate) sheet to be interrupted causing surface damage or to cause the polyethylene to become too firmly bonded to the sheet or to change its character so that it is not possible to remove it clearly from the sheet after it has cooled to ambient temperature.

The conditions for a given thickness of poly(methyl methacrylate) sheet having an RV of at least 1.5 can be determined experimentally in each individual case but it has been found from the experience of a large number of experiments that the preferred conditions can be defined by mathematical relationships involving the thickness of the sheet, the temperature of the oven and the length of the heating period. In a preferred process to ensure good thermoforming behaviour the logarithm (base e) of the length of the heating period should be greater than

$$(-0.257715T + 9.1484) - (-0.002754T + 0.0425526)X$$

where T is the thickness of the sheet in millimetres and X is the oven temperature in .degree.C. To ensure satisfactory behaviour of the polyethylene film and a subsequent good quality surface on the shaped article the logarithm (base e) of the length of the heating period should preferably be less than

$$(0.240344T.\text{sup.}2 - 3.404250T + 20.2842) - (0.001567T.\text{sup.}2 - 0.0222875T + 0.105177)X.$$

These preferred conditions define the heating cycles for poly(methyl methacrylate) homopolymer sheet having an RV of at least 1.5, a thickness between about 3.0 mm and 8.0 mm for temperature between at least 140.degree. C. and about 200.degree. C. These conditions are particularly suitable for sheet of RV of 3.0 and above. For sheet of RV between 1.5 and 3.0 conditions which give as short a heat-up period as possible within the prescribed limits should be chosen. As examples of the use of the mathematical relationships it can be calculated that for poly(methyl methacrylate) sheet of 3.2 mm thickness a satisfactory behaviour is obtained at 150.degree. C. when the heating time is greater than about 15

between about 5 and 8 minutes. For the same sheet of 8 mm thickness the preferred ranges are about 45 to 60 minutes at 160.degree. C. and about 20 to 22 minutes at 200.degree. C.

The polyethylene protected (poly(methyl methacrylate) sheet for use in this invention must have the polyethylene film in intimate contact with sheet before the heating and thermoforming operation is commenced. This intimate contact is achieved by the correct choice of polyethylene film and application conditions. The polyethylene film should have a melt flow index as determined using the ASTM Method 1238-70 of between 1 and 4, preferably between 2 and 3. The film must have a thickness of at least 40 microns, preferably at least 50 microns. When the thickness is above 100 microns not only does the protection become more expensive but it is much more difficult to apply the film to the sheet so that it remains in intimate contact with the sheet. For intimate contact the film will also have been treated, at least on the surface to be adhered to the sheet, by corona discharge to improve the adhesion of the film to the sheet when the film is applied to the sheet using heat and pressure. The film may be applied to the sheet by a variety of methods in which heat is supplied either to the sheet or the film so that when pressure is applied to the film/sheet laminate the polyethylene is softened to obtain maximum adhesion to the sheet. In a preferred process rollers at a temperature of about 105.degree. C. are applied with a pressure of about 2 kg/cm.sup.2 to adhere polyethylene film of 50 micron thickness to poly(methyl methacrylate) sheet, both the film and the sheet being fed to the rollers at ambient temperatures.

Whilst good adhesion between the polyethylene and the sheet is required in this application process it has been found that those grades of polyethylene which give increased adhesion when the laminate is subjected to the thermoforming temperatures are not suitable for use in the invention because it is not possible to remove the polyethylene without damaging the sheet surface after thermoforming.

It is to be understood that the term polyethylene includes copolymers of ethylene with minor amounts of copolymerisable monomers, but the amount of copolymerisable monomer, if any, should be insufficient to cause any major alteration to the physical properties of the product in comparison with the homopolymer. It is preferred that the polyethylene contains less than 5% by weight of monomers such as vinyl acetate or the esters of acrylic and methacrylic acids. For example, polyethylene containing as little as 6% vinyl acetate as a comonomer has been found to be unsuitable because it is too firmly adhered and has insufficient strength after the thermoforming process to be cleanly removeable. Preferably the film should be composed of a homopolymer of ethylene but in any event should not contain comonomers which give rise to an appreciable increase in adhesion after the film has been applied to the sheet and whilst it is being heated to thermoforming temperatures. Additives, such as slip additives, should also be avoided. In practice the suitability of a particular polyethylene copolymer is readily determined by thermoforming the sheet/film laminates according to the method of the invention and assessing the ease with which the film can be removed from the shaping after thermoforming. It should be possible to remove the film cleanly and without leaving traces of the film on the shaped article.

Although no treatment is necessary to reduce the size of the static charge when the protective film is eventually removed it may be an advantage in some circumstances to reduce the charge produced. This may be brought about by applying an electrically conductive layer on the surface of the thermoplastics sheet before applying the polyethylene film. Convenient materials for providing such a layer are the water soluble, cationic, surface active agents such as alkyl pyridinium bromides. These are usually effective as solutions at concentrations of less than 0.5% by weight of water. Such solutions may readily be applied to the thermoplastics sheet and allowed to dry before applying the polyethylene film by the use of heat and pressure.

The protected sheets may be heated prior to thermoforming by any of the conventional means such as an air oven or by infra-red heaters.

The invention is further illustrated by the following Examples.

EXAMPLE 1

A sheet of poly(methyl methacrylate) of RV 4.0 and 3.2 mm thickness carrying a protective layer of polyethylene homopolymer film (50 microns in thickness and having a Melt Flow Index of 2.3) on one of its surfaces, was heated in a horizontal position with the polyethylene film uppermost in an electrically heated air oven maintained at a temperature of 200.degree. C. The sheet was removed after a period of 5 minutes and carried horizontally to a vacuum mould chamber. After clamping the sheet above the mould the softened sheet was drawn by vacuum so that the unprotected surface contacted the mould surface. After allowing the sheet to cool to about 50.degree. it was removed from the mould. The polyethylene film was removed from the sheet without difficulty. The surface quality of the sheet under the film was excellent.

32
137

The procedure of Example 1 was repeated using a sheet of 8 mm thickness. The sheet and protective polyethylene film were heated at 165.degree. C. for 40 minutes before thermoforming in a mould as described. After thermoforming the film was readily removed to give a shaped article of excellent surface finish.

EXAMPLE 3

The procedure of Example 1 was repeated using sheets of varying thickness at a temperature of 165.degree. C. The results, shown below, indicate a very satisfactory performance. Although the films were removed after cooling to examine the surface of the shaping, trials have shown that the film will remain in place to give effective protection at least for several months and is still readily removeable at that time.

Sheet Thickness		Heating	
		Oven Temperature	Time
Film	(mm)	(.degree. C.)	(mins)
Polyethylene homopolymer			
	3.2	165.degree. C.	20
(MFI = 2.3)			
Polyethylene homopolymer			
	5.0	"	35
(MFI = 2.3)			
Polyethylene homopolymer			
	8.0	"	45 - (MFI = 2.3)

In all cases the film was easily removed on cooling leaving the surface of the shaping unblemished.

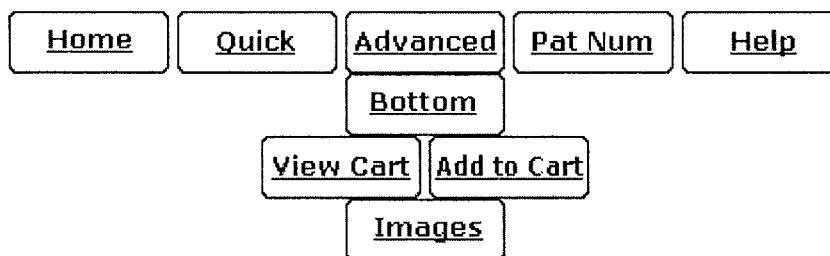
COMPARATIVE EXAMPLE

The procedure of Example 1 was used to evaluate the performance of various types of polyethylene film. The evaluation was one on sheet of 3 mm thickness at an oven temperature of 165.degree. C. for 20 minutes. The results obtained were as follows:

Film	Comments
Polyethylene containing	
1% glyceryl monooleate	Film was holed during heating leaving surface marks after removal of the film.
Polyethylene containing	
6.4% vinyl acetate	Film was extensively bubbled causing surface marking and was very difficult to remove.
Polyethylene containing	
7.5% vinyl acetate	Film extensively bubbled, surface marking on shaping,
comonomer	difficulty in removing film.
(MFI = 2.0)	

37
138

Top				
Home	Quick	Advanced	Pat Num	Help

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(1 of 1)

**United States Patent
Turner****4,443,401
April 17, 1984**

Apparatus for and method of thermoforming plastic cans

Abstract

This relates to the thermoforming of can bodies for use in packaging beverages under pressure from polyester sheet material, preferably PET. In accordance with the invention, a forming gas is applied to the periphery of the clamped sheet portion in radially outwardly spaced relation with respect to an associated mold cavity and the sheet material is billowed up into a large cavity formed in the clamp so as to provide for high stretching and orientation of the peripheral portion of the sheet before the sheet is directed into an associated mold cavity. Further, a plunger which normally forces the billowed or initially stretched sheet into the mold cavity may be constructed so as to be radially expandible to thus positively radially expand the sheet material within the mold. The operation of the molding apparatus is one wherein the periphery of the sheet material from which the cup is formed has a much greater biaxial orientation than heretofore possible, and therefore the resultant can body is much stronger than that previously feasible with the same material. This abstract forms no part of the specification of this application and is not to be construed as limiting the claims of the application.

Inventors: **Turner; Howard M.** (Mount Vernon, OH)Assignee: **The Continental Group, Inc.** (Stamford, CT)Appl. No.: **331738**Filed: **December 17, 1981****Current U.S. Class:** 264/544; 264/314; 264/549; 264/550; 425/387.1; 425/388;
425/389; 425/398; 425/400**Intern'l Class:** B29C 017/04**Field of Search:** 425/387.1, 388, 389, 398, 400
264/547, 549, 314, 550, 292, 551, 544**References Cited [Referenced By]****U.S. Patent Documents**

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Primary Examiner: Silbaugh; Jan H.
Attorney, Agent or Firm: Brown; Charles E.

Claims

45
140

I claim:

1. In an apparatus for the thermoforming of containers, said apparatus comprising a female mold member defining a mold cavity having an opening defined by a surrounding clamp surface, a clamp overlying said mold member to retain a sheet between said clamp and said mold member, means mounting said mold member and said clamp for relative movement axially of said mold cavity between a sheet clamping position and a molded article releasing position, and a sheet forming plunger carried by said clamp and movable relative to said clamp into said mold cavity for at least effecting an initial forming of a sheet within said mold cavity, the improvement comprising said clamp having a clamping surface surrounding said mold cavity opening and being radially outwardly spaced from said mold cavity opening wherein said clamp is operable to clamp within the confines of said clamp an area of sheet material greatly in excess of the area of said mold cavity opening, said clamp defining a sheet forming cavity opposing said mold cavity, a gas supply means carried by said mold member for initially billowing clamped sheet material upwardly into said sheet forming cavity to enhance biaxial orientation of clamped sheet material, said mold having an annular ledge surrounding said opening and within that portion of said mold opposed in clamping relation by said clamp, and said gas supply means being solely in said ledge closely adjacent said mold portion opposing said clamp for directly impinging gas on a clamped heated plastic sheet to effect stretching of such sheet and billowing thereof into said sheet forming cavity starting at the periphery of that portion of clamped sheet material within said clamp.
2. An improvement according to claim 1 wherein said gas supply means includes an annular groove in said mold ledge adjacent that portion of said mold opposed in clamping relation by said clamp, and means for introducing a gas under pressure into said annular groove.
3. An improvement according to claim 1 wherein said sheet forming cavity is of a generally hemispherical configuration.
4. An improvement according to claim 1 wherein said sheet forming plunger projects into said sheet forming cavity to cooperate with said gas supply means and said sheet forming cavity to stretch and orient sheet material prior to entry of such sheet material into said mold cavity.
5. In an apparatus for the thermoforming of containers, said apparatus comprising a female mold member defining a mold cavity having an opening defined by a surrounding clamp surface, a clamp overlying said mold member to retain a sheet between said clamp and said mold member, means mounting said mold member and said clamp for relative movement axially of said mold cavity between a sheet clamping position and a molded article releasing position, and a sheet forming plunger carried by said clamp and movable relative to said clamp into said mold cavity for at least effecting an initial forming of a sheet within said mold cavity, the improvement comprising said clamp having a clamping surface surrounding said mold cavity opening and being radially outwardly spaced from said mold cavity opening wherein said clamp is operable to clamp within the confines of said clamp an area of sheet material greatly in excess of the area of said mold cavity opening, said clamp defining a sheet forming cavity opposing said mold cavity, a gas supply means carried by said mold member for initially billowing clamped sheet material upwardly into said sheet forming cavity to enhance biaxial orientation of clamped sheet material, said mold having an annular ledge surrounding said opening and within that portion of said mold opposed in clamping relation by said clamp, and said gas supply means being in said ledge closely adjacent said mold portion opposing said clamp for directly impinging gas on a clamped heated plastic sheet to effect stretching of such sheet and billowing thereof into said sheet forming cavity starting at the periphery of that portion of clamped sheet material within said clamp, said sheet forming plunger having expansion means for effecting radial expansion of said plunger after said plunger has advanced into said mold cavity, said expansion means including said plunger being formed in circumferential segments, and there are means for urging said segments apart in radial directions only.
6. In an apparatus for the thermoforming of containers, said apparatus comprising a female mold member defining a mold cavity having an opening defined by a surrounding clamp surface, a clamp overlying said mold member to retain a sheet between said clamp and said mold member, means mounting said mold member and said clamp for relative movement axially of said mold cavity between a sheet clamping position and a molded article releasing position, and a sheet forming plunger carried by said clamp and movable relative to said clamp into said mold cavity for at least effecting an initial forming of a sheet within said mold cavity, the improvement comprising said clamp having a clamping surface surrounding said mold cavity opening and being radially outwardly spaced from said mold cavity opening wherein said clamp is operable to clamp within the confines of said clamp an area of sheet material greatly in excess of the area of said mold cavity opening, said clamp defining a sheet forming cavity opposing said mold cavity, a gas supply means carried by said mold member for initially billowing clamped sheet material upwardly into said sheet forming cavity to enhance biaxial orientation of clamped sheet material, said mold having an annular ledge surrounding said opening and within that

said ledge closely adjacent said mold portion opposing said clamp for directly impinging gas on a clamped heated plastic sheet to effect stretching of such sheet and billowing thereof into said sheet forming cavity starting at the periphery of that portion of clamped sheet material within said clamp, said gas supply means including an annular groove in said mold ledge adjacent that portion of said mold opposed in clamping relation by said clamp, and means for introducing a gas under pressure into said annular groove, said groove being provided with a porous gas passing member for diffusing gas passing out from said groove.

7. A method of thermoforming comprising the steps of providing a mold of the type including a mold cavity surrounded by an annular ledge, positioning a sheet of biaxially orientable plastic heated to a selected temperature in overlying relation to the mold, clamping the sheet against the mold ledge remote from the mold cavity, applying a sheet forming gas under pressure to the sheet from the mold ledge adjacent the clamped portion of the sheet to upwardly billow the sheet beginning generally at the periphery to effect biaxial orientation in said sheet including in a peripheral part of said sheet, engaging the billowed portion of the sheet with a plunger and forcing the sheet axially into the mold cavity, and then expanding the sheet to conform to the configuration of the mold cavity.

8. A method according to claim 7 wherein the billowing of the sheet is controlled by providing a sheet forming cavity in opposed overlying relation to the mold cavity and deforming the sheet within said sheet forming cavity.

9. A method according to claim 7 wherein the expanding of the sheet within the mold is effected by expanding the plunger.

10. A method according to claim 7 wherein the sheet forming gas is diffused prior to engaging the sheet.

11. A method according to claim 7 wherein the sheet forming gas is applied solely from the mold ledge.

Description

This invention relates in general to new and useful improvements in thermoforming of plastic containers and more particularly to an apparatus for and method of thermoforming plastic cans suitable for packaging carbonated beverages and the like which are packaged under pressure.

At the present there is being formed from polyester sheet material, particularly polyethylene terephthalate (PET) cans in which liquids, such as soft drinks and beer, are being packaged under pressure. However, it has been found that the side wall of the cans, particularly in the flange area, does not have sufficient strength and is subject to undue cracking or rupture. It is the purpose of this invention to provide an apparatus and method for forming similar cans which are not so subject to such cracking or rupture.

It is known that polyesters, particularly PET, when molded to have high biaxial orientation, exhibit great strength and resistance to cracking. However, when articles are thermoformed in the normal manner, the polyester is primarily subjected to stretching in one direction, i.e. axially of the container, with there being very little radial or hoop orientation.

In the past, during the initial forming stage the interior of the mold cavity has been pressurized so as to cause the sheet material to billow upwardly a short distance within the associated clamp for material distribution. This billow, however, does not provide adequate biaxial orientation.

In accordance with this invention, it is proposed to provide the mold with a relatively wide ledge and wherein an associated clamp will clamp the sheet material against the mold ledge remote from the mold cavity. Then, instead of internally pressurizing the mold cavity from within the mold cavity to provide the sheet billowing pressure, the mold ledge is provided, adjacent that portion thereof which is opposed by the clamp, with an annular passage for directing a gas under pressure against the sheet material adjacent to the area which is clamped against the mold. In this way uniform stretching of the sheet material at a selected orientation temperature is initiated near the clamp which provides relatively high orientation in the hoop direction followed by plug assist forming.

Further, in accordance with this invention, the relatively shallow prior billow used for initially decreasing flange thickness of the sheet material in the clamp is greatly increased in size and assumes generally hemispherical configuration. In this manner, a greater stretching of the sheet material by a billowing or ballooning thereof is initially effected with this stretching being primarily in the hoop or

The upwardly billowing sheet material is engaged by a plunger which may initially project into the clamp cavity. As soon as the billowing is completed, the gaseous forming pressure is removed and the mold cavity may be vented to atmosphere while at the same time downward movement of the plunger is effected and the previously upwardly billowing sheet material is drawn down into the mold cavity.

The movement of the sheet material into the mold cavity may be assisted by applying vacuum to the vents and, after the plunger has reached the limits of its downward movement, vacuum is now drawn in the mold cavity if it has not been previously effected. At the same time, air may be directed into the interior of the sheet material so as to assist the vacuum and wherein final forming of the sheet material to the mold cavity configuration is effected. If desired, as will be described in detail hereinafter, the plunger may be of an expandable type.

By controlling the area of the sheet material which is initially stretched under gaseous pressure and by permitting a relatively great stretching of the sheet material in the hoop direction before the sheet material is forced into the mold cavity by the plunger, it has been found that biaxial orientation may be obtained in that portion of the resultant container which forms the flange to which a closure is secured, and, further, there is relatively greater orientation in the hoop direction in the body so as to prevent the undue rupture or cracking which has been experienced to date. The relatively greater orientation in the hoop direction in the body also serves greatly to improve creep resistance.

With the above and other objects in view that will hereinafter appear, the nature of the invention will be more clearly understood by reference to the following detailed description, the appended claims, and the several views illustrated in the accompanying drawings.

IN THE DRAWINGS

FIG. 1 is a schematic sectional view taken through a can and a closure for the can which is of the general type which is to be formed in accordance with this invention.

FIG. 2 is a vertical sectional view taken through a single cavity mold, and shows the principle of mold construction in accordance with this invention.

FIG. 3 is a vertical sectional view similar to FIG. 2, and shows the sheet material clamped in place and being deformed within the material forming cavity by way of gaseous pressure.

FIG. 4 is a sectional view similar to FIG. 3 with the plunger in a lowered position ready to enter into the mold cavity.

FIG. 5 is a vertical sectional view similar to FIG. 4, but with the plunger at the end of its travel into the mold cavity.

FIG. 6 is a vertical sectional view similar to FIG. 5, and shows the plunger in its radially expanded condition.

FIG. 7 is a vertical sectional view similar to FIG. 6, and shows the mold with vacuum applied to the mold cavity for drawing the partially formed sheet to the configuration of the mold.

FIG. 8 is a sectional view taken through one form of plunger, and shows the general construction thereof.

FIG. 9 is a sectional view similar to FIG. 8 of a modified form of plunger.

FIG. 10 is an elevational view of another form of expandable plunger.

FIG. 11 is a transverse sectional view taken generally along the line 11--11 of FIG. 10, and shows the constructional details of the plunger.

FIG. 12 is a fragmentary vertical sectional view taken through the center of the plunger of FIG. 10, and shows the details of cam means for effecting the expansion of the plunger.

FIG. 13 is a vertical sectional view with parts broken away of yet another form of expandable plunger utilizing hydraulic means to effect the expansion thereof.

Referring now to the drawings in detail, reference is first made to FIG. 1 wherein there is illustrated a typical container of the type which is to be made in accordance with this invention. The container, which

a container has been in the past commercially exploited and is the subject of patents and patent applications of others. The illustrated container includes a can, generally identified by the numeral 12, which is formed of PET or other thermoplastics or thermoplastic laminates provided in sheet form and thermoformed within a mold. The can 12 includes a body 14 having an integral bottom 16 and with the open end of the can having a cover securing flange 18. A suitable cover, closure or end unit 20 is provided for sealing the can after it has been filled with a suitable liquid product, such as beer and soda. The end unit 20 is provided with a peripheral curl 22 which seats on the flange 18 and which is turned or folded with the flange 18 to form a conventional seam securing the end unit 20 to the can 12 in gas tight relation. Although a conventional metal end unit has been illustrated, it is to be understood that the container of this invention is not restricted to metal end units and may have the open upper end thereof slightly modified for cooperation with a variety of different types of conventional end units. The can is preferably tapered as illustrated so that cans may nest one within the other and, if desired, the upper portion of the can may be radially outwardly stepped to provide an anti-wedging shoulder.

Reference is now made to FIG. 2 wherein there is illustrated a mold assembly for receiving sheet material heated to a selected orientation temperature for forming the can 12. The mold assembly is generally identified by the numeral 24 and includes a mold 26, a clamp 28 and a plunger 30. For the most part, the mold 26 is of a conventional construction. The mold 26 has formed therein a mold cavity 32 which will be described hereinafter. The mold 26 is provided with minute passages 34 which open into the mold cavity 32 for the purpose of initially venting the mold cavity as sheet material S is forced down into the mold cavity, and thereafter applying a vacuum to the sheet material to draw the sheet material to the configuration of the mold cavity.

The clamp 28 is provided with an annular clamping surface 36 which cooperates with the upper surface of the mold 26 to clamp the thermoplastic material in sheet form between the clamp and the mold and may be temperature controlled.

It is to be understood that the mold 26 and the clamp 28 are carried by suitable support means 38 and 40, respectively, for effecting the relative movement of the mold 26 and the clamp 28 axially of the mold cavity between an open position and a closed position. Primary movement of the unit will be that of the mold 26 so as to clear a newly formed can while the sheet material retains its original planar state. There may be selected movement of the clamp.

The plunger 30 is carried by a separate movable support 42 for movement with and independently of the clamp 28.

The clamp 28 is provided with a relatively deep, generally hemispherical sheet forming cavity 44. In the past, this cavity, if used at all, has been relatively shallow. Further, it will be seen that the sheet engaging portion 36 of the clamp is spaced a considerable distance from the mold cavity 32 so that there is defined at the top of the mold 26 surrounding the mold cavity 32 a relatively wide annular ledge 45. The size of the ledge 45 increases that area of the sheet which is available for stretching. Further, in lieu of having a sheet billowing pressurized gas being introduced into the mold cavity 32, such as through the minute passages 34, there is provided an annular gas passage 46 which opens through the ledge 45 adjacent that portion of the mold 26 which opposes the effective portion of the clamp 28. Gas (air) under pressure is supplied to the passage 46 through a supply passage 48 from a supply line 50.

By placing the gas supply passage 46 in a position relatively widely spaced radially from the opening of the mold cavity 32 and at a position adjacent the clamp 28, it will be seen that, first of all, a larger area of the sheet material will be subjected to billowing. Secondly, by applying the gaseous pressure directly and uniformly against the outer portion of the sheet, it will be seen that the initial stretching of the sheet material is not preferentially in the center of the sheet material, but in the peripheral portion thereof. Thus, greater circumferential orientation of the sheet material is obtained in that portion of the sheet material which eventually becomes the flange 18, as well as that portion which forms the upper portion of the body.

By increasing the size of the sheet forming cavity 44 and by making it generally hemispherical in outline, it will be seen that the initial forming of the sheet at the selected orientation temperature provides for relatively great radial or circumferential stretching which will produce high biaxial orientation of the sheet material, particularly that which is in the upper part of the resultant can body and in the flange 18.

Referring now to FIG. 8, it will be seen that there is illustrated a modified form of plunger which is expandable, the plunger being generally identified by the numeral 52. The plunger 52 includes a head section 54 and a base section 56 which are joined together by a separator bar 58. Telescoped over the head section 54 and the base section 56 is a resiliently deformable sleeve 60.

passage 62 is connected to a suitable source of fluid under pressure (not shown) and opens into the space within the sleeve 60 between the head 54 and the base 56. It will be seen that when fluid is introduced into the sleeve 60, the sleeve will expand radially outwardly as shown in dotted lines to be beneficially utilized in the initial stretching of the thermoplastic sheet material within the mold cavity 32. It is to be understood that when the fluid pressure is relieved within the sleeve 60, it will have sufficient resiliency to return to its original state.

If desired, the base 56 may also be of a generally bladder-like construction and may be expandable in association with like pockets (not shown) in the bottom of the mold cavity to define feet or other bulbous portions on the can 12.

Reference is now made to FIG. 9 wherein there is illustrated still another form of expandable plunger generally identified by the numeral 64. The plunger 64 differs from the plunger 52 only in the axial extent of the expandable portion thereof.

The plunger 64 includes a head 66 and a base 68 joined by a spacer 70. The sleeve of resilient deformable material 72 is telescoped over the head 66 and the base 68.

The plunger 64 is carried by a rod 74 which is hollow to define a fluid passage 76 which opens into a space within the sleeve 72 between the head 66 and the base 68. The passage 76 will be connected to a source of fluid under pressure which, when introduced into the interior of the sleeve 72, will outwardly expand the sleeve 72 in a radial direction to the configuration shown in dotted lines.

Referring now to FIGS. 10 and 11, it will be seen that there is illustrated yet another form of expandable plunger, generally identified by the numeral 78. The plunger 78 includes a head 80 and a base 82 retained in spaced relation by a vertical spacer 84. Between the head 80 and the base 82 are a plurality of plunger segments 86 which are mounted relative to the head 80 and the base 82 in any desired manner wherein they will move in a controlled radial direction.

Referring now to FIG. 12, it will be seen that one type of actuator for the plunger segments 86 is illustrated. In this embodiment, the upper and lower portions of the plunger segments will be provided with cam surfaces 90 of which only the lower cam surface is illustrated. A control rod 92 is mounted on the spacer rod 84 for selective vertical movement and is provided with upper and lower cams of which only a lower cam 94 is illustrated. The cams will cooperate with the cam surface of the plunger segments so, when the control rod 92 is moved downwardly, the cam segments 86 will be moved radially outwardly. If desired, suitable return means in the form of a spring may be utilized for returning the cam segments to their retracted positions. On the other hand, there may be an interlock between each cam and the respective cam surface so as to draw the segments 86 back to their original positions.

Referring now to FIG. 10, it will be seen that the plunger 78 is carried by a support rod 98 which is hollow and has slidably mounted therein the control rod 92.

Reference is now made to FIG. 13 wherein yet another form of plunger, generally identified by the numeral 100, is illustrated. The plunger 100 includes a head 102 and a base 104 which is spaced from the head 102 by a rod 106. The plunger 100, like the plunger 78, is provided with a plurality of expandable segments 108. The ends of the plunger segments 108 are mounted with respect to the head 102 and the base 104 for controlled radial movement.

Each set of opposed plunger segments 108 is positioned by means of two fluid cylinders 110 having piston rods 112 connected to the respective segments.

It is to be understood that the plunger 100 will be provided with a suitable support rod, such as the support rod 98, and that the same may be hollow for a fluid to be delivered to the cylinders 110. It is also to be understood that the cylinders 110 may either be of a double acting type or may be spring biased to a position wherein the segments 108 are in their retracted positions.

Referring now to FIG. 3, it will be seen that the operation of the mold assembly in accordance with this invention is illustrated. A sheet S of suitable material, preferably PET although various other thermoplastic materials as well as laminates may be utilized, heated to a selected orientation temperature, is placed between the mold 26 and the clamp 28 and the relative movement of the mold 26 and the clamp 28 together is effected so as to clamp the sheet in place. In FIG. 3, the sheet is illustrated as clamped in place and with the blowing has having been operative to billow the sheet generally upwardly around the plunger 30 to the configuration of the sheet forming cavity 44 of the clamp 28. In view of the fact that the forming gas from the passage 46 strikes the sheet adjacent the periphery of that portion which is clamped by the clamp 28, there is more stretching of the annular ring of material whose ID is the OD of the plug and whose OD is the ID of the clamp.

It has been found that forming gas from the passage 46 is preferably diffused. Accordingly, the upper part of the passage 46 is provided with an insert 47 which may be in the form of a porous gas passing member such as a sintered material, or the member 47 may be an apertured member or formed of a plurality of closely spaced rings. Also, while the plunger 30 has been illustrated in a substantially fully retracted position, depending upon the specific configuration of the cavity 44, the sheet material being formed, the mold cavity 32 and the plunger shape, the plunger may be in selected lowered positions at the time the sheet is billowed upwardly within the cavity 44.

Referring now to FIG. 4, it will be seen that the plunger 30 has moved down with the billowed sheet having a greater generally toroidal configuration. In view of the fact that the pressurizing gas from the passage 46 has now been cut off and the vent passages 34 opened to the atmosphere, the movement of the plunger 30 primarily effects a reshaping of the sheet material without additional stretching.

In FIG. 5, the plunger has moved down into the mold cavity 32 so as to move the central part of the sheet material down into the bottom portion of the cavity. It is to be understood that at some point during the downward movement of the plunger, or at least when the plunger reaches its lowermost position, the vent passages 34 are connected to a vacuum source so as to assist in the shaping of the sheet material to match the configuration of the mold cavity 32. If desired, a forming gas may be directed into the mold cavity 32 interiorly of the formed sheet material through suitable openings in the plunger or clamp so as to assist in the forming of the sheet material to the shape of the cavity 32.

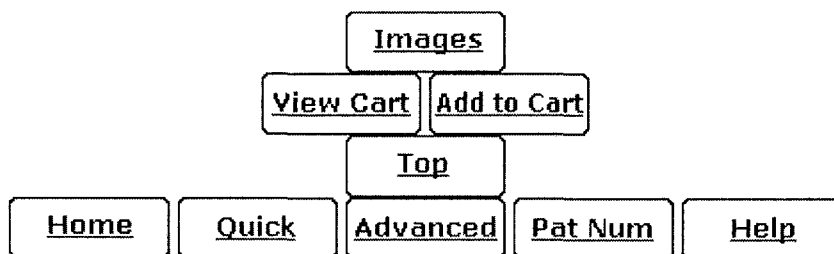
When the plunger 30 of FIG. 2 is of a fixed shape, i.e. non-expandable, the final forming operation is effected solely by way of the aforementioned vacuum and internal pressure. This is shown in FIG. 7. On the other hand, it is feasible, as explained above with respect to the plungers of FIGS. 8-13, that the plunger could be radially expandable and such a plunger operation is shown in FIG. 6 wherein there is a controlled radial expansion of the sheet material and thus further hoop orientation of the sheet material due to the mechanical action of the plunger.

It is to be understood that at all times during the sheet forming operation the sheet material must be maintained at the optimum temperatures for orientation and/or forming. Thus, selective heating of the plunger, mold, clamp, blowing gas, etc., may be required.

It will be seen that in the thermoforming operation in accordance with this invention there is considerable radial or circumferential stretching of the sheet material as well as axial stretching as would normally occur. This additional radial or circumferential stretching together with the axial stretching produces a biaxial orientation of the polyester material and thus provides a relatively great strength within the polyester material. By obtaining biaxial orientation within the flange 18 in the upper part of the body 14, flange cracking and body cracking or splitting can be minimized.

Although only a preferred embodiment of the molding apparatus and the use thereof has been specifically illustrated and described herein, it is to be understood that minor variations may be made in the mold assembly constructed without departing from the spirit and scope of the invention as defined by the appended claims.

* * * * *



146



U.S. Patent

Apr. 17, 1984

Sheet 3 of 3

4,443,401

Full Text
Help

Go to Page:

Go



Sections:

- Front Page
- Drawings
- Specifications
- Claims

FIG. 7.

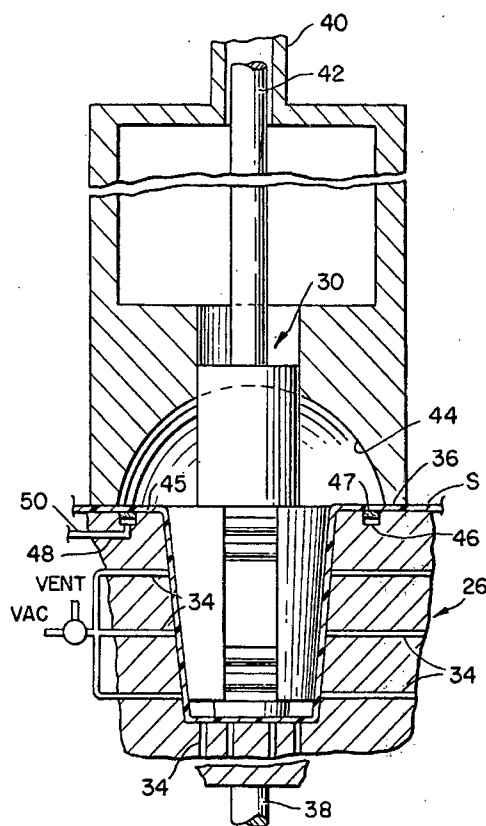


FIG. 9.

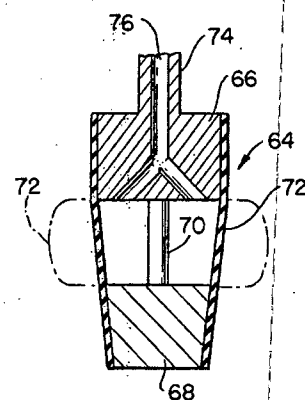


FIG. 10.

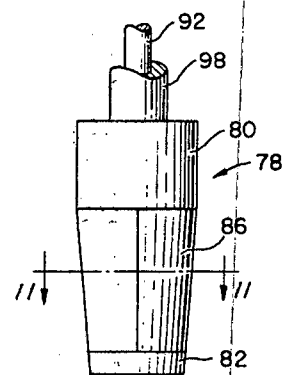


FIG. 13.

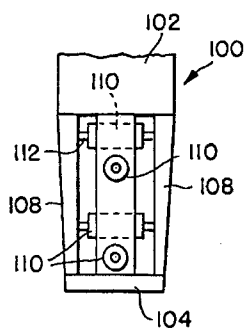


FIG. 12.

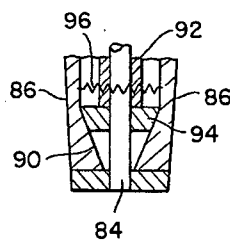
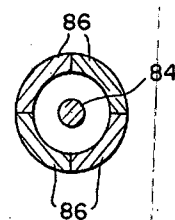


FIG. 11.



47

147



△ [Full Text](#)
? [Help](#)

Go to Page:



- Sections:
- [Front Page](#)
 - [Drawings](#)
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 - [Claims](#)

FIG. 6.

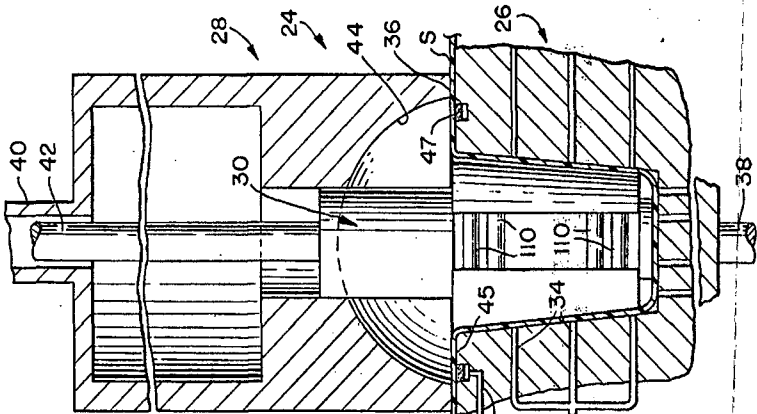


FIG. 5.

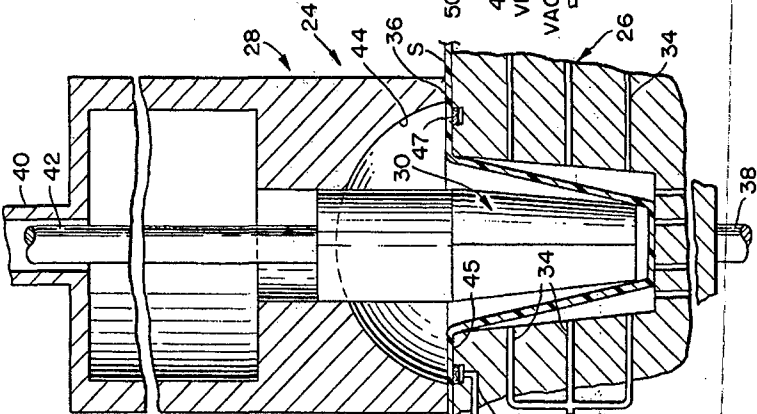
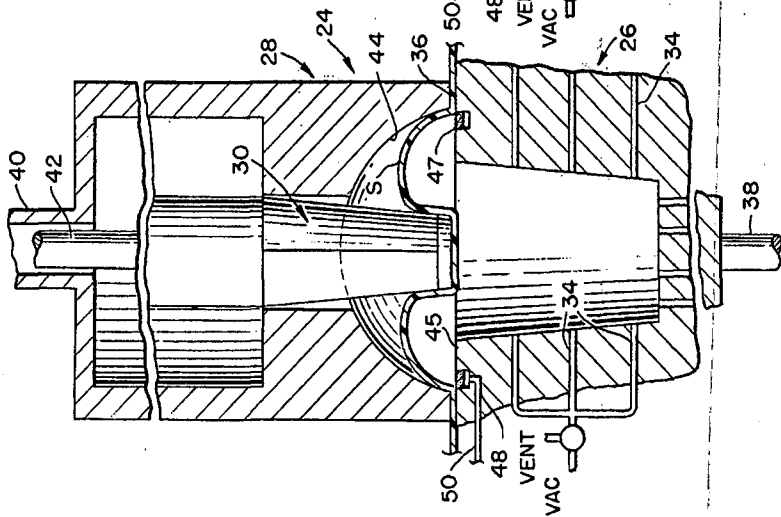


FIG. 4.



43
148



U.S. Patent Apr. 17, 1984

Sheet 1 of 3

4,443,401

△ [Full Text](#)
? [Help](#)

Go to Page:



- Sections:
- [Front Page](#)
 - [Drawings](#)
 - [Specifications](#)
 - [Claims](#)

FIG. 1.

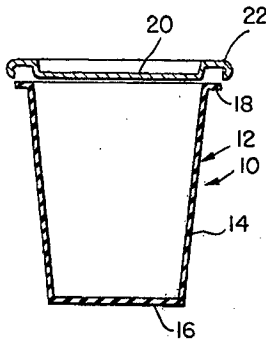


FIG. 2.

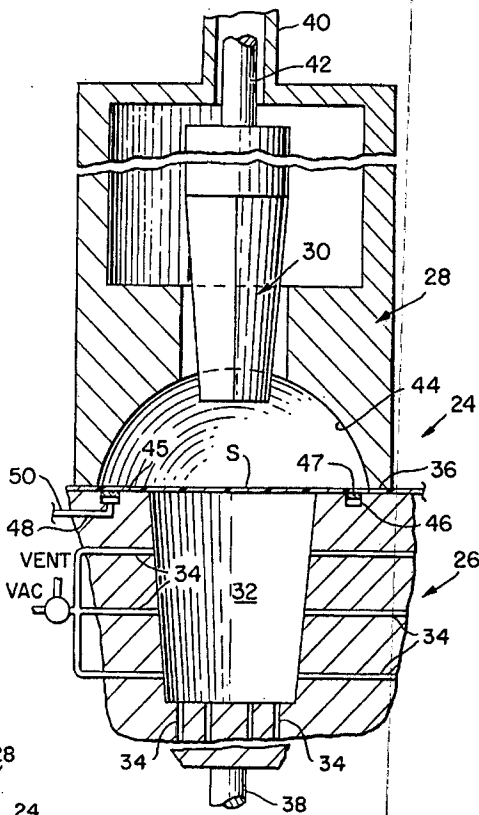


FIG. 3.

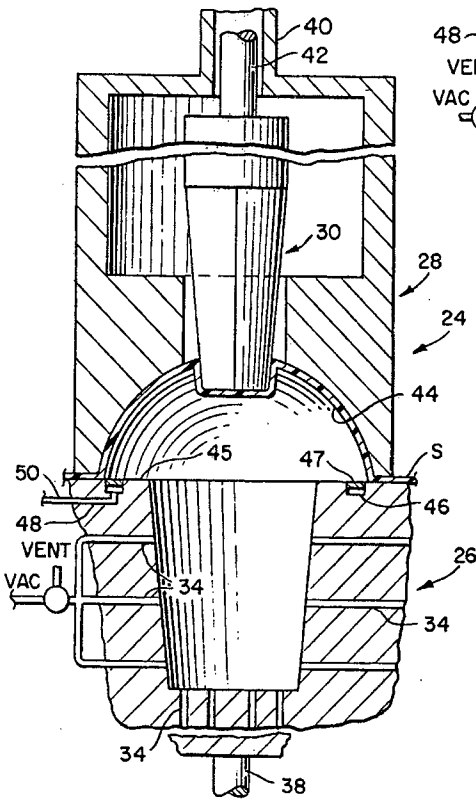
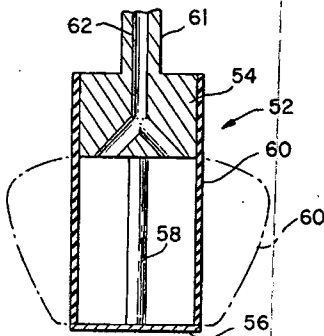
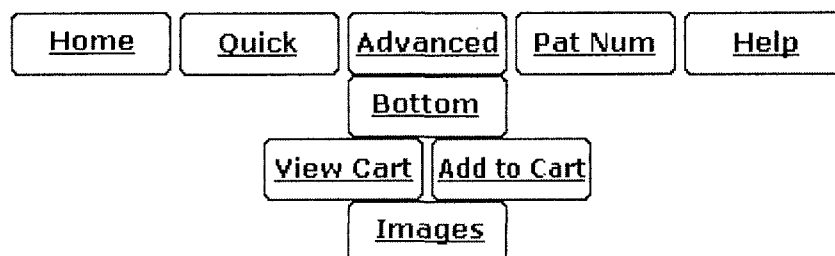


FIG. 8.



USPTO PATENT FULL-TEXT AND IMAGE DATABASE

(1 of 1)

United States Patent
Whiteside, et al.

4,608,009
August 26, 1986

Thermoforming equipment for differential pressure forming products in thermoplastic material

Abstract

Improvements in differential pressure, thermoforming machinery for molding articles in thermoplastic material wherein a mold station incorporates female mold mechanism and opposed mold mechanism, a web advancing mechanism indexes a plastic web in which products are to be formed between said mold mechanisms, a drive moves the female and opposed mold mechanisms between open and closed positions on opposite sides of the plastic web, severing knife means is cooperable with a final increment of said relative movement to dispose said mechanism in closed position to sever the products formed from the web, and ejector mechanism is operable after severing is accomplished and there has been relative movement of said mold mechanisms toward open position to eject the product.

Inventors: **Whiteside; Robert C.** (Harrison, MI); **Arends; Albert W.** (Gladwin, MI)

Assignee: **John Brown Inc.** (Beaverton, MI)

Appl. No.: **613864**

Filed: **May 23, 1984**

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Intern'l Class:

B29C 051/36; B29C 051/44; 589; 590; 592; 593; 451.3

Field of Search:

425/145,161,162,292,324.1,327,347,388,395,397,405 R,422,451,451.2,451.5,451.6 264/153,334,549-551,553

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Claims

What is claimed is:

1. A differential pressure, thermoforming machine for molding articles in thermoplastic material comprising:

a. a frame;

b. a mold station incorporated in said frame, said mold station including a female mold mechanism with cavity forming means and an opposed mold mechanism;

c. a longitudinally extending, web advancing mechanism for indexing a plastic web, in which products are to be formed, between said mold mechanisms;

d. means for relatively moving said female and opposed mold mechanisms between mold open and mold closed positions on opposite sides of said plastic web;

e. a roll stand upstream from said mold station for supporting a roll of the plastic web in a position aligned longitudinally with said mold station such that a supply of the web can be unwound from the roll and fed to the web advancing mechanism;

f. heater elements disposed between the roll stand and mold station for heating the web to a moldable state;

g. a dancer arm assembly movable in an oscillating path angularly to the longitudinal extent of said advancing mechanism and said web to pull a section of said web from the roll such as to form a loop of predetermined extent and then release it for movement in indexed increments to the mold station;

h. means mounting said dancer arm assembly for swinging movement about a generally horizontal axis extending transversely to the web;

i. a crank link having a first end connected to the dancer arm assembly for moving said dancer arm assembly in an oscillating path;

j. a drive crank pivotally connected to said link oscillatable through substantially half an arc of revolution for moving said crank link through part of a revolution wherein said crank link drives said dancer arm assembly first at a gradually accelerating speed, then at increased speed, and finally at a gradually decelerating speed, when said dancer arm assembly is moved both in a direction to release the web to the advancing mechanism and then away from the web to pull a further increment of web from the roll; and

k. drive means for moving said drive crank in correlation with said web advancing mechanism.

2. The machine of claim 1 wherein said drive means for moving said drive crank comprises a spur gear, at least one rack in mesh engagement, with said spur gear, and separate power cylinders powering said rack in correlation with said web advancing mechanism to revolve said gear first in one direction of rotation when the advancing mechanism is operating, and then in a return direction.

3. A differential pressure, thermoforming machine for molding articles in thermoplastic material comprising:

a. a frame;

b. a mold station incorporated in said frame, said mold station including a female mold mechanism with cavity forming means and an opposed mold mechanism;

- c. a longitudinally extending, web advancing mechanism for indexing a plastic web in which products are to be formed between said mold mechanisms;
- d. means for relatively moving said female and said opposed mold mechanisms between open and closed positions on opposite sides of said plastic web;
- e. severing knife means around said cavity forming means cooperable with a final increment of said relative movement to dispose said mechanism in a closed position to sever the products formed from the web;
- f. said means for relatively moving said mold mechanisms including a drive gear for causing relative movement to dispose said mold mechanisms in a forming position, and a final most-closed position in which severing of the articles by said severing knife means is accomplished;
- g. a ejector pin mechanism operable after severing is accomplished and there has been relative movement of said mold mechanisms toward open position to eject the product from the cavity forming means; and
- h. pusher means connected to be operated by said relative movement of one of said mold mechanisms to push the ejected product in a direction to clear the mold station.

4. A thermoforming machine for molding articles in thermoplastic material comprising:

- a. a frame;
- b. a mold station incorporated in said frame, said mold station including a mold assembly comprising a female mold mechanism with cavity forming means, and an opposed mold mechanism;
- c. a web advancing mechanism for disposing a plastic web, in which products are to be formed, between said mold mechanisms;
- d. means for relatively moving said female and said opposed mold mechanisms between open and closed positions on opposite sides of said plastic web;
- e. said means for relatively moving said female and said opposed mold mechanisms including expandible and contractible toggle links connected between said frame and one of said mold mechanisms, and drive means incorporating a motion transfer mechanism for relatively expanding and contracting said toggle links operable to expand said toggle links and move said one mold mechanism toward the other mold mechanism to a first forming position, and then to expand said toggle links a final increment to move said one mold mechanism a final increment toward the other mold mechanism to a severing position;
- f. severing knife means carried by said mold assembly around said cavity forming means cooperable with said final increment of expansion to sever the products formed from the web;
- g. said motion transfer mechanism including relatively repositionable, toggle link expanding, coupled parts operative in one relative position to transfer the motion of said drive means to cause expansion of said toggle links to move said one mold mechanism to said first forming position and then to cause further expansion of said toggle links to move said one mold mechanism to said severing position; said repositionable toggle link expanding, coupled parts being operative in a second relative position to move said one mold mechanism to said first forming position and to disable the said further expansion of said toggle links necessary to reach severing position; and
- h. position changing mechanism actuable for repositioning said parts between said first and second relative positions.

5. The machine of claim 4 wherein said drive means is controlled to drive said motion transfer mechanism through a continuous cycle commencing with said expansion of said toggle links a final increment to move said one mold mechanism to severing position, thence proceeding with contraction of said toggle links to move said one mold mechanism to a position removed from said other mold mechanism to permit operation of said web advancing mechanism, and terminating in expansion of said toggle links to move said one mold mechanism to said first forming position.

6. The machine of claim 4 wherein an ejector pin mechanism is mounted by said mold mechanism and operable, after severing and movement of said one mold mechanism away from said other mold mechanism, to eject the product from the cavity forming means; and pusher means is connected to be

direction to clear the mold station.

7. The machine of claim 4 wherein said position changing mechanism comprises a power cylinder carried by one of said repositionable parts and connected to the other.

8. The machine of claim 4 wherein said toggle links are revolvably coupled by a coupling pin and said parts include a connecting rod connected to said coupling pin and driven in a path to push said toggle link connecting pin to expand and contract said links.

9. The machine of claim 4 wherein said repositionable toggle link expanding coupled parts include a revolvable pin connecting said toggle links which includes an eccentric portion rotatably received by one of said toggle links such that revolving movement of said eccentric portion in one direction causes said further expansion of said toggle links, and a connecting rod coupled with said eccentric portion and to said drive means.

10. The machine of claim 9 wherein said connecting rod is driven in a path to push said pin bodily in a direction to contract and expand said toggle links, and also to revolve said pin.

11. The machine of claim 10 wherein said position changing mechanism includes a power cylinder connected between said revolvable pin and connecting rod to alter the motion transfer of said revolvable pin and said connecting rod by relatively pivoting said revolvable pin in the opposite direction.

12. A thermoforming machine for molding articles in thermoplastic material comprising:

a. a frame;

b. a mold station incorporated in said frame, said mold station including a mold assembly comprising a female mold mechanism with cavity forming means, and an opposed mold mechanism;

c. a mechanism for disposing a plastic web, in which products are to be formed, between said mold mechanisms;

d. means for relatively moving said female and said opposed mold mechanisms between open and closed positions on opposite sides of said plastic web;

e. said means for relatively moving said female and said opposed mold mechanisms including expandible and contractible, pivotally coupled toggle links connected between said frame and one of said mold mechanisms, and drive means incorporating a motion transfer mechanism for relatively expanding and contracting said toggle links operable to expand said toggle links and move said one mold mechanism toward the other mold mechanism to a first forming position, and then to expand said toggle links a final increment to move said one mold mechanism a final increment toward the other mold mechanism to severing position;

f. severing knife means carried by said mold assembly around said cavity forming means cooperable with said final increment of expansion to sever the products formed from the web;

g. said motion transfer mechanism including a revolvable pin connecting said toggle links which includes an eccentric portion rotatably received by one of said coupled toggle links such that revolving movement of said eccentric portion in one direction causes further expansion of said toggle links, coupled with a connecting rod connected with said drive means to transfer the motion of said drive means to first cause expansion of said toggle links to move said one mold mechanism to said first forming position and then to cause further expansion of said toggle links to move said one mold mechanism to said severing position via rotation of said pin.

13. The improved invention of claim 12 wherein said drive means comprises a crank arm connected to one end of said connecting rod and moving it in a path to push said pin bodily in a direction to contract and expand said links, and to also revolve said pin.

Description

BACKGROUND OF THE INVENTION

The thermoforming art is well developed and normally such machinery includes mold carrying platens driven cyclically in relative movement toward and away from each other between open and closed

to satisfy various of the requirements for efficient and reliable thermoforming machines, and among them are machines incorporating some of the features disclosed in the following U.S. Pat. Nos.:

U.S. Pat. Nos. 3,105,270; 3,726,458; 3,216,491; 3,876,488; 3,338,997; 4,354,816; 3,346,923; 4,368,024; 3,577,596; 3,890,308; 3,719,445; 4,158,539.

Improvements in such systems have been generally concerned with efforts to increase the productivity of such machinery and to operate it at ever-faster speeds to turn out products at an ever-increasing pace. Much of the machinery which is in use is of a relatively heavy and complex nature and a need has been identified for smaller thermoforming systems which are, for instance, capable of the "trim-in-place" processing of polypropylene and other thermoplastic materials. A thermoformer of this type may, for example, provide a maximum mold size of 20.times.13 inches with a 5 inch depth of draw. Such a machine will handle 22 inches.times.30 inch diameter rolls of material in thicknesses up to 2 mm., at operating speeds of as much as 40 strokes per minute.

SUMMARY OF THE INVENTION

Systems of the type which we have designed require that the material be efficiently and reliably pulled from the supply roll and advanced between the molds at speeds consonant with the mold cycles utilized. Such systems further require drive mechanism for moving the molds relatively to provide a "trim-in-place" feature, and to do so conjunctively with a "no-trim" mechanism which will effectively disable the trim movement on a selective basis. Such systems also require mechanism for synchronously removing the products which are separated from the web from between the molds to a collection station in an advantageous and reliable manner.

Finally, systems of this type must provide other operating advantages which enhance the saleability of such machines in various countries throughout the world.

One of the prime objects of the present invention is to design a relatively smaller and yet efficient machine which is still capable of producing parts at relatively high speeds in a manner which enhances the productivity, performance and profitability of such machinery.

Still another object of the invention is to provide an extremely versatile machine of relatively inexpensive construction which is well suited to the world market for such machines.

Still another object of the invention is to provide dancer mechanism for thermoforming equipment which is not subject to the extremes of acceleration and deceleration which were a characteristic of prior designed machinery, and which, accordingly, avoids the problems previously encountered as a result.

A further object of the invention is to provide dancer roll drive mechanism which operates efficiently and smoothly, avoids tearing of the thermoplastic sheet and undue jarring and the consequent wear of the machine parts, and does so without sacrificing cycle time.

Still another object of the invention is to provide very efficient drive mechanism for moving at least one of the mold members relative to the other which provides a part "trim-in-place" feature while still permitting an effective "no-trim" control which provides for the optional and selective disablement of the "trim-in-place" increment of travel.

Still another object of the invention is to design simple and effective product ejecting mechanism operated via the movement of at least one of the molds to a spread, moldopen position to move parts trimmed from the web and ejected from the mold cavities, over to a collection station.

Other objects and advantages of the invention will become apparent by reference to the following specification and to the drawings.

IN THE DRAWINGS

FIG. 1 is a schematic, side elevational view of a thermoforming system employing the improvements of the invention;

FIG. 2 is a greatly enlarged, fragmentary view showing a dancer roll in several positions, the chain lines indicating the extended position of the dancer roll in which the roll operates to pull a length of material from the plastic roll preparatory to feeding it between the ovens in increments to a position between the thermoforming molds;

FIG. 3 is a fragmentary, front elevational view thereof;

FIG. 4 is a considerably enlarged, fragmentary transverse elevational view illustrating the drive link mechanism for moving the lower mold platen upwardly and downwardly;

FIG. 5 is a side elevational view thereof;

FIG. 6 is a still more enlarged, sectional elevational view, particularly illustrating "trim-in-place" knives which may be used with the machinery;

FIG. 7 is a fragmentary, end elevational view, particularly illustrating the ejector members for moving the trimmed products out of the mold cavities;

FIG. 8 is a schematic side elevational view thereof;

FIG. 9 is a fragmentary, schematic side elevational view illustrating pusher mechanism linkage for removing the trimmed parts in an advanced position;

FIG. 10 is a view similar to FIG. 9, but showing the part displacing pusher moved to fully displaced position between the upper and lower molds to push the parts ejected from the mold cavities over to a part collecting conveyor;

FIG. 11 is a fragmentary, top plan view of a portion of the pusher plate; and

FIG. 12 is a typical electrical control diagram.

THE GENERAL MACHINE

Referring now more particularly to the accompanying drawings, and in the first instance to FIG. 1, thermoplastic materials such as polypropylene, polyethylene, and polystyrene are supplied in the form of a wound roll, generally designated R, which in the usual manner is supported for rotation on supports 11a on shaft 11, which, in the usual manner, is journaled in bearings 11b (see FIG. 2) supported on the machine frame F. The machine frame is shown only fragmentarily as comprising end and side rails 8 and 9 respectively, supported on legs 12.

The plastic web or sheet P is shown in FIG. 2, in chain lines, as having been pulled from the roll R by a dancer roll 13, mounted on arms 14 which are pivotally supported by a shaft 15 which is journaled in bearings 16 on frame legs 12. The dancer roll assembly will presently be described in more detail.

The plastic web P leads around under the dancer roll 13, and up over roll supports 18. As is usual, and described in the present assignees' U.S. Pat. No. 3,216,491, which is incorporated herein by reference, advancing chains 19 provided with piercing pins 20 at each side of the machine, then engage the edges of the plastic web P, and pierce them to grip the web and enable the chains to move the sheet in indexing increments.

The chains 19, which receive the web from a bridging web support pan 17, may be trained around sprockets 21 mounted on shaft 21a, side rails 21b and downstream sprockets 22 mounted on an idler shaft 23. The chains 19 also train around sprockets 24, mounted on an idler shaft 25, and chain drive sprockets 26 mounted on the chain drive shaft 27 which is powered by suitable Geneva mechanism or the like, to move the chains 20 in advancing increments in the conventional manner. The drive shaft 27 is driven synchronously with the mold platen closing and opening drive mechanism to advance the next increment of plastic web P between the molds of the thermoforming machine when the molds are in spread position.

Provided in the usual manner to heat the thermoplastic web P to a deformable condition are temperature controlled upper and lower ceramic heater ovens 28 and 29, respectively, situated between the dancer roll 13 and the upper and lower mold assemblies generally designated M-1 and M-2 respectively, generally. As will become apparent when the mold station elements are described in more detail, the upper mold assembly M-1 is stationary and it is the lower mold assembly M-2 which is moved upwardly and downwardly with respect to it.

THE DANCER MECHANISM

As FIGS. 2 and 3 particularly indicate, the dancer roll support arms 14 are fixed at their front ends to a shaft 15 and the roll 13 is oscillated in the arcuate path indicated in FIG. 2 by a connecting rod 31. At its lower end, rod 31 is pivotally connected as by pin 32 to a forwardly extending link 33 which is fixed to shaft 15. At its upper end, connecting rod 31 is connected via a pivot pin 34 with a vertically extending drive member or crank 35, which is swung through a 180.degree. arc, and then back again. The drive

in one direction of rotation and then in the other is a rack gear 38. The rack gear 38 is driven in opposite directions by opposed fluid pressure operated cylinders 39 and 40 having floating pistons provided in opposed relation. When air is admitted to the ends of cylinder 39 to drive the rack 38 to the left in FIG. 2, air must be egressed from the far end of the cylinder 40 to permit this to happen, and vice versa when rack 38 is returned. A bracket 41 may be provided for supporting the cylinders 39 and 40 from frame rails 9.

As will be apparent from FIG. 2, the support arms 14, which have brackets 14a journaling the dancer roll shaft 13a, move through about 25.degree. of travel and then swing back. What is achieved is a relatively rapid payout of material from the roll R, then a rapid movement of dancer roll 13 upwardly so that the chains 20 can synchronously index the web. The roll 13 moves with such speed that the material can index without delay and the indexing is completed when roll 13 reaches the "up" position.

Previous mechanism employing air cylinders to directly power the dancer roll support arms created problems because of the acceleration and deceleration extremes. Now, with crank 35 swinging 180.degree., and operating through connecting rod 31, a controlled acceleration and deceleration is built in and the shock effects of acceleration and deceleration are much mitigated.

THE MOLD STATION

As FIG. 1 indicates, the upper mold assembly M-1 is stationary and includes a mold member 45 supported on frame F opposite the mold assembly M-2 which includes the usual mold member 46, with a series of mold cavities 47. The upper mold assembly M-1 has openings 48 for the plug assist members 49, which, as FIG. 4 indicates, are movable down into mold cavities 47 to assist in moving portions of the plastic web P into the cavities. The plug assists 49 may be mounted on rods 49a, attaching to a support plate 50 which is connected to the piston rod 51 of an air operated cylinder 52, housing a piston 53. Supports 45a may be provided for supporting the cylinder 52 on mold member 45. Cylinder 52 is a double-acting cylinder, which has its piston rod 51 extending from both ends, and the upper end of rod 51 mounts a stop plate 54, which is movable down into engagement with the frame supported stop 55.

It is to be understood that the plug assists 49 operated in conjunction with an air pressure supplying valve and manifold device 56, which, after the plug assists 49 have moved the plastic P into the cavities 47, provides the air pressure to intimately engage the plastic with the contours of the mold cavities. Vacuum ports 46a can also be provided in the mold 46 in the usual manner. As FIG. 4 indicates, the lower end of each mold cavity 47 is formed by an ejector pin assembly, generally designated 57, which includes ejector pins 58, to presently be described with respect to their operation in more detail, and ejector pin heads 59 which provide the desired configuration for the bottom of the mold cavities 47.

As shown more particularly in FIG. 6, a steel ring die 61 may be fixed in position by the mold 46 to form the upper end of each mold cavity 47. As FIG. 6 indicates, each ring 61 is a severing or cut-off knife which is effective to sever the cup-shaped part C which has been formed in the molding operation from the plastic web P.

Provided on frame support members 62, at the mold station, are a pair of ways or guides 63 on which a platen 64 (which carries mold 46) is guided during raising and lowering movement. Supporting plates 65 are provided on the ends of platen 64 for the purpose of mounting bearing blocks or gibs 66 and 67 which travel along the ways 63.

The platen 64 is raised and lowered by toggle linkage assemblies generally designated 70, which are of a unique nature to provide for both a final upward incremental movement of mold 46 and severing rings 61, and for a selectively operated, "no-trim" repositioning operation. The toggle linkage is driven in a scissors fashion to expand and retract, and thereby move the platen 64 and mold 46 upwardly and downwardly in the thermoforming cycle.

Each toggle link assembly 70 is connected to the platen 64 by a bar 71, and is connected to the frame F at its lower end by a pin 73 supported by a pair of frame support brackets 72. The toggle links 74 of each assembly 70 are pivotally mounted on a frame-fixed pin 73 and, at their upper ends, each pair of links 74 is provided with co-axial bores 75 which support the co-axial ends of a pin 76 having an enlarged eccentric central part 77 (FIG. 5). The ends of pin 76 have an axis a and the portion 77 has an axis b. The upper toggle links 77a for each assembly 70 are each connected to the platen 64 by a pivot pin 78a carried by the bars 71, and at their lower ends have bores 77b which journal the eccentric portions 77. Keyed to each portion 77 as at 77c is a block 78 on one end of which a connecting rod 79 is pivoted, as by a pin 79a. The connecting rod 79 for each assembly 70 is driven by a crank arm 80 mounted on a drive shaft 81 for moving the crank arms 80 through 360.degree. increments of rotation.

Projecting from each block 78 are braces 82 for pivotally mounting a spring returned, single-acting

79. As will later become apparent, cylinders 83 may be push button operated by the machine operator to bring a "no-trim" repositioning into play.

The purpose of eccentric pins 76 is to provide a final increment of upward movement of mold 46 via eccentric portions 77 at the beginning of the mold retract cycle, after a short time delay to permit cooling of the parts C which are formed. Drive shaft 81 may be driven via a suitable electric motor M through suitable Geneva mechanism or the like (not shown), such that crank arms 80 are indexed in a manner which later will be described.

THE PART EJECTING MECHANISM

FIGS. 7-10 schematically depict the mechanism for, first of all, moving the parts C upwardly out of the mold cavities 47 and, then, pushing them laterally to a position removed from between the mold assemblies M-1 and M-2. For the purposes of convenience of illustration, the mold 46 has been shown as only of sufficient width to produce a single row of cups C in these Figures. In FIGS. 7 and 8 the ejector pins 58 are shown as connected by a plate 90. The plate 90 mounts receiving guide rods 91 which pass through openings in the plate 92 (which is attached to the frame F). Coil springs 93 are provided around the pins 91 to restrain the plate 90 and ejector pins 58 when the platen 64 moves downwardly.

The upper ends of springs 93 are normally disposed a predesignated distance below the plate 90, as shown in FIG. 7. When mold 46 initially lowers, the ejector pin assembly 57 will lower with it for a sufficient portion of the mold's travel to clear the sag in the sheet. Then, when plate 90 contacts springs 93, mold 46 will continue to lower, while the springs 93 maintain the heads 59 of the pin assemblies in position such that the parts C are soon positioned above the mold cavities 47 and die rings 61.

In FIG. 9, mechanism is disclosed for moving such cups C out from between the mold assemblies M-1 and M-2. Provided at each side of the machine, downstream from the mold assemblies M-1 and M-2, are a pair of guide rods 94 which mount pusher plate carriages 95 to which a pusher plate 95a is connected. Brackets 96 on the frame F are provided at each side of the machine to support pivotal links 97 via pivot pins 98. Each arcuately oscillating link 97 is connected with a carriage 95 via a link 99, and pivot pins 100 and 101. Each link 97 is connected with the platen 64 via a link 102, and pivot pins 103 and 104.

The linkage is uniquely designed so that initial downward movement of the platen 64 creates no substantial forward movement of the pusher plate 95a. It is only when link 102 travels from the position shown in FIG. 8 to the position shown in broken lines at x in FIG. 9, that material forward movement of plate 95a commences. The built-in time delay provides sufficient time for the cups C to clear the cavities 47 and rings 61 before pusher plate 95a is moved across.

In the advanced position of the pusher plate 95a, which is reached automatically when the platen 64 is lowered to the position shown in FIG. 10, the parts or cups C are engaged by the pusher 95a and moved over to a collection station which may comprise, for example, a transversely moving belt conveyor 105. FIG. 11 discloses the configuration of the plate 95a which normally is provided with cupreceiving recesses 95b.

THE OPERATION

Assuming that the mold assembly M-2 is stopped in raised forming position with the crank arms 80 in the 10 o'clock position shown in FIG. 5, the next successive cycle will be initiated by a resetting timer T which, after a time delay sufficient to provide for some cooling of the formed parts C to be trimmed, engages clutch CL (connected with constantly driven motor M) to drive shaft 81. Crank arms 80 will commence to move toward the 12 o'clock position, but because the movement is initially mostly upwardly rather than to the right in FIG. 5, the effect is to raise the position of pin 80 and the right end of block 78 without contracting links 74, 77a. The effect is to rotate eccentric portion 77 slightly counterclockwise in FIG. 5 with respect to pin axis "a" and raise links 77a upwardly. This moves platen 64, mold 46 and severing dies upwardly sufficiently to trim the parts (see FIG. 6). Further movement of the arms 80 toward the 12 o'clock position provides much more rightward than upward movement and this starts to collapse the links 74, 77a and lower mold 46. At this time, contacts 106 close to energize the clutch CL-1, which drives the shaft 27, powering the web advancing chains 19. At the same time, dancer roll 13 is operated by the arm 35 moving 180.degree. from the down position in which it is shown in FIG. 3, to an up position and, in so doing, moving the dancer roll 13 from the "at rest" broken line position shown in FIG. 2, to the solid line position. This occurs when double acting, solenoid operated cylinders 39 and 40 are operated by contacts 107 controlled by an encoder such as shown in U.S. Pat. No. 3,814,934 or the like, which is responsible for closing and opening the various sets of contacts which operate the various components of the machine. Contacts 108 are then immediately closed by the encoder to operate cylinders 39 and 40 in the reverse direction and move roll

During operation of the chains 19 and roll 13, as crank arms 80 move right and toward the 4 o'clock position, the links 74 and 77a will be collapsed to lower the mold 46 and platen 64. After an initial lowering movement, the plate 90 engages the springs 93 and holds the cups C in position, while the platen 64 and mold 46 continue to descend. At the same time, movement of the platen 64 downwardly causes the linkage 102, 97 and 99 to react to initially delay, as previously explained, and then to move the pusher carriage mounts 95 forwardly and cause the pusher plate 95a to push cups C over to a discharge conveyor 105. On the later movement of mold 46 upwardly, the pusher plate 95a is automatically removed from between the mold assemblies M-1 and M-2 to the FIG. 9 position by the same linkage 102, 97 and 99.

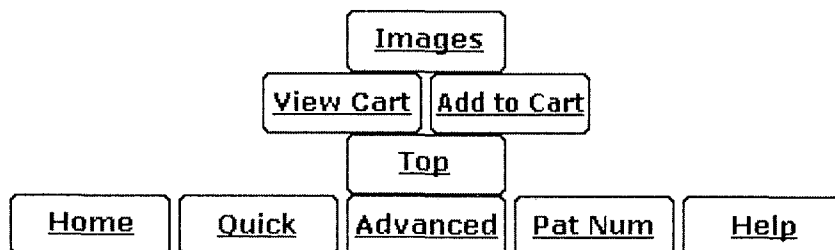
During the return movement of roll 13, a fresh length of plastic web P is pulled from the roll R and the dancer roll 13 is then halted in down position. The advancing chains 19 have finished their sheet forwarding movement and shaft 27 is halted at the time roll 13 commences to move downwardly. At this time, crank arms 80 are in the 7 o'clock position and the mold 46 (which reached down position when crank arms 80 were in the 4 o'clock position) has moved upwardly, to a considerable extent, the links 74 and 77a expanding as the crank arms 80 moved leftward. When the crank arms 80 reach the 10 o'clock position where the links 74, 77a are fully expanded, drive shaft 81 is braked and halted.

At this time, the mold 46 has been raised to a position of substantial engagement with the plastic web P and contacts 109 are made to operate cylinder 52 and cause the plug assists 49 to move areas of the heated deformable plastic into the mold cavities 47. At about the time plug assists 49 reach their lowermost positions, contacts 110 are made and the air valve 56 operates to release air under pressure to passages 48 to complete moving the deformable plastic web portions into intimate engagement with the contours of the mold cavities 47. Contacts 109a are then made by the encoder to move cylinder 52 and piston rod 51 upwardly and raise the plug assists 49. The crank arms 80 remain at rest in the 10 o'clock position until the next cycle is commenced. Because the mold closing and opening motion is crank-operated, via cranks 80, the acceleration and deceleration is gradual, and the problems incident to sudden starts and stops do not occur. The machine is accordingly considerably more trouble-free than much of the prior art machinery.

In the set-up of the machine, and until all of the various parts are aligned and the operation is "proved", it is often desirable to eliminate the severing in place operation, such that the entire web with the cups formed therein proceeds to the scrap grinder. The operator need merely press a push button 111 which operates each cylinder 83 and retracts the piston rod 85 of each. Since crank arms 80 cannot move, this retraction causes each block 78 and eccentric pin portion 77 to swing downwardly (clockwisely in FIG. 5) about an axis "a" and lowers the links 77a just sufficiently so that movement of the crank arms 80 away from the 10 o'clock position toward the 12 o'clock position will not cause sufficient upward movement of the mold 46 and severing rings 61 to sever the parts formed. The position of links 74 does not change when the position of eccentric portion 77 is changed. When the operator desires to again include the trim-in-place feature, it is only necessary to release push button 111 and permit the single acting cylinders 83 to return to the FIG. 5 position.

While one embodiment of the invention has been described in detail, it will be apparent to those skilled in the art the disclosed embodiment may be modified. Therefore, the foregoing description is to be considered exemplary, rather than limiting, and the true scope of the invention is that defined in the following claims.

* * * * *





U.S. Patent

Aug. 26, 1986

Sheet 4 of 4

4,608,009

 Full Text

? Help

Go to Page:

Go



Sections:

- Front Page
- Drawings
- Specifications
- Claims

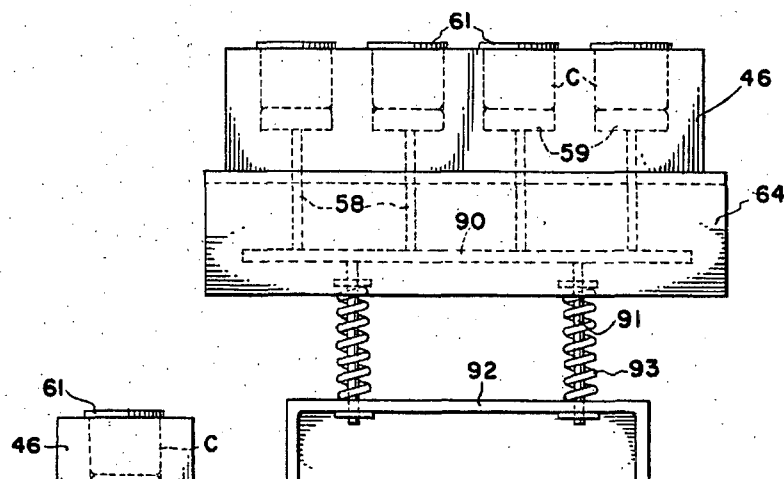


FIG. 7

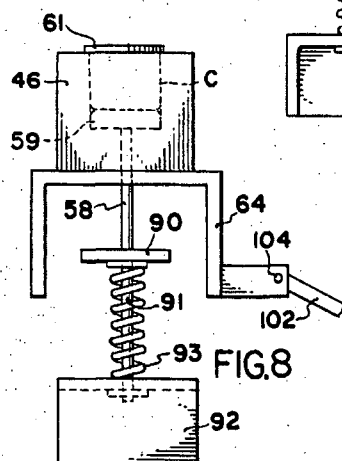


FIG.8

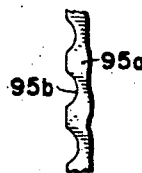


FIG. 11

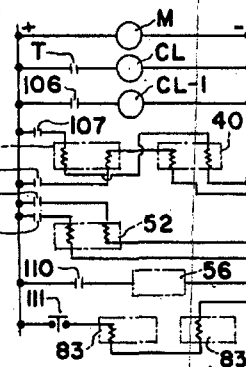


FIG. 12

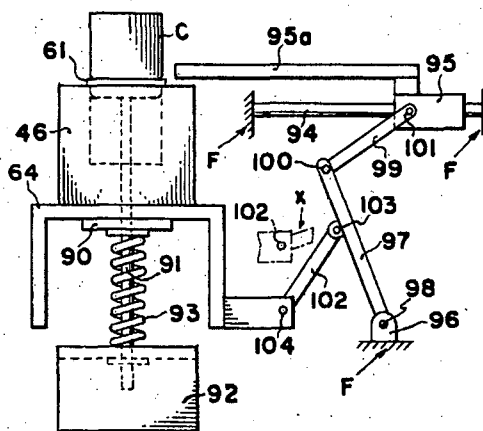


FIG.9

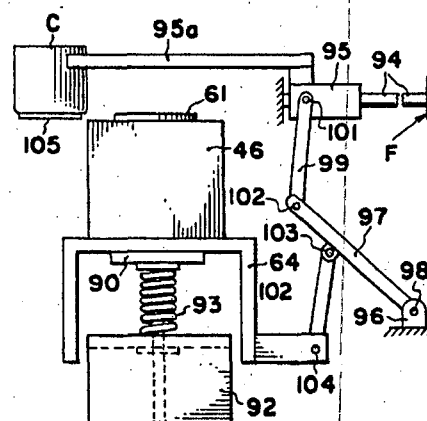


FIG.10

54
159



U.S. Patent Aug. 26, 1986 Sheet 3 of 4 4,608,009

Full Text
Help

Go to Page:
Go



- Sections:
- Front Page
 - Drawings
 - Specifications
 - Claims

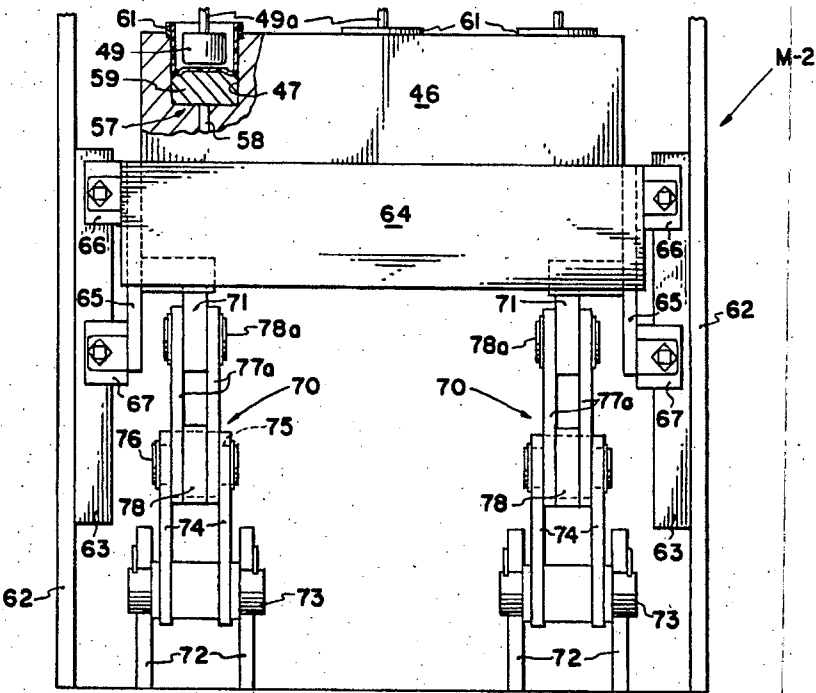


FIG. 4

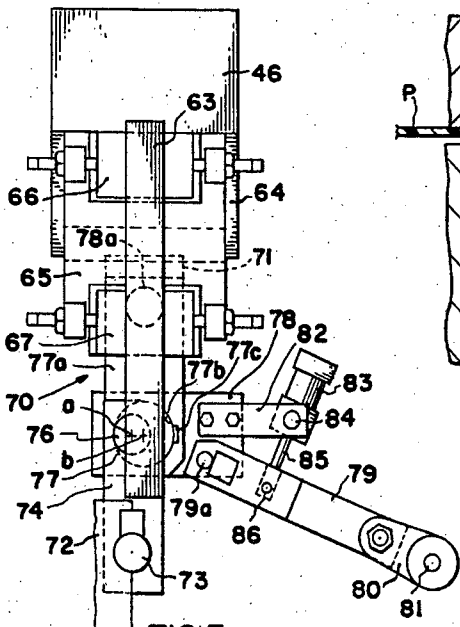


FIG. 5

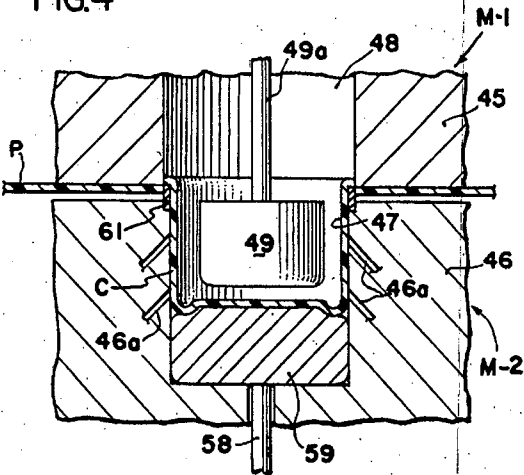


FIG. 6



^ Full Text
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Go to Page:

Go



Sections:

- [Front Page](#)
- [Drawings](#)
- [Specifications](#)
- [Claims](#)

U.S. Patent Aug. 26, 1986 Sheet 2 of 4 4,608,009

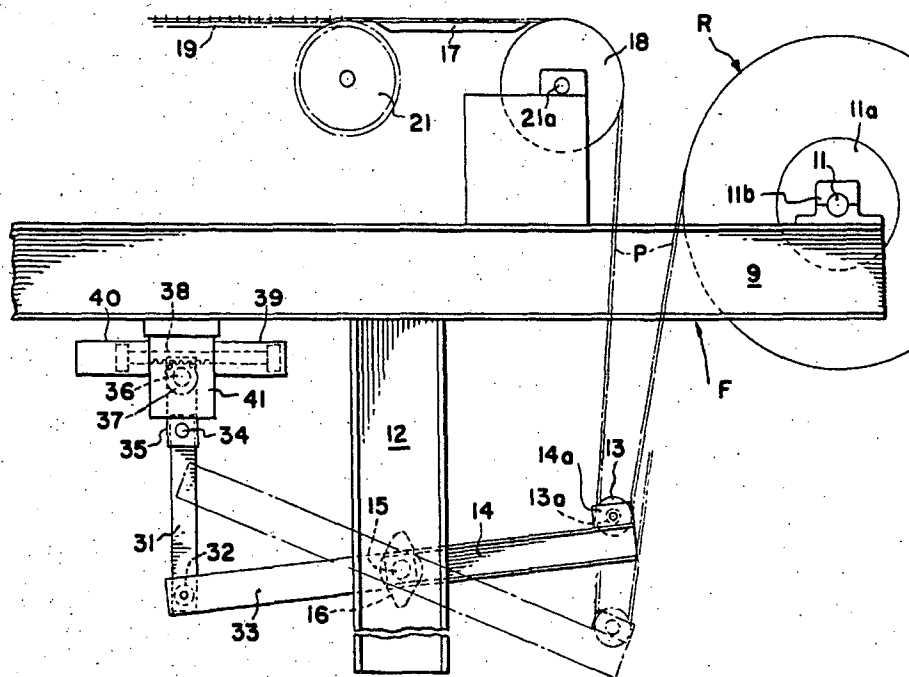


FIG. 2

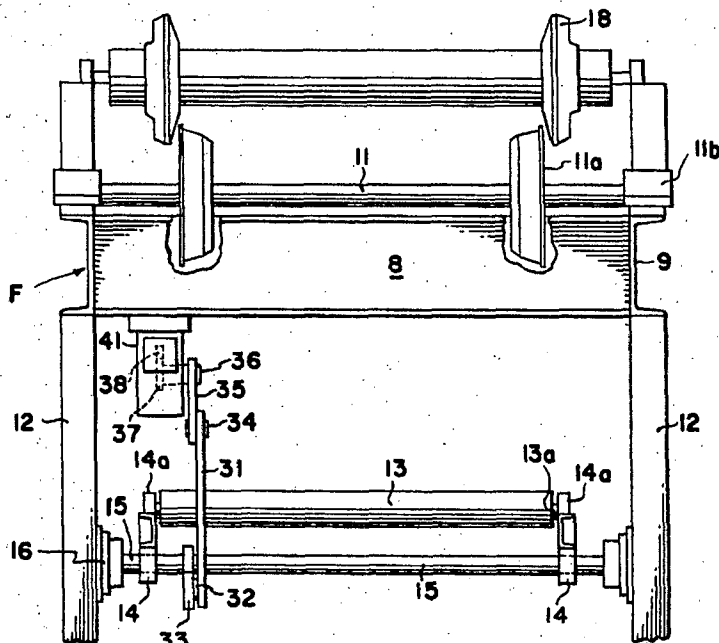


FIG. 3



U.S. Patent Aug. 26, 1986

Sheet 1 of 4

4,608,009

[^ Full Text](#)
[? Help](#)

Go to Page:

Go



Sections:

- Front Page
- Drawings
- Specifications
- Claims

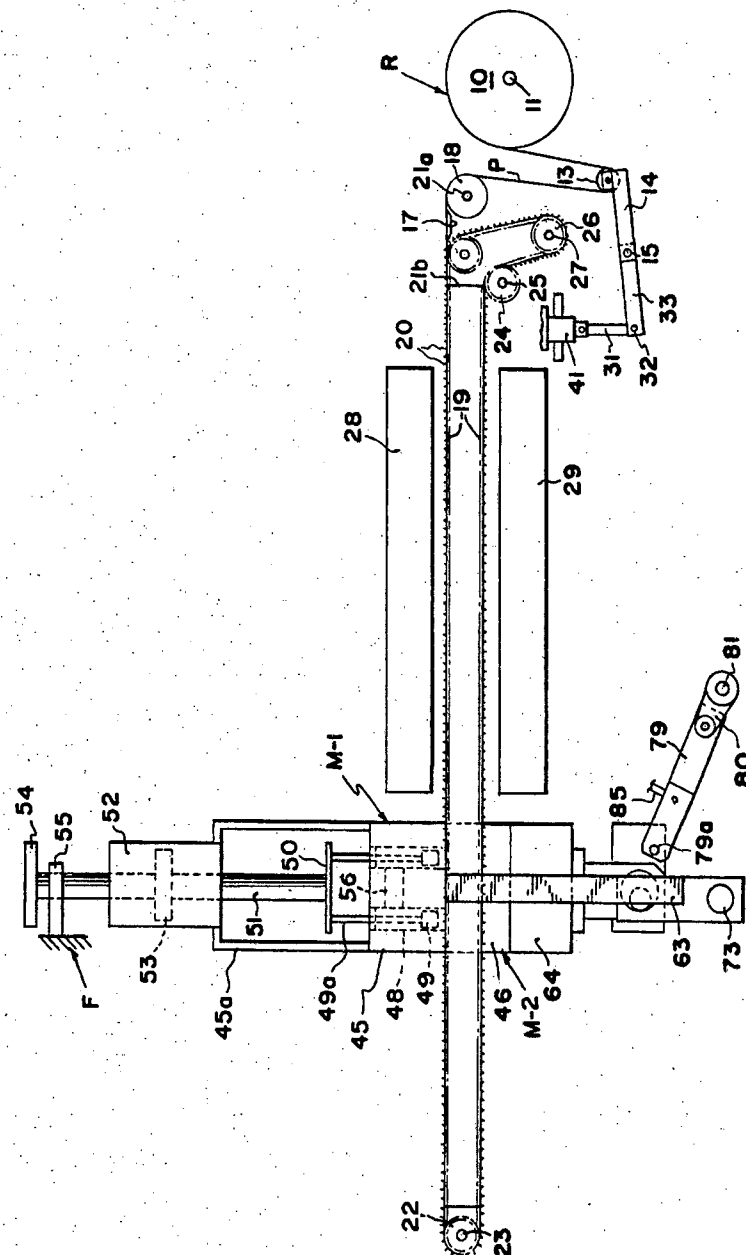
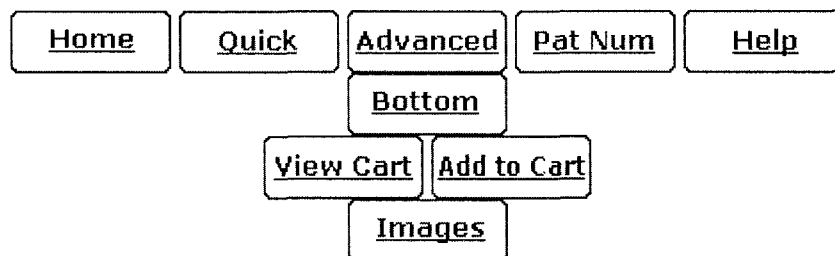


FIG. 1

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(1 of 1)

United States Patent
Nied, et al.**5,290,490**
March 1, 1994

Method and apparatus for differentially heating and thermoforming a polymer sheet

Abstract

A method and apparatus for thermoforming 3-dimensional articles of chosen wall thickness dimensions from a polar polymer sheet. The polymer sheet is dielectrically heated, the heating being controlled to impress a predetermined thermal pattern on the sheet. The thermal pattern is selected in accordance with the amount of stretching to which each area of the sheet is subjected during the subsequent work-forming step, the areas subjected to greater stretching being heated to a lower temperature and vice versa. Thus, the stretching action is balanced and results in accurate control of the wall thickness of the final article.

Inventors: **Nied; Herman F.** (Clifton Park, NY); **Chen; Alexander T.** (Schenectady, NY)Assignee: **General Electric Company** (Schenectady, NY)Appl. No.: **911249**Filed: **July 7, 1992****Current U.S. Class:****264/491; 219/773; 264/522; 425/160; 425/174.8E;
425/DIG13****Intern'l Class:****B29C 035/14; B29C 051/42****Field of Search:****264/26,522,521,DIG. 65 425/174.8 E,160,DIG. 13,174.8 R
219/10.41,10.43,10.61 R,10.57,10.81****References Cited [Referenced By]****U.S. Patent Documents**

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Primary Examiner: Timm; Catherine

Attorney, Agent or Firm: Scanlon; Patrick R., Webb, II; Paul R.

Parent Case Text

This application is a continuation of application Ser. No. 07/545,799, filed Jun. 26, 1990, now abandoned.

Claims

What is claimed is:

1. A method for dielectrically heating a sheet of polar polymer material, comprising the steps of:

placing said sheet between first and second spaced electrodes, wherein at least said first electrode comprises a plurality of discrete electrode segments proximately positioned to each other, and

dielectrically heating said sheet by applying RF energy to said first and second electrodes;

varying the RF energy applied to respective ones of said plurality of discrete electrode segments so that different segments can have different applications of RF energy to impress a selected thermal pattern on said sheet.

2. The method according to claim 1, wherein said step of varying the RF energy comprises applying RF energy to respective ones of said segments for time intervals of different length so as to attain said selected thermal pattern on said sheet.

3. The method according to claim 1, wherein said step of varying the RF energy comprises applying RF energy to respective ones of said segments at different voltages so as to attain said selected thermal pattern on said sheet.

4. The method according to claim 1, wherein said step of varying the RF energy comprises applying RF energy to respective ones of said segments at different frequencies so as to attain said selected thermal pattern on said sheet.

5. A method for thermoforming a sheet of polar polymer material into articles having chosen cross-sectional thickness dimensions, said method comprising the steps of:

positioning said sheet between a first electrode having a plurality of discrete electrode segments and a second electrode such that said electrodes face opposite sheet surfaces;

dielectrically heating said sheet by energizing said electrodes with a high frequency power source;

varying the high frequency power applied to respective ones of said plurality of discrete electrode segments so that different segments can have different applications of high frequency power to impress a selected thermal pattern on said sheet; and

die-forming said articles from said thermally patterned sheet such that each of said thickness dimensions is determined by the temperature of the originating sheet area and the physical working performed thereon during the die-forming step.

6. The method according to claim 5, wherein said step of varying the high frequency power comprises applying high frequency power to respective ones of said segments for time intervals of different length so as to attain said selected thermal pattern.

7. The method according to claim 5, wherein said step of varying the high frequency power comprises applying high frequency power to respective ones of said segments at different voltages so as to attain said selected thermal pattern.

8. The method according to claim 5, wherein said step of varying the high frequency power comprises applying high frequency power to respective ones of said segments at different frequencies so as to attain said selected thermal pattern.

9. Apparatus for dielectrically heating an article, said apparatus comprising:

a first electrode, said first electrode comprising a plurality of discrete electrode segments;

a second electrode spaced from said first electrode to receive an article to be heated therebetween;

a source of RF energy connected to said first and second electrodes; and

control means for varying the RF energy applied to respective ones of said plurality of discrete electrode segments so that different segments can have different applications of RF energy to impress a selected thermal pattern on said article.

10. Apparatus according to claim 9, wherein said control means includes means for varying the length of the time interval during which RF energy is applied to respective ones of said segments so that different segments can have RF energy applied for different time intervals, the different time intervals causing said selected thermal pattern.

11. Apparatus according to claim 9, wherein said control means includes means for varying the voltage at which RF energy is applied to respective ones of said segments so that different segments can have different voltages, the different voltages causing said selected thermal pattern.

12. Apparatus according to claim 9, wherein said control means includes means for varying the frequency at which RF energy is applied to respective ones of said segments so that different segments can have different frequencies, the different frequencies causing said selected thermal pattern.

13. Apparatus according to claim 9, wherein said second electrode includes a lubricious surface.

14. Apparatus for forming a polar polymer sheet into articles having chosen cross-sectional dimensions, said apparatus comprising:

a first electrode, said first electrode comprising a plurality of discrete electrode segments;

a second electrode spaced from said first electrode;

means for positioning a polar polymer sheet between said first and second electrodes;

a source of RF energy connected to said first and second electrodes;

control means for varying the RF energy applied to respective ones of said plurality of discrete electrode segments so that different segments can have different applications of RF energy to impress a selected thermal pattern on said sheet; and

means for die-forming articles from said thermally patterned sheet such that each of said thickness dimensions is determined by the temperature of the originating sheet area and the physical working

60
165

15. Apparatus according to claim 14, wherein said control means includes means for varying the length of the time interval during which RF energy is applied to respective ones of said segments so that different segments can have RF energy applied for different time intervals, the different time intervals causing said selected thermal pattern.

16. Apparatus according to claim 14, wherein said control means includes means for varying the voltage at which RF energy is applied to respective ones of said segments so that different segments can have different voltages, the different voltages causing said selected thermal pattern.

17. Apparatus according to claim 14, wherein said control means includes means for varying the frequency at which RF energy is applied to respective ones of said segments so that different segments can have different frequencies, the different frequencies causing said selected thermal pattern.

18. Apparatus according to claim 14, wherein said positioning means includes means for moving said sheet past said electrodes;

said second electrode including a lubricious surface facing said sheet to diminish friction or adhesion with respect to said sheet.

19. Apparatus according to claim 14, wherein said die-forming means comprises:

a die including at least one die surface shaped to provide the desired configuration of said articles;

gripping means for sealably holding said sheet against said die; and

means for applying differential gas pressure to opposite surfaces of said sheet to force said sheet to conform to said die surface.

20. Apparatus according to claim 19, wherein said die surface is perforated, said means for applying differential gas pressure comprising means for applying vacuum pressure through said perforated die surface to draw said sheet into contact therewith.

21. Apparatus according to claim 19, wherein said means for applying differential gas pressure comprises means for applying positive pressure against the sheet surface remote from said die surface.

Description

BACKGROUND OF THE INVENTION

The present invention is directed in general to thermoforming, and in particular to a method and apparatus for thermoforming articles from a polar polymer sheet wherein the wall thickness of the articles can be accurately controlled to predetermined dimensions.

Thermoforming is a well-known method for fabricating articles such as drinking cups, blister packages, food containers, etc., which uses any suitable drawing or deep drawing technique, such as vacuum forming, pressure forming, plug-assist, mechanical matched die forming or twin sheet hollow part forming or any combination of such techniques. In all cases the sheet material is heated up to the softening temperature called, forming temperature, so that it can be physically worked, i.e. work-formed into the desired articles. For example, some of the forming temperatures of General Electric Company's polymer sheets are about 450.degree. F. to 500.degree. F. for Xenoy.RTM. blend of polycarbonate and polybutylene terephthalate, about 340.degree. F. to 400.degree. F. for Lexan.RTM. polycarbonate, about 520.degree. F. to 560.degree. F. for Ultem.RTM. polyetherimide, and about 280.degree. F. to 340.degree. F. for Cynolac.RTM. acrylonitrile butadiene styrene.

Although the thermoforming process has enjoyed wide success for fabricating shallow depth articles, difficulties are encountered in the fabrication of deep drawn containers or articles having thin walls. It has proven difficult to control the flow of the plastic sheet material as it is work-formed and hence to control the wall thickness of the articles being thermoformed. Precise control of the wall thickness at predetermined areas is desirable in order to provide strength to the article as required, as well as to reduce the cost of the material which is used.

In a typical thermoforming process, the sheet is heated uniformly prior to the work-forming step. During the subsequent work-forming step, the heated sheet is expanded into a die cavity by means of applied

the process, portions of the sheet are stretched more than others, resulting, for example, in thin and flimsy bottom corners in a deep drawn container, while other parts of the container will be relatively thick in cross section. Thus, wall ruptures during the work-forming step are fairly common in such a situation.

A number of techniques have been devised to address the aforementioned problem. For example, by using what is designated as a "plug-assist" thermoforming process, a tapered metal plug is employed to effectively prestretch the sheet in selected areas prior to work-forming in the die in an effort to improve the final article wall thickness distribution. Such a process requires relatively complex machinery and extensive process controls to achieve the desired results.

Another known method of controlling the wall thicknesses is by heating certain areas of the sheet preferentially, sometimes referred to as zone heating. This can be done by conductive, convective or radiant heating. The principal heating technique in use today for thermoforming articles, typically uses resistance heaters, ceramic heaters, quartz lamps, or the like. To localize the heating effect, selected areas of the sheet may be screened from the heat source.

The preferential heating techniques discussed above have a number of disadvantages. Where radiant or convective heating is used, the heat is externally and diffusively introduced into the sheet through the sheet surfaces. Since the temperature distribution is transient in nature, it will change with time as the heat diffuses through the plastic sheet surface. This effect precludes the possibility of achieving a sharply defined temperature distribution within the sheet.

In the case of conductive preferential heating, the heating process is not only slow, but the surface of the sheet must be heated to a higher than necessary temperature for the core within to reach the required thermoforming temperature. The overheated surfaces may cause the sheet to sag or prestretch prior to its transfer from the heating station to the thermoforming station and produce unpredictable wall thicknesses in the thermoformed articles.

It should be pointed out that the aforementioned zone heating patterns, and the shapes of the plugs used in a "plug-assist" process, are generally determined by trial and error. As such, they are rarely optimal for a particular plastic sheet, or for a particular heating process. Thus, existing thermoforming techniques do not permit precise control and the wall thickness of the final article cannot be accurately predicted.

SUMMARY OF THE INVENTION

In accordance with the present invention, selected areas of a polar polymer sheet are dielectrically heated to different predetermined temperatures prior to subjecting the sheet to an article forming step, by using dielectric heating apparatus wherein the sheet is positioned between at least one set of mutually facing electrode configurations. The wall thickness of any portion of the article to be formed from the sheet is a function of the temperature attained by the corresponding sheet area throughout the thickness of the sheet, and of the manner in which the sheet area is physically worked during the immediately following article forming step while it retains its attained temperature. The amount of heating applied to different sheet areas may be controlled in a variety of ways, e.g. by applying RF energy for time intervals of different length or by placing different portions of at least one electrode at different distances from the sheet.

Thus, a thermal pattern is impressed on the sheet, the pattern being selected in accordance with the desired wall thickness of corresponding portions of the article to be formed. For example, where a finished article of uniform wall thickness is desired, the sheet areas to be normally subjected to greater stretching during the article forming step are heated to a lower temperature, while the sheet areas to be subjected to less stretching are heated to a higher temperature. As a consequence, uniform stretching of the sheet occurs during the subsequent article forming step, resulting in a finished article of uniform wall thickness.

After the aforementioned thermal pattern is impressed on the sheet, the sheet is placed into an article forming die where it is forced to conform to the die surface to form the shape of the desired article. Subsequently, the article so formed is separated from the remainder of the sheet.

An object of the present invention includes method and apparatus for thermoforming articles from a polar polymer sheet wherein the wall thickness of the articles can be accurately controlled to predetermined dimensions.

Another object of the present invention is to provide an apparatus for dielectrically heating a polar polymer sheet to different predetermined temperatures prior to subjecting the sheet to an article forming

Still another object of the present invention is a simple apparatus for a continuous production of thermoformed articles of uniform wall thickness from a polar polymer sheet.

Still another object of the present invention is an apparatus for thermo-forming a polar polymer sheet into 3-dimensional articles having chosen cross-sectional thickness dimensions, said apparatus comprising, dielectric heating means including a set of mutually facing electrodes, said set including at least first and second spaced electrodes; means for positioning said sheet and said electrodes relative to each other such that said first and second electrodes face opposite sheet surfaces; means for applying RF energy to said electrodes to provide dielectric heating in the intermediately positioned sheet; means for controlling said dielectric heating to impress a selected thermal pattern on said sheet wherein different sheet areas are heated to different temperatures in accordance with said chosen thickness dimensions; and means for die-forming said articles from said thermally patterned sheet such that each of said thickness dimensions is determined by the temperature of the originating sheet area and the physical working performed thereon by said die-forming means.

Yet another object of the present invention is a method for dielectrically heating a polar polymer sheet to different predetermined temperatures.

Other objects of the present invention, together with the features and advantages thereof will become apparent from the following detailed description and when read with the accompanying drawings which illustrate exemplary embodiments of the present invention.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a plan view of a preferred embodiment of the invention.

FIG. 2 is a cross-sectional view of the apparatus of FIG. 1 taken along plane 2--2.

FIG. 3 shows an exemplary RF power control circuit for use with the apparatus of FIGS. 1 and 2.

FIG. 4 illustrates another embodiment of the present invention for carrying out preferential dielectric heating.

FIG. 5 illustrates a further embodiment of the present invention for carrying out preferential dielectric heating.

FIG. 6 is a cross-sectional view of the apparatus of FIG. 5 taken along plane 6--6.

DETAILED DESCRIPTION OF THE INVENTION

Referring now to the drawings, and specifically to FIGS. 1 and 2, the illustrated embodiment of the invention shows a continuous production arrangement for fabricating hollow containers having walls of controlled thickness from a continuous sheet of a polar polymer material. However, it should be noted that present invention is not limited to the arrangement shown and that fabrication may also occur from pre-cut sheets that are hand fed or fed by means of a rotary or a shuttle type mechanism. Thermoforming apparatus, generally indicated by numeral 1, includes a dielectric heater 2 for heating a sheet 5, an article forming press 3 for forming hollow-shaped containers 10 from sheet 5, and an article trimming press 4 in which containers 10 are separated from sheet 5 and are dropped off onto conveyor belt 12 for transfer to a packaging station.

A supply roll 14 dispenses under tension to an RF shielded chamber of dielectric heater 2, located on a main body 6 of thermoforming apparatus 1. Inside a chamber of dielectric heater 2, sheet 5 is held at its edges by two rows of gripping jaws 16, placed along both the edges of the sheet 5. Sheet 5 is thereby positioned between first and second electrodes 18 and 20 respectively. Jaws 16 may be programmed to close while sheet 5 is being heated and remain open the rest of the time.

In the preferred embodiment of the invention illustrated in FIGS. 1 and 2, first and second electrodes 18 and 20 respectively are employed to apply RF energy to sheet 5. The surface of second electrode 20 which faces sheet 5 is coated with lubricious material 22, e.g. Teflon.RTM. material to reduce the friction between it and sheet 5 and to prevent any adhesion between them. Electrode 18 preferably comprises a plurality of discrete conductive electrode segments 24 proximately positioned to one another but spaced sufficiently to be capable of independent energization. Although the invention is not so limited in the illustrated embodiment, all segments lie in a common plane parallel to sheet 5 and are equally spaced from the latter. Further, the segments need not be square-shaped, as shown. Segments 24 are affixed to an insulation member 26 and they receive RF power from an RF power source 28 by way

simultaneously, sequentially or intermittently, such control being accomplished by means of a controller 32 which is capable of being programmed manually or via a software program. In order to increase the efficiency of heating and to prevent excessive local heating, hot air may be circulated within the chamber of heater 2, through an intake duct 34 and an exhaust duct 36.

In accordance with the present invention, RF heating is induced in a polar polymer sheet for the direct excitation of the molecules of the sheet by an RF frequency field. The polar polymers can be defined as those polymers that have positively and negatively charged portions present within the polymeric structure. As a result RF heating can be induced in such polymers by direct excitation of these polymer molecules through a rapidly oscillating high frequency electric field supplied by a dielectric heater. The aforesaid direct excitation causes these polar polymer molecules to rotate and translate at high speeds. This substantial increase in molecular kinetic energy is seen as increased heat. Non-polymer polymers such polyolefins may not be heated dielectrically because of the dearth of a positively and a negatively charged portions within their molecular structures.

The energy delivered to the polar polymer sheet by an RF field applied by a pair of electrodes on opposite sides of the sheet is given by the expression:

$$P = K f E^2 (\tan \delta) \epsilon \quad (1)$$

where

P = power delivered to the sheet (W/cm.³)

K = 55.6.times.10.⁻¹⁴ (constant dependent on units) and

f = field frequency (Hz)

E = local field strength in the sheet material (volts/cm)

$\tan \delta$ = dielectric loss tangent (property of the sheet material being heated)

ϵ = dielectric constant (property of the sheet material being treated)

For a given field strength and a fixed frequency, the power density P can be calculated. The local field strength E in the polymer sheet is a function of the applied voltage and the geometry of the electrode. For a constant applied voltage, the local field strength E is approximately inversely proportional to the spacing between the electrodes. The temperature rise T per cm.³ in the polymer sheet can then be calculated from:

$$T = Pt/mc \quad (2)$$

where t is time in seconds, m is the mass of the sheet portion being heated, and c is the specific heat of the heated polymer sheet. Since P is proportional to the square of the electric field strength, an effective way of controlling temperature is by increasing or decreasing the field strength E . Further, since E is generally inversely proportional to the mutual spacing of the electrodes, such temperature control can be effected through the aforesaid spacing of the electrodes, or of mutually facing portions thereof.

FIG. 3 shows an exemplary RF power control circuit 28 for the apparatus illustrated in FIGS. 1 and 2. As shown, a variable frequency RF generator 38 coupled to connectors 30 by way of an on-off switch 40 and a rheostat 42 or similar device for varying the applied voltage. The grounded side of generator 38 is connected to second electrode 20 by way of a connector 44. It will be obvious to those skilled in the art that circuit 28 can be implemented in other ways and indeed it is contemplated that it be implemented in a manner capable of being controlled by controller 32.

As shown in FIGS. 1 and 2, a die-forming press 3 is operatively positioned on body 6 of apparatus 1, adjacent to heater 2. Press 3 may consist of a die press further comprising a fixed upper platen 46 and a movable lower platen 48 upon which a thermoforming die 50 is mounted. A mechanical power is supplied to platen 48 by a fluid cylinder 52, in accordance with a predetermined process program.

In the embodiment shown in FIGS. 1 and 2, thermoforming die 50 contains a series of perforations 54 at its bottom through which a vacuum is applied by way of a vacuum pump.

An article trimming station 4, adjacent to article forming press 3, is operatively positioned on main body 6 of thermoforming apparatus 1. Station 4 may consist of a die press which comprises a movable upper platen 56, powered by fluid cylinder 58 and positioned above sheet 5 and a movable lower platen 60

64
169

respectively.

In operation, a desired portion of sheet 5 from supply roll 14 is fed into dielectric heater 2 by the pulling action supplied by motor 66 to waste roller 68. Jaws 16 then clamp sheet 5 to stretch it taut and heating is initiated to impress a predetermined thermal pattern on the sheet portion in the heater. It is contemplated that sheet 5 could be also heated by a plurality of sequentially positioned first and second electrodes for progressive heating or simultaneous heating of larger areas of sheet 5. It is further contemplated that sheet 5 could be held stationary and first electrode 18 and second electrode 20 are moved to position sheet 5 therebetween. Sheet 5 could be also fed into dielectric heater 2 in a direction other than the horizontal direction shown in FIG. 1.

Polar polymer sheet 5 could be a mono or a multi layered sheet. It is contemplated that it could also be a composite material, or a nonpolar polymer material impregnated or blended with polar material such that the resulting composite behaves like a polar material.

As shown in FIG. 3, segments 24 are energized from RF generator 38. Controller 32 is capable of varying either the RF frequency, the RF voltage, or the interval during which the RF power is applied to each segment 24. In the latter case, either the initiation or termination of power application may be varied for the respective segments. Controller 32 is programmed to impress the predetermined thermal pattern on the sheet portion in the heater.

Referring to FIG. 2, it is contemplated that, prior to dielectric heating, sheet 5 may be preheated to a uniform intermediate temperature by recirculating hot air supplied via duct 34 and exhaust through duct 36. Such preheating reduces the duration of the overall heating cycle.

Once sheet 5 has the desired thermal pattern impressed on it a suitably desired control signal is sent to jaws 16 to release the edges of the sheet. Similarly, a signal is sent to motor 66 to move sheet 5 such that the sheet area carrying the thermal pattern moves to die-forming press 3 for performing a die-forming step. Jaws 16 sealably hold sheet 5 against the face of die 50. A further control signal actuates fluid cylinder 52 to move platen 48 and die 50 up, to trap sheet 5 between die 50 and fixed platen 46. A differential gas pressure provided by vacuum is then applied through perforations 54 to die 50 to force the trapped area of sheet 5 to stretch and conform to the shape of the cavity. The thermal pattern on sheet 5 is selected such that the area of sheet 5 exposed to greater stretching, e.g., the bottom corners are heated to a lower temperature than the sheet areas subjected to minimal stretching, thereby providing for a substantially uniform stretching action throughout and hence produces a finished article with substantially uniform wall thickness where desired.

In the example under consideration, the shaped article 10, in the form of a cup, remains attached to sheet after it is formed. Upon command, movable platen 48 moves down to release article 10 and allows sheet 5 to move to trimming station 4. Suitable control signals actuate movable platens 60 and 56 to move trimming dies 62 and 64, respectively against each other in order to trim article 10 from sheet 5. The trimmed article then falls onto conveyor belt 12 for transfer to a packaging station. Further control signals reverse the motions of the trimming dies and move sheet 5 along to be rolled onto waste roller 68.

FIG. 4 illustrates another embodiment of the present invention showing the controlling means used for dielectrically heating sheet 5 in a selected thermal pattern. The heat controlling means are provided by first electrode 70 having a continuously contoured shape for varying the spacing between electrode 70 and sheet 5. The contour on said first electrode is made in conformity with a desired thermal pattern being impressed on sheet 5.

In operation of the embodiment of the present invention, as shown in FIG. 4, sheet 5 is dielectrically heated by electrode 70 which forms a continuous contoured surface in which different portions of the electrode, e.g. portions 72 and 74, are stationed at a different spacing from sheet 5. Thus, sheet 5 under surface portion 74, is heated less than the area under surface portion 72. Thus, a thermal pattern determined by the contour of electrode 70 is impressed on sheet 5. Accordingly, the contours of electrode 70 provide the control of the dielectrically applied heat. If a different thermal pattern is desired on sheet 5, electrode 70 must either be exchanged or reconfigured.

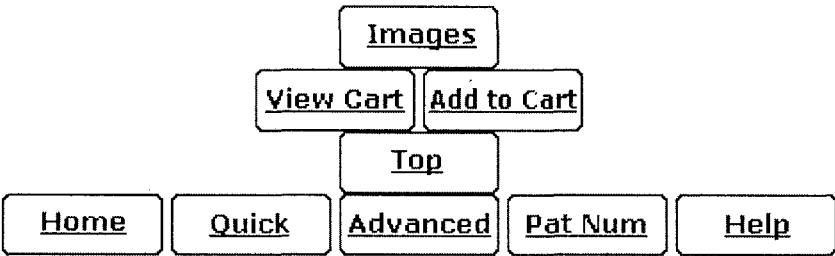
FIGS. 5 and 6 illustrate yet another embodiment of the present invention showing the controlling means used for dielectrically heating sheet 5 in a selected thermal pattern. The heat controlling means are provided by a grounded metallic shield 76 interposed between a preferably planar first electrode 78 and sheet 5. Shield 76 is made of a wire mesh screen, or a thin metal plate. Shield 76 grounded to ground 80, is shaped in conformity with the desired thermal pattern being impressed on sheet 5.

In the embodiment of the invention illustrated in FIGS. 5 and 6, a grounded metal mesh screen shield 76

second electrode 20, the areas on sheet 5 that are screened by the shield from RF energy are heated less than the areas directly exposed to RF energy. Thus, a desired thermal pattern is impressed on sheet 5. It will be understood that the shape of shield 76 has to be changed if a different thermal pattern is desired.

The method and apparatus described above lend themselves to different variations within the preview of the present invention. For example, air under pressure may be used instead of a vacuum to force the trapped sheet area into the cavity. Alternatively, in lieu of differential air pressure, or in conjunction with it, a matched metal die set may be used wherein a core portion forces the trapped sheet area into a cavity portion to produce the desired shape of the article. A hollow-shaped article may be formed by the aforementioned method when air pressure is applied between twin dielectrically heated sheets pinched between a split female die whereby the twin sheets are forced to conform to the die shape. By impressing a selected thermal pattern on the dielectrically heated twin sheets, a hollow-shaped article having a uniform wall is produced. The aforementioned process is further enhanced by applying vacuum from the die side.

It will be understood that the foregoing description and drawings are only illustrative of the present invention and it is not intended that the invention be limited thereto. Numerous variations, changes, substitutions, and modifications will now occur to those skilled in the art which come within the scope of the present invention without departing from the spirit and scope thereof. Accordingly, it is intended that the invention be limited only by the scope of the appended claims.



U.S. Patent

Mar. 1, 1994

Sheet 1 of 4

5,290,490



Full Text
Help

Go to Page:

Go



Sections:

[Front Page](#)

● [Drawings](#)

● [Specifications](#)

[Claims](#)

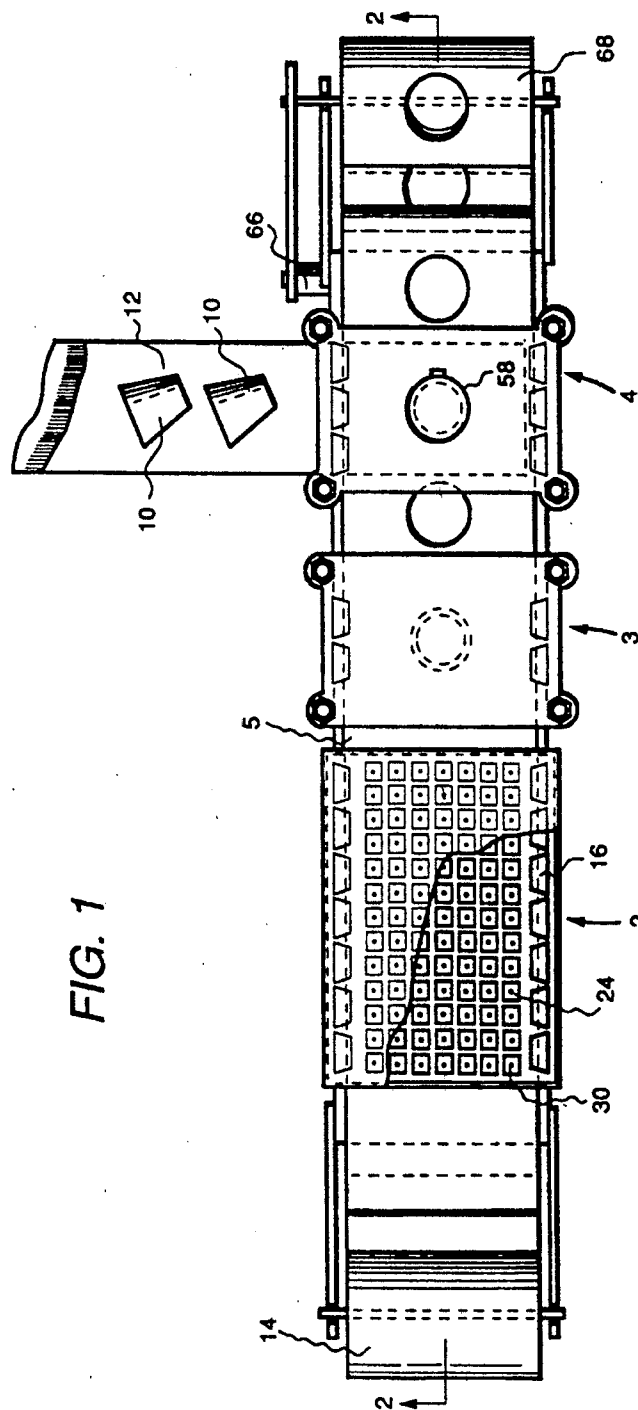


FIG. 1

U.S. Patent

Mar. 1, 1994

Sheet 2 of 4

5,290,490



[Full Text](#)
[Help](#)

Go to Page:

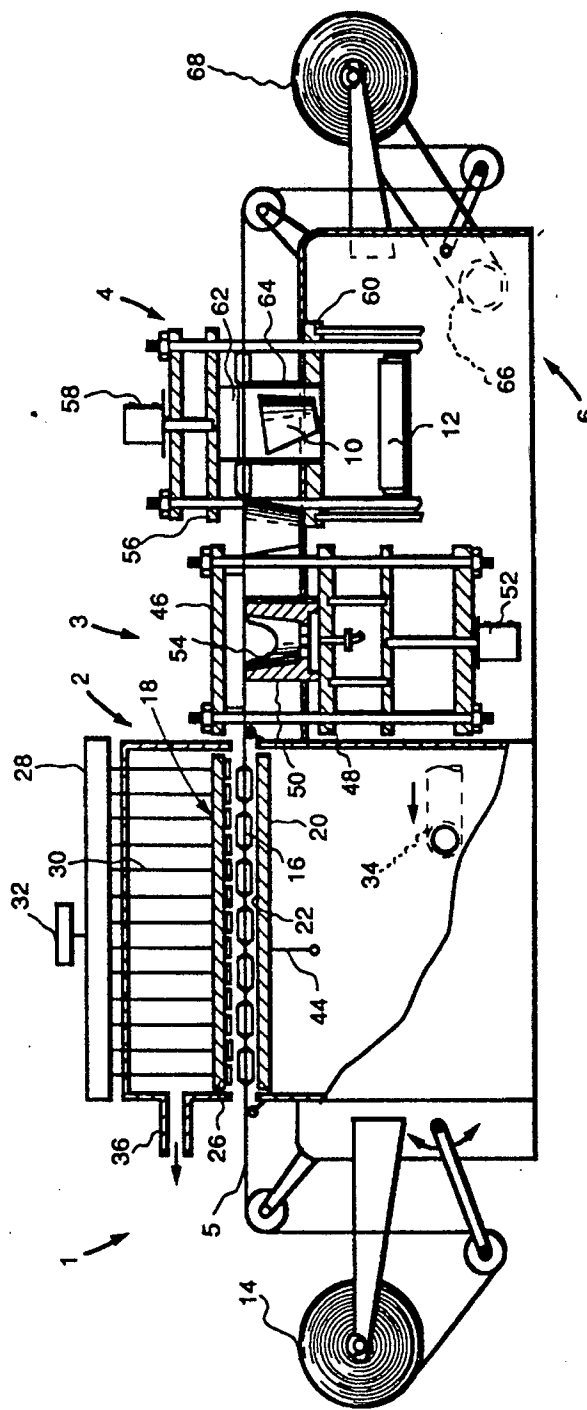
Go



Sections:

- [Front Page](#)
- [Drawings](#)
- [Specifications](#)
- [Claims](#)

FIG. 2





Full Text
Help

Go to Page:
Go



- Sections:
- Front Page
 - Drawings
 - Specifications
 - Claims

FIG. 4

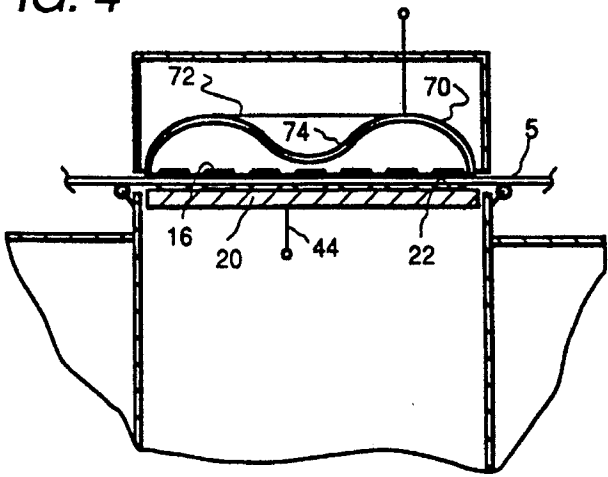
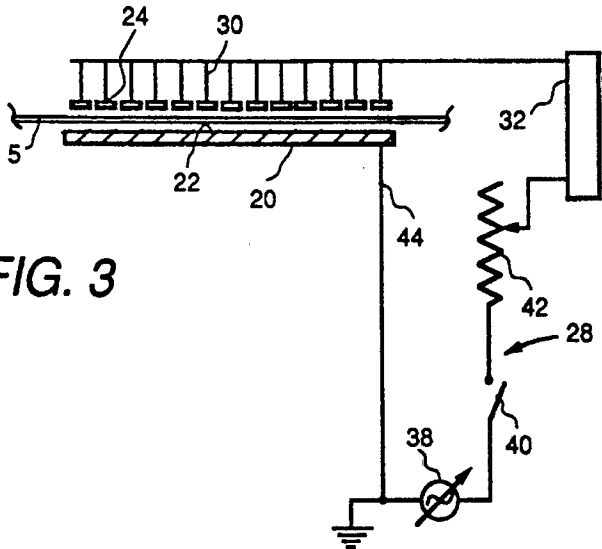


FIG. 3



69
174



U.S. Patent

Mar. 1, 1994

Sheet 4 of 4

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Sections:

- [Front Page](#)
- [Drawings](#)
- [Specifications](#)
- [Claims](#)

FIG. 5

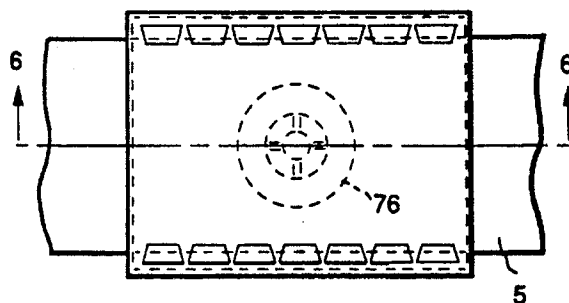
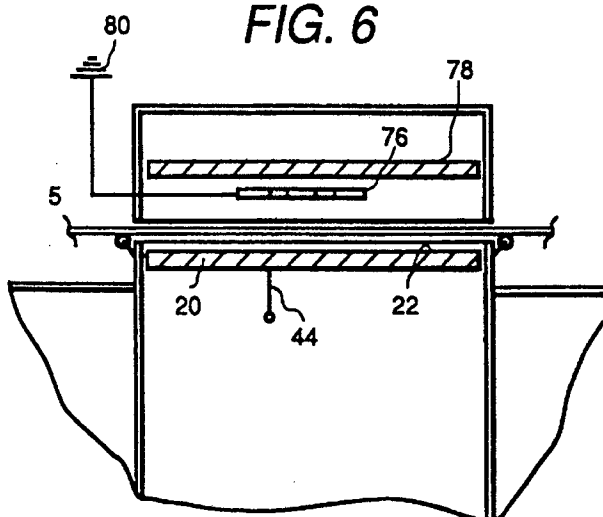


FIG. 6



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(1 of 1)

United States Patent
Giovannone, et al.

5,795,535
August 18, 1998

Method of thermoforming plastic articles

Abstract

A precut die apparatus arranged and adapted for use in a thermoform-trimming method and system to produce plastic molded articles, and to the method and system in which the apparatus is employed. The precut apparatus is positioned, in the method and system, between the form press and the trim station. The precut apparatus is arranged to precut, in a desired and selected manner, the thermoformed sheet material containing thermoformed articles therein, about the periphery of the thermoformed articles. The precut provides for a bridged and joining area of the sheet material to allow for slight movement and adjusting of the molded articles for precise alignment in the punch and die trim step of the thermoforming and trimming operation.

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425/302.1

Intern'l Class: B29C 051/10

Field of Search: 264/153,163,551,553 425/301,302.1,307
83/21,22,40,41,49,33

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Primary Examiner: Silbaugh; Jan H.

Assistant Examiner: Lee; Edmund H.

Attorney, Agent or Firm: Crowley; Richard P.

Claims

What is claimed is:

1. A method for the production of a plastic article from a thermoplastic sheet material in a

- a) providing a thermoplastic sheet material;
- b) heating the thermoplastic sheet material to a selected temperature to form a preheated thermoplastic sheet material;
- c) thermoforming the preheated thermoplastic sheet material in a thermoform press, forming a plurality of thermoformed articles having an outer periphery in the sheet material, the articles formed in a spaced-apart arrangement from each other in the sheet material, and to define a surround area of the sheet material about each article;
- d) trimming in a diecutting trim press the thermoformed articles from the sheet material, and
- e) recovering accurately cut plastic articles from the trim press at a recovery station, the improvement which comprises:

precutting in a striking operation about the outer periphery of each of the thermoformed articles employing a die platen with a plurality of spaced apart overlapping cutting blades and a striking platen to form, in the surround area of each of the articles, a plurality of overlapping diecut lines and elongated, spaced apart joining strips of selected length and defined width between ends of the overlapping diecut lines, the diecut lines extending about the outer periphery of each of said articles, the joining strips to provide for retaining the thermoformed articles in the sheet material and to permit a slight movement and accurate alignment of the thermoformed articles in the trimming step.

- 2. The method of claim 1 which includes holding each of said articles during the striking operation by means of an article-receiving space in the striking platen.
- 3. Claim The method of claim 1 which includes spacing said overlapping cutting blades generally uniformly apart from each other to form joining strips of uniform width.
- 4. The method of claim 1 which includes overlapping said cutting blades to an extent of about 5-50% at each end over adjoining blades.
- 5. The method of claim 1 which includes providing a uniform number of cutting blades, a first end of one blade overlapping within an interior surface at a second end of another blade, and an exterior surface at a second end of one blade overlapping a first end of another adjoining blade.
- 6. The method of claim 1 which includes forming a plurality of generally arcuate diecut lines extending about the outer periphery and a plurality of arcuate joining strips generally uniformly spaced apart about a generally circular article.
- 7. The method of claim 1 which includes spacing said cutting blades apart an overlapping width distance of about 1/16 to 1/2 inch.
- 8. The method of claim 1 which includes providing a trim press with a spring-biased guide die and punch.
- 9. The method of claim 1 which includes feeding vertically into a trim press an indexed row of precut thermoformed articles in the thermoplastic sheet material.
- 10. The method of claim 1 which includes recovering finished, molded articles and recovering scrap materials from the surround area.
- 11. The method of claim 1 which includes thermoforming and precutting in a single operation.
- 12. The method of claim 1 wherein the thermoplastic sheet material comprises a thermoplastic polymer characterized by shrinkage at a high or irregular shrink rate after thermoforming, which shrinkage substantially occurs up to 24 hours after thermoforming.
- 13. The method of claim 1 wherein the thermoplastic sheet material comprises polypropylene or a high density polyethylene.
- 14. The method of claim 1 which includes precutting to form a plurality of about three to six joining strips of 1 to 4 inches in length.
- 15. The method of claim 1 which includes guiding and centering the precut plastic articles in the sheet

16. A method for the production of a plastic article from a thermoplastic sheet material in a thermoforming operation, which method comprises:

- a) providing a thermoplastic sheet material;
- b) heating the thermoplastic sheet material to a selected temperature to form a preheated thermoplastic sheet material;
- c) thermoforming the preheated thermoplastic sheet material in a thermoform press, forming a plurality of thermoformed articles having an outer periphery in the sheet material, the articles formed in a spaced apart arrangement from each other in the sheet material, and to define a surround area of the sheet material about each article;
- d) trimming in a diecutting trim press the thermoformed articles from the sheet material, and
- e) recovering accurately cut plastic articles from the trim pres at a recovery station, the improvement which comprises:

forming in the surround area about each thermoformed article a plurality of separate, generally arcuate cut lines, which in total surround the outer periphery of each thermoformed article, and which cut lines are spaced apart and overlap at each end an adjacent cut line to form a plurality of separate spaced apart, generally arcuate joining strips of selected width and length to provide for slight movement and accurate alignment of the thermoformed articles during trimming.

17. The method of claim 16 which includes forming the cut lines and joining strips by precutting the sheet material employing a striking platen and a die platen.

18. The method of claim 16 which includes forming the joining strips in a generally uniform spaced apart arrangement about the thermoformed articles, all the joining strips of generally uniform length and width.

19. The method of claim 16 which includes overlapping the ends of the cut lines in an amount of from about 5 to 50 percent of the length of the cut lines.

Description

DESCRIPTION

BACKGROUND OF THE INVENTION

A wide variety of plastic articles may be made by a thermoforming method and system. Typically, a thermoforming system would include a source of a thermoplastic sheet material, such as a roll unwinding station, a heating station to heat the thermoplastic sheet material, and a thermoforming form press station, wherein the heated thermoplastic sheet material is formed by a vacuum-pressure system employing upper and lower platens to thermoform molded articles in the sheet material; for example, a plurality of cup-like food containers. Thermoformed articles, formed in the thermoplastic sheet material in the thermoform press, are then trimmed employing a punch and die arrangement within a trim press, to remove the surrounding support area from each of the thermoformed articles. The system optionally includes a recovery station to recover the molded articles and the scrap material, and may include a stacking and packaging station.

Generally, the thermoform press will form a plurality of thermoformed articles in the sheet material in various rows, while the trim press will trim the articles as indexed into the trim press row by row, or in multiple rows. Where, for example, the thermoformed article comprises a plastic container or dish, such as a deli container or food container, care must be taken to position accurately each row of the thermoformed articles in the trim press, so as to insure accurate centering of the molded article in the sheet prior to trimming, so as to provide for an accurately cut periphery about the outer portion of the food container. Inaccuracy in the trim press, in the trimming of the plastic articles, may, for example, lead to slight flanges or improper fitting of the plastic lid of the food container.

Thermoformed systems are designed to deliver a high volume of quality parts from most major polymers, particularly in sheet form, and which polymers would include high impact polystyrene (HIPS), polypropylene (PP), high density polyethylene (HDPE), oriented polystyrene (OPS),

be used, typically in sheet form, and with the sheet form varying in thickness; for example, up to 80-100 mils or higher. It is known that certain plastic materials have a high or irregular shrink rate; such as, for example, some polypropylenes and high density polyethylenes, wherein a great part of the shrinkage; for example, 60-90%, may occur immediately after thermoforming of the article; however, the remaining shrinkage of the article may occur within the next 12 to 24 or more hours. In addition, some polymer materials employed have irregular shrinkage rates depending on their prior history and chemical structure and treatment. These polymers, in particular, when employed in the thermoforming system and method, may create difficulties for accurate trimming for the thermoformed articles from the sheet material in the trim press, since such shrinkage makes it difficult to provide for consistent and accurate reproducible centering of the articles in the trim press.

In view of such difficulties with these polymers, there are available machines that combine a thermoform form press and trim press together, so that polymers with a high-shrink or irregular shrink rate may be quickly thermoformed and trimmed, in a single operation in a single machine. However, such machines and tooling tend to be complex in operation, quite expensive, not wholly satisfactory in overcoming the problems associated with such polymers, and not adapted to be inserted in a regular thermoforming system production line.

It is therefore desirable to provide for a new and improved thermoforming method and system to provide for the accurate alignment and the accurate trimming of thermoformed articles in a sheet material, and more particularly to provide for a separate, single precut apparatus between the form press and the trim press in a regular production line to permit thermoformed articles and sheets to be accurately aligned, centered and trimmed in a punch and die trim press.

SUMMARY OF THE INVENTION

The invention relates to a precut apparatus arranged and adapted for use in a thermoform-trim method and system to produce molded thermoplastic articles, and to the method and system in which the apparatus is employed. The invention further relates to a thermoplastic sheet material to be formed into thermoformed articles, and to the articles so formed.

The present invention is directed to a precut die apparatus, arranged and constructed for use in a thermoforming-trimming method and system, for example, for positioning between the form and trim press, and a system which employs the apparatus and method. The precut apparatus is arranged to precut in a desired and selected fashion the thermoplastic sheet material containing a plurality of thermoformed articles therein from the mold press, and prior to trimming of the molded articles from the thermoformed sheet material. The precut die apparatus of the invention comprises a die platen having a plurality of cutting blades, typically steel rule or machined cutting blades, and extending upwardly, generally perpendicularly, above the surface of the die, and each blade having a first and a second end. The blades are arranged on the die platen with each of the first ends overlapping each of the second ends of the adjoining blade a selected overlap distance, and with each of the blades spaced apart from each other a selected distance. The blades together extend generally about the entire periphery of each of the thermoformed articles to be trimmed by the trim press, and form a cutting line about the periphery with forming stripes attaching the thermoformed article with the inner cut surround area.

In one embodiment, with generally circular molded articles to be trimmed, the first end of one arcuate blade is positioned slightly inside the second end of one overlapping adjoining arcuate blade, and the second end of the one blade is positioned slightly outside the first end of an other arcuate overlapping adjoining blade. The number of inside-outside overlaps may vary, depending on the molded article to be trimmed and its periphery. This arrangement provides a plurality of joining or bridging strips of selected arcuate length and width, with the strip generally arranged uniformly about the periphery of the molded article in the thermoformed sheet. For example, with a circular molded article, the blades may overlap in a generally parallel arrangement to provide for joining strips of uniform width; e.g., 1/16 to 1/2 inch or more, and the overlap arranged to provide for joining strips of uniform width; e.g., 1 to 4 inches, or more, with the strips ranging from about as low as three to six or more, depending on the size and nature of the thermoformed article to be trimmed. The strips are formed in the surround area in the thermoformed sheet material; that is, the area of the sheet material which has not been thermoformed, and which retains the thermoformed article in the position in the sheet material, and which surround area becomes generally scrap material after trimming.

The blades of the precut apparatus are arranged in length and spacing to provide, after the precutting operation; that is, after precutting about the periphery of the thermoformed articles and material, for a plurality of adjoining or bridging strips of the sheet material, about the thermoformed article. The length and the width of the adjoining or bridging strips may vary as desired, depending on the nature and thickness of the thermoformed material and the article. The strips are arranged so as to permit, after thermoforming, and prior to introduction into the trim press, a slight movement of the thermoformed

the article may be accurately and properly aligned and centered prior to employing the punch and die of the trim press, to separate the article from the surrounding sheet material.

It is recognized that the die cutting blades may be arranged in various design patterns, and the joining or bridging strips vary in number, length, width, and uniformity, provided that the joining strips provide for adequate non-movement and stability of the thermoformed articles in the sheet material between the form press and the trim press, and yet permit limited movement of the indexed articles in the trimming operation to provide for precise alignment with the trimming operation; e.g., centering of the molded article before trimming.

The invention comprises a system for the production of thermoformed plastic articles from a thermoplastic sheet material, and which system comprises a sheet material unwind station, wherein the thermoplastic sheet material may be unrolled for use in the system, and a heating station for heating the thermoplastic sheet material, typically heating the top and bottom of the sheet material to a preselected temperature, typically ranging from 200.degree. to 300.degree. F. The preheat station, for example, may employ calrod-type heaters, or quartz heaters. The system further provides for a form or press station, wherein the heated thermoplastic sheet material is subject to thermoforming by upper and lower platens, in order to thermoform, typically by the use of vacuum pressure, a plurality of the thermoformed articles in the thermoplastic sheet material.

The system includes a die precut station, wherein the thermoformed sheet material, with the thermoformed articles formed therein, are subject to a precutting operation, to form a plurality of selected joining strips about at least a portion and preferably about the periphery of each of the thermoformed articles, so as to permit the slight movement of the thermoformed articles in the sheet material sufficient to permit alignment in the subsequent trimming operation.

The system includes a trim press, usually employing a punch and die arrangement for trimming, and which generally aligns selected parts of the thermoformed sheet material; e.g., a row, fed from the precut station to the trim press, so as to trim and center accurately the precut, thermoformed articles in the thermoformed sheets. The system generally includes a recovery station for the recovery and/or stacking and packaging of the trimmed articles and the recovery of scrap material.

The invention also includes a method of producing thermoplastic articles, which method comprises presenting a sheet of thermoplastic material from a source of such thermoplastic sheet material into a heater system for preheating the thermoplastic film material to a selected temperature, and forming the heated thermoplastic material in a form press to form a plurality of thermoformed articles in the thermoplastic sheet material. The articles are typically spaced apart from each other to form a surround area of sheet material about each thermoformed article.

The method includes precutting the surround area about each thermoformed article in the thermoplastic sheet material, so as to form a plurality of joining or bridging strips of the sheet material of selected length and width about the periphery of each article, and trimming the precut thermoformed sheet material using a punch and die trim press. The precut articles in the thermoformed sheet material are adapted to move slightly, so that each of the molded articles, in the trimming step, may be accurately positioned within the die prior to the punching operation of the trim press to remove the article from the surrounding area of the preformed sheet material. The method includes recovering an accurately trimmed thermoplastic article.

The precut apparatus and the thermoforming trimming molding system and method of the invention may be employed with a wide variety of thermoplastic materials to make various thermoformed articles, including, but not limited to, those type of thermoplastic materials, for example, in sheet form, which shrink over a period of time or shrink irregularly or unpredictably, or which provide for any difficulties in connection with the accurate trimming of the articles in the trim press, by virtue of the nature, thickness or material of the thermoplastic material, or the shape of the article, and may be used overall with regular, uniform shrink polymers to insure accurate trimming.

The invention is also directed to a precut thermoformed sheet material with molded articles in the sheet material with a selected cutting pattern about the periphery of the articles, and forming adjoining or bridging strips about the molded articles and in the selected pattern, so as to permit the slight movement of the articles in any trimming operation.

The invention includes a thermoplastic sheet material which has a plurality of thermomolded articles therein, the articles spaced-apart generally uniformly from each other. The surround area about at least a portion of each thermoformed or molded article, and generally uniformly positioned about the periphery of each article, includes joining or bridging strips of defined width and length, preferably of uniform length and width to permit slight movement of the thermomolded articles in a subsequent trimming

joining strips have a diecutting line about the entire periphery of the article, which diecutting line forms one side of the joining strip. Usually, the joining strips are arranged so that such strips do not extend about the entire circumference of the article, but are positioned and arranged, if extended, to surround the article. Where desired, the precut thermomolded article in the sheet material may be stored and subsequently trimmed in a different location, where the trimming does not follow the thermoform press station. The joining strips retain the molded articles to the thermoformed sheet material after the precut die station.

The use of the invention, in particular the precut apparatus, is particularly desirable where thermoforming articles are desired which require very close and accurate tolerances; for example, but not limited to, where plastic food containers must be trimmed and lids affixed to the plastic food containers.

It is recognized that the precut die apparatus employed includes a die platen having upright, perpendicular steel rule or machined dies as cutting blades, and another flat striking platen. The steel rule or machined dies may have the blades arranged in different arrangements and designs for different types of precut patterns and joining strips. The precut die employs a plurality of cutting blades, at least three cutting blades, and the blades should be arranged to cut about the periphery of the surface of each thermoformed article in the sheet. Each end of the blade should overlap an adjoining end of the other blade, and the overlap may vary, for example, from about 5 to 50%, such as 10 to 30%. The spacing between the blades may also vary, and be non-uniform or uniform, but typically the space can range from about 1/16-1/2 inch, more typically about 1/8-1/4 inch. Generally, the blades are placed so that they are parallel in the overlapping section of the blades, so as to provide for, in one embodiment, generally uniform joining or bridging strips around the surround area of the sheet material, with a diecut line about the periphery of the thermoformed article.

The joining or bridging strips should provide for the thermoformed articles in the sheet material to be slightly flexible, and to permit alignment of a particular article with the punch and die in the trim press. The joining or bridging strips shall hold the thermoformed article in the sheet material, so that after rearrangement of a strip of the sheet material; e.g., across one line of articles in the trim press, the articles may be slightly moved by virtue of the precutting pattern about the article, and centered for trimming by the guide means in the trim press. Thus, the precut die pattern employed in the apparatus may assume various helical, spiral and curved forms, various types of adjoining, and various shapes and sizes of the joining and bridging strips about the article.

A prior art thermoformer system with a material unwind stand, heater stand, form press, trim station and optional stacker stand is illustrated and described for example, in "2500 Series" Bulletin, and the trim press illustrated and described in "Model PT30" Bulletin, both of Sencorp Systems, Inc., Hyannis, Mass., hereby incorporated by reference.

The invention will be described for the purposes of illustration only in connection with the manufacture of a thermoformed plastic container, such as a food container; however, it is recognized that various modifications, changes and additions in the embodiment, as disclosed and illustrated, may occur to those persons skilled in the art, all falling within the spirit and scope of the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a schematic illustration of the thermoforming system of the invention.

FIG. 2 is an enlarged, schematic perspective illustration of the precutting station of the system of FIG. 1.

FIG. 3 is a partial perspective view of sections of a thermoformed sheet material, with FIG. 3A showing the molded articles in the thermoformed sheet prior to introduction into the precut station; FIG. 3B showing the molded articles with the precuts thereabout; FIG. 3C showing the precut spaces created by slight movement of the precut molded articles in the sheet material; and FIG. 3D showing the finished trimmed molded article.

FIG. 4 is a top plan view of the precut die platen of FIG. 2.

FIG. 5 shows enlarged cutaway sectional views of the trimming step, with an article guide orienting the precut, molded piece into the correct die cut position, with FIG. 5A showing the system in the open non-trimming position and FIG. 5B showing the system in the closed, trimming position.

DESCRIPTION OF THE EMBODIMENTS

sheet material 12, like PET or PP at 40-60 mils/thickness, is unwound from a large roll 14 and continuously fed by an index chain or belt 24 into a heat station 16, where quartz or calrod-type heaters 18 heat the sheet material 12 on both sides, to 225.degree.-275.degree. F., prior to entry into the press station 20. A mold press 22 thermoforms and molds articles 27 in the sheet material 12, to create a unit of molded articles 25. The units 25 are then continuously indexed into a precut station 28, where the precut die apparatus of the invention 30 precuts the articles 27 in the unit 25.

The articles 27, still attached to the thermoformed sheet material 12, are then index-fed in precut units 32 over a feed canopy 37 and into feeder guides 39 of the punch and die trim station 35. After the articles 27 are positioned by guides 40 and trimmed by the punch 38 and die 36 in the trim station 35, the trimmed articles 27 are stacked in a stacker 52 and the unused thermoplastic sheet material 54 removed.

FIG. 2 shows a cutaway, perspective view of a thermoformable sheet material 12, with a molded article 27 in a thermoformed unit 25. The precut die apparatus 30 is positioned to precut, by means of moving peripherally positioned blades 46 against the periphery 26 of the molded article 27 in the thermoplastic sheet material 12, with the striking platen 29 working with the lower precut die apparatus 30.

FIG. 3 shows in partial cutaway perspective view the thermoformed articles and precut process of the invention, with FIG. 3A showing the thermoformed molded article 27 in the sheet material 12 subsequent to the molding process, in a thermoformed unit 25. FIG. 3B shows the molded articles 27 with the precut 31 made by blades 46 of the apparatus of the invention 30 (shown in FIG. 2), forming a precut unit 32. FIG. 3C shows the molded articles 27, in the precut unit 32, in a slightly removed position from the sheet material 12, with precut spaces 33 formed by the precuts 31, allowing slight movement of the article 27, while still retaining the article to the sheet material. FIG. 3D shows the finished trimmed article 27 with periphery 26.

FIG. 4 shows a top plan view of the precut die apparatus of the invention 30 with cutting blades 46 having overlap section 34 to form adjoining bridges, attached to a base 44. The base is removably attached to the precut station 28 (shown in FIG. 1) by fasteners 48.

FIG. 5 shows in further detail the trim station 35 of the thermoforming and cutting system of FIG. 1. The precut molded unit 32 of the sheet material 12, with molded articles 27 molded therein, is fed by index chain 24 into the feeder guides 39. The feeder guides 39 position generally the precut molded sheet material unit 32 between the stationary die 36 and the moveable punch 38. Removable spring-loaded article guides 40 precisely guide and orient the molded article 27 to the exact position necessary in the punch and die system for proper and precise trimming of the periphery of the molded article 27. Slight movement and precise alignment of the molded article 27 is allowed by the precuts 31 about the periphery 26 of each molded article 27. After trimming, the molded articles 27 are recovered and the scrap material 54 is collected for reuse.

In operation, a continuous roll 14 of thermoplastic sheet material 12 is unwound and fed onto an indexing belt 24 which feeds the material into a heat station 16. Optionally, a thermoplastic extruded foam material may be continuously extruded and fed into the thermoforming and cutting system. The thermoplastic material used in this method and system may include, but not be limited to, HIPS, PP, HDPE, OPS, PET, vinyl and most major polymers.

In the heat station 16, top and bottom heaters 18, such as calrod pre-heaters, heat the material 12 to a temperature of from 200.degree. to 300.degree. F. to allow for molding of the pieces by the mold press 22 in the press station 20. Other heaters that may be used include black faced quartz heaters and heaters of varying lengths.

Molding or forming of the articles is accomplished with a heavy duty four-post, four-point toggle operated press with upper and lower moving platens. The return strokes of both platens are independently controlled by adjustable stops and decelerating valves. A standard crank motor, or optionally a servo motor, locates the press in the index direction. As the thermoplastic material is molded in the thermopress station 20, it cools and shrinks a certain amount. While the majority of the cooling and shrinking takes place immediately upon thermoforming, it is recognized that additional and further cooling and shrinking takes place during and after the entire process.

The pieces are molded in the press station 20 in rows of two or three articles or more, and in units of rows, such as units of three or four or more rows of articles, comprising a unit of, for example, three rows with three molded articles in each row. These units, or "shots", may vary in size and composition depending on the size and shapes of the thermoformed articles.

After the articles are molded, the shots of thermoformed articles are indexed by the index belt 24 into

upwardly against an upper platen 29 and the blades 46 cut through the sheet material 12 to form a precut 31 about the periphery 26 of each of the molded articles 27 in the shot 25. These precuts 31 create a precut shot 32 that permits slight movement of the molded articles 27, to allow for precise alignment in the trim station 38.

While it is recognized that this process comprises a separate mold press station and precut station, it is optionally possible for the molding and precutting step to be performed in one step in a combined mold/press form and precut station.

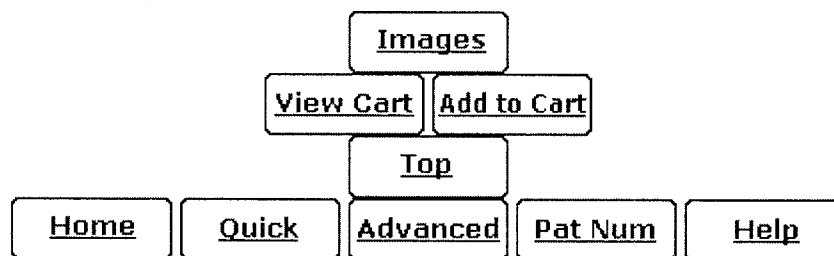
The thermoformed and precut material, which is still cooling and shrinking a certain amount, is then fed over a canopy 37 and into a feed advance guide 39, which feeds the shots 32 into the trim station 35. The canopy 37 is constructed of rods curved in a precise arc shaped to feed the shot 32 freely into the trim station 35. The shots 32 are positioned within the punch and die, with the stationary die 36, which is a stationary vertical die, and the moveable punch 38. One or multiple rows of parts are punched at each cycle. The diecut press has a removable spring article guide 40, which guide positions the molded articles exactly over the stationary die 36 for precise cutting. The precut spaces 33 created by the precuts 31 allow for precise alignment of the articles, which molded articles may have undergone additional shrinkage, which may affect their exact fit into the diecut surface. The trim platen delivers total press power of 121/2 tons (11,340 Kg) through the mechanical linkage to the drive shaft.

After the articles 27 are positioned and trimmed, they are removed to a stacker 52, and optionally a packager as desired. The remaining sheet material 54 is recovered for recycling and reuse.

Thus, the precut die apparatus of the invention provides for adjusting and slight flexibility of positioning of the molded article in the die cut step. This flexibility, or slight movement, is necessary and important in a system where thermoplastic material experiences additional or unpredictable shrinkage in a thermoforming process. The precut method of the invention avoids the waste and inefficiency caused by disoriented thermoformed articles due to irregular shrinkage of the material used.

This precut method allows for the use of a wider variety of thermoplastic materials in a thermoforming and cutting process. As with all other components of the thermoforming and cutting system, the precut die apparatus of the invention is removable and replaceable, and may be used separately, and the precut thermoformed sheet material fed later into a trim press or placed between a trim press and trim station on a thermoforming production line.

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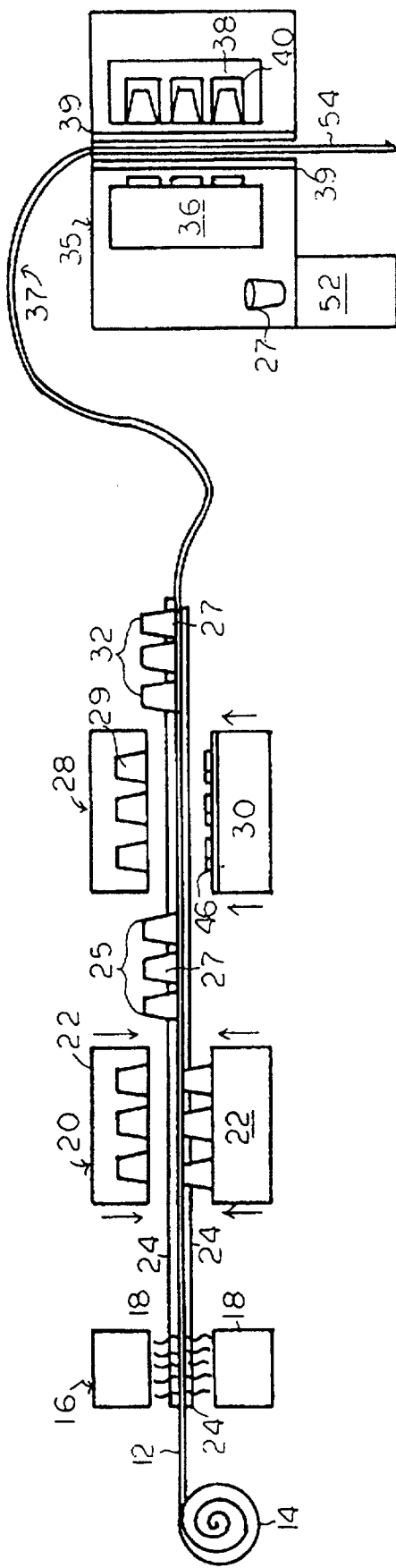


FIG 1

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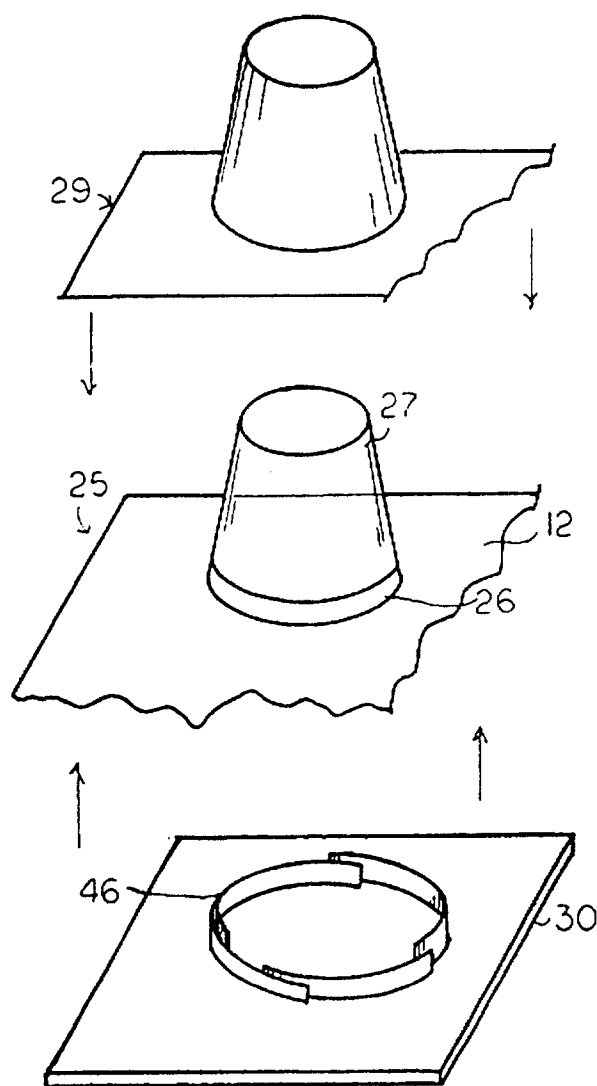
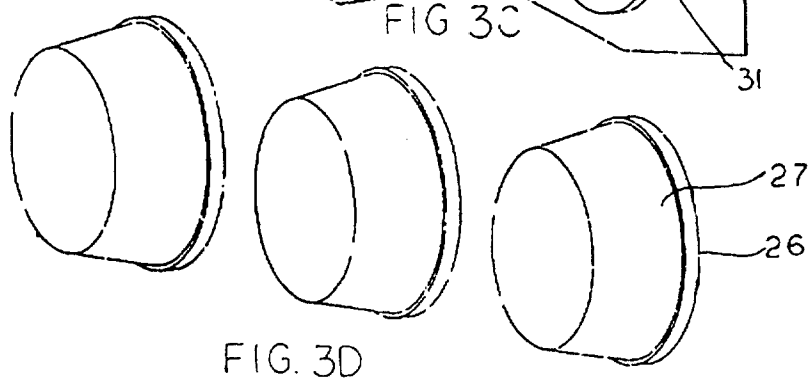
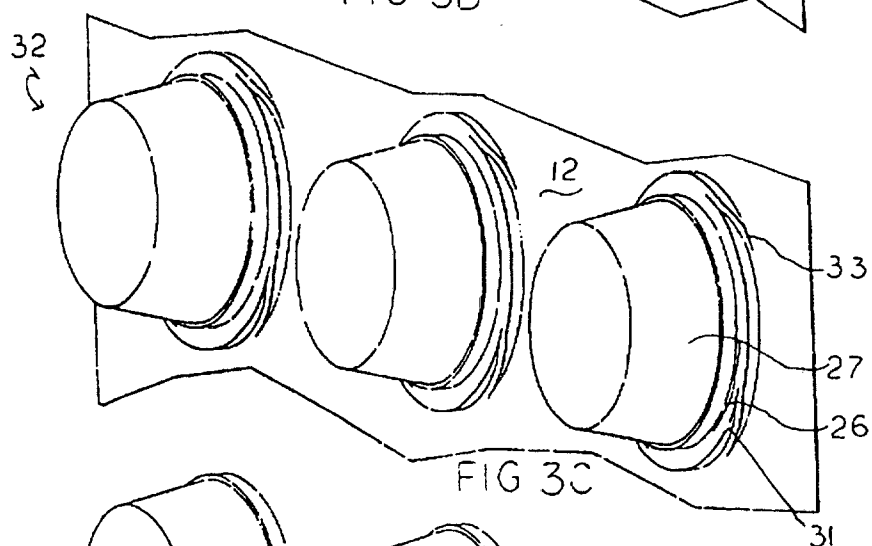
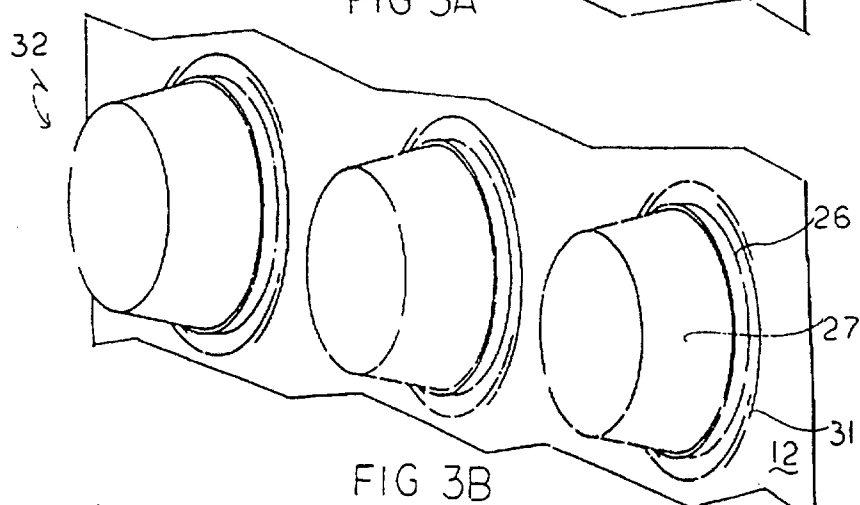
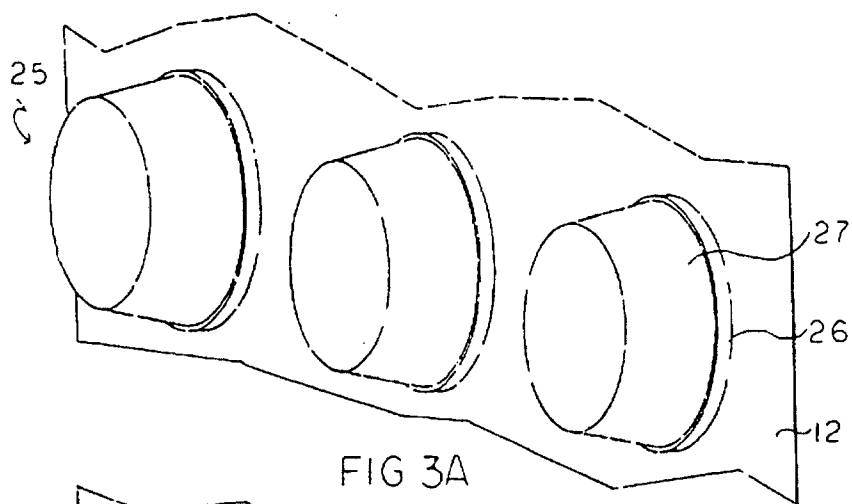


FIG. 2



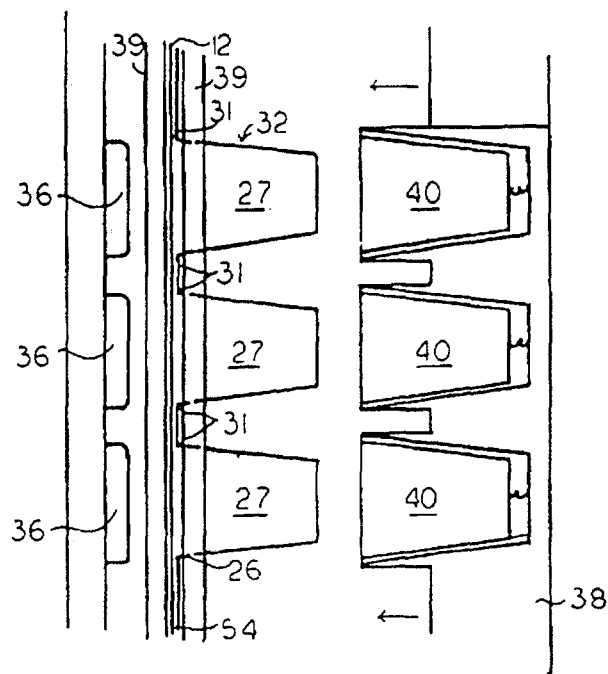


FIG 5A

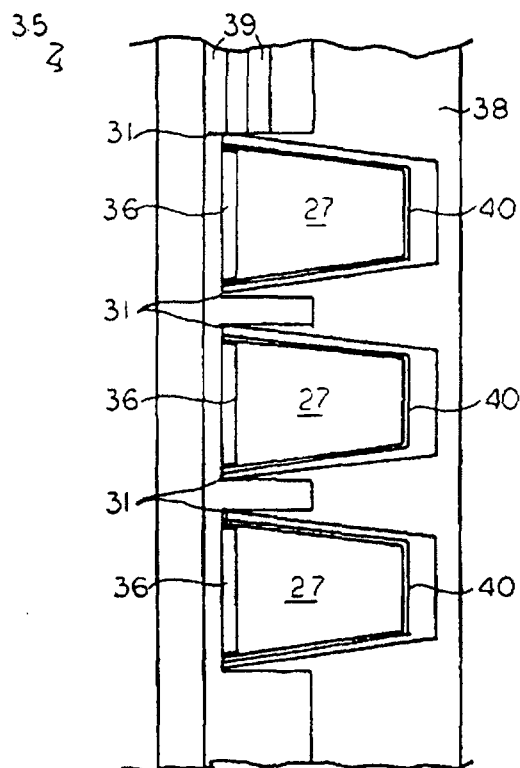
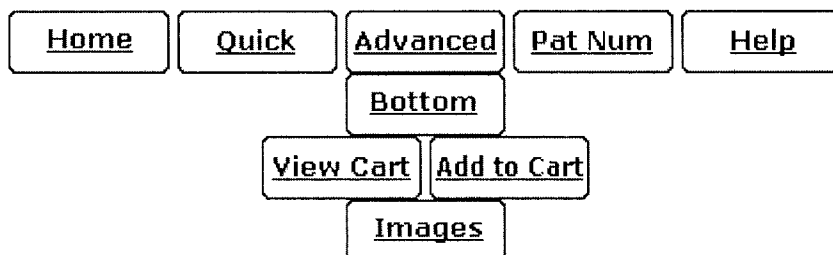


FIG 5B

FIG 5

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(1 of 1)

United States Patent
Fujii**5,571,473**
November 5, 1996

Process for thermoforming thermoplastic resin sheet

Abstract

A process for producing a formed article by heating a thermoplastic resin sheet and then thermoforming a part to be formed involves heating the part to be formed by placing in contact with a heating plate while at least a part of a non-formed part of the thermoplastic resin sheet is not heated by placing in contact with the heating plate, and then heating the part to be formed and at least a part of the non-formed part by placing them in a non-contact state with a heating means is disclosed.

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Dec 28, 1989[JP]

1-342392

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Intern'l Class: B29C 051/10; B29C 051/42
Field of Search: 264/25,327,510,512,522,DIG. 65,458 425/174.4,384

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Primary Examiner: Timm; Catherine
Attorney, Agent or Firm: Antonelli, Terry, Stout & Kraus

Parent Case Text

This application is a Continuation application of Ser. No. 905,406, filed Jun. 29, 1992, now abandoned, which application is a Continuation-In-Part application of Ser. No. 627,838, filed Dec. 17, 1990, now

24
189

Claims

What is claimed is:

1. In a process for producing a formed article by heating a thermoplastic resin sheet and then thermoforming a part of the sheet, the improvement which comprises heating said part to be thermoformed and an adjacent portion of another part of the resin sheet by placing said part and said adjacent portion in contact with a heating plate while a remaining portion of the thermoplastic resin sheet is not heated by contact with the heating plate, and then heating said part to be thermoformed, the adjacent portion and the remaining portion by placing the part to be thermoformed, said adjacent portion and the remaining portion in a non-contact state with a heating means; the part and the adjacent portion of the thermoplastic resin sheet heated with said heating plate being in a temperature range of 80.degree. to 140.degree. C. and said part and said portions subsequently heated in the non-contact state with said heating means being in a temperature range of 150.degree. to 180.degree. C.
2. A process for thermoforming a thermoplastic resin sheet according to claim 1, wherein both sides of the part to be thermoformed and the adjacent portion of the another part are heated by contacting with the heating plate.
3. A process for thermoforming a thermoplastic resin sheet according to claim 1, wherein only one side of the part to be thermoformed and the adjacent portion is heated by contacting with said heating plate.
4. A process for thermoforming a thermoplastic resin sheet according to claim 1, wherein said thermoplastic resin sheet is a laminated or coextruded sheet.
5. A process for thermoforming a thermoplastic resin sheet according to claim 4, wherein said laminated or coextruded sheet comprises PP/EVOH/PP/HDPE.
6. A process for thermoforming a thermoplastic resin sheet according to claim 1, wherein said thermoplastic resin sheet is a polypropylene sheet.
7. In a process for producing a formed article by heating a thermoplastic resin sheet and then thermoforming a part of the thermoplastic resin sheet, the improvement which comprises heating said part of said resin sheet to be thermoformed and a neighboring portion of said part within the range of from at least 2 mm to 10 mm from said part by placing said part and said neighboring portion in contact with at least one heating plate while a remaining portion of said thermoplastic resin sheet is not heated by contact with said at least one heating plate, and then heating said part, said neighboring portion and said remaining portion of said thermoplastic resin sheet by placing said part, said neighboring portion and said remaining portion in a non-contact state with a heating means; the part and the neighboring portion heated in contact with said at least one heating plate being in a temperature range of 80.degree. to 140.degree. C. and the part, the neighboring portion and the remaining portion heated subsequently in the non-contact state with said heating means being in a temperature range of 150.degree. to 180.degree. C.
8. A process for thermoforming a thermoplastic resin sheet according to claim 7, wherein both sides of the part to be thermoformed and the neighboring portion are heated simultaneously by contacting with two heating plates, one at each side of the thermoplastic resin sheet.
9. A process for thermoforming a thermoplastic resin sheet according to claim 7, wherein only one side of the part to be thermoformed and the neighboring portion is heated by contacting with said at least one heating plate.

Description

BACKGROUND OF THE INVENTION 1. FIELD OF THE INVENTION

The present invention relates to a process for thermoforming a thermoplastic resin sheet and an apparatus therefor, and particularly it relates to a process for effectively preparing a variety of formed articles such as a container or the like by heating a thermoplastic resin sheet to thermoform a formed part and a production apparatus thereof. 2. Description of the Related Arts

There have previously been produced formed articles such as containers having a variety of shapes.

with a forming die. As the means for heating the thermoplastic resin sheet in the apparatus for thermoforming, there are known an indirect heating method of heating the sheet by keeping it out of contact with a heating source (Japanese Utility Model Laid-Open Publication No. 134218/1980) and a direct method for heating the sheet by directly placing it in contact with a heating source such as a heating plate or the like (Japanese Utility Model Laid-Open Publication Nos. 99765/1976 and 35962/1978, Japanese Utility Model Publication No. 21399/1988 etc.).

However, according to the aforementioned heating method, corrugation is caused due to the thermal expansion of the sheet during the former half of the heating step which inhibits uniform heating of the sheet, and the drawdown following corrugation is also large. Thus, a special thermoplastic resin sheet having extremely small values of corrugation and drawdown must be used or a sheet having a small width must be used for performing a good forming.

On the other hand, the direct heating method at a heating temperature in the vicinity of and below the sheet melting point often causes wrinkle due to the thermal expansion or drawdown of the sheet or transfer of the heating plate impression, which leads to an inferior appearance of the formed product. Although heating at a temperature below the aforementioned heating temperature causes no wrinkle, impression transfer to, or fusing of the sheet, defective formings are often produced and the heat resistance of the formed product obtained is insufficient unless forming is conducted at an extremely high pressure. Moreover, heating at a temperature higher than the melting point of the sheet causes wrinkle, fusing or impression transfer, and thus special sheets must be used. However, such sheets were successful in the prevention of wrinkle or fusing, but they could not avoid diminishing the gloss of the surface.

SUMMARY OF THE INVENTION

Thus, the present inventor examined various conditions of heating a thermoplastic resin sheet for the purpose of solving the aforementioned problems and conducted earnest research in order to develop a process for efficiently thermoforming.

As a result, the present inventor has found that a formed article with excellent appearance and physical properties can be efficiently produced even from crystalline resins such as polyolefins having a narrow temperature range in which forming can be performed, for example, polyethylene, polypropylene, polystyrene or the like by conducting pressure forming of a sheet having been heated under a specific condition. The present invention has thus been accomplished on the basis of such finding.

That is, the present invention provides a process for producing a formed article by heating a thermoplastic resin sheet and then thermoforming a part to be formed, wherein the part to be formed is heated by placing in contact with a heating plate while at least some non-formed part of the thermoplastic resin sheet is not heated by placing in contact with a heating plate, and then said part to be formed and at least a part of said non-formed part are heated together by placing them in a non-contact state with a heating means. The present invention also provides a thermoforming apparatus for producing a formed article by heating a thermoplastic resin sheet with a heating device and then thermoforming a part to be formed with a forming die, wherein the heating device is provided with a direct heating part having a heating plate which is directly contacted with the part to be formed of the thermoplastic resin sheet and a non-contact heating part which is provided between the direct heating part and the forming die and works for heating the entire thermoplastic resin sheet in a non-contact state.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a front view of a thermoforming apparatus, and FIG. 2 is a plane view illustrating the lower half of the heating apparatus.

1: thermoforming apparatus,

2: sheet feeding part,

3: heating device,

31: direct heating part,

32: heating plate,

33: heating face,

35: indirect heating part,

4: forming die

DESCRIPTION OF THE PREFERRED EMBODIMENTS

As described above, according to the present invention, the part to be formed of the thermoplastic sheet is first heated preferably by directly heating both sides in contact with the heating plate, then indirectly heating the entire sheet and forming the sheet thus heated with the forming die. Thus, it will be possible to efficiently thermoform a variety of thermoplastic resins, crystalline resins, laminated or coextruded films thereof such as polyolefins, for example, polyethylene, polypropylene, polystyrene or the like.

The present invention is explained in more detail with reference to an example of the apparatus for thermoforming a thermoplastic resin sheet illustrated in the drawings.

FIG. 1 is a front view of a thermoforming apparatus and FIG. 2 is a plane view illustrating the lower half of the heating apparatus.

The thermoforming apparatus 1 is composed of a sheet feeding part 2, a heating device 3 and a forming die 4, and the heating device 3 is constituted of a direct heating part 31 at the first half stage and an indirect heating part 35 at the latter stage.

The aforementioned direct heating part 31 is for heating the part to be formed of the thermoplastic resin sheet by contacting it with the heating plates and is provided with a pair of upper and lower heating plates 32 which travel up and down along with the conveyance of the sheet and are provided with the heating faces 33 for directly heating the part to be formed locally so that they protrude from the non-contact faces corresponding to the non-formed parts of the sheet. The heating faces 33 can be fabricated with a metal which is conventionally used for such heating faces, and a TEFLON (trademark for fluorine-containing polymers) coating or a TEFLON cloth can be applied to the surface. Furthermore, from an effective heating viewpoint, the sheet is heated preferably by heat transfer to the sheet in-between the heating faces 33 on the pair of the upper and lower heating plates 32. If the sheet can be satisfactorily heated in a tight contact with the heating faces 33, it is sufficient that the heating plates 32 are provided on either one of the upper or lower sides.

While the temperature of the heating face 33 can be appropriately controlled depending on the materials or thickness of the sheet, the desired heat resistance or gloss of a formed product, the upper limit of the temperature is generally determined so that the fusing of the sheet does not occur. For example, the temperature of the heating face is in the range of 80.degree. to 140.degree. C. for sheets of conventional polypropylenes. The heating plate 32 must have a shape consisting of a contact part which can satisfactorily heat the part of the sheet to be formed and a non-contact part which will not contact with the non-formed part, and the heating plate may be contacted a plurality of times with the part to be formed along with the conveyance of the sheet. As the direct heating device, there can be used a direct heating device which is disclosed in Japanese Utility Model Publication No. 21399/1988.

The indirect heating part 35 in the latter stage of the heating device can be fabricated in a similar manner as conventional heating devices which heat the entire sheet with heat sources such as a far-infrared heater or an infrared heater having a short or medium wave length. The heating temperature is set up depending on the materials or thickness of the sheet or the desired physical properties of a formed product, and the upper limit of the temperature is determined by the presence of the drawdown. For example, the heating temperature is in the range of 150.degree. to 180.degree. C. for sheets of conventional polypropylenes. When emphasis is put on transparency, it is preferable in the range of the melting point or less. It is preferable in the range of 180.degree. C. or less for a polypropylene sheet having a nucleating agent added thereto. Heating sources may be arranged on the both sides or on either one side provided that the sheet can be sufficiently heated.

Thus, the direct heating of the part to be formed of the sheet at the first half stage and the indirect heating of the entire sheet at the latter stage permit the sheet to be heated to an appropriate temperature required for pressure forming in a forming die 4 while suppressing the generation of the drawdown, wrinkle, fusing or impression transfer. At the first half stage, no wrinkle or fusing of sheet are found since the heating at this stage is only a preliminary heating, that is, heating at a low temperature is satisfactory due to heating at the latter stage. At the latter stage, no wrinkle is found because of the absence or only a small amount of the drawdown, and no impression transfer from the heating plate will be caused because the heating is in a non-contact state. Only a small amount of drawdown is believed to take place since the relationship of heating at the first half stage is maintained also at the latter stage, and thus the sheet is maintained by the non-contact region at the first half stage (the region at a temperature

87
192

As the forming die 4, any of various forming dies which have been conventionally used for thermoforming thermoplastic resins can be used depending on the shapes of the formed products, and a variety of means such as a plate forming, a roll forming, a vacuum forming, a pressure forming, a plug assist forming, a non-plug assist forming or the like can be employed.

As described above, a variety of formed products such as containers which have an extremely small amount of drawdown and have excellent form reproduction ability, surface gloss, appearance, heat resistance or the like can be produced at a high speed and with a wide sheet, and production at a high efficiency can be performed. Such production requires no special apparatus and can be performed with a simple apparatus. It can be used widely for thermoforming a variety of thermoplastic resin sheets.

In particular, many benefits can be expected from applying the process of the present invention to thermoforming crystalline resins such as polyolefin, for example, polyethylene, polypropylene, polystyrene or the like or laminated or multilayered films thereof.

The process of the present invention is further explained with reference to Examples and Comparative Examples.

EXAMPLE 1

As a sheet rollstock, a coextruded sheet comprising polypropylene (PP)/ethylene vinylalcohol (EVOH)/polypropylene (PP)/high density polyethylene (HDPE) and having a thickness of 800 .mu.m (trade name: Idemitsu MAGICTOP Sheet) was used, a dessert container having a diameter of 65 mm and a depth of 25 mm was produced with a thermoforming apparatus 1, as described above, comprising a sheet feeding part 2, a heating device 3 which comprises a direct heating part 31 at the first half stage and an indirect heating part 35 at the latter stage, and a forming die 4. Heating was conducted at 110.degree. C. at the heating face of the upper side and at 150.degree. C. at the heating face of the lower side of the direct heating part 31 and at an environmental temperature of the heating source of 300.degree. C. Furthermore, as the forming die 4, a plug-assisted pressure forming type was used by pressure for forming of 3 kg/cm.sup.2 and a forming cycle of 20 shots/min.

The maximum amount of drawdown on thermoforming, form reproduction ability, presence of bridge, gloss or heat resistance of a container obtained were evaluated. The results are shown in Table 1 together with the heating conditions.

EXAMPLES 2 TO 4

Containers were produced in the same manner as Example 1 except that a monolayer sheet of polypropylene having a thickness of 600 .mu.m (trade name: Idemitsu PURELAY Sheet) was used as a sheeting and heating was conducted at the temperatures of the heating faces in the upper and lower sides and at the environmental temperatures of the heating source. The results of evaluation are shown in Table 1.

EXAMPLE 5

A container was produced in the same manner as Example 1 except that heating was conducted only from the upper side at the indirect heating part 35 and at the environmental temperature at the heating source of 350.degree. C. The results of evaluation are shown in Table 1.

COMPARATIVE EXAMPLES 1 TO 4

Containers were produced in the same manner as Example 2 except that the sheet was heated under the conditions described in Table 1. The results of evaluation are shown in Table 1.

TABLE 1

		Direct heating part	
		Temperature of Environmental temperature	
	Sheet material		
		heating plate of heating source	
No.	fed	Upper	
		Lower	
		Heating part	
		.degree. (C.)	
Example 1			
	Coextruded		

193

300
 sheet*.sup.1 molded
 Example 2
 Single 110 110 Part to be
 300
 layer sheet*.sup.2
 molded
 Example 3
 Single 150 -- Part to be
 300
 layer sheet*.sup.2
 molded
 Example 4
 Single -- 150 Part to be
 300
 layer sheet*.sup.2
 molded
 Example 5
 Single 110 110 Part to be
 350
 layer sheet*.sup.2
 molded (upper side)
 Comparative
 Single 110 110 Entirety
 300
 Example 1
 layer sheet*.sup.2
 Comparative
 Single 150 150 Part to be
 --
 Example 2
 layer sheet*.sup.2
 molded
 Comparative
 Single 150 150 Entirety
 --
 Example 3
 layer sheet*.sup.2
 Comparative
 Single -- -- -- 300
 Example 4
 layer sheet*.sup.2

No.	(mm)	Thermomoldability Amount of maximum drawdown*.sup.3 form repro- ducibility*.sup.4 State of container Bridge*.sup.4 Gloss*.sup.4 Heat resistance*.sup.4
-----	------	--

Example 1	Substantially no drawdown	Good None Good 145
Example 2	Substantially no drawdown	Good None Good 130
Example 3	Substantially no drawdown	Good None Good 130
Example 4	Substantially no drawdown	Good None Good 130
Example 5	Substantially no drawdown	Good None Good 130
Comparative	5 to 10	Good Partly Good 130
Example 1		present
Comparative		

29
194

Bad 90

Example 2

Comparative

40 to 50 Bad Present

Bad 90

Example 3

Comparative

40 to 50 Good present

Bad 130

Example 4

*.sup.1 PP/EVOH/PP/HDPE, 800 .mu.m.

*.sup.2 Polypropylene single layer sheet, 600 .mu.m.

*.sup.3 Amount of maximum drawdown was evaluated by the amount of drawdown of a sheet in a molding zone.

*.sup.4 Form reproducibility, bridge and gloss were evaluated by naked eye.

*.sup.5 Heat resistance was evaluated by the temperature where the shrinkage of a container was in the range of 30% or less after heating in an air oven for 30 minutes.

The following Table A shows the reason why the width of the neighboring portion to be heated is limited to 2 mm to 10 mm. In Table A, the experiments were conducted in the same manner as in the previous Examples of the present specification except that the conditions described in Table A were changed.

TABLE A

Direct heating part		Width of the	
Sheet	Temperature of	Heat-	neighboring
material	heating plate	ing	portion to
fed	Upper	Lower part	be heated
Comparative			
Single	110.degree. C.	110.degree. C.	part to
			0 mm
Example A			
layer			be
sheet			molded
Example A			
Single	110.degree. C.	110.degree. C.	part to
			2 mm
layer			be
sheet			molded
Example B			
Single	110.degree. C.	110.degree. C.	part to
			10 mm
layer			be
sheet			molded
Comparative			
Single	110.degree. C.	110.degree. C.	part to
			15 mm
Example B			
layer			be
sheet			molded
Thickness of		Amount of	
Environmental		top entrance	
temperature of		maximum	

46
195

heating source		drawdown
tainer		(mm)
Comparative	300.degree. C.	
	450.mu.	Substantially
Example A		no drawdown
Example A	300.degree. C.	
	230.mu.	Substantially
		no drawdown
Example B	300.degree. C.	
	220.mu.	Substantially
		no drawdown
Comparative	300.degree. C.	
	230.mu.	5 to 10
Example B		
(Note)		
##STR1##		

When the width of the neighboring part to be heated was less than 2 mm, the top entrance part of the container was not extended, thereby leaving the other part (the lower part) thin, which decreased the strength of the container. When the width of the neighboring part to be heated was more than 10 mm, the drawdown was increased and the same result as that in the entire heating was obtained. Therefore, the best results were obtained when the neighboring portion to be heated was 2 mm to 10 mm.

In a contact heating process of the first stage, an important feature of the present invention lies in heating said part of said resin sheet to be formed and the neighborhood (i.e. neighboring portion) of said part within the range of from at least 2 mm to 10 mm from said part by placing said part and said neighborhood in contact with heating plates while the remaining portion of the non-formed part of said sheet is not heated by not placing said sheet in contact with heating plates.

In short, an important feature of the present invention lies in heating the part to be formed and the neighborhood of said part (i.e. a neighboring portion) while the remaining portion of the non-formed part of said sheet is not heated, in a contact heating process of the first stage.

Owing to this important feature, the present invention provides the effects that (1) the sheet can be heated to an appropriate temperature required for pressure forming in a forming die while suppressing the generation of the drawdown, wrinkle, fusing or impression transfer, and that (2) an excellent formed article is obtained due to the good formability of the neighborhood of the part to be formed.

In contact heating, the sheet temperature (the temperature of the surface and the interior of the sheet) is usually in the range of 80.degree. to 140.degree. C.

As heretofore described, the heating plate may be contacted a plurality of times with the part to be formed along with the conveyance of the sheet. This disclosure indicates the following fact. The heating time should be prolonged for increasing the molding velocity. For increasing twice the molding velocity, for example, the portion to be formed is heated twice by contact heating.

In contact heating, the temperature of the heating face is in the range of 80.degree. to 140.degree. C. for sheet, wherein the sheet temperature is almost the same as the plate temperature.

In indirect heating, the heating temperature (sheet temperature) is in the range of 150.degree. to 180.degree. C.

* * * * *

FIG. 1

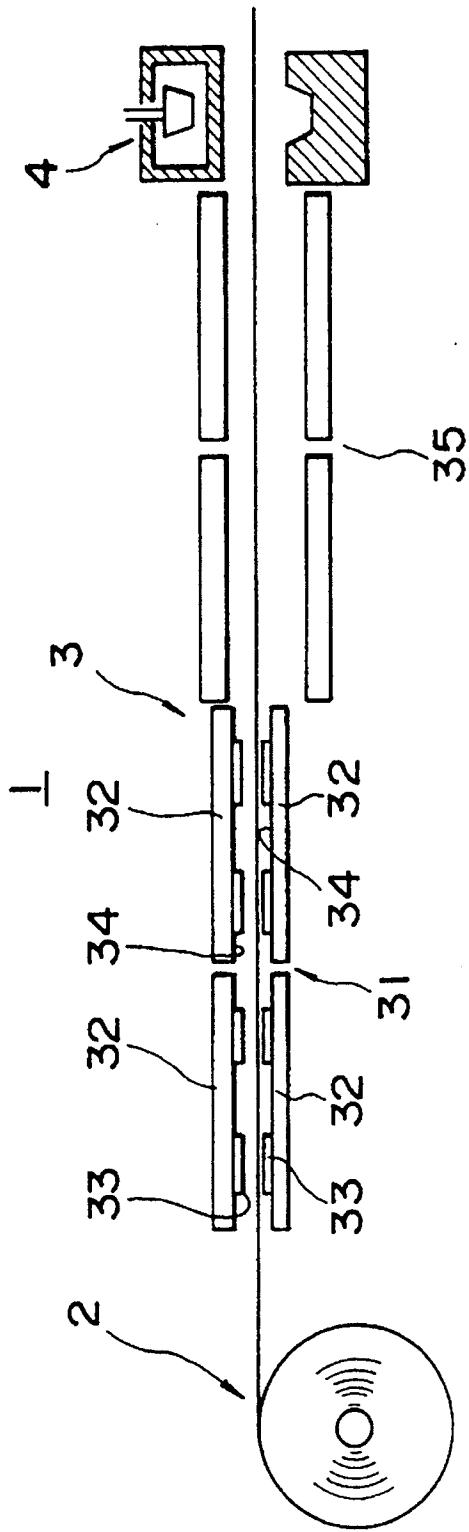
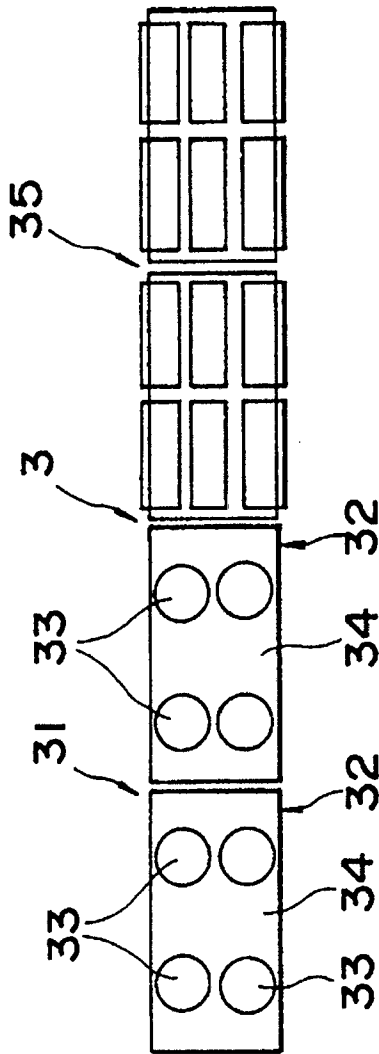


FIG. 2



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(1 of 1)

United States Patent

Padovani

5,591,463

January 7, 1997

Apparatus for the thermoforming and stacking of hollow objects incorporating a base formed from thermoplastics sheet material

Abstract

Apparatus for the thermoforming of hollow objects at a base comprises thermoforming of the objects from a sheet of thermoplastics material in a half of a double female mould that can be moved between a forming area against a male die and a discharge area to one or the other side of the forming area. The thermoformed objects are transferred from the discharge area onto a plurality of receiving formers moving sequentially stepwise along a track. One or more processing or handling operations are performed on the objects while the formers are stationary.

Inventors: **Padovani; Pietro** (Verona, IT)
Assignee: **ISAP OMV Group S.p.A.** (Verona, IT)
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Foreign Application Priority Data

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Intern'l Class:

B29C 051/20

Field of Search:

425/345,349,358,359,398,399,400,403.1,527,397,73,292,296,420,DIG. 201 264/280,322,163,297.7,153,155,156 206/519 198/800

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Primary Examiner: Woo; Jay H.

Assistant Examiner: Leyson; Joseph

Attorney, Agent or Firm: Ladas & Parry

Parent Case Text

This is continuation application of application Ser. No. 07/937,362 filed on Aug. 28, 1992, now abandoned.

Claims

I claim:

1. Apparatus for thermoforming of hollow objects from a sheet of thermoplastic material, the apparatus comprising:

a support frame,

a male die mounted on the support frame,

a double female mold having female cavities thereof facing the male die to effect alternate transverse movements with respect to the male die between an operation position in which one half of the female mold is located in front of the male die and the other half is in an easily accessible side discharge position away from the male die;

driving means for controlling the alternate transverse movements of the double female mold;

a stepwise sheet feeder arranged to feed a sheet of thermoformable heated material between the male die and the double female mold;

actuation means to effect closing and opening movement between the male die and the double female mold when one half of the female mold is in said operation position, in a direction normal to the alternate transverse movements and in sequential synchronization therewith, thereby forming hollow objects;

a cutting device having control means for actuation during mating engagement between the male die and the female mold to cut out an object from the sheet of thermoformable material;

a stepwise endless chain conveyor having a sequence of plate formers each of which receives the object in one forming operation, the chain conveyor being arranged to operate in synchronization with the driving means;

at least one processing pick-up head capable of lifting a plurality of objects alternately from each half of the double female mold when in the discharge position and transferring the objects thus lifted into a respective plate former on the conveyor; and

at least one processing station located along the conveyor for carrying out sequential processing each time of all of the objects while loaded in a plate former on the conveyor in synchronization with said driving means.

2. The apparatus as claimed in claim 1 wherein the pick-up head has an upper portion, a perforated suction plate arranged underneath the upper portion and being provided with a plurality of through holes for air which are in communication with an interior of the pick-up head and have the same spacing and the same arrangement as the cavities in the double female mold, a source of vacuum or negative pressure in communication with the upper portion, an activating arm designed to move the pick-up head between a pick-up position above a female mold and a release position above a former on the stepwise conveyor.

forming operation by drawing up edges thereof to the suction plate and causing them to at least partly adhere thereto.

3. The apparatus as claimed in claim 1 wherein at least one suction hood is located alongside the conveyor to remove volatile vapors from the thermoforming process.

4. The apparatus as claimed in claim 1 further comprising a stacker station for receiving the objects, the stacker station being placed downstream of a last processing station along the conveyor.

5. The apparatus as claimed in claim 4 wherein the stacker station comprises a vertical stacker, a slide guide rotatably mounted about its own longitudinal axis, a trolley structure for slidably mounting the stacker station along the guide and arranged to transfer a plurality of stacks of objects from the stacker station to a supporting surface, and activating means to rotate a supporting guide in a controlled way so that the stacker station can be selectively oriented once it has been moved away from the conveyor.

6. The apparatus as claimed in claim 1 wherein said at least one processing station comprises a drilling unit equipped with as many drilling tools as there are objects on each former.

7. The apparatus as claimed in claim 6 wherein the drilling unit is operated by a toggle device.

8. The apparatus as claimed in claim 1 wherein said at least one processing station includes a labelling unit.

9. The apparatus as claimed in claim 1 wherein said at least one processing station includes at least one rim curling work station downstream of each pick-up head.

10. The apparatus as claimed in claim 1 wherein said at least one processing station includes at least one sterilization unit.

11. The apparatus as claimed in claim 10 wherein the sterilization unit includes a tunnel chamber placed alongside one length of the conveyor.

12. The apparatus as claimed in claim 1, wherein the stepwise conveyor has two draw chains, a pair of toothed returning wheels for each chain at the ends of the conveyor, an idling toothed wheel and a slide guide placed opposite each toothed returning wheel, an articulated attachment on two opposite sides of each former articulated to the draw chains, two engaging means on each former located on opposite sides with respect to each articulated attachment, one engaging means slidable engaging the idling toothed wheel and the other engaging means engaging the slide guide at an end of the conveyor.

13. The apparatus as claimed in claim 1 wherein one half of the female mold is shaped to produce stacking spacing feet on the thermoformed objects which differ in orientation, position and size from corresponding feet produced in the other half so as to ensure perfect stacking of the objects without binding them together.

Description

This invention relates to an apparatus for the thermoforming of hollow cup-shaped objects such as beakers, goblets, cups, tubs and the like, from a sheet of thermoplastics material, and their removal from the press in which they are produced.

BACKGROUND OF THE INVENTION

As is known, so-called "thermoforming" machines, fall into two quite separate classes depending upon their method of operation; firstly there are thermoforming machines which form and cut the sheet at separate workstations and secondly there are machines which form and cut the sheet at a single workstation. Such machines are used in the production of objects of thermoplastics material, e.g. "disposable" objects, from a sheet of hot pressed material.

This invention relates to an apparatus which falls into this second class, in that the shaping or forming of objects and their separation from the sheet of starting material is effected at a single workstation.

The state of the art for thermoforming apparatus incorporating a single forming station, separation from the initial sheet and subsequent removal from the press, is represented by conventional single station machines and those according to U.S. Pat. No. 4,560,339 which will be briefly described hereinafter

FIG. 1 is a side view in diagrammatic form of a thermoforming machine having an upper male die and a single lower female mould shown in the open press position prior to forming;

FIG. 2 is a side view of the machine of FIG. 1 shown with the press closed during the forming stage;

FIG. 3 is a view similar to that shown in FIG. 2 with the press closed during the cutting stage;

FIG. 3a is a schematic view of a detail of FIG. 3 shown on an enlarged scale;

FIG. 4 is a side view of the machine of FIG. 3 shown with the press open after the formed object has been cut out but still remains in the press;

FIG. 5 is a similar view to that in FIG. 4 but at a subsequent stage in which the pressed object is removed from the female mould and removed from the pressing area to a stacking collector;

FIG. 6 is a side view of a variation of the machine shown in FIG. 5 having a multiple row of moulds which discharge in bulk to a separate stacker;

FIGS. 7 to 10 show diagrammatic views of another variation of the machine shown in FIG. 5, in which the pressed objects are removed from the pressing area by means of a suction plate which can be placed between the male and female parts of the press;

FIG. 11 diagrammatically illustrates a plate which can lift a plurality of articles pressed in a single pressing operation by suction, used in the machine according to FIGS. 7 to 10;

FIG. 12 diagrammatically illustrates a front view of a thermoforming machine having a single upper male die and a double lower female mould which moves alternately beneath the male die; and

FIG. 13 includes a diagram which illustrates the stages and opening/closing cycle times for a thermoforming press having a single female mould.

The thermoforming cycle in machines which carry out forming and cutting at a single workstation can be described schematically as follows.

Stage 1: Sheet feed with the press open (FIG. 1)

A portion of sheet material A is delivered from a feed role (not shown) and is heated by irradiators B, e.g. infrared sources, and caused to advance between the open portions of the press, that is into the thermoforming area, in the direction of arrow F. The press consists of an upper male part or die M.sub.1 and a lower female part M.sub.2. Both parts M.sub.1 and M.sub.2 may be single or multiple, in which latter case several objects O can be obtained from each pressing operation.

Stage 2: Forming while the press is closed (FIG. 2)

The lower female part M.sub.2 rises against fixed male die M.sub.1 and object O is hot formed by causing rough shaping die M.sub.1p to enter the cavity M.sub.2c of female mould part M.sub.2 and thereafter injecting compressed air or applying negative pressure through a hole OF in male die M.sub.1. The compressed air causes the material A around rough forming die M.sub.1p to adhere to the side wall of cavity M.sub.2c and movable base M.sub.2f thereof. Then cavity M.sub.2c is cooled by a water cooling circuit generically indicated by C, and object O is also cooled and then subjected to a process of progressive structural and dimensional stabilisation.

Stage 3: Cutting (FIGS. 3 and 3a)

In this stage, all the lower part M.sub.2 of the press moves a distance ST, usually 1.5 mm (FIG. 3a) towards upper die M.sub.1, which is sufficient to separate the edge BO of object O from starting sheet material A.

The three stages described above are common to all thermoforming machines which shape and cut at a single workstation, or forming area (see diagram in FIG. 13). However a distinction is made between two classes of thermoforming machines on the basis of the different arrangements used to remove thermoformed objects O from the female mould M.sub.2 and subsequent operations (counting, stacking, etc.). The former have a single female mould M.sub.2, the latter has a double female mould, one on the left M.sub.2c and one on the right M.sub.2d, which are integral with each other, as will be explained below with reference to FIG. 12 and the object of Italian Patent No. 1,073,243.

The cutting stage (stage 3) completes the closed press cycle of operations (FIG. 13).

After this stage, the lower part M.sub.2 of the press descends, or moves away from upper part M.sub.1, following an S-shaped track (FIG. 4) carrying with it formed and cut object O, which therefore moves below the waste starting material A. Subsequently moving base component M.sub.2f of lower mould M.sub.2 ceases its downwards movement while the remaining part of mould M.sub.2 continues to move downward, thus drawing out and releasing object O completely from cavity M.sub.2c of mould M.sub.2.

At this point in the cycle there arises the difficult problem of moving or removing the thermoformed object or objects O from the forming area and stacking them. Various systems have been proposed, and the two most widely in use will be described below.

The first is the air blowing system (FIG. 5) which consists of supplying compressed air along a main CL provided with nozzles U which produce jets G which lift up objects O, causing them to tip slightly or topple into one or more collection channels R. The objects, continuing along collection channel R, become stacked forming a stack P.

This system can however only be used if the objects in mould M.sub.2 are arranged in a single file.

If the objects in mould M.sub.2 are in several rows (multiple files) the air jets G may remove objects O from the area bounded by parts M.sub.1 and M.sub.2 of the press, but they will be discharged in bulk. In order to get these back into order and then stack them, it is necessary to have a suitable stacking device PL (FIG. 6), which is separate from the thermoforming machine, but whose function must be synchronised therewith. This naturally involves heavy additional costs, greater complexity in operation and a high percentage of damaged objects which then have to be rejected.

In thermoforming machines provided with a stacker PL, objects O are "removed" by blowing them out of the forming area and causing them to impact against a stop surface AR before falling into a collecting bin V. At the base of collecting bin V there may be provided, as one of a number of possible systems, a conveyor belt collector TR controlled by a Maltese cross device which has a plurality of panels hinged together, each of which has a hole W.sub.1 which houses one object O. After impacting against surface AR which is orientated with a well-defined inclination, the objects end up by falling into holes W.sub.1 to be then transported intermittently towards a pusher I.sub.p controlled by a toggle E which pushes them one by one into a collection channel R where they form a stack P.

This system, which is mentioned here by way of example as one of many similar types, has many disadvantages.

To begin with, only circular objects which are taller than particular minimum dimensions can be stacked. It is not therefore possible to stack objects which are constrained to a specific orientation, e.g. objects of rectangular shape.

Also, in falling and being mixed together in bin V, many objects become deformed or otherwise damaged.

For these reasons the known system illustrated in FIG. 6, and others like it, are now considered to be obsolete.

The second system using a suction plate is illustrated diagrammatically in FIG. 7 to 11 and is the object of Italian Patent No. 1,175,178. During the opening T of the press, which is effected by lower female mould M.sub.2, a suction plate PA is inserted between the upper edge B of thermoformed object O, but below waste A of the starting material, in such a position that object or objects O can be sucked up when mould M.sub.2 has finished its descent T (press completely open).

Mould M.sub.2 then stops in its lowest position to allow suction plate PA to move away from the area bounded by dies M.sub.1 and M.sub.2 (forming area--FIG. 8), carrying with it objects O to an area adjacent to the thermoforming machine where they are picked up by suckers VS hinged on arms BG of a stacker R (FIGS. 9 and 10). As soon as plate PA reaches the position illustrated in FIG. 8, and is therefore outside the forming area, mould M.sub.2 begins its upwards movement, sheet material A advances by a further step and a new thermoforming cycle is thus initiated. At the same time suckers VS (FIG. 9) takes objects O from plate PA. By means of a rotation of arm BG and a simultaneous rotation about pin Q suckers VS are turned over and carried against a multiple collector R where the objects are stacked into stacks P (FIG. 10).

The difficulties and disadvantages which limit the performance of the extraction system in

1. The very long distance T by which the press must open, which is the sum of the height of the object or objects O and the distance travelled S (FIGS. 4 and 7) plus a specific distance to ensure a reasonable margin of safety (FIG. 7). However, as the time used in moving distance T is time which is of no use to the cycle it will be understood that, other things being equal, the output of the machine will be lower the taller the objects O which have to be removed.

2. Travel S is provided to create the space necessary for plate PA to insert itself between material A and thermoformed object or objects O. Keeping travel distance S short implies creating problems with the size of suction plate PA. Increasing distance S means appreciably lowering the productivity of the thermoforming machine. The definition of track S and the dimensioning of plate PA are therefore always the result of a compromise. However the dimensions of suction plate PA are also governed by the requirement that it must not impede the advance of sheet material A, which being in a heated state, has a tendency to weaken and fall downwards.

3. Keeping the press open for the time required for suction plate PA to enter and leave the forming zone increases the dead time in the thermoforming cycle (FIGS. 7, 8 and 13).

The fact that presses have to stand open for the time required for inserting plate PA between material A and object or objects O which have to be removed, sucking up the objects and removing them (a time which is commonly equal to 30% of the cycle time, i.e. a by no means negligible period) has a greatly adverse effect on the productivity of the machine.

If relatively large objects or small objects in a number of rows are present in mould M.sub.2 then the time for moving plate PA increases, because the distance T which has to be travelled is greater, or because plate PA has to travel a back and forth distance which is at least equal to the width LA of mould M.sub.2 (FIG. 7).

4. The time for which object or objects O remain in the press, that is with their own walls in contact with the cooled wall of cavity of M.sub.2c of mould M.sub.2, is another important parameter which affects the productivity of a thermoforming machine. In fact as soon as mould M.sub.2 reaches the position illustrated in FIG. 4, object O is displaced away from the wall of cavity M.sub.2c and therefore the stabilizing cooling of the plastics material which has been subjected to thermoforming ceases. As may be seen from the diagram in FIG. 13, the cooling time t_{st} for stabilization in the press is the time between the injection of the forming air $t_{sub.1}$ (through hole FO) and the start of removal $t_{sub.3}$ (FIG. 4). Normally this time is equivalent to about half the cycle time. When it is necessary to increase cooling time t_{st} the rate of the thermoforming machine has to be slowed.

5. Because the objects are directly sent to the stacker from plate PA it is not possible to carry out any additional operations (e.g. perforation, labelling or the like) on objects O between the removal operation and stacking.

If it is necessary to carry out additional operations on thermoformed and stacked objects O, the objects have to be repositioned, and this usually means destacking them and sending them to suitable machines to carry out the required operations, with a consequent risk of damaging the objects and producing rejects.

One of the greatest disadvantages of thermoforming machines with suction plate extraction lies in the shape and restricted dimensions of the suction plate itself. In fact, with reference to FIG. 11, it will be noted how the pressure difference, between the external environment and the negative pressure created by the suction through plate PA in the space within thermoformed objects O, creates the force by which objects O are attracted to and held against the plate. It can be said to a good approximation that this pressure difference is equal to the loss of head which air flows $Q_{1/2}$ and $Q_{2/2}$ and $Q_{3/2}$ create when passing through slots FE along edges BO.

Within Plate PA then:

the air in section S.sub.1 will have a velocity $V_{sub.1}$ which will cause a flow Q_1 to pass,

in section S.sub.2 it will have a speed $V_{sub.2}$ which is different from $V_{sub.1}$ and such as to pass a flow $Q_1=Q_2$.

in section S.sub.3 the speed will be $V_{sub.3}$ which is different from $V_{sub.1}$ and $V_{sub.2}$ and such as to cause the passage of a flow equal to $Q_1+Q_2+Q_3$. Ideal operating conditions arise when $Q_1=Q_2=Q_3$. As suction plate PA has to be inserted between sheet material A and the upper edges BO of objects O, its height dimension must be as small as possible so as not to constrain the distance by which the press

48
203

V.sub.3 is very much greater than V.sub.1, so that when it is in operation Q1 is greater than Q2, which is in turn greater than Q3. This means that the system operates under conditions which are very far from optimum conditions.

In thermoforming machines which have double lower female mould of the type disclosed in Italian Patent No. 1,053,243 and illustrated diagrammatically in FIG. 12, the objects are formed by alternately coupling the two female parts M.sub.2s and M.sub.2d with the single upper male part M.sub.1.

When dies M.sub.1 and M.sub.2 are closed the thermoforming takes place in the manner described above in stages 1 and 3.

With such machines it is possible to obtain advantages in subsequent stages, in that:

- 1) The distance T travelled by the press on opening it independent of the depth or height of the thermoformed objects and may therefore be kept at a minimum value sufficient to feed in material A, with a great reduction in the passive time in the cycle, as is shown in the diagram in FIG. 13.
- 2) The press remains open only for the time necessary to advance sheet material A and effect the alternate lateral movement of female moulds M.sub.2s and M.sub.2d. These operations take place at the same time, without providing any stoppage for removing thermoformed objects O.
- 3) The time for which objects O remain in cavity M.sub.2c with their walls in contact with the mould is longer than the thermoforming cycle (FIG. 13), because objects O remain in close contact with the die from the time of cutting until the next thermoforming operation in the other female mould. In other words the cooling of a thermoformed object O is extended throughout the following stages:

forming, for example in M.sub.1 -M.sub.2s

cutting out

press opening

lateral movement of the double female mould

closing of dies M.sub.1 -M.sub.2d

forming in M.sub.1 -M.sub.2d

The stacking of objects O on these thermoforming machines takes place in stacker R.sub.s in the case of the objects formed in M.sub.2s during forming stage in mould M.sub.2s and R.sub.d in the case of those formed in M.sub.2d.

Base members M.sub.2fs and M.sub.2fd remove objects O by travelling distance C.sub.t (FIG. 12) and stack them alternately pushing the objects formed in female mould M.sub.2s into left hand collection or stacking device R.sub.s and those formed in female mould M.sub.2d into right hand collection or stacking device R.sub.d. Devices R.sub.s and R.sub.d are located to the sides of the fixed part of die M.sub.1. It may happen therefore that objects O which have recessed angular supporting portions (e.g. 2, 3, 4 or more indentations or indented feet located at the same level) provided, as is usual in the art, to prevent one object binding completely within another during stacking, (which would make it impossible for the objects to be then destacked for use), are located in a perfect vertical orientation and alignment, because they all come from the same mould. In this case it will be seen that there is accurate superimposition of two or more consecutive stacked objects, so that the spacing effect of the feet or indentations is neutralized and as a result the objects bind firmly together making it difficult to separate them.

Another cause of poor spacing and therefore of irreversible binding between the stacked thermoformed objects lies in inaccurate forming of the stacking feet or indentations (which generally project towards the interior of the object by a fraction of a millimetre or a little more), being made of a thermoplastics material which is therefore dimensionally unstable at the time of forming, these are obtained with fairly wide dimensional tolerances. There will therefore be variations in the connecting angle to both the feet and the base of each object, depending on the nature of the thermoplastics material used, and the shape and depth of the objects being thermoformed, which are unacceptable for correct stacking of the objects.

Objects which do not destack, or which destack with difficulty, require manual intervention, reduce productivity and almost always end up by increasing the number of rejects.

44
204

As will be noted, the distance C.sub.t travelled by base members M.sub.2fs and M.sub.2fd depends on the maximum height of the objects O being formed and is therefore longer when the objects are deeper. It is essential in fact that interference between the bottom of object O and the lateral movement and closing of the press is avoided.

FIG. 12 illustrates pins S.sub.p which center parts M.sub.2s and M.sub.2d with respect to fixed part M.sub.1 as the press closes, through being inserted by a certain amount into corresponding seats Z provided in mould M.sub.2. A.sub.1 also indicates diagrammatically the members which feed or advance sheet material A.

As in thermoforming machines having a single female mould, so in machines having a double female mould, stacking of the objects takes place without there being any practical possibility of carrying out additional operations on thermoformed objects O, as these are gathered into stacks immediately after thermoforming.

SUMMARY OF THE INVENTION

An object of this invention is to eliminate or substantially to reduce the disadvantages described above which arise with known thermoforming methods and machines and forms of extraction.

Another object of this invention is to provide extraction of thermoformed objects from the forming zone in a thermoforming apparatus by making use of a suction plate which is not subject to critical dimensional constraints.

A specific object of this invention is to make it possible to carry out a whole series of additional and/or auxiliary operations on the thermoformed objects during each thermoforming cycle, while keeping the objects outside the press in the same mutual positions which they occupied in the forming mould.

Another object of this invention is to provide a substantial reduction in the open press waiting time in order to improve productivity and efficiency.

Another object of this invention is to effect a drastic reduction of up to one half in the height of the press, with a consequent reduction in the masses in movement, the cost of manufacturing the press itself and a substantial increase in the speed of movement or lateral movement of the press.

Yet another object of this invention is to provide the production of thermoformed objects which may be finished through one or more supplementary operations carried out at the same time as a thermoforming operation before stacking and packaging, without it being necessary to restart processing.

In accordance with this invention there is provided apparatus for the thermoforming of hollow objects incorporating a base from a sheet of thermoplastics materials, comprising

a male die and a double female mould, one half of which mould can move alternately with respect to the other half for mating with the male die in turn while at the same time carrying the object or objects produced previously in the other half of the female mould to an easily accessible discharge area,

a sheet feed to deliver a sheet of thermoforming material in steps between the male and female moulds,

a cutting device which is brought into operation at the end of each closing movement of the press,

a stepwise conveyor having a plurality of plates or formers, each of which is capable of receiving and supporting the object or objects from one forming operation in the same mutual positions which they occupied in the press,

at least one pick-up head capable of lifting one set of formed objects alternately from each half of the double female mould from one side or the other of the male die and of transferring them to a corresponding plate or former on the conveyor and

at least one processing or handling station located along the conveyor for the simultaneous handling or processing of all the objects from at least one forming operation.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a side view of diagrammatic form of a thermoforming machine having an upper male die and a single lower female mould shown in the open press position prior to forming;

420
205

FIG. 3 is a view similar to that shown in FIG. 2 with the press closed during the cutting stage;

FIG. 3a is a schematic view of a detail of FIG. 3 shown on an enlarged scale;

FIG. 4 is a side view of the machine of FIG. 3 shown with the press open after the formed object has been cut out but still remains in the press;

FIG. 5 is a similar view to that in FIG. 4 but at a subsequent stage in which the pressed object is removed from the female mould and removed from the pressing area to a stacking collector;

FIG. 6 is a side view of a variation of the machine shown in FIG. 5 having a multiple row of moulds which discharge in bulk to a separate stacker;

FIGS. 7 to 10 show diagrammatic views of another variation of the machine shown in FIG. 5, in which the pressed objects are removed from the pressing area by means of a suction plate which can be placed between the male and female parts of the press;

FIG. 11 diagrammatically illustrates a plate which can lift a plurality of articles pressed in a single pressing operation by suction, used in the machine according to FIGS. 7 to 10;

FIG. 12 diagrammatically illustrates a front view of a thermoforming machine having a single upper male die and a double lower female mould which moves alternately beneath the male die; and

FIG. 13 includes a diagram which illustrates the stages and opening/closing cycle times for a thermoforming press having a single female mould.

The present invention will be further illustrated, by way of example, with reference to FIGS. 14 to 33 of the accompanying drawings, in which:

FIG. 14 is a front elevational view in schematic form of part of a conveyor utilised in the apparatus of the invention,

FIG. 15 is a plan view of the device of FIG. 14,

FIGS. 16 and 17 are respectively a plan view and a magnified plan view similar to that shown in FIG. 15, but with the pick-up heads in a different stage of the working cycle,

FIGS. 16A and 16B are respectively partial views from above on a magnified scale of the two halves of a double female mould,

FIGS. 18 and 19 are elevational views in schematic form of the thermoforming press in two different stages of operation without the stepwise conveyor,

FIG. 20 is a view from below and on a magnified scale of a portion of the pick-up head,

FIGS. 21A, 21B and 21C show details of FIG. 19 on a magnified scale,

FIG. 22 illustrates a detail of FIG. 14 on a magnified scale,

FIG. 23 is a view similar to that of FIG. 14, but in a different stage in the operating cycle,

FIG. 24 shows a detail of FIG. 23,

FIG. 25 is a front elevational view of a stacker which can be used downstream of the stepwise conveyor, during the loading stage,

FIG. 25A shows a detail of FIG. 25 on a magnified scale showing the manner in which the thermoformed objects are stacked,

FIG. 26 shows a detail of FIG. 25 on a magnified scale,

FIG. 27 shows the stacker of FIG. 25 during the stage of discharging onto a plate,

FIG. 28 shows a detail of FIG. 26 in a position ready for discharging,

101
206

FIGS. 30 and 31 diagrammatically illustrate successive stages in the horizontal discharging of the stacker of FIG. 29,

FIG. 32 shows a variation with respect of FIG. 23, and

FIG. 33 shows a diagram of the thermoforming stages and cycle times for the equipment illustrated in FIGS. 14 to 31, for comparison with the diagram of FIG. 13.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

With reference to the figures listed above, it will be noted that the thermoforming means or press according to this invention comprises a supporting structure 1 on which is mounted a fixed upper plate 2 bearing a male die 3, which in the example illustrated is also fixed, a sliding die-supporting table 4, which is e.g. supported on roller feet suitable for high loads with automatic lubrication (not shown in the drawing) to make horizontal movements (arrow A), and a lower plate 5 which can move in a vertical direction (arrow B--FIG. 18) which is driven by e.g. two toggle units (not shown). Sliding table 4 supports two female moulds (a double female mould) 6 and 7 which are identical and are located alongside each other at the same level, which are intended to be moved by the sliding table 4 alternately beneath the fixed die 3 where they are caused to rise up and mate against the die and successively open by being lowered in order to be moved laterally with respect to the fixed die 3. In other words, mould 6 is moved to the left and mould 7 is moved to the right (as seen in the Figs. in the drawing) with respect to the fixed die 3.

A sheet 8 of thermoplastics material, which may be wound on to a mandrel or be derived directly from an extrusion unit combined with the thermoforming device, is made to advance by means of a chain feed indicated generally by reference numeral 9, in a direction normal to that of the movement of double female mould 6, 7 beneath fixed die 3 but above double female mould 6, 7, in steps, in time with the rate of pressing or forming.

As will be better seen in FIGS. 18 and 19, fixed die 3 may have a plurality of depressions 10 each of which has an open lower end bounded by a free edge 11 (FIGS. 21A and 21B) and houses a corresponding male plug 12 fixed at the end of a corresponding vertical control rod 13 slidably mounted between the upper wall of the fixed die and extending beyond it to meet and be joined to an upper activating bar or plate 14, which is in turn controlled by activating means, not shown in the drawings, e.g. of a type well-known to those skilled in the art. The two female moulds 6 and 7 each have a plurality of upwardly open cavities 15 equal in number to the number of depressions 10 and having the same spacing, in such a way that when a female mould mates with the fixed die each depression or pit 10 accurately mates with a corresponding cavity 15 below.

Centering means comprising e.g. four pins 16 borne by upper plate 2, which are fixed or which can be caused to project to engage in corresponding receiving seats 17 provided in the female mould when the dies are closed together are provided for correct mating between female moulds 6 and 7 and fixed die 3.

The base of each cavity 15 is equipped with an extraction device (FIGS. 18, 19, 21A, 21B and 21C) comprising a head 18 which can move upwards as it is controlled by a corresponding rod 19 which is integral with a control bar or plate 20, which is intended to release and push out one or more thermoformed objects 150 from between the press after the dies have opened.

Advantageously, each cavity 15 may have a constriction 21 forming a step around the formed object, the height of which from the base of the cavity defines the stacking height H for formed objects 150 (FIG. 21A).

Lower plate 5 is driven by suitable units (not shown), for example two toggle units, in order to effect the vertical closing and opening movements between female moulds 6, 7 and fixed die 3.

Two eccentrics, which by causing plate 5 to move through a small distance make it possible to cut out and separate the objects from the sheet, may be provided beneath the base of the two toggle units. This operation, as is usual in the art, is carried out during the closure of female moulds 6, 7 against fixed die 3.

Fixed upper plate 2 has two vertical supporting columns 22 and 23 (FIGS. 15, 16 and 17), on each of which is rotatably mounted a corresponding projecting arm 24, 25 which at its free end bears a suction pick-up head 26, 27, which is constructed e.g. in the shape of a bell cup which is closed off at the base by a perforated suction plate 28 communicating with a source of vacuum or negative pressure above in order to draw out the air, such as a suction pump, which is not shown, by means of a flexible conduit

107
207

orderly arrangement at a distance from the intersection of longitudinal 30 and transverse 31 suction grooves, advantageously with a spacing equal to that of cavities 15 in female moulds 6 and 7.

Arms 24 and 25 are located on one side respectively of fixed die 3 and are caused to move angularly about columns 22 and 23 between a position in which corresponding pick-up head 26 and 27 is above a corresponding female mould 6 or 7, when this is moved laterally completely away from fixed die 3, and a position outside the thermoforming machine by a corresponding motor/reduction gear unit 32, 33 driven in such a way as to cause pick-up heads 26, 27 to make rhythmical angular movements in time with the back and forth alternating movements of moulds 6 and 7 in order to effect the transfer of thermoformed objects 150, as will be further described hereinafter.

Within the radius of action of arms 24 and 25 there is located a stepwise conveyor 35 (FIGS. 14, 15, 16, 22 and 23), which is formed of two sliding and supporting sides or banks 36, a plurality of plates or formers 37 slidably supported by the sides and drawn at their two opposite ends by a pair of chains 38 which pass round a pair of chainwheels 39 at the ends of the conveyor (FIG. 22). Each plate or former 37 has an intermediate pin 40 providing an articulation to a chain 38 and two lateral rollers 41 and 42 at each end thereof which engage with the chains. Alongside the banks 36 rollers 41 and 42 are free or may run along corresponding straight upper 43 and lower 44 guides or rails, while at the transmission end of the conveyor, pin 40 is caused to follow a circular path around a wheel 39, the front roller (with respect to the direction of movement, e.g. roller 41 in FIG. 22) is caused to follow a track which is also circular along a corresponding fixed guide 45 which has the same radius of curvature as the original curvature of the wheel 39 and the rear roller (roller 42 in FIG. 22) is engaged between two radiused teeth 46 of a wheel 47 which has its own axis of rotation along the line of the wheel 39 and the said pitch line. With this arrangement, at the ends of conveyor 35 each plate or former 37 is returned to a position which is always parallel to the other plates or formers and when in the discharge position is relatively far from the plate or former which preceded it and the one which follows it.

It is therefore possible to provide a treatment or processing station 50 (FIGS. 14 and 23) and a stacking station 51 at the transmission ends of conveyors 35 and possible intermediate treatment or processing stations as will be described below.

Processing station 50 is designed to perform various operations on formed objects 150, which are located in an easily accessible position for working units provided at the said station, while in stacking station 51 the formed objects can be stacked before finally being removed from conveyor 35.

Plates or formers 37 each have a plurality of holes or seats 37a having the same diameter (or a slightly smaller diameter) and the same spacings as cavities 15 in female moulds 6 and 7, so that they can receive the objects obtained from a forming operation transferred thereto by heads 26 and 27. Plates or formers 37 are moved stepwise along an upper track along conveyor 35, along which they receive formed objects 150 from heads 26 and 27 alternatively, are stopped sequentially in a stepwise manner at processing station 50 and are then passed along a lower track to reach stacking station 51.

Treatment or processing station 50 may be designed to carry out any desired additional operation, such as e.g. perforating the bases of shaped objects 150, dry printing or stamping of the objects, labelling, filling with soluble beverage powders, sterilisation, etc.

In FIGS. 14 and 23, station 50 is illustrated by way of example by a toggle driven drilling head equipped with drilling bits 52 arranged with the same spacing as holes 37a and formers 37 and operated with the same operating rhythm as stepwise conveyor 35.

However any other suitable operating unit capable of carrying out a desired process or manipulation upon the formed objects may be provided instead of or in association with toggle-operated driving unit 50.

Stacking station 51 (FIGS. 14 and 23 to 29) comprises a supporting frame 53 upon which is located the downstream end of conveyor 35, a lower pusher 54 which can be driven in an alternating vertical back and forth motion in time with the stepwise operation of conveyor 35 and having a plurality of pusher heads 55 equal in number to and having the same spacing as holes 37a in formers 37, and a stacker 56 placed above conveyor 35 in vertical alignment with pusher 54. Stacker 56 may be of any suitable type, e.g. having a plurality of parallel tubular rods 57 held together by a frame 58 (FIG. 25) on which is also slidably mounted an upper pusher 59 which can also be driven in an alternating back and forth motion as will be described below.

Each rod 57 is advantageously provided with teeth 60 (FIGS. 26 and 28) which are retractable in that they are hinged about a transverse axis 61 so that they can be moved angularly between a position in which they are withdrawn into the rod (FIG. 28) so that objects 150 can slide between the rods and a

As will be better seen from FIGS. 16A, 16B and 25A, it is possible to arrange matters in such a way that female mould 6 produces objects identical to those produced in female mould 7, but having e.g. four feet or indentations 152 offset by a predetermined angle in such a way that given that the stacks of objects at station 51 are formed from objects deriving from mould 6 and mould 7 alternately, because these are loaded onto formers 37 of conveyor 35, the flat part of the base of an object 150 (even when the bottom edge has a relatively large connecting angle) is always brought to rest against a sufficient number of feet 152.

A similar result is achieved if instead of having a different angular orientation of feet 152 in the two female moulds, a different number of feet 152 are provided. This naturally makes it possible to have a perfect stacking arrangement at all times without any risk of permanent or irreversible binding between objects 150 and thus reducing the number of rejects.

Stacker 56 is supported on a trolley structure 62 which can run by means of wheels 63 along a beam or section 64 to transfer a plurality of stacks of objects 150 from stacker 56, e.g. onto a standing and supporting surface 65, which may if desired be capable of being raised and lowered, as shown diagrammatically in FIGS. 25 and 27.

Beam 64 may be rotatably supported around its own longitudinal axis 66 and may have angular projections around it through a toothed section 67 which engages a toothed pinion 68 keyed onto drive shaft 69 of a motor/reduction gear unit 70. With this arrangement, stacker 56 can be inclined through 90 degrees or any intermediate angle thus placing it, for example, in a horizontal position and setting it down onto a supporting platform 71 (FIGS. 29 to 31). Platform 71 is designed to perform a stepwise descending movement (through a transmission 72, a screw 73 and a corresponding nut) to enable a transverse expeller 74 to transfer a row of stacked objects 150 to a cage conveyor 75 which carries the stacked objects to e.g. a packing station.

The functioning of the means described above is extremely simple. When the press is open a predetermined length of sheet 8 is caused to advance by means of chain feed 9 beneath fixed die 3, whereupon female mould 6 or 7 (e.g. die 6) which is located beneath the fixed die is raised and mated against die 3 with the consequent thermoforming of objects 150 and the subsequent cutting thereof. Mould 6 together with mould 7 move downwards to open the press and immediately afterwards mould-bearing table 4 moves laterally so as to carry mould 6 completely away from fixed die 3 and mould 7 beneath die 3 ready for the next thermoforming cycle.

In the meantime pick-up head 26 is moved into the extraction area above female mould 6, which is now completely unobstructed, and as soon as mould 7 closes against the fixed die it removes formed objects 150 from mould 6, which had been previously removed or loosened from cells 15 by heads 18 of the extraction device. Rotating around its column 22 (FIG. 16) head 26 moves above a former 37 on conveyor belt 35 and deposits formed objects 150 into an identical number of holes 37a (FIGS. 15 and 16).

In the subsequent forming, cycle pick-up head 27 moves over mould 7 which has been moved laterally with respect to fixed die 3 into the extraction area and, with a similar movement to that of head 26, transfers formed objects from mould 7 to former 37 on conveyor 35 in a similar way. In this way, head 27 will set objects 150 down on alternate formers on the conveyor. The same will be done by pick-up head 26, but on the formers left unoccupied by head 27, so that all formers 37 are finally filled with objects 150 before they are delivered to processing station 50.

It will be noted that the fact that each formed object is transferred to stepwise conveyor 35 and remains there makes it possible to extend the stabilization times outside the press considerably, which is an advantageous feature for improving the quality of formed objects 150. In fact in the example illustrated objects 150 are supported on the formers of conveyor 35 for seven or more thermoforming cycles.

From time to time it is possible to sample objects 150 from a former 37 selected at random to check the quality of objects 150 without this producing the slightest disturbance in the equipment's operating cycle.

At workstation 50 the objects are processed or partly filled with powder material, or labelled etc., and are then passed along the lower portion of conveyor 35 towards stacking station 51, from which they are removed in stacks to be delivered for use or to a packing station for delivery. Even while they are moving along the lower portion of the conveyor they undergo prolonged stabilization, and remain in the same mutual positions as they had in the thermoforming press.

It will be noted how, in addition to providing easy and uniform control of the internal negative pressure

101
209

all applications and is not dependent on the existence of an edge 151 on the objects being picked up. Also, contrary to the situation in conventional systems, through the use of heads 26 and 27 the movement for extracting objects 150 from the presses is equal to the stacking height H (FIG. 21A).

More particularly, with reference to FIG. 21B when a mould 6 or 7 (e.g. mould 6) is moved into the extraction or discharge position, head 26 is moved into a position above mould 6 at the same time, as already mentioned. The distance h_o which extraction device 18 and 20 has to move for partial extraction of objects 150 before these are picked up by head 26 is effected while part 7 of the press is carrying out another thermoforming cycle. This also applies to the subsequent extraction movements performed by head 27, for its rotation and the deposition of objects 150 to formers 37 and to its return into position above mould 7 so that no dead times are added to any of the forming cycles.

This means that waiting times during which the press is open, which as mentioned above with reference to thermoforming machines with a suction plate which enters into the pressing or forming area itself represents 30% of the thermoforming cycle, are drastically reduced.

It will also be noted how the removal of objects 150 is only partly entrusted to the movement of the heads or bases 18. The objects are in fact removed (FIG. 21C) by means of the movement separating the mould and the plate, partly caused by lowering of the mould and partly by the raising of bases 18. Because these movements take place simultaneously with other dead times in each forming cycle they do not affect the productivity of the equipment.

If a comparison is made between the machine according to the known state of the art in FIG. 11, it will easily be noted that, if

h_o is the height of objects 150,

h_p is the height of control plate 20,

h_a is the length of the approach travel for stacking, and

h_s is the dimension (height) of a double female mould 6, 7, the total height H of a mould M.sub.2s and M.sub.2d in FIG. 12 will be the sum $H_o = h_p + h_o + h_a + h_s$.

The height of female moulds 6 and 7 in FIG. 21B according to this invention is instead $H = h_p + h_a + h_s$, that is H is H_o less than an amount equal to at least the maximum height of the thermoformed objects 150. Because the height H_o of the mould in a conventional machine with stacking is usually slightly greater than twice the height of the thermoformed objects, it can be concluded that the extraction performed by heads 26 and 27 in the appropriate extraction or discharge areas completely outside the pressing area and away from fixed die 3 at least halves the height of female moulds 6 and 7.

The reduction in the height of the moulds brings about an appreciable decrease in their weight, and therefore their inertia, which means that more rapid lateral movements can be performed.

Also, it will be noted from FIG. 21B that mould 7 is illustrated in the extraction or discharge position. The fact that mould 7 is moved in a position completely outside the pressing or thermoforming area has made it possible to dimension suction heads 26 and 27 in such a way that the sum of the flows ($Q_1 + Q_2 + Q_3$) all passes through section H_{pe} . In sections S1, S2 and S3 the rates of flow will be identical in each and therefore the value of the pressure p_i which is set up within the head will be uniform over the entire surface of plate 28. This has the result of optimising the most important parameter for the satisfactory operation of a pick-up head 26, 27, with the result that it is possible to achieve the optimum condition in which $Q_1 = Q_2 = Q_3$.

The invention described above may be subjected to numerous modifications and variations within the scope thereof. Thus, for example, conveyor 35 may be replaced by a conveyor with an empty return track, or with empty formers 37, after being passed around a terminal return wheel of considerable diameter or a number of return wheels in such a way that stations 50 and 51 can operate on its upper track. Here again processing stations 50 may be more than one in number and may be arranged in sequence along the conveyor.

If desired, station 50 may be omitted or in any event may be left inactive for particular types of object 150.

Furthermore, as illustrated in FIGS. 23 and 32, a suction hood 80 for the volatile residues produced from thermoplastic material A which is used for the thermoforming of objects 150 may advantageously be provided in any suitable position above, around or below conveyor 35. A tunnel treatment chamber 85,

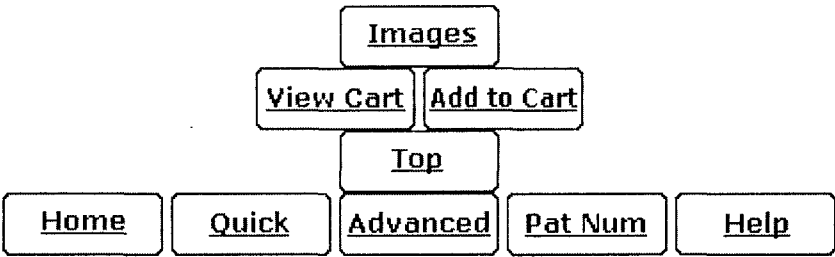
125
210

and which may be provided with a plurality of needles 86 intended for the injection of a fluid, such as cold air, to achieve optimum stabilization of objects 150 outside the press is also illustrated diagrammatically in FIG. 32.

If desired, downstream of each pick-up head 26 and 27 a rim curling workstation is arranged to form curled rims on all the objects formed in the same moulding operation immediately after they have been discharged on a plate or former 37. In this case the conveyor 35 has a correspondingly greater length by at the least two plates or formers, whereby making it possible for the objects to be formed with a curled rim within the cyclic time while being still hot as they have just been picked up from the mould 6 or 7, and thus there is no need to heat them just for the rim finishing operation before reaching the processing station 50.

Materials and dimensions may be varied in accordance with requirements.

* * * * *



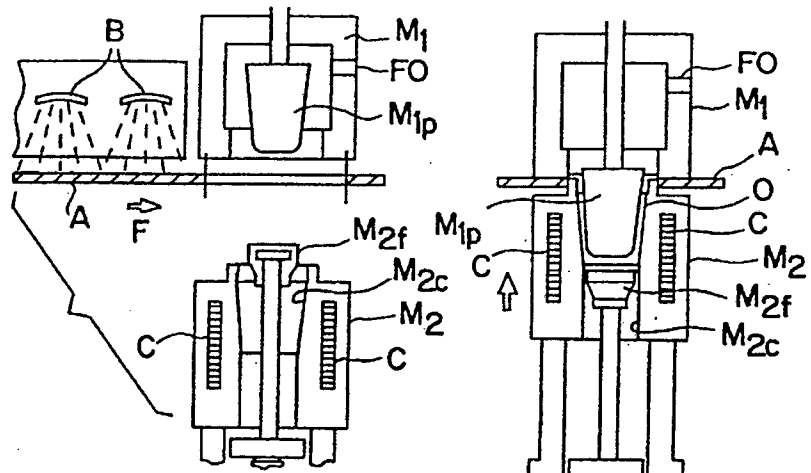


FIG. 1
PRIOR ART

FIG. 2
PRIOR ART

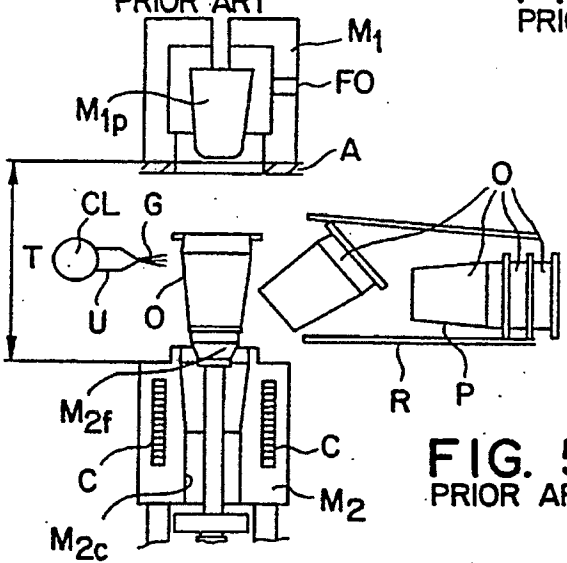


FIG. 5
PRIOR ART

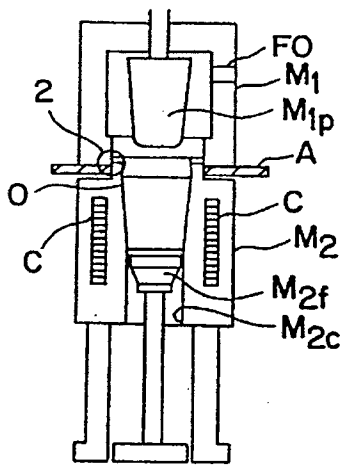


FIG. 3
PRIOR ART

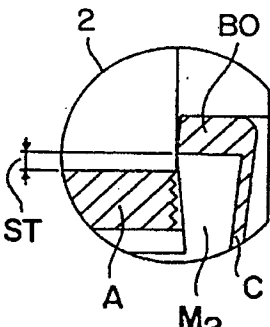


FIG. 3a
PRIOR ART

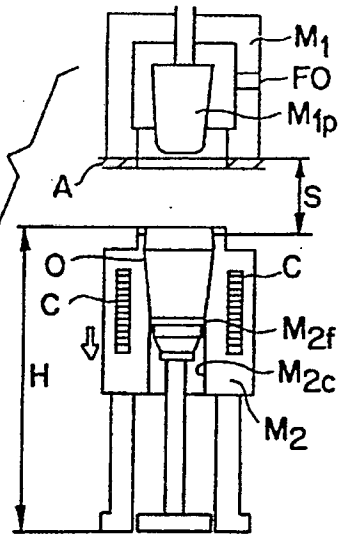


FIG. 4
PRIOR ART

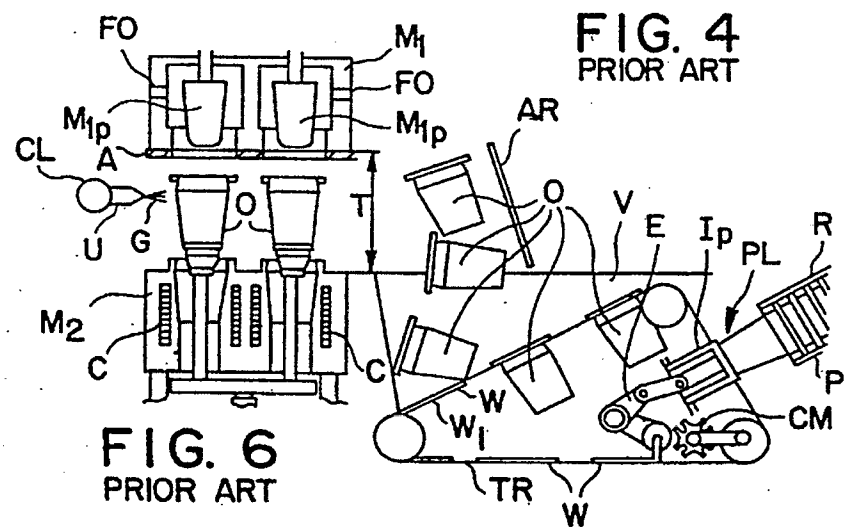


FIG. 6
PRIOR ART

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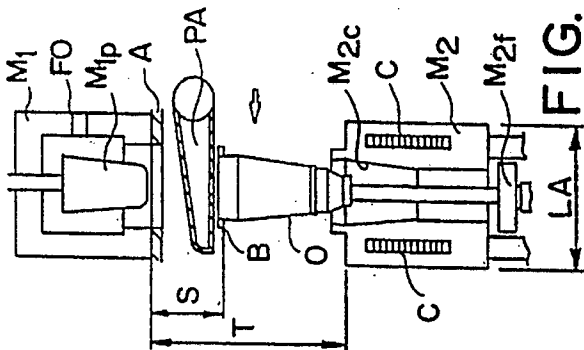


FIG. 7
PRIOR ART

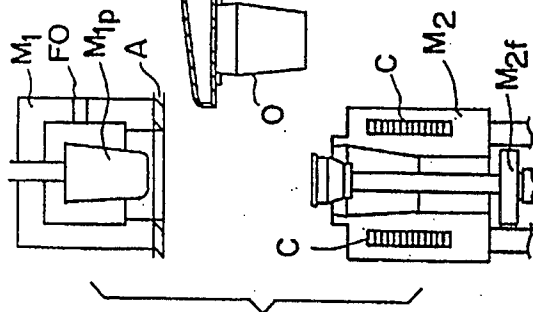


FIG. 8
PRIOR ART



FIG. 9
PRIOR ART

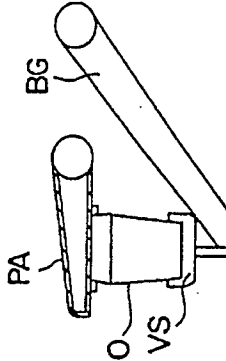


FIG. 10
PRIOR ART

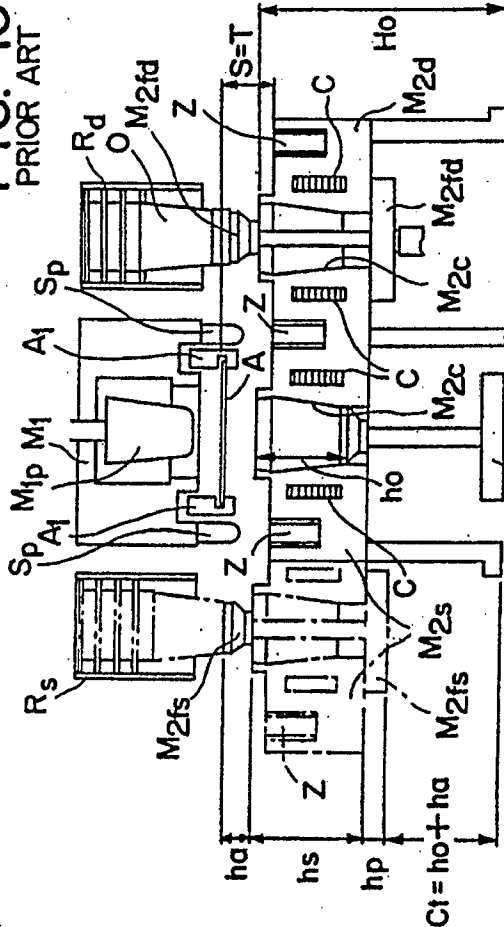


FIG. 11
PRIOR ART

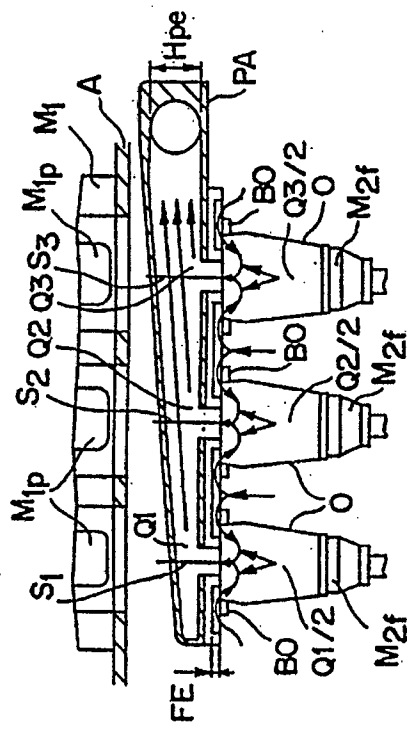


FIG. 12
PRIOR ART

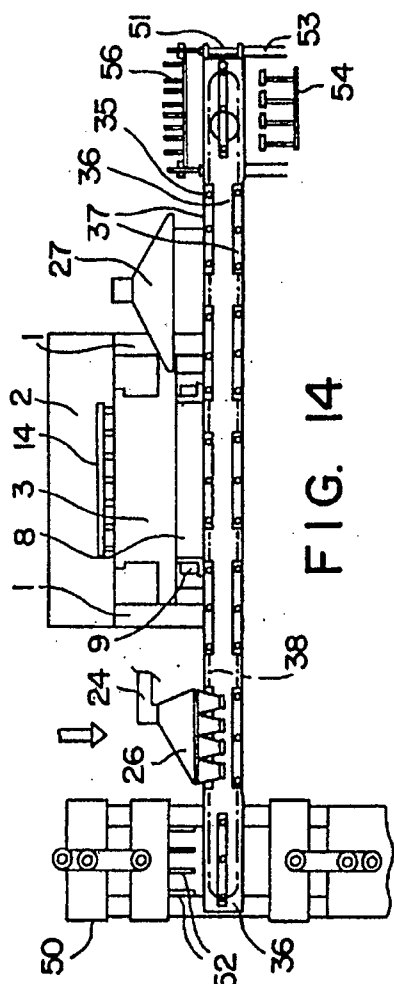
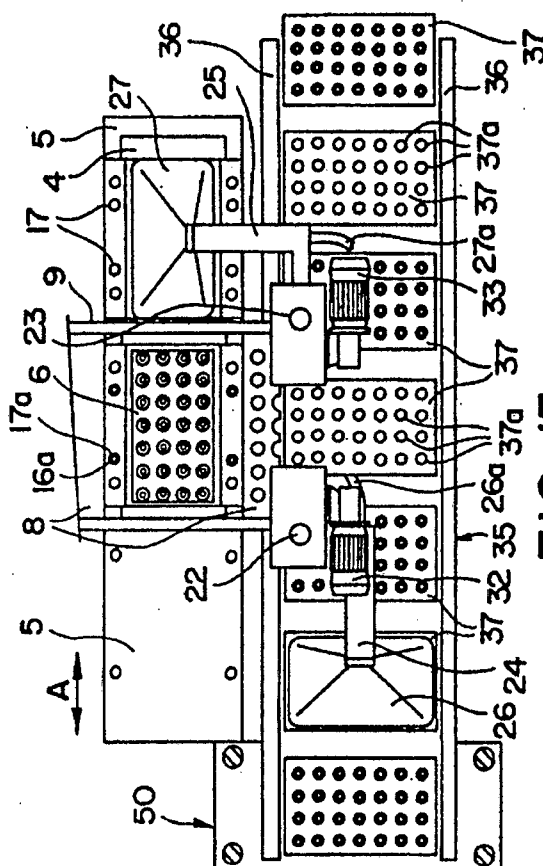


FIG. 14



516

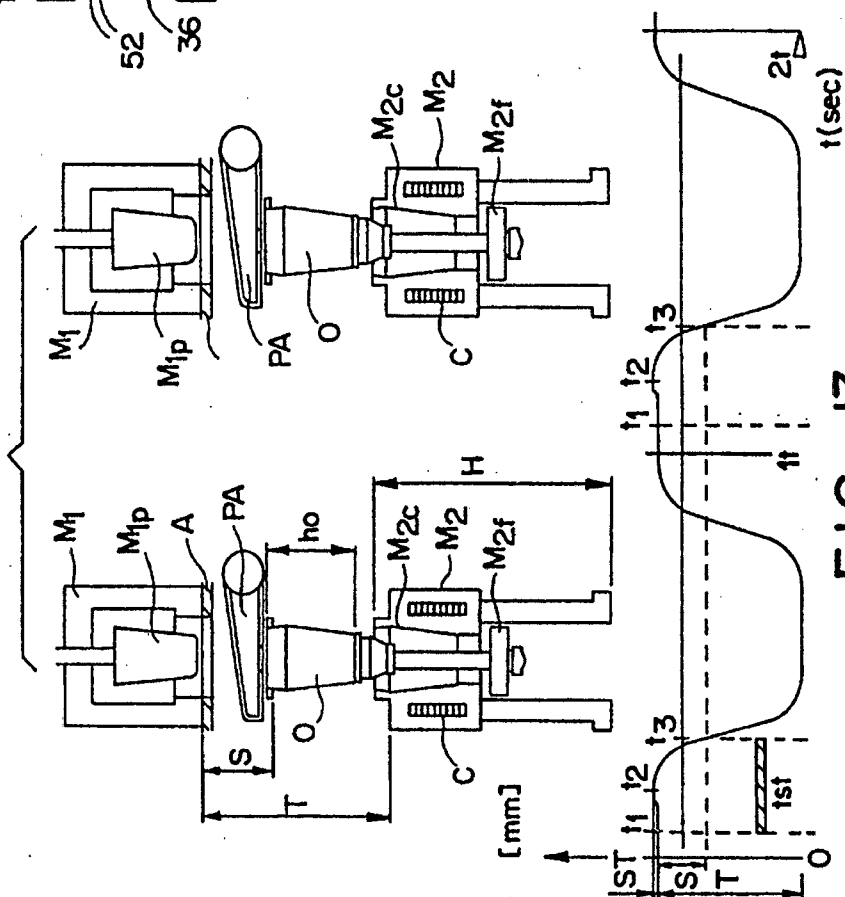


FIG. 13
PRIOR ART

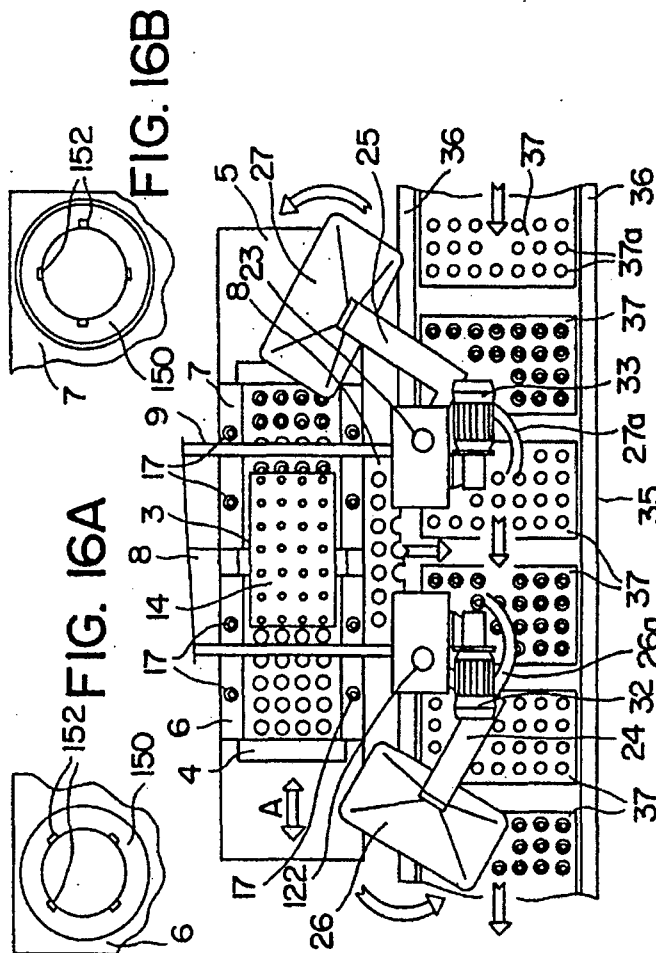


FIG. 16

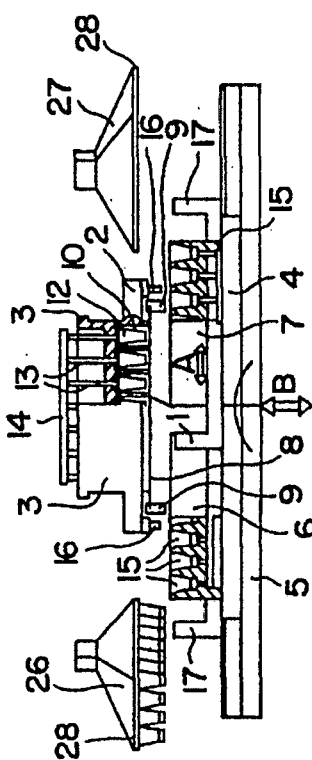


FIG. 18

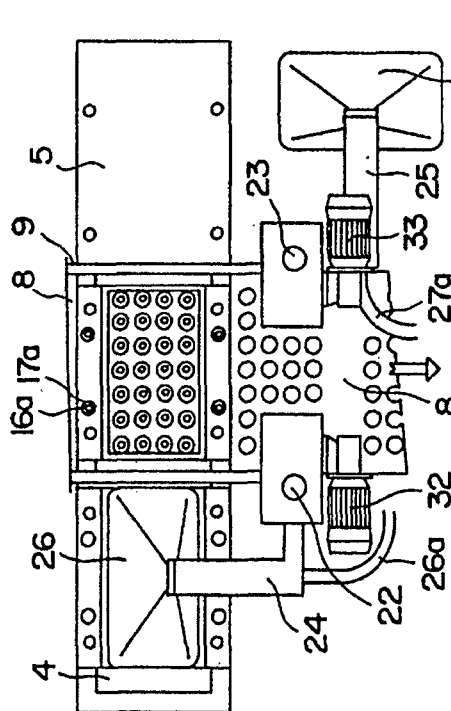


FIG. 17

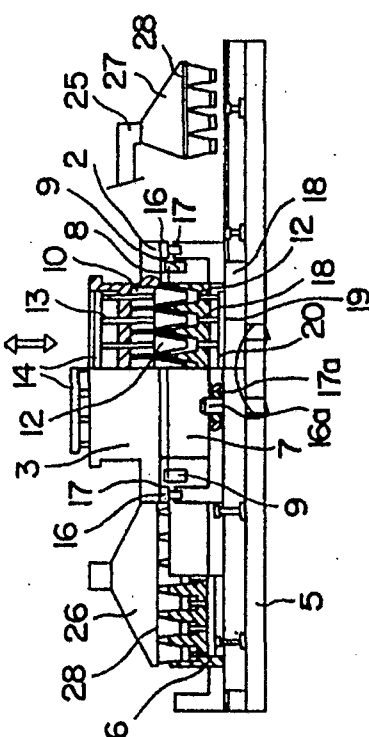


FIG. 19

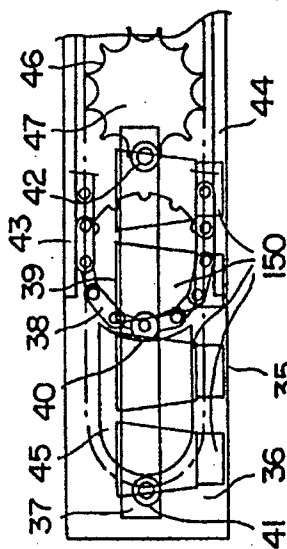


FIG. 22

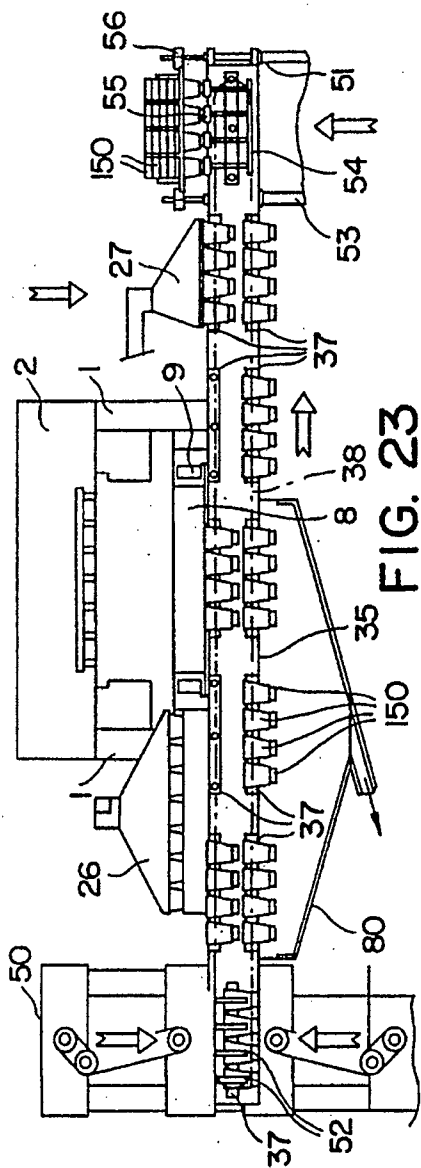


FIG. 23

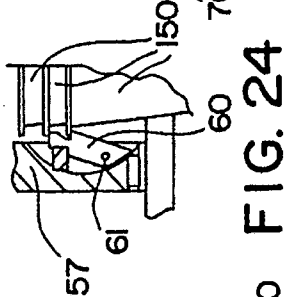


FIG. 24

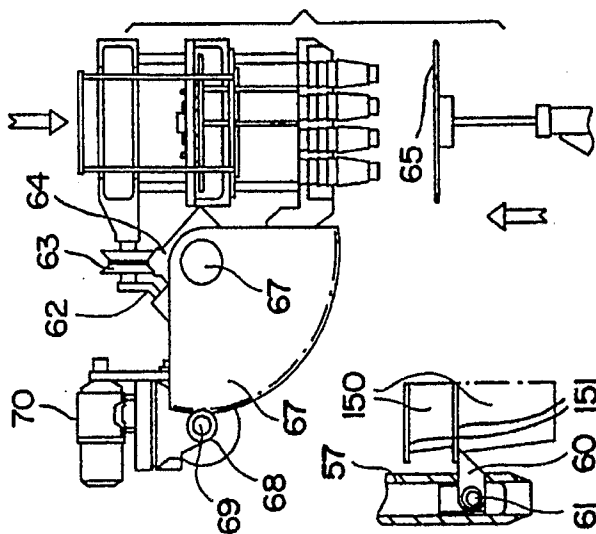


FIG. 26

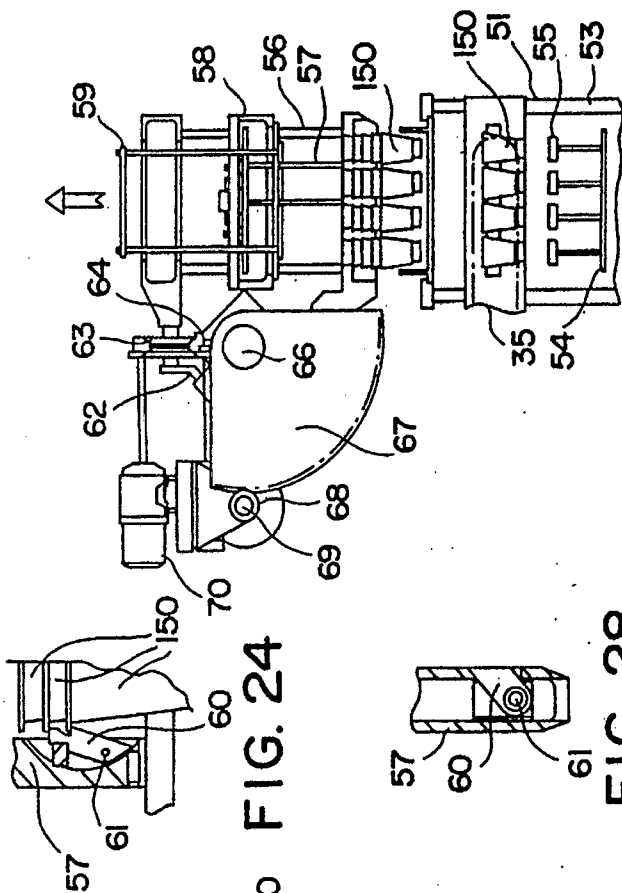


FIG. 25

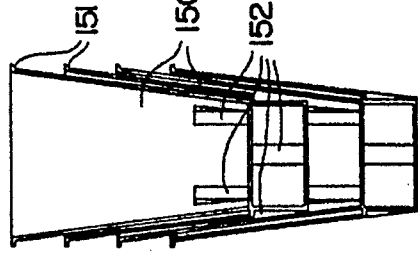


FIG. 25A

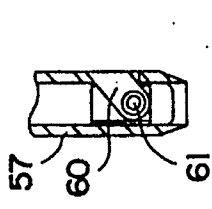


FIG. 28

FIG. 27

USPTO PATENT FULL-TEXT AND IMAGE DATABASE

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View Cart		Add to Cart		
Images				

(1 of 1)

United States Patent
Padovani**5,650,110**
July 22, 1997

Method for thermoforming and stacking hollow objects

Abstract

A method for the thermoforming of hollow objects having a base from a sheet of thermoplastics material, which effects in one single predetermined operating cycle, the production of a pressed object by hot forming and cutting out of the object or objects between one half of a movable double female mould which is located in the forming area opposite a male die, movement of the female half of the mould, said half containing therewithin the thermoformed object or objects, towards a corresponding discharge area alternately to one side or the other of the forming area; picking up the object or objects from the female half of the mould located in corresponding discharge area and transferring each object to a plurality of receiving formers of a shape corresponding to the mould, which formers can move sequentially stepwise along a track, sequential movement of the formers to at least one workstation or handling station at the same time as the female mould moves back to place its other half opposite the male die in order to produce a subsequently formed object, and performing at least one processing or handling operation on all the objects carried by at least one former at the same time as the next formed object is produced.

Inventors: **Padovani; Pietro** (Verona, IT)
Assignee: **ISAP OMV Group S.p.A.** (Verona, IT)
Appl. No.: **485232**
Filed: **June 6, 1995**

Foreign Application Priority Data

Feb 03, 1992[IT]

VR92A0012

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Intern'l Class: **B29C 051/20**

Field of Search: **264/153,145,210.2,297.7,297.5,151,544,550,551
425/387.1,388,347,359,302.1,403.1
53/559,561,433,453,456,425,452**

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JP-A-61 047 232 (Meiwa Sangyo K.K.) 7 Mars 1986 *abrege*.

Primary Examiner: Timm; Catherine
Attorney, Agent or Firm: Ladas & Parry

Parent Case Text

This is a continuation of application Ser. No. 08/181,184 filed Jan. 13, 1994 now U.S. Pat. No. 5,453,237, which is a divisional of application Ser. No. 07/937,362, filed Aug. 28, 1992, abandoned.

Claims

I claim:

1. A method for thermoforming an object from a sheet of thermoplastics material, the method comprising:

producing the object by hot forming and cutting out the object between one half of a movable double female mold and an opposing male die, the one half of the female mold and male die being located in a forming area;

moving the one half of the female mold from the forming area to a discharge area, the one half of the female mold containing the object therewithin, and simultaneously moving the other half of the female mold from the discharge area into the forming area opposite the male die to produce a further object;

picking up the object from the half of the female mold while in the discharge area and transferring the object to one of a plurality of receiving formers each having a shape corresponding to the female mold, the receiving formers being sequentially moved in a stepwise fashion along a track;

sequentially moving the formers at the same time as the one half of the female mold moves into the discharge area and the other half of the female mold moves from the discharge area into the forming area opposite the male die; and

performing at least one processing operation on the object carried by at least one former at the same time as the further object is produced.

2. The method as claimed in claim 1, further comprising moving away the object processed in the receiving former at the same time as the further object is transferred to a receiving former.

3. The method as claimed in claim 1 wherein a plurality of objects are formed.

4. The method as claimed in claim 3, wherein the processing operation comprises stacking the objects.

5. The method as claimed in claim 3, wherein the stacking of the objects from a former occurs simultaneously with at least one other processing operation on the object in another former.

6. The method as claimed in claim 1, wherein the processing operation comprises perforating a base of the object.

7. The method as claimed in claim 1, wherein the processing operation comprises labeling of the object.

8. The method as claimed in claim 1, wherein the processing operation comprises sterilization of the object.

9. The method as claimed in claim 1, wherein the processing operation comprises prefilling the object with a predetermined quantity of a product packed in the object.

on the object using heat from the hot forming.

11. The method as claimed in claim 1, further comprising stabilizing the object on the receiving formers for a time equal to at least seven consecutive thermoforming cycles.

12. The method as claimed in claim 3, wherein the processing operation comprises extracting at least one object for quality control while the object is on the receiving former.

Description

This invention relates to a method and apparatus for the thermoforming of hollow cup-shaped objects such as beakers, goblets, cups, tubs and the like, from a sheet of thermoplastics material, and their removal from the press in which they are produced.

BACKGROUND OF THE INVENTION

As is known, so-called "thermoforming" machines, fall into two quite separate classes depending upon their method of operation; firstly there are thermoforming machines which form and cut the sheet at separate workstations and secondly there are machines which form and cut the sheet at a single workstation. Such machines are used in the production of objects of thermoplastics material, e.g. "disposable" objects, from a sheet of hot pressed material.

This invention relates to a method and apparatus which falls into this second class, in that the shaping or forming of objects and their separation from the sheet of starting material is effected at a single workstation.

The state of the art for thermoforming methods and apparatus incorporating a single forming station, separation from the initial sheet and subsequent removal from the press, is represented by conventional single station machines and those according to U.S. Pat. No. 4,560,339 which will be briefly described hereinafter with reference to FIGS. 1 to 13 of the accompanying drawings, in which:

FIG. 1 is a side view in diagrammatic form of a thermoforming machine having an upper male die and a single lower female mould shown in the open press position prior to forming;

FIG. 2 is a side view of the machine of FIG. 1 shown with the press closed during the forming stage;

FIG. 3 is a view similar to that shown in FIG. 2 with the press closed during the cutting stage;

FIG. 3a is a schematic view of a detail of FIG. 3 shown on an enlarged scale;

FIG. 4 is a side view of the machine of FIG. 3 shown with the press open after the formed object has been cut out but still remains in the press;

FIG. 5 is a similar view to that in FIG. 4 but at a subsequent stage in which the pressed object is removed from the female mould and removed from the pressing area to a stacking collector;

FIG. 6 is a side view of a variation of the machine shown in FIG. 5 having a multiple row of moulds which discharge in bulk to a separate stacker;

FIGS. 7 to 10 show diagrammatic views of another variation of the machine shown in FIG. 5, in which the pressed objects are removed from the pressing area by means of a suction plate which can be placed between the male and female parts of the press;

FIG. 11 diagrammatically illustrates a plate which can lift a plurality of articles pressed in a single pressing operation by suction, used in the machine according to FIGS. 7 to 10;

FIG. 12 diagrammatically illustrates a front view of a thermoforming machine having a single upper male die and a double lower female mould which moves alternately beneath the male die; and

FIG. 13 includes a diagram which illustrates the stages and opening/closing cycle times for a thermoforming press having a single female mould.

The thermoforming cycle in machines which carry out forming and cutting at a single workstation can be described schematically as follows.

Stage 1: Sheet feed with the press open (FIG. 1).

A portion of sheet material A is delivered from a feed role (not shown) and is heated by irradiators B, e.g. infrared sources, and caused to advance between the open portions of the press, that is into the thermoforming area, in the direction of arrow F. The press consists of an upper male part or die M.sub.1 and a lower female part M.sub.2. Both parts M.sub.1 and M.sub.2 may be single or multiple, in which latter case several objects O can be obtained from each pressing operation.

Stage 2: Forming while the press is closed (FIG. 2).

The lower female part M.sub.2 rises against fixed male die M.sub.1 and object O is hot formed by causing rough shaping die M.sub.1p to enter the cavity M.sub.2c of female mould part M.sub.2 and thereafter injecting compressed air or applying negative pressure through a hole FO in male die M.sub.1. The compressed air causes the material A around rough forming die M.sub.1p to adhere to the side wall of cavity M.sub.2c and movable base M.sub.2f thereof. Then cavity M.sub.2c is cooled by a water cooling circuit generically indicated by C, and object O is also cooled and then subjected to a process of progressive structural and dimensional stabilisation.

Stage 3: Cutting (FIGS. 3 and 3a).

In this stage, all the lower part M.sub.2 of the press moves a distance ST, usually 1.5 mm (FIG. 3a) towards upper die M.sub.1, which is sufficient to separate the edge BO of object O from starting sheet material A.

The three stages described above are common to all thermoforming machines which shape and cut at a single workstation, or forming area (see diagram in FIG. 13). However a distinction is made between two classes of thermoforming machines on the basis of the different arrangements used to remove thermoformed objects O from the female mould M.sub.2 and subsequent operations (counting, stacking, etc.). The former have a single female mould M.sub.2, the latter has a double female mould, one on the left M.sub.2c and one on the right M.sub.2d, which are integral with each other, as will be explained below with reference to FIG. 12 and the object of Italian Patent No. 1,073,243.

The cutting stage (stage 3) completes the closed press cycle of operations (FIG. 13).

After this stage, the lower part M.sub.2 of the press descends, or moves away from upper part M.sub.1, following an S-shaped track (FIG. 4) carrying with it formed and cut object O, which therefore moves below the waste starting material A. Subsequently moving base component M.sub.2f of lower mould M.sub.2 ceases its downwards movement while the remaining part of mould M.sub.2 continues to move downward, thus drawing out and releasing object O completely from cavity M.sub.2c of mould M.sub.2.

At this point in the cycle there arises the difficult problem of moving or removing the thermoformed object or objects O from the forming area and stacking them. Various systems have been proposed, and the two most widely in use will be described below.

The first is the air blowing system (FIG. 5) which consists of supplying compressed air along a main CL provided with nozzles U which produce jets G which lift up objects O, causing them to tip slightly or topple into one or more collection channels R. The objects, continuing along collection channel R, become stacked forming a stack P.

This system can however only be used if the objects in mould M.sub.2 are arranged in a single file.

If the objects in mould M.sub.2 are in several rows (multiple files) the air jets G may remove objects O from the area bounded by parts M.sub.1 and M.sub.2 of the press, but they will be discharged in bulk. In order to get these back into order and then stack them, it is necessary to have a suitable stacking device PL (FIG. 6), which is separate from the thermoforming machine, but whose function must be synchronised therewith. This naturally involves heavy additional costs, greater complexity in operation and a high percentage of damaged objects which then have to be rejected.

In thermoforming machines provided with a stacker PL, objects O are "removed" by blowing them out of the forming area and causing them to impact against a stop surface AR before falling into a collecting bin V. At the base of collecting bin V there may be provided, as one of a number of possible systems, a conveyor belt collector TR controlled by a Maltese cross device which has a plurality of panels hinged together, each of which has a hole W.sub.1 which houses one object O. After impacting against surface AR which is orientated with a well-defined inclination, the objects end up by falling into holes W.sub.1 to be then transported intermittently towards a pusher I.sub.p controlled by a toggle E which pushes

This system, which is mentioned here by way of example as one of many similar types, has many disadvantages.

To begin with, only circular objects which are taller than particular minimum dimensions can be stacked. It is not therefore possible to stack objects which are constrained to a specific orientation, e.g. objects of rectangular shape.

Also, in falling and being mixed together in bin V, many objects become deformed or otherwise damaged.

For these reasons the known system illustrated in FIG. 6, and others like it, are now considered to be obsolete.

The second system using a suction plate is illustrated diagrammatically in FIG. 7 to 11 and is the object of Italian Patent No. 1,175,178. During the opening T of the press, which is effected by lower female mould M.sub.2, a suction plate PA is inserted between the upper edge B of thermoformed object O, but blow waste A of the starting material, in such a position that object or objects O can be sucked up when mould M.sub.2 has finished its descent T (press completely open).

Mould M.sub.2 then stops in its lowest position to allow suction plate PA to move away from the area bounded by dies M.sub.1 and M.sub.2 (forming area--FIG. 8), carrying with its objects O to an area adjacent to the thermoforming machine where they are picked up by suckers VS hinged on arms BG of a stacker R (FIGS. 9 and 10). As soon as plate PA reaches the position illustrated in FIG. 8, and is therefore outside the forming area, mould M.sub.2 begins its upwards movement, sheet material A advances by a further step and a new thermoforming cycle is thus initiated. At the same time suckers VS (FIG. 9) takes objects O from plate PA. By means of a rotation of arm BG and a simultaneous rotation about pin Q suckers VS are turned over and carried against a multiple collector R where the objects are stacked into stacks P (FIG. 10).

The difficulties and disadvantages which limit the performance of the extraction system in thermoforming machines with a single female mould are:

1. The very long distance T by which the press must open, which is the sum of the height of the object or objects O and the distance travelled S (FIGS. 4 and 7) plus a specific distance to ensure a reasonable margin of safety (FIG. 7). However, as the time used in moving distance T is time which is of no use to the cycle it will be understood that, other things being equal, the output of the machine will be lower the taller the objects O which have to be removed.
2. Travel S is provided to create the space necessary for plate PA to insert itself between material A and thermoformed object or objects O. Keeping travel distance S short implies creating problems with the size of suction plate PA. Increasing distance S means appreciably lowering the productivity of the thermoforming machine. The definition of track S and the dimensioning of plate PA are therefore always the result of a compromise. However the dimensions of suction plate PA are also governed by the requirement that it must not impede the advance of sheet material A, which being in a heated state, has a tendency to weaken and fall downwards.
3. Keeping the press open for the time required for suction plate PA to enter and leave the forming zone increases the dead time in the thermoforming cycle (FIGS. 7, 8 and 13).

The fact that presses have to stand open for the time required for inserting plate PA between material A and object or objects O which have to be removed, sucking up the objects and removing them (a time which is commonly equal to 30% of the cycle time, i.e. a by no means negligible period) has a greatly adverse effect on the productivity of the machine.

If relatively large objects or small objects in a number of rows are present in mould M.sub.2 then the time for moving plate PA increases, because the distance T which has to be travelled is greater, or because plate PA has to travel a back and forth distance which is at least equal to the width LA of mould M.sub.2 (FIG. 7).

4. The time for which object or objects O remain in the press, that is with their own walls in contact with the cooled wall of cavity of M.sub.2c of mould M.sub.2, is another important parameter which affects the productivity of a thermoforming machine. In fact as soon as mould M.sub.2 reaches the position illustrated in FIG. 4, object O is displaced away from the wall of cavity M.sub.2c and therefore the stabilising cooling of the plastics material which has been subjected to thermoforming ceases. As may be seen from the diagram in FIG. 13, the cooling time t_{st} for stabilisation in the press is the time

4). Normally this time is equivalent to about half the cycle time. When it is necessary to increase cooling time the rate of the thermoforming machine has to be slowed.

5. Because the objects are directly sent to the stacker from plate PA it is not possible to carry out any additional operations (e.g. perforation, labelling or the like) on objects O between the removal operation and stacking.

If it is necessary to carry out additional operations on thermoformed and stacked objects O, the objects have to be repositioned, and this usually means destacking them and sending them to suitable machines to carry out the required operations, with a consequent risk of damaging the objects and producing rejects.

One of the greatest disadvantages of thermoforming machines with suction plate extraction lies in the shape and restricted dimensions of the suction plate itself. In fact, with reference to FIG. 11, it will be noted how the pressure difference, between the external environment and the negative pressure created by the suction through plate PA in the space within thermoformed objects O, creates the force by which objects O are attracted to and held against the plate. It can be said to a good approximation that this pressure difference is equal to the loss of head which air flows $Q_{1/2}$ and $Q_{2/2}$ and $Q_{3/2}$ create when passing through slots FE along edges BO.

Within Plate PA then:

the air in section S.sub.1 will have a velocity $V_{sub.1}$ which will cause a flow Q_1 to pass,

in section S.sub.2 it will have a speed $V_{sub.2}$ which is different from $V_{sub.1}$ and such as to pass a flow $Q_1=Q_2$.

in section S.sub.3 the speed will be $V_{sub.3}$ which is different from $V_{sub.1}$ and $V_{sub.2}$ and such as to cause the passage of a flow equal to $Q_1+Q_2+Q_3$. Ideal operating conditions arise when $Q_1=Q_2=Q_3$. As suction plate PA has to be inserted between sheet material A and the upper edges BO of objects O, its height dimension must be as small as possible so as not to constrain the distance by which the press opens and make it excessively long. In practice therefore it is preferable to use a configuration in which $V_{sub.3}$ is very much greater than $V_{sub.1}$, so that when it is in operation Q_1 is greater than Q_2 , which is in turn greater than Q_3 . This means that the system operates under conditions which are very far from optimum conditions.

In thermoforming machines which have double lower female mould of the type disclosed in Italian Patent No. 1,053,243 and illustrated diagrammatically in FIG. 12, the objects are formed by alternately coupling the two female parts M.sub.2s and M.sub.2d with the single upper male part M.sub.1.

When dies M.sub.1 and M.sub.2 are closed the thermoforming takes place in the manner described above in stages 1 and 3.

With such machines it is possible to obtain advantages in subsequent stages, in that:

- 1) The distance T travelled by the press on opening is independent of the depth or height of the thermoformed objects and may therefore be kept at a minimum value sufficient to feed in material A, with a great reduction in the passive time in the cycle, as is shown in the diagram in FIG. 13.
- 2) The press remains open only for the time necessary to advance sheet material A and effect the alternate lateral movement of female moulds M.sub.2s and M.sub.2d. These operations take place at the same time, without providing any stoppage for removing thermoformed objects O.
- 3) The time for which objects O remain in cavity M.sub.2c with their walls in contact with the mould is longer than the thermoforming cycle (FIG. 13), because objects O remain in close contact with the die from the time of cutting until the next thermoforming operation in the other female mould. In other words the cooling of a thermoformed object O is extended throughout the following stages:

forming, for example in M.sub.1 -M.sub.2s

cutting out

press opening

lateral movement of the double female mould

forming in M.sub.1 -M.sbsb.2.sub.d

The stacking of objects O on these thermoforming machines takes place in stacker R.sub.s in the case of the objects formed in M.sub.2s during forming stage in mould M.sub.2s and R.sub.d in the case of those formed in M.sub.2d.

Base members M.sub.2fs and M.sub.2fd remove objects O by travelling distance C.sub.t (FIG. 12) and stack them alternately pushing the objects formed in female mould M.sub.2s into left hand collection or stacking device R.sub.s and those formed in female mould M.sub.2d into right hand collection or stacking device R.sub.d. Devices R.sub.s and R.sub.d are located to the sides of the fixed part of die M.sub.1. It may happen therefore that objects O which have recessed angular supporting portions (e.g. 2, 3, 4 or more indentations or indented feet located at the same level) provided, as is usual in the art, to prevent one object binding completely within another during stacking, (which would make it impossible for the objects to be then destacked for use), are located in a perfect vertical orientation and alignment, because they all come from the same mould. In this case it will be seen that there is accurate superimposition of two or more consecutive stacked objects, so that the spacing effect of the feet or indentations is neutralised and as a result the objects bind firmly together making it difficult to separate them.

Another cause of poor spacing and therefore of irreversible binding between the stacked thermoformed objects lies in inaccurate forming of the stacking feet or indentations (which generally project towards the interior of the object by a fraction of a millimetre or a little more), as, being made of a thermoplastics material which is therefore dimensionally unstable at the time of forming, these are obtained with fairly wide dimensional tolerances. There will therefore be variations in the connecting angle to both the feet and the base of each object, depending on the nature of the thermoplastics material used, and the shape and depth of the objects being thermoformed, which are unacceptable for correct stacking of the objects.

Objects which do not destack, or which destack with difficulty, require manual intervention, reduce productivity and almost always end up by increasing the number of rejects.

As will be noted, the distance C.sub.t travelled by base members M.sub.2fs and M.sub.2fd depends on the maximum height of the objects O being formed and is therefore longer when the objects are deeper. It is essential in fact that interference between the bottom of object O and the lateral movement and closing of the press is avoided.

FIG. 12 illustrates pins S.sub.p which centre parts M.sub.2s and M.sub.2d with respect to fixed part M.sub.1 as the press closes, through being inserted by a certain amount into corresponding seats Z provided in mould M.sub.2. A.sub.1 also indicates diagrammatically the members which feed or advance sheet material A.

As in thermoforming machines having a single female mould, so in machines having a double female mould, stacking of the objects takes place without there being any practical possibility of carrying out additional operations on thermoformed objects O, as these are gathered into stacks immediately after thermoforming.

SUMMARY OF THE INVENTION

An object of this invention is to eliminate or substantially to reduce the disadvantages described above which arise with known thermoforming methods and machines and forms of extraction.

Another object of this invention is to provide a method for the extraction of thermoformed objects from the forming zone by making use of a suction plate which is not subject to critical dimensional constraints.

A specific object of this invention is to make it possible to carry out a whole series of additional and/or auxiliary operations on the thermoformed objects during each thermoforming cycle, while keeping the objects outside the press in the same mutual positions which they occupied in the forming mould.

Another object of this invention is to provide a substantial reduction in the open press waiting time in order to improve productivity and efficiency.

Another object of this invention is to effect a drastic reduction of up to one half in the height of the press, with a consequent reduction in the masses in movement, the cost of manufacturing the press itself and a substantial increase in the speed of movement or lateral movement of the press.

120
225

Yet another object of this invention is to provide the production of thermoformed objects which may be finished through one or more supplementary operations carried out at the same time as a thermoforming operation before stacking and packaging, without it being necessary to restart processing.

In accordance with a first aspect of this invention, a method is provided for the thermoforming of hollow objects having a base from a sheet of thermoplastics material, which effects in one single predetermined working cycle:

the production of a pressed object by hot forming and cutting out of the object or objects between one half of a movable double female mould which is located in the forming area opposite a male die,

Movement of the female half of the mould, said half carrying the thermoformed object or objects therewithin, towards a corresponding discharge area alternately to one side or the other of the forming area,

removing the object or objects from the female half of the mould in its corresponding discharge area and transferring each object to one of a plurality of receiving formers of a shape corresponding to the mould, which formers can move sequentially in steps along a track,

sequential movement of the formers towards least one workstation or handling station at the same time as the female mould moves back to bring its other half opposite the male die in order to produce a subsequent formed object, and

carrying out at least one processing or handling operation on all the objects carried by at least one former at the same time as the next formed object is produced.

In accordance with a further aspect of this invention there is provided apparatus for the thermoforming of hollow objects incorporating a base from a sheet of thermoplastics materials, comprising

a male die and a double female mould, one half of which mould can move alternately with respect to the other half for mating with the male die in turn while at the same time carrying the object or objects produced previously in the other half of the female mould to an easily accessible discharge area,

a sheet feed to deliver a sheet of thermoforming material in steps between the male and female moulds,

a cutting device which is brought into operation at the end of each closing movement of the press,

a stepwise conveyor having a plurality of plates or formers, each of which is capable of receiving and supporting the object or objects from one forming operation in the same mutual positions which they occupied in the press,

at least one pick-up head capable of lifting one set of formed objects alternately from each half of the double female mould from one side or the other of the male die and of transferring them to a corresponding plate or former on the conveyor and

at least one processing or handling station located along the conveyor for the simultaneous handling or processing of all the objects from at least one forming operation.

BRIEF DESCRIPTION OF THE DRAWINGS

The present invention will be further illustrated, by way of example, with reference to FIGS. 14 to 33 of the accompanying drawings, in which:

FIG. 14 is a front elevational view in schematic form of part of a conveyor utilised in the apparatus of the invention,

FIG. 15 is a plan view of the device of FIG. 14,

FIGS. 16 and 17 are respectively a plan view and a magnified plan view similar to that shown in FIG. 15, but with the pick-up heads in a different stage of the working cycle,

FIGS. 16A and 16B are respectively partial views from above on a magnified scale of the two halves of a double female mould,

FIGS. 18 and 19 are elevational views in schematic form of the thermoforming press in two different stages of operation without the stepwise conveyor,

FIG. 20 is a view from below and on a magnified scale of a portion of the pick-up head,

FIGS. 21A, 21B and 21C show details of FIG. 19 on a magnified scale,

FIG. 22 illustrates a detail of FIG. 14 on a magnified scale,

FIG. 23 is a view similar to that of FIG. 14, but in a different stage in the operating cycle,

FIG. 24 shows a detail of FIG. 23,

FIG. 25 is a front elevational view of a stacker which can be used downstream of the stepwise conveyor, during the loading stage,

FIG. 25A shows a detail of FIG. 25 on a magnified scale showing the manner in which the thermoformed objects are stacked,

FIG. 26 shows a detail of FIG. 25 on a magnified scale,

FIG. 27 shows the stacker of FIG. 25 during the stage of discharging onto a plate,

FIG. 28 shows a detail of FIG. 26 in a position ready for discharging,

FIG. 29 shows the stacker of FIG. 25 in a position for horizontal discharging,

FIGS. 30 and 31 diagrammatically illustrate successive stages in the horizontal discharging of the stacker of FIG. 29,

FIG. 32 shows a variation with respect of FIG. 23, and

FIG. 33 shows a diagram of the thermoforming stages and cycle times for the equipment illustrated in FIGS. 14 to 31, for comparison with the diagram of FIG. 13.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

With reference to the figures listed above, it will be noted that the thermoforming means or press according to this invention comprises a supporting structure 1 on which is mounted a fixed upper plate 2 bearing a male die 3, which in the example illustrated is also fixed, a sliding die-supporting table 4, which is e.g. supported on roller feet suitable for high loads with automatic lubrication (not shown in the drawing) to make horizontal movements (arrow A), and a lower plate 5 which can move in a vertical direction (arrow B--FIG. 18) which is driven by e.g. two toggle units (not shown). Sliding table 4 supports two female moulds (a double female mould) 6 and 7 which are identical and are located alongside each other at the same level, which are intended to be moved by the sliding table 4 alternately beneath the fixed die 3 where they are caused to rise up and mate against the die and successively open by being lowered in order to be moved laterally with respect to the fixed die 3. In other words, mould 6 is moved to the left and mould 7 is moved to the right (as seen in the Figs. in the drawing) with respect to the fixed die 3.

A sheet 8 of thermoplastics material, which may be wound on to a mandrel or be derived directly from an extrusion unit combined with the thermoforming device, is made to advance by means of a chain feed indicated generally by reference numeral 9, in a direction normal to that of the movement of double female mould 6, 7 beneath fixed die 3 but above double female mould 6, 7, in steps, in time with the rate of pressing or forming.

As will be better seen in FIGS. 18 and 19, fixed die 3 may have a plurality of depressions 10 each of which has an open lower end bounded by a free edge 11 (FIGS. 21A and 21B) and houses a corresponding male plug 12 fixed at the end of a corresponding vertical control rod 13 slidably mounted between the upper wall of the fixed die and extending beyond it to meet and be joined to an upper activating bar or plate 14, which is in turn controlled by activating means, not shown in the drawings, e.g. of a type well-known to those skilled in the art. The two female moulds 6 and 7 each have a plurality of upwardly open cavities 15 equal in number to the number of depressions 10 and having the same spacing, in such a way that when a female mould mates with the fixed die each depression or pit 10 accurately mates with a corresponding cavity 15 below.

Centering means comprising e.g. four pins 16 borne by upper plate 2, which are fixed or which can be caused to project to engage in corresponding receiving seats 17 provided in the female mould when the dies are closed together are provided for correct mating between female moulds 6 and 7 and fixed die 3.

227

The base of each cavity 15 is equipped with an extraction device (FIGS. 18, 19, 21A, 21B and 21C) comprising a head 18 which can move upwards as it is controlled by a corresponding rod 19 which is integral with a control bar or plate 20, which is intended to release and push out one or more thermoformed objects 150 from between the press after the dies have opened.

Advantageously, each cavity 15 may have a constriction 21 forming a step around the formed object, the height of which from the base of the cavity defines the stacking height H for formed objects 150 (FIG. 21A).

Lower plate 5 is driven by suitable units (not shown), for example two toggle units, in order to effect the vertical closing and opening movements between female moulds 6, 7 and fixed die 3.

Two eccentrics, which by causing plate 5 to move through a small distance make it possible to cut out and separate the objects from the sheet, may be provided beneath the base of the two toggle units. This operation, as is usual in the art, is carried out during the closure of female moulds 6, 7 against fixed die 3.

Fixed upper plate 2 has two vertical supporting columns 22 and 23 (FIGS. 15, 16 and 17), on each of which is rotatably mounted a corresponding projecting arm 24, 25 which at its free end bears a suction pick-up head 26, 27, which is constructed e.g. in the shape of a bell cup which is closed off at the base by a perforated suction plate 28 communicating with a source of vacuum or negative pressure above in order to draw out the air, such as a suction pump, which is not shown, by means of a flexible conduit 26a and 27a. As may be better seen in FIG. 20, plate 28 has a plurality of through holes 29 placed in an orderly arrangement at a distance from the intersection of longitudinal 30 and transverse 31 suction grooves, advantageously with a spacing equal to that of cavities 15 in female moulds 6 and 7.

Arms 24 and 25 are located on one side respectively of fixed die 3 and are caused to move angularly about columns 22 and 23 between a position in which corresponding pick-up head 26 and 27 is above a corresponding female mould 6 or 7, when this is moved laterally completely away from fixed die 3, and a position outside the thermoforming machine by a corresponding motor/reduction gear unit 32, 33 driven in such a way as to cause pick-up heads 26, 27 to make rhythmical angular movements in time with the back and forth alternating movements of moulds 6 and 7 in order to effect the transfer of thermoformed objects 150, as will be further described hereinafter.

Within the radius of action of arms 24 and 25 there is located a stepwise conveyor 35 (FIGS. 14, 15, 16, 22 and 23), which is formed of two sliding and supporting sides or banks 36, a plurality of plates or formers 37 slidably supported by the sides and drawn at their two opposite ends by a pair of chains 38 which pass round a pair of chainwheels 39 at the ends of the conveyor (FIG. 22). Each plate or former 37 has an intermediate pin 40 providing an articulation to a chain 38 and two lateral rollers or pin 41 and 42 at each end thereof which engage with the chains. Alongside the banks 36 rollers 41 and 42 are free or may run along corresponding straight upper 43 and lower 44 guides or rails, while at the transmission end of the conveyor, pin 40 is caused to follow a circular path around a wheel 39, the front roller (with respect to the direction of movement, e.g. roller 41 in FIG. 22) is caused to follow a track which is also circular along a corresponding fixed guide 45 which has the same radius of curvature as the original curvature of the wheel 39 and the rear roller (roller 42 in FIG. 22) is engaged between two radiused teeth 46 of a wheel 47 which has its own axis of rotation along the line of the wheel 39 and the said pitch line. With this arrangement, at the ends of conveyor 35 each plate or former 37 is returned to a position which is always parallel to the other plates or formers and when in the discharge position is relatively far from the plate or former which preceded it and the one which follows it.

It is therefore possible to provide a treatment or processing station 50 (FIGS. 14 and 23) and a stacking station 51 at the transmission ends of conveyors 35 and possible intermediate treatment or processing stations as will be described below.

Processing station 50 is designed to perform various operations on formed objects 150, which are located in an easily accessible position for working units provided at the said station, while in stacking station 51 the formed objects can be stacked before finally being removed from conveyor 35.

Plates or formers 37 each have a plurality of holes or seats 37a having the same diameter (or a slightly smaller diameter) and the same spacings as cavities 15 in female moulds 6 and 7, so that they can receive the objects obtained from a forming operation transferred thereto by heads 26 and 27. Plates or formers 37 are moved stepwise along an upper track along conveyor 35, along which they receive formed objects 150 from heads 26 and 27 alternatively, are stopped sequentially in a stepwise manner at processing station 50 and are then passed along a lower track to reach stacking station 51.

Treatment or processing station 50 may be designed to carry out any desired additional operation, such

123
228

filling with soluble beverage powders, sterilisation, etc.

In FIGS. 14 and 23, station 50 is illustrated by way of example by a toggle driven drilling head equipped with drilling bits 52 arranged with the same spacing as holes 37a and formers 37 and operated with the same operating rhythm as stepwise conveyor 35.

However any other suitable operating unit capable of carrying out a desired process or manipulation upon the formed objects may be provided instead of or in association with toggle-operated driving unit 50.

Stacking station 51 (FIGS. 14 and 23 to 29) comprises a supporting frame 53 upon which is located the downstream end of conveyor 35, a lower pusher 54 which can be driven in an alternating vertical back and forth motion in time with the stepwise operation of conveyor 35 and having a plurality of pusher heads 55 equal in number to and having the same spacing as holes 37a in formers 37, and a stacker 56 placed above conveyor 35 in vertical alignment with pusher 54. Stacker 56 may be of any suitable type, e.g. having a plurality of parallel tubular rods 57 held together by a frame 58 (FIG. 25) on which is also slidably mounted an upper pusher 59 which can also be driven in an alternating back and forth motion as will be described below.

Each rod 57 is advantageously provided with teeth 60 (FIGS. 26 and 28) which are retractable in that they are hinged about a transverse axis 61 so that they can be moved angularly between a position in which they are withdrawn into the rod (FIG. 28) so that objects 150 can slide between the rods and a position in which they project from the rod (FIG. 26) to engage an edge 151 of an object 150.

As will be better seen from FIGS. 16A, 16B and 25A, it is possible to arrange matters in such a way that female mould 6 produces objects identical to those produced in female mould 7, but having e.g. four feet or indentations 152 offset by a predetermined angle in such a way that given that the stacks of objects at station 51 are formed from objects deriving from mould 6 and mould 7 alternately, because these are loaded onto formers 37 of conveyor 35, the flat part of the base of an object 150 (even when the bottom edge has a relatively large connecting angle) is always brought to rest against a sufficient number of feet 152.

A similar result is achieved if instead of having a different angular orientation of feet 152 in the two female moulds, a different number of feet 152 are provided. This naturally makes it possible to have a perfect stacking arrangement at all times without any risk of permanent or irreversible binding between objects 150 and thus reducing the number of rejects.

Stacker 56 is supported on a trolley structure 62 which can run by means of wheels 63 along a beam or section 64 to transfer a plurality of stacks of objects 150 from stacker 56, e.g. onto a standing and supporting surface 65, which may if desired be capable of being raised and lowered, as shown diagrammatically in FIGS. 25 and 27.

Beam 64 may be rotatably supported around its own longitudinal axis 66 and may have angular projections around it through a toothed section 67 which engages a toothed pinion 68 keyed onto drive shaft 69 of a motor/reduction gear unit 70. With this arrangement, stacker 56 can be inclined through 90 degrees or any intermediate angle thus placing it, for example, in a horizontal position and setting it down onto a supporting platform 71 (FIGS. 29 to 31). Platform 71 is designed to perform a stepwise descending movement (through a transmission 72, a screw 73 and a corresponding nut) to enable a transverse expeller 74 to transfer a row of stacked objects 150 to a cage conveyor 75 which carries the stacked objects to e.g. a packing station.

The functioning of the means described above is extremely simple. When the press is open a predetermined length of sheet 8 is caused to advance by means of chain feed 9 beneath fixed die 3, whereupon female mould 6 or 7 (e.g. die 6) which is located beneath the fixed die is raised and mated against die 3 with the consequent thermoforming of objects 150 and the subsequent cutting thereof. Mould 6 together with mould 7 move downwards to open the press and immediately afterwards mould-bearing table 4 moves laterally so as to carry mould 6 completely away from fixed die 3 and mould 7 beneath die 3 ready for the next thermoforming cycle.

In the meantime pick-up head 26 is moved into the extraction area above female mould 6, which is now completely unobstructed, and as soon as mould 7 closes against the fixed die it removes formed objects 150 from mould 6, which had been previously removed or loosened from cells 15 by heads 18 of the extraction device. Rotating around its column 22 (FIG. 16) head 26 moves above a former 37 on conveyor belt 35 and deposits formed objects 150 into an identical number of holes 37a (FIGS. 15 and 16).

with respect to fixed die 3 into the extraction area and, with a similar movement to that of head 26, transfers formed objects from mould 7 to former 37 on conveyor 35 in a similar way. In this way, head 27 will set objects 150 down on alternate formers on the conveyor. The same will be done by pick-up head 26, but on the formers left unoccupied by head 27, so that all formers 37 are finally filled with objects 150 before they are delivered to processing station 50.

It will be noted that the fact that each formed object is transferred to stepwise conveyor 35 and remains there makes it possible to extend the stabilisation times outside the press considerably, which is an advantageous feature for improving the quality of formed objects 150. In fact in the example illustrated objects 150 are supported on the formers of conveyor 35 for seven or more thermoforming cycles.

From time to time it is possible to sample objects 150 from a former 37 selected at random to check the quality of objects 150 without this producing the slightest disturbance in the equipment's operating cycle.

At workstation 50 the objects are processed or partly filled with powder material, or labelled etc., and are then passed along the lower portion of conveyor 35 towards stacking station 51, from which they are removed in stacks to be delivered for use or to a packing station for delivery. Even while they are moving along the lower portion of the conveyor they undergo prolonged stabilisation, and remain in the same mutual positions as they had in the thermoforming press.

It will be noted how, in addition to providing easy and uniform control of the internal negative pressure over the whole working surface of plate 28, the use of suction pick-up heads 26 and 27 is applicable to all applications and is not dependent on the existence of an edge 151 on the objects being picked up. Also, contrary to the situation in conventional systems, through the use of heads 26 and 27 the movement for extracting objects 150 from the presses is equal to the stacking height H (FIG. 21A).

More particularly, with reference to FIG. 21B when a mould 6 or 7 (e.g. mould 6) is moved into the extraction or discharge position, head 26 is moved into a position above mould 6 at the same time, as already mentioned. The distance h_o which extraction device 18 and 20 has to move for partial extraction of objects 150 before these are picked up by head 26 is effected while part 7 of the press is carrying out another thermoforming cycle. This also applies to the subsequent extraction movements performed by head 27, for its rotation and the deposition of objects 150 and formers 37 and to its return into position above mould 7 so that no dead times are added to any of the forming cycles.

This means that waiting times during which the press is open, which as mentioned above with reference to thermoforming machines with a suction plate which enters into the pressing or forming area itself represents 30% of the thermoforming cycle, are drastically reduced.

It will also be noted how the removal of objects 150 is only partly entrusted to the movement of the heads or bases 18. The objects are in fact removed (FIG. 21C) by means of the movement separating the mould and the plate, partly caused by lowering of the mould and partly by the raising of bases 18. Because these movements take place simultaneously with other dead times in each forming cycle they do not affect the productivity of the equipment.

If a comparison is made between the machine according to the known state of the art in FIG. 11, it will easily be noted that, if

h_o is the height of objects 150,

h_p is the height of control plate 20,

h_a is the length of the approach travel for stacking, and

h_s is the dimension (height) of a double female mould 6, 7, the total height H of a mould M.sub.2s and M.sub.2d in FIG. 12 will be the sum $H_o = h_p + h_o + h_a + h_s$.

The height of female moulds 6 and 7 in FIG. 21B according to this invention is instead $H = h_p + h_a + h_s$, that is H is H_o less than an amount equal to at least the maximum height of the thermoformed objects 150. Because the height H_o of the mould in a conventional machine with stacking is usually slightly greater than twice the height of the thermoformed objects, it can be concluded that the extraction performed by heads 26 and 27 in the appropriate extraction or discharge areas completely outside the pressing area and away from fixed die 3 at least halves the height of female moulds 6 and 7.

The reduction in the height of the moulds brings about an appreciable decrease in their weight, and therefore their inertia, which means that more rapid lateral movements can be performed.

230

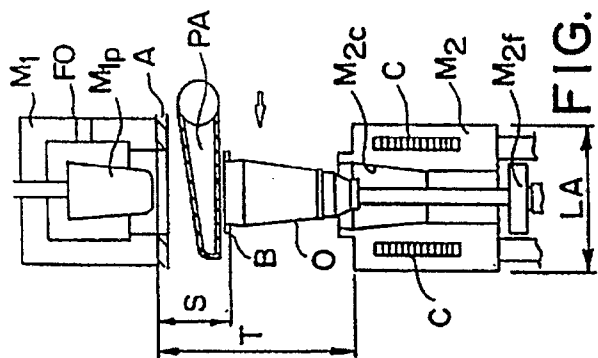


FIG. 7
PRIOR ART

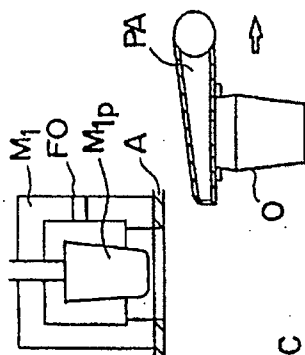


FIG. 8
PRIOR ART



FIG. 9
PRIOR ART

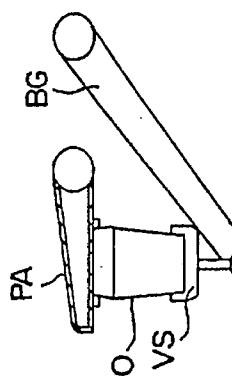


FIG. 10
PRIOR ART

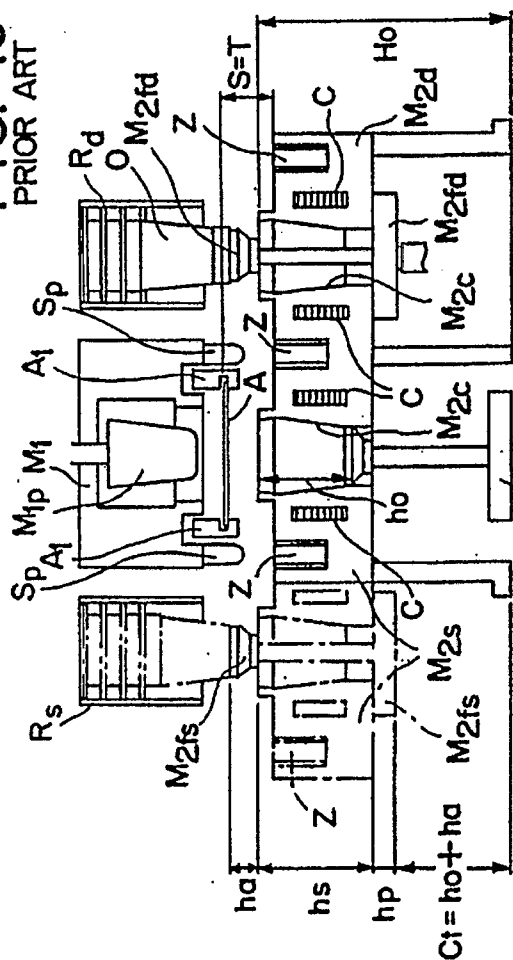


FIG. 12
PRIOR ART

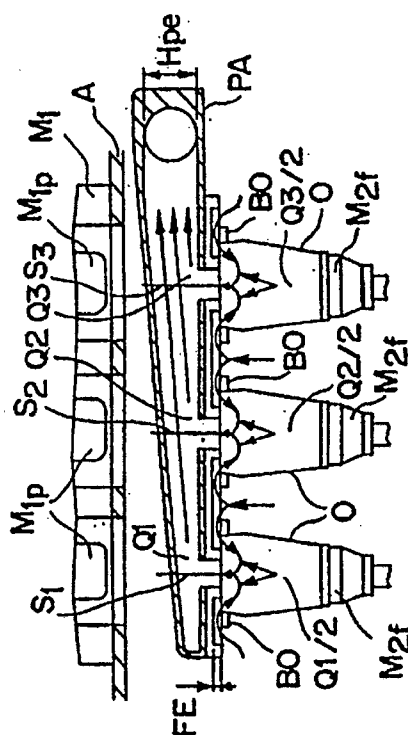


FIG. 11
PRIOR ART

231

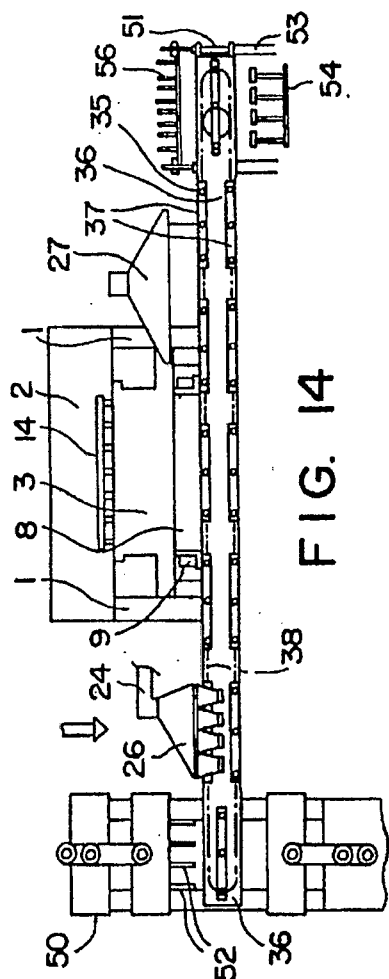


FIG. 14

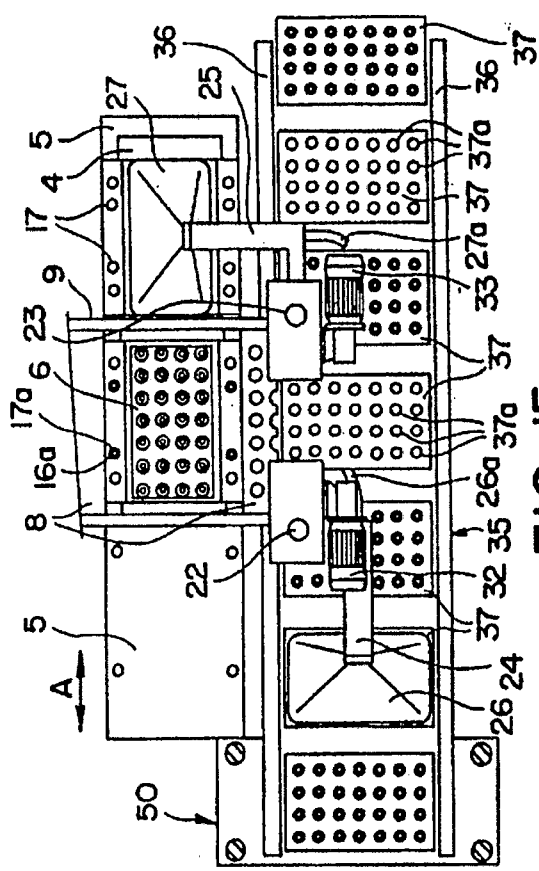


FIG. 15

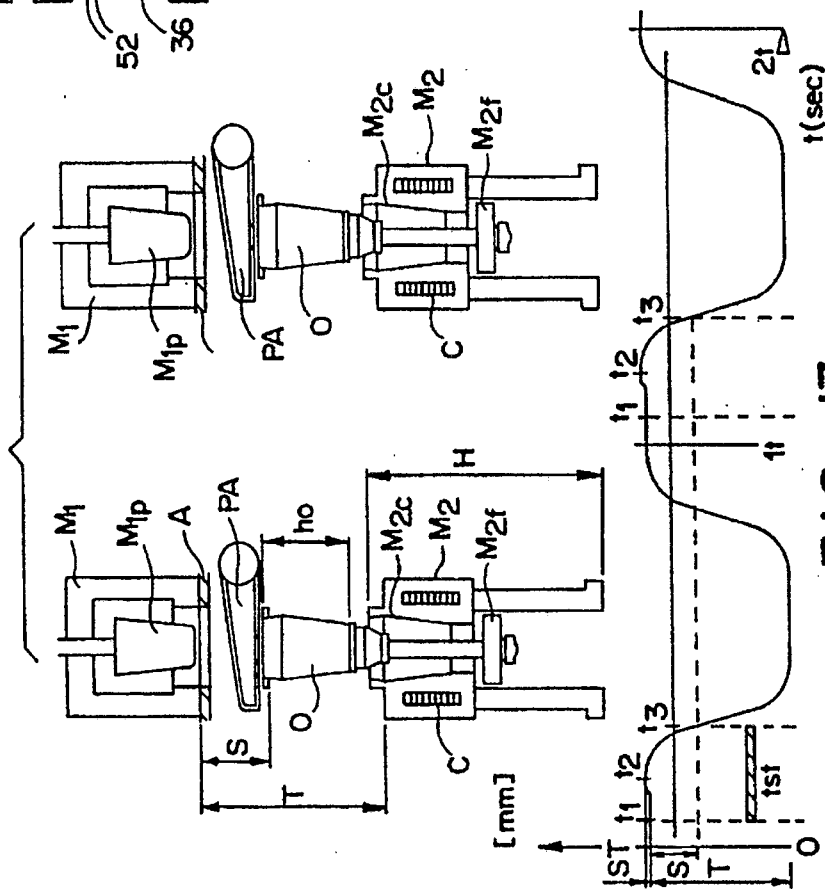


FIG. 13
PRIOR ART

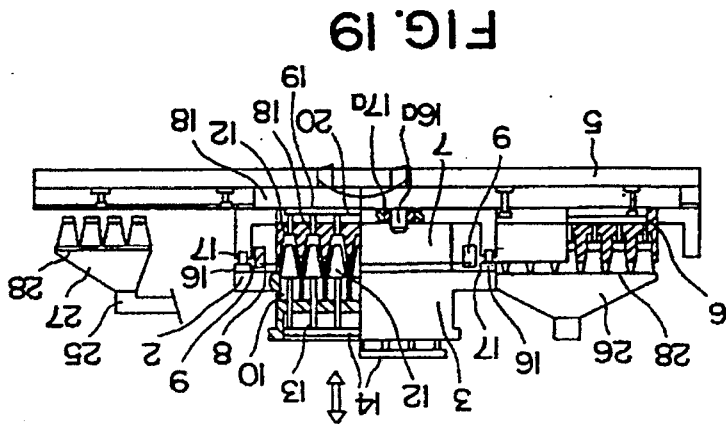
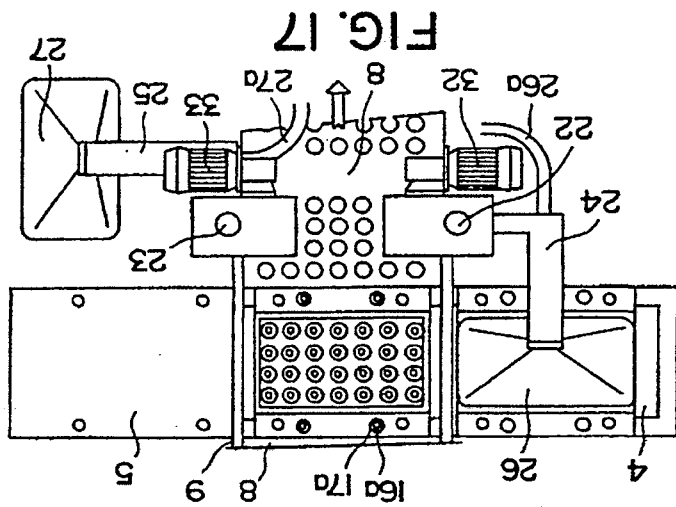


FIG. 18

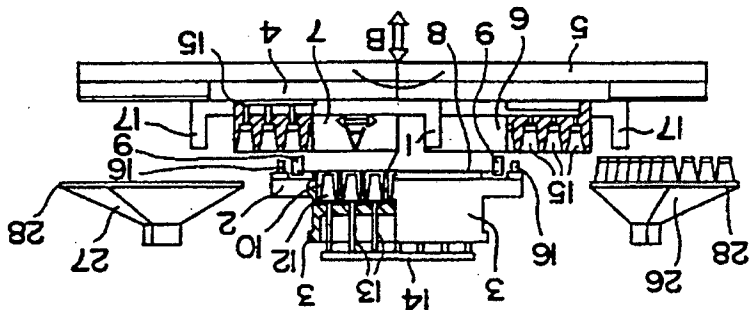


FIG. 16

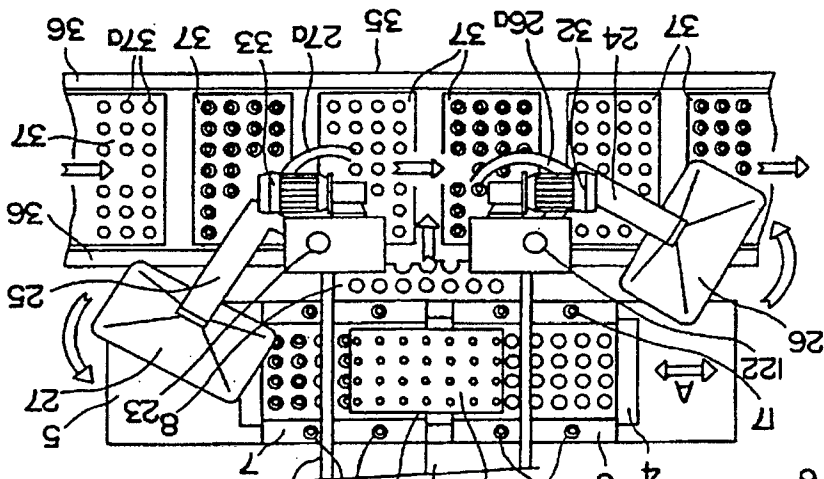
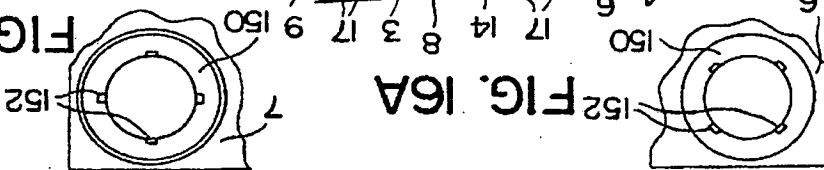
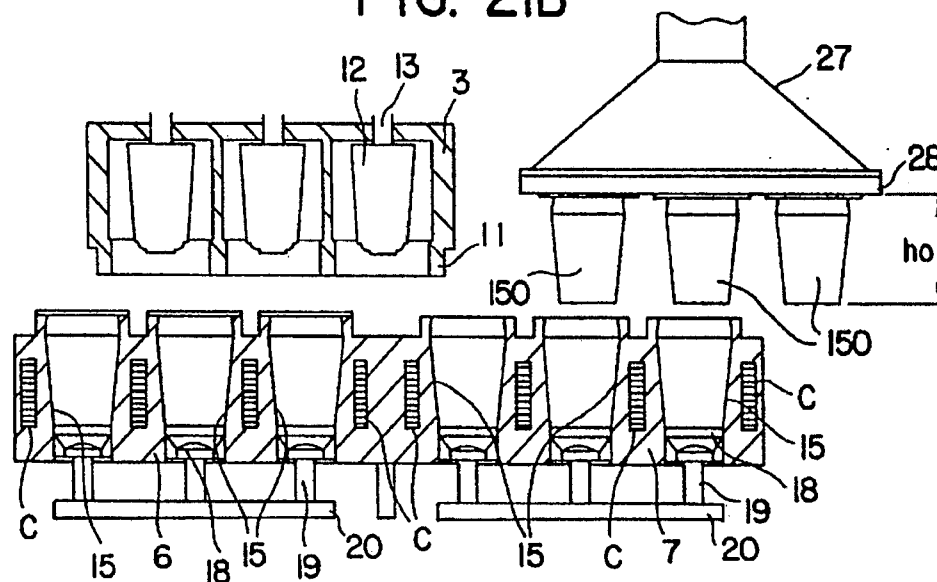
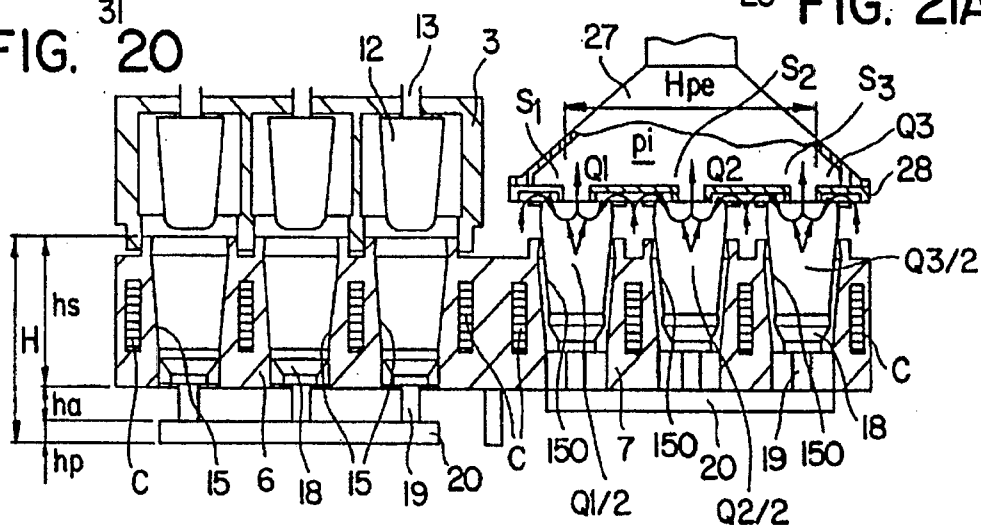
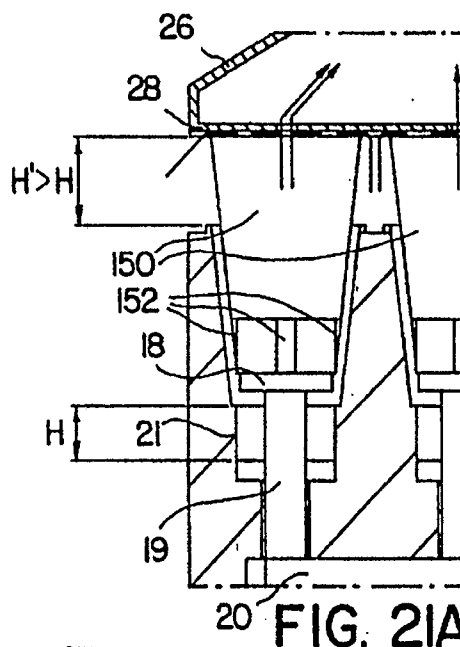
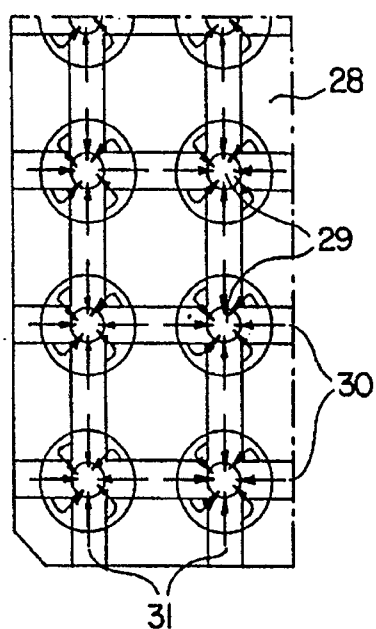


FIG. 16A



178
233



129
234

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Bogota, July 04, 2002

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GRUNECKER, KINKELDEY, STOCKMAIR & SCHWANHAUSSER
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MUNCHEM D-80538
GERMANY

Agte: 06131

CLIENT : BASF AKTIENGESELLSCHAFT
OUR REFERENCE : COLO 00361-801-115-3
YOUR REFERENCE : O.Z. 0050/48085/BCH
PATENT FOR : NEUE B-AMINO UND B-AZIDOCARBONSAUREDERIVATE, IHRE
HERSTELLUNG UND VERWENDUNG ALS
ENDOTHELINREZEPTORANTAGONISTEN
APPLICATION : 98034781 FILED 18 JUNE 1998

Dear Sirs,

1. We refer to your telefax of today regarding the captioned case.
2. Please note that it would only be possible to apply for an extension of 30 days, which means that the non-extendable deadline would be OCTOBER 29, 2002. The total cost for the same is of US\$ 239.
3. Please let us know your instructions at your earliest convenience.

Sincerely Yours,

CAVELIER ABOGADOS

Martha Lucía Rincón
martharincon@cavelier.com

John Bateman
johnbateman@cavelier.com

JBP/MRE/ID-000202/FAXJUL02
F2002-12241

235

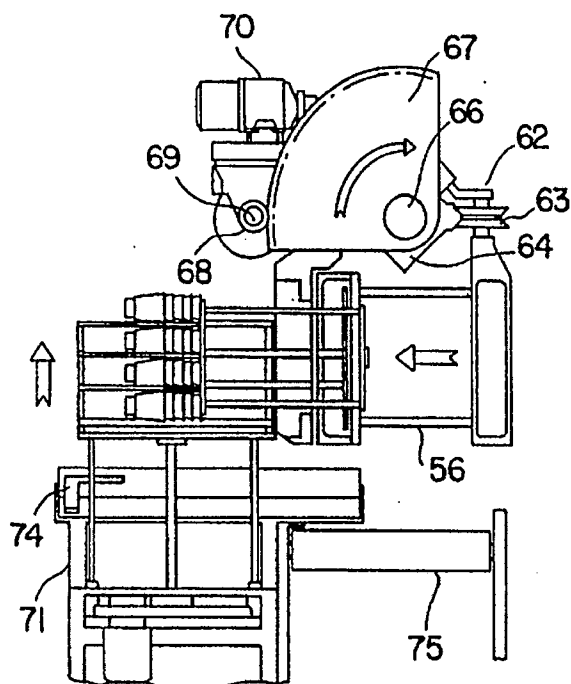


FIG. 29

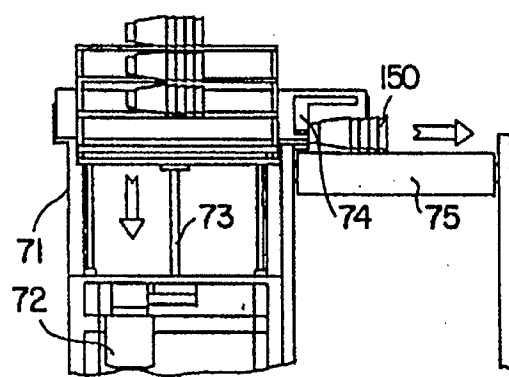


FIG. 30

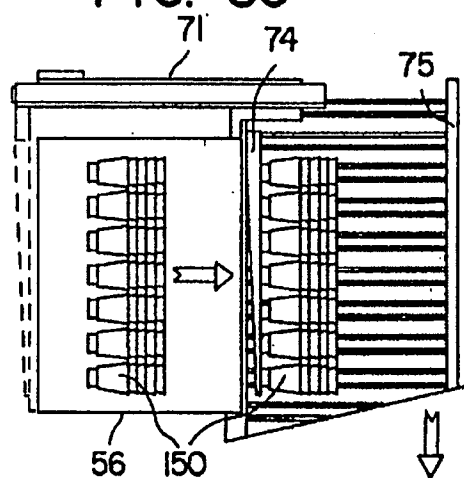


FIG. 31

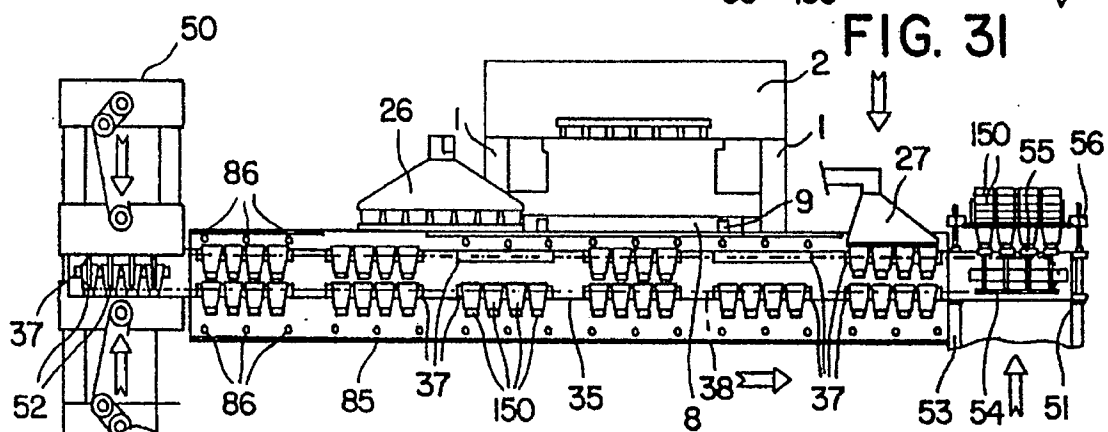


FIG. 32

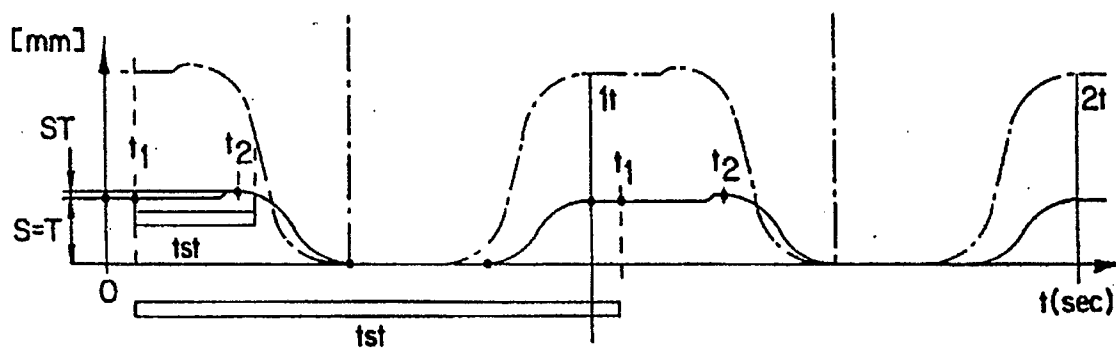


FIG. 33

SUPERINTENDENCIA DE INDUSTRIA Y COMERCIO

RADICACIÓN: 0-53003

EDICTO No. 4743

**LA SECRETARÍA GENERAL AD-HOC
HACE SABER:**

Que esta Superintendencia profirió **Resolución No. 5045 de 28-FEB-2006**. Que el contenido de la parte resolutive es como sigue: El Superintendente Delegado para la Propiedad Industrial.

RESUELVE

ARTICULO PRIMERO: Declarar abandonada la solicitud de privilegio de patente de modelo de utilidad contenida en el expediente de la referencia.

ARTICULO SEGUNDO: Rechazar la solicitud de conversión de patente de modelo de utilidad por patente de invención, de acuerdo con las razones expuestas en la parte considerativa de la presente resolución.

ARTICULO TERCERO: Notificar el contenido de la presente resolución al Doctor Carlos Olarte, o a quien haga sus veces, en su calidad de apoderado de la sociedad Carvajal S.A., entregándole copia de la misma y advirtiéndole que contra ella procede el recurso de reposición ante el Superintendente Delegado para la Propiedad Industrial, del cual podrá hacer uso al momento de la notificación, o dentro de los 5 días hábiles siguientes a ella.

NOTIFÍQUESE Y CUMPLASE

Dada en Bogotá, D.C., a los

28 FEB. 2006

EL SUPERINTENDENTE DELEGADO PARA LA PROPIEDAD INDUSTRIAL,


GIANCARLO MARCENARO JIMENEZ

Para notificar a los interesados, se fija el presente EDICTO en lugar visible al público en la SUPERINTENDENCIA DE INDUSTRIA Y COMERCIO, por el término de (10) diez días hábiles contados a partir de las 8:30 a.m. de hoy.

Secretaría General Ad-Hoc 22-MAR-2006
Secretaría General Ad-Hoc
EDICTO No. 4743

Este edicto se desfija hoy 04-ABR-2006 a las cinco (5:00 p.m.)

