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**METHOD AND APPARATUS FOR
APPLYING A SURFACTANT TO MOLD SURFACES**

CROSS-REFERENCE TO RELATED APPLICATION

5 This application is a continuation-in-part patent application of Serial No. 08/258,263; filed June 10, 1994.

BACKGROUND OF THE INVENTION

10 **1. Field of the Invention**

 The present invention relates to a method of employing a surfactant which is provided in order to assist with the release from each other of mold components of a multi-part mold employed in the molding
15 of polymeric articles; for instance, such as hydrophilic contact lenses, upon completion of the molding process for the polymeric articles.

 The method pursuant to the invention also contemplates the application of the surfactant in the
20 form of a film or coating on surface portions of one of the mold components in order to facilitate the disengagement between the mold components during demolding, and the removal of excess polymeric molding material adhesively deposited on surfaces thereon;
25 which, for example, may be in the shape of rings formed externally of the respective mold cavities for the contact lenses, and which are formed through the displacement of polymeric material from the mold cavity.

 Moreover, pursuant to a further aspect of the
30 invention, there is provided a novel and unique apparatus which is adapted to effectuate the application

1 of a coating or film containing a surfactant to surfaces
of mold components for molding hydrophilic polymer
articles, especially such as hydrophilic contact lenses
or the like. Accordingly, any excess molding material
5 encountered during the molding of the contact lenses
which is expelled from the mold cavities and resultingly
adhesively deposited in the shape of rings on surface
portions between the mold components located externally
about the mold cavities, can be easily and cleanly
10 removed upon heat separation of the mold components in
view of the presence of the surfactant coating or film.
This also facilitates the essentially undamaged removal
of the molded articles from the mold cavities during
separation of the components thereof upon completion of
15 the molding process for the articles.

An extensive array of methods is currently
employed in this technology in carrying out the
manufacture of hydrophilic polymer articles, such as
hydrophilic contact lenses, through the implementation
20 of a considerable variety of processes; among which
there are included spin casting, static cast molding,
lathing, combinations of casting and lathing, and
particularly frequently, through the use of two-part
molds. In the utilization of separable two-part molds
25 for the molding of hydrophilic contact lenses, upon
completing the molding step it is of critical importance
to be able to release the hydrophilic contact lenses
from their surface engagement with and adherence to the
mold parts, or at least one of the mold halves, without
30 causing any damage to the contact lenses upon separating
the mold parts, which would render the lenses unusable.

1 Various concepts employed for effectuating the release
of hydrophilic contact lenses from surfaces of molds,
particularly two-part molds which are intended to be
physically separated, are through the employment of
5 laser or infrared heat mold part separating devices, the
use of external heat and/or the application of heated
gas, hot air or steam. However, all too frequently,
damage is sustained by the contact lenses during removal
thereof from the molds in that the material of the mold
10 parts may exhibit a tendency to adhere and inhibit easy
release upon effectuating separation of the mold parts.
This potential damage which generally renders the
contact lenses unable to meet necessary quality and/or
inspection standards may consist of tears, nicks or
15 other surface defects formed in the contact lenses,
prevalent of which there may be the so-called "piece of
material" (POM) defects caused by excess polymer debris
or particles produced during molding permanently
adhering to the contact lenses upon mold separation.

20 Generally, such mold parts for hydrophilic
contact lenses consist of a curvilinear (concave/convex)
center or front curve mold part adapted to form, in
cooperation with a mating base mold curve part, a two-
part mold for the contact lenses. Hydrophilic contact
25 lenses of the type considered herein are usually
constituted from a hydrophilic polymer, preferably a
HEMA-based polymer (hydroxyethyl methacrylate), although
other suitable monomers may comprise hydroxy ethyl
acrylate (HEA), hydroxy propyl methacrylate, hydroxy
30 propyl acrylate and hydroxy trimethyl ethylene acrylate,
among numerous other applicable materials.

1 The components of the mold within which the
hydrophilic polymer contact lenses are molded may
consist of suitable pallets each including a plurality
of cavities receiving mold parts having female and/or
5 male base surfaces or curvilinear wall portions for the
formation of the curved contact lenses and an annular
rim portion extending thereabout. The molds as
described, for instance in the molding technology, may
be constituted from suitably selected conventional
10 plastic materials, whereby the hydrophilic polymer
articles; i.e. the contact lenses, will possibly adhere
to one of the mold parts through the presence of mold
parts having different properties or being formed of
different materials. The mold parts may consist of
15 plastic materials such as polyethylene, polypropylene,
polystyrene, polyvinyl chloride among other suitable
plastic mold materials, as is known in the technology.

 In order to remove the molded hydrophilic
contact lenses from the respective mold cavities,
20 separation of the mold halves or portions is
implemented, and the formed contact lenses may then be
removed from the mold cavities. Due to excess portions
of the polymeric material of the hydrophilic contact
lenses which are expelled from the mold cavities of the
25 cooperating mold components, and which form ring-shaped
elements of the preferably HEMA-based polymer from which
the contact lenses are made surrounding the exteriors of
the mold cavities, and exhibit tendencies to strongly
adhere to the mold surfaces on which the rings are
30 deposited. These rings make separating of the mold
cavities difficult, resulting in mold breakage and

1 damage to the lenses. Further, the rings, or fragments
thereof, become uncontrollable debris in automated
production lines, contaminating both the production line
and the final lens package. Moreover, the foregoing can
5 also conceivably cause a perfectly "good" contact lens
to be rejected after demolding due to the formed HEMA-
ring or a portion thereof remaining on the front curve
of the mold. This results in uneconomical production
conditions being encountered during the manufacture of
10 such contact lenses.

2. Discussion of the Prior Art

In order to implement the high-speed and mass-
produced molding of such hydrophilic contact lenses,
there have been developed two-part molds incorporating
15 pallet-supported mold structures; for example, as
disclosed in U.S. Patent No. 4,640,489 to Larsen, and
wherein methods of forming shaped polymeric hydrogel
articles, such as hydrophilic contact lenses, are also
elucidated in the disclosures of U.S. Patent Nos.
20 4,680,336 and 5,039,459 to Larsen et al., wherein the
last-mentioned two patents are assigned to the common
assignee of the present application and the disclosures
of which are incorporated herein by reference.

The release of hydrophilic contact lenses from
25 adherent mold surfaces subsequent to the completion of
the contact lens molding process can be facilitated or
improved upon, as is set forth in the disclosure of U.S.
Patent 5,264,161 to Druskis et al. In that instance,
surfactants are introduced in solution into a hydration
30 bath employed in the molding cavities for molding the
hydrophilic polymeric structures or contact lenses. The

1 surfactant which is dispersed in the hydration bath in
concentrations not exceeding 10% by weight aids in
facilitating release of the lenses from adherent
contiguous mold surfaces being separated, with the
5 function of such surfactant being to reduce the surface
tension properties of water or liquids, and to thereby
reduce the level of adherence between components
consisting, on the one hand, of the contact lenses and,
on the other hand, the mold surfaces which become
10 adherent during molding. Numerous types of surfactants
are disclosed in this patent publication, particularly
such as polymeric surfactants including polyoxyethylene
sorbitan mono-oleates, and which are especially suitable
for releasing in an undamaged state any hydrophilic
15 polymer articles from adherent mold surfaces which are
constituted of plastic materials. Nevertheless, the
utilization of surfactants in suspension in a liquid
hydration bath does not provide the desired control over
the release of the hydrophilic polymer articles or
20 contact lenses from the mold surfaces prior to hydration
in the bath and, in particular, does not readily afford
an easy removal of HEMA-based rings of molding material
formed in adherence with mold surfaces extending about
the mold cavities, or a more effortless separation
25 between the mold component, whereby the rate of damage
being encountered by the contact lenses upon mold
separation and removal from the molds is still
unacceptably high and is not readily controllable to a
degree affording a satisfactory economic manufacturing
30 environment.

1 SUMMARY OF THE INVENTION

Accordingly, in order to improve upon the ability of such hydrophilic polymeric articles, especially hydrophilic polymer contact lenses, of being
5 inherently releasable in an undamaged state from the mold cavities of mold structures in which they are molded, the present invention contemplates the provision of a stamping station in a mold filling and assembling machine for the formation of hydrophilic polymer contact
10 lenses which are ordinarily constituted from a HEMA-based plastic material, wherein a plurality of stamping heads each includes at least one stamp for applying a thin layer or film of a polymeric surfactant; in this instance, preferably a polyethylene oxide sorbitan mono-
15 oleate, commercially sold under the tradename "Tween 80", to surface regions extending about the front curve of a mold part for the forming of contact lenses. This surfactant layer, in essence, assists in the separation of a mold part defining a base curve adapted to matingly
20 cooperate with a second mold part defining the front curve for molding a contact lens, and in the removal of excess molding material forming a HEMA-based ring extending externally of the mold cavity for each contact lens from any potential adhesion to the surfactant-
25 coated mold part surface during demolding of the lens.

Pursuant to the invention, the novel stamping station which provides for the application of a thin layer of the polymeric surfactant to the surface portions extending about the front curve of the mold
30 part, such as a flange surface, contemplates the positioning of at least one mold pallet or a pair of

1 mold pallets containing the front curves of a two-part
mold (which are adapted for subsequent mating with mold
parts for molding the contact lens base curves) directly
beneath a stamping head consisting of a plurality of
5 stamps each of which is adapted to engage respectively
one of the surfaces or flange portions extending about
the front curves located on the mold pallet or pallets.
A pad arrangement which comprises a reservoir of the
surfactant; for instance, a polymeric surfactant such as
10 Tween 80, includes a plurality of discrete pads adapted
to be moved beneath the stamping head and permitted to
remain there while the stamps of the stamping head are
moved downwardly into contact with each therewith
associated pad, and then retracted upwardly to allow the
15 pad to be moved out from beneath the stamping head. The
foregoing contacting between the stamps of the stamping
head and the therewith aligned surfactant-impregnated
pad arranged in the surfactant reservoir resultingly
causes each stamp to be wetted with the surfactant; in
20 effect, the Tween 80 surfactant. Thereafter, the
stamping head is moved downwardly towards the mold
pallet or pallets so as to enable the stamps to each
respectively contact a therewith aligned surface or
flange extending about a respective front curve
25 positioned on the mold pallet, thereby depositing a very
thin layer or film of the surfactant of controlled
thickness onto the surface about each respective front
curve. The stamping head with the stamps is then
retracted upwardly and the machine sequences to the next
30 mold pallet or pair of pallets of front curves of a two-
part contact lens mold while concurrently advancing the

1 preceding surfactant-coated front curves on their mold
pallet or pallets towards a station of the machine in
which there is implemented the assembly of the back
curve onto the front curve.

5 Pursuant to a specific aspect of the
invention, the discrete pads for enabling the stamps to
be wetted with the surfactant includes an upwardly
opened reservoir extending substantially across the full
width of the collective stamps, and whereby each of the
10 individual or discrete pads is adapted to be at least
partly immersed in surfactant in the reservoir so as to
absorb the surfactant and enable to be wicked upwardly
through each of the pads. A cover plate sealingly
covers the upwardly opened area of the reservoir and has
15 a plurality of apertures formed therein commensurate
with the number of pads and associated stamps adapted to
contact the latter, so as to form a sealing cover
structure preventing any of the surfactant from spilling
out of the reservoir. This is effectuated in that a
20 seal is interpositioned between the perimeter of the
reservoir and the lower surface of the cover plate, and
the apertures in the cover plate contact the
circumferential edges of each of the pads along their
upper surfaces. In order to enable visual inspection of
25 the reservoir so as to be able to ascertain the level or
quantity of surfactants contained therein, at least
portions of the surface portion of the cover plate, the
latter of which is generally constructed of a metallic
material, may be constructed from a transparent
30 material, preferably such as Lexan (registered
trademark).

1 The application of a uniform thin layer or
film of the surfactant to the various flange surfaces
extending about each front curve of which the molding
cavity has previously been filled with HEMA molding
5 material for the contact lens and then subsequently
matingly engaged by an associated base curve mold part
after applying the surfactant, and on which flange
surfaces there are deposited and adhered thereto HEMA-
based rings of excess material from the molding material
10 for each of the contact lenses, facilitates that
subsequent to molding each contact lens can be removed
from the respective mold cavity thereof during
separation of the mold parts. The layer of surfactant
which is applied or stamped onto the flange surface of
15 the front curve may preferably, although not
necessarily, be within the range of about 0.05 to
0.50 mg of surfactant for each front curve. This
separation of the mold parts; in effect, between the
front curves and base curves, is rendered easier due to
20 the presence of the surfactant layer between the engaged
circumferential edge surfaces of the respective front
curve and base curve mold parts. Moreover, the
surfactant on the flange or surface portion of the front
curve mold part to which the HEMA-based ring of excess
25 contact lens molding material expelled from the mold
cavity adheres, reduces the degree of adhesion and
enables the ready removal of the HEMA-based ring from
each respective surface about the front curve, which
during demolding results in a better than 95% removal
30 rate of the HEMA ring without any damage being
encountered by the contact lenses.

1 In accordance with another advantageous
feature of the invention, the stamping head provides for
a resiliently mounted multiple stamp structure enabling
each individual stamp to "float" or be shiftable to some
5 extent independently of the displacement of the other
stamps in view of a spring-biased mounting construction
for each stamp. This, in effect, will ensure that an
even amount of pressure is applied to the surfaces or
flanges extending about each front curve supported on
10 the mold pallet upon being contacted by a respective
stamp having a surfactant-wetted surface previously
imparted thereto by the pad, so as to cause a uniformly
thick layer or film of an equal amount of surfactant to
be applied about each of the respective front curves.

15 As set forth herein, in accordance with a
specific aspect of the invention, as contained in the
reservoir in a predetermined discretely spaced position,
each pad for applying the surfactant to an associated
one of the stamps of the stamping head may utilize a
20 material structure to constitute a substantially porous
pad; for example, a polyethylene pad; each pad
preferably, although not necessarily, being an
essentially cylindrical member of a surfactant-
absorptive material which is intended to absorb
25 surfactant from the reservoir and wick it towards the
top of the respective pad when the latter is contacted
by the downwardly displaced stamps during application or
wetting with surfactant. A nylon filter, for instance,
having a mesh size within the range of about 0.50 to 2.0
30 microns, and preferably of a 1.2 micron mesh size, is
supported on the top surface of respectively each porous

1 pad, and acts as a metering device so as to permit only
a very minor quantity of the surfactant to pass
therefrom through the nylon membrane filter to the
contacting surfaces on the stamps of the stamping head
5 for forming a thin surfactant layer or wetted surface
thereon. This enables for highly precise control to be
exercised over the amount of surfactant being passed
through the nylon filter to the stamps and, thereafter
upon withdrawal of the pad, to be subsequently deposited
10 by the stamps on the surfaces or flanges extending about
the front curves which are positioned on the mold
pallet.

In comparison with the prior art, such as is
represented by U.S. Patent No. 5,264,161 to Druskis
15 et al., which only discloses utilizing surfactants which
are in suspension in a bath solution for improving upon
the release of molded polymer articles from molds during
separation, the present invention provides an improved
control over the amounts of surfactant being in a novel
20 manner distributed over and deposited on the applicable
surface areas about the front curve mold part, thereby
enabling removal of HEMA-based rings of molding material
adheringly deposited about the front curves, with only a
minimal danger of damage to the lenses being
25 encountered, thereby also rendering the entire procedure
and apparatus highly cost effective and economical in
the manufacture of contact lenses of uniformly high
quality.

Accordingly, it is an object of the present
30 invention to provide an arrangement for depositing
controlled amounts of a surfactant on mold surfaces to

- 1 facilitate the separation of the mold parts, such as
between front curves and base curves, enabling the
removal of HEMA-based rings of excess molding material
adhering to mold surfaces about the front curves, and
5 thereby essentially eliminating contamination of the
production line and the packages upon completion of the
lens molding procedure.

Another object of the present invention
resides in the provision of a method for depositing thin
10 films of surfactants on mold part surfaces to assist in
the separation during demolding of the mold parts, such
as between front curves and base curves utilized for the
molding of contact lenses, enabling the removal of HEMA-
based rings of excess molding material adhering to mold
15 surfaces about the front curves, and facilitating an
essentially undamaged release of the molded contact
lenses, utilizing the arrangement as described herein.

BRIEF DESCRIPTION OF THE DRAWINGS

20 Reference may now be had to the following
detailed description of an exemplary embodiment of a
stamping arrangement utilized for the application of a
polymeric surfactant to surface portions extending about
the front curves of a mold structure for molded
25 polymeric articles, particularly such as hydrophilic
polymer contact lenses, facilitating separation of the
mold parts and removal of any HEMA-based rings of
molding material adhering thereto, taken in conjunction
with the accompanying drawings; in which:

30 Figure 1 illustrates a top plan view of a
typical mold pallet of a two-part mold for selectively

1 supporting thereon either the back or front curves
employed for the molding of hydrophilic polymer contact
lenses;

5 Figure 2 illustrates a perspective view of a
frame assembly of front curves for the molding of
contact lenses;

Figure 3 illustrates a sectional, generally
diagrammatic view through an assembled front curve and
base curve arrangement for molding hydrophilic polymer
10 contact lenses;

Figure 4 diagrammatically illustrates a top
plan view of a stamping station for the application of a
surfactant to stamps on a stamping head and thereafter
for the deposition of a film or quantity of the
15 surfactant onto surface portions on the front curves of
mold parts positioned on contact lens molding pallets;

Figure 5 illustrates an elevational sectional
view of the stamping station and mechanism for
selectively moving a stamp pad arrangement and molding
20 pallets under the stamping head, taken along line 5-5 in
Figure 4;

Figure 6 illustrates a top plan view of the
surfactant reservoir containing the pads of the stamp
pad arrangement;

25 Figure 7 illustrates a sectional view taken
along line 7-7 in Figure 6;

Figure 8 illustrates, on an enlarged scale, a
fragmentary detail of the reservoir taken along line 8-8
in Figure 6; and

30

35

1 Figure 9 illustrates, generally
diagrammatically, an alternate embodiment of a stamp for
applying the surfactant to the lens mold.

5 DETAILED DESCRIPTION

Referring now in more specific detail to
Figures 1 to 3 of the drawings, there is illustrated a
mold frame or pallet 10 of a suitable rigid material
having recesses 16 which are adapted to mount front
10 curve flanges 18 for molding, in cooperation with
suitable base curves 19 each jointly forming therewith a
two-part mold, in this instance, a plurality of eight
hydrophilic polymer contact lenses (not shown). As is
well known in the art as mentioned hereinabove, the
15 material employed for the hydrophilic contact lenses
maybe constituted of a HEMA-based (hydroxyethyl-
methacrylate) or equivalent material.

As shown in Figure 2, another embodiment or
modification of a mold frame or pallet 14 comprises
20 individual concave mold units 12 forming injection
points for the molding material for the plurality of
contact lenses which are to be molded, and is adapted to
mate with convex mold units of a two-part mold. The
frame structure of mold front curves of the two-part
25 mold are somewhat different than those contemplated in
Figures 1 and 3, although surfactant may be applied
thereto in the same manner, as described hereinbelow;
and other variations thereof also readily lend
themselves for use with the inventive apparatus and
30 method.

- 1 Each concave mold unit 12 defines a front
curve 18 for the containment of a monomer material for
the subsequent molding of a contact lens, as shown in
Figure 3. Extending about the front curve is an
5 integral flange 18a, joined to the front curve by means
of an annular lip 18b extending about the mold cavity
filled with HEMA-based lens molding material.

- In order to provide the complete two-part
mold, a second mold part comprising a base curve 19 is
10 subsequently adapted to be matingly superimposed on the
front curve 18, after the latter is supplied with a
molding monomer, so as to form a molding cavity 20 for
forming a contact lens therebetween, with the base curve
19 peripherally being seated on the annular lip 18b.
15 The base curve 19 includes a radially outwardly
extending annular flange 19a, and when parts 18, 19 are
assembled, forms an annular gap with flange 18a, between
which there is received excess HEMA-based molding
material expelled from the molding cavity 20 so as to
20 form a HEMA-ring which adheres to the adjoining flange
surfaces.

- Generally, the mold parts 18 and 19 are
constituted of a suitable plastic material, such as a
polyolefin including low, medium and high-density
25 polyethylene, polypropylene, polystyrene, or other
plastics which are adapted for this purpose; i.e.
molding hydrophilic polymer contact lenses. Preferably,
the mold part 19 is thinner and more flexible than the
mold part 18. Specifics of such mold constructions,
30 including the front curves and base curves for molding
contact lenses, are known in the technology, having

1 reference to U.S. Patent No. 4,640,489 to Larsen, and
are not discussed in more specific detail herein except
as applicable to the invention.

Referring now in greater detail to the
5 embodiment of a stamping station as represented in
Figures 4 through 8, and particularly the representation
of Figures 4 and 5, there is illustrated a stamping
station 30 for applying a thin film or layer of a
surfactant of the type described hereinbelow, to the
10 flange surface 18a of each respective front curve which
is located in each depression 12, 16, respectively, of a
pair of contiguous end-to-end positioned mold pallets 10
as shown in Figure 1 or mold pallets 14 as shown in
Figure 2. Other types of mold pallets, of course,
15 readily lend themselves to the invention, and the
embodiments of the mold pallets are considered to be
only as being generally representative by way of
example.

Caution should be exercised to avoid applying
20 surfactant to the lip 18b itself about the mold cavity,
inasmuch as touching the lip with surfactant may cause a
defect in the lens which is to be molded. The
application of the surfactant layer or film to the
surface 18a of the front curves 18 on the mold pallet 10
25 is intended to assist in the separation therefrom of the
subsequently applied base curves 19 during demolding and
in removing the HEMA-based rings which are adherent
primarily to the surface of flanges 18 between the
annular mold part flanges 18a, 19a at a demolding
30 station subsequent to completion of the lens molding

1 procedure, so as to reduce potential damage to the
contact lenses being released from the mold cavities 20.

As illustrated in Figures 4 and 5, the
stamping station 30 includes a frame structure 32 having
5 a support member or base 34 on which there are
positioned a plurality of spaced downwardly depending
upright guide columns 36. These stationary guide
columns 36 have slide members 38 vertically slidable
therein for supporting components for a stamping head
10 unit 40 so as to be vertically displaceable along the
guide columns. The stamping head unit 40 is mounted to
enable vertical reciprocation of the stamps, as
described below, proximate the upper end of the columns
36 through the intermediary of suitable guide bushings
15 42 and slide members 38, and wherein the vertical
displacement is implemented through suitable actuating
elements or drive units, such as hydraulic or pneumatic
actuators, which are not described in further detail
herein, and which, if desired, may be operated from a
20 suitable control and sensor unit (not shown).

The stamping head unit 40 includes mounted
thereon a plurality of stamps 50 each adapted to be
moved in vertical reciprocatory movement in a
coordinated manner in conjunction with retainer plate
25 element 52 mounted on the stamping head unit 40, wherein
the number of stamps 50 is correlated with the number of
front curves 18 located in the mold depressions 12, 16
formed in the respective mold pallet 10 or mold frame
14. Each stamp 50 consists of a rubber or composition
30 of about 90% urethane and 10% silicone in at least the

1 portions thereof which are adapted to contact the front
curves on the mold pallet 10 or 14.

Mounted on the main frame of the apparatus so
as to be horizontally slidable into and out of position
5 beneath the stamping head unit 40 is a stamp pad
arrangement 60 which is fastened to a frame structure 62
at opposite ends thereof through the intermediary of
suitable fastener members, and whereby the entire frame
structure 62 including the stamp pad arrangement 60 may
10 be selectively moved into and out of position beneath
the stamping head unit 40 through the activation of a
pneumatic cylinder 64 and piston device 66 attached
thereto at one end thereof.

In this instance, the apparatus of the
15 stamping station 30 is of a width so as to be able to
accommodate two of the mold pallets or frames 10 or 14
in contacting end-to-end relationship, in order to
simultaneously accommodate sixteen mold curve parts, as
is clearly indicated in Figure 5 of the drawings, and
20 with the stamp pad arrangement 60 being of a
commensurate length and width in plan view, as shown in
Figures 4 and 5.

In the present instance, in a modification of
the apparatus illustrated in the parent application,
25 Serial No. 08/258,263, rather than having a continuous
stamping pad which is impregnated with the surfactant,
the stamp pad arrangement 60 disclosed herein consists
of a reservoir 70 in the form of an upwardly opening
trough-like structure, possibly containing up to a 6-
30 week supply of surfactant, in which there are fixedly
mounted a plurality of stamp pads 72, each generally of

1 circular cross-section or cylindrical shape, reference
being had specifically to Figures 6 through 8 of the
drawings showing the detailed structure of the stamping
pad arrangement 60. The reservoir 70 is basically
5 constituted of a metallic material, such as for example,
a stainless steel, having a rectangular configuration,
mounted by means of suitable fasteners 74 to the
actuating frame structure 62 which, in turn, is
connected to the pneumatic cylinder 64 and, in a
10 rectangular recessed portion 76 thereof includes a
plurality of the generally cylindrical stamp pads 72
mounted or supported on upstanding pins 78.

The reservoir 70 is covered by a single
generally rectangular flat plate member 80, which may
15 also be constituted of a suitable metal such as
stainless steel and which has a peripheral sealing
member 82, such as an O-ring, positioned to extend
between the upper perimeter of the reservoir, which may
have a suitable groove 84 formed therein for receiving
20 the O-ring or sealing member 82, and the lower surface
of the plate member 80 whereby upon the plate member 80
being fastened to the reservoir 70 through suitable
fasteners 88, such as screws or the like. Apertures 90
are formed in the plate member 80, located to be aligned
25 and commensurate in number with each of the stamp pads
72, and dimensioned to contact the upper circumferential
surfaces of the latter, as shown in Figure 8, and
thereby form a complete sealing arrangement for the
surfactant contained in the reservoir 70.

30 In order to provide visual capability of
inspection that there is an adequate supply of

- 1 surfactant in the reservoir 70 able to be absorbed by
the stamp pads 72, at least one or two surface portions
94 of the metallic plate member 80 may be cut out and
suitable plates 96 of a transparent plastic material,
5 such as Lexan (registered trademark), fixedly positioned
in the cut-out areas.

The upper surface of each stamp pad 72 is
covered by a filter 100, preferably of nylon, having a
mesh size within the range of about 0.5 to 2.0 microns
10 so as to act as a metering device and allow only a
relatively small quantity of surfactant to pass
therethrough as the surfactant is wicked from each stamp
pad 72 to the top thereof upon pads being pressingly
contacted by the bottom ends of the stamps 50 of
15 stamping head unit 40, as described hereinbelow.

The shiftable stamp pad and reservoir
structure 70, 72 through the horizontally displaceable
nature thereof, as shown in Figure 4 of the drawings, is
adapted to be moved between the upright columns 36 and
20 slide members 38 into position below the stamps 50 or
moved outwardly away therefrom when not needed.

The foregoing stamp pad and reservoir
arrangement 60, 70 and its actuating structure 64, 66 is
located at an elevation or height above a mold pallet
25 track (not shown in detail) along which the pairs of
mold pallets 10 or 14 are adapted to be sequentially
advanced into position below the stamping head unit 40,
as shown in Figure 5, in order to enable each of the
stamps 50 to apply a thin film or coating of surfactant
30 to the respective surfaces 18a, 18b of the front curves
18 located on the pallets before being transported

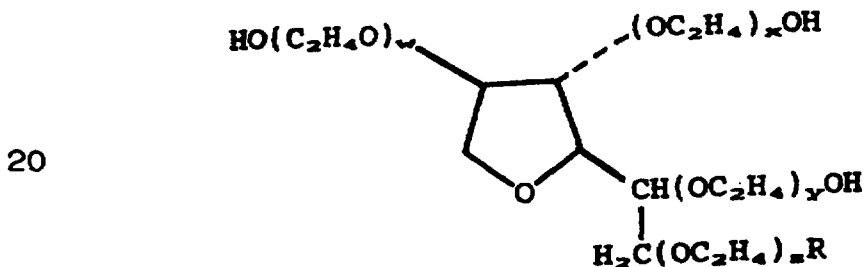
- 1 further along the lens manufacturing system in
connection with the forming of the contact lenses.

OPERATION OF THE APPARATUS

- 5 In order to facilitate the deposition of a
thin film layer of surfactant onto the flange surface
18a of the front curves 18 on the mold pallet 10 or
frame 14 which has been positioned below the stamping
head unit 40, the stamping head unit 40 is maintained in
10 a fully raised position on slide members 38. This is
implemented by means of a suitable lifting cylinder
arrangement (not shown) acting on slide members 38 so as
to be vertically movable within the guide columns 36.
The extent of vertical movement may be controlled by a
15 suitable control and sensor arrangement (not shown).
Each stamp pad 72 in its reservoir 70 is interposed in
spaced relationship between a molding pallet 10 or 14
and the lower ends of the stamps 50 on the stamping head
unit 40, which components are vertically aligned with
20 each other in spaced relationship. This interposition
of the stamp pads 72 is carried out by shifting the
frame structure 62 through operation of cylindrical-
piston device 64, 66 so as to locate the reservoir 70
beneath the stamps 50. Thereafter, the stamping head
25 unit 40 is actuated so as to cause the stamps 50 to be
each displaced downwardly into predetermined contact
with the upper surface of a membrane filter 100 on an
associated stamp pad 72, whereby a certain amount of
surfactant is expelled upwardly through the nylon filter
30 100 and deposited on the lower downwardly facing surface

1 of each stamp 50, forming a thin layer or coating of the
surfactant thereon.

The surfactant contained in reservoir 70 with which each pad 72 is impregnated may be a solution with an almost 100% concentrated strength of surfactant dispersed therein so as to enable forming a layer thereof on the therewith contacting surfaces of the stamps 50. Preferably, the surfactant is constituted of Tween 80 (registered trademark); i.e. a Polysorbate 80. This is basically polyethylene oxide sorbitan mono-oleate or the like equivalent, and consists of an oleate ester of sorbitol and its anhydrides copolymerized with approximately 20 moles of ethylene oxide for each mole of sorbitol and sorbitol anhydrides; of generally the formula:



[Sum of w, x, y, z is 20; R is $(C_{17}H_{33})COO$]

25 In order to ensure that a uniform layer or very thin film of the surfactant is deposited on the surface 18a of each of the front curves 18 which are located on the mold pallet 10 or 14, each stamp 50 is

30 individually resiliently imparted to the action of a suitable biasing spring 104, preferably such as a coil

1 spring encompassing part of a stamp rod 106 supporting
the stamp 50 at a lower end thereof, thereby ensuring
that notwithstanding manufacturing tolerances, a uniform
pressure will be subsequently exerted by the surfactant-
5 wetted stamps 50 against all contacting surfaces 18a,
18b on the front curves 18 which are located on the mold
pallets. Upon the surfactant having been wicked up
through each stamp pad 72, expelled through the
respective nylon filter 100 and deposited on the lower
10 surface of each stamp 50, the stamping head unit 40 and
stamps 50 are displaced upwardly, and the stamp pad
arrangement 60 with its reservoir 70 is moved
horizontally by means of the piston-cylinder device 64,
66 out of the stamping station 30 from its position
15 between the guide columns 36, thereby freeing the space
between the stamps 50 and the therewith aligned front
curves 18 on mold pallet 10 or 14. Thereafter, the
stamps 50 and the stamping head unit 40 are again
shifted downwardly along the vertical guide columns 36
20 by means of slides 38 until the stamps 50 have their
surfactant-wetted lower end surfaces contact the
surfaces 18a, 18b on the front curves 18, thereby
depositing a thin layer or film of the surfactant
thereon, with such layer being at a uniform thickness on
25 each respective front curve surface 18a, 18b due to
resilient biasing forces being exerted by each of the
springs 110 acting on the respective stamps 50.

Subsequently, the stamps of the stamping head
unit 40 are again moved vertically upwardly and a
30 subsequent set of molding pallets 10 or frames 14
mounting front curves 18 advanced into the stamping

1 station of the apparatus, while the preceding molding
pallet 10 or frame 14 which has the front curve surface
thereon already treated with the surfactant is advanced
out of the stamping station so as to be mated with base
5 curves 19, as is known in the art. The process may then
be repeated with the subsequently introduced front
curves 18 on mold pallets 10 or frames 14 in the same
continuous manner.

The foregoing structure enables the deposition
10 of a thin and uniform layer or film of the surfactant
onto specified flange surface 18a of the front curves 18
so as to enable easier subsequent separation of the base
curves 19 therefrom and removal of the HEMA-based ring
material excessed during the molding of the hydrophilic
15 polymer contact lenses, upon completion of the molding
sequence, and in the absence of damage being encountered
by the molded contact lenses being released from the
separated mold parts.

Although in the foregoing described embodiment
20 of the apparatus, each rubber stamp 50 is shown as a
dished element fastened to its associated shaft or rod
element 106 and actuating construction by means of a
screw member 112, having specific reference to Figure 5
of the drawings; pursuant to an alternative embodiment,
25 as shown in Figure 9 of the drawings, rather than being
fastened by means of a screw element, each rubber stamp
120 may comprise an annular ring, with a widening or
wedge-like annular flange portion 122 adapted to be
forced into a similarly configured complimentary groove
30 structure 124 formed in the end of its support rod 126,
thereby clampingly engaging the rubber stamp while

1 eliminating the need for any screw member, the latter of
which could conceivably loosen or fall off during
continuous and repetitive operation of the apparatus.
This press-fitted engagement of the resilient rubber
5 stamp 120 by its flange 122 in the groove 124 ensures
the firm engagement thereof while eliminating a
loosenable fastening component and simplifying the
structure thereof.

While there has been shown and described what
10 are considered to be preferred embodiments of the
invention, it will, of course, be understood that
various modifications and changes in form or detail
could readily be made without departing from the spirit
of the invention. It is, therefore, intended that the
15 invention be not limited to the exact form and detail
herein shown and described, nor to anything less than
the whole of the invention herein disclosed as
hereinafter claimed.

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1 WHAT IS CLAIMED IS:

1. An apparatus for applying a surfactant to at least one surface of a mold part of a two-part mold having said first mold part engageable with a
5 cooperative second mold part for the molding of polymer articles, wherein said surfactant assists in the release between said first and second mold parts and enables removal of excess polymer molding material adherent to said at least one surface of said first mold part; said
10 apparatus comprising:
 - a) support means mounting at least one said first mold part being movable to a predetermined location in said apparatus;
 - b) applicator means including at least one
15 surfactant applicator being arranged in spaced relationship above said support means, said at least one surfactant applicator being positionable in vertical alignment with said at least one first mold part;
 - c) means mounting an upwardly opening
20 reservoir containing a surfactant being interposable between said applicator means and said support means for said at least one first mold part at least one pad member arranged in said reservoir for absorbing surfactant from said reservoir;
 - d) actuating means for imparting a vertical
25 downward displacement to said applicator means to cause said at least one surfactant applicator to contact said at least one pad member and assume a quantity of said surfactant therefrom, said actuating means thereafter
30 imparting a vertical upward displacement to said applicator means; and



1 e) means for displacing said reservoir
mounting means from the interposition thereof in said
apparatus between said applicator means and said at
least one first mold part, said actuating means for said
5 applicator means displacing said applicator means
downwardly to an extent such that the surfactant-wetted
surface portions of said at least one surfactant
applicator contact said at least one surface of said
first mold part so as to impart a coating of said
10 surfactant thereto.

2. An apparatus as claimed in Claim 1,
wherein a cover member is fixedly positioned on said
reservoir at least one aperture being formed in said
cover member in alignment with said at least one pad
15 member to enable said at least one surfactant applicator
to contact said at least one pad member.

3. An apparatus as claimed in Claim 2,
wherein said at least one pad member sealingly contacts
against a lower surface of said cover member adjacent
20 the circumference of said at least one aperture.

4. An apparatus as claimed in Claim 3,
wherein seal means extends about said reservoir and a
lower surface of said cover member so as to prevent
surfactant from spilling out of said reservoir during
25 operation of said apparatus.

5. An apparatus as claimed in Claim 4,
wherein said seal means is positioned in a groove formed
in the lower surface of said cover member.

6. An apparatus as claimed in Claim 4,
30 wherein said seal means comprises an O-ring seal.



1 7. An apparatus as claimed in Claim 2,
wherein said cover member comprises a flat plate having
at least one transparent surface portion to enable
visual viewing of the contents of said reservoir.

5 8. An apparatus as claimed in Claim 7,
wherein said transparent surface portion is constituted
of a rigid transparent plastic material.

 9. An apparatus as claimed in Claim 2,
wherein a plurality of said first mold parts are mounted
10 in predetermined spaced relationship on said support
means each in vertical alignment with respectively one
surfactant applicator of a plurality of said
applicators, a plurality of said pad members being
discretely located in said reservoir each in alignment
15 with respectively one of said surfactant applicators,
and a plurality of said apertures being formed in said
cover member each in alignment with respectively one of
said pad members.

 10. An apparatus as claimed in Claim 1,
20 wherein said applicator means comprises stamping means
and said at least one surfactant applicator comprises a
stamp.

 11. An apparatus as claimed in Claim 10,
wherein said actuating means raises said stamping means
25 upwardly into the initial position thereof subsequent to
imparting the layer of said surfactant to said at least
one surface of said first mold part; and operative means
displaces said support means for said at least one first
mold part and successively conveys further mold support
30 means mounting at least one other said first mold part
into said location in said apparatus.



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1 12. An apparatus as claimed in Claim 11,
 wherein said means mounting said at least one pad member
 comprises operative means for alternately positioning
 said at least one pad member beneath said stamping means
5 and withdrawing said at least one pad member from said
 location in said apparatus to enable said at least one
 stamp to advance downwardly into contact with said at
 least one surface of said at least one first mold part.

 13. An apparatus as claimed in Claim 1,
10 wherein said at least one pad member comprises a porous
 member absorptive of a solution in said reservoir
 containing said surfactant.

 14. An apparatus as claimed in Claim 1,
 wherein an upper surface of said at least one pad member
15 facing said at least one surfactant applicator means is
 covered by a membrane filter having a mesh size with
 openings within the range of about 0.5 to 2.0 microns.

 15. An apparatus as claimed in Claim 14,
 wherein said membrane filter is a nylon filter
20 controlling the amount of surfactant expelled upwardly
 through said filter response to being contacted by said
 at least one surfactant applicator so as to deposit a
 predetermined quantity of said surfactant on contacting
 surface portions of said at least one surfactant
25 applicator.

 16. An apparatus as claimed in Claim 1,
 wherein at least the surface portions of said at least
 one surfactant applicator contacting said at least one
 pad member operatively associated therewith for assuming
30 surfactant therefrom is constituted from rubber or a



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1 compound comprising about 90% urethane and 10%
silicone.

17. An apparatus as claimed in Claim 1,
wherein a plurality of said first mold parts are mounted
5 on said support means, each said first mold part
comprising a front curve for molding a hydrophilic
polymer contact lens and an encompassing flange portion,
each said mold means being operatively aligned with
respectively one of a plurality of said surfactant
10 applicator whereby contact between said front curve and
an associated surfactant applicator transfers a thin
film of said surfactant to a facing surface on said
flange portion about said front curve from said
surfactant applicator so as to thereby at a subsequent
15 demolding operation facilitating detaching of a second
mold part comprising a base curve for said lens and a
ring of excess molding material adhesively deposited on
the surfaces of said flange portion about said front
curve.

20 18. An apparatus as claimed in Claim 17,
wherein said support means for said first mold parts
comprises at least one mold pallet.

19. An apparatus as claimed in Claim 17,
wherein spring means resiliently mount each said
25 surfactant applicator on said applicator means to enable
each said surfactant applicator to floatingly displace
relative to each other upon contacting said respective
front curve so as to ensure an even contact to be
applied to each said front curve and impart a uniform
30 layer of said surfactant to each said front curve.

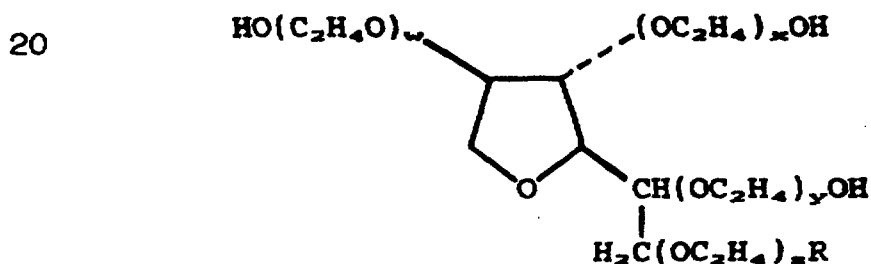


1 20. An apparatus as claimed in Claim 1,
 wherein said at least one surfactant applicator
 comprises an annular member mounted in an end surface of
 said applicator means adapted to face said at least one
 5 pad member and surface on said at least on first mold
 part.

21. An apparatus as claimed in Claim 20,
 wherein said end surface comprises an annular groove for
 clampingly receiving said surfactant applicator.

10 22. An apparatus as claimed in Claim 1,
 wherein said surfactant comprises a polyethylene oxide
 sorbitan mono-oleate.

23. An apparatus as claimed in Claim 1,
 wherein said surfactant comprises an oleate ester of
 15 sorbitol and its anhydrides copolymerized with
 approximately 20 moles of ethylene oxide for each mole
 of sorbitol and sorbitol anhydrides, of generally the
 formula:



[Sum of w, x, y, z is 20; R is $(\text{C}_{17}\text{H}_{33})\text{COO}$]

24. A method for applying a surfactant to at
 least one surface of at least one first mold part of a
 30 two-part mold utilized for the molding of polymer
 articles so as to facilitate disengagement between said



- 1 first mold part from a second mold part and the removal
of any excess molding material present on said at least
one surface on said first mold part, said method
comprising the steps of:
- 5 a) moving support means mounting said at
least one first mold part to a predetermined location;
- b) arranging applicator means including at
least one surfactant applicator in spaced relationship
above said support means, and positioning said at least
10 one surfactant applicator in vertical alignment with
said at least one first mold part;
- c) coating said at least one surfactant
applicator with a layer of surfactant by contacting at
least one pad member located in a reservoir containing a
15 supply of said surfactant;
- d) withdrawing said reservoir containing said
at least one pad member to a position offset from said
at least one surfactant applicator; and
- e) displacing said applicator means
20 downwardly to an extent such that surfactant-wetted
surface portions of said at least one surfactant
applicator contact the at least one surface on said at
least one first mold part to impart a coating of said
surfactant to said surface.
- 25 25. A method as claimed in Claim 24, wherein
said applicator means comprises stamping means and said
at least one surfactant applicator comprises a stamp.
26. A method as claimed in Claim 25, wherein
said stamping means is raised upwardly into the initial
30 position thereof subsequent to coating said surfactant
on said at least one first mold part; and displacing



1 said support means from and inserting at least one
successive support means into position at said location.

27. A method as claimed in Claim 24,
comprising alternately positioning at least one said
5 pad member beneath said stamping means and withdrawing
said pad member from said location to enable said at
least one stamp to advance downwardly into contact with
said at least one surface on said at least one first
mold part.

10 28. A method as claimed in Claim 27, wherein
said at least one pad member comprises a porous member
absorptive of a solution of said surfactant.

29. A method as claimed in Claim 28, wherein
an upper surface of said porous member is covered by a
15 membrane filter having a mesh size with openings within
the range of about 0.5 to 2.0 microns.

30. A method as claimed in Claim 29, wherein
said filter is a nylon filter controlling the amount of
surfactant passed outwardly through said filter in
20 response to pressure exerted thereon by said at least
one stamp upon being contacted thereby so as to deposit
a predetermined quantity of said surfactant on said at
least one stamp.

31. A method as claimed in Claim 25, wherein
25 at least the surface portions of said at least one stamp
contacting said at least one pad member for assuming
surfactant therefrom is constituted from rubber or a
compound comprising about 90% urethane and 10%
silicone.

32. A method as claimed in Claim 25, wherein
30 a plurality of said first mold parts are mounted on said



1 support means forming at least one pallet, each said
first mold parts comprising a front curve and
encompassing flange portion for molding a hydrophilic
polymer contact lens, each said first mold parts being
5 operatively aligned with respectively one said stamp
whereby contact between the facing surface on said
flange portion of the front curve and an associated
stamp transfers a thin film of said surfactant to said
surface from said stamp, thereby facilitating subsequent
10 release of a second mold part forming a base curve for
molding said leans and a ring of molding material
adhesive deposited on said flange surface.

33. A method as claimed in Claim 31, wherein
each said stamp is resiliently mounted on said stamping
15 means to enable each said stamp to floatingly displace
relative to each other upon contacting said respective
surface in the flange about the front curve so as to
ensure an even contact to be applied thereto and to
impart a uniform coating of said surfactant to each said
20 surface.

34. A method as claimed in Claim 24, wherein
said surfactant comprises a polyethylene oxide sorbitan
mono-oleate.

35. A method as claimed in Claim 24, wherein
25 said surfactant comprises an oleate ester of sorbitol
and its anhydrides copolymerized with approximately 20
moles of ethylene oxide for each mole of sorbitol and
sorbitol anhydrides, of generally the formula:

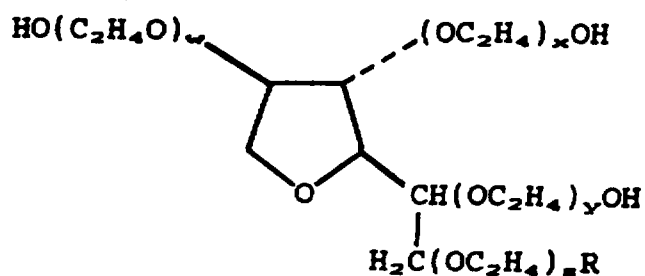
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[Sum of w, x, y, z is 20; R is (C₁₇H₃₃)COO]

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36. A method as claimed in Claim 24, wherein about 0.05 to 0.50 mg of surfactant is applied to each said surface of said one mold part.

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37. A method as claimed in Claim 15, wherein a cover member having at least one aperture for said at least one pad member is sealingly mounted over said reservoir.

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38. A method as claimed in Claim 37, wherein said cover member is provided with transparent surface portions to enable viewing of the contents of said reservoir.

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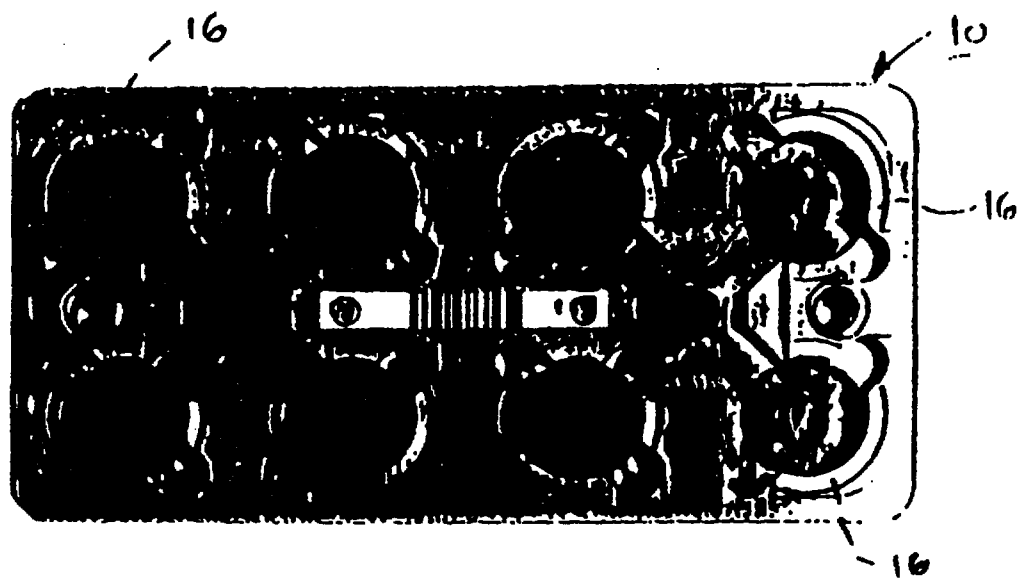


FIG. 1

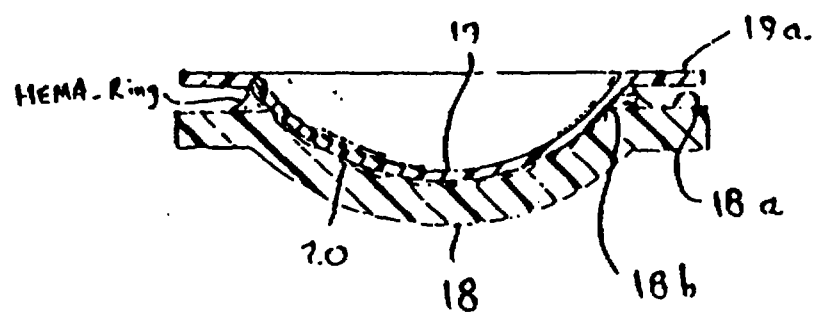
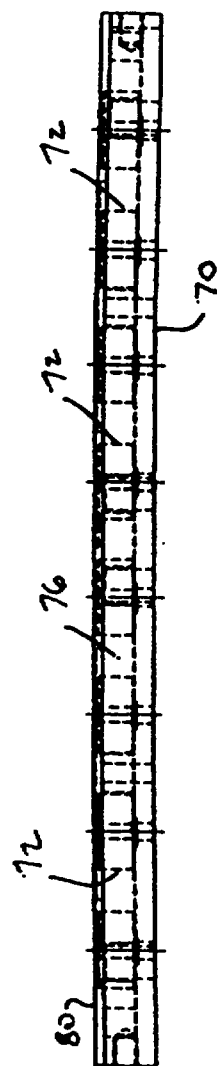
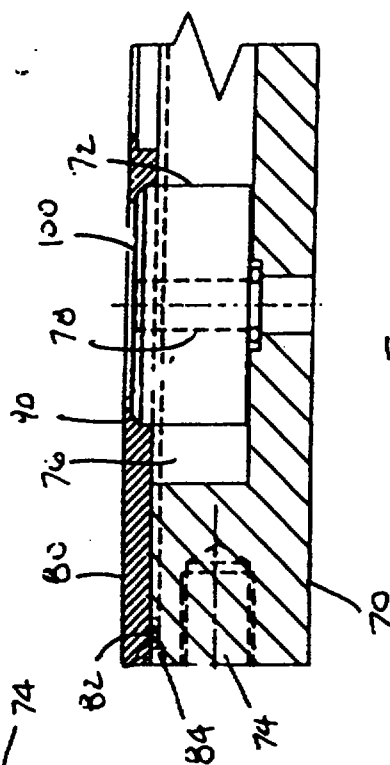
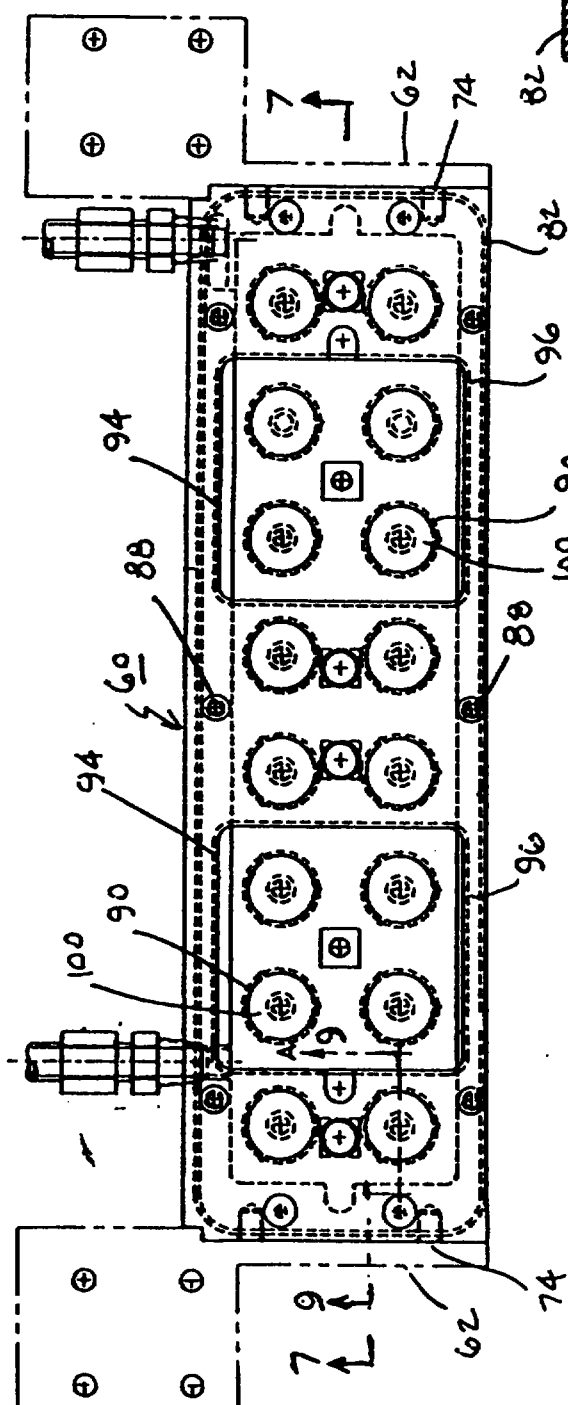
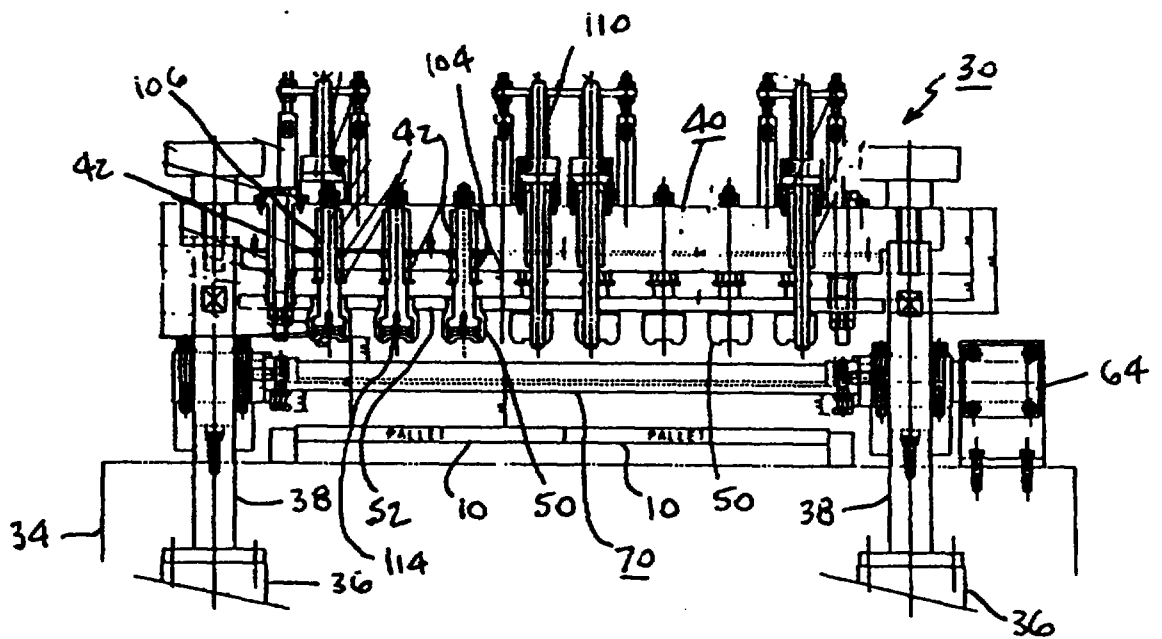
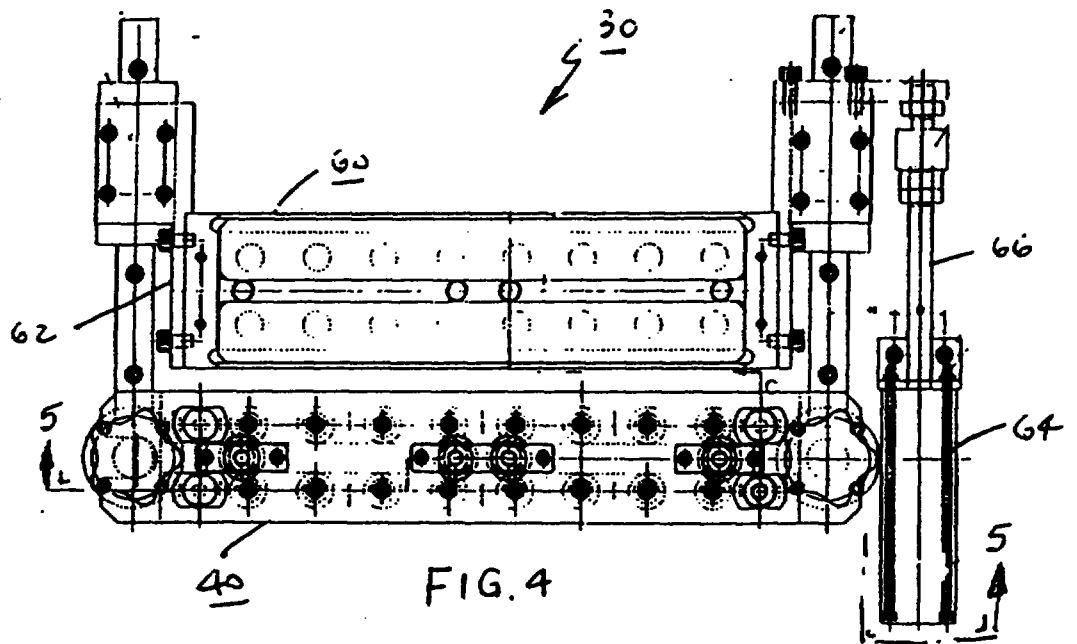


FIG. 3





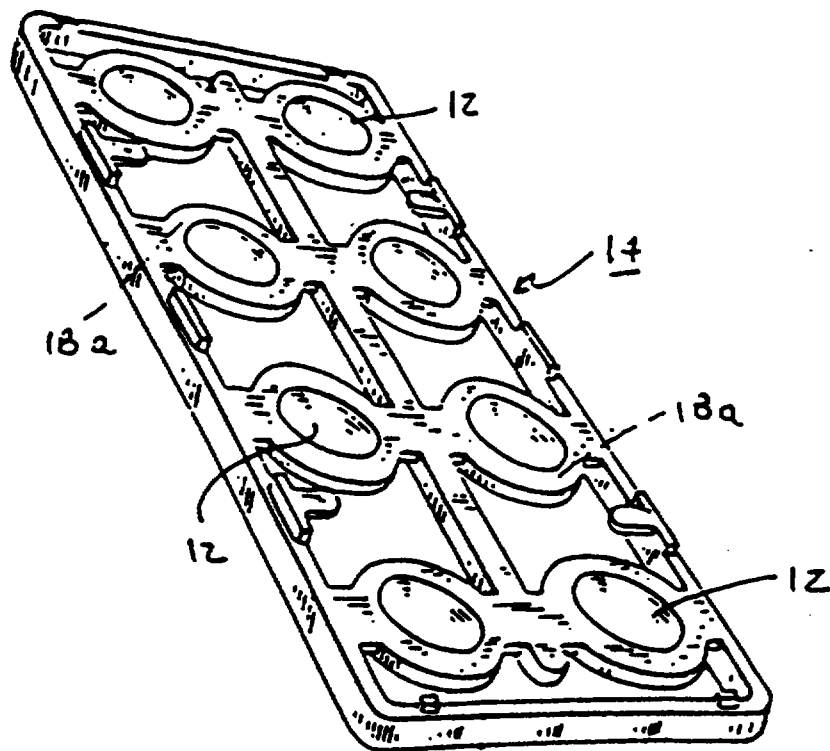


FIG. 2

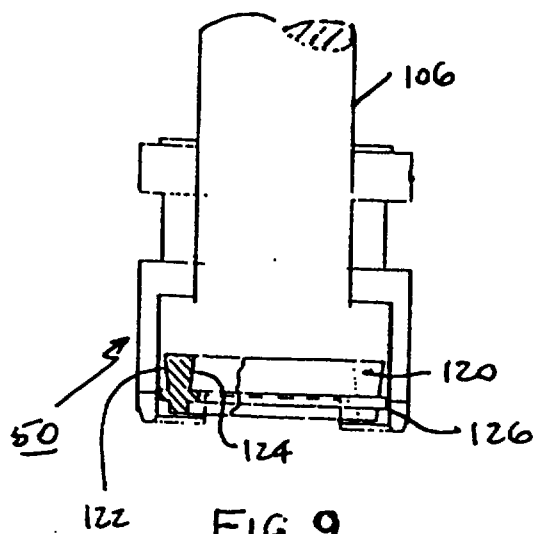


FIG. 9

METHOD AND APPARATUS FOR APPLYING A SURFACTANT TO MOLD SURFACES

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ABSTRACT OF THE DISCLOSURE

A method of and apparatus for employing a surfactant which is provided in order to assist in the release from each other of mold components of a multi-part mold employed in the molding of polymeric articles; for instance, such as a hydrophilic contact lens, upon completion of the molding process for the polymeric articles. The surfactant is applied in the form of a film or coating on surface portions of one of the mold components in order to facilitate the disengagement between the mold components during demolding, and the removal of excess polymeric molding material adhesively deposited on surfaces thereon.

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