

1 AUTOMATED APPARATUS AND METHOD
FOR CONSOLIDATING PRODUCTS FOR PACKAGING

Cross Reference to Related Applications

5 The present application is a continuation-in-part of copending U.S. patent application having Serial No. 08/257,791, filed June 10, 1994.

1. Field of the Invention

10 The present invention relates generally to the field of manufacturing ophthalmic lenses, especially molded, hydrophilic contact lenses, and more specifically to an automated apparatus for consolidating contact lenses for packaging after inspection thereof.

15 2. Description of the Prior Art

 The molding of hydrophilic contact lenses is disclosed in U.S. Patent No. 4,495,313 to Larsen; U.S. Patent No. 4,640,489 to Larsen, et al.; U.S. Patent No. 4,680,336 to Larsen et al.; U.S. Patent No. 4,889,664 to 20 Larsen et al.; and U.S. Patent No. 5,039,459 to Larsen et al., all of which are assigned to the assignee of the present invention.

 These prior art references disclose a contact 25 lens production process wherein each lens is formed by sandwiching a monomer or monomer mixture between a front curve (lower) mold section and back curve (upper) mold section, carried in a two by four mold array. The monomer is polymerized, thus forming a lens which is 30 then removed from the mold sections and further treated in a hydration bath and packaged for consumer use.

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1 U.S. Patent Nos. 5,080,839 and 5,094,609
disclose, respectively, a process for hydrating contact
lenses and a chamber for hydrating contacts lenses
formed with a monomer or monomer mixtures disclosed in
5 the forgoing patents. The process disclosed in these
patents significantly reduces the thruput time by
hydrating the lens and releasing the lens from the mold
cavity with deionized water and a small amount of
surfactant without any salts, so that the time consuming
10 ionic neutralization of the polymer from which the lens
blank is made does not occur during the hydration
process. When deionized water is used, the final step
of the process is to introduce buffered saline solution
into the final package with the lens and then seal the
15 lens within the package so that the final lens
equilibrium (ionic neutralization, final hydration and
final lens dimensioning) is accomplished in the package
at room temperature or during sterilization.

U.S. Patent No. 4,961,820, also assigned to
20 the assignee of the present invention, discloses a final
package for a contact lens, wherein the package is
formed from a transparent plastic material such as
polypropylene and a foil laminate that is heat sealed
thereto.

25 While U.S. Patents 5,080,839 and 5,094,609
contemplate that the entire hydration process and
transfer to final packaging may take place in a fully
automated fashion, and while the chamber and process
described in the foregoing patents enabled automated
30 handling of the lens during hydration, suitable
automated equipment to inspect and handle the lenses at

- 1 high production rates and implement the methods thereof
in a fully automated apparatus was not readily available
or taught by the prior art.

5 SUMMARY OF THE INVENTION

Recent developments in the inspection of
contact lenses produced in accordance with the foregoing
methods has enabled automated lens inspection, as taught
in U.S.S.N. 08/994,564 entitled "Lens Inspection Method
10 and Apparatus", (VTN 0037) (Atty. Docket 9275) assigned
to the assignee of the present invention. Further,
recent developments in the hydration and automated
handling of wet contact lenses, as taught in U.S.S.N.
08/258,556 "Automated Method and Apparatus for Hydrating
15 Soft Contact Lenses" (Docket 8998), also assigned to the
assignee in the present invention, has enabled automatic
robotic handling of lenses during hydration, and prior
to the inspection thereof by the automated lens
inspection system.

20 The removal of lenses, that are out of product
specification, from a serial product stream of contact
lenses generates random variations in the product flow
which must be consolidated prior to packaging.

The present invention therefore provides an
25 automated apparatus for consolidating serial product
flow wherein the product flow includes random variations
in the flow. The present invention provides a
consolidation apparatus for receiving the serial
products from the production line, and then
30 consolidating random variations in the product flow.
The automated robotic handling means then selects and

1 predetermined number and arrangement of product units
and transports that number and arrangement to a
subsequent packaging station for packaging,
sterilization, and final shipment.

5 It is further an object of the present
invention to provide a consolidation apparatus between
two serial production operations, wherein the number and
arrangement of product varies between input and output.
The present invention enables use of a first x,y array
10 of product units merging from a serial production line,
and consolidating those product units into a second x,y
array of units which corresponds to an array used in
second production operation relating to the product.

It is further an object of the present
15 invention to provide a programmable logic controller
(hereinafter PLC) which maintains a status count for
each of the individual products in the consolidation
apparatus of the present invention, including a count
for each random addition of product, and a separate
20 count for each selection and transport of product from
the consolidation apparatus to the final packaging
station.

While the invention is described with
particular reference to molded contact lenses wherein
25 the lens has been molded between a first and second mold
half, as described in U.S.S.N. 08/258,654 "Consolidated
Contact Lens Molding" (Docket 9016) it is understood the
present consolidation apparatus is equally suitable for
the consolidation of lenses formed by lathe cutting
30 wherein the hydrogel is maintained at a dry state while
the desired optical surfaces are cut and polished.

1 Further, the apparatus of the present invention may also
be used in consolidating spin cast lenses which subject
a liquid monomer to centrifugal force in a mold which
has the same shape as the desired optical surfaces of
5 the lens.

The present invention is therefore directed to
a consolidation apparatus for consolidating a plurality
of products having random variations in product
arrangement with gaps between the products, said
10 apparatus comprising

(a) a moving conveyor actuated by driving
means, said conveyor having an input end and an output
end, and said conveyor receiving a plurality of products
with random variations in the arrangement thereof at
15 said input end and conveying said products from the
input end to the output end;

(b) a pair of alignment guides which extend
longitudinally from the input end up to and including
the output end and which align and prevent the lateral
20 movement of the products;

(c) at least one rail mounted parallel and
above the conveyor, under which the products are
conveyed, said rail extending longitudinally to the
output end, said rail being sufficiently superposed over
25 said products to prevent their shingling movement;

(d) a first and second stop means, both
mounted for vertical reciprocation, said second stop
means situated adjacent to the output area, and said
first stop means located at a predetermined distance
30 upstream in the direction of conveyance of the products,
said second stop means in one operative condition

1 blocking the advancement of the products to the output
end to consolidate any gaps between the products and
said first stop means in one operative condition
blocking the advancement of products to said second stop
5 means to enable a predetermined number of said products
to be present between said first and second stop means;
and

(e) sensor means to actuate the vertical
reciprocation of said first and second stop means.

10 The present invention is also directed to an
automated apparatus for controlling the automatic
packaging of contact lenses in a contact lens
fabrication facility, said apparatus comprising:

(a) a first robotic transfer device for
15 periodically transferring a first predetermined amount
of packages of contact lenses having random variations
in product arrangement from a first station to the
intermediate consolidation apparatus;

(b) a consolidation apparatus comprising:

20 (1) a conveyor, said conveyor having an
input end and an output end, said conveyor receiving a
plurality of packages with random variations in the
arrangement thereof at said input end;

(2) means for actuating the conveyor to
25 transfer the packages from the input end to the output
end;

(3) alignment guides which extend
longitudinally from the input end up to and including
the output end of said conveyor which align the packages
30 and prevent the lateral movement thereof;

1 (4) rail guide mounted parallel and
above the conveyor which superpose over the packages
moving on the conveyor to prevent shingling of said
products;

5 (5) a first and second stop means
mounted perpendicular to the direction of conveyance of
the packages and both mounted for vertical
reciprocation, said second stop means situated adjacent
to the output area and said first stop means located at
10 a predetermined distance upstream in the direction of
conveyance of the packages, said second stop means in
one operative condition blocking the advancement of the
packages to the output end to consolidate any gaps
between said packages, and in another operative
15 condition permitting the advancement of the packages to
the output area; and said first stop means separating a
second predetermined number of packages located between
the first and second stop means from the remainder of
the packages upstream; and

20 (6) sensor means in transmittal
communication with a controller, which communicates the
presence of the packages to said controller;

(c) a second robotic assembly for
periodically transferring a second predetermined amount
25 of individual packages from said consolidation buffer to
a second processing station; and

(d) a controller which is in transmittal
communication with said sensor means, said first and
said second stop means and said second robotic assembly,
30 said controller causing the actuation of the vertical
reciprocation of the first and second stop means, and

1 coordinating said vertical reciprocation of both first
and second stop means with the movement of said second
robotic assembly.

Another embodiment of the present invention is
5 directed to the consolidation apparatus being
longitudinally divided into identical sections, each
section having its own set of first and second stop
means, sensor means, alignment guides and said rail
guide.

10 Another embodiment of the present invention is
directed to the consolidation apparatus having at least
two identical sections, each section having its own set
of first and second stop means, sensor means, alignment
guides and rail guides, and each having a second sensor,
15 said second sensor being in transmittal communication
with said controller and transmitting information with
respect to the number of packages being conveyed in each
section to said controller, and identifying a first
section conveying fewer packages relative to a second
20 section which in response thereto, said controller
causes said first robotic device to transfer more
packages to said first section relative to said second
section until said first section conveys about an equal
number of packages as said second section.

25 BRIEF DESCRIPTION OF THE DRAWINGS

The foregoing objects and advantages of the
present invention for an automated apparatus and method
for consolidating products for packaging may be more
30 readily understood by one skilled in the art with
reference being had to the following detailed

1 description of the preferred embodiments, taken in
conjunction with the accompanying drawings, wherein like
elements are designated by identical reference numerals
throughout the several views, and in which:

5 Figure 1 is a diagrammatic illustration of
plural robotic handling means, and a consolidation
apparatus for removing random variations in product
flow.

10 Figure 2 is a plan view of the consolidation
apparatus of the present invention.

Figure 3 is an isometric view of a contact
lens carrier which serves as both an inspection carrier,
and a portion of the final contact lens package.

15 Figure 4 is an isometric view of an inspection
carrier used to transport a plurality of the contact
lens carriers illustrated in Figure 3 through the
automated lens inspection system.

20 Figure 5 is a diagrammatic top view of the
consolidation apparatus of the present invention,
including guide and rail.

Figure 6 is a side view of the rail.

Figure 7a is a cross-section of the output
area of the consolidation apparatus of Figure 2; Figure
7b is a side view of same.

25 Figure 8 is a cross-section of a second stop
means in the consolidation apparatus of Figure 2.

Figure 9 is a cross-section of a first stop
means in the consolidation apparatus of Figure 2.

30 Figure 10 is a cross-section of a sensor used
in the consolidation apparatus of the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

5 The present invention was designed for and is particularly adapted for use in the post hydration processing section of an automated contact lens production facility. Contact lenses molded in an automated production line, such as that described in copending application U.S.S.N. 08/258,654 entitled "Consolidated Contact Lens Molding"; hydrated in a
10 hydration system as described in U.S.S.N. 08/258,556, entitled "Automated Method and Apparatus for Hydrating Soft Contact Lenses"; and automatically inspected as described in U.S.S.N. 07/993,756 entitled "Lens Inspection Method and Apparatus" (VTN 0037) are
15 particularly well suited for consolidation and packaging by the present invention.

The present invention envisions a multi-purpose disposable lens package carrier which transports a contact lens during inspection thereof, and serves as
20 a portion of the final packaging after inspection. Package carrier 20 is illustrated in Figure 3 and is formed from injection molded or thermal formed plastic sheet material, such as polypropylene and includes a planar essentially rectangularly shaped base member 34
25 having an angularly depending wall portion 38 at one end thereof forming a first flange member and a pair of registration flanges 33(a), 33(b), one of which is visible in Figure 3, at the other end thereof which are used to align the package carrier for robotic handling.
30 This package carrier is more fully described in copending application U.S.S.N. 995,607, the disclosure of which is incorporated here by reference thereto.

1 Registration notches 31(a),(b) are provided on either
side of the base 34 to cooperate with registration pins
on various support pallets used in the processing and
packaging operations to register the package carrier and
5 lens for further handling or treatment. Offset from the
center of the package is a cavity 36 integrally formed
therein which is of an essentially semi-spherical
configuration, generally in conformance with a
curvilinear shape of a contact lens (not shown) which is
10 adapted to be stored therein in a sealed condition while
immersed in a suitable sterile aqueous solution in a
manner similar to that described in U.S. Patent No.
4,691,820 to Martinez; which is assigned to the assignee
of the present invention, the disclosure of which being
15 incorporated herein by reference thereto. The height
"h" of flange member 38 depending from the planar base
member 34 is complimentary to the height or depth of
cavity 36, and provides for self-alignment of the
package carrier in cooperation with depending flanges
20 33(a),(b) on specially configured pallet carriers, as
will hereinafter be described. Depending flange 38 is
also used in the final packaging of the product in
cooperation with a plurality of generally "chevron-
shaped" ridges 32, which will assist the end user in
25 gripping the package while peeling open a foil laminate
cover.

The cavity 36 also includes a plurality of
tick marks 37 which are used to assist in holding a
contact lens in the centered position in the cavity
30 during the removal of deionized water at one of the post
hydration processing stations. The package carrier is

1 also equipped with an annular flange 39 which is used
for heat sealing a foil laminate cover in order to
provide a hermetic seal for the contact lens during
final distribution. A cut-out 35 may optionally be
5 provided to facilitate gripping the flange 38 and the
package when the cover stock or foil laminate is removed
for consumer usage.

Base member 34 also includes a smooth planar
surface 34(a) to provide a suitable engagement zone for
10 vacuum grippers on the upper side, and a vacuum rail on
the lower side, which are used to transport the package
carrier during various stages of the operation.

An inspection carrier for transporting the
package carriers through the automated lens inspection
15 system is illustrated in Figure 4. The inspection
carrier 10 includes a first and second row 10(a), 10(b)
of cavities 40 which receive the bowl 36 of the package
carrier and provides an optical sight path for the
automated lens inspection system. Each of the
20 intermediate registration pins 41 engage a package
carrier on either side, with the end registration pins
41(a) engaging a single package. These registration
pins provide for precise registration of the package
carrier in the longitudinal dimension of the inspection
25 carrier while a pair of hard edges 42(a), 42(b) provide a
reference surface for the downwardly descending flanges
33(a), 33(b), which together with pins 41 register the
carrier package against rotational skewing. The
inspection pallet 10 is further provided with three
30 registration openings 43 on either side of the pallet
which are used to transport the pallet through the

1 automatic lens inspection station and to lock the pallet
in place during loading and unloading of the package
carriers. The inspection pallet is further provided
with a pair of grooves 44(a), 44(b) which provides a
5 positive grip for an overhead transport mechanism that
places and then removes the inspection pallet from the
automatic lens inspection system. A pair of slanted
faces 45 provides clearance for the downwardly
descending flange member 38 of the package carrier 20.

10 Figure 1 is a diagrammatic illustration of the
automated apparatus of the present invention used to
consolidate serial product flow when the serial product
flow has random variations therein. While prefigured 2
X 8, 2 X 5 and 4 X 8 arrays are used in the description
15 of the present invention, it is understood that a
variety of arrays and configurations may be used in the
practice of the invention described herein.

As illustrated in Figure 1, an inspection
pallet 10 carrying sixteen product articles 20, arranged
20 in a 2 X 8 array 20(a) is transported in the direction
of arrow A from an automated inspection system that has
separately reviewed each of the products 20 according to
a predefined product criteria. Pallet 10 travels on a
conveyor 12(b) through each of the three positions
25 10(a), (b) and (c) illustrated in Figure 1. After the
products have been removed from the inspection pallet
10, as indicated in 10(c), the empty inspection pallets
are returned via return conveyor 13 to be refilled with
product.

30 A robotic handling device 200 is positioned
adjacent conveyors 12, 13 and has mounted thereon a

1 2 X 8 vacuum array 202 having sixteen independently
actuatable vacuum gripping means mounted thereon.
Pallet 10(b) is conveyed along conveyor 12 to a
predetermined product pick point, as illustrated in
5 Figure 1 and the 2 X 8 array 202 is positioned
thereabove to remove each of the sixteen products from
the inspection carrier 10(b). As illustrated in Figure
1, products 20(b), (c) and (d) have been marked with an
"X" to diagrammatically illustrate the removal of flawed
10 or out spec products. In the practice of the present
invention, a programmable logic controller ("PLC") is
used to control the various elements of the present
invention and receives a datablock from the automated
inspection system having a flag set for each of the
15 products 20(b), (c) and (d) that are flawed or out of
spec.

After the products 20 have been removed from
the inspection carrier 10(b), the robotic transfer
device 200 positions the 2 X 8 array over conveyor belt
20 14 and selectively discharges the products 20(b), (c)
and (d). Those products are then removed by conveyor 14
for subsequent destruction or recycling.

The robotic device 200 then places the
remaining products on a consolidation buffer apparatus
25 995 with product array of 20(d). The products are
placed on the input end 996. The product array of 20(d)
includes gaps or random variations in the product flow
resulting from the removal of the out of spec products
20(b), (c) and (d) from the serial product flow. The
consolidation apparatus 995 includes a conveyor
30 connected to actuating means which drives the conveyor.

1 The conveyor runs underneath the products 20d and
advances the packages from the input end 996 in the
direction of arrow C to the output end 915.

The consolidation apparatus may be subdivided
5 into several sections extending longitudinally from the
input end 996 to the output end 915 each conveying its
own stream of products. As shown in Figure 1, the
consolidation apparatus is subdivided into two sections,
each conveying its own set of products with random
10 variations and each consolidating its own set of
products in accordance with the description herein.
Each section of the consolidation apparatus includes
alignment means on the conveyor which align the
packages, and each section has a rail mounted above the
15 conveyor, which superposes over the packages and
prevents shingling movement thereof. In addition, each
section has a stop means, identified as 904(a) in one
section and 904(b) in the second section. Each is
mounted above the conveyor for vertical reciprocation,
20 and when each is down, it blocks the advancement of the
products to the output end 915. When each stop means
904(a) and 904(b) is blocking the advancement of the
products, the lead products in each section stop its
forward movement on the moving conveyor, and the
25 products immediately behind it also stop their forward
movement when they come in contact with the lead
product. This process continues until eventually the
gaps between a predetermined number of packages are
filled and these packages are consolidated.

Both sections also have another stop means
30 identified as 907(a) in the first section and 907(b) in

the second section. These stop means 907(a) and 907(b) separate a predetermined number of packages from the remainder of the packages upstream in each section.

5 These predetermined number of packages lie between 907(a) and 904(a) in the first section and 907(b) and 904(b) in the second section. In Figure 1, the predetermined number of packages is five, so that an array of five packages lie between the two stop means in
10 each section.

The stop means 904(a) and 904(b) are coordinately raised so that a 2 X 5 array of packages are advanced to the output end 915. When these predetermined number of packages are advanced to the
15 output end, stop means 904(a) and 904(b) are lowered so that no additional products can be advanced. Once a full array of lens packages are disposed in the output end, a second robotic assembly 650 equipped with an array 658 which contains ten vacuum gripping means in a
20 2 X 5 matrix is used to remove the packages from the output end 915. The 2 X 5 array 658 is positioned over products 20f and the vacuum gripping means is actuated to withdraw the first ten products to the saline solution injector and foil wrapper sealing assembly 700
25 where the packages are filled with saline solution and sealed with a foil wrapper.

The present application focuses on the consolidation apparatus which is described in greater detail hereinbelow. The steps outlined hereinabove,
30 with respect to post-hydration, are described in greater detail in copending application U.S.S.N. 08/431,633,

entitled "Contact Lens Transfer Device" (Attorney Docket 9402/9010Z), and the contents are incorporated herein by reference.

5 Focusing on the consolidation apparatus 995 reference is made to Figures 2 and 5 through 11. Reference is especially made to Figure 5, which represents a top view of the consolidation package.

10 Although the figures show two rows of the lens packages, represented by pallet 20 and identical sections of the consolidation apparatus having two sets of elements, it is to be understood that the embodiment is shown only for illustrative purposes, and that the consolidation apparatus may have any number of sections,
15 each having all of the elements described herein.

 The lens packages are deposited on a conveyor 998 at the input end, connected to a motor (not shown) which continually drives the conveyor and which advances the product array in the direction of the arrow
20 illustrated in Figure 1.

 Although any conveyor normally used in the contact lens manufacturing industry can be utilized, it is preferable that a belt conveyor be utilized. The conveyor is made up of material that is normally used in
25 this art, taking into consideration the weight of all of the objects that rest on the conveyor during the process, the forces of friction between the moving parts, the speed of movement of the conveyor belt and the ability of the material to withstand the stress
30 and/or tension created therefrom. Normally, the conveyor consists of a rubber or metal belt operating over a suitable drive (not shown) tail and bend

1 terminals (not shown) and over belt idles or slide beds
(not shown).

Each row of lens packages is transported by
the conveyor. The conveyor 998 is divided into two
5 parallel channels 997(a) and 997(b). One row of lens
packages is conveyed downstream between guides 901(a)
and 901(b), while the other row of lens packages is
conveyed downstream between guides 901(c) and 901(d).
These guides extend longitudinally down the conveyor
10 from the input end 996 to the outward end 915. Inasmuch
as there is no difference between the series of steps in
each row, reference for purposes of discussion will
refer to the conveyance of one set of products down just
one of the channels.

15 At the input end 996(a) the distance between
the upper guide 901(a) and lower guide 901(b) is longer
than the length (and width) of each of the packages in
order to provide ample space for the robotic deposit 200
to place the packages onto the conveyor belt. At a
20 position downstream in the direction of flow, at 908(a)
and 908(b), the guides become tapered relative to each
other so that the lens packages fit perfectly
therebetween as they are transported by the conveyor
down the guides.

25 The tapered guides align the products in the
array so that they are all facing the same direction and
are all moving down the guides parallel to one another.
The tapered guides also prevent lateral movement of the
products.

30 In addition to the guides, there is a rail
902(a) which runs parallel to the conveyor and is

1 mounted on a frame above the conveyor. Rail 902(a)
longitudinally extends past a first stop means 907(a) to
a second stop means 904(a), which is a partition to the
output end 915. The rail 902(a) is a hold down bar
5 which is superposed over the smooth planar surface 34(a)
of the packages 20. When the packages slide under the
rail, shingling movement, i.e., up-down movement, of the
packages is prevented. A side view of rail 902(a) is
shown in Figure 6.

10 Thus, the lens packages are transported along
the conveyor between tapered guides 901(a) and 901(b)
and under rail 902(a). As they slide downstream on the
conveyor, they will pass a first stop means 907(a) which
reciprocates perpendicular i.e., vertically, with
15 respect to the movement of the packages on the conveyor.

The first stop means is illustrated in Figure
9. It comprises a vertically aligned plate or rod 970
having one of its facial planes perpendicular to the
axis of motion of the conveyor 995. The plate 970 is
20 powered by a pneumatic cylinder 951. The selective
actuation of said plate 970 causes it to be placed in
the path of the advancing packages 20 on the conveyor
998, thereby preventing their movement downstream on the
moving conveyor. As an illustrative example, when the
25 first stop means 907(a) is in a first operative
position, e.g., down, the packages cannot advance
forward, even though the conveyor is still moving. On
the other hand, when the first stop means 907(a) is up,
the packages can advance forward on the moving conveyor.
30 Thus, the first stop means 907(a) allows separation
between adjacent packages, even when butted together.

1 In a preferred embodiment, the plate 970 is in
the shape of a cylindrical pin that reciprocates
vertically through the registration notices 31(a) and
31(b) of the contact lenses illustrated in Figure 3.
5 Inasmuch as the contact lenses are extremely fragile and
delicate, this mode of action is an unobtrusive means of
preventing the advancement of the contact lens packages
without damaging the lenses.

At a predetermined distance downstream is the
10 second stop means 904(a) also known as a gate. In the
embodiments shown in Figures 2 and 5, the distance
between the first stop means and the second stop means
is about the width of five contact lens packages. The
second stop means 904(a) stops the advancement of the
15 packages into the output end 915a.

A cross section of the second stop means is
illustrated in Figure 8. It comprises a vertically
aligned plate 971 having one of its facial planes
perpendicular to the axis of motion of the conveyor 998.
20 The plate 971 is powered by pneumatic cylinder 953. The
selective actuation of the plate 971 causes it to be
placed in the path of the moving packages 20 on the
conveyor, thereby preventing the advancement of the
packages to the output end 915a.

25 For purposes of illustration, when the second
stop means 904(a) is down (i.e. the gate is closed) the
packages cannot advance to the output end 915 on the
moving conveyor. More specifically, when the second
stop means 904(a) is down, the lead package cannot
30 advance to the output means. This causes the second
package to stop its downstream advancement when it comes

1 into contact with the lead package. This, in turn,
causes each of the packages upstream from the lead
package to come into contact with the package in front
of it. In this way, the packages are consolidated into
5 a regular array, and the gaps become eliminated.

On the other hand, when the second stop 904(a)
means is up (i.e., the gate is open), the packages
proceed to the output area 915a wherein a 2 X 5 array of
packages is removed by robotic assembly 650 to the
10 saline solution injector and foil sealing assembly.

In reference to Figures 2 and 5, it is noted
that the tapered guides 901(a) and 901(b) extend to the
end of the conveyor, thus the packages remain aligned as
they pass second stop means 904(a). However, the rail
15 902(a) does not extend past the second stop means
904(a). Therefore, in order to prevent the shingling of
the packages in the output end 915(a), when the packages
advance past the second stop means on the moving
conveyor, hold down bars 903(a) in the output end
20 actuate over the top of the packages before being
carried by the second robotic assembly 650. When the
robotic assembly 650 comes down to pick up the ten
packages, the hold down bars 903(a) retract by actuating
back, leaving the top of the packages exposed.

25 Figure 7(a) is a cross section of the output
area, including the hold down bars 903(a) and 903(b) in
the outer section. Figure 7(b) is a side view of the
same. Each hold down bar is comprised of a plate 972
powered by a pneumatic cylinder 954 which causes the
30 hold down bar to move or retract over the packages in
the output area. The output area also contains a

- 1 photosensor 955 which triggers a signal to the robotic assembly 650 through the PLC 940 to start removing the packages from the output area.

Thus, a typical cycle proceeds as follows.

- 5 The packages on the consolidation apparatus have gaps therebetween and proceed down the moving conveyor to the second stop means 904(a), which blocks the advancement of the packages on the moving conveyor. First, the lead package is stopped, and the second package upstream
- 10 therefrom is stopped when it comes into contact with the first package. The third package upstream stops its forward motion when it contacts the second package and this process continues, consolidating the packages on the moving conveyor 995. When a predetermined number of
- 15 packages e.g., five packages, in the embodiment in Figure 5, are stopped by second stop means 904(a) first stop means 907(a) is actuated to separate the five packages between the first and second stop means 907(a) and 904(a), respectively from the remainder of the
- 20 packages upstream. With the five packages between the two stop means, the second stop means 904(a) is released, allowing the packages to enter the output end 915(a). As they enter the output area, the 903(a) hold down bar actuates to come down and superpose over the
- 25 top of the packages to prevent shingling thereof. As the last of the packages passes under the second stop means 904(a), the second stop means 904(a) is lowered thereby blocking the movement of any further packages to the output end.

- 30 As the packages between the first and second stop means proceeds to the output area, the packages

1 upstream from the first stop means 907(a) initially do
not move, thus creating a gap. When this gap is
created, the first stop means 907(a) is actuated up and
the packages move forward to second stop means 904(a),
5 which, by this time, has been completely lowered to
prevent any further advancement of packages. When five
packages are stopped between first stop means 904(a) and
907(a), the second stop means 907(a) is actuated to
block the passage of any more packages past it, thereby
10 separating five packages from the remainder of the
packages upstream. The cycle is then repeated.

Meanwhile, when the packages pass through the
gate at the output end, photosensor 955 triggers a
signal through the PLC 940 to lower robotic assembly 650
15 to transfer the packages in the output end to the next
station. As the robotic assembly 650 is lowered, hold
down bars 903(a) retracts and are actuated back leaving
the tops of the packages exposed for the robotic
assembly 650 to grab for transfer to the next station.

20 All of these activities described hereinabove
are coordinated by PLC 940. It receives transmittal
information of the presence of each of the packages from
sensors means such as photo sensors 955a or 955b which
are located at various locations mounted above the
25 conveyor.

A cross section of a sensor means such as 905a
is illustrated in Figure 10. It consists of a sensor
958 which is protected by a fiber protector 957 and
mounted onto the rail by a fiber holder 956. The
30 sensors utilized here are commercially available and are
those that are normally used in this art. The sensors

1 that are normally used are infrared sensors, although,
as indicated hereinabove, sensor 955a is a photosensor.
The sensor may be a reflective sensor as is commercially
5 available from Omron. Alternatively, the sensor could
be a proximity sensor or a fiber optic probe, as
commercially available from Keyence as Model 24W-V25R,
used with an amplifier model 24W-AA1C.

Sensor means designated as 905(a),(b) are located
behind the first stop means 907(a) and second stop means
10 904(a), respectively. They check to see if packages are
present at the first and second stop means,
respectively. If packages are stationary and block a
sensor, a signal is triggered to PLC 940. When signals
are triggered by both sensors means, 905(a) and 905(b)
15 to PLC 940, it means that the packages have been
consolidated between the two stoppers, 907(a) and
904(a). For purposes of illustration, assume that a
signal is produced when the package blocks a sensor
means and assume no signal is generated when there is a
20 gap. Accordingly, if the sensor means 905(a) and 905(b)
are blocked, a signal from both sensor means 905(a) and
905(b) is transmitted to PLC 940. PLC 940 coordinates
the movement of the robotic transfer 650 at the output
area with the opening of the second stop means 904(a)
25 thus allowing the packages to proceed to the output
area. When all of the packages between the stop means
905(a) and 907(a) pass to the output area 915(a), there
will be a gap between the packages, wherein no signal is
produced from sensor means 905(a) in front of stop means
30 904(a). As a result, PLC 940 commands the closing of
the second stop means 904(a).

1 As the packages move through the second stop
means 904(a) after a preset time, PLC 940 controls the
removal of the first stop means 907(a), allowing the
packages to proceed to the second stop means 904(a).
5 However, because sensor means 905(a) triggers no signal
after the fifth package entered the output end 915,
these packages cannot proceed past the second stop means
904(a) which is closed. As the packages stop moving as
they consolidate, and the sensor means 905(a) and 905(b)
10 above both the first and second stop means 907(a) and
904(a), respectively, are blocked, then the first stop
means 907(a) will be lowered and no more packages will
advance past first stop means 907(a) and the whole
process repeats itself.

15 The above description only referred to the
disposition which respect to one stream of packages.
However, as indicated hereinabove, the embodiment
depicted in Figures 1, 4 and 5 depict two streams of
packages being conveyed to the output end. The second
20 stream has the same elements as the first stream
described hereinabove, i.e. guides 901(c) and 901(d),
which become tapered at 908(b), and 908(c), rail 902(b),
first stop means 907(b) and second stop means 904(b),
hold down bars 903(b) in the output area 915(b) and
25 sensor means 905(c) and 905(d), located in front of the
first stop means 907(b) and second stop means 904(b),
respectively. Furthermore, the elements function like
their counterparts described hereinabove.

 However, inasmuch as there are two streams of
30 products, there is an additional coordination which is
controlled by PLC 940. As described hereinabove, each

1 stream has five products between the first and second
stop means, which are advanced to the output zone when
the second stop means of the first stream 904(a) and the
second stop means of the second stream 904(b) are
5 raised. As also described, the second robotic assembly
650 transfers a 2 x 5 array to the next station.
Therefore, the PLC 940 needs to coordinate the release
of the two stop means 904(a) and 904(b). Thus, the stop
means 904(a) and 904(b) are not raised until sensors
10 905(a), 905(b), 905(c) and 905(e) are blocked, and as a
result, both means 904(a) and 904(b) are raised almost
simultaneously so that the packages 20 pass the second
stop means 904(a) and 904(b) in each stream,
simultaneously, with each package in each stream being
15 in the same corresponding position as its counterpart in
the other stream. The hold down bars 903(a) and 903(b)
actuate down to prevent shingling of the products as
they pass into the output end 915(a) and 915(b),
respectively. They are retracted simultaneously in
20 coordination to the movement of the robotic assembly
650, which transfers the regular array of packages, (2 x
5) to the next station. Thus, the movement of all of
these elements, the second stop means 904(a) and 904(b),
the hold down has 903(a) and 903(b) and the robotic
25 assembly 650 is controlled by PLC 940 which causes the
movement of these elements to be in synchronization.

In embodiments, having more than one stream of
products conveyed to the output end, there is a second
coordination, which involve a second type of sensor 906.

30 The second type of sensor means marked 906
checks for the presence of packages 20 and are used in

1 conjunction with the placement robot assembly zone from
upstream to keep the two lines of packages equal. For
instance, if three sensor means marked 906 were blocked
on one side and only one of the sensor means marked 906
5 was blocked to the other side, the information would be
relayed to PLC 940 which would cause the robot assembly
200 to place more packages on the conveyor into the
stream having fewer packages. These sensor means are
located at various positions above the conveyor in the
10 consolidation apparatus. Although three are indicated
in each section of the Figures, the consolidation
apparatus may contain more or less. However, the
consolidation apparatus requires the presence of at
least two sensor means 906, one located in the vicinity
15 of the first stop means 907 and another one located at a
separate location on the consolidation apparatus.

PLC 940 referred to hereinabove, is part of a
packaging control system, which is described in copending
application entitled Interactive Control System for
20 Packaging Control, having U.S.S.N. 08/257,793, the
contents of which are incorporated by reference. The
packing control system constitutes a PLC and associated
circuitry and software, for providing the tracking and
serial flow of products. Preferably, the PLC is a TI
25 system 545 (Texas Instruments). The PLC is programmed
with Application Productivity Tool (APT) software. The
PLC is provided with a memory storage device 102 having
adequate addressing and storage capabilities for PLC 940
to access and process data. As an illustration of how
30 it works, the relationship between the sensor means 906
and the PLC 940 will be described. As indicated

1 hereinabove, sensor means 906 for each section is in
transmittal communication with the PLC 940. Each time a
package blocks the sensor means 706 in one of the
streams, it triggers a signal to the PLC 940. It counts
5 the number of signals from the sensors 906 in each of
the streams. PLC 940 has the computer capability to
compare the values of the number of signals it receives
from each stream, and determines the difference in
value, respectively, between the total number of
10 packages that are conveyed on one stream relative to the
other stream. If the total number of packages that are
conveyed on any one stream is greater than the total
number of packages conveyed on the other stream, then
PLC 940 commands robotic assembly 200 to place more
15 packages on the section having the fewer number of
packages. Additional packages are placed on the input
portion of the conveyor belt having fewer number of
packages until the number of signals received from the
sensors 906 from both streams is about equal.
20 While the invention has been particularly
shown and described with respect to the preferred
embodiments thereof, it will be understood by those
skilled in the art that the foregoing, and other changes
in form and details, may be made therein without
25 departing from the spirit and scope of the invention,
which is limited only by the scope of the following
claims.

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35



1 WHAT IS CLAIMED IS:

1. A consolidation apparatus for consolidating a plurality of products having random variations in product arrangement with gaps between the products, said apparatus comprising:
- (a) a conveyor, said conveyor having an input end and an output end, and said conveyor receiving a plurality of products with random variations in the arrangement thereof at said input end;
- (b) means for actuating the conveyor to transfer the products from the input end to the output end;
- (c) alignment guides which longitudinally extend from the input end up to and including the output end of said conveyor and which align the products and prevent the lateral movement thereof;
- (d) rail guide mounted above said conveyor which superposes above the products moving on the conveyor to prevent shingling of said products as they move downstream to the output end;
- (e) a first and second stop means mounted for vertical reciprocation perpendicular to the direction of conveyance of said products, said second stop means situated adjacent to the output area, and said first stop means situated at a predetermined distance in the direction of conveyance of the products from said second stop means; said second stop means in one operative condition blocking the advancement of the products to the output end to consolidate any gaps between said products and in another operative condition permitting the advancement of the products to the output end, and



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1 said first stop means separating a predetermined number
of products located between the first and second stop
means from the remainder of the products upstream and
which in an operative condition permits the advancement
5 of the products to the second stop means and in another
operative condition blocks the advancement of said
products and

(f) a first sensor means to actuate vertical
reciprocation of said first and second stop means.

10 2. The consolidation apparatus of Claim 1
wherein said actuating means is a motor.

3. The consolidation apparatus of Claim 1
wherein each of said products is a contact lens package
carrier which comprises a planar rectangularly shaped
15 base member with a pair of notches on the sides thereof
and an angularly dependency wall thereof forming flange
members, the face of said package containing offset from
the center cavity having semi-spherical configuration in
the curvilinear shape of a contact lens, and a planar
20 surface therebelow said cavity.

4. The consolidation apparatus of Claim 1
wherein each of said products is a contact lens package
carrier which comprises an essentially planar
rectangularly shaped base member having a pair of
25 notches on the sides thereof and an angularly depending
wall portion at each end thereof forming flange members
said face containing offset from the center a cavity in
the curvilinear shape of a contact lens and a planar
surface therebelow, and wherein the first stop means
30 insert into one of said notches.



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1 5. The consolidation apparatus of Claim 1
wherein each of said products is a contact lens carrier
which comprises an essentially planar rectangularly
shaped base member having a pair of notches on the sides
5 thereof and an angularly depending wall portion at each
end thereof forming flanges, said face containing offset
from the cavity in the curvilinear shape of a contact
lens and a planar surface therebelow, and wherein said
10 rail guide superposes on the planar surface of said
lens.

6. The consolidation apparatus of Claim 4
wherein said first stop means is in the shape of a pin.

7. The consolidation apparatus of Claim 1
wherein said first sensor means is an infrared sensor.

15 8. The consolidation apparatus of Claim 1
having a pair of sensor means situated on a frame above
the conveyor in front of said first and second stop
means.

9. The consolidation apparatus of Claim 1
20 wherein said apparatus includes at least two pairs of
tapered guides, at least two rails adjacent and parallel
to each other, at least two first and second stop means
and at least two sensor means.

10. The consolidation apparatus of Claim 1
25 which provides a consolidated regular array of products
at said output end, said product arranged and positioned
for robotic handling.

11. An automated apparatus for controlling
the automatic packaging of contact lenses in a contact
30 lens fabrication facility, said apparatus comprising:



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- 1 (1) a first robotic transfer device for periodically transferring a first predetermined amount of packages of contact lenses having random variation in product arrangement from a first station to the
- 5 intermediate consolidation apparatus;
 - (2) a consolidation apparatus comprising
 - (a) a conveyor, said conveyor having an input end and an output end, and said conveyor receiving a plurality of packages with random variations in the
 - 10 arrangement thereof at said input end;
 - (b) means for actuating the conveyor to transfer the packages from the input end to the output end;
 - (c) alignment guides which longitudinally
 - 15 extend from the input end up to and including the output end of said conveyor and which align the packages and prevent the lateral movement thereof;
 - (d) rail guide mounted above said conveyor which superposes over the packages moving on the
 - 20 conveyor to prevent shingling of said packages as they move downstream to the output end;
 - (e) a first and second stop means mounted for vertical reciprocation perpendicular to the direction of conveyance of said packages, said second stop means
 - 25 situated adjacent to the output area, and said first stop means situated at a predetermined distance from said second stop means in the direction of conveyance of the packages, said second stop means in one operative condition blocking the advancement of the packages to
 - 30 the output end to consolidate any gaps between said packages and in another operative condition permitting



1 the advancement of the packages to the output end in a
second predetermined amount, and said first stop means
separating a second predetermined amount of packages
from the remainder of the packages upstream and

5 (f) a first sensor means in transmittal
communication with a controller which communicates the
presence of consolidation packages directly in front of
said first and second stop means;

(3) a second robotic assembly for periodically
10 transferring the second predetermined amount of
individual packages from said consolidation apparatus to
a second processing station, and

(4) a controller which is in transmittal
communication with said sensor means, said first and
15 second stop means and said second robotic assembly, said
controller causing the actuation of the vertical
reciprocation of the first and second stop means and
coordinating said vertical reciprocation of the second
stop means with the movement of said second robotic

20 assembly.

12. The automated apparatus of Claim 11
wherein at least two streams of packages are advanced on
said conveyor which is longitudinally divided into at
least two sections, each section having a pair of
25 parallel guides, a rail guide and a first and second
stop means and a sensor.

13. The automated apparatus of Claim 11
wherein each section additionally comprise a second
sensor means which monitors the number of packages in
30 each section, each second sensor being in transmittal
communication with said controller communicating the



1 number of packages in each section, said controller
determining the difference of the number of packages
being conveyed in a section relative to a second
section, identifying a first section conveying fewer
5 packages relative to a second section, and causing said
first robotic device to transfer more packages to said
first section until the number of packages conveyed in
said first section contains about an equal number of
packages as in said second section.

10 14. The automated apparatus of Claim 11
wherein each of said packages comprises an essentially
planar rectangular shaped base member having a pair of
notches on the sides thereof, and an angularly depending
wall portion at each end thereof forming flange members
15 the face of each said packages containing offset from
the center a cavity in a semi-spherical configuration in
the curvilinear shape of a contact lens and a planar
surface therebelow, and wherein the first stop means
inserts into one of said notches.

20 15. The automated apparatus of Claim 14
wherein said first stop means is in the configuration of
a cylindrical pin.

16. The automated apparatus of Claim 11
having a pair of first sensor means situated on a frame
25 above the conveyor directly in front of said first and
second stop means.

17. The automated apparatus of Claim 13
wherein said second sensor means is situated on a frame
above the conveyor directly in front of said first stop
30 means.