

A-1005

CONTACT LENS TRANSFER DEVICE

1

CROSS REFERENCE TO RELATED APPLICATION

The present invention is a continuation-in-part of prior application "Automated Apparatus and Method for Preparing Contact Lenses for Inspection and Packaging", U.S.S.N. 08\258,557, (VTN-0086) which has also been assigned to the assignee of the present invention.

10

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates generally to the field of manufacturing contact lenses. More particularly, the present invention relates to an apparatus which removes contact lenses from a first set of pallets, inserts them into corresponding packaging elements on a second set of pallets, and transports the lens-packaging elements through inspection and final package sealing assemblies.

20

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 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 lens production process wherein each lens is formed by

35

This Sheet Has Been Replaced



THIS SHEET HAS BEEN  
REPLACED

1 sandwiching 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  
5 then removed from the mold sections and further treated  
in a hydration bath and packaged for consumer use.

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  
10 formed with a monomer or monomer mixtures disclosed in  
the forgoing patents. The process disclosed in these  
patents significantly reduce the thruput time by  
hydrating the lens and releasing the lens from the mold  
cavity with deionized water and a small amount of  
15 surfactant without any salts, so that the time consuming  
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  
20 into the final package with the lens and then seal the  
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.

25 U.S. Patent No. 4,961,820, also assigned to  
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  
30 thereto.

This Sheet Has Been Replaced



THIS SHEET HAS BEEN  
REPLACED

1           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  
5 described in the foregoing patents enabled automated  
handling of the lens during hydration, suitable  
automated equipment to transport the lenses at high  
production rates and maintain low discard rates of  
manufactured lenses due to delay and dehydration thereof  
10 was not readily available or taught by the prior art.

SUMMARY OF THE INVENTION

          A manufacturing assembly line may include  
apparatuses for both the manufacture of a product and of  
15 packaging therefor. In addition, apparatuses may be  
provided which are directed to the insertion of the  
product into the packaging and/or to the inspection of  
the product. In addition, recent developments in the  
inspection of contact lenses produced in accordance with  
20 the foregoing methods has enabled automated lens  
inspection, as taught in U.S.S.N. 08\994,564, entitled  
"Lens Inspection Method and Apparatus", (VTN 0037)  
(Attorney Docket 9275) assigned to the assignee of the  
present invention. Further, recent developments in the  
25 hydration and automated handling of wet contact lenses,  
as taught in U.S.S.N. 08\258,556, entitled "Automated  
Method and Apparatus for Hydrating Soft Contact Lenses"  
(VTN-0074) (Attorney Docket 8998), also assigned to the  
assignee in the present invention, has enabled automatic  
30 robotic handling of lenses during hydration, and prior



1 to the inspection thereof by the automated lens  
inspection system.

Automated manufacturing processes often  
include steps which are particularly sensitive to  
5 interruption. For example, with respect to the  
manufacture of contact lens mold sections, the  
successful molding of thermoplastic elements having  
sufficiently correct optical surfaces requires that  
temperature fluctuations in the molding station remain  
10 steady. Other apparatuses in manufacturing lines,  
however, are subject to frequent interruption; requiring  
resupplies of materials, substitution of parts, etc.  
For example, materials for manufacturing packaging  
materials may be supplied in segmented rolls which, once  
15 depleted must be replaced.

The design of a fabrication line, which  
includes apparatuses of both type, must provide buffer  
zones in which parts being manufactured continually by  
one apparatus may be held temporarily as another is  
20 interrupted for a short time. It is therefore, a goal  
of those in the art to provide one or more accumulators  
or buffer zones for use in fabrication lines to even out  
such fluctuations. Again, with specific respect to the  
manufacture of contact lenses, recent developments are  
25 disclosed in U.S.S.N. 08\258,557, entitled "Automated  
Apparatus and Method for Preparing Contact Lenses for  
Inspection and Packaging", (VTN-0086) (Attorney Docket  
9010), also assigned to the assignee of the present  
invention, in which a buffer station is incorporated  
30 into the production line, for the purposes of permitting  
continuous function of some apparatuses, while other



1 apparatuses are interrupted. The specification of  
U.S.S.N. 08\258,557 is herein incorporated by reference.

The present invention is directed to the  
portion of the contact lens assembly line in which: a  
5 pallet of packaging elements are filled with a quantity  
of deionized water; a set of contact lenses, which have  
been molded, hydrated, and washed, are removed from a  
pallet and inserted into their respective packaging  
elements; the combined set of packaging elements and  
10 respective lenses are transported to a buffering  
station; the set of elements are transferred to a low  
vibration conveyor line; the contact lenses are  
inspected for flaws; the deionized water is removed from  
the packages; the combined elements are removed from  
15 their pallets, the packages containing flawed lenses are  
deposited on a conveyor line which deposits the elements  
in a collection bin, and the packages containing correct  
lenses are deposited on a good line; the lenses on the  
good line are consolidated into a regular array and  
20 transported onto a pallet; and a quantity of saline  
solution is introduced into the packages and a foil  
cover is heat sealed to the package.

More specifically, with respect to the  
assemblies which carry out the processes introduced  
25 above, and which comprise the apparatuses of the present  
invention, the deionized water injector assembly is a  
device for injecting a quantity of deionized water into  
packaging elements on a pallet. This deionized water  
injector assembly is mounted above a conveyor line along  
30 which pallets of regularly arrayed packaging elements  
are transported from a remote fabrication location to

This Sheet Has Been Replaced



THIS SHEET HAS BEEN  
REPLACED

1 the second location where they receive contact lenses.  
The spatial distribution of the regular array of the  
packaging elements is specifically established to match  
the optical array in the inspection station.

5 The lens extraction and insertion assembly of  
the present invention is a lens transfer device which  
lifts lenses from hydration pallets at a first location  
and deposits them, along with an additional dose of  
deionized water, into the packaging elements at the  
10 second location. In addition to transferring the  
lenses, the device also alters the spatial distribution  
of the lenses from their orientation in the hydration  
pallets to an orientation which corresponds to the  
packaging elements (and the lens inspection station).

15 More specifically with respect to the means by  
which the lenses are extracted from the hydration  
pallets and transferred to the packaging elements, the  
hydration pallets comprise a set of concave recessions  
in which the lenses are disposed, along with a quantity  
20 of deionized water. The bottom of the recessions  
comprise at least one hole through which a fluid may be  
ejected, therein lifting the wet lenses out of the  
recessions. The lens transfer assembly comprises a set  
of elongate finger elements which extend downward, each  
25 finger element having a convex lens transfer surface  
onto which the lifted lens may be secured via surface  
tension. The convex lens transfer surface of the finger  
is further designed with an annular raised skirt around  
the tip which prevents the lens from sliding out of the  
30 desired position during transfer. The lenses which have  
been transferred to the convex lens transfer surfaces on

35 This Sheet Has Been Replaced



THIS SHEET HAS BEEN  
REPLACED

1 the fingers of the lens transfer device, may have small  
bubbles of air on their exposed surface. The small  
bubbles, if permitted to remain on the surface of the  
lens through the inspection process may interfere with  
5 proper inspection, and cause the lens to be improperly  
determined to be bad, and discarded unnecessarily. At  
least one jet of air is blown onto each lens for the  
purposes of removing the air bubbles from this exposed  
surface.

10 The fingers of the lens transfer assembly are  
set out in rows on parallel beams which are slidably  
mounted on guide rails. The parallel beams are coupled  
together via piston/ cylinder elements, and are drawn  
together once the lenses have been extracted and the  
15 bubble blow off step have been carried out. This action  
alters the relative separation of the lenses with  
respect to one axis, so that the lenses will be arrayed  
to match the array provided by a lens inspection pallet.

The lens transfer assembly then is linearly  
20 translated to the second location, into position above  
the inspection pallet. The fingers of the lens transfer  
assembly are further designed with an interior conduit,  
extending from a small orifice in the lens transfer  
surface of the finger to a reservoir of deionized water,  
25 through which deionized water may be selectively  
ejected. With the fingers, and the lenses secured  
thereto, in position above the packages, a small jet of  
deionized water is ejected through each orifice, therein  
decoupling the contact lenses from the lens transfer  
30 surfaces and depositing them into the packages that were  
loaded in the inspection carrier.

This Sheet Has Been Replaced



THIS SHEET HAS BEEN  
REPLACED

1           The pallet and the package elements which now  
contain contact lenses are then transported via a  
conveyor belt to a buffering station. More  
specifically, the pallets are transported to a  
5 segregating apparatus, which directs alternating pallets  
onto parallel conveyor lines. The conveyor lines extend  
a sufficient distance, from their first ends to their  
remote ends, that a significant temporal delay may be  
accommodated, and the lenses stored without requiring  
10 stopping the molding line which requires a long start up  
time.

          The buffering station taught in U.S.S.N.  
08\258,557, entitled "Automated Apparatus and Method for  
Preparing Contact Lenses for Inspection and Packaging",  
15 is positioned after the inspection station, at a point  
in the manufacturing line where the packages containing  
the lenses have been drained of deionized water.  
Deprived of a liquid environment, the lenses are  
permitted to stand for no longer than 15 minutes before  
20 rejection thereof. Moving the buffering station to a  
point in the line at which the lenses remain bathed in  
deionized water permits indefinite holding without  
damaging the lenses.

          At the remote end of the buffering station, at  
25 the ends of the parallel conveyor lines along which the  
pallets may be stored, there is an integrator assembly  
which integrates alternate pallets from the two conveyor  
lines to continue toward the next station. More  
specifically, the parallel conveyor lines of the  
30 buffering station have, mounted to their end (the end  
toward which the pallets are transported), a device

This Sheet Has Been Replaced



THIS SHEET HAS BEEN  
REPLACED

1 which selectively merges the two streams of pallets so  
that they may pass onto the next conveyor.

5 In the embodiment of the buffering station  
which is described more particularly below with respect  
to the Figures, the conveyor lines which transport the  
pallets to the buffering station and which extend after  
the buffering station are co-linear and immediately  
adjacent to a first one of the two parallel conveyor  
lines. The segregator device, therefore, first allows a  
single pallet to advance onto the first buffer line, and  
10 then transfers the next pallet to the parallel second  
buffer line. In a similar, but inverse fashion, the  
integrator device operates by permitting one pallet from  
the first buffer line to pass, then transports a pallet  
from the second buffer line to the conveyor line which  
15 continues beyond the buffering station so that it may  
follow, and then begins anew by allowing the next pallet  
from the first buffer line to pass.

20 In alternative variations of this apparatus,  
the segregator and integrator devices continually or  
selectively divide and consolidate the stream of pallets  
along the two buffer lines. In the first variation, the  
stream of pallets is divided by the segregator and  
consolidated by the integrator at all times during the  
operation of the manufacturing line. In the alternate  
25 variation, the segregator and integrator are engaged  
only under circumstances when the subsequent stations  
have been interrupted. The segregator of this  
alternative variation would operate only during  
interrupted times; the integrator would function past  
30 the resumption of the subsequent assemblies until there



1 are no more pallets on the second buffer line. It is  
understood that there are a variety of alternative  
buffering algorithms which the segregator and integrator  
5 devices may utilize for separating and bringing together  
the pallets, all of which are equivalent in function and  
exist within the scope of this invention.

The stream of pallets which continue from the  
buffering station are transported to a pickup location.  
At this location the pallets are lifted off the conveyor  
10 line by a low vibration pallet transfer assembly and  
placed on a low vibration conveyor. The low vibration  
conveyor transports the pallets through the inspection  
station wherein a determination is made of the optical  
properties of the hydrated and packaged lenses. It is  
15 understood that the proper inspection of the lenses may  
not occur if the perceived optical properties of the  
lenses are distorted by air bubbles which have adhered  
to the surface of the lenses. Waves and disturbances  
within the deionized water in the packages have a  
20 similar distortion effect, causing false determinations  
of defects. The low vibration conveyor line, therefore,  
provides a means for minimizing the distortions  
resulting from water disturbances.

It is understood, however, that in order to  
25 maintain the same rate of product flow through the  
system, the reduction in speed of the stream of pallets  
along the low vibration conveyor line must be  
compensated by a corresponding increase in the density  
of the pallets moving therealong. The low vibration  
30 pallet transfer assembly, therefore, places successive  
pallets adjacent to one another on the low vibration



1 line, such that the spacing between the pallets is substantially reduced from the previous conveyor lines.

Determination of the optical correctness of each lens in each pallet is stored in the memory of a controller/processor so that subsequently a means for  
5 separating the good lenses from the bad may be utilized. First, however, the pallets, which contain packages filled with deionized water are transported to a water extraction assembly. Only after the optical correctness  
10 of the lenses has been determined may the proper saline solution be introduced into the package. The delay in introducing the saline solution until after the lenses have been inspected permits the line to proceed much more quickly, as, as stated above, the optical and  
15 physical characteristics of the lens requires several hours in the saline solution to equilibrate. It is understood that this equilibration is advantageously carried out in the sealed packages, once the lenses have been removed from the manufacturing line.

20 In the inspection station, a light beam or pulse is directed from sources onto the lens-packages, received by a vertical lens unit, and directed and focused on a screen to produce an image of the lens. The image is converted to an electrical information  
25 signal which is processed to determine if the lens is acceptable for consumer use. The lens inspection results are stored in the programmable logic controller which coordinates subsequent consolidation and transfer assemblies.

30 After inspection, the pallets are lifted into a water extraction assembly which is mounted above the

This Sheet Has Been Replaced



THIS SHEET HAS BEEN  
REPLACED

1 conveyor line. A device for deionized water extraction  
from packages containing contact lenses is taught in  
U.S.S.N. 08/999,234 entitled "Solution Removal Nozzle",  
which is also assigned to the assignee of the present  
5 invention.

Once the water has been removed, the packages  
are transported along the conveyor line to a lens-  
package pickup point. At this location the packages are  
lifted by a lens-package transfer assembly from the  
10 pallets and moved to alternative conveyor lines. More  
particularly, there are alternative variations of the  
lens-package transference assembly; a first in which the  
lens-package elements are all removed from the pallets,  
and a second in which only those packages which contain  
15 a correct lens are removed. It is understood that the  
first variation transports the packages over to a reject  
conveyor line, and pauses during transport to deposit  
any incorrectly formed lenses and the packages in which  
they are disposed. The assembly then transports the  
20 remaining correctly formed lenses and packages to the  
good conveyor line. In the second variation, the lens-  
package transfer assembly removes only the properly  
formed lenses and packages from the pallets and  
transports them to the good conveyor line. Any rejected  
25 lenses are then removed from the inspection pallets in a  
subsequent collection procedure. In either variation,  
it is understood that the determinations made by the  
inspection assembly, which were stored in memory by a  
processor/controller are herein acted upon by the lens-  
30 package transfer assembly.

This Sheet Has Been Replaced



THIS SHEET HAS BEEN  
REPLACED

1 More specifically, with respect to the lens-  
package transfer assembly, a set of bellowed fingers,  
extending downward from a vacuum manifold are first  
positioned directly above the packages on a pallet. By  
5 descending from a position above, bringing the tips of  
the fingers into contact with the packages, and drawing  
a vacuum in an interior open volume, the packages are  
secured to the lens-package transfer assembly. As  
stated above, the processor/controller may either  
10 control the selective pickup of the optically correct  
lens-packages, or the assembly may pick up all of the  
lens-packages. In either case, the desired lens-  
packages are transported to the good conveyor line,  
where the vacuum is released and the lens packages are  
15 dropped from the tips of the fingers.

In either case, the array of lens-packages  
which are ultimately deposited onto the good conveyor  
line are not necessarily in a regular array, as they  
were on the pallet (having had the incorrectly formed  
20 lens-package elements removed). The good line,  
therefore, also carries out a consolidating function,  
whereby the lens-packages are brought back together into  
a regular distribution. More specifically, the conveyor  
line carries the articles into separate corral  
25 structures. A first lens-package is conveyed between  
converging guide rails (which align the lens-package  
along one axis of motion), and into a corral. The first  
lens-package in line is stopped by a gate at the distal  
end. The next lens-package follows the lead one and is  
30 stopped by coming in contact with the first. Once a  
predetermined number of lens-packages have entered the

This Sheet Has Been Replaced



THIS SHEET HAS BEEN  
REPLACED

1 corral, and a regular array of lens-packages has been  
established, the lens-packages are removed from the  
conveyor line and deposited onto a final packaging  
pallet.

5 More particularly, the lens-package elements  
are removed from the corral, into which they have been  
directed by a conveyor line, by a rotating lens-package  
transfer assembly. This assembly comprises an array of  
bellowed fingers, similar in most respects to those of  
10 the lens-package transfer assembly, which lift the array  
of lens-package elements and places them onto pallets.  
The assembly further includes a rotational motion which  
rotates the array of elements to match the orientation  
of the pallets used for primary packaging.

15 Once the lens-packaging elements have been  
deposited onto these pallets, they enter into a saline  
dosing and sealing assembly. More specifically, the  
pallets are incrementally translated into position  
beneath a saline solution deposition unit. This unit  
20 comprises a row of fluid dispensers which fill the  
packages with saline solution. As the pallets are  
incrementally registered beneath the fluid dispensers, a  
buffered saline solution is injected into each of the  
packages and each of the lenses begins its equilibration  
25 process, matching the tonicity of a human eye (which has  
an equivalent salinity).

Once the packages have been filled with  
saline, the pallets continue forward and are sealed with  
a foil wrapper. More particularly, with respect to the  
30 device which applies and seals the foil wrapper to the  
package, an elongate section of foil wrapper material is

This Sheet Has Been Replaced



THIS SHEET HAS BEEN  
REPLACED

1 advanced through a printer (for printing information  
pertaining to the particular lens specifications). The  
foil is then cut into sections which are sized to fit  
across the tops of an array of packaging elements. The  
5 foil sections and the lens-package assemblies are  
advanced into alignment with one another. A vacuum  
gripper head grasps a foil section and descends to the  
package elements, placing the section in contact  
therewith. Once the foil wrapper is in position, a  
10 sealing mechanism is brought into contact with the  
packages and heat seals the foil to the package in a  
single high temperature short cycle sealing operation.  
The sealed packages are then advanced beyond the sealing  
assembly where they may be stored during equilibration,  
15 and ultimately packaged for distribution.

#### BRIEF DESCRIPTION OF THE DRAWINGS

The advantages and assemblies of the present  
invention set forth in the foregoing summary of an  
20 automated apparatus for combining, inspecting and  
sealing contact lenses and packaging elements may be  
more readily understood by one skilled in the art with  
reference being had to the following detailed  
description of the preferred embodiments, taken in  
25 conjunction with the accompanying drawings, wherein like  
elements are designated by identical reference numerals  
throughout the several views, and in which:

Figure 1 is a perspective view of a packaging  
element in which a contact lens may be inserted, and  
30 which serves as both a receptacle for the lens during

---

This Sheet Has Been Replaced



35

|                                 |
|---------------------------------|
| THIS SHEET HAS BEEN<br>REPLACED |
|---------------------------------|

1 inspection, and a portion of the primary contact lens  
package.

Figure 2 is a perspective view of an  
inspection pallet used to transport a plurality of the  
5 packaging elements illustrated in Figure 1 through  
several assemblies and stations of the present  
invention.

Figures 3a and 3b are elevation views, side  
and front views respectively, of an apparatus which  
10 fills packaging elements on a pallet with a quantity of  
degassed deionized water.

Figure 4 is a top view of the hydration pallet  
in which the hydrated and washed lenses are presented at  
the first location.

15 Figures 5a, 5b, and 5c are side, top, and  
perspective views, respectively, of the lens transfer  
and insertion assembly which removes the molded contact  
lenses from the hydration pallet, alters their relative  
spacing, and places the contact lenses in the packaging  
20 elements.

Figure 6 is a side view of a finger element of  
the lens transfer and insertion assembly onto which the  
lenses are disposed.

25 Figure 7 is a cross-sectional view of the air  
bubble removal fluid ejection mechanism for removing  
bubbles from the exterior surface of the contact lenses.

Figure 8 is a top view of the pallet transfer  
unit which transfers pairs of pallets from the lens  
transfer conveyor line to the buffer conveyor line.

30

35

This Sheet Has Been Replaced



THIS SHEET HAS BEEN  
REPLACED

1           Figure 9 is a perspective view of the buffer station through which the pallets carrying the lens-packaging elements are directed.

5           Figure 10 is a perspective view of the segregator device which is disposed at the entrance to the buffering station.

          Figure 11 is a perspective view of the integrator device which is disposed at the exit of the buffering station.

10          Figure 12 is an overview showing the assembly station locations of the post hydration apparatus of the present invention, including the inspection station and the deionized water extraction assembly.

15          Figure 13 is a perspective view of the low vibration pallet transfer assembly which transports the pallets carrying the lens-packaging elements from one conveyor line to the low vibration inspection conveyor line.

20          Figure 14 is a perspective view of the first rotating lens-package transfer assembly which removes the packages and lenses from the inspection pallets and deposits the optically correct lens-packages on the good conveyor line.

25          Figure 15 is a perspective view of the good conveyor line which further serves to consolidate the lens-packaging elements into a regular array.

30          Figure 16 is a perspective view of the second rotating lens-package transport assembly which removes regular arrays of lens-packaging assemblies from the good conveyor line and deposits them in pallets for saline injection and foil sealing.

This Sheet Has Been Replaced



THIS SHEET HAS BEEN  
REPLACED

1           Figure 17 is a conceptual diagrammatic  
illustration of the saline solution injector and foil  
sealing assembly.

5           Figure 18 is a side view of the saline  
solution injector and foil sealing assembly.

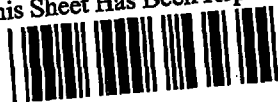
          Figure 19 is a perspective view of the saline  
solution injecting subassembly.

10 DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

          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  
15 automated production line, such as that described in co-  
pending application U.S.S.N. 08\258,654, entitled  
"Consolidated Contact Lens Molding" (VTN-0772) (Attorney  
Docket 9016); hydrated in a hydration system as  
described in U.S.S.N. 08\258,556, entitled "Automated  
20 Method and Apparatus for Hydrating Soft Contact Lenses";  
and automatically inspected as described in U.S.S.N.  
08\994,564, entitled "Lens Inspection Method and  
Apparatus" are particularly benefitted by the present  
invention.

25           The present invention shall be herein  
described with respect to its specific assemblies and  
apparatuses, and to the Figures illustrating these  
features. More specifically, the present invention  
shall be described, with reference to the following  
30 several assemblies:

35           This Sheet Has Been Replaced



THIS SHEET HAS BEEN  
REPLACED

1 First, the deionizing water injection assembly  
which fills the packaging elements prior to the lenses  
being inserted therein;

5 Second, the lens transfer and insertion  
assembly which receives the lenses from hydration  
pallets, alters their spatial distribution, and injects  
them into the packaging elements;

10 Third, the buffering station, and the  
segregator and integrator devices included therein,  
which provide a buffering region for temporarily holding  
a group of lens-packaging pallets during interruption of  
subsequent assemblies;

15 Fourth, the low vibration lens-package  
transport, inspection, and water extraction assemblies  
which removes the inspection pallets from a conveyor  
line and inserts them onto the low vibration inspection  
assembly conveyor line, determines which lens-packages  
are optically correct, and then removes the deionized  
water from the packages;

20 Fifth, the lens-package transfer assembly,  
which removes the lens-package elements from the pallet  
and deposits those lens-packages which were determined  
to be optically correct onto a good conveyor line;

25 Sixth, the good conveyor line and rotating  
lens-package transfer assembly, which conveyor line  
consolidates the optically correct lens-package elements  
into regular arrays, and the lens-package transfer  
assembly extracts the arrays, rotates the elements in  
the horizontal plane, and transports them to another  
30 line of pallets; and

This Sheet Has Been Replaced



THIS SHEET HAS BEEN  
REPLACED

1 Seventh, the saline solution injector and foil  
sealing assemblies, which introduce the appropriate  
saline solution into the lens-packaging elements and  
heat seals a foil label onto the top of the packaging  
5 element for shipping and identification.

THE DEIONIZING WATER INJECTION ASSEMBLY

Referring now to Figure 1, a suitable  
packaging element 10 is illustrated in a perspective  
10 view. This packaging element is more fully described in  
copending application U.S.S.N. 995,607, the disclosure  
of which is incorporated here by reference thereto. The  
packaging element 10 may be formed by injection molding  
or be thermally formed of plastic sheet material, such  
15 as polypropylene. The packaging element 10 includes an  
essentially rectangularly shaped platform portion 12,  
which may be visually divided into laterally distinct  
portions 14a and 14b by registration notches 16a and 16b  
which are formed in opposing sides of the platform  
20 portion. The first portion 14a defines a concave  
recession 24 which is particularly well suited for  
receiving therein and transporting a contact lens and  
fluid. The second portion 14b is generally flat,  
providing an ideal location for contact with a vacuum  
25 lifting means in that it provides a stable surface to  
seat against.

The package carrier is further defined by a  
wall portion 18 which descends at an angle, outwardly  
and downwardly from the platform portion 12 at one end  
30 thereof, forming an angled flange member. Descending  
downwardly from the corners platform portion 12, at the

This Sheet Has Been Replaced



THIS SHEET HAS BEEN  
REPLACED

1 opposing ends thereof, are a pair of registration  
flanges 20 and 22, only one of which is visible in the  
view shown in Figure 1. The registration flanges 20 and  
22 are used, in conjunction with the angled flange 18  
5 and registration notches 16a and 16b, to align the  
packaging element 10 during robotic handling. In  
particular, the notches 16a and 16b are provided on  
either side of the platform 12 so that they may  
cooperate with registration pins on various carrier  
10 pallets. Flange structures 18, 20, and 22 mate with the  
topological structure of pallets onto which the  
packaging elements are disposed, therein providing  
additional securing means for holding the element on the  
pallet.

15 As stated above, the first portion 14a of the  
platform includes a concave recession 24 which is of an  
essentially semi-spherical configuration, generally in  
conformance with a curvilinear shape of a contact lens  
(not shown). The contact lenses are therefore, adapted  
20 to be stored in the recession 24, 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  
25 incorporated herein by reference thereto. The  
perpendicular extent of the wall portion 18 which  
descends outwardly and downwardly from the platform  
member 12 is equivalent to the height or depth of  
recession 24 therein providing self alignment of the  
30 packaging element.

35

|                                 |
|---------------------------------|
| THIS SHEET HAS BEEN<br>REPLACED |
|---------------------------------|

This Sheet Has Been Replaced



1           The concave recession 24 also includes a  
plurality of small gripping marks 26 which are used to  
assist in holding a contact lens in the centered  
position in the recession 24 during the removal of  
5 deionized water at the deionized water extraction  
assembly which will be more fully described, with  
reference to the appertaining Figures hereinafter.

          The outer edge of the recession 24 includes a  
raised annular rim 28 which is provided for enhancing  
10 the efficacy of the heat sealing of the foil label in  
the foil sealing assembly which hermetically seals the  
contact lenses and packaging elements for commercial  
distribution. A cut-out 30 is used to facilitate  
gripping the foil wrapper when it is removed by a  
15 consumer to access and use the lens contained therein.

          Referring now to Figure 2, an inspection  
pallet on which the packaging elements are transported  
to the deionized water injection assembly, through the  
lens transfer assembly, the lens inspection assembly,  
20 and the deionized water extraction assembly, to the  
lens-package transfer assembly, is shown in a  
perspective view. Pallet 40 includes a first and second  
parallel rows 42,44 of cavities 46 which are shaped to  
receive the underside of the recession 24 of the  
25 packaging element 10. The parallel rows 42,44 of  
cavities are separated by a channel 48 which is defined  
by two walls 50a,50b. The wall corresponding to row 44  
descends downwardly and outwardly, the angulation of the  
slant being specifically set to receive flatly thereon,  
30 the descending wall portion 18 of each packaging element  
10 disposed on row 44. The outer edge 54 of row 42 is



1 similarly slanted to receive thereon the wall portions  
18 of the packaging elements 10 disposed on row 44.

5 The pallet is further provided with a pair of  
elongated notches 56,58 for receiving the registration  
flanges 20,22 of the packaging element. The elongated  
notches 56,58 further provide a positive grip surface  
for transferring means that lift, rotate, and transport  
the pallet.

10 In addition, the pallet 40 includes  
registration pins 52 which engage the packaging elements  
at the lateral edges. These registration pins 52 engage  
the registration notches 16a,16b of the packaging  
elements 10 to provide additional accuracy in their  
15 registration, specifically with respect to the  
longitudinal axis of the pallet. The combination of  
slanted walls 50b and 54, grooves 56 and 58, and the  
registration pins 52, which each couple with  
corresponding features of the packaging elements,  
provide particularly effective means to ensure against  
20 rotational skewing.

The inspection pallet 10 is further provided  
with three registration openings 60, on either side of  
the pallet 40, which are used by means associated with  
assemblies of the present invention to transport, and  
25 lock the pallet in place, during operation thereof.

As suggested by Figure 2, the packaging  
elements 10 are fabricated in sets of sixteen, and are  
disposed on pallets 40 in predetermined arrays,  
typically 2 X 8. The pallets and packages are  
30 transported, via a conveyor line, to the deionized water

35 This Sheet Has Been Replaced



THIS SHEET HAS BEEN  
REPLACED

1 injection assembly in sets of two, oriented to define  
therebetween an array which is 4 x 8.

Referring now to Figures 3a and 3b, the  
deionized water injection assembly 100 is shown in a  
5 front side view and a lateral side view. This assembly  
100 comprises four separate elements: a water dispensing  
head 110; a set of coordinated vertically oriented stops  
120a,b; a pallet positioning device 130; and a water  
overflow drain unit 140. The water dispensing head 110  
10 translates up and down with respect to a conveyor line  
102 and to the pallets 40 thereon. The coordinated  
vertically oriented stops 120a,b are utilized to stop  
the advancing pallets 40, and feed one pair of pallets  
per cycle. The pallet positioning device 130 receives  
15 the pair of advancing pallets 40, advances itself and  
the pallets horizontally to a first water dispensing  
location, then to a second dispensing location. Once  
the packages have been filled, after the second  
location, the pallet positioning device 130 translates  
20 vertically which permits the pallets 40 continue to  
advance along the conveyor 102. The positioning device  
130 reciprocates back into position to receive a next  
set of advancing pallets 40. The water overflow drain  
unit 140 is positioned beneath the conveyor line,  
25 vertically aligned with water dispensing head 130, for  
catching waste water from the dispenser.

As illustrated in Figure 3a, the set of  
coordinated vertically oriented stops 120a,b advancing  
pallets 40, prior to dosing. Each of the stops 120a,b  
30 includes a vertically aligned plate 122 having one of  
its facial planes perpendicular to the axis of motion of

THIS SHEET HAS BEEN  
REPLACED



1 the conveyor line 102. The plate 122 is coupled to a  
piston/cylinder 124, the selective vertical actuation of  
which advances the plate 122 into the stream of pallets  
40 advancing along the conveyor line 102.

5 As illustrated in Figures 3a and 3b the  
deionized water dispensing head 110 includes a  
horizontally disposed reciprocating support plate 112.  
The support plate 112 has sixteen holes 116 arrayed in a  
4 x 4 matrix. The top of the plate 112 receives a set  
10 of sixteen flexible hoses 114, for example tygon tubing  
or other fluid conduit, for delivering deionized water  
to a set of sixteen narrow and elongate teflon tubes 118  
which extend downwardly from the bottom of the plate 112  
and are particularly well suited to delivering precise  
15 doses of deionized water therethrough. Teflon is a  
particularly desirable material for such a use as water  
generally does not adhere to teflon surfaces in large  
droplets which may fall therefrom at inappropriate times  
in the deposition cycle.

20 The plate 112 is coupled, at a lateral edge,  
to a piston/cylinder 111, which may be actuated to raise  
and lower the head 110 (and the teflon tubes 118) in  
accordance with a predetermined deionized water  
deposition cycle which is more fully described  
25 hereinbelow.

Beneath the conveyor line, vertically aligned  
with water dispensing head 130, is a water drain unit  
140 which is so disposed to catch any excess water which  
may emanate from the dispenser during purge cycle or  
30 cycle misfeeds. The water drain unit comprises a basin  
142 having a sloped base, therein forming a funnel-like

This Sheet Has Been Replaced



REPLACED

1 shape, directing water therein toward a hole 144 in the  
base. The hole 144 is coupled to a drainage tube 146  
which carries the drainage water away from the assembly  
to a remote location.

5 The fourth element of the deionized water  
injection assembly 100 comprises a pallet positioning  
device 130. This element receives a pair of advancing  
pallets 40 and first holds them in position beneath the  
deposition head 110 in a first position so that the  
10 first sixteen recesses 24 of the packaging elements may  
be filled with deionized water. Once the first sixteen  
recesses 24 have been filled, the pallet positioning  
device 130 translates horizontally to a second position,  
thereby repositioning the pallets 40 at a second  
15 position beneath the deposition head 110. At this  
position the second sixteen recesses 40 of the pair of  
pallets 40 receive a quantity of deionized water. Once  
the second step of water deposition has taken place, the  
registration device release the pallets, rises to allow  
20 the pallets to advance beneath it, and reciprocates back  
to the pallet receiving location (the first location).

More specifically with respect to the elements  
of the pallet positioning device 130, the positioning  
device comprises a pair of spaced apart arms 131,132  
25 which extend laterally across the conveyor line 102, and  
which are ideally spaced for receiving and holding pairs  
of pallets 40 which advance down the conveyor line 102.  
The arms 131,132 are coupled at their lateral ends 133  
to vertically oriented piston/cylinder 134 which raises  
30 and lowers the arms 132 in accordance with the timing of  
the deposition cycle.

35

This Sheet Has Been Replaced



THIS SHEET OF DRAWING  
REPLACED

1           In addition to the vertically oriented  
piston/cylinder 134, the arms 131,132 are coupled  
together via an elongate spar member 135 and a  
horizontally disposed piston/cylinder 136. Actuation of  
5 the piston/cylinder 136 causes the arms 131,132 to move  
relative to one another. Specifically, arm 131, which  
is positioned in front of the deposition head, up stream  
from the deposition head with respect to the flow of the  
conveyor line 102, remains stationary as the other arm  
10 132 is directed farther downstream from the deposition  
head 110, therein moving the pair of pallets 40, into  
the second deposition position.

In operation the entire assembly functions in  
accordance with a predetermined timing schedule,  
15 beginning with the advance of a pair of pallets 40 along  
the conveyor line 102, toward the assembly. Once a pair  
of pallets 40 have passed the first of the coordinated  
vertical stops 120a, plates 122 are raised, so that  
additional pallets 40 may be restrained from continuing  
20 into the water dosing location.

The two pallets 40 continue to advance until  
they reach the second of the coordinated vertical stops  
120b, at which point the pallet positioning device 130  
descends into position holding the pallet in the first  
25 deposition position. Deionized water is then injected  
via the teflon tubes 118 into the first sixteen recesses  
24 of the pallets. Once the water has been injected,  
vertical stop 120b is retracted and the horizontally  
oriented piston/cylinder 136 of the positioning device  
30 130 is actuated, thereby advancing the pallets 40 to the  
second deposition position. Once the second set of

This Sheet Has Been Replaced



THIS SHEET HAS BEEN  
REPLACED

1 sixteen recesses 24 have been filled with deionized  
water, the arms 131,132 are raised by vertically  
oriented piston/cylinder 134, and the horizontally  
oriented piston/cylinder 136 is retracted.

5 Once the first pair of pallets 40 have  
advanced past the assembly 100, vertical stop 120a is  
lowered to permit the next pair of pallets through the  
dispensing station, and the second set of vertical stops  
120b are raised. After the second pair of pallets have  
10 advanced, the vertical stops 120b are raised to stop the  
following pallets 40 from entering, and the cycle  
repeats.

Once the packaging elements 10 have each  
received a quantity of deionized water, the packaging  
15 elements and pallets are transferred along the conveyor  
line to a lens loading location where each recess 24  
receives a contact lens by a loading assembly described  
hereinbelow.

#### 20 THE LENS TRANSFER AND INSERTION ASSEMBLY

Referring now to Figure 4, a contact lens  
hydration pallet 200 is shown in a top view wherein  
phantom lines correspond to internal structures of the  
hydration pallet. The hydration pallet 200 comprises 32  
25 semi-spherical recesses 202 in which contact lenses are  
transported through a series of extraction stations,  
which are described more fully in co-pending application  
U.S.S.N. 08\258,556, entitled "Automated Method and  
Apparatus for Hydrating Soft Contact Lenses", also  
30 assigned to the assignee of the present invention.

This Sheet Has Been Replaced



THIS SHEET HAS BEEN  
REPLACED

1           The hydration pallet 200 has a plurality of  
conduits 206 which extend upwardly from the top surface  
of the pallet. These conduits 206 are coupled, via  
internal branch conduits 208, to small holes 204, one of  
5 which is disposed at the bottom of each recess 202, at  
the bottom thereof. The holes 204 are thereby coupled  
in gas and/or fluid flow communication with an external  
supply, whereby a fluid or gas may be selectively  
introduced between the surface of the recess 202 and a  
10 lens disposed therein. The selective introduction of  
this gas or fluid, via the hole 204, is used to propel  
the lenses upward so that they may each adhere to  
corresponding convex lens attachment surface of the  
finger elements of the lens transfer assembly as  
15 described hereinbelow.

Referring now to Figures 5a, 5b, and 5c, the  
contact lens transfer assembly 210 is shown in side, top  
and perspective views, respectively. The assembly 210  
generally comprises a head element 240 and a dual axis  
20 linearly translating mounting unit 220. First, with  
respect to the dual axis linearly translating mounting  
unit 220, a mounting bracket 222 is coupled at its lower  
horizontal surface 222a to the head element 240. The  
mounting bracket 222 is, in turn, mounted to a base  
25 element 224, in relation to which, the mounting bracket  
222 may be raised or lowered by means of a vertically  
oriented translation mechanism. It is understood that a  
variety of means may be employed for the raising and  
lowering of the mounting bracket 222 including an  
30 articulated robot. However, a preferred mechanism

This Sheet Has Been Replaced



THIS SHEET HAS BEEN  
REPLACED

1 comprises an IKO ball screw drive system to reciprocally  
translate the head from position to position.

As illustrated in Figure 5c, the base element  
224 is mounted to a horizontal track 226, along which it  
5 translates in accordance with the actuation of a motive  
means. In Figure 5c the motive means 228 is shown to be  
a ball screw drive, however, it is understood that a  
variety of alternative translation means may be employed  
to provide an equivalent function. For example, the  
10 translation means may comprise a hydraulic or pneumatic  
piston/cylinder device, or it may comprise a scissoring  
arm assembly. The ball screw is preferred for its  
accuracy, mechanical simplicity, long term operability,  
and efficiency.

15 With respect to the head element 240, a  
coupling element 242 is affixed at its upper end to the  
lower surface of the mounting bracket 222. The lower  
end of the coupling element 242 is mated to a pair of  
guide plates 244 which are substantially parallel and  
20 held in spaced relation to one another by cross bars  
246. Slidably mounted on the cross bars 246, also in  
spaced apart relation to one another, is a set of four  
horizontal support beams 248. The support beams 248  
slidably mounted on the cross bars 246 so that they may  
25 be drawn together or spread apart in accordance with  
their appropriate positioning.

The means by which the support beams 248a-d  
may be moved relative to one another is provided by a  
pair of piston/cylinders 250,252. The embodiment of  
30 Figure 5b shows the first piston/cylinder 250 couples  
the two inner beams 248b,c, and the second

35 This Sheet Has Been Replaced



THIS SHEET HAS BEEN  
REPLACED

1 piston/cylinder 252 couples the two outer beams 248a,d.  
As shown in Figure 5b, the second piston/cylinder is  
mated directly to a bracket 254 on one of the outer  
beams 248a, and mated to a linkage plate 256 which  
5 couples the piston/cylinder 252 to bracket 260 which is  
attached to outer beam 248d. The first piston/cylinder  
250 is coupled directly to brackets 262a,262b which are  
in turn mated to the two inner beams 248b,c.

Extending downward from each support beam  
10 248a-d are a plurality of finger elements 264, to which  
the lenses adhere during transfer. In the preferred  
embodiment, there are thirty-two fingers 264, mounted in  
a 4 x 8 array of four beams and eight fingers per beam,  
which correspond to the thirty-two recesses 202 of the  
15 lens hydration pallet 200. Selective actuation of the  
piston/cylinders 250,252, which causes the beams to move  
relative to one another, causes the relative spacing of  
the finger elements 264 to be altered.

Referring now also to Figure 6, a side view of  
20 a finger element 264 is provided. The finger element  
264 comprises an elongate shape having a convex lens  
attachment surface 266, the curve of the surface 266  
generally corresponding to the curvature of the concave  
surface of a contact lens. A central bore 268 extends  
25 through the finger 264 from the top 270 to the lens  
transfer surface 266. This bore 268 is included for the  
selective ejection of a fluid therethrough, which fluid  
may be deionized water, as will be discussed below with  
respect to the deposition of a lens into a corresponding  
30 packaging element 40.

35 This Sheet Has Been Replaced



THIS SHEET HAS BEEN  
REPLACED

1           The end of each finger 264 includes an annular  
slotted skirt 272 which separates the curvate shape of  
the lens transfer surface 266 from the generally  
cylindrical shaft portion 274 of the finger 264. This  
5           slotted skirt 272, which includes alternating vertically  
oriented slots 272a and skirt elements 272b helps retain  
the lens on the attachment surface 266 and prevents it  
from sliding, or otherwise moving out of a desired  
position. The vertically aligned slots 272a are designed  
10          to provide a channel through which a fluid or gas which  
is directed upwardly at the lens transfer surface may  
flow smoothly. The skirt elements 272b are provided to  
prevent a contact lens from sliding off the lens  
transfer surface when said fluid or gas is directed at  
15          the surface.

          A circular mounting disc 271 is disposed about  
the cylindrical shaft of the finger 264, at a position  
remote from the tip 266. The mounting disc 271 may be  
coupled to the upper or lower surface of the  
20          corresponding support beam 248, such that the top of the  
finger 264 may be coupled to an external supply of fluid  
such as deionized water with the lens transfer surface  
266 extending downward. In either case, the tops 270 of  
the fingers 264 are coupled to tubes 273, which are  
25          preferably flexible, and which may selectively supply  
fluids such as air or deionized water to the central  
bore 268 in accordance with the predetermined operation  
of the assembly.

          As illustrated in Figure 5c, in operation a  
30          hydration pallet is advanced along the lens conveyor  
line 275 to a position directly beneath the lens



1 transfer assembly 210. The dual axis linearly  
translating mounting unit 220 lowers the head array 240  
so that the lens transfer surfaces of the fingers 264  
are positioned directly above the recesses 202 of the  
5 pallet. Once in position, a quantity of air is directed  
through the conduits 206,208 in the plate. This air  
floats the contact lenses out of the recesses 202, and  
onto the lens attachment surfaces 266 of the fingers  
264. As the lenses have been carried in the pallet  
10 through several extraction stations prior to arriving at  
the lens transfer assembly 210, the lenses and recesses  
202 of the pallet have residual deionized water thereon.  
This deionized water assists the lenses in adhering to  
the surface 266 of the finger 264 via surface tension.  
15 While the lens will adhere to the curved lens attachment  
surface 266 with or without an additional surfactant, a  
surfactant may be added to more efficiently wet the  
surfaces together and promote retention of the lens by  
virtue of the surface tension of the deionized water and  
20 the surrounding atmospheric pressure. In the transfer,  
it is desirable to position each of the finger tips 266  
within 1.5 mm of the lens to ensure a direct and precise  
transfer.

Occasionally the outer surface of the lens may  
25 have bubbles of air, in the deionized, water attached to  
it. If the bubbles remain, and are not dissolved, or  
otherwise removed from the lens, subsequent inspection  
of the optical correctness of the lenses will be  
compromised. Degassed ionized water is used in the  
30 hydration apparatus to minimize bubble formation, and in  
order to ensure that air bubbles are removed from the

This Sheet Has Been Replaced



THIS SHEET HAS BEEN  
REPLACED

1 surface of the lens, when the head element 240 and  
fingers 264 are raised, the mounting assembly transports  
them to a bubble blow off unit 280 disposed between the  
hydration conveyor line 275 and the packaging element  
5 pallet line 102.

Referring now to Figure 7, a cross-sectional  
view of finger 264 carrying a lens and a recess 282 of  
the bubble blow off unit 280 is shown. The bubble blow  
off unit 280 comprises a plate 284 having a regular  
10 array of recesses 282 therein. The regular array of  
recesses 282 is designed to match the spacing of the  
fingers 264 of the lens transfer assembly head 240. The  
base of the recess 282 includes a through hole 286,  
which forms the mouth of a conduit 288 which extends  
15 downward to an air supply means. Selective ejection of  
air through the conduit is directed at the lens which is  
adhered to the lens attachment surface 266 of the finger  
264. The force of the jet of air may cause the lens to  
migrate across the attachment surface 266, however, the  
20 slotted skirt 272 prevents the lens from sliding more  
than a portion of one lens radius from the center  
position. The jet removes the bubbles from the lens  
surface so that the inspection process will not falsely  
identify such air bubbles as fabrication errors in the  
25 lens itself.

Once the bubble removal process has been  
carried out, the piston/cylinders 250,252 are actuated  
to bring the beams 248 together. This change in  
relative distribution of lenses perpendicular to the  
beams 248 (whereby the four rows of eight fingers are  
30 brought closer to one another, but the spatial

This Sheet Has Been Replaced



THIS SHEET HAS BEEN  
REPLACED

1 separation of fingers within the rows remains unchanged)  
is necessary because the distribution of packaging  
elements on the inspection pallet 40 is set in  
accordance with the inspection station apparatus, which  
5 is not the same as the relative spacing of the lenses  
during molding or hydration.

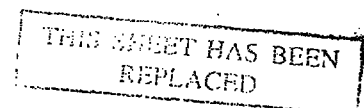
Once the piston/cylinders 250,252 have set the  
fingers 264, and the lenses thereon, into the properly  
distributed array, the horizontally oriented translation  
10 means 228 transports the head element 240 and the lenses  
to a position above the pallet 40 on conveyor line 102.  
With the lenses are positioned above their corresponding  
recesses 202, a quantity of deionized water is  
discharged from the tip of the finger, via the central  
15 bore 268, into the space between the lens and the lens  
attachment surface. This quantity of deionized water is  
sufficient to disrupt the surface tension adhesion of  
the lens to the surface, causing the lens to be carried  
along with the water into the package element 10.

20 The contact lenses and lens-package elements  
are carried on the pair of inspection pallets 40, by the  
conveyor 102 to the next station which is the buffering  
station. The fingers of the lens transfer assembly then  
return to their open spatial array, and the head element  
25 240 is reciprocated back to its receiving position above  
the hydration conveyor line 275, and awaits the next  
batch of contact lenses.

#### THE BUFFERING STATION (SEGREGATOR & INTEGRATOR DEVICES)

30 The process of manufacturing contact lenses is  
in large part determined by the handling requirements of

35



This Sheet Has Been Replaced



1 the lenses themselves. For example, one of the most  
important restrictions around which all of the molded  
article handling assemblies are designed is that the  
optical surfaces should not be touched. The handling  
5 requirement which is most relevant to the present  
assembly is that the lenses, once hydrated, must not be  
allowed to remain dry for more than 15 minutes.

As is the case with most manufacturing line  
machinery, the assemblies of the present invention,  
10 which together form the post lens hydration apparatus,  
require periodic maintenance and/or refilling with  
materials used in manufacturing. For example, the  
primary packaging station (the saline solution injector  
and foil sealing assemblies) requires periodic  
15 replacement of the foil material which is heat sealed to  
the packaging elements. The performance of other  
assemblies, however, are susceptible to being  
interrupted. However, the molding assemblies need to be  
kept in continuous operation for proper equilibration  
20 which is critical for optimal yield quantities.

In order to ensure that certain assemblies be  
permitted to run continuously, and still provide for  
periodic maintenance or resupply of other stations, one  
or more buffering station are necessary. The ideal  
25 position for a buffering station must be one where the  
lenses remain in an aqueous environment. The buffering  
station of the present invention is positioned between  
the lens transfer assembly and the inspection station.

The pallets 40, which have been filled with  
30 deionized water, and into which contact lenses have been  
deposited, each define a 2 x 8 array. In pairs, the

This Sheet Has Been Replaced



THIS SHEET HAS BEEN  
REPLACED

1 pallets define a 4 x 8 array. At the lens insertion  
station (the lens transfer assembly) the pairs of  
pallets are advanced side by side; the elongate axis  
defined by the columns of 8 recesses, of each pallet  
5 being parallel to the direction of motion of the  
conveyor line.

Referring now to Figures 8, 9, 10 and 11,  
which are perspective views of the buffering station,  
including the segregator unit, and the integrator unit,  
10 respectively. As illustrated in Figure 9, the buffer  
station comprises first, second, third, and fourth  
segments 304, 308, 312, 316 of a conveyor line, each of  
which is disposed for movement of pallets in the same  
direction. A segregator unit 320 is positioned after  
15 the first segment 304, and an integrator unit 340 is  
positioned before the fourth segment 316. The second  
and third segments 308, 312 run parallel to one another,  
each beginning at the segregator unit 320 and ending at  
the integrator unit 340.

20 A first segment 304 of the buffer conveyor  
line is disposed perpendicularly to the lens transfer  
conveyor line 102 which advances the pallets from the  
lens transfer assembly, as set forth above. Referring  
specifically to Figure 8, the end of the lens transfer  
25 conveyor line 102 and the beginning of the first segment  
304 of the buffer conveyor line, and the lateral pallet  
transfer unit 306 which transfers the pallets 40 from  
the former to the latter are shown in a top view. As  
the pairs of pallets 40 reach the end of the lens  
30 transfer conveyor 102 they are stopped from advancing by  
a guide 300. The pallets 40 are then pushed by a push

35 This Sheet Has Been Replaced



THIS SHEET HAS BEEN  
REPLACED

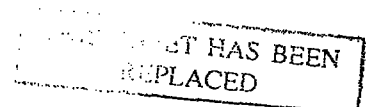
1 plate 302 from the lens transfer conveyor line 102, onto  
the first segment 304 of the buffer conveyor line.

More particularly with respect to the motion  
of the pusher plate 302, the pusher plate 302 includes  
5 an arm 303 extending from its back portion which is  
motively coupled to a slide element 305 which is  
disposed beyond the wall element 300. Selective  
actuation of the slide element 305 in the forward  
direction provides the linear lateral motion of the  
10 pusher plate 302 and transfers the pallets 40 to the  
first segment 304 of the buffer conveyor. Reverse  
actuation of the slide element 305 reciprocates the  
pusher plate 302 into position to receive the next pair  
of pallets 40. It is understood that a variety of  
15 mechanisms may be employed which provide the appropriate  
motion of the pusher plate; examples being a ball screw  
drive, hydraulic, pneumatic, or air piston/cylinder  
elements, or mechanical scissoring devices.

As the pairs of inspection pallets 40 are  
20 transferred to the first segment 304 of the buffer line,  
they are translated from a parallel relationship to a  
tandem relationship, because the segment 304 is oriented  
perpendicularly with respect to the lens transfer  
conveyor 102. The pair is now advanced in tandem with  
25 one pallet following the other, each having its elongate  
axis oriented perpendicularly with respect to the  
direction of motion of the first segment 304 of the  
buffer conveyor.

The pallets 40 are advanced in tandem to the  
30 segregator unit 320 which permits alternating pallets  
40, for example the first of the pairs, to advance

This Sheet Has Been Replaced



1 linearly onto a second segment 308 of the buffer  
conveyor line; the second segment 308 of the buffer  
conveyor line being co-linear with the first segment  
304. A vertical stop mechanism 310a, which is similar  
5 in form and function to the vertical stop 120 of the  
deionized water injection assembly, is disposed before  
the segregator 320 to permit only one pallet of the pair  
onto the segregator 320. With respect to the second  
pallets of the pairs, the segregator 320 transfers them  
10 to the third segment 312 of the buffer conveyor, which  
runs parallel to the second segment 308.

Vertical stops 310b, 310c which are disposed on  
the second and third segments 308, 312 of the buffer  
conveyor line, are positioned to prevent premature  
15 advancement of the pallets 40 on the conveyors until  
transfer is completed.

The segregator 320 is continuously engaged,  
providing both a constant spacing of individual pallets  
40 from one another, and providing a dual track holding  
20 line for the pallets 40 during interruptions in the  
subsequent assemblies of the manufacturing line. The  
pallets 40 thereby form parallel lines extending along  
the second and third segments 308, 312 for distances  
which are determined to be sufficient to store the  
25 number of pallets 40 which will be produced during  
normal service interruptions in the manufacturing line,  
as for example twenty minutes.

At the distal ends of the second and third  
segments 308, 312, an integrator unit 340 is provided to  
30 merge the two streams of pallets 40 so that they may  
advance, in a regularly spaced unitary stream, along the

This Sheet Has Been Replaced



THIS SHEET HAS BEEN  
REPLACED

1 fourth segment 316 of the buffer conveyor, to the  
inspection station. Again, vertical stops 310d,310e are  
positioned at the ends of the segments 308,312  
respectively, and are engaged to ensure that only one  
5 pallet 40 enters the integrator at a given time.

The integrator 340 remains engaged during  
normal operation of the manufacturing line, but is  
disengaged to stop the advance of any further pallets 40  
when an interruption occurs. During this time, the  
10 pallets 40 which continue to advance from the lens  
transfer assembly are stored in parallel lines on the  
second and third segments 308,312 of the buffer  
conveyor. Once the interruption ends, the integrator  
340 is reengaged and merges the stored pallets in a  
15 continuous stream. A final vertical stop 310f is  
disposed at the outlet of the integrator 340 to prevent  
premature advancement or skewing on the powered  
conveyor, and to enable spacing between pallets 40 on  
the fourth segment 316, as they enter the inspection  
20 station.

Referring specifically to Figure 10, which is  
a perspective view of the segregator unit, particular  
attention is provided to the features and function of  
the segregator 320. A housing 321, which is an inverted  
25 L-shaped member is mounted to the lateral edge of the  
conveyor line, at the coupling point of the first and  
second segments 304,308. Extending outward from the L-  
shaped member 321 are a pair of substantially parallel  
guide rails 323. The rails 323 are received by a  
30 stationary plate 327 which is mounted to the outside  
lateral edge of the third segment 312 of the buffer

This Sheet Has Been Replaced



THIS SHEET HAS BEEN  
REPLACED

1 conveyor. A first moving plate 329 is slidably mounted  
to the guide rails 323 such that the plane of this first  
plate 329 is aligned vertically and parallel to the  
direction of conveyor motion. This first plate 329  
5 reciprocates from a first position between the second  
and third conveyor segments 308,312 and a second  
position at the stationary plate 327. A second moving  
plate 331 is similarly mounted to the guide rails 323,  
and to a motive means (not shown) such that it may be  
10 reciprocated from a position at the outside lateral edge  
of the second conveyor segment 308 to a position between  
the second and third segments 308,312. The first and  
second plates 329,331 are maintained in a spaced apart  
relation such that a pallet 40 may be transferred  
15 therebetween, from the first segment 304 to the third  
segment 312 upon selective reciprocation of the plates  
329,331 along the guide rails 323.

In operation, as can be inferred from Figure  
10, the reciprocation of the plates 329,331 is  
20 selectively controlled such that alternating pallets are  
transferred to the third segment 312. It is understood  
that a variety of motive means and/or coupling means may  
be utilized for reciprocating the plates 329,331  
together, for example the guide rails may comprise a  
25 threading and the mounting of the plates 329,331 thereto  
comprises a nut which may be translated along the guide  
rails 323 by the rotation thereof. A separate, but  
equivalent, design includes an air piston/cylinder  
mounted within the L-shaped member 321 which is coupled  
30 to the driving plate 331 and which reciprocates it. In  
such a design, a coupling means, for example a fixed rod



1 mated to both plates 329,331, must be utilized to slave  
the motion of plate 329 to the motion of the dive plate  
331.

Referring now to Figure 11, which is a  
5 perspective view of the integrator unit, a detailed  
description of the features and functions of the  
integrator unit is provided. Similar in many respects  
to the segregator unit 320, the integrator is  
essentially the same device which operates in reverse.  
10 A housing element 341, which is L-shaped and mounted to  
the outside lateral edge of the second segment 312 of  
the buffer conveyor. A pair of guide rails 343 extend  
outward from the housing member 341 and are received by  
a stationary plate 347, mounted to the outside lateral  
15 edge of the third segment 312 of the buffer conveyor. A  
set of spaced apart moving plate 349, 351 are slidably  
mounted to the guide rails 343 such that the planes of  
these plates 349,351 are aligned vertically and parallel  
to the direction of conveyor motion. The second moving  
20 plate 351 is coupled to a motive means (not shown) such  
that it may be reciprocated from a position at the  
outside lateral edge of the second conveyor segment 308  
to a position between the second and third segments  
308,312. The first and second plates 349,351 are  
25 maintained in a spaced apart relation such that a pallet  
40 may be transferred therebetween, from the third  
segment 312 to the fourth segment 316 upon selective  
reciprocation of the plates 349,351 along the guide  
rails 343.

30 In operation, as can be inferred from Figure  
11, the reciprocation of the plates 349,351 is

This Sheet Has Been Replaced



THIS SHEET HAS BEEN  
REPLACED

1 selectively controlled such that alternating pallets,  
one from the second segment 308 followed by one from the  
third segment 312, advance to the fourth segment 316.  
It is understood that a variety of motive means and/or  
5 coupling means may be utilized for reciprocating the  
plates 349,351 together, for example the guide rails 343  
may be threaded matable to a threaded hole or nut in the  
plates 349,351. A separate, but equivalent, design  
includes an air piston/ cylinder mounted within the L-  
10 shaped member 341 which is coupled to the driving plate  
351 and which reciprocates it. In such a design, a  
coupling means, for example a fixed rod mated to both  
plates 349,351, must be utilized to slave the motion of  
plate 349 to the motion of the drive plate 351.

15 THE LOW VIBRATION LENS-PACKAGE TRANSPORT ASSEMBLY, THE  
INSPECTION ASSEMBLY, AND THE WATER EXTRACTION ASSEMBLY

Referring now to Figure 12, a top view  
diagrammatic of the present invention is provided. As  
20 is illustrated, the lens transfer station 299, where the  
lenses are transferred to the packaging elements on the  
inspection pallets 40 is sequentially followed by the  
buffering station 399. The pallets, having advanced  
through the buffering station are transferred through a  
25 conveyor station 499 to the inspection station 599, by a  
low vibration conveyor assembly as described  
hereinbelow.

Figure 13 is a perspective view of the low  
vibration transfer assembly which transfers the  
30 inspection pallet from conveyor 316 to the inspection  
station. When a pallet 40 has passed through the

35 This Sheet Has Been Replaced



THIS SHEET HAS BEEN  
REPLACED

1 integrator unit of the buffer assembly and has passed  
down the fourth segment of the buffer conveyor, it is  
translated to a staging area 325 as illustrated in  
previously described Figure 9. At this staging area 325  
5 an overhead double axis transport carrier reciprocates,  
picks up the single pallet 40 for transfer to the  
automatic lens inspection station as illustrated in  
Figure 13. The overhead transport is a double axis  
Hauser Transport Mechanism, and is used to isolate the  
10 automatic lens inspection system from the remainder of  
the post-hydration line.

It is important that vibrations of the lenses  
and the deionized water be minimized during this  
transport, and through the entire inspection line so  
15 that water waves are avoided, as they can cause optical  
distortions which, in turn, may cause false  
determinations of lens quality. By utilizing a double  
axis transport mechanism, the pallet can be gently  
conveyed to the automatic lens inspection system, and  
20 thereby avoid such vibrations which that might otherwise  
impair the inspection results.

After the first pallet has been lifted from  
the staging area, the next pallet may be advanced into  
the staging area to be carried onto the inspection line  
25 conveyor. The double axis transport mechanism  
transports the pallets from the buffer conveyor, where  
the pallets are advanced at a given speed and spacing,  
to the inspection line, where the speed of the pallets  
is substantially slowed to avoid vibration. It is  
30 necessary, therefore, for the spacing of the pallets on  
the inspection conveyor to be substantially closer

This Sheet Has Been Replaced



THIS SHEET HAS BEEN  
REPLACED

1 together so that the inspection conveyor may accommodate  
the same number of pallets in a given time.

5 The low vibration pallet transfer assembly 400  
comprises a pair of pallet grasping plates 402a,402b  
which are mounted, in spaced relation to one another, to  
corresponding blocks 404a,404b. One of the grasping  
plates 402a is slidably mounted to its block 404a such  
that selective actuation of an extending mechanism  
(housed within block 404a) widens or reduces the spacing  
10 between the two grasping plates 402a,402b. The blocks  
404a,404b are mounted to a common wall element 406 which  
is slidably mounted to a base element 408. A second  
motive mechanism (also not shown) is disposed within the  
base element 408 and coupled with the common wall 406  
15 such that the wall 406 can be selectively raised and  
lowered. The base element 408 is mounted to a  
horizontal track 410 having a translating means for  
reciprocating the entire assembly from a position above  
the staging area 325 to the inspection station conveyor  
20 line 420.

In operation, the low vibration pallet  
transfer assembly 400 reciprocates to the staging area  
325 to receive a pallet 40. The common plate 406 is  
lowered, thereby positioning the pallet grasping plates  
25 402a,402b adjacent to the lateral edges of the pallet  
40. The motive element within the block 402a is  
actuated to draw the plates closer, therein bringing the  
inner surfaces of the plates 402a,402b in contact with  
the pallet 40. Once the pallet has been grasped  
30 securely by the lateral plates 402a,402b, the common  
wall 406 is raised, and the pallet is transported to the

This Sheet Has Been Replaced



THIS SHEET HAS BEEN  
REPLACED

1 inspection station conveyor line, which is disposed  
perpendicularly to the fourth segment 316 of the  
buffering conveyor line. Once in position above the  
inspection conveyor line 420, the pallet 40 is lowered  
5 onto the line and released by actuation of the plate  
widening mechanism. The pallet is then carried into the  
inspection station. Once the pallet is transferred to  
the low vibration lens transfer assembly 400 rises and  
reciprocates back to the staging area 325 to receive the  
10 next pallet 40.

In the Automatic Lens Inspection System, the  
inspection pallets 40 are conveyed through the system as  
a pulse of light is directed through the lens-packages  
and contact lenses, and focused on a camera to generate  
15 an image of the lens therebelow. Preferably, the camera  
includes an array of pixels, each of which generates a  
respective one electric signal proportional to, or  
representing, the intensity of the light incident on the  
pixel. Those electric signals are then digitally  
20 processed to determine if the lens is acceptable for  
consumer use. Suitable procedures for processing or  
analyzing the electric signals from the pixel array are  
disclosed in copending Patent Application Nos. 993,756  
and 995,281, entitled "Automatic Lens Inspection  
25 System", the disclosures of which are herein  
incorporated by reference. Separate systems are  
utilized to inspect the sixteen lenses carried in a  
pallet. After completing the test for the last bank of  
lenses, the Automatic Lens Inspection System sends a  
30 datablock with the vision inspection results to the  
programmable logic controller used to consolidate the

This Sheet Has Been Replaced



THIS SHEET HAS BEEN  
REPLACED

1 lenses for packaging. This information is used by the  
lens-package transfer assembly as described below.

After the lenses have been inspected by the  
automatic lens inspection system, the pallet is lifted  
5 by second double axis overhead transport and placed on  
conveyor for transport to the deionized water removal  
station (which is station 699 in Figure 12). The  
deionized water is removed by a specially configured  
nozzle, as described in U.S.S.N. 08/999,234, entitled  
10 "Solution Removal Nozzle", the disclosure of which is  
hereby incorporated herein by reference thereto. As  
described earlier, the deionized water is used to center  
the lens within the package carrier during the  
inspection process, but is removed prior to packaging,  
15 to enable a precise dosing of a buffered saline solution  
in the final package, as will hereinafter be described  
in detail.

After removal of the deionized water, the  
lenses, package carriers and inspection pallet are  
20 transported to the lens-package transfer assembly which  
removes the packaging elements and lenses therefrom,  
deposits the optically incorrect lens-packages (as  
determined by the inspection station) on a conveyor for  
bad lenses, and deposits the correct lens-packages on  
25 good conveyor.

THE FIRST ROTATING LENS-PACKAGE TRANSFER  
ASSEMBLY

Referring now to Figure 15, the lens-package  
30 transfer assembly is shown in a perspective view, in  
position above a pallet of lens-packages which have had

35 This Sheet Has Been Replaced



THIS SHEET HAS BEEN  
REPLACED

1 the deionized water removed therefrom. The assembly 500  
comprises a reciprocating support 502 coupled at the  
lower end of a vertical shaft 504. The shaft 504 is, in  
turn, coupled at its upper end to a rotation means 506  
5 whereby the shaft 504 and the support 502 may be  
selectively rotated by 90 degrees in accordance with the  
predetermined positioning of a pallet 40 or the  
orientation of the conveyor (see Figure 16) onto which  
the lens-packages are deposited. It is understood that  
10 the rotating means 506 may comprise an air cylinder  
having stops which, for example, correspond to a 90  
degree rotation so that the shaft may be reciprocated  
between two orientations which are perpendicular.

The rotating means 506 is disposed within a  
15 mounting platform 501, which is in turn coupled to a  
dual axis transport subassembly (the horizontal track  
thereof is identified as element 503 in Figure 15). The  
dual axis transport subassembly transports the support  
502 from a first location to a second location, for  
20 example, from a position above the water extraction  
conveyor line to a position above the consolidating  
conveyor line (which is described more fully with  
reference to Figure 16).

Extending downwardly from the support 502 are  
25 a set of resilient bellowed fingers 508 having a  
generally elliptical shape. The fingers 508 each have  
an open tip 510 at their lower ends which forms an  
entrance into a central volume which extends the length  
of the finger. The upper ends of the fingers 508 are  
30 coupled to the vacuum tubes 512 such that the central  
volume of the fingers are in sealed gas flow relation to

This Sheet Has Been Replaced



THIS SHEET HAS BEEN  
REPLACED

1 tubes 512 which are individually coupled to a vacuum  
source (not shown). Each tube is separately valved; the  
valves being independently controlled by a processor in  
accordance with signals received from the inspection  
5 station with respect to which lens-packages contain  
correct lenses. Selective activation of the vacuum  
source would, therefore, provide a low pressure suction  
at the tips 510 of the finger 508. When this low  
pressure suction is employed, the tips 510 of the  
10 fingers may be placed onto a flat surface, therein  
sealing the central volume, and securing the flat  
surface to the finger 508.

In operation, a pallet 40 having lens-  
packages, from which the deionized water has been  
15 removed, is transported to the first location, the lens-  
packages being substantially aligned with the fingers  
508 of the first rotating lens transfer assembly 500.  
The fingers 508 are directed downward until their tips  
510 contact the flat surface portion 46b of the  
20 packaging element, forming a sealing interface  
therewith. Selective actuation of the valves  
controlling the drawing of a vacuum within each finger  
508 causes the package elements and lenses to be lifted  
from the pallet. It is understood that all of the lens-  
25 packages may be removed from the pallet 40 and  
subsequent actuation of the valves may be utilized to  
deposit the incorrectly molded lenses on a separate,  
bad, conveyor, and the optically correct lenses on the  
good conveyor, or in the alternative, only the good  
30 lenses are transferred, and the rejected lenses are  
later removed from the inspection pallet by an

This Sheet Has Been Replaced



THIS SHEET HAS BEEN  
REPLACED

1 alternative means. This procedure can be used to  
increase (shorten) the cycle time of the transfer  
device.

5 Once the appropriate lens-packages are removed  
from the pallet 40, the manifold 502 and fingers 508 are  
rotated 90 degrees by the rotating means 506 while  
simultaneously being reciprocated upward and laterally  
by the dual axis transport subassembly. The fingers 508  
are repositioned over the consolidating conveyor, at  
10 which point the vacuum within the fingers 508 which are  
holding lens-packages is released, and the lens-packages  
are deposited on the conveyor.

Once the optically correct lens-packages have  
been so deposited, the assembly 500 reciprocates back to  
15 extract a new set of lens-packages from the next  
inspection pallet 40.

CONSOLIDATING CONVEYOR AND SECOND ROTATING LENS-PACKAGE  
ASSEMBLY

20 The first rotating lens-package transfer  
assembly 500 deposits the optically correct lens-  
packages onto the consolidating conveyor 602 as shown in  
Figure 16. The consolidating conveyor comprises a belt-  
type motive surface 604 onto which the two rows of lens-  
25 packages are transported. The conveyor surface 604 is  
divided into parallel longitudinal channels 605 by a  
guide wall 606. As shown in Figure 16, the rows of  
lens-packages may not be regularly distributed on the  
conveyor surface when they are deposited.

30 The lens-packages are transported along the  
conveyor until the lead packages contact a moveable gate

35 This Sheet Has Been Replaced



THIS SHEET HAS BEEN  
REPLACED

1 element 610. The gate element 610 interferes with the  
continued transport of the lead lens-packages in each of  
the channels 605. As the progression of the lead lens-  
packages is halted, the packages which follow  
5 subsequently come into contact with the lead packages,  
therein being consolidated into a regularly spaced  
array. A sensor block is disposed above the conveyor  
surface 604, at a location upstream from the gate  
element 610. An additional sensor may be located at a  
10 distance wherein a specific number of lens-packages may  
be aligned therebetween in a staging position 609. For  
example, the array of lens-packages which is positioned  
between the wall element 608 and the sensor element 610  
in the embodiment illustrated in Figure 16 is 2 x 5.  
15 Gate element 610 provides for a controlled flow of only  
the correct number of lens packages necessary to  
complete the 2 x 5 array in the staging position.

Referring now also to Figure 17, a perspective  
view of the second rotating lens-package transfer  
20 assembly 650 is shown. Once a full 2 x 5 array of lens-  
packages are disposed in this staging position 609, a  
second rotating lens-package transfer assembly 650  
lowers a set of suction fingers which remove the array,  
rotates, and transports the lens-packages to a pallet of  
the saline solution injector and foil sealing assembly.  
25

More specifically with respect to the second  
rotating lens-package transfer assembly, the assembly  
comprises features which are similar in most respects to  
the first lens-transfer assembly 500. The assembly  
30 includes a support 652 which is mounted to the lower end  
of a rotating shaft 654. The upper end of the shaft 654

This Sheet Has Been Replaced



THIS SHEET HAS BEEN  
REPLACED

1 is coupled to a rotating means (not shown) which rotates  
the support through 90 degrees in the horizontal plane.  
Extending downwardly from the support 652 is an array of  
regularly spaced fingers 658, the tips 660 of which are  
5 hollow so that a vacuum may be drawn therethrough. This  
vacuum is used to securely hold the lens-package  
elements during transport. The fingers 658, which are  
hollow so as to form a conduit through which the vacuum  
may be drawn, are coupled to tubes 662, at the support  
10 652 for the purposes of supplying the vacuum pressure to  
the finger tips 660.

The rotating shaft 654 is coupled, through the  
rotating means, to a mounting platform 651. The  
mounting platform is, in turn, mounted to a dual axis  
15 motive means (track 653 comprises the horizontal axial  
component along which the mounting platform translates.  
In operation the assembly is positioned above the  
consolidating conveyor 602, at the staging position 609,  
as the array of lens-packages is consolidated. Once the  
20 sensor elements have determined that a full 2 x 5 array  
of lens-packages has been formed, the manifold 652 and  
fingers 658 are lowered by the dual axis motive means.  
A vacuum is drawn in the finger tips 660 once the lens-  
packages are contacted in order that a secure grip on  
25 the lens-packages may be maintained. The manifold 652  
and fingers 658 are then raised, rotated, and translated  
to a position above the pallet stream of the next  
assembly.

As with the first rotating lens-package  
30 transfer assembly 500, the rotating means and the dual  
axis motive preferably comprise, respectively, an air

35 This Sheet Has Been Replaced



THIS SHEET HAS BEEN  
REPLACED

1 cylinder with 90 degree stops, and a pair of  
perpendicular IKO ball screw mechanisms.

THE SALINE SOLUTION INJECTOR AND FOIL SEALING ASSEMBLY

5 Referring now to Figures 18, 19 and 20,  
various perspective views of the saline solution  
injector and foil sealing assembly 700 are shown.  
Figure 18 is a schematic device layout of the assembly  
including a conveyor loop 702 having a plurality of  
10 pallets 704 spaced therealong. The pallet stream is  
intermittently driven such that the pallets stop at the  
various subassembly stations which are sequentially  
spaced along the conveyor 702.

The related assemblies and subassemblies which  
15 cooperate to provide saline and heat sealed covers to  
previously unsealed lens-packages include the second  
rotating lens-package transfer assembly 650 disposed at  
the front of the conveyor 704, the saline injector  
subassembly 750 positioned adjacent to the front of the  
20 conveyor, a short distance downstream from the transfer  
assembly 650, a foil pick and place unit 777 which  
receives the foil from a printing machine, and a heat  
seal unit 780 which seals the foil to the packages.

Each of the fixed pallets 704 is particularly  
25 designed to support a 2 x 5 array of individual lens-  
packages. It should be appreciated, however, that  
alternative embodiments of this assembly can be  
designed, in accordance with the number of fingers of  
the second lens-package transfer assembly 650, and the  
30 size of the staging position 609 of the consolidating

This Sheet Has Been Replaced



THIS SHEET HAS BEEN  
REPLACED

1 conveyor, to accommodate a different number of rows and  
a different number of packages in each row.

With specific reference to Figure 20, at the  
saline solution injector subassembly 750, the lens-  
5 packages are filled with a saline solution which has a  
tonicity compatible with the human eye. Stationary  
pallets 704 are advanced, with lens-packages thereon,  
beneath a horizontal beam 752. The beam 752 is coupled  
at a lateral end to a mounting base 754 which is  
10 adjacent to the conveyor loop 702. A 1 x 5 array of  
dosing tubes 756 extend downward from the beam 752, and  
are supplied with saline solution by saline conduits  
758, each of which is supplied by a separate dosing pump  
(not shown).

15 Upon incremental advance of the pallets 704  
into a position aligned with the dosing tubes 754, the  
dosing pumps are actuated so that a precise dosage of  
saline solution is deposited into the packaging recesses  
24. Each contact lens is thereby completely immersed in  
20 saline solution. The rate of pumping of saline solution  
and the diameter of each dosing tube 756 is chosen such  
that no saline solution splashes from any of the  
recesses of the packages, which is very important as any  
saline solution splashed onto the annular rim 28 would  
25 interfere with subsequent foil sealing operations.

The optical verification probes (not shown)  
may be mounted in front of the saline injector  
subassembly to verify that lens-packages are present in  
the advancing pallet 704 so that the dosing tubes 756 do  
30 not dispense saline solution into empty pallets.  
Additional sensors may be similarly mounted along the

35 This Sheet Has Been Replaced



THIS SHEET HAS BEEN  
REPLACED

conveyor, downstream from the saline injector 750, to  
detect the presence of the proper measured dose of  
5 saline solution in each lens-package. A variety of such  
sensors are available, and are taught in co-pending  
application U.S.S.N. 08/431,891, entitled "Linear  
Packaging Array" (Attorney Docket No. 9401), for example  
the sensor may be a reflective sensor as is commercially  
10 available from Omron, or it could be a proximity sensor  
or could be a fiber optic probe, as commercially  
available from Keyence as model 24W-V25R, used with an  
amplifier, model 24W-AA1C. Each detector checks and  
verifies for a proper height of saline solution in each  
15 lens-package.

Referring again to Figure 18, and also to  
Figure 19, at a subsequent foil pick and place station  
775, a pair of strips of laminar foil are placed over  
the 2x5 array of package bases, each foil strip covering  
20 a 1x5 column of packaging elements. The foil strips  
have printed thereon all identification indicia required  
for the final package. The laminar top cover sheets are  
produced by a foil labeling machine pursuant to the  
disclosure of patent application U.S.S.N. 08/106,386,  
25 entitled "Double Sided Foil Printing" (VTN-0089)  
(Attorney Docket 9013). The foil labeling machine  
extends at a right angle to the linear packaging  
machine, as indicated by the FOIL arrow in Figure 18.  
The pair of foil strips are received from the labeling  
30 machine and placed by a foil pick and place unit over  
the top of each 1x5 row of the 2x5 array of package  
bases.

This Sheet Has Been Replaced



THIS SHEET HAS BEEN  
REPLACED

1           An optional mechanical chucking station 777,  
positions each foil strip to ensure that it is properly  
positioned and aligned relative to the lens-packages in  
the pallet 704. In addition, a subsequent cover  
5   presence verification station may be used to verify the  
correct general positioning of each foil strip.

          At a subsequent station 780 the foil strips  
are heat sealed to the lens-packages. More  
specifically, a set of heated seal heads, mounted at  
10 spaced intervals along the length of heating head plate  
782, and supported by a pneumatic cylinder or press 784,  
presses the foil strips against the lens-packages such  
that the foil and the annular rims 28 of the packaging  
elements are squeezed between the heated seal heads and  
15 the pallet 704.

          A final optical inspection station (not shown)  
may be located downstream of the heat sealing station  
780, including a plurality of optical detector probes  
for examining the outer edges of each sheet of laminated  
20 foil strips on the array of lens-packages to ascertain  
that the foil is properly and precisely positioned and  
heat sealed relative to the array of lens-packages.

          At the position which is farthest downstream,  
a robotic assembly 790, having a plurality of vacuum  
25 suction cups removes the sealed 1x5 array of packages  
from the pallet 704, and transports them to an output  
position.

          While the several assemblies, embodiments and  
variations of the present invention for post hydration  
30 handling of contact lens-packaging elements are  
described in detail herein, it should be understood that

35

This Sheet Has Been Replaced



THIS SHEET HAS BEEN  
REPLACED

1 the disclosure and teachings of the present invention  
will suggest many alternative designs to those skilled  
in the art. The scope of the present invention is,  
therefore, understood and intended to be limited only by  
5 the claims recited hereinbelow.

10

15

20

25

---

This Sheet Has Been Replaced



30

35

|                                 |
|---------------------------------|
| THIS SHEET HAS BEEN<br>REPLACED |
|---------------------------------|



1 What is claimed is:

1. An apparatus for transporting contact lens elements from a first location to a second location, said apparatus comprising:

5 a plurality of elongate finger elements, each element having a convex lens transport surface defined thereon;

a lens transfer carriage, said carriage having an array of said elongate finger elements which receive the contact lens elements at a first location;

10 a drive to alter the spatial relationship of the array;

a translation device to transport the carriage and the lenses to a second location;

15 an orifice defined within said convex lens transport surface for injecting a fluid between said lens and said surface to deposit the lenses into a second lens carrier at said second location.

2. The apparatus as set forth in claim 1, wherein said lens transfer carriage further comprises:

20 a set of horizontal guide rails;

a plurality of beam elements, slidably mounted in parallel on at least one of said of horizontal guide rails; and

25 at least one reciprocating drive coupled to said beam elements for reciprocating same along said guide rails with respect to one another.

3. The apparatus as set forth in claim 2, wherein said plurality of finger elements are disposed in a plurality of linear arrays, with a linear array

35 This Sheet Has Been Replaced



THIS SHEET HAS BEEN  
REPLACED



1 extending downwardly from each of said beams, said  
fingers each comprising;

an elongate shaft, having an upper and lower  
end with the convex lens transfer surface at the lower  
end of the shaft,

5 a slotted annular skirt disposed along the  
shaft adjacent to said tip, for maintaining the contact  
lens at a predetermined position.

4. The apparatus as set forth in claim 1,  
wherein said apparatus further includes

10 a second translation mechanism for  
reciprocating said carriage along a second axis of  
movement.

5. The apparatus as set forth in claim 2,  
wherein said finger elements further comprise a central  
15 bore, extending from said upper end to said orifice in  
said lens transport surface, for receiving therethrough,  
and selectively ejecting therefrom, a quantity of fluid.

6. The apparatus as set forth in claim 1,  
wherein said apparatus further comprises, at said first  
20 location, a lens pallet having:

a plate having a plurality of recesses, each  
of said recesses aligned with said lens transport  
surfaces and having at least one hole therein, in which  
recesses a contact lens may be disposed; and

25 a plurality of internal conduits within said  
plate, extending from each of said holes to a fluid  
source, whereby selective ejection of fluid through the  
conduits causes a contact lens in said recess to be  
ejected therefrom and received by an associated lens  
30 transport surface.

This Sheet Has Been Replaced





1           7. The apparatus as set forth in claim 6,  
further comprising an air jet unit positioned at said  
second location, said air jet unit comprising:

5           a plate having a plurality of a regularly  
spaced recesses therein, said regular spacing  
corresponding to the spatial distribution of said  
fingers;

          at least one hole in each of said recesses;  
a conduit extending from a remote air

10 reservoir to said hole in each of said recesses;

          an air pressure means for selectively  
directing air through said conduit, out of said through  
hole, and at a contact lens which is secured to the lens  
transfer surface of said finger for removal of any  
bubbles thereon.

15           8. An assembly for extracting an array of  
contact lenses from a hydration pallet, changing the  
spatial distribution of the contact lenses, and  
depositing said contact lenses into packaging elements,  
said assembly comprising:

20           a mounting bracket including plurality of  
horizontal guide rails;

          a plurality of beam elements, slidably mounted  
in parallel on said plurality of horizontal guide rails;

25           at least one drive assembly motively coupled  
to said beam elements for reciprocation thereof along  
said guide rails between a compact spacing and a wide  
spacing;

30           a plurality of finger elements disposed in a  
linear array, extending downwardly from at least one of  
said beams, said fingers each comprising;

35           This Sheet Has Been Replaced



THIS SHEET HAS BEEN  
REPLACED



1 an elongate shaft, having an upper and  
lower end,  
a central bore, extending from said upper  
end to said lower end, for receiving  
5 therethrough a quantity of fluid, and  
selectively ejecting from said lower end said  
quantity of fluid,

a lens transfer surface at the lower end  
of the shaft for receiving, and securely  
10 holding, thereon a contact lens,

a slotted annular skirt disposed along the  
shaft adjacent to said tip, for maintaining  
the contact lens at a predetermined position;  
and

15 a dual axis translation mechanism for  
reciprocating said mounting bracket along a vertical  
axis and a horizontal axis.

9. A contact lens transfer assembly, said  
assembly comprising

20 at least one beam element, said beam element  
facilitating transfer of contact lenses between two  
locations;

a finger element, said finger element  
including an elongate shaft having a lens transfer  
surface on a first end and a means for attaching said  
25 shaft to said beam element on a remote second end;

said elongate shaft including a slotted  
annular skirt adjacent to said first end; and

30 a central bore extending through said elongate  
shaft for introducing a fluid between said lens transfer

This Sheet Has Been Replaced



THIS SHEET HAS BEEN  
REPLACED



1 surface and a contact lens secured thereon to release  
said lens.

5 10. A contact lens transfer assembly as set  
forth in claim 9, wherein said lens transfer assembly is  
shaped to conform to a concave surface of a contact lens  
so that same can be secured to the lens transfer surface  
by surface tension.

10 11. A contact lens transfer assembly as set  
forth in claim 9, wherein said slotted annular skirt  
includes:

at least one skirt element which prevent a  
contact lens from sliding off the lens transfer surface  
when said fluid or gas is directed at same, and

15 a set of vertically aligned slots defined by  
said skirt element through which a fluid or gas which is  
directed upwardly at the lens transfer surface may flow.

12. A method of transporting contact lens  
elements, said method comprising the steps of:

20 positioning an array of elongate finger  
elements above an array of lens carrier cavities, each  
of said finger elements having a lens transfer surface  
defined thereon;

25 injecting a fluid into each of said cavities  
having a contact lens therein to said lens from its  
associated cavity and transfer the lens to an associated  
lens transfer surface;

transporting said array of elongate finger  
elements to a second location; and

30 releasing the lenses into a set of lens  
carriers at said second location.

This Sheet Has Been Replaced



THIS SHEET HAS BEEN  
REPLACED



1           13. The method as set forth in claim 12,  
which further comprises the step of changing the  
relative spatial dimensions of said array after said  
lenses have been transferred to said lens transfer  
surfaces.

5           14. The method as set forth in claim 12,  
wherein said method further comprises:

          ejecting a quantity of air from an orifice  
defined in each of said cavities beneath each lens to  
propel it onto said lens transfer surface.

10          15. The method as set forth in claim 14,  
wherein said step of ejecting a quantity of air from  
beneath each lens is followed by the step of directing a  
jet of air at each lens for the purposes of removing any  
air bubbles which be present on the lens surface.

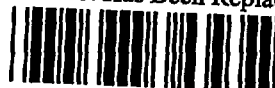
15

20

25

30

This Sheet Has Been Replaced



35

THIS SHEET HAS BEEN  
REPLACED

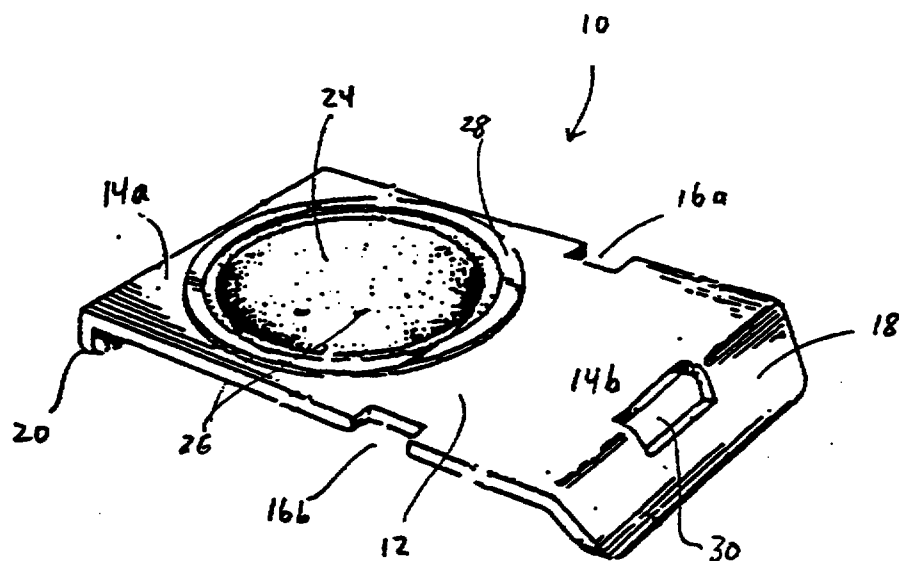
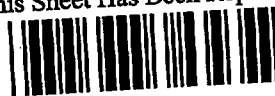


Fig. 1

This Sheet Has Been Replaced



THIS SHEET HAS BEEN  
REPLACED

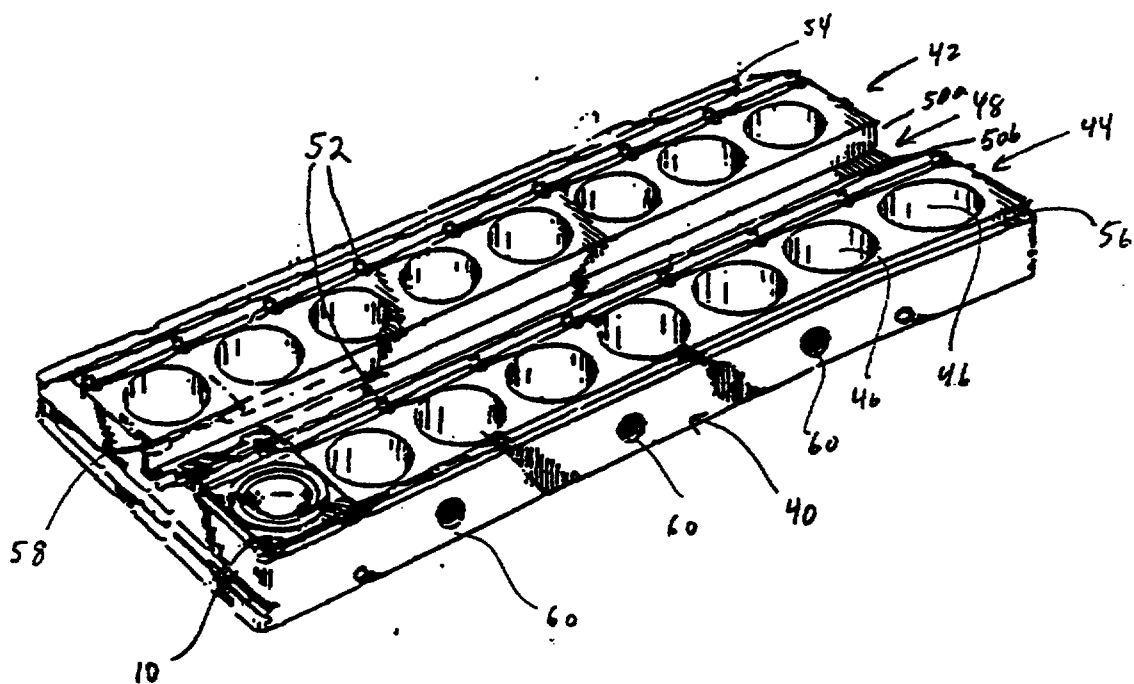


Fig. 2

This Sheet Has Been Replaced



THIS SHEET HAS BEEN  
REPLACED

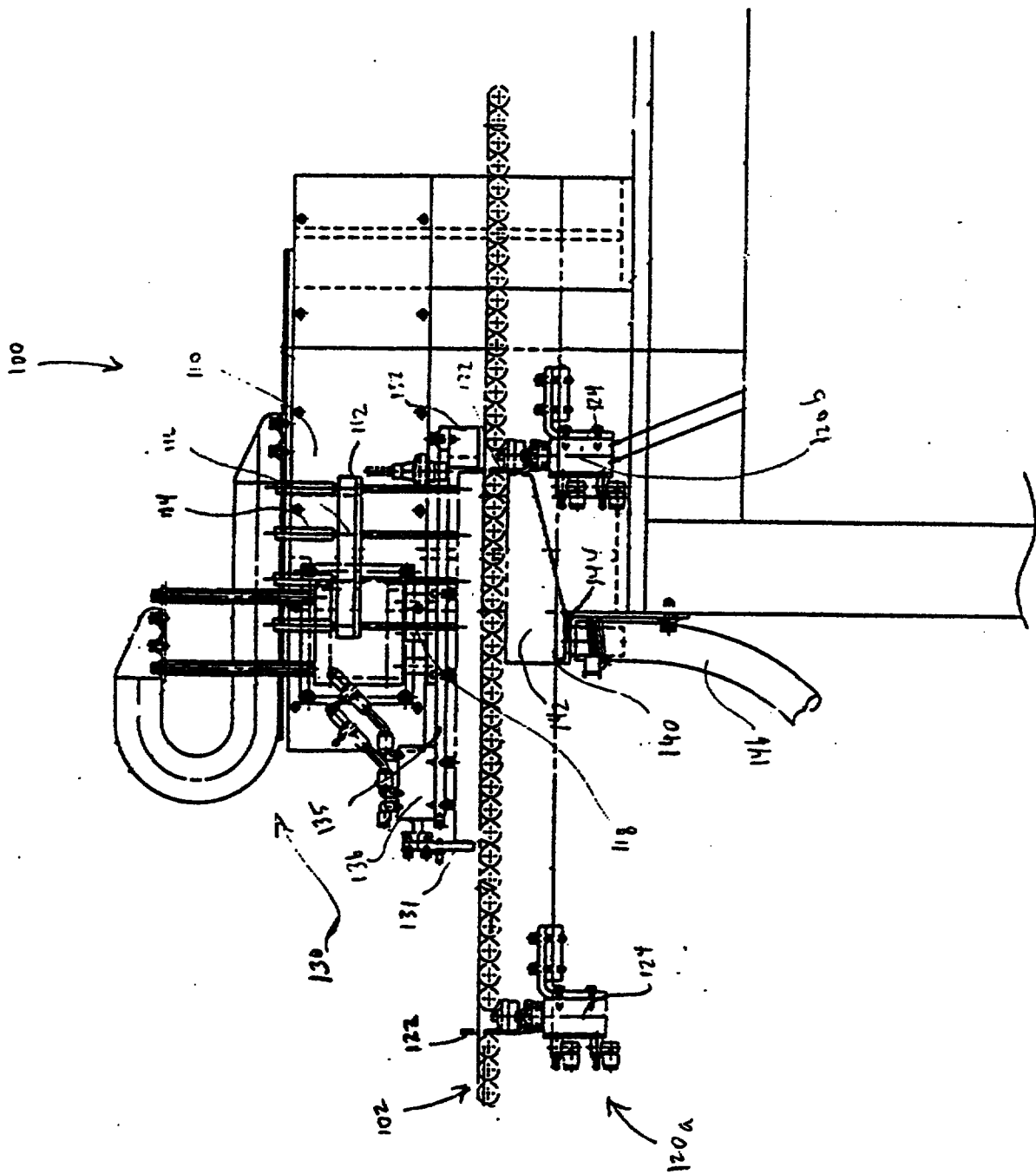
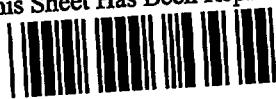


Fig 3a

This Sheet Has Been Replaced



THIS SHEET HAS BEEN REPLACED

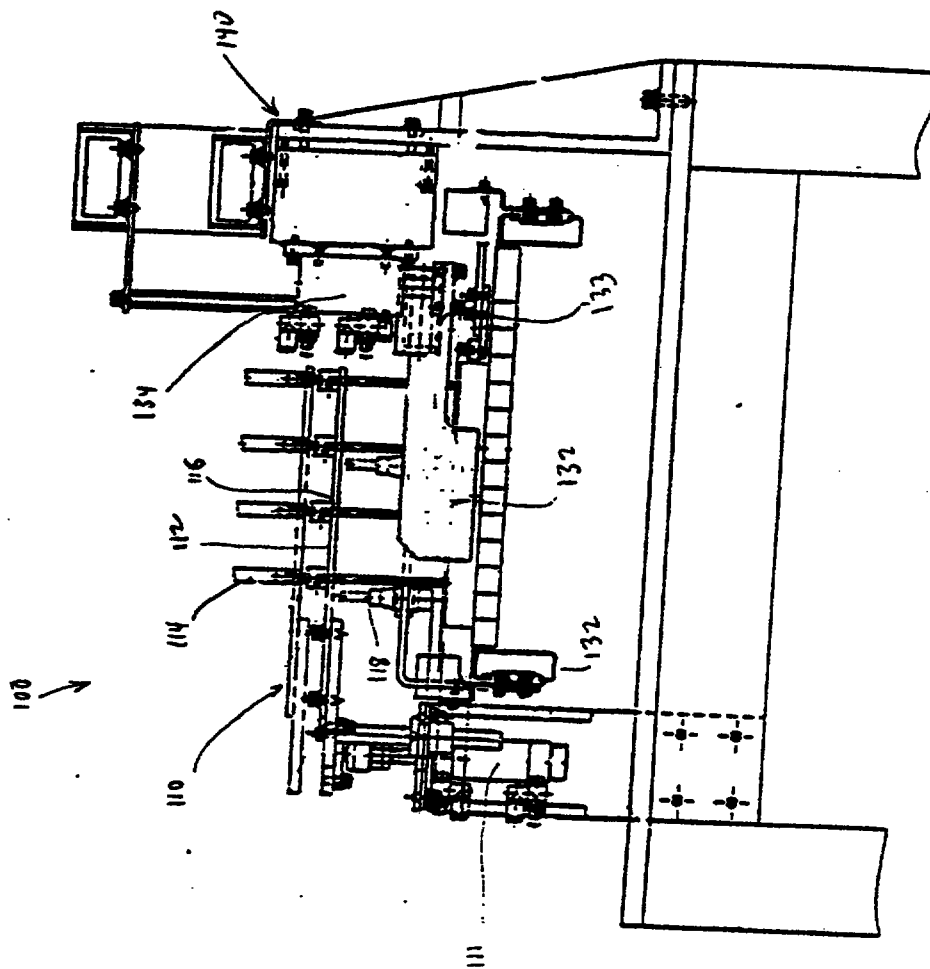


Fig 31

This Sheet Has Been Replaced

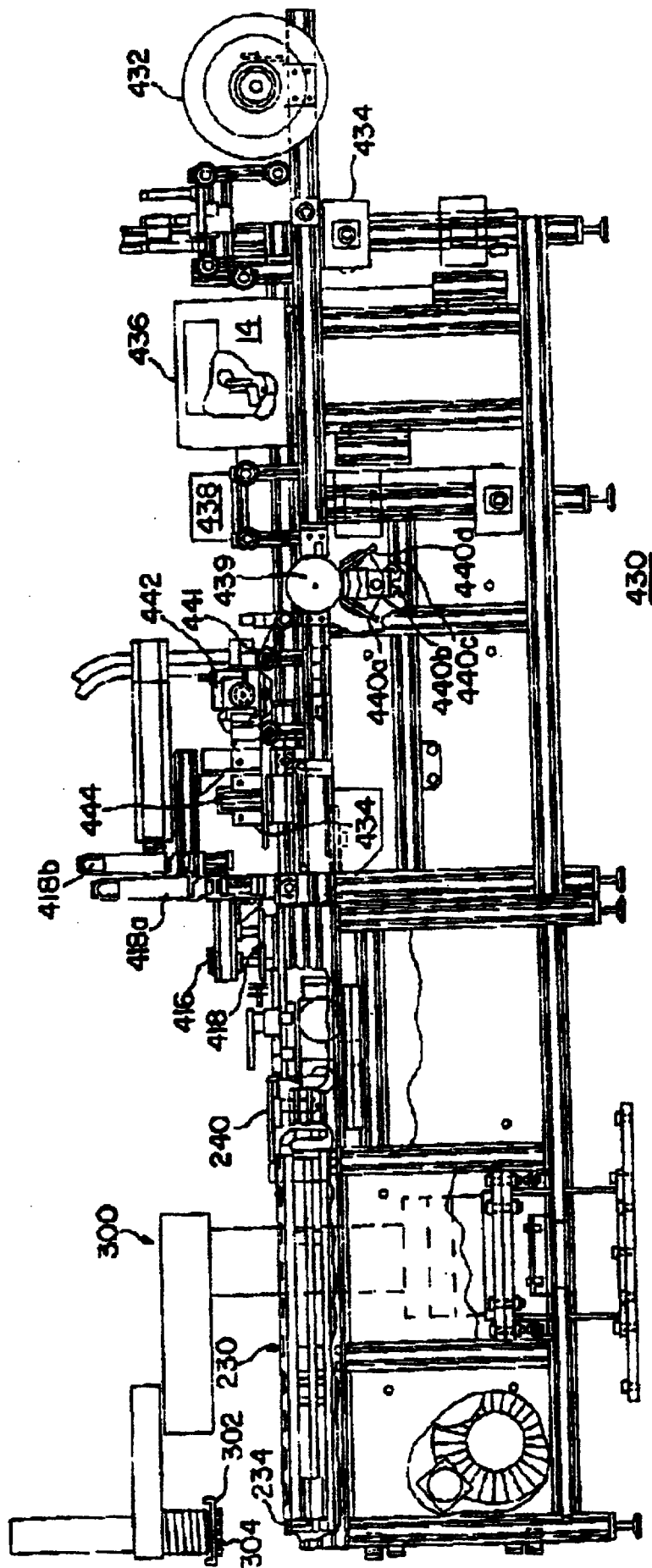


THIS SHEET HAS BEEN  
REPLACED

This Sheet Has Been Replaced



FIG. 4



THIS SHEET HAS BEEN  
REPLACED

This Sheet Has Been Replaced

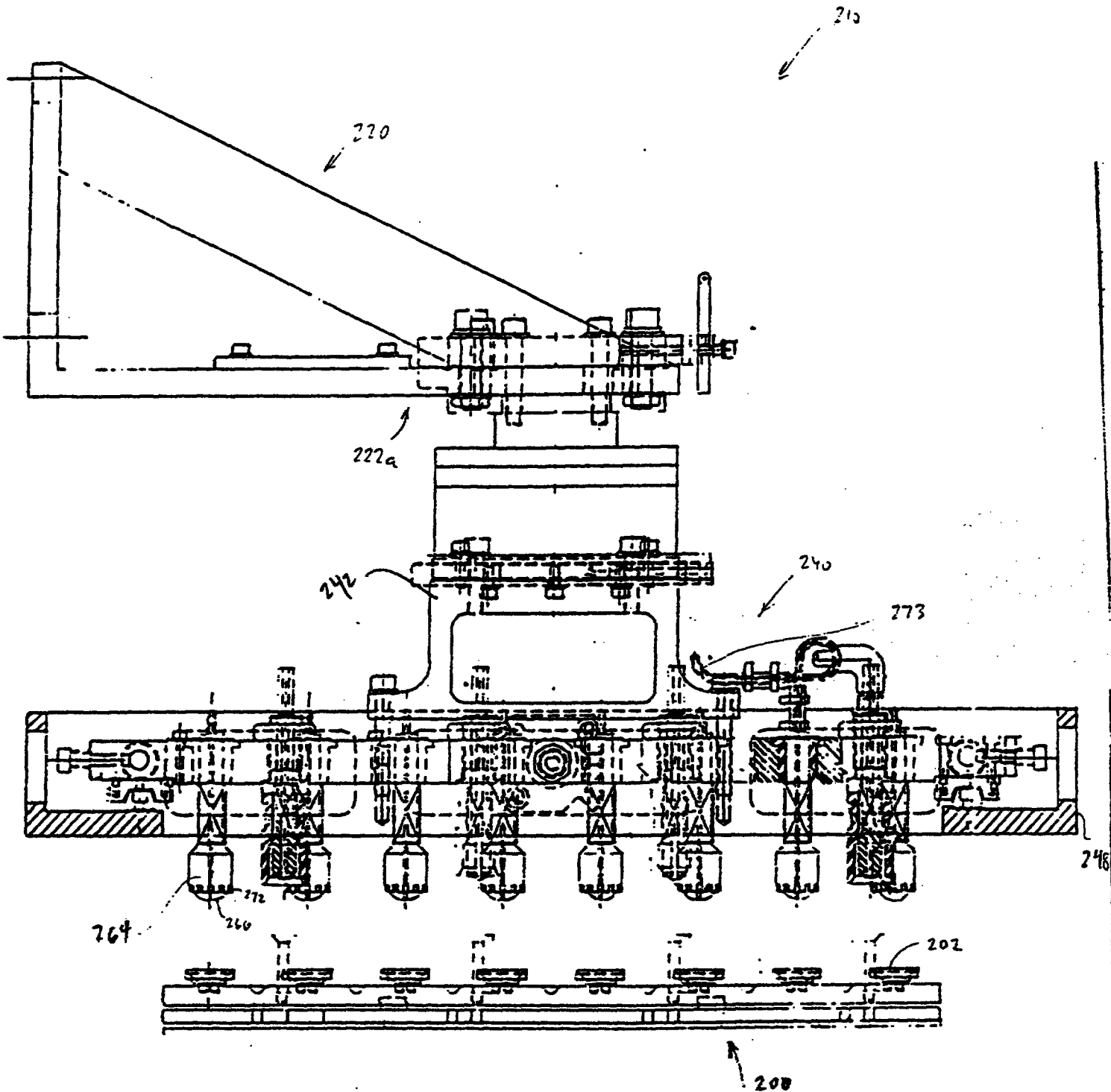


Fig. 5a

THIS SHEET HAS BEEN  
REPLACED

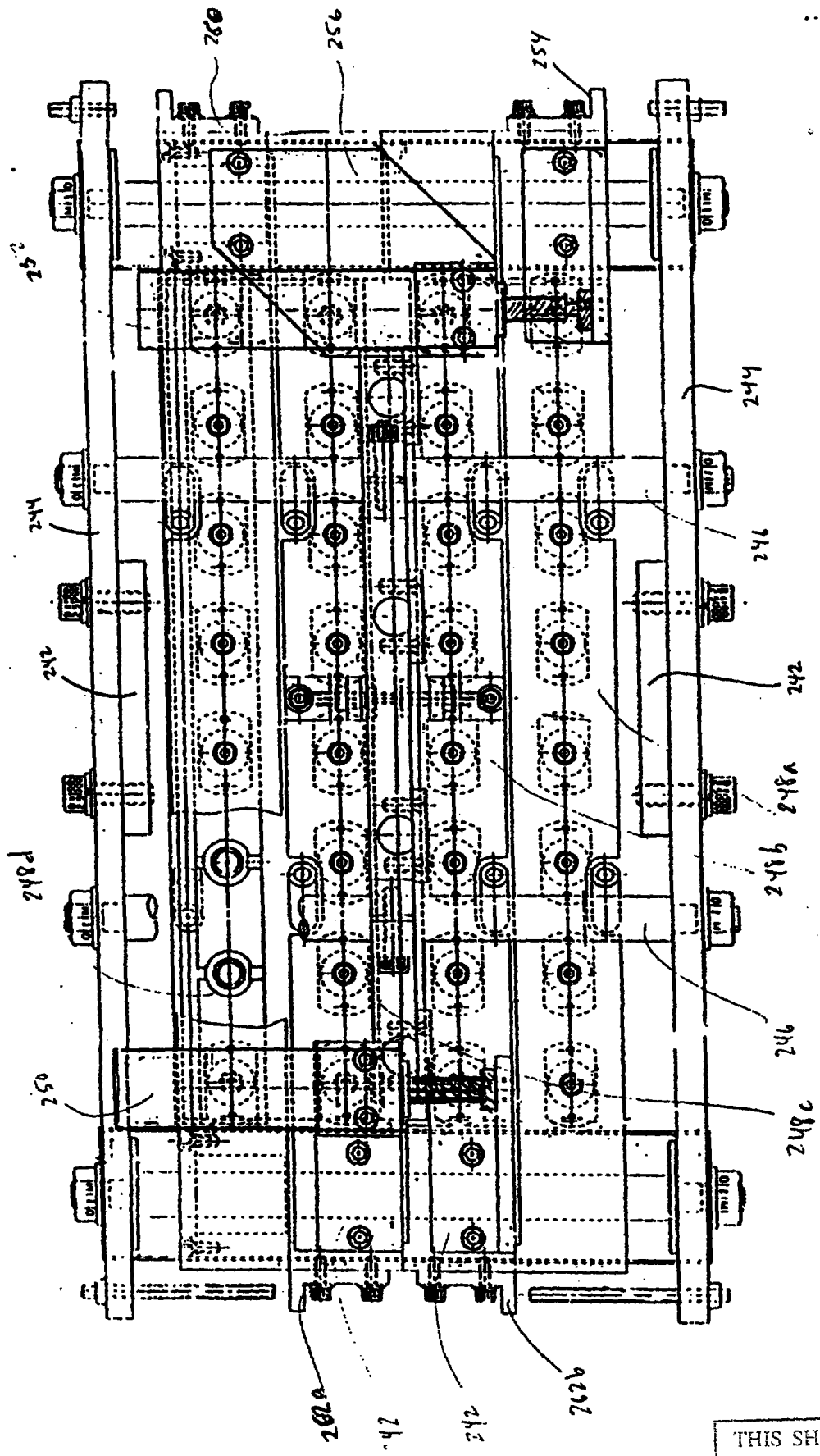


Fig. 5b

This Sheet Has Been Replaced

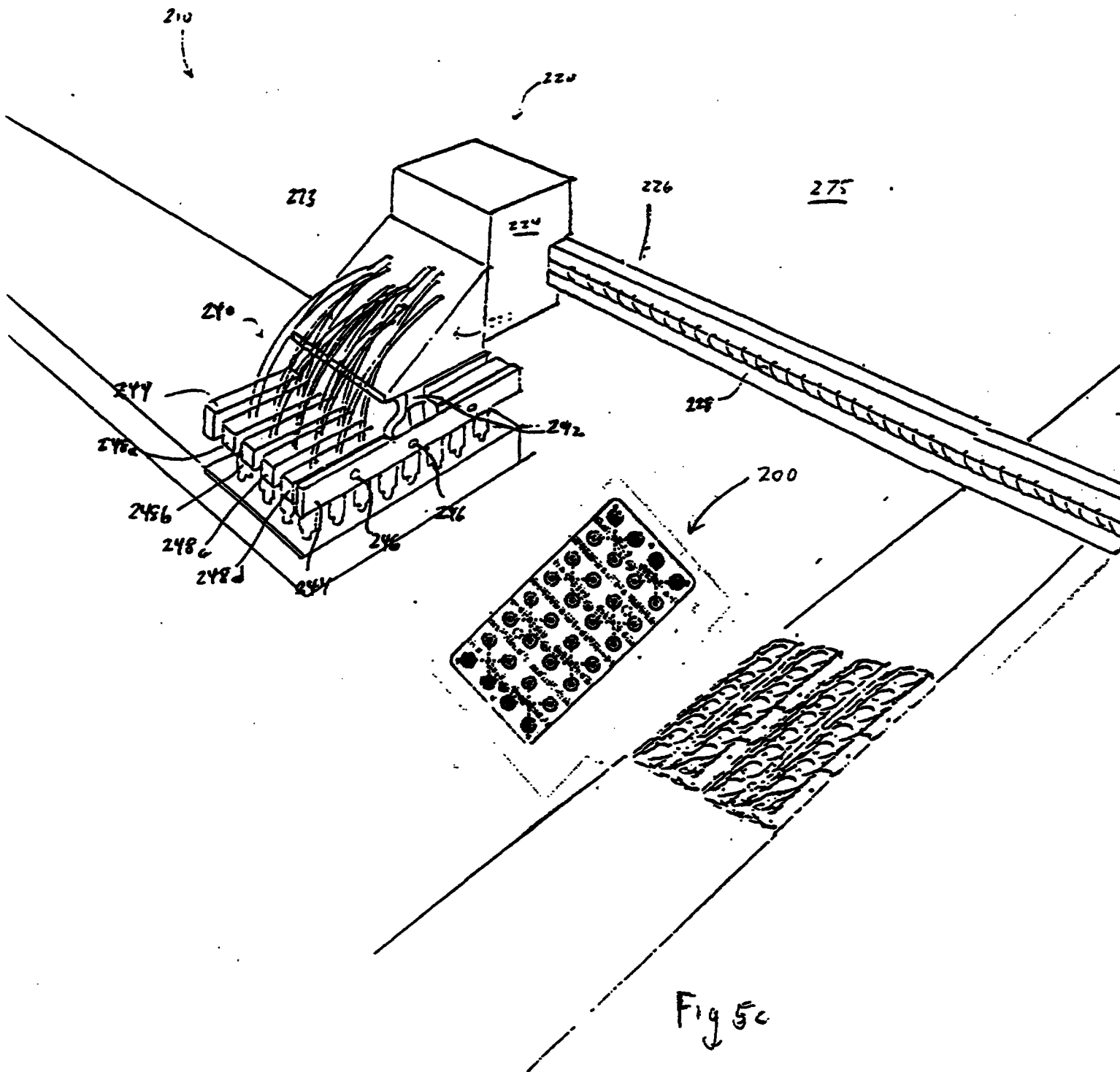


Fig 5c

THIS SHEET HAS BEEN  
REPLACED

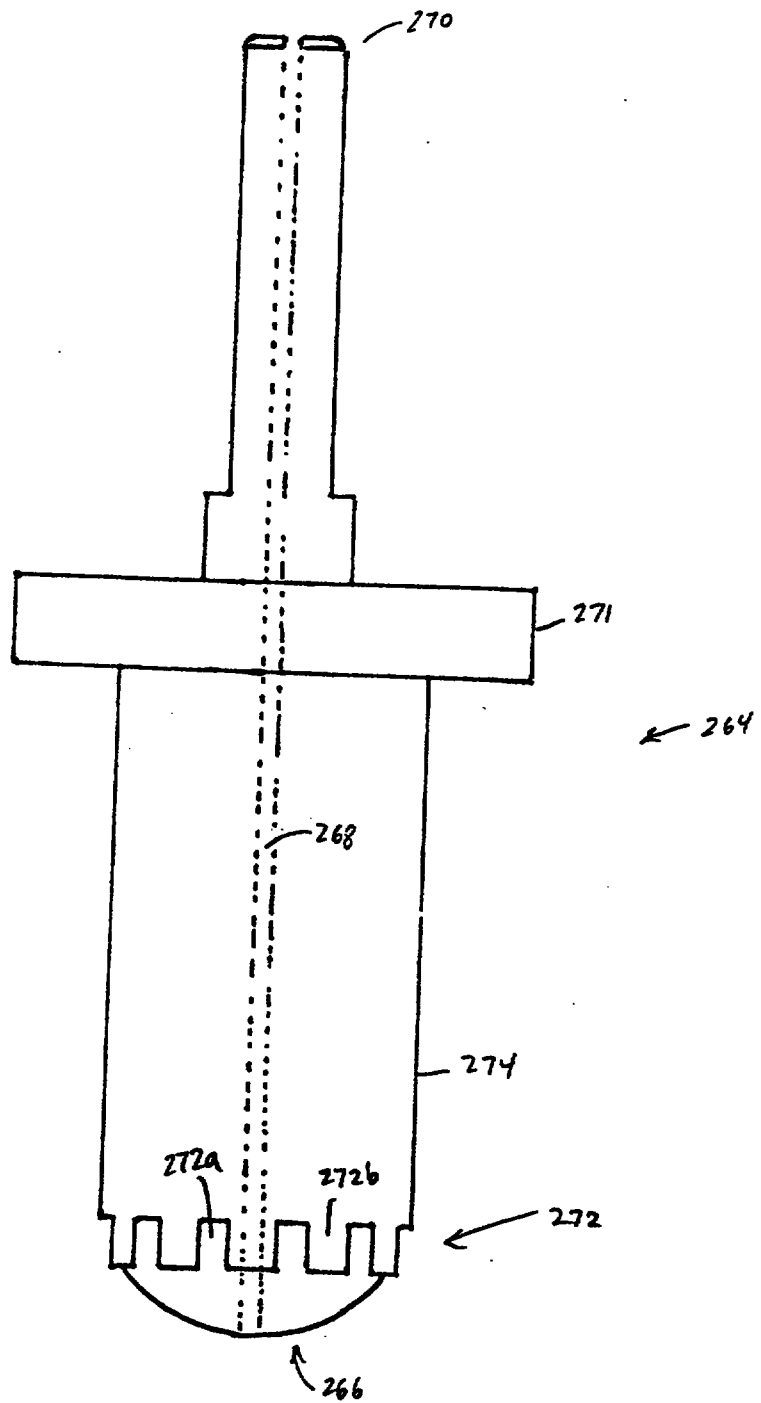


Fig. 6

This Sheet Has Been Replaced



THIS SHEET HAS BEEN  
REPLACED

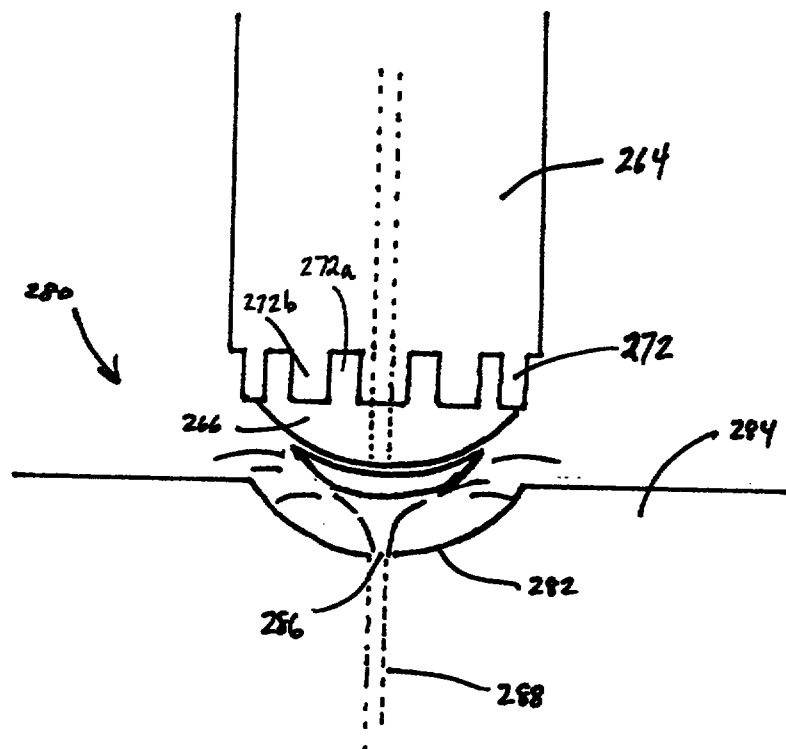


Fig 7

This Sheet Has Been Replaced



THIS SHEET HAS BEEN  
REPLACED

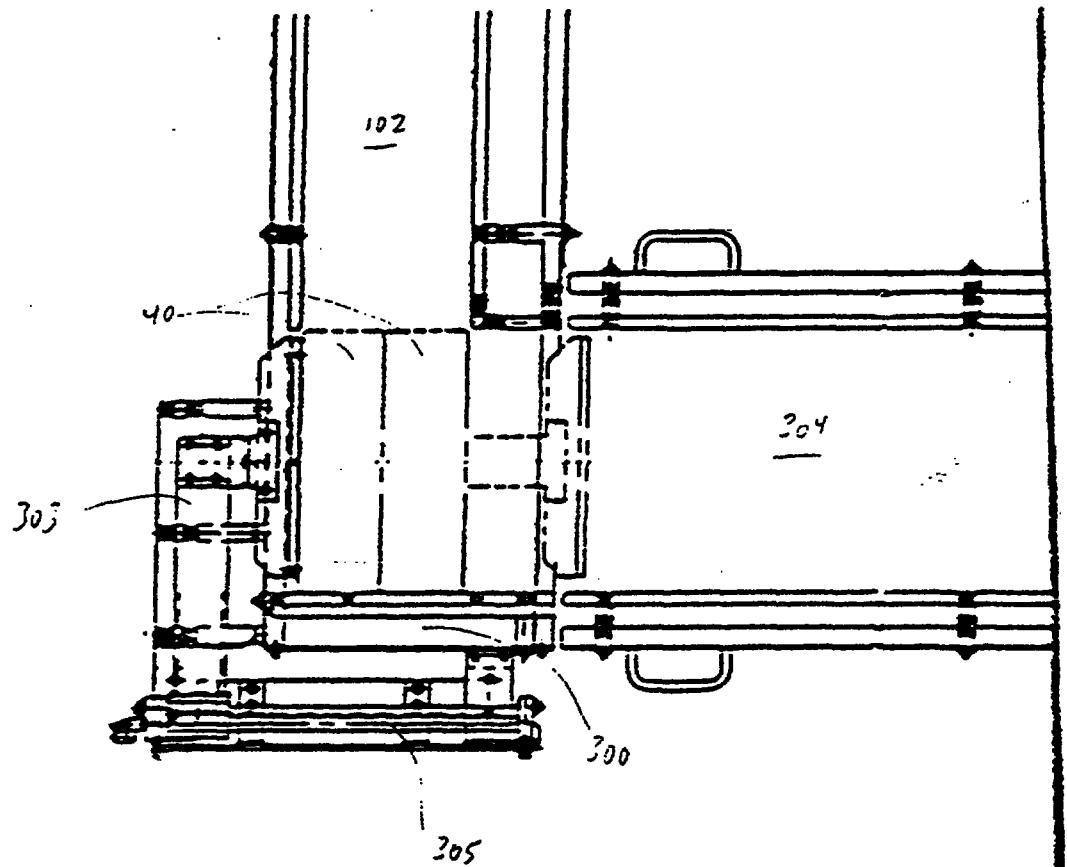


Fig. 8

This Sheet Has Been Replaced



THIS SHEET HAS BEEN  
REPLACED

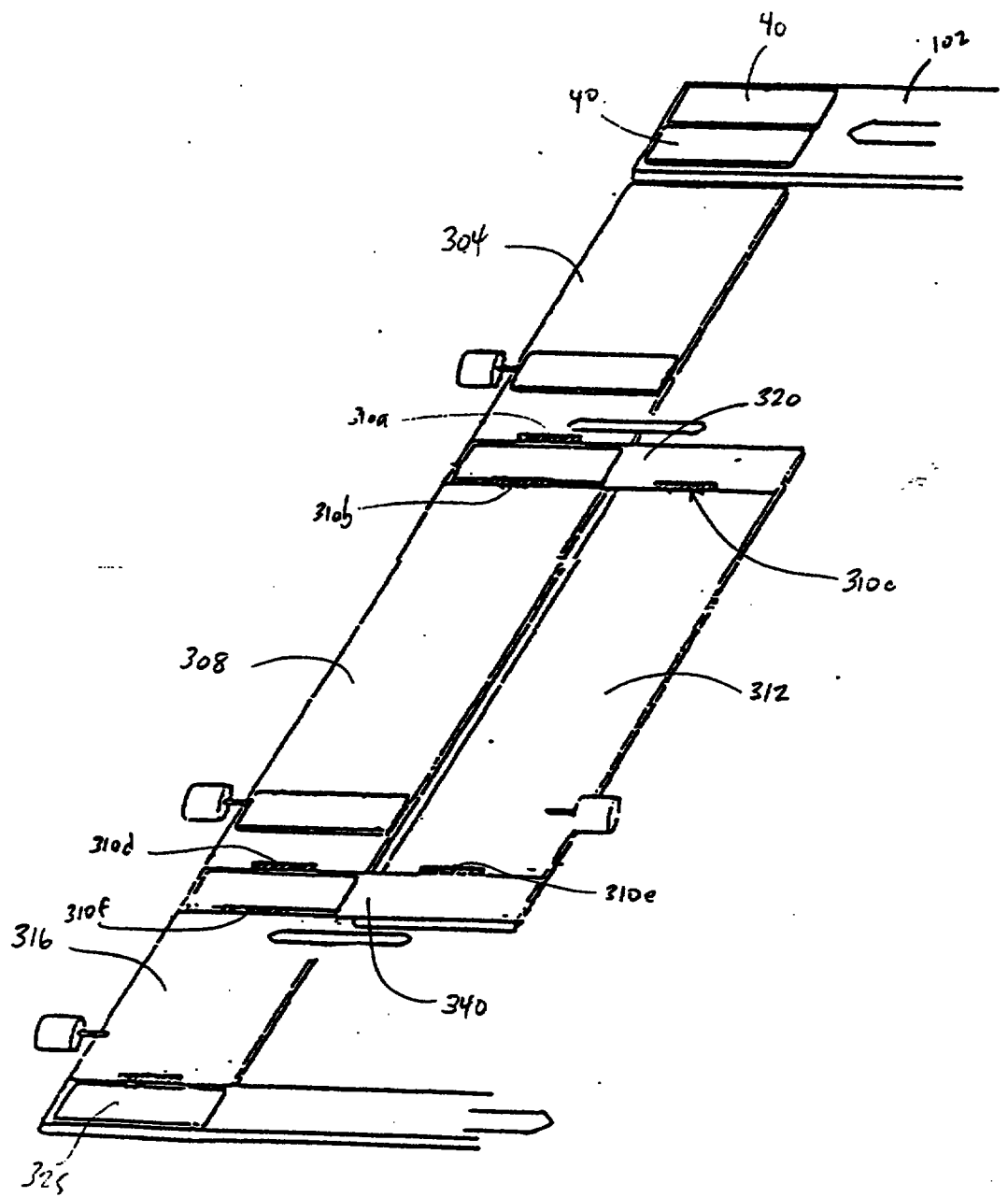


Fig 9

This Sheet Has Been Replaced



THIS SHEET HAS BEEN  
REPLACED

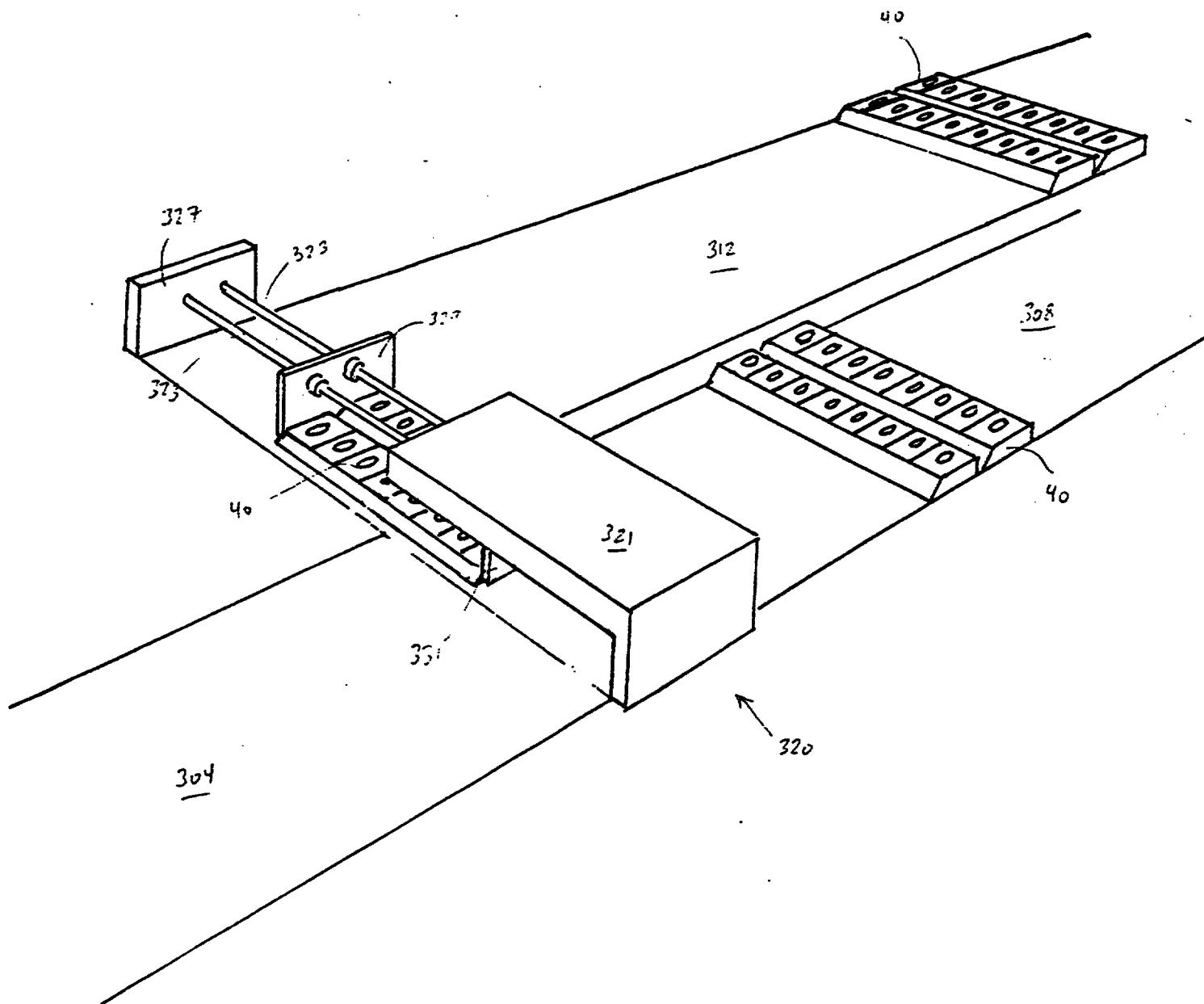


Fig. 10

This Sheet Has Been Replaced



THIS SHEET HAS BEEN  
REPLACED

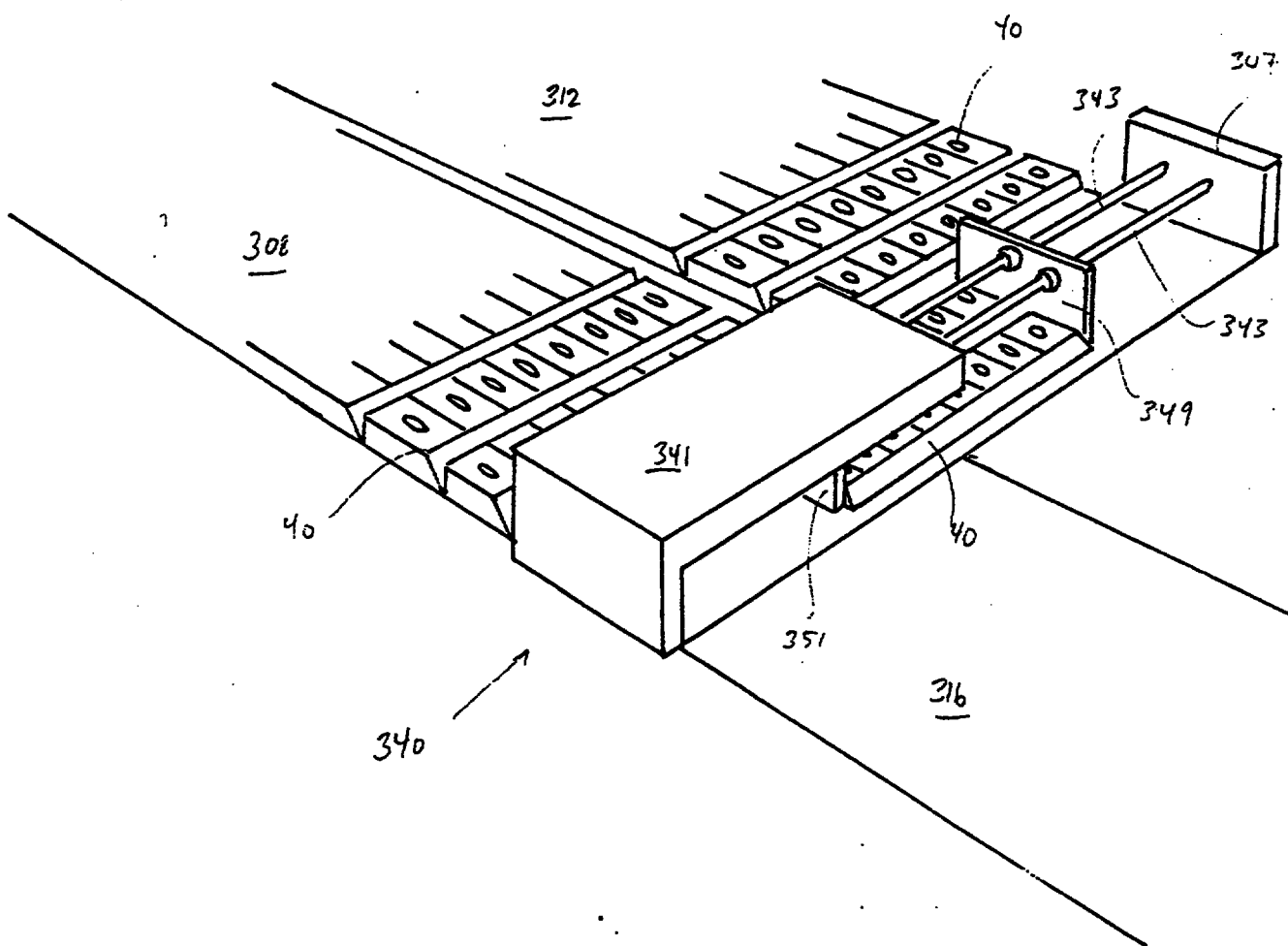
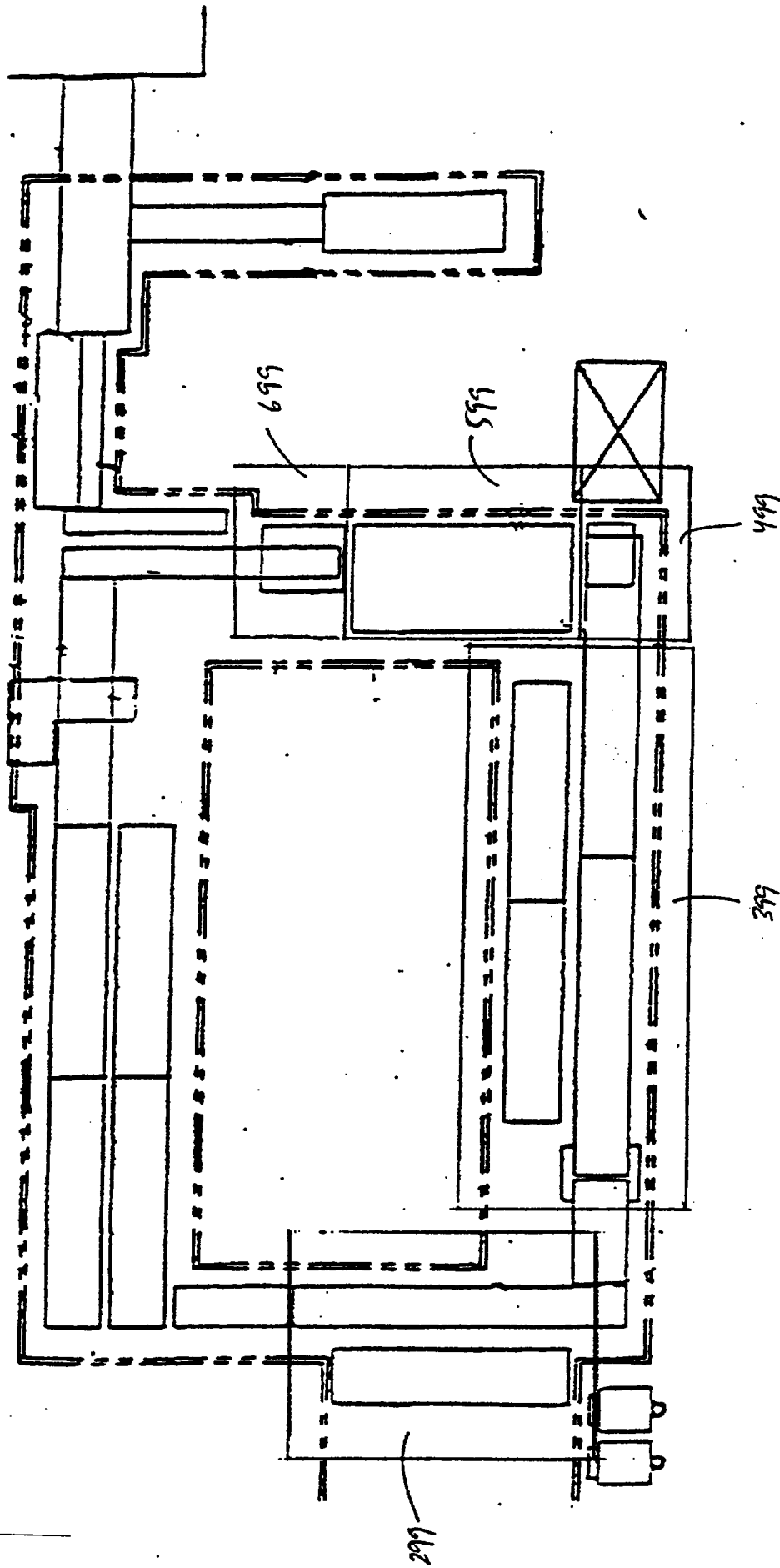


Fig. 11

This Sheet Has Been Replaced



THIS SHEET HAS BEEN  
REPLACED



This Sheet Has Been Replaced



THIS SHEET HAS BEEN  
REPLACED

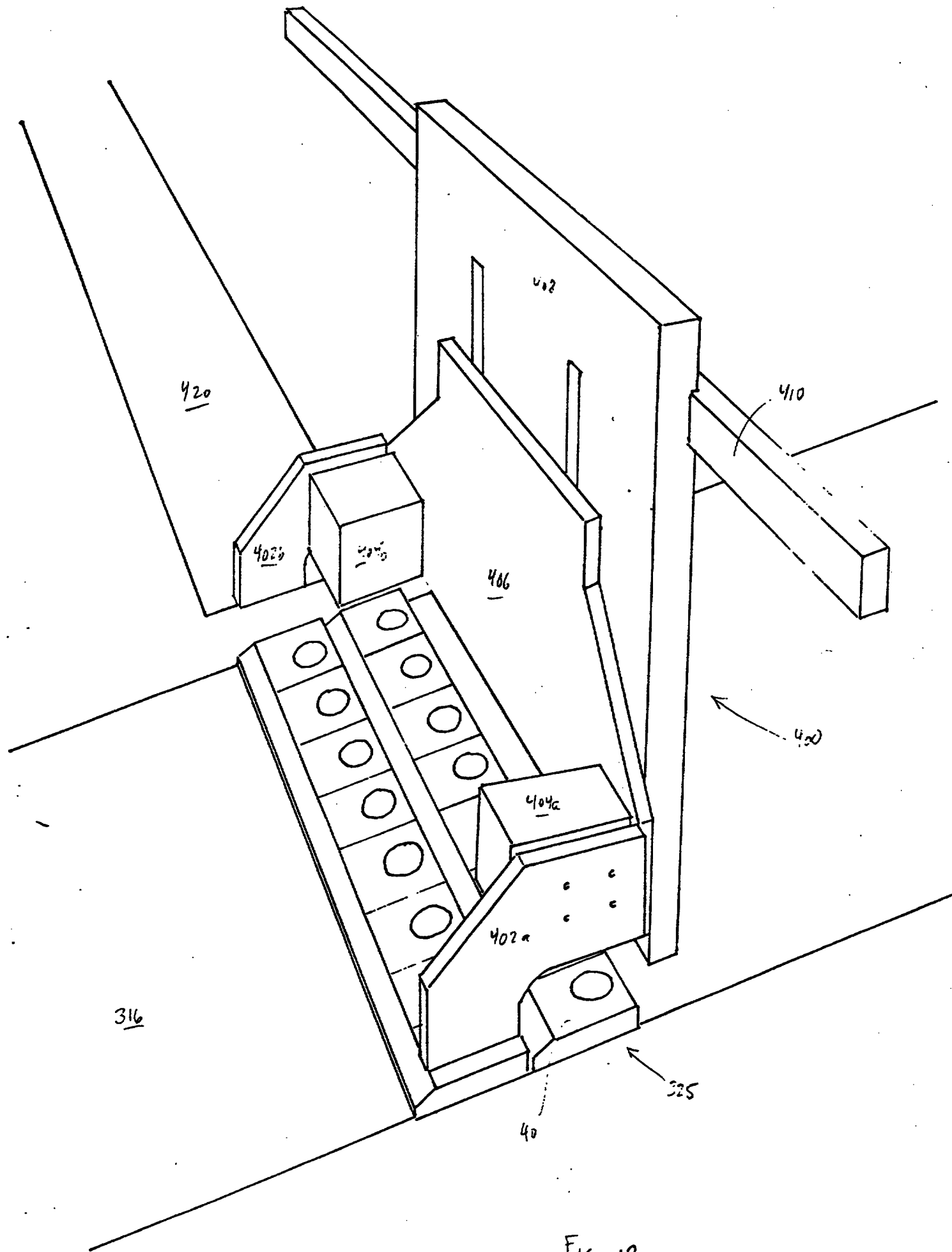


Fig 13

This Sheet Has Been Replaced



THIS SHEET HAS BEEN  
REPLACED

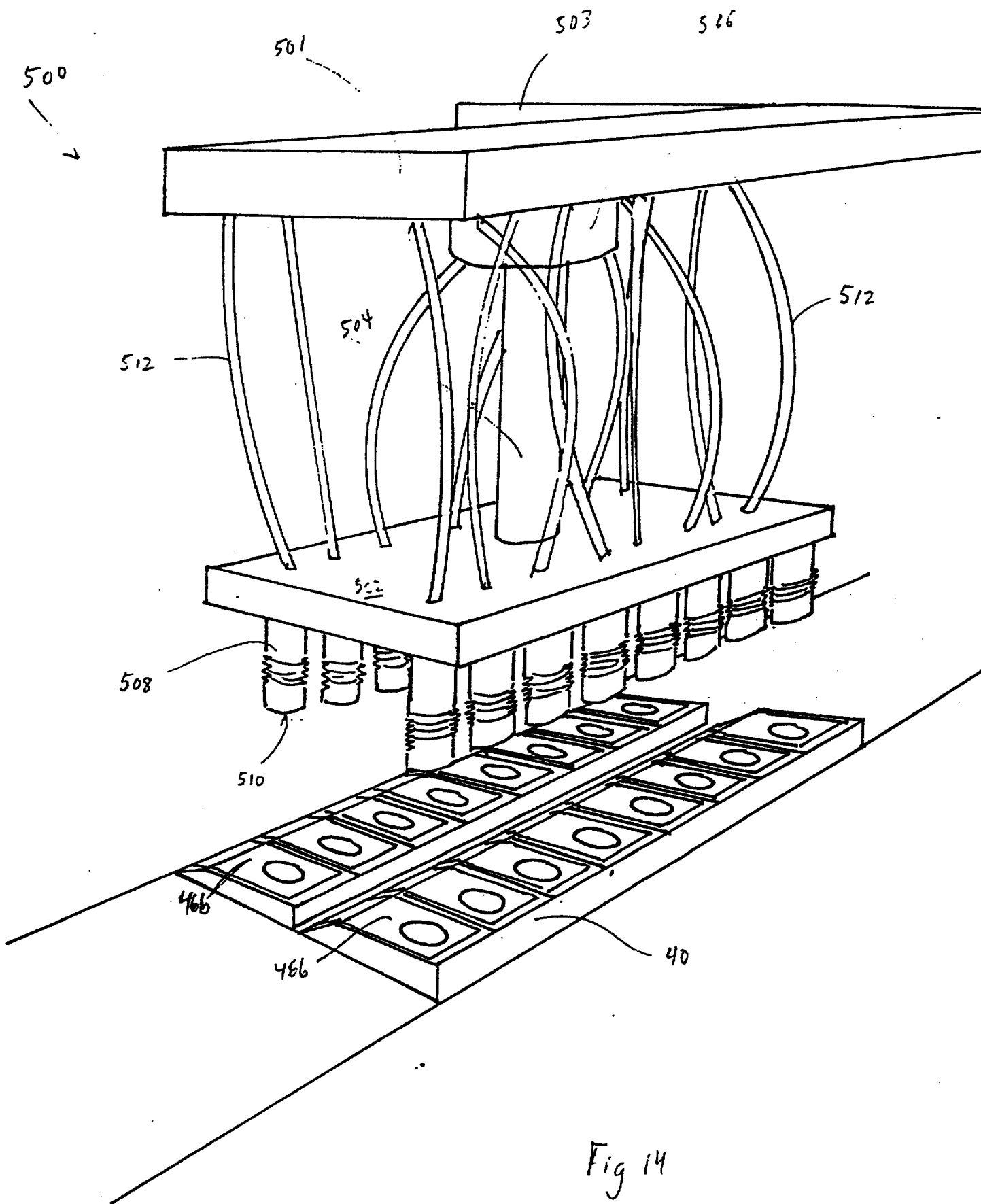


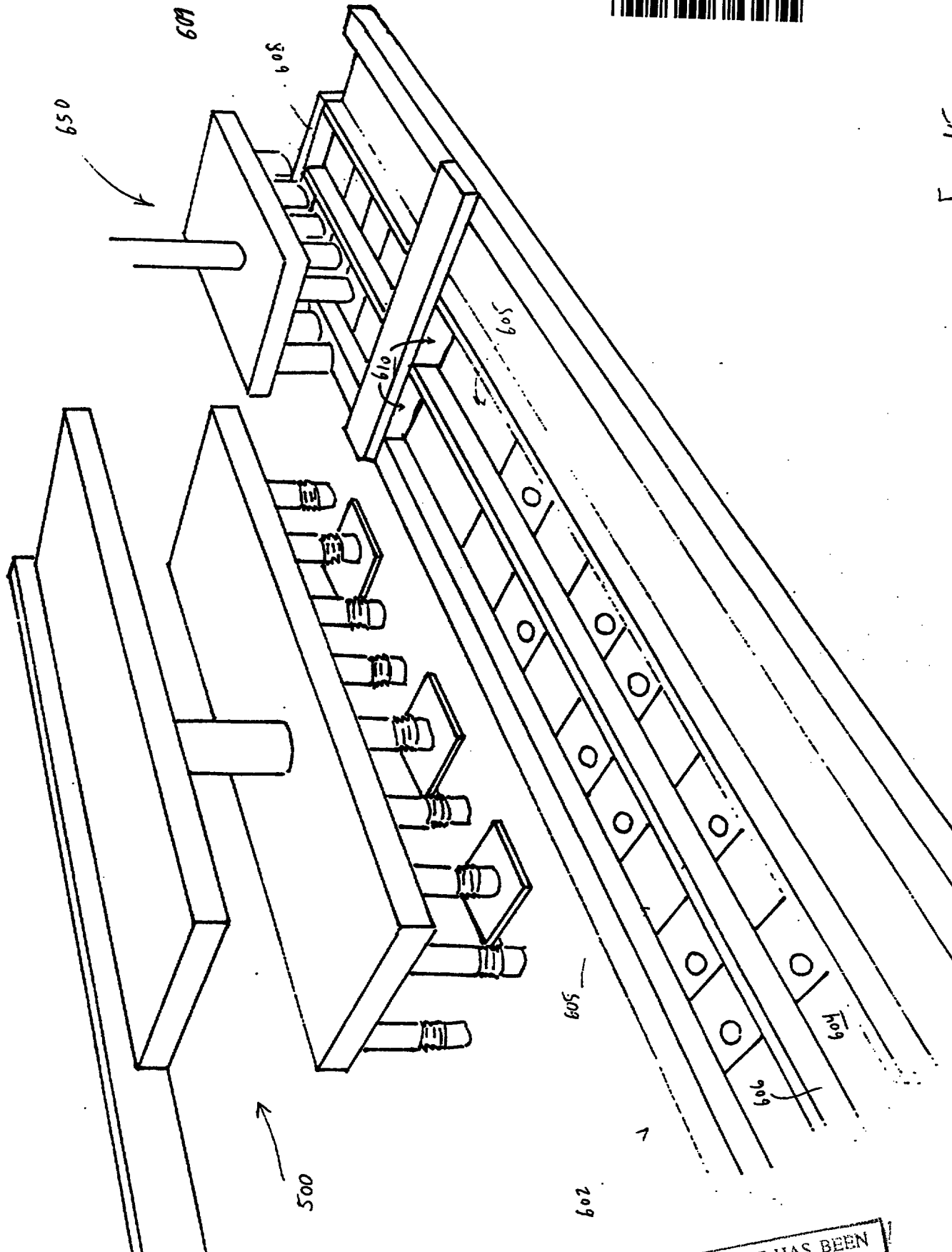
Fig 14

This Sheet Has Been Replaced



THIS SHEET HAS BEEN  
REPLACED

This Sheet Has Been Replaced



THIS SHEET HAS BEEN  
REPLACED

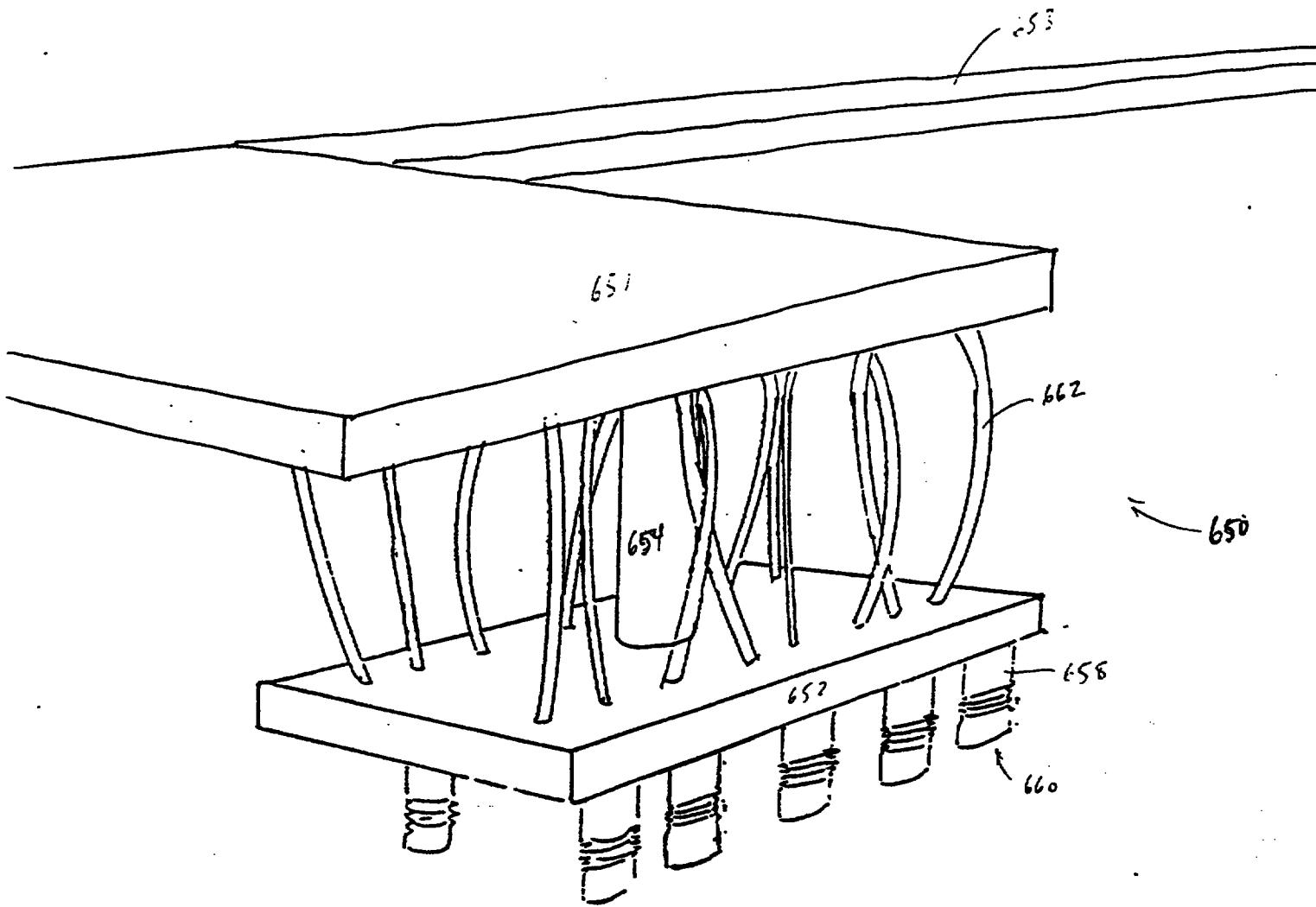
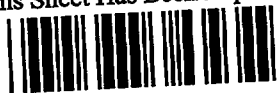
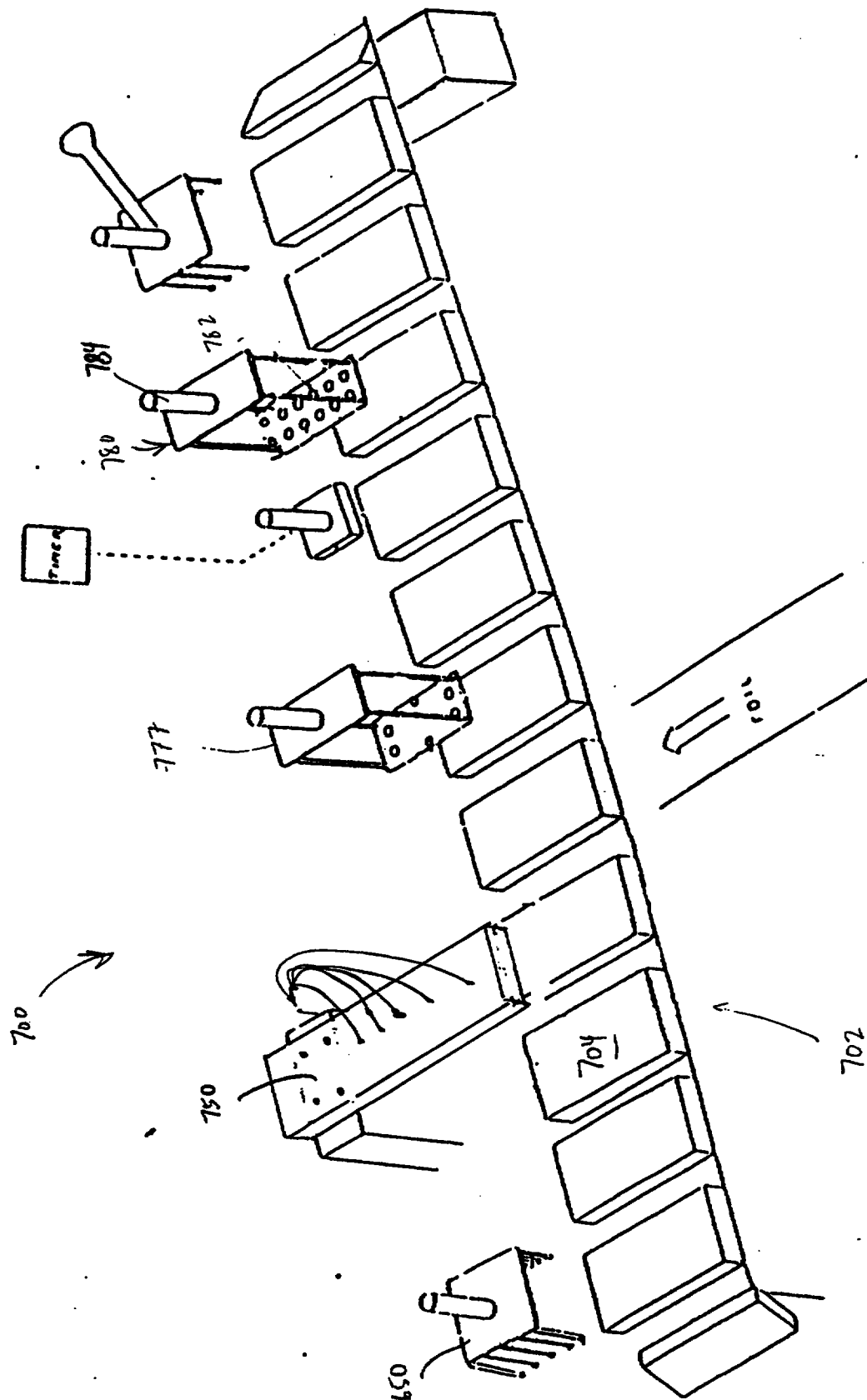


Fig 16

This Sheet Has Been Replaced



THIS SHEET HAS BEEN  
REPLACED



This Sheet Has Been Replaced



THIS SHEET HAS BEEN  
REPLACED

001

780

784

782

777

704

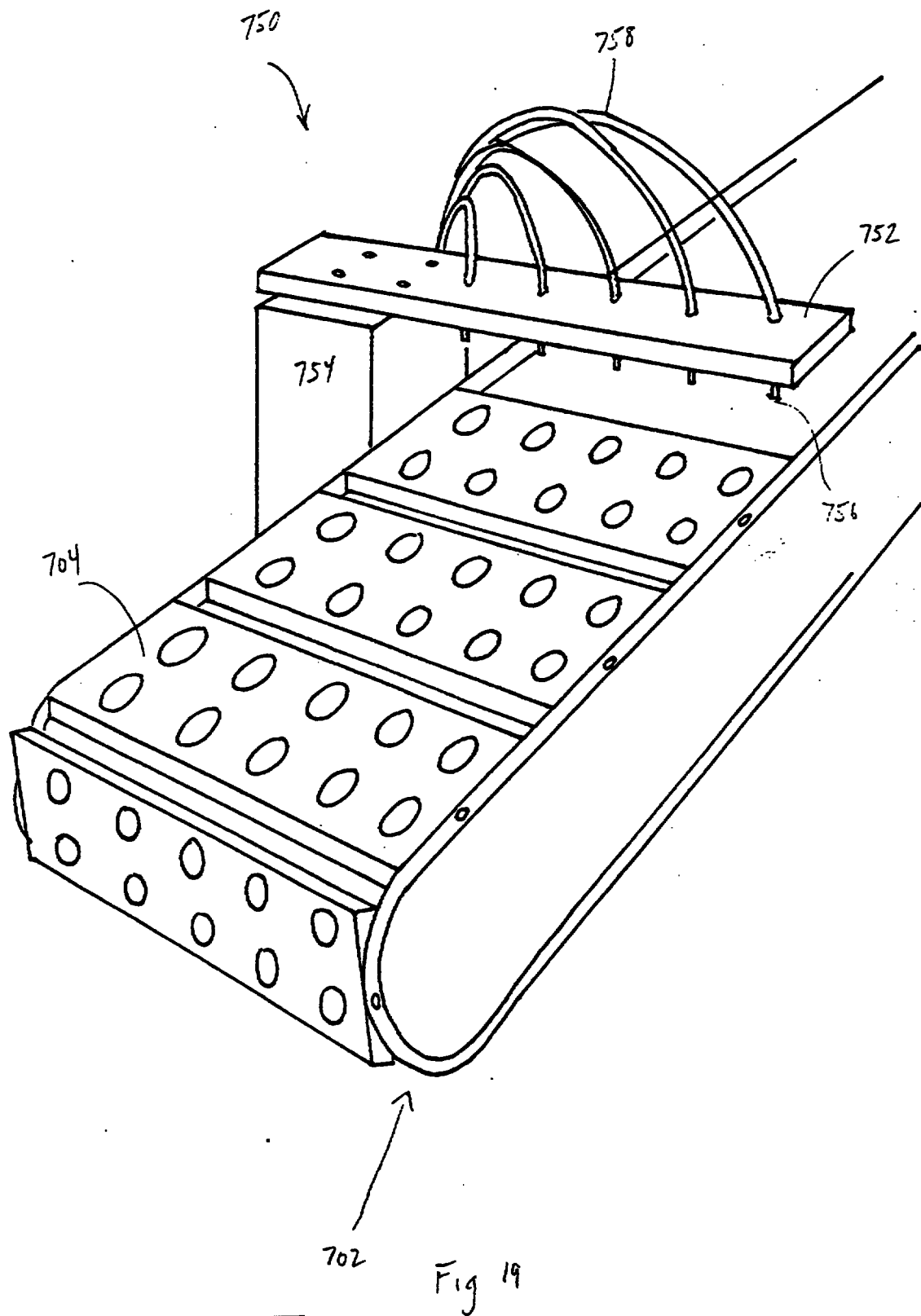
752

Fig. 18

This Sheet Has Been Replaced



THIS SHEET HAS BEEN  
REPLACED



This Sheet Has Been Replaced



THIS SHEET HAS BEEN  
REPLACED

## CONTACT LENS TRANSFER DEVICE

### ABSTRACT

1

The present invention, which relates to the transfer of contact lenses in post hydration processing of the lenses. A lens transfer and insertion assembly removes contact lenses from lens hydration pallets, alters their spatial distribution, and deposits them into packaging elements. The lenses are transferred with fluid and retained on the transfer assembly by surface tension.

5

10

15

20

25

30

35

This Sheet Has Been Replaced



THIS SHEET HAS BEEN  
REPLACED

11 DEC 1996

64

## CONTACT LENS TRANSFER DEVICE

## ABSTRACT

1

The present invention, which relates to the transfer of contact lenses in post hydration processing of the lenses. A lens transfer and insertion assembly removes contact lenses from lens hydration pallets, alters their spatial distribution, and deposits them into packaging elements. The lenses are transferred with fluid and retained on the transfer assembly by surface tension.

5

10

15

20

---

This Sheet Has Been Replaced

25



30

THIS SHEET HAS BEEN  
REPLACED

35

0-78501-30

11 DEC 1996

1

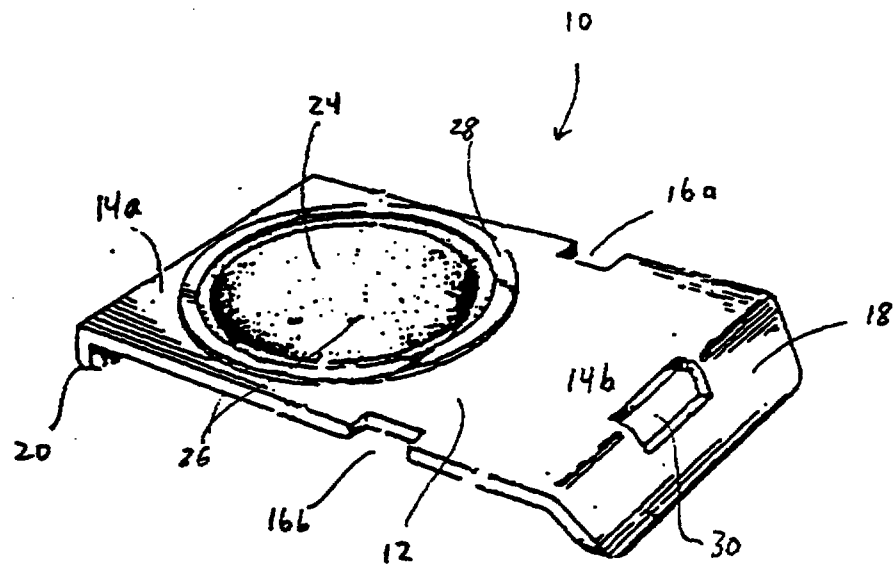


Fig. 1

1-1830-000

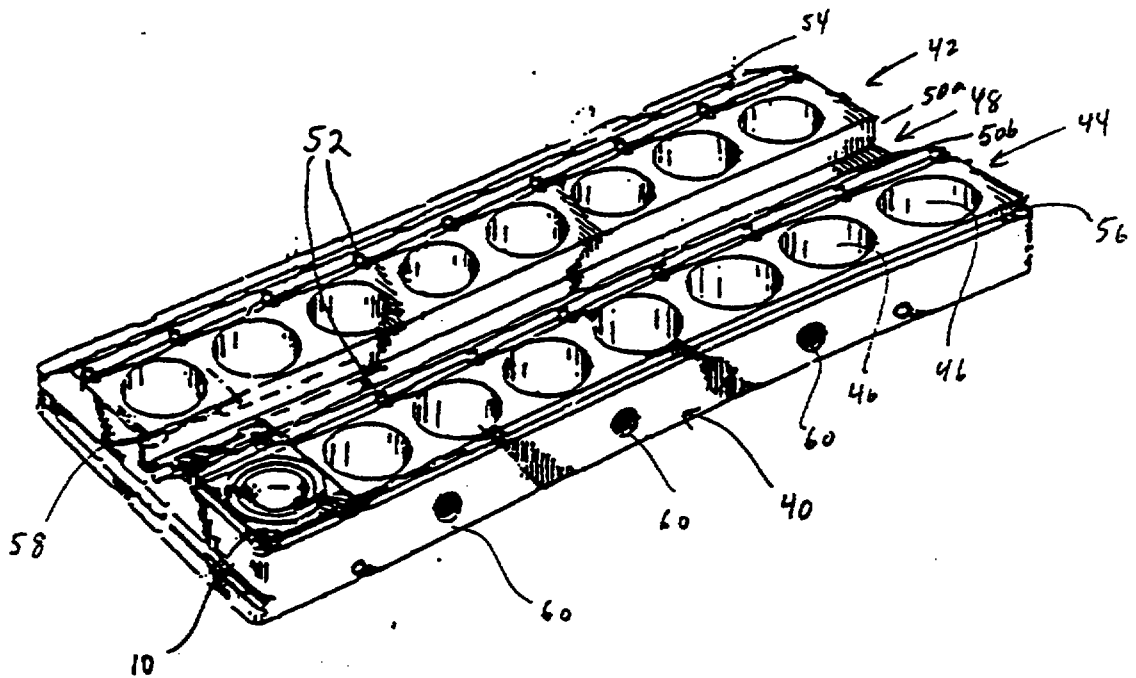


Fig. 2

11 DEC 1996

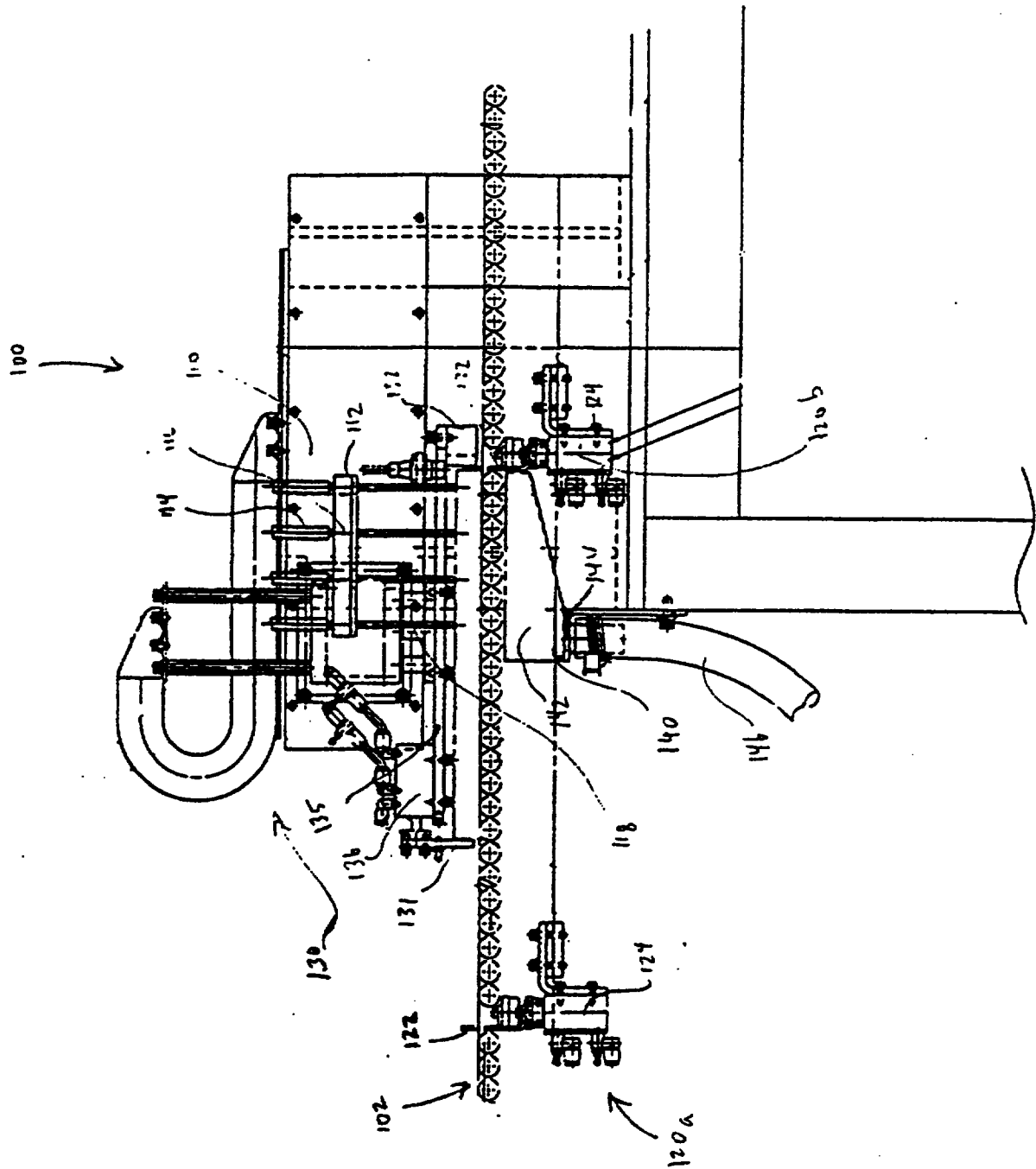


Fig 3a

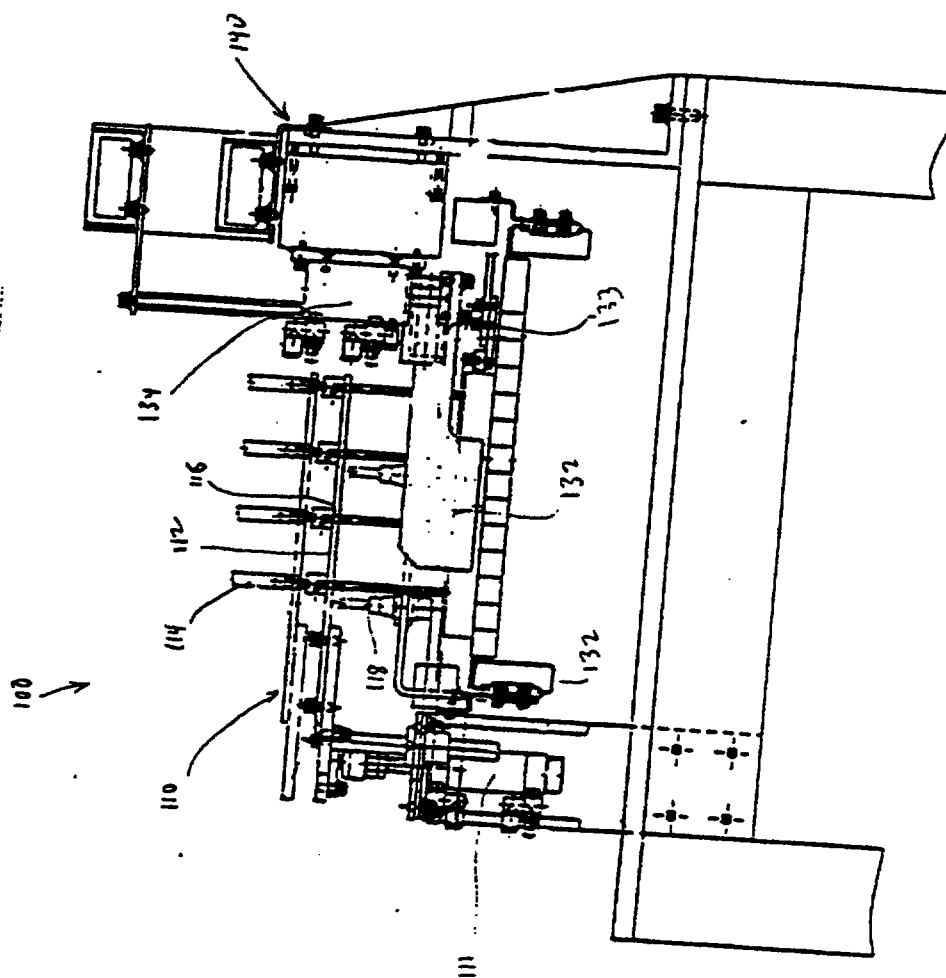
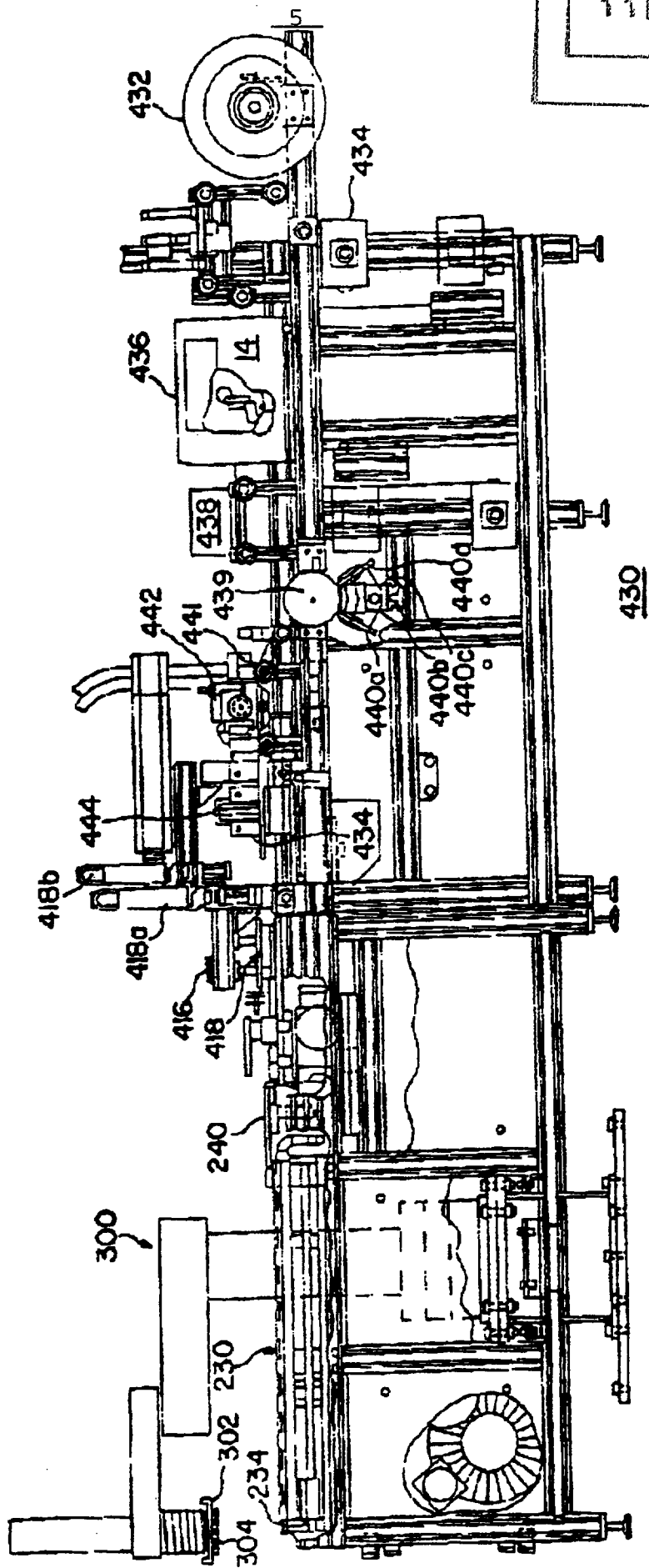


Fig 31

FIG. 4



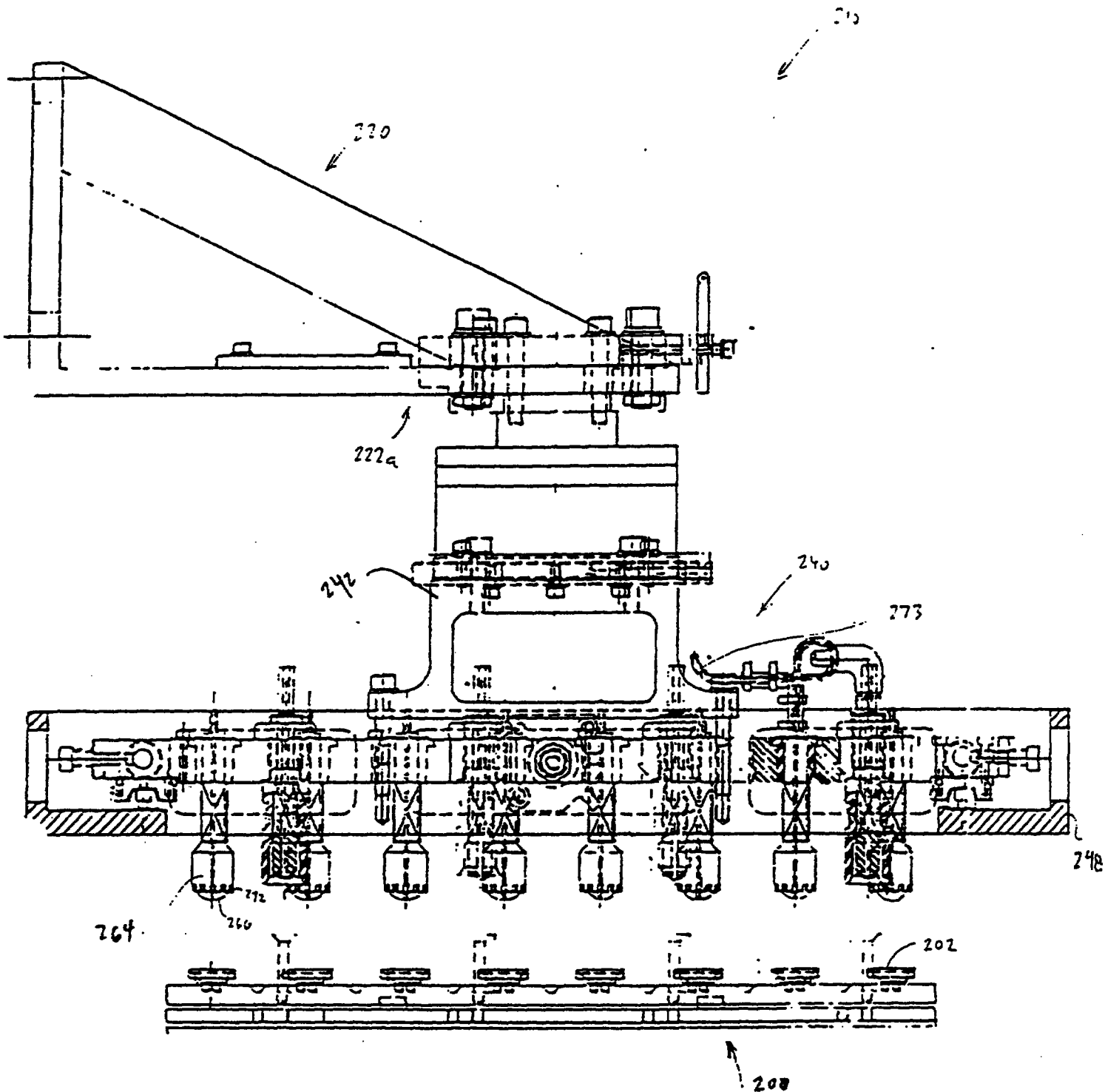


Fig. 5a

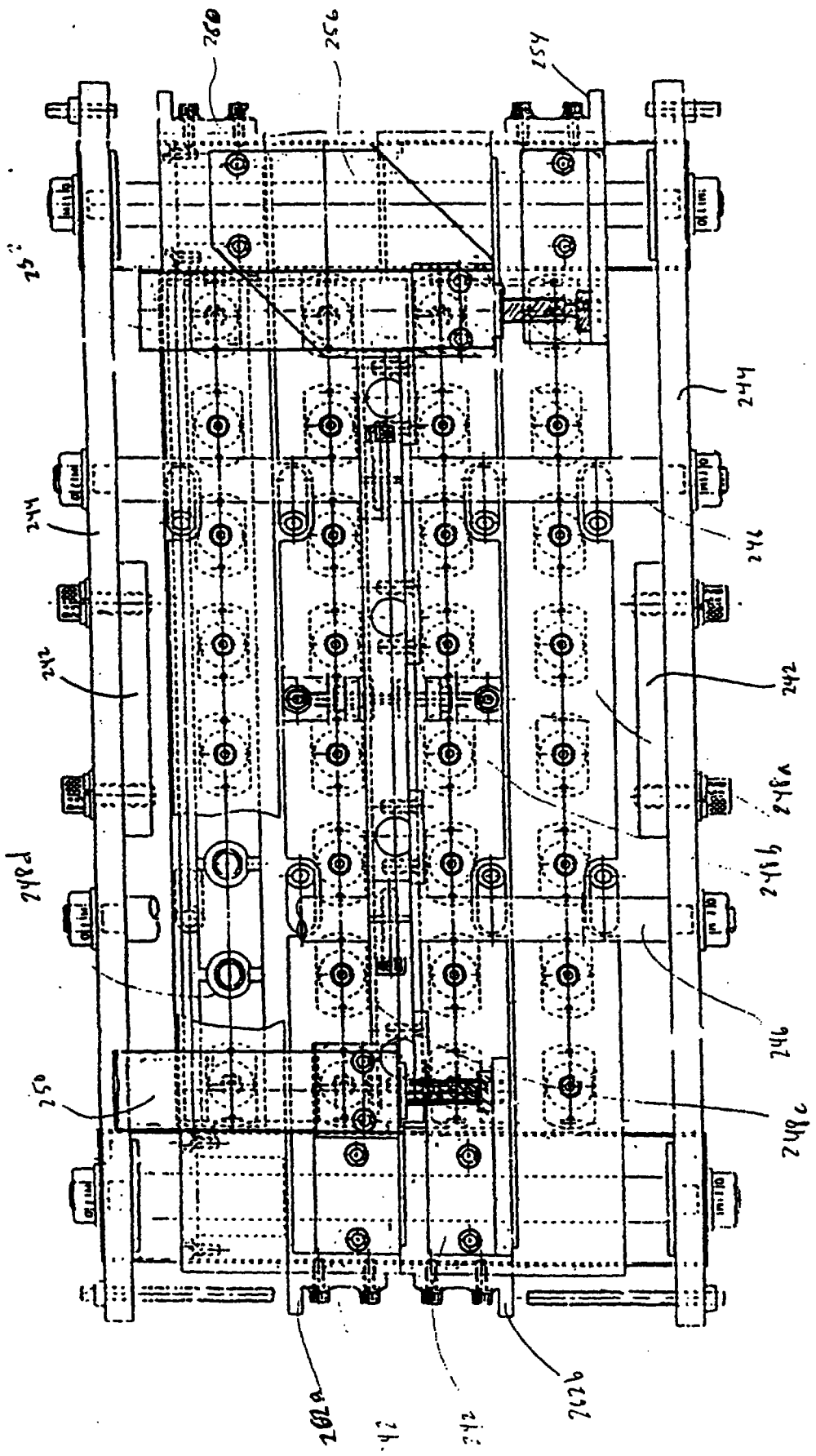
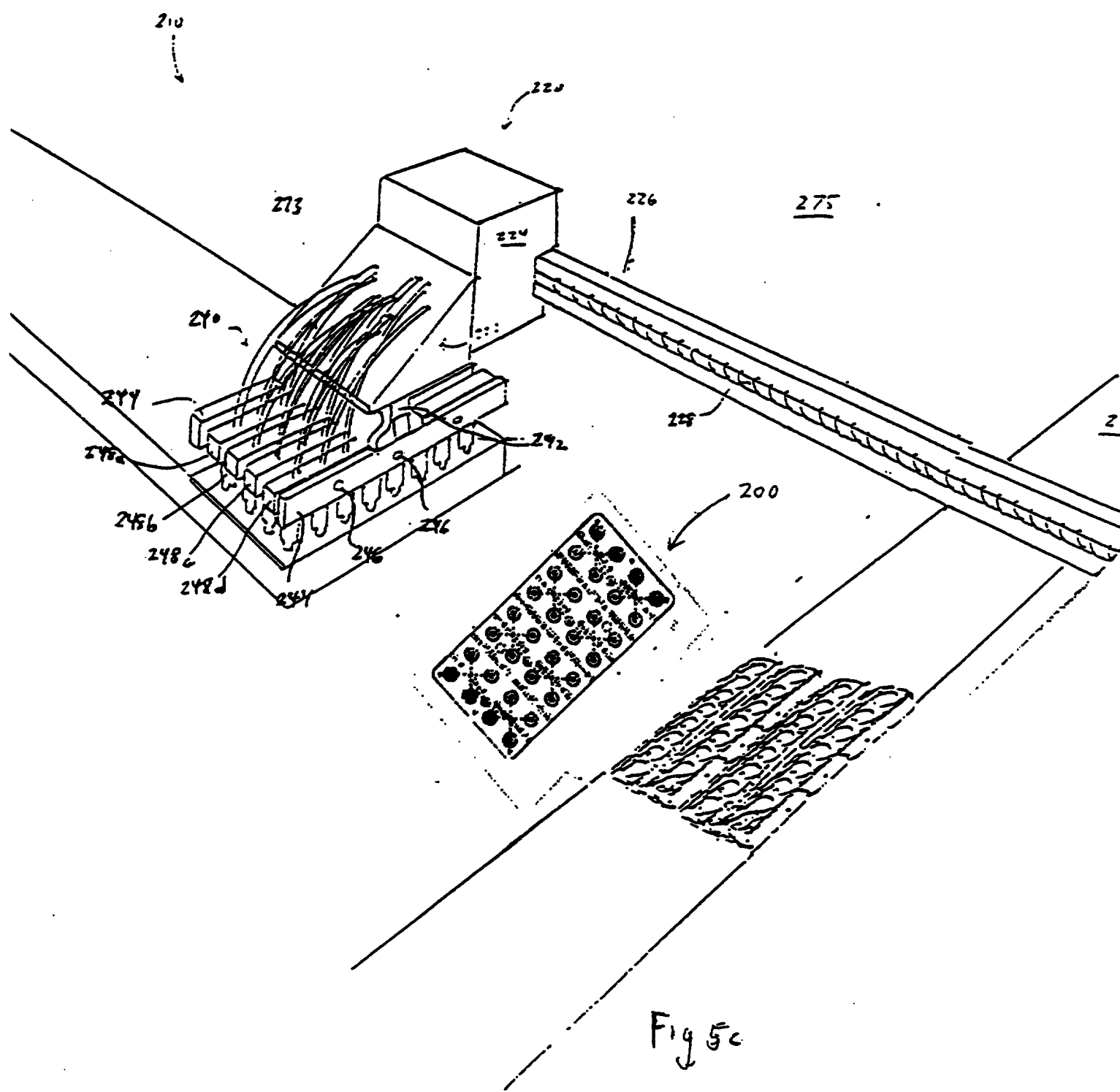


Fig 5b



9

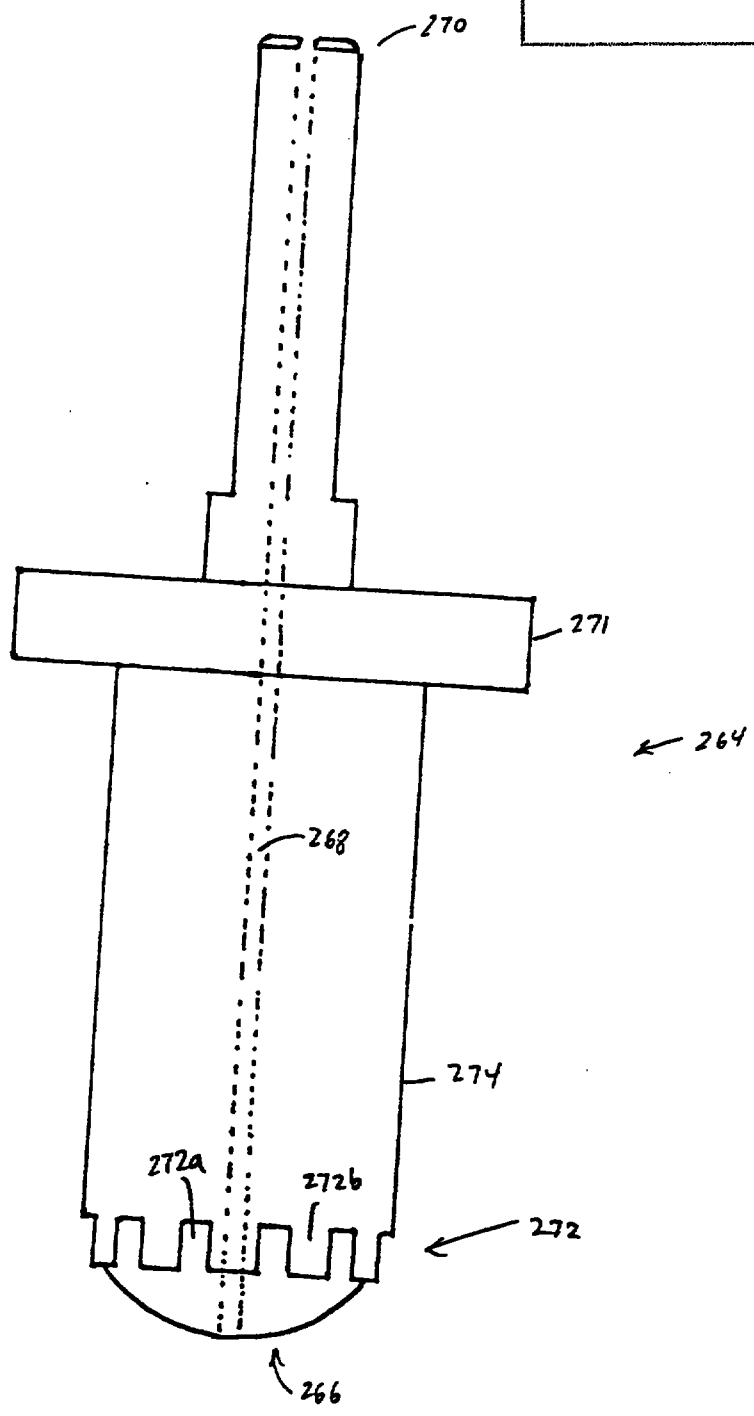


Fig 6

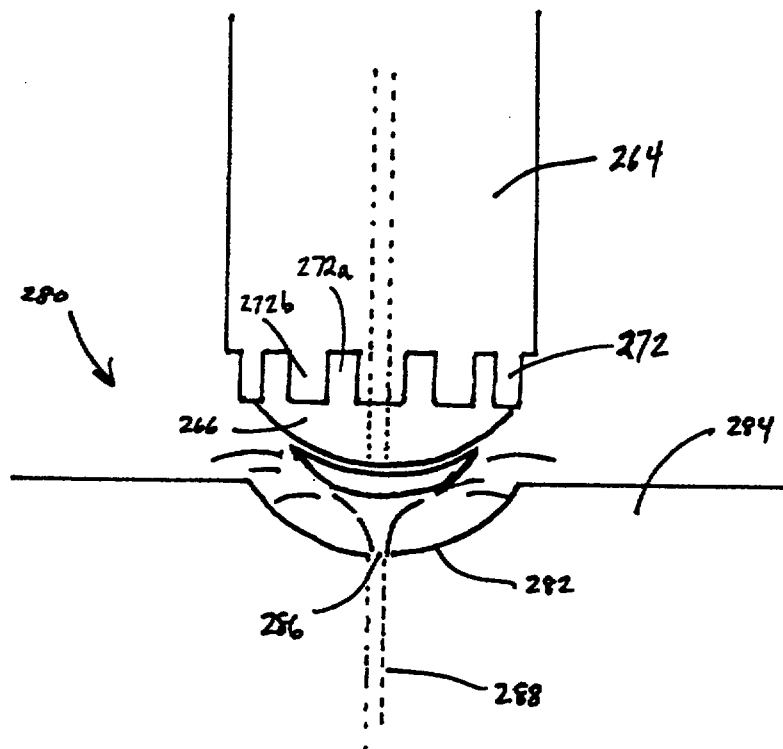


Fig 7

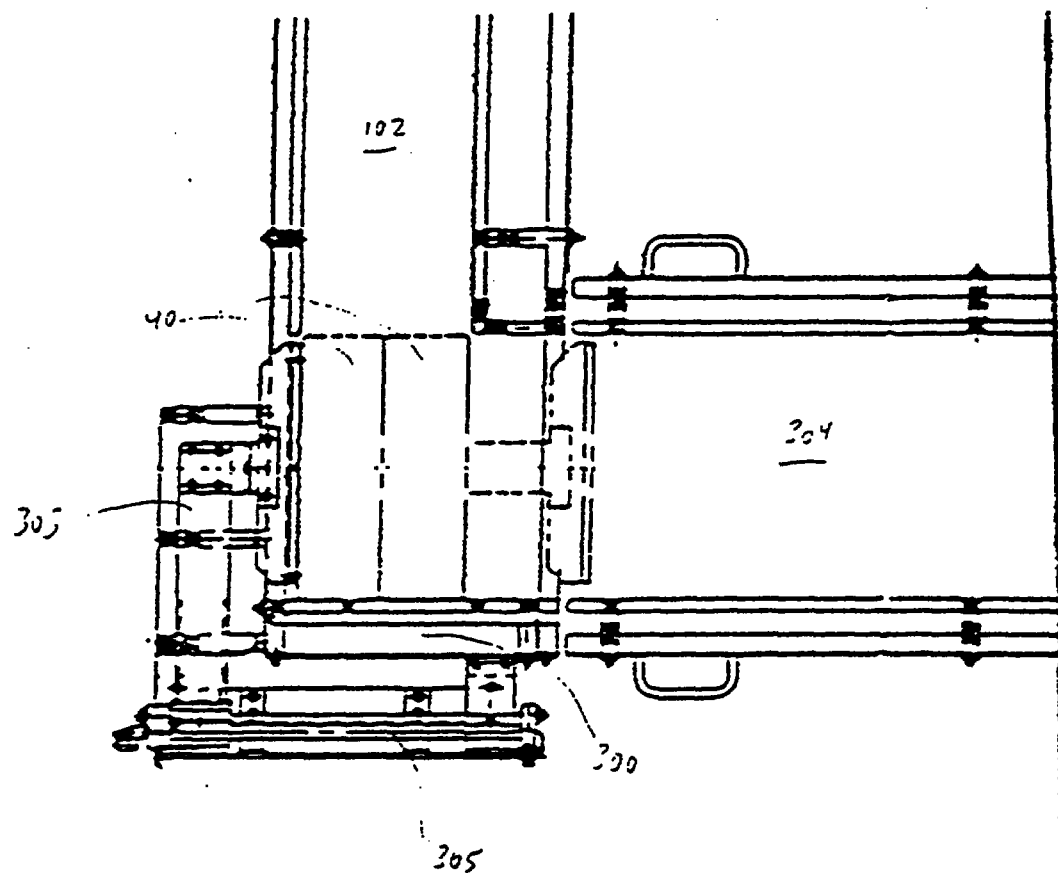


FIG 8

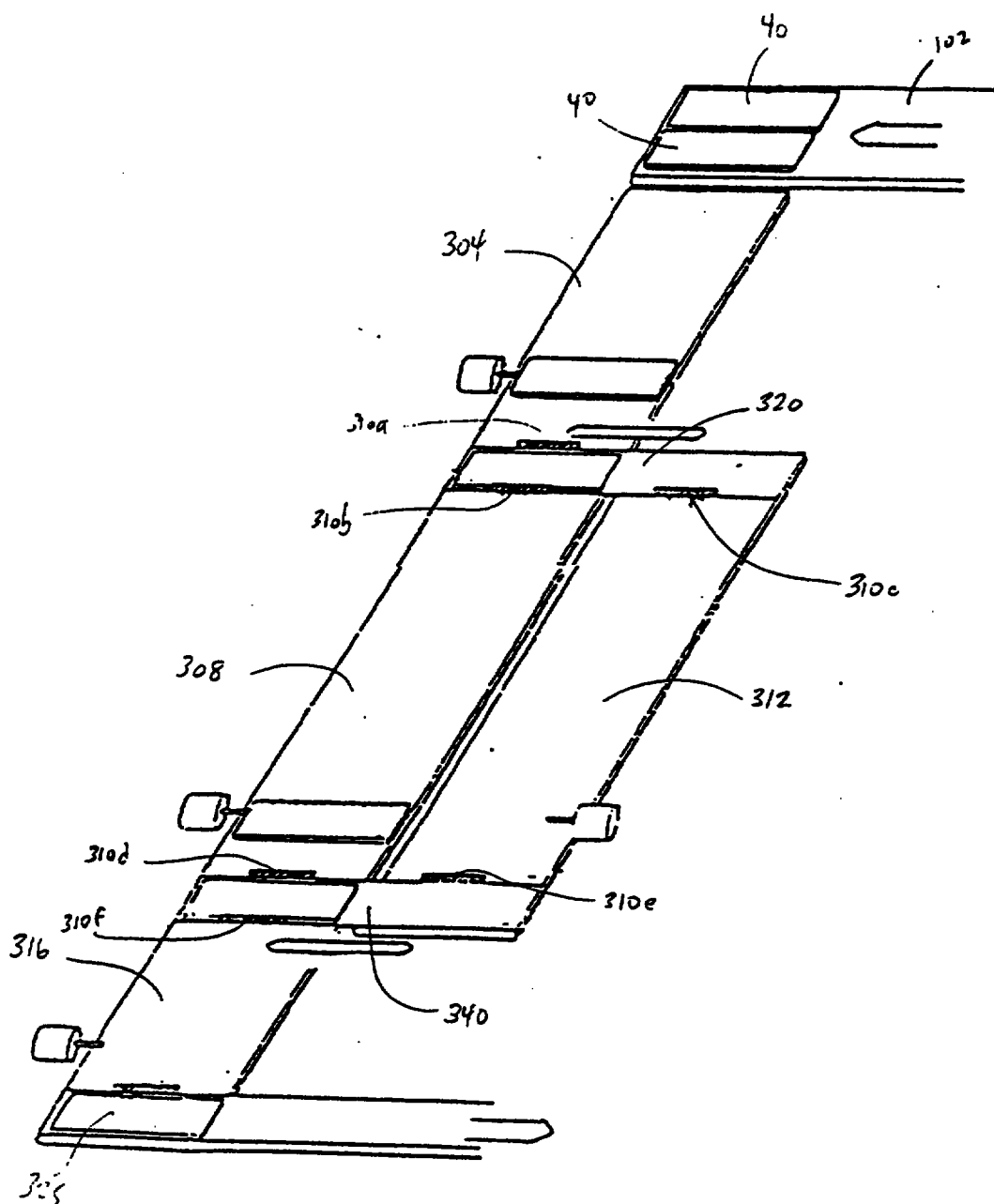


Fig 9

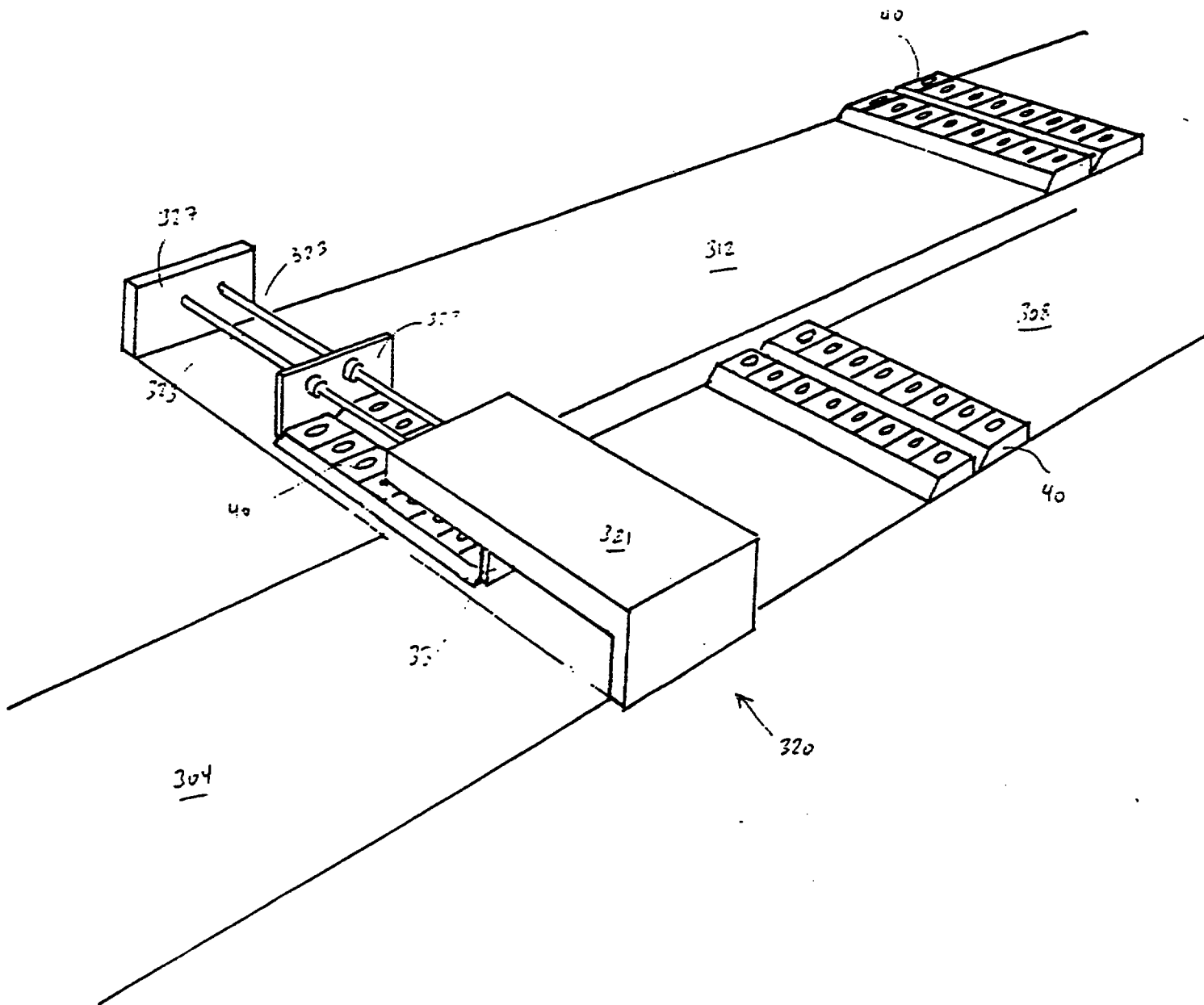


Fig. 10

11 DEC 1996

14

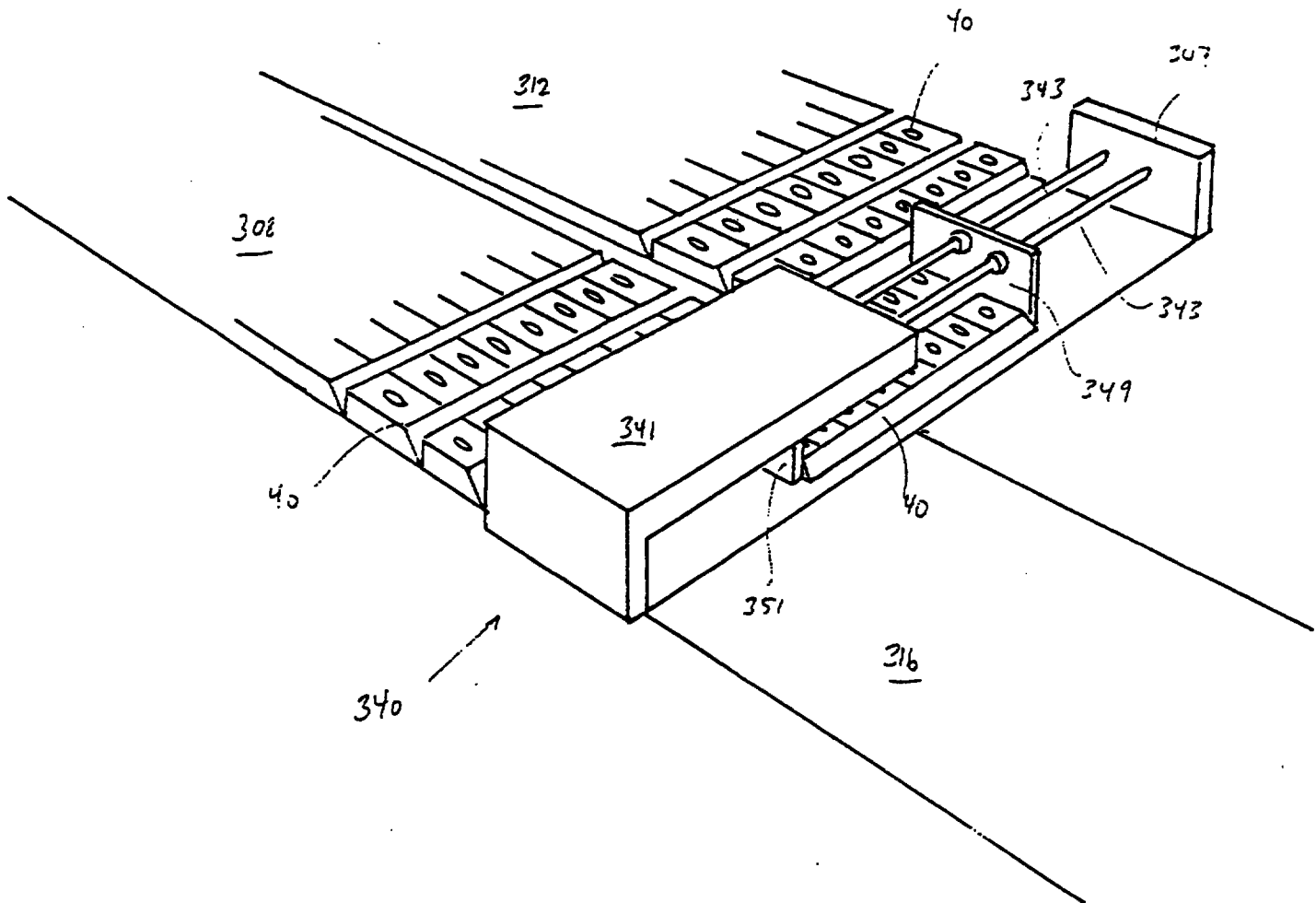


Fig 11

REPLACEMENT SHEET

11 DEC 1996

15

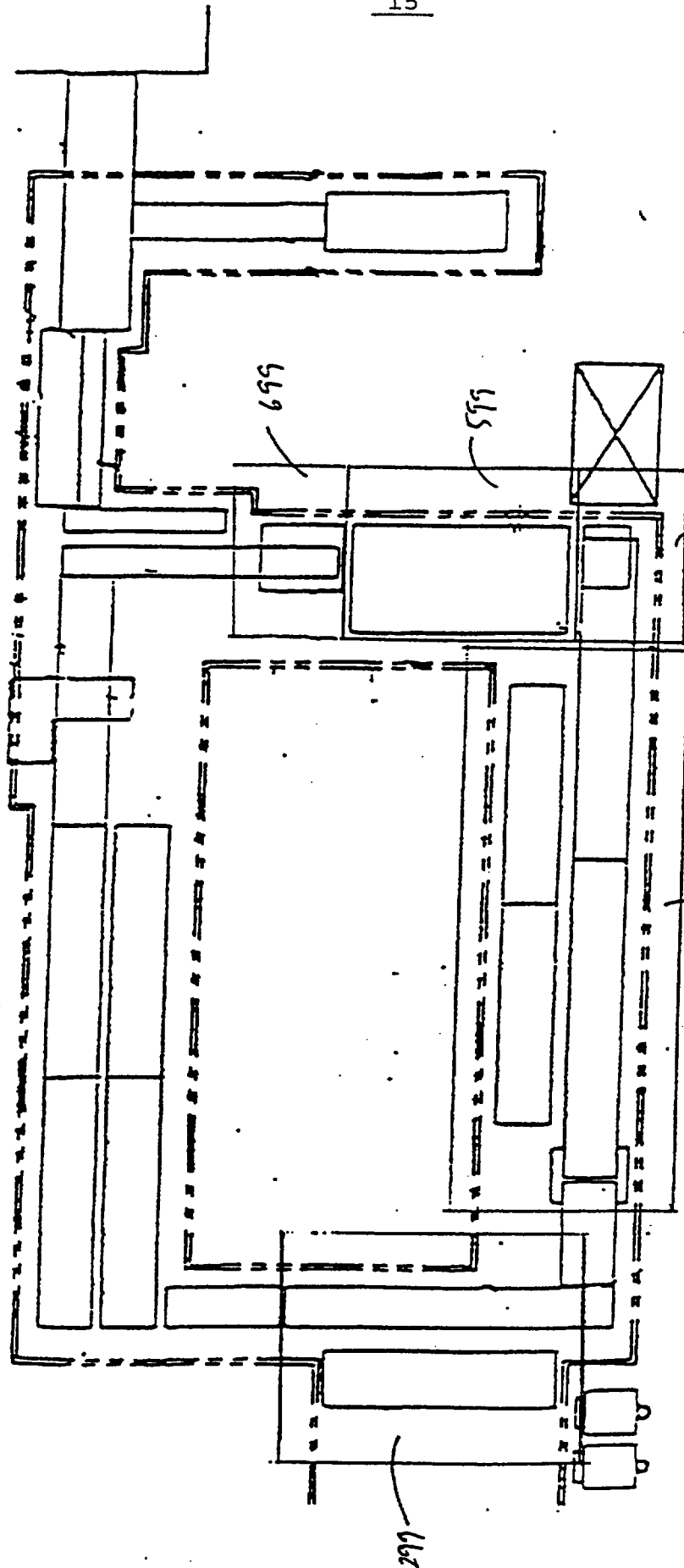


Fig 12

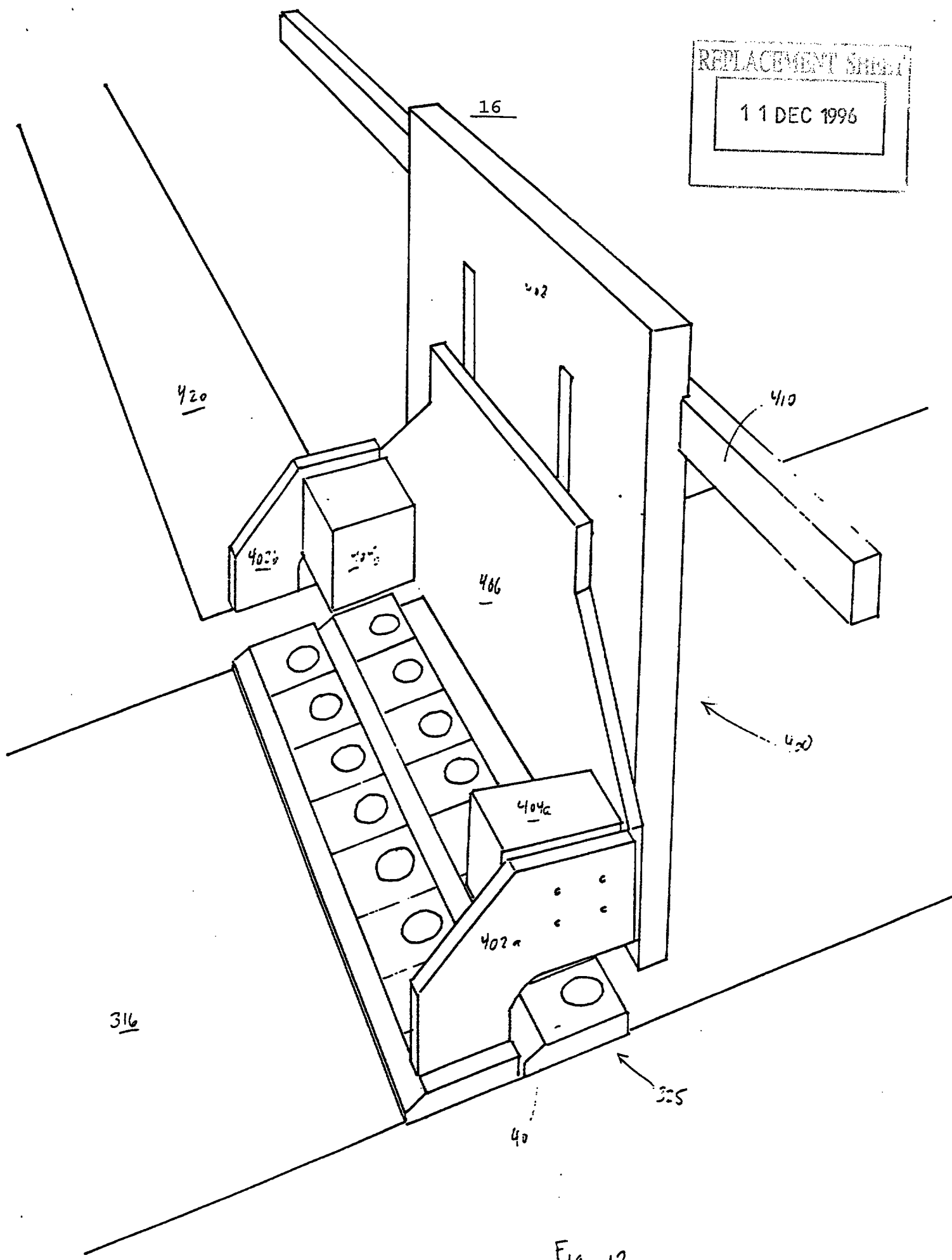
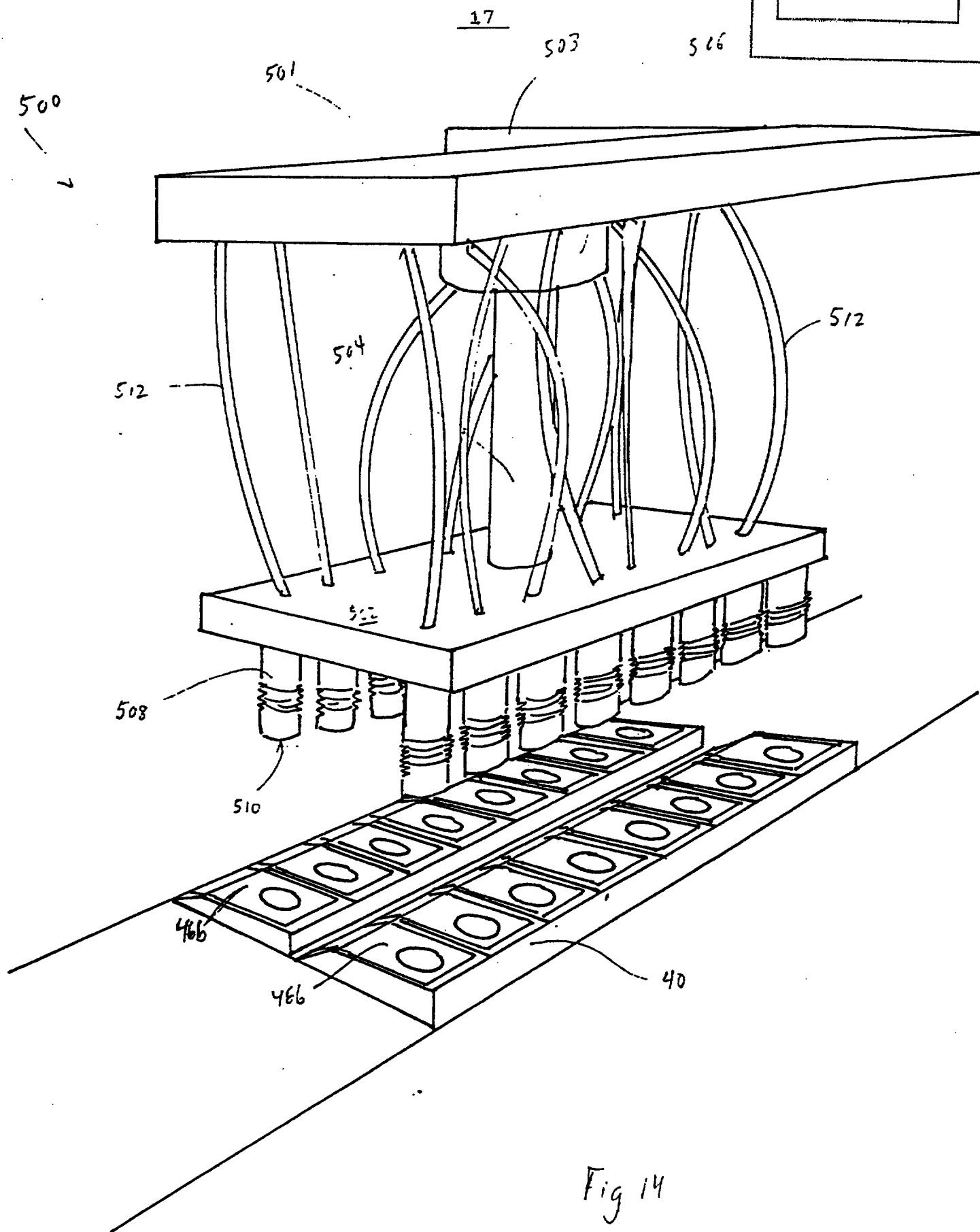
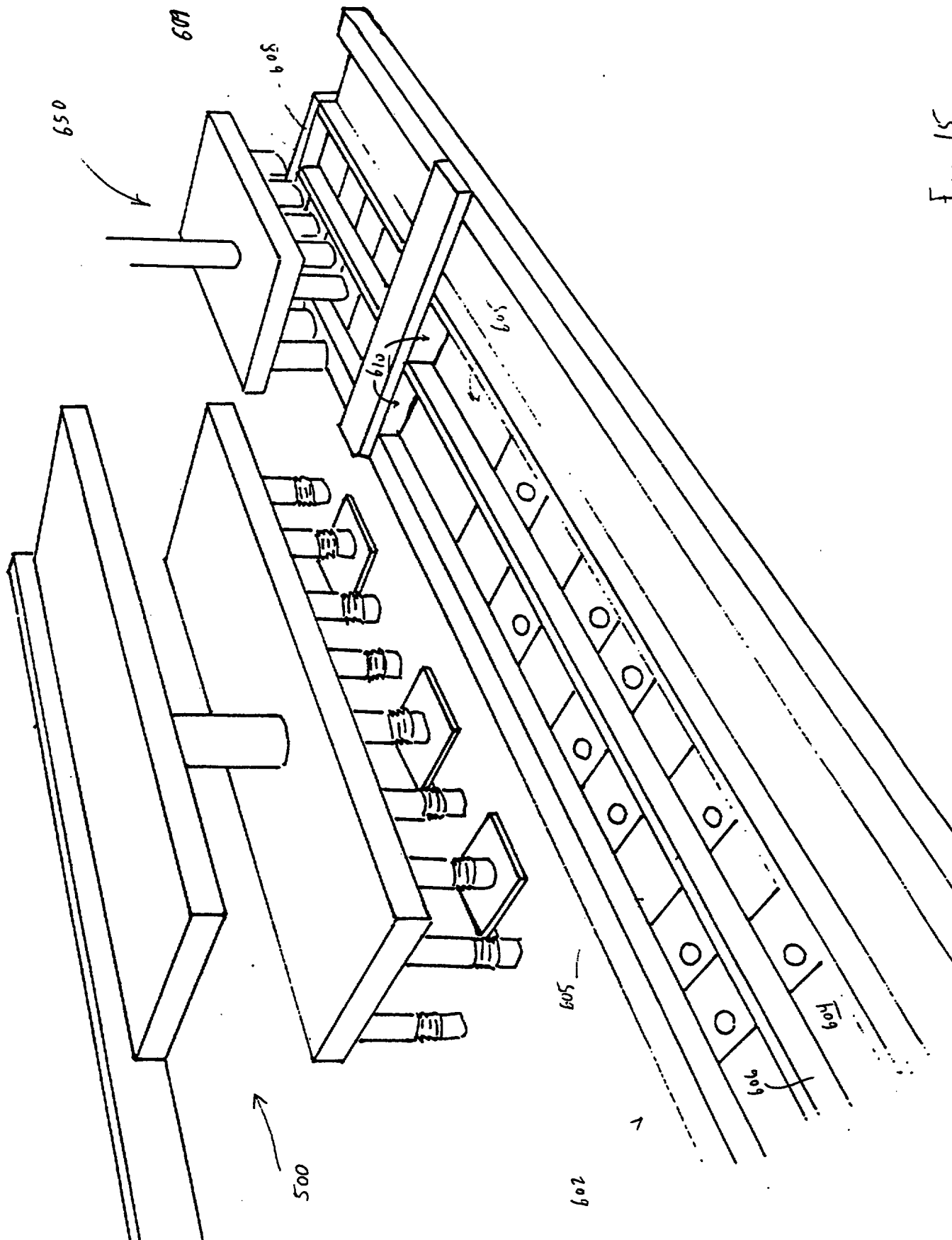


Fig 13

11 DEC 1996



11 DEC 1996



11 DEC 1996

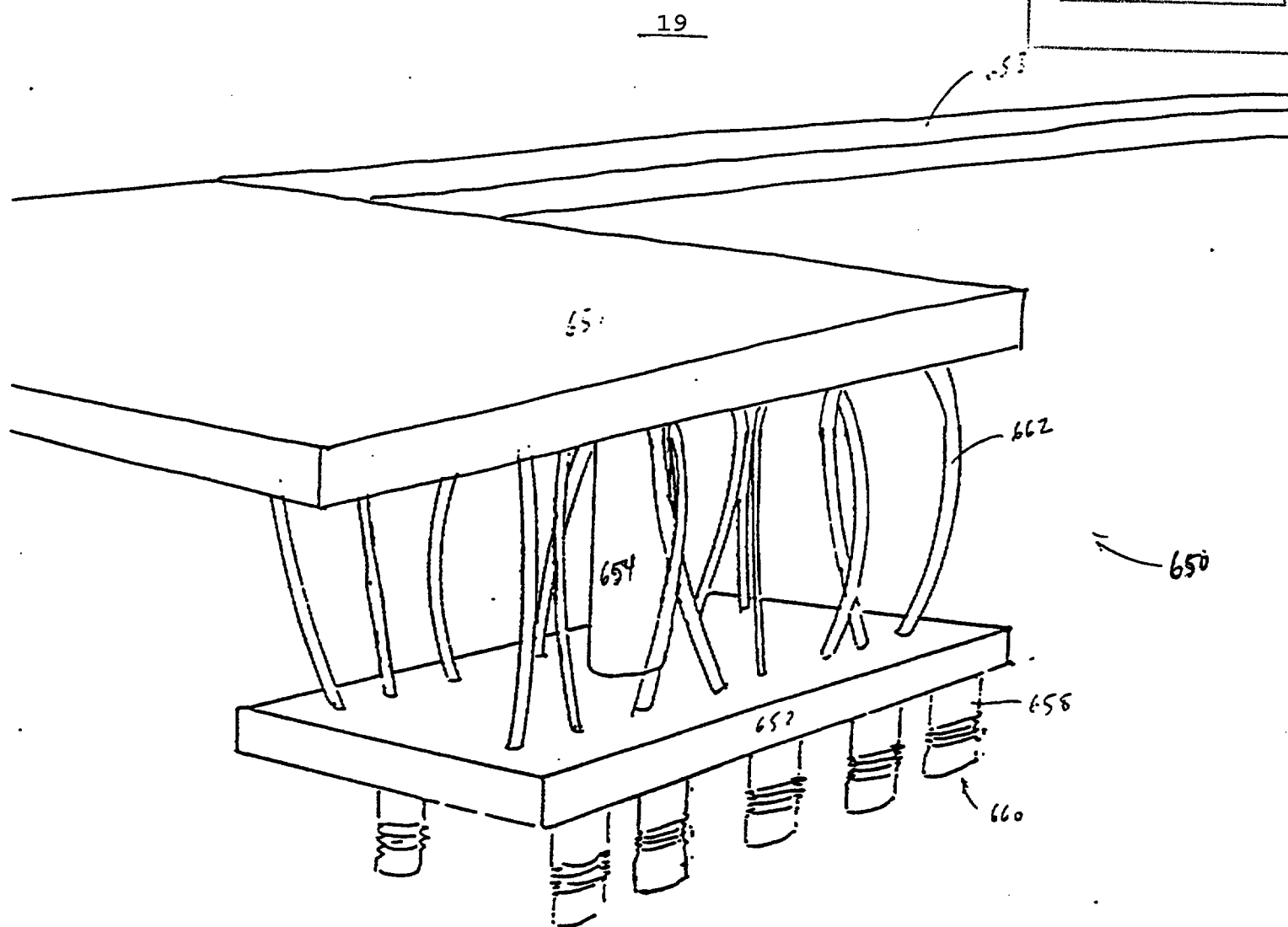
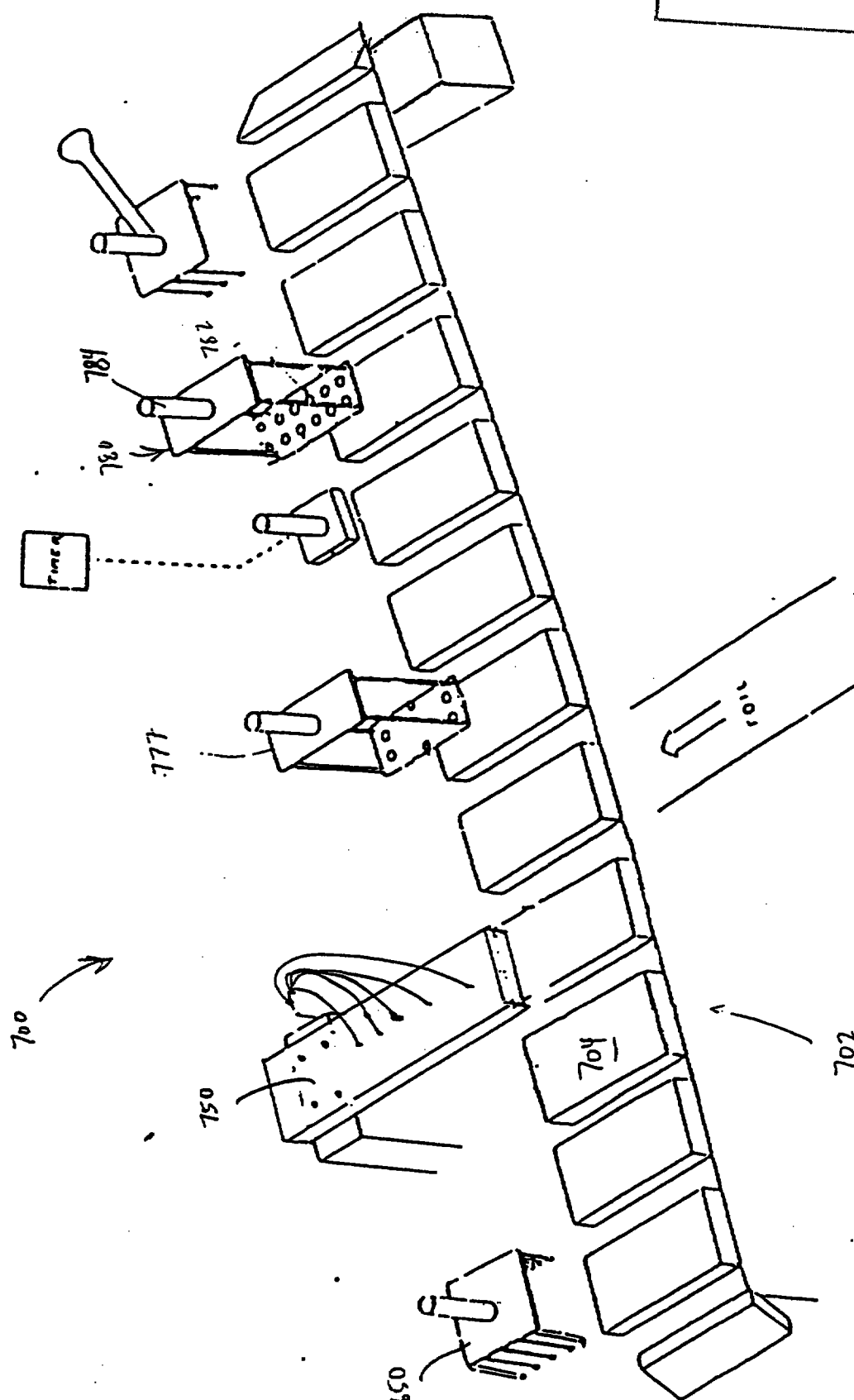


Fig 16

11 DEC 1996

20



11 DEC 1996

21

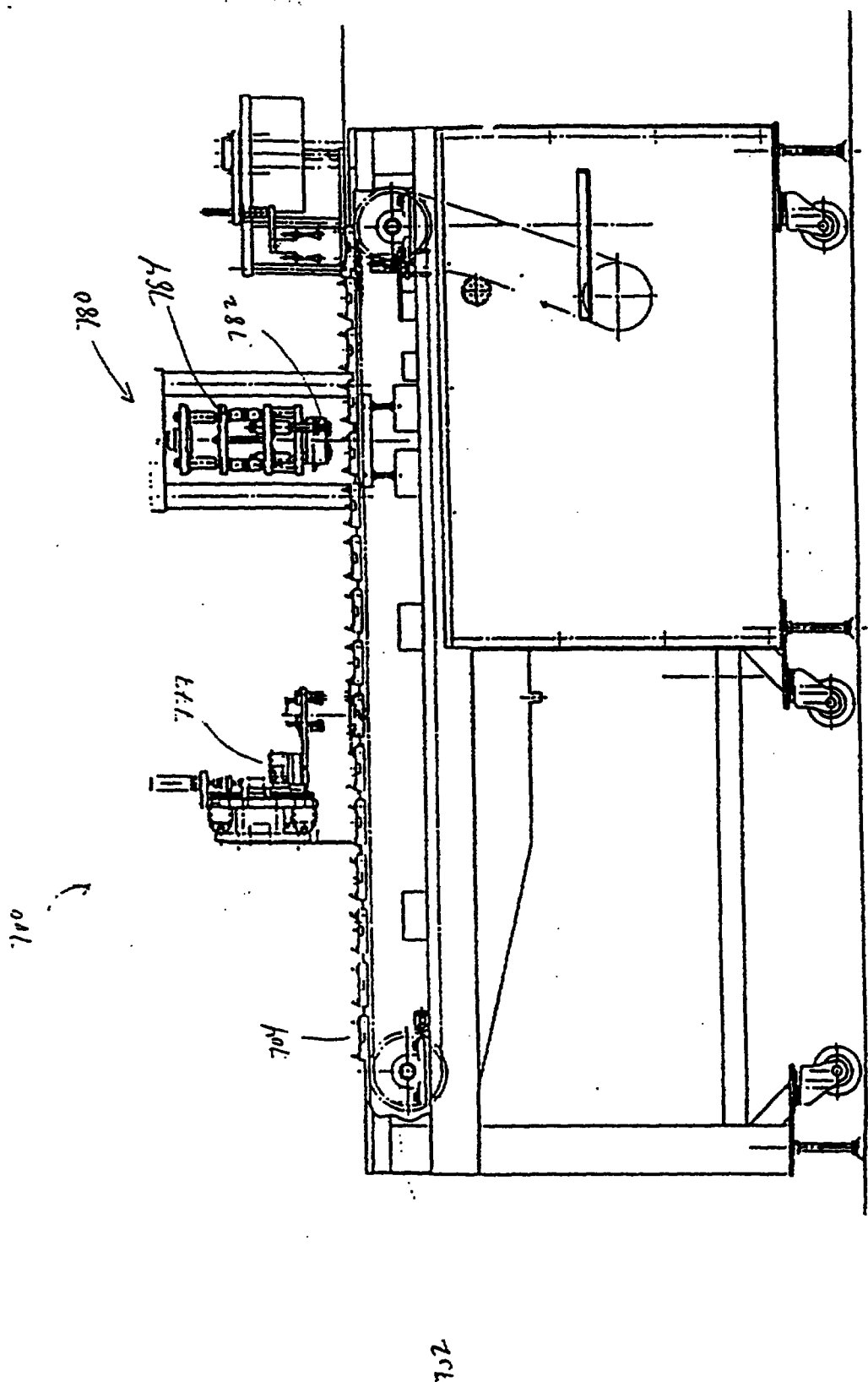


Fig. 18

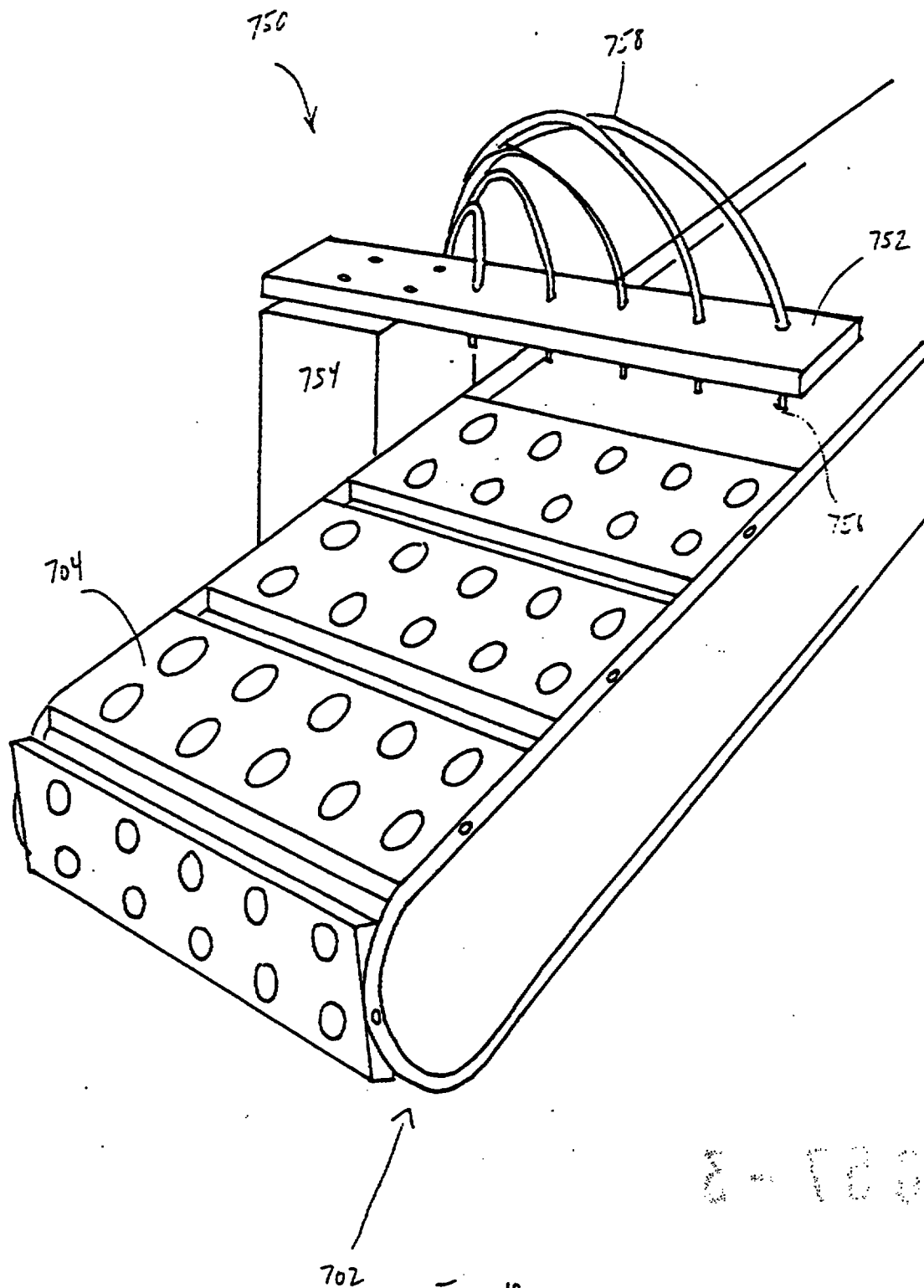


Fig 19

8-7838800

17 FEB 1997

1

CONTACT LENS TRANSFER DEVICE

## CROSS REFERENCE TO RELATED APPLICATION

The present invention is a continuation-in-part of prior application "Automated Apparatus and Method for Preparing Contact Lenses for Inspection and Packaging", U.S.S.N. 08\258,557, (VTN-0086) which has also been assigned to the assignee of the present invention.

## BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates generally to the field of manufacturing contact lenses. More particularly, the present invention relates to an apparatus which removes contact lenses from a first set of pallets, inserts them into corresponding packaging elements on a second set of pallets, and transports the lens-packaging elements through inspection and final package sealing assemblies.

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 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 lens production process wherein each lens is formed by

17 FEB 1967

-2-

1 sandwiching 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  
5 then removed from the mold sections and further treated  
in a hydration bath and packaged for consumer use.

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  
10 formed with a monomer or monomer mixtures disclosed in  
the forgoing patents. The process disclosed in these  
patents significantly reduce the thruput time by  
hydrating the lens and releasing the lens from the mold  
cavity with deionized water and a small amount of  
15 surfactant without any salts, so that the time consuming  
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  
20 into the final package with the lens and then seal the  
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.

25 U.S. Patent No. 4,961,820, also assigned to  
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  
30 thereto.

35

17 FEB 1987

-3-

1 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  
5 described in the foregoing patents enabled automated  
handling of the lens during hydration, suitable  
automated equipment to transport the lenses at high  
production rates and maintain low discard rates of  
manufactured lenses due to delay and dehydration thereof  
10 was not readily available or taught by the prior art.

#### SUMMARY OF THE INVENTION

A manufacturing assembly line may include  
apparatuses for both the manufacture of a product and of  
15 packaging therefor. In addition, apparatuses may be  
provided which are directed to the insertion of the  
product into the packaging and/or to the inspection of  
the product. In addition, recent developments in the  
inspection of contact lenses produced in accordance with  
20 the foregoing methods has enabled automated lens  
inspection, as taught in U.S.S.N. 08\994,564, entitled  
"Lens Inspection Method and Apparatus", (VTN 0037)  
(Attorney Docket 9275) assigned to the assignee of the  
present invention. Further, recent developments in the  
25 hydration and automated handling of wet contact lenses,  
as taught in U.S.S.N. 08\258,556, entitled "Automated  
Method and Apparatus for Hydrating Soft Contact Lenses"  
(VTN-0074) (Attorney Docket 8998), also assigned to the  
assignee in the present invention, has enabled automatic  
30 robotic handling of lenses during hydration, and prior

17 FEB 1987

-4-

1 to the inspection thereof by the automated lens  
inspection system.

Automated manufacturing processes often  
include steps which are particularly sensitive to  
5 interruption. For example, with respect to the  
manufacture of contact lens mold sections, the  
successful molding of thermoplastic elements having  
sufficiently correct optical surfaces requires that  
temperature fluctuations in the molding station remain  
10 steady. Other apparatuses in manufacturing lines,  
however, are subject to frequent interruption; requiring  
resupplies of materials, substitution of parts, etc.  
For example, materials for manufacturing packaging  
materials may be supplied in segmented rolls which, once  
15 depleted must be replaced.

The design of a fabrication line, which  
includes apparatuses of both type, must provide buffer  
zones in which parts being manufactured continually by  
one apparatus may be held temporarily as another is  
20 interrupted for a short time. It is therefore, a goal  
of those in the art to provide one or more accumulators  
or buffer zones for use in fabrication lines to even out  
such fluctuations. Again, with specific respect to the  
manufacture of contact lenses, recent developments are  
25 disclosed in U.S.S.N. 08\258,557, entitled "Automated  
Apparatus and Method for Preparing Contact Lenses for  
Inspection and Packaging", (VTN-0086) (Attorney Docket  
9010), also assigned to the assignee of the present  
invention, in which a buffer station is incorporated  
30 into the production line, for the purposes of permitting  
continuous function of some apparatuses, while other

17 FEB 1997

-5-

1 apparatuses are interrupted. The specification of  
U.S.S.N. 08\258,557 is herein incorporated by reference.

The present invention is directed to the  
portion of the contact lens assembly line in which: a  
5 pallet of packaging elements are filled with a quantity  
of deionized water; a set of contact lenses, which have  
been molded, hydrated, and washed, are removed from a  
pallet and inserted into their respective packaging  
elements; the combined set of packaging elements and  
10 respective lenses are transported to a buffering  
station; the set of elements are transferred to a low  
vibration conveyor line; the contact lenses are  
inspected for flaws; the deionized water is removed from  
the packages; the combined elements are removed from  
15 their pallets, the packages containing flawed lenses are  
deposited on a conveyor line which deposits the elements  
in a collection bin, and the packages containing correct  
lenses are deposited on a good line; the lenses on the  
good line are consolidated into a regular array and  
20 transported onto a pallet; and a quantity of saline  
solution is introduced into the packages and a foil  
cover is heat sealed to the package.

More specifically, with respect to the  
assemblies which carry out the processes introduced  
25 above, and which comprise the apparatuses of the present  
invention, the deionized water injector assembly is a  
device for injecting a quantity of deionized water into  
packaging elements on a pallet. This deionized water  
injector assembly is mounted above a conveyor line along  
30 which pallets of regularly arrayed packaging elements  
are transported from a remote fabrication location to

17 FEB 1987

-6-

1 the second location where they receive contact lenses.  
The spatial distribution of the regular array of the  
packaging elements is specifically established to match  
the optical array in the inspection station.

5 The lens extraction and insertion assembly of  
the present invention is a lens transfer device which  
lifts lenses from hydration pallets at a first location  
and deposits them, along with an additional dose of  
deionized water, into the packaging elements at the  
10 second location. In addition to transferring the  
lenses, the device also alters the spatial distribution  
of the lenses from their orientation in the hydration  
pallets to an orientation which corresponds to the  
packaging elements (and the lens inspection station).

15 More specifically with respect to the means by  
which the lenses are extracted from the hydration  
pallets and transferred to the packaging elements, the  
hydration pallets comprise a set of concave recessions  
in which the lenses are disposed, along with a quantity  
20 of deionized water. The bottom of the recessions  
comprise at least one hole through which a fluid may be  
ejected, therein lifting the wet lenses out of the  
recessions. The lens transfer assembly comprises a set  
of elongate finger elements which extend downward, each  
25 finger element having a convex lens transfer surface  
onto which the lifted lens may be secured via surface  
tension. The convex lens transfer surface of the finger  
is further designed with an annular raised skirt around  
the tip which prevents the lens from sliding out of the  
30 desired position during transfer. The lenses which have  
been transferred to the convex lens transfer surfaces on

17 FEB 1997

-7-

1 the fingers of the lens transfer device, may have small  
bubbles of air on their exposed surface. The small  
bubbles, if permitted to remain on the surface of the  
lens through the inspection process may interfere with  
5 proper inspection, and cause the lens to be improperly  
determined to be bad, and discarded unnecessarily. At  
least one jet of air is blown onto each lens for the  
purposes of removing the air bubbles from this exposed  
surface.

10 The fingers of the lens transfer assembly are  
set out in rows on parallel beams which are slidably  
mounted on guide rails. The parallel beams are coupled  
together via piston/ cylinder elements, and are drawn  
together once the lenses have been extracted and the  
15 bubble blow off step have been carried out. This action  
alters the relative separation of the lenses with  
respect to one axis, so that the lenses will be arrayed  
to match the array provided by a lens inspection pallet.

The lens transfer assembly then is linearly  
20 translated to the second location, into position above  
the inspection pallet. The fingers of the lens transfer  
assembly are further designed with an interior conduit,  
extending from a small orifice in the lens transfer  
surface of the finger to a reservoir of deionized water,  
25 through which deionized water may be selectively  
ejected. With the fingers, and the lenses secured  
thereto, in position above the packages, a small jet of  
deionized water is ejected through each orifice, therein  
decoupling the contact lenses from the lens transfer  
30 surfaces and depositing them into the packages that were  
loaded in the inspection carrier.

17 FEB 1997

-8-

1           The pallet and the package elements which now  
contain contact lenses are then transported via a  
conveyor belt to a buffering station. More  
specifically, the pallets are transported to a  
5 segregating apparatus, which directs alternating pallets  
onto parallel conveyor lines. The conveyor lines extend  
a sufficient distance, from their first ends to their  
remote ends, that a significant temporal delay may be  
accommodated, and the lenses stored without requiring  
10 stopping the molding line which requires a long start up  
time.

          The buffering station taught in U.S.S.N.  
08\258,557, entitled "Automated Apparatus and Method for  
Preparing Contact Lenses for Inspection and Packaging",  
15 is positioned after the inspection station, at a point  
in the manufacturing line where the packages containing  
the lenses have been drained of deionized water.  
Deprived of a liquid environment, the lenses are  
permitted to stand for no longer than 15 minutes before  
20 rejection thereof. Moving the buffering station to a  
point in the line at which the lenses remain bathed in  
deionized water permits indefinite holding without  
damaging the lenses.

          At the remote end of the buffering station, at  
25 the ends of the parallel conveyor lines along which the  
pallets may be stored, there is an integrator assembly  
which integrates alternate pallets from the two conveyor  
lines to continue toward the next station. More  
specifically, the parallel conveyor lines of the  
30 buffering station have, mounted to their end (the end  
toward which the pallets are transported), a device

17 FEB 1997

-9-

1 which selectively merges the two streams of pallets so  
that they may pass onto the next conveyor.

5 In the embodiment of the buffering station  
which is described more particularly below with respect  
to the Figures, the conveyor lines which transport the  
pallets to the buffering station and which extend after  
the buffering station are co-linear and immediately  
adjacent to a first one of the two parallel conveyor  
lines. The segregator device, therefore, first allows a  
10 single pallet to advance onto the first buffer line, and  
then transfers the next pallet to the parallel second  
buffer line. In a similar, but inverse fashion, the  
integrator device operates by permitting one pallet from  
the first buffer line to pass, then transports a pallet  
15 from the second buffer line to the conveyor line which  
continues beyond the buffering station so that it may  
follow, and then begins anew by allowing the next pallet  
from the first buffer line to pass.

In alternative variations of this apparatus,  
20 the segregator and integrator devices continually or  
selectively divide and consolidate the stream of pallets  
along the two buffer lines. In the first variation, the  
stream of pallets is divided by the segregator and  
consolidated by the integrator at all times during the  
operation of the manufacturing line. In the alternate  
25 variation, the segregator and integrator are engaged  
only under circumstances when the subsequent stations  
have been interrupted. The segregator of this  
alternative variation would operate only during  
interrupted times; the integrator would function past  
30 the resumption of the subsequent assemblies until there

35

17 FEB 1997

-10-

1 are no more pallets on the second buffer line. It is  
understood that there are a variety of alternative  
buffering algorithms which the segregator and integrator  
5 the pallets, all of which are equivalent in function and  
exist within the scope of this invention.

The stream of pallets which continue from the  
buffering station are transported to a pickup location.  
At this location the pallets are lifted off the conveyor  
10 line by a low vibration pallet transfer assembly and  
placed on a low vibration conveyor. The low vibration  
conveyor transports the pallets through the inspection  
station wherein a determination is made of the optical  
properties of the hydrated and packaged lenses. It is  
15 understood that the proper inspection of the lenses may  
not occur if the perceived optical properties of the  
lenses are distorted by air bubbles which have adhered  
to the surface of the lenses. Waves and disturbances  
within the deionized water in the packages have a  
20 similar distortion effect, causing false determinations  
of defects. The low vibration conveyor line, therefore,  
provides a means for minimizing the distortions  
resulting from water disturbances.

It is understood, however, that in order to  
25 maintain the same rate of product flow through the  
system, the reduction in speed of the stream of pallets  
along the low vibration conveyor line must be  
compensated by a corresponding increase in the density  
of the pallets moving therealong. The low vibration  
30 pallet transfer assembly, therefore, places successive  
pallets adjacent to one another on the low vibration

17 FEB 1997

-11-

1 line, such that the spacing between the pallets is substantially reduced from the previous conveyor lines.

5 Determination of the optical correctness of each lens in each pallet is stored in the memory of a controller/processor so that subsequently a means for separating the good lenses from the bad may be utilized. First, however, the pallets, which contain packages filled with deionized water are transported to a water extraction assembly. Only after the optical correctness  
10 of the lenses has been determined may the proper saline solution be introduced into the package. The delay in introducing the saline solution until after the lenses have been inspected permits the line to proceed much more quickly, as, as stated above, the optical and  
15 physical characteristics of the lens requires several hours in the saline solution to equilibrate. It is understood that this equilibration is advantageously carried out in the sealed packages, once the lenses have been removed from the manufacturing line.

20 In the inspection station, a light beam or pulse is directed from sources onto the lens-packages, received by a vertical lens unit, and directed and focused on a screen to produce an image of the lens. The image is converted to an electrical information  
25 signal which is processed to determine if the lens is acceptable for consumer use. The lens inspection results are stored in the programmable logic controller which coordinates subsequent consolidation and transfer assemblies.

30 After inspection, the pallets are lifted into a water extraction assembly which is mounted above the

17 FEB 1997

-12-

1 conveyor line. A device for deionized water extraction  
from packages containing contact lenses is taught in  
U.S.S.N. 08/999,234 entitled "Solution Removal Nozzle",  
which is also assigned to the assignee of the present  
5 invention.

Once the water has been removed, the packages  
are transported along the conveyor line to a lens-  
package pickup point. At this location the packages are  
lifted by a lens-package transfer assembly from the  
10 pallets and moved to alternative conveyor lines. More  
particularly, there are alternative variations of the  
lens-package transference assembly; a first in which the  
lens-package elements are all removed from the pallets,  
and a second in which only those packages which contain  
15 a correct lens are removed. It is understood that the  
first variation transports the packages over to a reject  
conveyor line, and pauses during transport to deposit  
any incorrectly formed lenses and the packages in which  
they are disposed. The assembly then transports the  
20 remaining correctly formed lenses and packages to the  
good conveyor line. In the second variation, the lens-  
package transfer assembly removes only the properly  
formed lenses and packages from the pallets and  
transports them to the good conveyor line. Any rejected  
25 lenses are then removed from the inspection pallets in a  
subsequent collection procedure. In either variation,  
it is understood that the determinations made by the  
inspection assembly, which were stored in memory by a  
processor/controller are herein acted upon by the lens-  
30 package transfer assembly.

17 FEB 1987

-13-

1 More specifically, with respect to the lens-  
package transfer assembly, a set of bellowed fingers,  
extending downward from a vacuum manifold are first  
positioned directly above the packages on a pallet. By  
5 descending from a position above, bringing the tips of  
the fingers into contact with the packages, and drawing  
a vacuum in an interior open volume, the packages are  
secured to the lens-package transfer assembly. As  
stated above, the processor/controller may either  
10 control the selective pickup of the optically correct  
lens-packages, or the assembly may pick up all of the  
lens-packages. In either case, the desired lens-  
packages are transported to the good conveyor line,  
where the vacuum is released and the lens packages are  
15 dropped from the tips of the fingers.

In either case, the array of lens-packages  
which are ultimately deposited onto the good conveyor  
line are not necessarily in a regular array, as they  
were on the pallet (having had the incorrectly formed  
20 lens-package elements removed). The good line,  
therefore, also carries out a consolidating function,  
whereby the lens-packages are brought back together into  
a regular distribution. More specifically, the conveyor  
line carries the articles into separate corral  
25 structures. A first lens-package is conveyed between  
converging guide rails (which align the lens-package  
along one axis of motion), and into a corral. The first  
lens-package in line is stopped by a gate at the distal  
end. The next lens-package follows the lead one and is  
30 stopped by coming in contact with the first. Once a  
predetermined number of lens-packages have entered the

17 FEB 1997

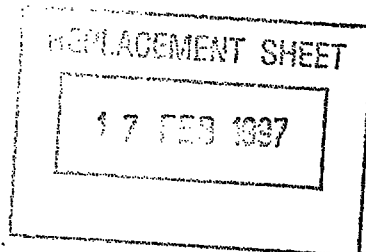
-14-

1 corral, and a regular array of lens-packages has been established, the lens-packages are removed from the conveyor line and deposited onto a final packaging pallet.

5 More particularly, the lens-package elements are removed from the corral, into which they have been directed by a conveyor line, by a rotating lens-package transfer assembly. This assembly comprises an array of bellowed fingers, similar in most respects to those of  
10 the lens-package transfer assembly, which lift the array of lens-package elements and places them onto pallets. The assembly further includes a rotational motion which rotates the array of elements to match the orientation of the pallets used for primary packaging.

15 Once the lens-packaging elements have been deposited onto these pallets, they enter into a saline dosing and sealing assembly. More specifically, the pallets are incrementally translated into position beneath a saline solution deposition unit. This unit  
20 comprises a row of fluid dispensers which fill the packages with saline solution. As the pallets are incrementally registered beneath the fluid dispensers, a buffered saline solution is injected into each of the packages and each of the lenses begins its equilibration  
25 process, matching the tonicity of a human eye (which has an equivalent salinity).

Once the packages have been filled with saline, the pallets continue forward and are sealed with a foil wrapper. More particularly, with respect to the  
30 device which applies and seals the foil wrapper to the package, an elongate section of foil wrapper material is



-15-

1 advanced through a printer (for printing information  
pertaining to the particular lens specifications). The  
foil is then cut into sections which are sized to fit  
across the tops of an array of packaging elements. The  
5 foil sections and the lens-package assemblies are  
advanced into alignment with one another. A vacuum  
gripper head grasps a foil section and descends to the  
package elements, placing the section in contact  
therewith. Once the foil wrapper is in position, a  
10 sealing mechanism is brought into contact with the  
packages and heat seals the foil to the package in a  
single high temperature short cycle sealing operation.  
The sealed packages are then advanced beyond the sealing  
assembly where they may be stored during equilibration,  
15 and ultimately packaged for distribution.

#### BRIEF DESCRIPTION OF THE DRAWINGS

The advantages and assemblies of the present  
invention set forth in the foregoing summary of an  
20 automated apparatus for combining, inspecting and  
sealing contact lenses and packaging elements may be  
more readily understood by one skilled in the art with  
reference being had to the following detailed  
description of the preferred embodiments, taken in  
25 conjunction with the accompanying drawings, wherein like  
elements are designated by identical reference numerals  
throughout the several views, and in which:

Figure 1 is a perspective view of a packaging  
element in which a contact lens may be inserted, and  
30 which serves as both a receptacle for the lens during

17 FEB 1987

-16-

1 inspection, and a portion of the primary contact lens  
package.

Figure 2 is a perspective view of an  
inspection pallet used to transport a plurality of the  
5 packaging elements illustrated in Figure 1 through  
several assemblies and stations of the present  
invention.

Figures 3a and 3b are elevation views, side  
and front views respectively, of an apparatus which  
10 fills packaging elements on a pallet with a quantity of  
degassed deionized water.

Figure 4 is a top view of the hydration pallet  
in which the hydrated and washed lenses are presented at  
the first location.

15 Figures 5a, 5b, and 5c are side, top, and  
perspective views, respectively, of the lens transfer  
and insertion assembly which removes the molded contact  
lenses from the hydration pallet, alters their relative  
spacing, and places the contact lenses in the packaging  
20 elements.

Figure 6 is a side view of a finger element of  
the lens transfer and insertion assembly onto which the  
lenses are disposed.

Figure 7 is a cross-sectional view of the air  
25 bubble removal fluid ejection mechanism for removing  
bubbles from the exterior surface of the contact lenses.

Figure 8 is a top view of the pallet transfer  
unit which transfers pairs of pallets from the lens  
transfer conveyor line to the buffer conveyor line.

30

35

17 FEB 1997

-17-

1           Figure 9 is a perspective view of the buffer station through which the pallets carrying the lens-packaging elements are directed.

5           Figure 10 is a perspective view of the segregator device which is disposed at the entrance to the buffering station.

          Figure 11 is a perspective view of the integrator device which is disposed at the exit of the buffering station.

10          Figure 12 is an overview showing the assembly station locations of the post hydration apparatus of the present invention, including the inspection station and the deionized water extraction assembly.

15          Figure 13 is a perspective view of the low vibration pallet transfer assembly which transports the pallets carrying the lens-packaging elements from one conveyor line to the low vibration inspection conveyor line.

20          Figure 14 is a perspective view of the first rotating lens-package transfer assembly which removes the packages and lenses from the inspection pallets and deposits the optically correct lens-packages on the good conveyor line.

25          Figure 15 is a perspective view of the good conveyor line which further serves to consolidate the lens-packaging elements into a regular array.

30          Figure 16 is a perspective view of the second rotating lens-package transport assembly which removes regular arrays of lens-packaging assemblies from the good conveyor line and deposits them in pallets for saline injection and foil sealing.

17 FEB 1997

-18-

1           Figure 17 is a conceptual diagrammatic  
illustration of the saline solution injector and foil  
sealing assembly.

5           Figure 18 is a side view of the saline  
solution injector and foil sealing assembly.

Figure 19 is a perspective view of the saline  
solution injecting subassembly.

10 DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

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  
15 automated production line, such as that described in co-  
pending application U.S.S.N. 08\258,654, entitled  
"Consolidated Contact Lens Molding" (VTN-0772) (Attorney  
Docket 9016); hydrated in a hydration system as  
described in U.S.S.N. 08\258,556, entitled "Automated  
20 Method and Apparatus for Hydrating Soft Contact Lenses";  
and automatically inspected as described in U.S.S.N.  
08\994,564, entitled "Lens Inspection Method and  
Apparatus" are particularly benefitted by the present  
invention.

25           The present invention shall be herein  
described with respect to its specific assemblies and  
apparatuses, and to the Figures illustrating these  
features. More specifically, the present invention  
shall be described, with reference to the following  
30 several assemblies:

35

17 FEB 1967

-19-

1 First, the deionizing water injection assembly  
which fills the packaging elements prior to the lenses  
being inserted therein;

5 Second, the lens transfer and insertion  
assembly which receives the lenses from hydration  
pallets, alters their spatial distribution, and injects  
them into the packaging elements;

10 Third, the buffering station, and the  
segregator and integrator devices included therein,  
which provide a buffering region for temporarily holding  
a group of lens-packaging pallets during interruption of  
subsequent assemblies;

15 Fourth, the low vibration lens-package  
transport, inspection, and water extraction assemblies  
which removes the inspection pallets from a conveyor  
line and inserts them onto the low vibration inspection  
assembly conveyor line, determines which lens-packages  
are optically correct, and then removes the deionized  
water from the packages;

20 Fifth, the lens-package transfer assembly,  
which removes the lens-package elements from the pallet  
and deposits those lens-packages which were determined  
to be optically correct onto a good conveyor line;

25 Sixth, the good conveyor line and rotating  
lens-package transfer assembly, which conveyor line  
consolidates the optically correct lens-package elements  
into regular arrays, and the lens-package transfer  
assembly extracts the arrays, rotates the elements in  
the horizontal plane, and transports them to another  
30 line of pallets; and

17 FEB 1997

-20-

1 Seventh, the saline solution injector and foil  
sealing assemblies, which introduce the appropriate  
saline solution into the lens-packaging elements and  
heat seals a foil label onto the top of the packaging  
5 element for shipping and identification.

#### THE DEIONIZING WATER INJECTION ASSEMBLY

Referring now to Figure 1, a suitable  
packaging element 10 is illustrated in a perspective  
10 view. This packaging element is more fully described in  
copending application U.S.S.N. 995,607, the disclosure  
of which is incorporated here by reference thereto. The  
packaging element 10 may be formed by injection molding  
or be thermally formed of plastic sheet material, such  
15 as polypropylene. The packaging element 10 includes an  
essentially rectangularly shaped platform portion 12,  
which may be visually divided into laterally distinct  
portions 14a and 14b by registration notches 16a and 16b  
which are formed in opposing sides of the platform  
portion. The first portion 14a defines a concave  
20 recession 24 which is particularly well suited for  
receiving therein and transporting a contact lens and  
fluid. The second portion 14b is generally flat,  
providing an ideal location for contact with a vacuum  
25 lifting means in that it provides a stable surface to  
seat against.

The package carrier is further defined by a  
wall portion 18 which descends at an angle, outwardly  
and downwardly from the platform portion 12 at one end  
thereof, forming an angled flange member. Descending  
30 downwardly from the corners platform portion 12, at the

17 FEB 1997

-21-

1 opposing ends thereof, are a pair of registration  
flanges 20 and 22, only one of which is visible in the  
view shown in Figure 1. The registration flanges 20 and  
22 are used, in conjunction with the angled flange 18  
5 and registration notches 16a and 16b, to align the  
packaging element 10 during robotic handling. In  
particular, the notches 16a and 16b are provided on  
either side of the platform 12 so that they may  
cooperate with registration pins on various carrier  
10 pallets. Flange structures 18, 20, and 22 mate with the  
topological structure of pallets onto which the  
packaging elements are disposed, therein providing  
additional securing means for holding the element on the  
pallet.

15 As stated above, the first portion 14a of the  
platform includes a concave recession 24 which is of an  
essentially semi-spherical configuration, generally in  
conformance with a curvilinear shape of a contact lens  
(not shown). The contact lenses are therefore, adapted  
20 to be stored in the recession 24, 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  
25 incorporated herein by reference thereto. The  
perpendicular extent of the wall portion 18 which  
descends outwardly and downwardly from the platform  
member 12 is equivalent to the height or depth of  
recession 24 therein providing self alignment of the  
30 packaging element.

17 FEB 1997

-22-

1           The concave recession 24 also includes a  
plurality of small gripping marks 26 which are used to  
assist in holding a contact lens in the centered  
position in the recession 24 during the removal of  
5   deionized water at the deionized water extraction  
assembly which will be more fully described, with  
reference to the appertaining Figures hereinafter.

          The outer edge of the recession 24 includes a  
raised annular rim 28 which is provided for enhancing  
10   the efficacy of the heat sealing of the foil label in  
the foil sealing assembly which hermetically seals the  
contact lenses and packaging elements for commercial  
distribution. A cut-out 30 is used to facilitate  
gripping the foil wrapper when it is removed by a  
15   consumer to access and use the lens contained therein.

          Referring now to Figure 2, an inspection  
pallet on which the packaging elements are transported  
to the deionized water injection assembly, through the  
lens transfer assembly, the lens inspection assembly,  
20   and the deionized water extraction assembly, to the  
lens-package transfer assembly, is shown in a  
perspective view. Pallet 40 includes a first and second  
parallel rows 42,44 of cavities 46 which are shaped to  
receive the underside of the recession 24 of the  
25   packaging element 10. The parallel rows 42,44 of  
cavities are separated by a channel 48 which is defined  
by two walls 50a,50b. The wall corresponding to row 44  
descends downwardly and outwardly, the angulation of the  
slant being specifically set to receive flatly thereon,  
30   the descending wall portion 18 of each packaging element  
10 disposed on row 44. The outer edge 54 of row 42 is

17 FEB 1997

-23-

1 similarly slanted to receive thereon the wall portions  
18 of the packaging elements 10 disposed on row 44.

5 The pallet is further provided with a pair of  
elongated notches 56,58 for receiving the registration  
flanges 20,22 of the packaging element. The elongated  
notches 56,58 further provide a positive grip surface  
for transferring means that lift, rotate, and transport  
the pallet.

10 In addition, the pallet 40 includes  
registration pins 52 which engage the packaging elements  
at the lateral edges. These registration pins 52 engage  
the registration notches 16a,16b of the packaging  
elements 10 to provide additional accuracy in their  
15 registration, specifically with respect to the  
longitudinal axis of the pallet. The combination of  
slanted walls 50b and 54, grooves 56 and 58, and the  
registration pins 52, which each couple with  
corresponding features of the packaging elements,  
provide particularly effective means to ensure against  
20 rotational skewing.

The inspection pallet 10 is further provided  
with three registration openings 60, on either side of  
the pallet 40, which are used by means associated with  
assemblies of the present invention to transport, and  
25 lock the pallet in place, during operation thereof.

As suggested by Figure 2, the packaging  
elements 10 are fabricated in sets of sixteen, and are  
disposed on pallets 40 in predetermined arrays,  
typically 2 X 8. The pallets and packages are  
30 transported, via a conveyor line, to the deionized water

17 FEB 1997

-24-

1 injection assembly in sets of two, oriented to define  
therebetween an array which is 4 x 8.

Referring now to Figures 3a and 3b, the  
deionized water injection assembly 100 is shown in a  
front side view and a lateral side view. This assembly  
100 comprises four separate elements: a water dispensing  
5 head 110; a set of coordinated vertically oriented stops  
120a,b; a pallet positioning device 130; and a water  
overflow drain unit 140. The water dispensing head 110  
10 translates up and down with respect to a conveyor line  
102 and to the pallets 40 thereon. The coordinated  
vertically oriented stops 120a,b are utilized to stop  
the advancing pallets 40, and feed one pair of pallets  
per cycle. The pallet positioning device 130 receives  
15 the pair of advancing pallets 40, advances itself and  
the pallets horizontally to a first water dispensing  
location, then to a second dispensing location. Once  
the packages have been filled, after the second  
location, the pallet positioning device 130 translates  
20 vertically which permits the pallets 40 continue to  
advance along the conveyor 102. The positioning device  
130 reciprocates back into position to receive a next  
set of advancing pallets 40. The water overflow drain  
unit 140 is positioned beneath the conveyor line,  
25 vertically aligned with water dispensing head 130, for  
catching waste water from the dispenser.

As illustrated in Figure 3a, the set of  
coordinated vertically oriented stops 120a,b advancing  
pallets 40, prior to dosing. Each of the stops 120a,b  
30 includes a vertically aligned plate 122 having one of  
its facial planes perpendicular to the axis of motion of

17 FEB 1987

-25-

1 the conveyor line 102. The plate 122 is coupled to a  
piston/cylinder 124, the selective vertical actuation of  
which advances the plate 122 into the stream of pallets  
40 advancing along the conveyor line 102.

5 As illustrated in Figures 3a and 3b the  
deionized water dispensing head 110 includes a  
horizontally disposed reciprocating support plate 112.  
The support plate 112 has sixteen holes 116 arrayed in a  
4 x 4 matrix. The top of the plate 112 receives a set  
10 of sixteen flexible hoses 114, for example tygon tubing  
or other fluid conduit, for delivering deionized water  
to a set of sixteen narrow and elongate teflon tubes 118  
which extend downwardly from the bottom of the plate 112  
and are particularly well suited to delivering precise  
15 doses of deionized water therethrough. Teflon is a  
particularly desirable material for such a use as water  
generally does not adhere to teflon surfaces in large  
droplets which may fall therefrom at inappropriate times  
in the deposition cycle.

20 The plate 112 is coupled, at a lateral edge,  
to a piston/cylinder 111, which may be actuated to raise  
and lower the head 110 (and the teflon tubes 118) in  
accordance with a predetermined deionized water  
deposition cycle which is more fully described  
25 hereinbelow.

Beneath the conveyor line, vertically aligned  
with water dispensing head 130, is a water drain unit  
140 which is so disposed to catch any excess water which  
may emanate from the dispenser during purge cycle or  
30 cycle misfeeds. The water drain unit comprises a basin  
142 having a sloped base, therein forming a funnel-like

35

REPLACEMENT SHEET

17 FEB 1937

1 shape, directing water therein toward a hole 144 in the  
base. The hole 144 is coupled to a drainage tube 146  
which carries the drainage water away from the assembly  
to a remote location.

5 The fourth element of the deionized water  
injection assembly 100 comprises a pallet positioning  
device 130. This element receives a pair of advancing  
pallets 40 and first holds them in position beneath the  
deposition head 110 in a first position so that the  
10 first sixteen recesses 24 of the packaging elements may  
be filled with deionized water. Once the first sixteen  
recesses 24 have been filled, the pallet positioning  
device 130 translates horizontally to a second position,  
thereby repositioning the pallets 40 at a second  
15 position beneath the deposition head 110. At this  
position the second sixteen recesses 40 of the pair of  
pallets 40 receive a quantity of deionized water. Once  
the second step of water deposition has taken place, the  
registration device release the pallets, rises to allow  
20 the pallets to advance beneath it, and reciprocates back  
to the pallet receiving location (the first location).

More specifically with respect to the elements  
of the pallet positioning device 130, the positioning  
device comprises a pair of spaced apart arms 131,132  
25 which extend laterally across the conveyor line 102, and  
which are ideally spaced for receiving and holding pairs  
of pallets 40 which advance down the conveyor line 102.  
The arms 131,132 are coupled at their lateral ends 133  
to vertically oriented piston/cylinder 134 which raises  
30 and lowers the arms 132 in accordance with the timing of  
the deposition cycle.

17 FEB 1997

-27-

1           In addition to the vertically oriented  
piston/cylinder 134, the arms 131,132 are coupled  
together via an elongate spar member 135 and a  
horizontally disposed piston/cylinder 136. Actuation of  
5 the piston/cylinder 136 causes the arms 131,132 to move  
relative to one another. Specifically, arm 131, which  
is positioned in front of the deposition head, up stream  
from the deposition head with respect to the flow of the  
conveyor line 102, remains stationary as the other arm  
10 132 is directed farther downstream from the deposition  
head 110, therein moving the pair of pallets 40, into  
the second deposition position.

In operation the entire assembly functions in  
accordance with a predetermined timing schedule,  
15 beginning with the advance of a pair of pallets 40 along  
the conveyor line 102, toward the assembly. Once a pair  
of pallets 40 have passed the first of the coordinated  
vertical stops 120a, plates 122 are raised, so that  
additional pallets 40 may be restrained from continuing  
20 into the water dosing location.

The two pallets 40 continue to advance until  
they reach the second of the coordinated vertical stops  
120b, at which point the pallet positioning device 130  
descends into position holding the pallet in the first  
25 deposition position. Deionized water is then injected  
via the teflon tubes 118 into the first sixteen recesses  
24 of the pallets. Once the water has been injected,  
vertical stop 120b is retracted and the horizontally  
oriented piston/cylinder 136 of the positioning device  
30 130 is actuated, thereby advancing the pallets 40 to the  
second deposition position. Once the second set of

17 FEB 1997

-28-

1 sixteen recesses 24 have been filled with deionized water, the arms 131,132 are raised by vertically oriented piston/cylinder 134, and the horizontally oriented piston/cylinder 136 is retracted.

5           Once the first pair of pallets 40 have advanced past the assembly 100, vertical stop 120a is lowered to permit the next pair of pallets through the dispensing station, and the second set of vertical stops 120b are raised. After the second pair of pallets have  
10 advanced, the vertical stops 120b are raised to stop the following pallets 40 from entering, and the cycle repeats.

          Once the packaging elements 10 have each received a quantity of deionized water, the packaging  
15 elements and pallets are transferred along the conveyor line to a lens loading location where each recess 24 receives a contact lens by a loading assembly described hereinbelow.

20           THE LENS TRANSFER AND INSERTION ASSEMBLY

          Referring now to Figure 4, a contact lens hydration pallet 200 is shown in a top view wherein phantom lines correspond to internal structures of the hydration pallet. The hydration pallet 200 comprises 32  
25 semi-spherical recesses 202 in which contact lenses are transported through a series of extraction stations, which are described more fully in co-pending application U.S.S.N. 08\258,556, entitled "Automated Method and Apparatus for Hydrating Soft Contact Lenses", also  
30 assigned to the assignee of the present invention.

17 FEB 1997

1           The hydration pallet 200 has a plurality of  
conduits 206 which extend upwardly from the top surface  
of the pallet. These conduits 206 are coupled, via  
internal branch conduits 208, to small holes 204, one of  
5 which is disposed at the bottom of each recess 202, at  
the bottom thereof. The holes 204 are thereby coupled  
in gas and/or fluid flow communication with an external  
supply, whereby a fluid or gas may be selectively  
introduced between the surface of the recess 202 and a  
10 lens disposed therein. The selective introduction of  
this gas or fluid, via the hole 204, is used to propel  
the lenses upward so that they may each adhere to  
corresponding convex lens attachment surface of the  
finger elements of the lens transfer assembly as  
15 described hereinbelow.

Referring now to Figures 5a, 5b, and 5c, the  
contact lens transfer assembly 210 is shown in side, top  
and perspective views, respectively. The assembly 210  
generally comprises a head element 240 and a dual axis  
20 linearly translating mounting unit 220. First, with  
respect to the dual axis linearly translating mounting  
unit 220, a mounting bracket 222 is coupled at its lower  
horizontal surface 222a to the head element 240. The  
mounting bracket 222 is, in turn, mounted to a base  
25 element 224, in relation to which, the mounting bracket  
222 may be raised or lowered by means of a vertically  
oriented translation mechanism. It is understood that a  
variety of means may be employed for the raising and  
lowering of the mounting bracket 222 including an  
30 articulated robot. However, a preferred mechanism

17 FEB 1997

-30-

1 comprises an IKO ball screw drive system to reciprocally  
translate the head from position to position.

As illustrated in Figure 5c, the base element  
224 is mounted to a horizontal track 226, along which it  
5 translates in accordance with the actuation of a motive  
means. In Figure 5c the motive means 228 is shown to be  
a ball screw drive, however, it is understood that a  
variety of alternative translation means may be employed  
to provide an equivalent function. For example, the  
10 translation means may comprise a hydraulic or pneumatic  
piston/cylinder device, or it may comprise a scissoring  
arm assembly. The ball screw is preferred for its  
accuracy, mechanical simplicity, long term operability,  
and efficiency.

15 With respect to the head element 240, a  
coupling element 242 is affixed at its upper end to the  
lower surface of the mounting bracket 222. The lower  
end of the coupling element 242 is mated to a pair of  
guide plates 244 which are substantially parallel and  
20 held in spaced relation to one another by cross bars  
246. Slidably mounted on the cross bars 246, also in  
spaced apart relation to one another, is a set of four  
horizontal support beams 248. The support beams 248  
slidably mounted on the cross bars 246 so that they may  
25 be drawn together or spread apart in accordance with  
their appropriate positioning.

The means by which the support beams 248a-d  
may be moved relative to one another is provided by a  
pair of piston/cylinders 250, 252. The embodiment of  
30 Figure 5b shows the first piston/cylinder 250 couples  
the two inner beams 248b,c, and the second

17 FEB 1997

-31-

- 1 piston/cylinder 252 couples the two outer beams 248a,d.  
As shown in Figure 5b, the second piston/cylinder is  
mated directly to a bracket 254 on one of the outer  
beams 248a, and mated to a linkage plate 256 which  
5 couples the piston/cylinder 252 to bracket 260 which is  
attached to outer beam 248d. The first piston/cylinder  
250 is coupled directly to brackets 262a,262b which are  
in turn mated to the two inner beams 248b,c.

- Extending downward from each support beam  
10 248a-d are a plurality of finger elements 264, to which  
the lenses adhere during transfer. In the preferred  
embodiment, there are thirty-two fingers 264, mounted in  
a 4 x 8 array of four beams and eight fingers per beam,  
which correspond to the thirty-two recesses 202 of the  
15 lens hydration pallet 200. Selective actuation of the  
piston/cylinders 250,252, which causes the beams to move  
relative to one another, causes the relative spacing of  
the finger elements 264 to be altered.

- Referring now also to Figure 6, a side view of  
20 a finger element 264 is provided. The finger element  
264 comprises an elongate shape having a convex lens  
attachment surface 266, the curve of the surface 266  
generally corresponding to the curvature of the concave  
surface of a contact lens. A central bore 268 extends  
25 through the finger 264 from the top 270 to the lens  
transfer surface 266. This bore 268 is included for the  
selective ejection of a fluid therethrough, which fluid  
may be deionized water, as will be discussed below with  
respect to the deposition of a lens into a corresponding  
30 packaging element 40.

17 FEB 1997

-32-

1           The end of each finger 264 includes an annular  
slotted skirt 272 which separates the curvate shape of  
the lens transfer surface 266 from the generally  
cylindrical shaft portion 274 of the finger 264. This  
5           slotted skirt 272, which includes alternating vertically  
oriented slots 272a and skirt elements 272b helps retain  
the lens on the attachment surface 266 and prevents it  
from sliding, or otherwise moving out of a desired  
position. The vertically aligned slots 272a are designed  
10          to provide a channel through which a fluid or gas which  
is directed upwardly at the lens transfer surface may  
flow smoothly. The skirt elements 272b are provided to  
prevent a contact lens from sliding off the lens  
transfer surface when said fluid or gas is directed at  
15          the surface.

          A circular mounting disc 271 is disposed about  
the cylindrical shaft of the finger 264, at a position  
remote from the tip 266. The mounting disc 271 may be  
coupled to the upper or lower surface of the  
20          corresponding support beam 248, such that the top of the  
finger 264 may be coupled to an external supply of fluid  
such as deionized water with the lens transfer surface  
266 extending downward. In either case, the tops 270 of  
the fingers 264 are coupled to tubes 273, which are  
25          preferably flexible, and which may selectively supply  
fluids such as air or deionized water to the central  
bore 268 in accordance with the predetermined operation  
of the assembly.

          As illustrated in Figure 5c, in operation a  
30          hydration pallet is advanced along the lens conveyor  
line 275 to a position directly beneath the lens

17 FEB 1987

-33-

1 transfer assembly 210. The dual axis linearly  
translating mounting unit 220 lowers the head array 240  
so that the lens transfer surfaces of the fingers 264  
are positioned directly above the recesses 202 of the  
5 pallet. Once in position, a quantity of air is directed  
through the conduits 206,208 in the plate. This air  
floats the contact lenses out of the recesses 202, and  
onto the lens attachment surfaces 266 of the fingers  
264. As the lenses have been carried in the pallet  
10 through several extraction stations prior to arriving at  
the lens transfer assembly 210, the lenses and recesses  
202 of the pallet have residual deionized water thereon.  
This deionized water assists the lenses in adhering to  
the surface 266 of the finger 264 via surface tension.  
15 While the lens will adhere to the curved lens attachment  
surface 266 with or without an additional surfactant, a  
surfactant may be added to more efficiently wet the  
surfaces together and promote retention of the lens by  
virtue of the surface tension of the deionized water and  
20 the surrounding atmospheric pressure. In the transfer,  
it is desirable to position each of the finger tips 266  
within 1.5 mm of the lens to ensure a direct and precise  
transfer.

Occasionally the outer surface of the lens may  
25 have bubbles of air, in the deionized, water attached to  
it. If the bubbles remain, and are not dissolved, or  
otherwise removed from the lens, subsequent inspection  
of the optical correctness of the lenses will be  
compromised. Degassed ionized water is used in the  
30 hydration apparatus to minimize bubble formation, and in  
order to ensure that air bubbles are removed from the

17 FEB 1997

-34-

1 surface of the lens, when the head element 240 and  
fingers 264 are raised, the mounting assembly transports  
them to a bubble blow off unit 280 disposed between the  
hydration conveyor line 275 and the packaging element  
5 pallet line 102.

Referring now to Figure 7, a cross-sectional  
view of finger 264 carrying a lens and a recess 282 of  
the bubble blow off unit 280 is shown. The bubble blow  
off unit 280 comprises a plate 284 having a regular  
10 array of recesses 282 therein. The regular array of  
recesses 282 is designed to match the spacing of the  
fingers 264 of the lens transfer assembly head 240. The  
base of the recess 282 includes a through hole 286,  
which forms the mouth of a conduit 288 which extends  
15 downward to an air supply means. Selective ejection of  
air through the conduit is directed at the lens which is  
adhered to the lens attachment surface 266 of the finger  
264. The force of the jet of air may cause the lens to  
migrate across the attachment surface 266, however, the  
20 slotted skirt 272 prevents the lens from sliding more  
than a portion of one lens radius from the center  
position. The jet removes the bubbles from the lens  
surface so that the inspection process will not falsely  
identify such air bubbles as fabrication errors in the  
25 lens itself.

Once the bubble removal process has been  
carried out, the piston/cylinders 250,252 are actuated  
to bring the beams 248 together. This change in  
relative distribution of lenses perpendicular to the  
30 beams 248 (whereby the four rows of eight fingers are  
brought closer to one another, but the spatial

17 FEB 1997

-35-

1 separation of fingers within the rows remains unchanged)  
is necessary because the distribution of packaging  
elements on the inspection pallet 40 is set in  
accordance with the inspection station apparatus, which  
5 is not the same as the relative spacing of the lenses  
during molding or hydration.

Once the piston/cylinders 250,252 have set the  
fingers 264, and the lenses thereon, into the properly  
distributed array, the horizontally oriented translation  
10 means 228 transports the head element 240 and the lenses  
to a position above the pallet 40 on conveyor line 102.  
With the lenses are positioned above their corresponding  
recesses 202, a quantity of deionized water is  
discharged from the tip of the finger, via the central  
15 bore 268, into the space between the lens and the lens  
attachment surface. This quantity of deionized water is  
sufficient to disrupt the surface tension adhesion of  
the lens to the surface, causing the lens to be carried  
along with the water into the package element 10.

20 The contact lenses and lens-package elements  
are carried on the pair of inspection pallets 40, by the  
conveyor 102 to the next station which is the buffering  
station. The fingers of the lens transfer assembly then  
return to their open spatial array, and the head element  
25 240 is reciprocated back to its receiving position above  
the hydration conveyor line 275, and awaits the next  
batch of contact lenses.

#### THE BUFFERING STATION (SEGREGATOR & INTEGRATOR DEVICES)

30 The process of manufacturing contact lenses is  
in large part determined by the handling requirements of

17 FEB 1997

-36-

1 the lenses themselves. For example, one of the most  
important restrictions around which all of the molded  
article handling assemblies are designed is that the  
optical surfaces should not be touched. The handling  
5 requirement which is most relevant to the present  
assembly is that the lenses, once hydrated, must not be  
allowed to remain dry for more than 15 minutes.

As is the case with most manufacturing line  
machinery, the assemblies of the present invention,  
10 which together form the post lens hydration apparatus,  
require periodic maintenance and/or refilling with  
materials used in manufacturing. For example, the  
primary packaging station (the saline solution injector  
and foil sealing assemblies) requires periodic  
15 replacement of the foil material which is heat sealed to  
the packaging elements. The performance of other  
assemblies, however, are susceptible to being  
interrupted. However, the molding assemblies need to be  
kept in continuous operation for proper equilibration  
20 which is critical for optimal yield quantities.

In order to ensure that certain assemblies be  
permitted to run continuously, and still provide for  
periodic maintenance or resupply of other stations, one  
or more buffering station are necessary. The ideal  
25 position for a buffering station must be one where the  
lenses remain in an aqueous environment. The buffering  
station of the present invention is positioned between  
the lens transfer assembly and the inspection station.

The pallets 40, which have been filled with  
30 deionized water, and into which contact lenses have been  
deposited, each define a 2 x 8 array. In pairs, the

17 FEB 1997

-37-

1 pallets define a 4 x 8 array. At the lens insertion  
station (the lens transfer assembly) the pairs of  
pallets are advanced side by side; the elongate axis  
defined by the columns of 8 recesses, of each pallet  
5 being parallel to the direction of motion of the  
conveyor line.

Referring now to Figures 8, 9, 10 and 11,  
which are perspective views of the buffering station,  
including the segregator unit, and the integrator unit,  
10 respectively. As illustrated in Figure 9, the buffer  
station comprises first, second, third, and fourth  
segments 304, 308, 312, 316 of a conveyor line, each of  
which is disposed for movement of pallets in the same  
direction. A segregator unit 320 is positioned after  
15 the first segment 304, and an integrator unit 340 is  
positioned before the fourth segment 316. The second  
and third segments 308, 312 run parallel to one another,  
each beginning at the segregator unit 320 and ending at  
the integrator unit 340.

20 A first segment 304 of the buffer conveyor  
line is disposed perpendicularly to the lens transfer  
conveyor line 102 which advances the pallets from the  
lens transfer assembly, as set forth above. Referring  
specifically to Figure 8, the end of the lens transfer  
25 conveyor line 102 and the beginning of the first segment  
304 of the buffer conveyor line, and the lateral pallet  
transfer unit 306 which transfers the pallets 40 from  
the former to the latter are shown in a top view. As  
the pairs of pallets 40 reach the end of the lens  
30 transfer conveyor 102 they are stopped from advancing by  
a guide 300. The pallets 40 are then pushed by a push

35

17 FEB 1997

-38-

1 plate 302 from the lens transfer conveyor line 102, onto  
the first segment 304 of the buffer conveyor line.

More particularly with respect to the motion  
of the pusher plate 302, the pusher plate 302 includes  
5 an arm 303 extending from its back portion which is  
motively coupled to a slide element 305 which is  
disposed beyond the wall element 300. Selective  
actuation of the slide element 305 in the forward  
direction provides the linear lateral motion of the  
10 pusher plate 302 and transfers the pallets 40 to the  
first segment 304 of the buffer conveyor. Reverse  
actuation of the slide element 305 reciprocates the  
pusher plate 302 into position to receive the next pair  
of pallets 40. It is understood that a variety of  
15 mechanisms may be employed which provide the appropriate  
motion of the pusher plate; examples being a ball screw  
drive, hydraulic, pneumatic, or air piston/cylinder  
elements, or mechanical scissoring devices.

As the pairs of inspection pallets 40 are  
20 transferred to the first segment 304 of the buffer line,  
they are translated from a parallel relationship to a  
tandem relationship, because the segment 304 is oriented  
perpendicularly with respect to the lens transfer  
conveyor 102. The pair is now advanced in tandem with  
25 one pallet following the other, each having its elongate  
axis oriented perpendicularly with respect to the  
direction of motion of the first segment 304 of the  
buffer conveyor.

The pallets 40 are advanced in tandem to the  
30 segregator unit 320 which permits alternating pallets  
40, for example the first of the pairs, to advance

17 FEB 1987

-39-

1 linearly onto a second segment 308 of the buffer  
conveyor line; the second segment 308 of the buffer  
conveyor line being co-linear with the first segment  
304. A vertical stop mechanism 310a, which is similar  
5 in form and function to the vertical stop 120 of the  
deionized water injection assembly, is disposed before  
the segregator 320 to permit only one pallet of the pair  
onto the segregator 320. With respect to the second  
pallets of the pairs, the segregator 320 transfers them  
10 to the third segment 312 of the buffer conveyor, which  
runs parallel to the second segment 308.

Vertical stops 310b, 310c which are disposed on  
the second and third segments 308, 312 of the buffer  
conveyor line, are positioned to prevent premature  
15 advancement of the pallets 40 on the conveyors until  
transfer is completed.

The segregator 320 is continuously engaged,  
providing both a constant spacing of individual pallets  
40 from one another, and providing a dual track holding  
20 line for the pallets 40 during interruptions in the  
subsequent assemblies of the manufacturing line. The  
pallets 40 thereby form parallel lines extending along  
the second and third segments 308, 312 for distances  
which are determined to be sufficient to store the  
25 number of pallets 40 which will be produced during  
normal service interruptions in the manufacturing line,  
as for example twenty minutes.

At the distal ends of the second and third  
segments 308, 312, an integrator unit 340 is provided to  
30 merge the two streams of pallets 40 so that they may  
advance, in a regularly spaced unitary stream, along the

17 FEB 1997

-40-

1 fourth segment 316 of the buffer conveyor, to the  
inspection station. Again, vertical stops 310d, 310e are  
positioned at the ends of the segments 308, 312  
respectively, and are engaged to ensure that only one  
5 pallet 40 enters the integrator at a given time.

The integrator 340 remains engaged during  
normal operation of the manufacturing line, but is  
disengaged to stop the advance of any further pallets 40  
when an interruption occurs. During this time, the  
10 pallets 40 which continue to advance from the lens  
transfer assembly are stored in parallel lines on the  
second and third segments 308, 312 of the buffer  
conveyor. Once the interruption ends, the integrator  
340 is reengaged and merges the stored pallets in a  
15 continuous stream. A final vertical stop 310f is  
disposed at the outlet of the integrator 340 to prevent  
premature advancement or skewing on the powered  
conveyor, and to enable spacing between pallets 40 on  
the fourth segment 316, as they enter the inspection  
20 station.

Referring specifically to Figure 10, which is  
a perspective view of the segregator unit, particular  
attention is provided to the features and function of  
the segregator 320. A housing 321, which is an inverted  
25 L-shaped member is mounted to the lateral edge of the  
conveyor line, at the coupling point of the first and  
second segments 304, 308. Extending outward from the L-  
shaped member 321 are a pair of substantially parallel  
guide rails 323. The rails 323 are received by a  
30 stationary plate 327 which is mounted to the outside  
lateral edge of the third segment 312 of the buffer

17 FEB 1997

-41-

1 conveyor. A first moving plate 329 is slidably mounted  
to the guide rails 323 such that the plane of this first  
plate 329 is aligned vertically and parallel to the  
direction of conveyor motion. This first plate 329  
5 reciprocates from a first position between the second  
and third conveyor segments 308,312 and a second  
position at the stationary plate 327. A second moving  
plate 331 is similarly mounted to the guide rails 323,  
and to a motive means (not shown) such that it may be  
10 reciprocated from a position at the outside lateral edge  
of the second conveyor segment 308 to a position between  
the second and third segments 308,312. The first and  
second plates 329,331 are maintained in a spaced apart  
relation such that a pallet 40 may be transferred  
15 therebetween, from the first segment 304 to the third  
segment 312 upon selective reciprocation of the plates  
329,331 along the guide rails 323.

In operation, as can be inferred from Figure  
10, the reciprocation of the plates 329,331 is  
20 selectively controlled such that alternating pallets are  
transferred to the third segment 312. It is understood  
that a variety of motive means and/or coupling means may  
be utilized for reciprocating the plates 329,331  
together, for example the guide rails may comprise a  
25 threading and the mounting of the plates 329,331 thereto  
comprises a nut which may be translated along the guide  
rails 323 by the rotation thereof. A separate, but  
equivalent, design includes an air piston/cylinder  
mounted within the L-shaped member 321 which is coupled  
30 to the driving plate 331 and which reciprocates it. In  
such a design, a coupling means, for example a fixed rod

17 FEB 1997

-42-

1 mated to both plates 329,331, must be utilized to slave  
the motion of plate 329 to the motion of the dive plate  
331.

5 Referring now to Figure 11, which is a  
perspective view of the integrator unit, a detailed  
description of the features and functions of the  
integrator unit is provided. Similar in many respects  
to the segregator unit 320, the integrator is  
essentially the same device which operates in reverse.  
10 A housing element 341, which is L-shaped and mounted to  
the outside lateral edge of the second segment 312 of  
the buffer conveyor. A pair of guide rails 343 extend  
outward from the housing member 341 and are received by  
a stationary plate 347, mounted to the outside lateral  
15 edge of the third segment 312 of the buffer conveyor. A  
set of spaced apart moving plate 349, 351 are slidably  
mounted to the guide rails 343 such that the planes of  
these plates 349,351 are aligned vertically and parallel  
to the direction of conveyor motion. The second moving  
20 plate 351 is coupled to a motive means (not shown) such  
that it may be reciprocated from a position at the  
outside lateral edge of the second conveyor segment 308  
to a position between the second and third segments  
308,312. The first and second plates 349,351 are  
25 maintained in a spaced apart relation such that a pallet  
40 may be transferred therebetween, from the third  
segment 312 to the fourth segment 316 upon selective  
reciprocation of the plates 349,351 along the guide  
rails 343.

30 In operation, as can be inferred from Figure  
11, the reciprocation of the plates 349,351 is

17 FEB 1997

-43-

1 selectively controlled such that alternating pallets,  
one from the second segment 308 followed by one from the  
third segment 312, advance to the fourth segment 316.  
It is understood that a variety of motive means and/or  
5 coupling means may be utilized for reciprocating the  
plates 349,351 together, for example the guide rails 343  
may be threaded matable to a threaded hole or nut in the  
plates 349,351. A separate, but equivalent, design  
includes an air piston/ cylinder mounted within the L-  
10 shaped member 341 which is coupled to the driving plate  
351 and which reciprocates it. In such a design, a  
coupling means, for example a fixed rod mated to both  
plates 349,351, must be utilized to slave the motion of  
plate 349 to the motion of the drive plate 351.

15 THE LOW VIBRATION LENS-PACKAGE TRANSPORT ASSEMBLY, THE  
INSPECTION ASSEMBLY, AND THE WATER EXTRACTION ASSEMBLY

Referring now to Figure 12, a top view  
diagrammatic of the present invention is provided. As  
20 is illustrated, the lens transfer station 299, where the  
lenses are transferred to the packaging elements on the  
inspection pallets 40 is sequentially followed by the  
buffering station 399. The pallets, having advanced  
through the buffering station are transferred through a  
25 conveyor station 499 to the inspection station 599, by a  
low vibration conveyor assembly as described  
hereinbelow.

Figure 13 is a perspective view of the low  
vibration transfer assembly which transfers the  
30 inspection pallet from conveyor 316 to the inspection  
station. When a pallet 40 has passed through the

17 FEB 1997

-44-

1 integrator unit of the buffer assembly and has passed  
down the fourth segment of the buffer conveyor, it is  
translated to a staging area 325 as illustrated in  
previously described Figure 9. At this staging area 325  
5 an overhead double axis transport carrier reciprocates,  
picks up the single pallet 40 for transfer to the  
automatic lens inspection station as illustrated in  
Figure 13. The overhead transport is a double axis  
Hauser Transport Mechanism, and is used to isolate the  
10 automatic lens inspection system from the remainder of  
the post-hydration line.

It is important that vibrations of the lenses  
and the deionized water be minimized during this  
transport, and through the entire inspection line so  
15 that water waves are avoided, as they can cause optical  
distortions which, in turn, may cause false  
determinations of lens quality. By utilizing a double  
axis transport mechanism, the pallet can be gently  
conveyed to the automatic lens inspection system, and  
20 thereby avoid such vibrations which that might otherwise  
impair the inspection results.

After the first pallet has been lifted from  
the staging area, the next pallet may be advanced into  
the staging area to be carried onto the inspection line  
25 conveyor. The double axis transport mechanism  
transports the pallets from the buffer conveyor, where  
the pallets are advanced at a given speed and spacing,  
to the inspection line, where the speed of the pallets  
is substantially slowed to avoid vibration. It is  
30 necessary, therefore, for the spacing of the pallets on  
the inspection conveyor to be substantially closer

17 FEB 1997

-45-

1 together so that the inspection conveyor may accommodate  
the same number of pallets in a given time.

5 The low vibration pallet transfer assembly 400  
comprises a pair of pallet grasping plates 402a,402b  
which are mounted, in spaced relation to one another, to  
corresponding blocks 404a,404b. One of the grasping  
plates 402a is slidably mounted to its block 404a such  
that selective actuation of an extending mechanism  
(housed within block 404a) widens or reduces the spacing  
10 between the two grasping plates 402a,402b. The blocks  
404a,404b are mounted to a common wall element 406 which  
is slidably mounted to a base element 408. A second  
motive mechanism (also not shown) is disposed within the  
base element 408 and coupled with the common wall 406  
15 such that the wall 406 can be selectively raised and  
lowered. The base element 408 is mounted to a  
horizontal track 410 having a translating means for  
reciprocating the entire assembly from a position above  
the staging area 325 to the inspection station conveyor  
20 line 420.

In operation, the low vibration pallet  
transfer assembly 400 reciprocates to the staging area  
325 to receive a pallet 40. The common plate 406 is  
lowered, thereby positioning the pallet grasping plates  
25 402a,402b adjacent to the lateral edges of the pallet  
40. The motive element within the block 402a is  
actuated to draw the plates closer, therein bringing the  
inner surfaces of the plates 402a,402b in contact with  
the pallet 40. Once the pallet has been grasped  
30 securely by the lateral plates 402a,402b, the common  
wall 406 is raised, and the pallet is transported to the

17 FEB 1997

-46-

1 inspection station conveyor line, which is disposed  
perpendicularly to the fourth segment 316 of the  
buffering conveyor line. Once in position above the  
inspection conveyor line 420, the pallet 40 is lowered  
5 onto the line and released by actuation of the plate  
widening mechanism. The pallet is then carried into the  
inspection station. Once the pallet is transferred to  
the low vibration lens transfer assembly 400 rises and  
reciprocates back to the staging area 325 to receive the  
10 next pallet 40.

In the Automatic Lens Inspection System, the  
inspection pallets 40 are conveyed through the system as  
a pulse of light is directed through the lens-packages  
and contact lenses, and focused on a camera to generate  
15 an image of the lens therebelow. Preferably, the camera  
includes an array of pixels, each of which generates a  
respective one electric signal proportional to, or  
representing, the intensity of the light incident on the  
pixel. Those electric signals are then digitally  
20 processed to determine if the lens is acceptable for  
consumer use. Suitable procedures for processing or  
analyzing the electric signals from the pixel array are  
disclosed in copending Patent Application Nos. 993,756  
and 995,281, entitled "Automatic Lens Inspection  
25 System", the disclosures of which are herein  
incorporated by reference. Separate systems are  
utilized to inspect the sixteen lenses carried in a  
pallet. After completing the test for the last bank of  
lenses, the Automatic Lens Inspection System sends a  
30 datablock with the vision inspection results to the  
programmable logic controller used to consolidate the

17 FEB 1997

-47-

1 lenses for packaging. This information is used by the  
lens-package transfer assembly as described below.

5 After the lenses have been inspected by the  
automatic lens inspection system, the pallet is lifted  
by second double axis overhead transport and placed on  
conveyor for transport to the deionized water removal  
station (which is station 699 in Figure 12). The  
deionized water is removed by a specially configured  
nozzle, as described in U.S.S.N. 08/999,234, entitled  
10 "Solution Removal Nozzle", the disclosure of which is  
hereby incorporated herein by reference thereto. As  
described earlier, the deionized water is used to center  
the lens within the package carrier during the  
inspection process, but is removed prior to packaging,  
15 to enable a precise dosing of a buffered saline solution  
in the final package, as will hereinafter be described  
in detail.

After removal of the deionized water, the  
lenses, package carriers and inspection pallet are  
20 transported to the lens-package transfer assembly which  
removes the packaging elements and lenses therefrom,  
deposits the optically incorrect lens-packages (as  
determined by the inspection station) on a conveyor for  
bad lenses, and deposits the correct lens-packages on  
25 good conveyor.

#### THE FIRST ROTATING LENS-PACKAGE TRANSFER ASSEMBLY

Referring now to Figure 15, the lens-package  
30 transfer assembly is shown in a perspective view, in  
position above a pallet of lens-packages which have had

17 FEB 1997

-48-

1 the deionized water removed therefrom. The assembly 500  
comprises a reciprocating support 502 coupled at the  
lower end of a vertical shaft 504. The shaft 504 is, in  
turn, coupled at its upper end to a rotation means 506  
5 whereby the shaft 504 and the support 502 may be  
selectively rotated by 90 degrees in accordance with the  
predetermined positioning of a pallet 40 or the  
orientation of the conveyor (see Figure 16) onto which  
the lens-packages are deposited. It is understood that  
10 the rotating means 506 may comprise an air cylinder  
having stops which, for example, correspond to a 90  
degree rotation so that the shaft may be reciprocated  
between two orientations which are perpendicular.

The rotating means 506 is disposed within a  
15 mounting platform 501, which is in turn coupled to a  
dual axis transport subassembly (the horizontal track  
thereof is identified as element 503 in Figure 15). The  
dual axis transport subassembly transports the support  
502 from a first location to a second location, for  
20 example, from a position above the water extraction  
conveyor line to a position above the consolidating  
conveyor line (which is described more fully with  
reference to Figure 16).

Extending downwardly from the support 502 are  
25 a set of resilient bellowed fingers 508 having a  
generally elliptical shape. The fingers 508 each have  
an open tip 510 at their lower ends which forms an  
entrance into a central volume which extends the length  
of the finger. The upper ends of the fingers 508 are  
30 coupled to the vacuum tubes 512 such that the central  
volume of the fingers are in sealed gas flow relation to

17 FEB 1997

-49-

1 tubes 512 which are individually coupled to a vacuum  
source (not shown). Each tube is separately valved; the  
valves being independently controlled by a processor in  
accordance with signals received from the inspection  
5 station with respect to which lens-packages contain  
correct lenses. Selective activation of the vacuum  
source would, therefore, provide a low pressure suction  
at the tips 510 of the finger 508. When this low  
pressure suction is employed, the tips 510 of the  
10 fingers may be placed onto a flat surface, therein  
sealing the central volume, and securing the flat  
surface to the finger 508.

In operation, a pallet 40 having lens-  
packages, from which the deionized water has been  
15 removed, is transported to the first location, the lens-  
packages being substantially aligned with the fingers  
508 of the first rotating lens transfer assembly 500.  
The fingers 508 are directed downward until their tips  
510 contact the flat surface portion 46b of the  
20 packaging element, forming a sealing interface  
therewith. Selective actuation of the valves  
controlling the drawing of a vacuum within each finger  
508 causes the package elements and lenses to be lifted  
from the pallet. It is understood that all of the lens-  
25 packages may be removed from the pallet 40 and  
subsequent actuation of the valves may be utilized to  
deposit the incorrectly molded lenses on a separate,  
bad, conveyor, and the optically correct lenses on the  
good conveyor, or in the alternative, only the good  
30 lenses are transferred, and the rejected lenses are  
later removed from the inspection pallet by an

17 FEB 1997

-50-

1 alternative means. This procedure can be used to  
increase (shorten) the cycle time of the transfer  
device.

5 Once the appropriate lens-packages are removed  
from the pallet 40, the manifold 502 and fingers 508 are  
rotated 90 degrees by the rotating means 506 while  
simultaneously being reciprocated upward and laterally  
by the dual axis transport subassembly. The fingers 508  
are repositioned over the consolidating conveyor, at  
10 which point the vacuum within the fingers 508 which are  
holding lens-packages is released, and the lens-packages  
are deposited on the conveyor.

Once the optically correct lens-packages have  
been so deposited, the assembly 500 reciprocates back to  
15 extract a new set of lens-packages from the next  
inspection pallet 40.

CONSOLIDATING CONVEYOR AND SECOND ROTATING LENS-PACKAGE  
ASSEMBLY

20 The first rotating lens-package transfer  
assembly 500 deposits the optically correct lens-  
packages onto the consolidating conveyor 602 as shown in  
Figure 16. The consolidating conveyor comprises a belt-  
type motive surface 604 onto which the two rows of lens-  
25 packages are transported. The conveyor surface 604 is  
divided into parallel longitudinal channels 605 by a  
guide wall 606. As shown in Figure 16, the rows of  
lens-packages may not be regularly distributed on the  
conveyor surface when they are deposited.

30 The lens-packages are transported along the  
conveyor until the lead packages contact a moveable gate

35

17 FEB 1967

-51-

1 element 610. The gate element 610 interferes with the  
continued transport of the lead lens-packages in each of  
the channels 605. As the progression of the lead lens-  
packages is halted, the packages which follow  
5 subsequently come into contact with the lead packages,  
therein being consolidated into a regularly spaced  
array. A sensor block is disposed above the conveyor  
surface 604, at a location upstream from the gate  
element 610. An additional sensor may be located at a  
10 distance wherein a specific number of lens-packages may  
be aligned therebetween in a staging position 609. For  
example, the array of lens-packages which is positioned  
between the wall element 608 and the sensor element 610  
in the embodiment illustrated in Figure 16 is 2 x 5.  
15 Gate element 610 provides for a controlled flow of only  
the correct number of lens packages necessary to  
complete the 2 x 5 array in the staging position.

Referring now also to Figure 17, a perspective  
view of the second rotating lens-package transfer  
20 assembly 650 is shown. Once a full 2 x 5 array of lens-  
packages are disposed in this staging position 609, a  
second rotating lens-package transfer assembly 650  
lowers a set of suction fingers which remove the array,  
rotates, and transports the lens-packages to a pallet of  
the saline solution injector and foil sealing assembly.  
25

More specifically with respect to the second  
rotating lens-package transfer assembly, the assembly  
comprises features which are similar in most respects to  
the first lens-transfer assembly 500. The assembly  
30 includes a support 652 which is mounted to the lower end  
of a rotating shaft 654. The upper end of the shaft 654

17 FEB 1997

-52-

1 is coupled to a rotating means (not shown) which rotates  
the support through 90 degrees in the horizontal plane.  
Extending downwardly from the support 652 is an array of  
regularly spaced fingers 658, the tips 660 of which are  
5 hollow so that a vacuum may be drawn therethrough. This  
vacuum is used to securely hold the lens-package  
elements during transport. The fingers 658, which are  
hollow so as to form a conduit through which the vacuum  
may be drawn, are coupled to tubes 662, at the support  
10 652 for the purposes of supplying the vacuum pressure to  
the finger tips 660.

The rotating shaft 654 is coupled, through the  
rotating means, to a mounting platform 651. The  
mounting platform is, in turn, mounted to a dual axis  
15 motive means (track 653 comprises the horizontal axial  
component along which the mounting platform translates.  
In operation the assembly is positioned above the  
consolidating conveyor 602, at the staging position 609,  
as the array of lens-packages is consolidated. Once the  
20 sensor elements have determined that a full 2 x 5 array  
of lens-packages has been formed, the manifold 652 and  
fingers 658 are lowered by the dual axis motive means.  
A vacuum is drawn in the finger tips 660 once the lens-  
packages are contacted in order that a secure grip on  
25 the lens-packages may be maintained. The manifold 652  
and fingers 658 are then raised, rotated, and translated  
to a position above the pallet stream of the next  
assembly.

As with the first rotating lens-package  
30 transfer assembly 500, the rotating means and the dual  
axis motive preferably comprise, respectively, an air

17 FEB 1997

-53-

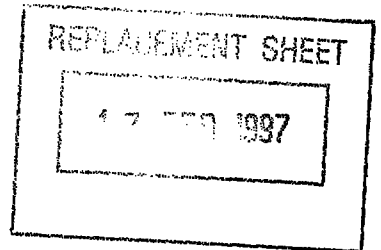
- 1 cylinder with 90 degree stops, and a pair of perpendicular IKO ball screw mechanisms.

THE SALINE SOLUTION INJECTOR AND FOIL SEALING ASSEMBLY

- 5 Referring now to Figures 18, 19 and 20, various perspective views of the saline solution injector and foil sealing assembly 700 are shown. Figure 18 is a schematic device layout of the assembly including a conveyor loop 702 having a plurality of  
10 pallets 704 spaced therealong. The pallet stream is intermittently driven such that the pallets stop at the various subassembly stations which are sequentially spaced along the conveyor 702.

- The related assemblies and subassemblies which  
15 cooperate to provide saline and heat sealed covers to previously unsealed lens-packages include the second rotating lens-package transfer assembly 650 disposed at the front of the conveyor 704, the saline injector subassembly 750 positioned adjacent to the front of the  
20 conveyor, a short distance downstream from the transfer assembly 650, a foil pick and place unit 777 which receives the foil from a printing machine, and a heat seal unit 780 which seals the foil to the packages.

- Each of the fixed pallets 704 is particularly  
25 designed to support a 2 x 5 array of individual lens-packages. It should be appreciated, however, that alternative embodiments of this assembly can be designed, in accordance with the number of fingers of the second lens-package transfer assembly 650, and the  
30 size of the staging position 609 of the consolidating



-54-

1 conveyor, to accommodate a different number of rows and  
a different number of packages in each row.

With specific reference to Figure 20, at the  
saline solution injector subassembly 750, the lens-  
5 packages are filled with a saline solution which has a  
tonicity compatible with the human eye. Stationary  
pallets 704 are advanced, with lens-packages thereon,  
beneath a horizontal beam 752. The beam 752 is coupled  
at a lateral end to a mounting base 754 which is  
10 adjacent to the conveyor loop 702. A 1 x 5 array of  
dosing tubes 756 extend downward from the beam 752, and  
are supplied with saline solution by saline conduits  
758, each of which is supplied by a separate dosing pump  
(not shown).

15 Upon incremental advance of the pallets 704  
into a position aligned with the dosing tubes 754, the  
dosing pumps are actuated so that a precise dosage of  
saline solution is deposited into the packaging recesses  
24. Each contact lens is thereby completely immersed in  
20 saline solution. The rate of pumping of saline solution  
and the diameter of each dosing tube 756 is chosen such  
that no saline solution splashes from any of the  
recesses of the packages, which is very important as any  
saline solution splashed onto the annular rim 28 would  
25 interfere with subsequent foil sealing operations.

The optical verification probes (not shown)  
may be mounted in front of the saline injector  
subassembly to verify that lens-packages are present in  
the advancing pallet 704 so that the dosing tubes 756 do  
30 not dispense saline solution into empty pallets.  
Additional sensors may be similarly mounted along the

17 FEB 1997

-55-

conveyor, downstream from the saline injector 750, to detect the presence of the proper measured dose of saline solution in each lens-package. A variety of such sensors are available, and are taught in co-pending application U.S.S.N. 08/431,891, entitled "Linear Packaging Array" (Attorney Docket No. 9401), for example the sensor may be a reflective sensor as is commercially available from Omron, or it could be a proximity sensor or could be a fiber optic probe, as commercially available from Keyence as model 24W-V25R, used with an amplifier, model 24W-AA1C. Each detector checks and verifies for a proper height of saline solution in each lens-package.

Referring again to Figure 18, and also to Figure 19, at a subsequent foil pick and place station 775, a pair of strips of laminar foil are placed over the 2x5 array of package bases, each foil strip covering a 1x5 column of packaging elements. The foil strips have printed thereon all identification indicia required for the final package. The laminar top cover sheets are produced by a foil labeling machine pursuant to the disclosure of patent application U.S.S.N. 08\106,386, entitled "Double Sided Foil Printing" (VTN-0089) (Attorney Docket 9013). The foil labeling machine extends at a right angle to the linear packaging machine, as indicated by the FOIL arrow in Figure 18. The pair of foil strips are received from the labeling machine and placed by a foil pick and place unit over the top of each 1x5 row of the 2x5 array of package bases.

17 FEB 1997

-56-

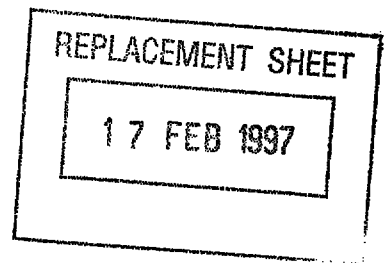
1           An optional mechanical chucking station 777,  
positions each foil strip to ensure that it is properly  
positioned and aligned relative to the lens-packages in  
the pallet 704. In addition, a subsequent cover  
5   presence verification station may be used to verify the  
correct general positioning of each foil strip.

          At a subsequent station 780 the foil strips  
are heat sealed to the lens-packages. More  
specifically, a set of heated seal heads, mounted at  
10 spaced intervals along the length of heating head plate  
782, and supported by a pneumatic cylinder or press 784,  
presses the foil strips against the lens-packages such  
that the foil and the annular rims 28 of the packaging  
elements are squeezed between the heated seal heads and  
15 the pallet 704.

          A final optical inspection station (not shown)  
may be located downstream of the heat sealing station  
780, including a plurality of optical detector probes  
for examining the outer edges of each sheet of laminated  
20 foil strips on the array of lens-packages to ascertain  
that the foil is properly and precisely positioned and  
heat sealed relative to the array of lens-packages.

          At the position which is farthest downstream,  
a robotic assembly 790, having a plurality of vacuum  
25 suction cups removes the sealed 1x5 array of packages  
from the pallet 704, and transports them to an output  
position.

          While the several assemblies, embodiments and  
variations of the present invention for post hydration  
30 handling of contact lens-packaging elements are  
described in detail herein, it should be understood that



-57-

1 the disclosure and teachings of the present invention  
will suggest many alternative designs to those skilled  
in the art. The scope of the present invention is,  
therefore, understood and intended to be limited only by  
5 the claims recited hereinbelow.

10

15

20

25

30

35



REPLACEMENT SHEET

17 FEB 1997

-58-

What is claimed is:

1. An apparatus for transporting contact lens elements from a first location to a second location, said apparatus comprising:

a plurality of elongate finger elements, each element having a convex lens transport surface defined thereon;

a lens transfer carriage, said carriage having an array of said elongate finger elements which receive the contact lens elements at a first location;

a drive to alter the spatial relationship of the array;

a translation device to transport the carriage and the lenses to a second location;

an orifice defined within said convex lens transport surface for injecting a fluid between said lens and said surface to deposit the lenses into a second lens carrier at said second location.

2. The apparatus as set forth in claim 1, wherein said lens transfer carriage further comprises:

a set of horizontal guide rails;

a plurality of beam elements, slidably mounted in parallel on at least one of said of horizontal guide rails; and

at least one reciprocating drive coupled to said beam elements for reciprocating same along said guide rails with respect to one another.

3. The apparatus as set forth in claim 2, wherein said plurality of finger elements are disposed in a plurality of linear arrays, with a linear array

This Sheet Has Been Replaced



THIS SHEET HAS BEEN  
REPLACED



-59-

REPLACEMENT SHEET

17 FEB 1997

1 extending downwardly from each of said beams, said  
fingers each comprising;

an elongate shaft, having an upper and lower  
end with the convex lens transfer surface at the lower  
end of the shaft,

5 a slotted annular skirt disposed along the  
shaft adjacent to said tip, for maintaining the contact  
lens at a predetermined position.

4. The apparatus as set forth in claim 1,  
wherein said apparatus further includes

10 a second translation mechanism for  
reciprocating said carriage along a second axis of  
movement.

5. The apparatus as set forth in claim 2,  
wherein said finger elements further comprise a central  
15 bore, extending from said upper end to said orifice in  
said lens transport surface, for receiving therethrough,  
and selectively ejecting therefrom, a quantity of fluid.

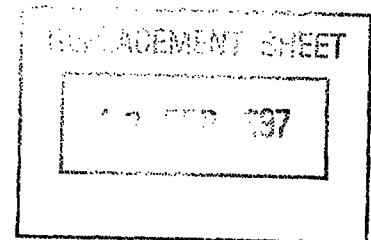
6. The apparatus as set forth in claim 1,  
wherein said apparatus further comprises, at said first  
20 location, a lens pallet having:

a plate having a plurality of recesses, each  
of said recesses aligned with said lens transport  
surfaces and having at least one hole therein, in which  
recesses a contact lens may be disposed; and

25 a plurality of internal conduits within said  
plate, extending from each of said holes to a fluid  
source, whereby selective ejection of fluid through the  
conduits causes a contact lens in said recess to be  
ejected therefrom and received by an associated lens  
30 transport surface.

This Sheet Has Been Replaced





1           7. The apparatus as set forth in claim 6,  
further comprising an air jet unit positioned at said  
second location, said air jet unit comprising:

5           a plate having a plurality of a regularly  
spaced recesses therein, said regular spacing  
corresponding to the spatial distribution of said  
fingers;

          at least one hole in each of said recesses;  
          a conduit extending from a remote air  
reservoir to said hole in each of said recesses;  
10          an air pressure means for selectively  
directing air through said conduit, out of said through  
hole, and at a contact lens which is secured to the lens  
transfer surface of said finger for removal of any  
bubbles thereon.

15          8. An assembly for extracting an array of  
contact lenses from a hydration pallet, changing the  
spatial distribution of the contact lenses, and  
depositing said contact lenses into packaging elements,  
said assembly comprising:

20          a mounting bracket including plurality of  
horizontal guide rails;

          a plurality of beam elements, slidably mounted  
in parallel on said plurality of horizontal guide rails;

25          at least one drive assembly motively coupled  
to said beam elements for reciprocation thereof along  
said guide rails between a compact spacing and a wide  
spacing;

30          a plurality of finger elements disposed in a  
linear array, extending downwardly from at least one of  
said beams, said fingers each comprising;





\* C L M S \*

-61-

REPLACEMENT SHEET

17 FEB 1997

1 an elongate shaft, having an upper and lower end,

5 a central bore, extending from said upper end to said lower end, for receiving therethrough a quantity of fluid, and selectively ejecting from said lower end said quantity of fluid,

10 a lens transfer surface at the lower end of the shaft for receiving, and securely holding, thereon a contact lens,

15 a slotted annular skirt disposed along the shaft adjacent to said tip, for maintaining the contact lens at a predetermined position; and

20 a dual axis translation mechanism for reciprocating said mounting bracket along a vertical axis and a horizontal axis.

9. A contact lens transfer assembly, said assembly comprising

25 at least one beam element, said beam element facilitating transfer of contact lenses between two locations;

30 a finger element, said finger element including an elongate shaft having a lens transfer surface on a first end and a means for attaching said shaft to said beam element on a remote second end;

said elongate shaft including a slotted annular skirt adjacent to said first end; and

a central bore extending through said elongate shaft for introducing a fluid between said lens transfer

THIS SHEET HAS BEEN  
REPLACED

35 This Sheet Has Been Replaced





-62-

REPLACEMENT SHEET

17 FEB 1997

1 surface and a contact lens secured thereon to release said lens.

5 10. A contact lens transfer assembly as set forth in claim 9, wherein said lens transfer assembly is shaped to conform to a concave surface of a contact lens so that same can be secured to the lens transfer surface by surface tension.

10 11. A contact lens transfer assembly as set forth in claim 9, wherein said slotted annular skirt includes:

at least one skirt element which prevent a contact lens from sliding off the lens transfer surface when said fluid or gas is directed at same, and

15 a set of vertically aligned slots defined by said skirt element through which a fluid or gas which is directed upwardly at the lens transfer surface may flow.

12. A method of transporting contact lens elements, said method comprising the steps of:

20 positioning an array of elongate finger elements above an array of lens carrier cavities, each of said finger elements having a lens transfer surface defined thereon;

25 injecting a fluid into each of said cavities having a contact lens therein to said lens from its associated cavity and transfer the lens to an associated lens transfer surface;

transporting said array of elongate finger elements to a second location; and

30 releasing the lenses into a set of lens carriers at said second location.

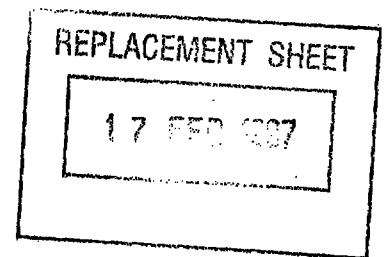
35 This Sheet Has Been Replaced



THIS SHEET HAS BEEN  
REPLACED



-63-



1 13. The method as set forth in claim 12,  
which further comprises the step of changing the  
relative spatial dimensions of said array after said  
lenses have been transferred to said lens transfer  
surfaces.

5 14. The method as set forth in claim 12,  
wherein said method further comprises:  
ejecting a quantity of air from an orifice  
defined in each of said cavities beneath each lens to  
propel it onto said lens transfer surface.

10 15. The method as set forth in claim 14,  
wherein said step of ejecting a quantity of air from  
beneath each lens is followed by the step of directing a  
jet of air at each lens for the purposes of removing any  
air bubbles which be present on the lens surface.

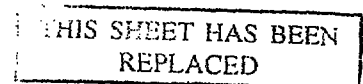
15

20

25

30

This Sheet Has Been Replaced



35

17 FEB 1997

64

## CONTACT LENS TRANSFER DEVICE

## ABSTRACT

1           The present invention, which relates to the  
transfer of contact lenses in post hydration processing  
of the lenses. A lens transfer and insertion assembly  
removes contact lenses from lens hydration pallets,  
5       alters their spatial distribution, and deposits them  
into packaging elements. The lenses are transferred  
with fluid and retained on the transfer assembly by  
surface tension.

10       Figure 1

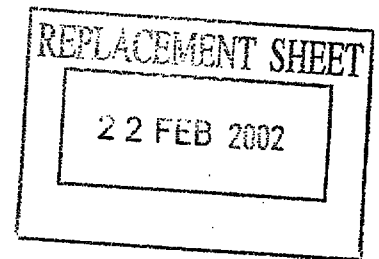
15

20

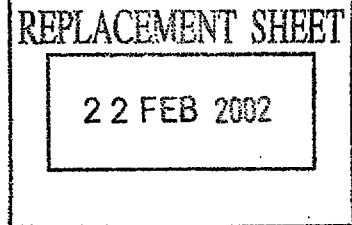
25

30

35



1. A contact lens transfer assembly, said assembly comprising:
  - at least one beam element, said beam element facilitating transfer of contact lenses between two locations;
  - at least one finger element, said finger element including an elongate shaft having a convex lens transfer surface on a first end and a means for attaching said shaft to said beam element on a remote second end;
  - said elongate shaft including a slotted annular skirt adjacent to the lens transfer surface on said first end thus separating the transfer surface from the shaft; and
  - a central bore extending through said elongate shaft for introducing a fluid between said lens transfer surface and a contact lens secured thereon to release said lens.
2. A contact lens transfer assembly as set forth in claim 1, wherein said lens transfer assembly is shaped to conform to a concave surface of a contact lens so that same can be secured to the lens transfer surface by surface tension.
3. A contact lens transfer assembly according to claim 1 or claim 2, comprising:
  - a plurality of said elongate finger elements;
  - a lens transfer carriage, said carriage having an array of said elongate finger elements which receive the contact lens elements at a first location;
  - a drive to alter the spatial relationship of the array;
  - a translation device to transport the carriage and the lenses to a second location to deposit the lenses into a second lens carrier at said second location.
4. The assembly according to claim 3, wherein said lens transfer carriage further comprises:
  - a set of horizontal guide rails;
  - a plurality of said beam elements, slidably mounted in parallel on at least one of said horizontal guide rails; and
  - at least one reciprocating drive coupled to said beam elements for reciprocating same along said guide rails with respect to one another.
5. The assembly according to claim 4, wherein said plurality of finger elements are disposed in a plurality of linear arrays, with a linear array extending downwardly from each of said beams.



6. The assembly according to claim 3, wherein said assembly further includes a second translation mechanism for reciprocating said carriage along a second, vertical axis of movement.
7. The assembly according to claim 3, wherein said assembly further comprises, at said first location, a lens pallet having:
  - a plate having a plurality of recesses, each of said recesses aligned with said lens transport surfaces and having at least one hole therein, in which recesses a contact lens may be disposed;
  - and
  - a plurality of internal conduits within said plate, extending from each of said holes to a fluid source, whereby selective ejection of fluid through the conduits causes a contact lens in said recess to be ejected therefrom and received by an associated lens transport surface.
8. The assembly according to claim 7, further comprising an air jet unit positioned at said second location, said air jet unit comprising:
  - a plate having a plurality of a regularly spaced recesses therein, said regular spacing corresponding to the spatial distribution of said fingers;
  - at least one hole in each of said recesses;
  - a conduit extending from a remote air reservoir to said hole in each of said recesses;
  - an air pressure means for selectively directing air through said conduit, out of said through hole,
  - and at a contact lens which is secured to the lens transfer surface of said finger for removal of any bubbles thereon.
9. An assembly according to claim 1, suitable for extracting an array of contact lenses from a hydration pallet, changing the spatial distribution of the contact lenses, and depositing said contact lenses into packaging elements, said assembly comprising:
  - a mounting bracket including plurality of horizontal guide rails;
  - a plurality of beam elements, slidably mounted in parallel on said plurality of horizontal guide rails;
  - at least one drive assembly motively coupled to said beam elements for reciprocation thereof along said guide rails between a compact spacing and a wide spacing;
  - a plurality of said finger elements disposed in a linear array, extending downwardly from at least one of said beams, and a dual axis translation mechanism for reciprocating said mounting bracket



|                   |
|-------------------|
| REPLACEMENT SHEET |
| 22 FEB 2002       |

60

along a vertical axis and a horizontal axis.