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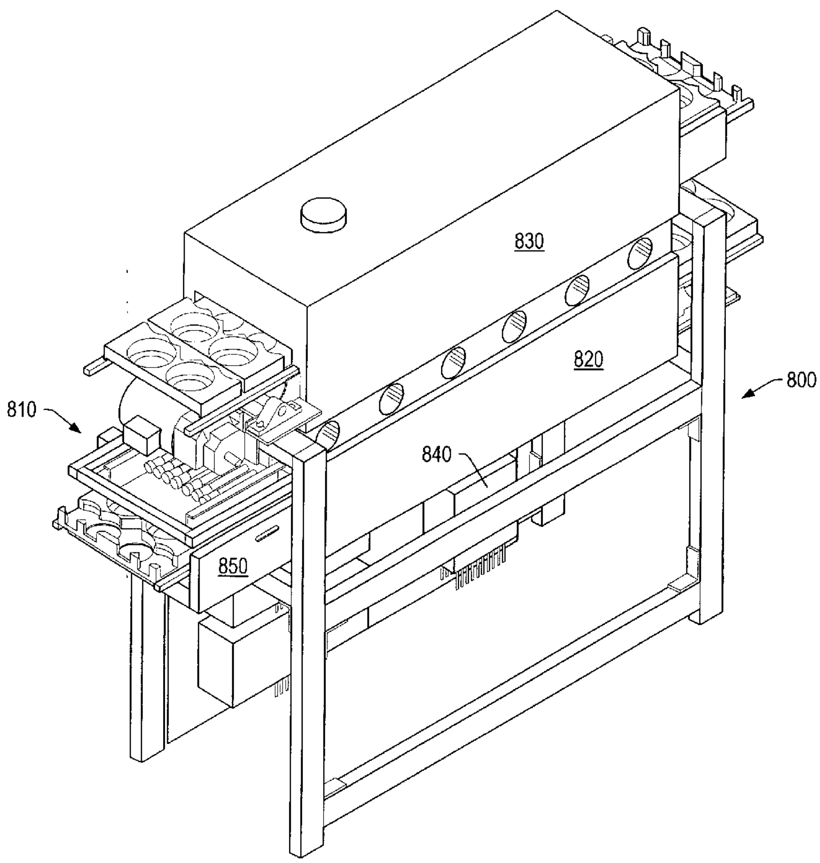
(54) Title: HIGH VOLUME LENS CURING SYSTEM



(57) Abstract: A high volume lens curing system is described. The high volume lens curing system is configured to cure multiple eyeglass lenses in a continuous manner using activating light.

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TITLE: HIGH VOLUME LENS CURING SYSTEM

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates generally to eyeglass lenses. More particularly, the invention relates to a lens forming composition, system and method for making photochromic, ultraviolet/visible light absorbing, and colored plastic lenses by curing a lens forming composition using activating light.

2. Description of the Relevant Art

It is conventional in the art to produce optical lenses by thermal curing techniques from the polymer of diethylene glycol bis(allyl)-carbonate (DEG-BAC). Curing of a lens by ultraviolet light tends to present certain problems that must be overcome to produce a viable lens. Such problems include yellowing of the lens, cracking of the lens or mold, optical distortions in the lens, and premature release of the lens from the mold. In addition, many of the useful ultraviolet light-curable lens forming compositions exhibit certain characteristics that increase the difficulty of a lens curing process. For example, due to the relatively rapid nature of ultraviolet light initiated reactions, it is a challenge to provide a composition that is ultraviolet light curable to form an eyeglass lens. Excessive exothermic heat tends to cause defects in the cured lens. To avoid such defects, the level of photoinitiator may be reduced to levels below what is customarily employed in the ultraviolet curing art.

While reducing the level of photoinitiator addresses some problems, it may also cause others. For instance, lowered levels of photoinitiator may cause the material in regions near an edge of the lens and proximate a gasket wall in a mold cavity to incompletely cure due to the presence of oxygen in these regions (oxygen is believed to inhibit curing of many lens forming compositions or materials). Uncured lens forming composition tends to result in lenses with "wet" edges covered by sticky uncured lens forming composition. Furthermore, uncured lens forming composition may migrate to and contaminate the optical surfaces of the lens upon demolding. The contaminated lens is then often unusable.

The low photoinitiator levels utilized in many ultraviolet curable lens forming compositions may produce a lens that, while fully-cured as measured by percentage of remaining double bonds, may not possess sufficient cross-link density on the lens surface to provide desirable dye absorption characteristics during the tinting process.

SUMMARY OF THE INVENTION

A high-volume lens curing apparatus includes at least a first lens curing unit and a second lens curing unit. The lens forming apparatus may, optionally, include an anneal unit. A conveyance system may be positioned within the first and/or second lens curing units. The conveyance system may be configured to allow a mold assembly to be transported from the first lens curing unit to the second lens curing unit. Lens curing units include an activating light source for producing activating light. Anneal unit may be configured to apply heat to an at least partially relive or relax the stresses caused during the polymerization of the lens forming material. A controller may be coupled to the lens curing units and, if present, an anneal unit, such that the controller is capable of substantially simultaneously operating the three units. The anneal unit may include a conveyor system for transferring the demolded lenses through the anneal unit. Such a system may be capable of producing more than 25 lenses per hour.

BRIEF DESCRIPTION OF THE DRAWINGS

The above brief description as well as further objects, features and advantages of the methods and apparatus of the present invention will be more fully appreciated by reference to the following detailed description of presently preferred but nonetheless illustrative embodiments in accordance with the present invention when taken in conjunction with the accompanying drawings in which:

Fig. 1 depicts an isometric view of a high-volume lens curing apparatus;

Fig. 2 depicts a cross-sectional side view of a high-volume lens curing apparatus;

Fig. 3 depicts a cross-sectional top view of a first curing unit of a high-volume lens curing apparatus;

Fig. 4 depicts a schematic of a fluorescent light ballast system;

Fig. 5 depicts a mold assembly;

Fig. 6 depicts an isometric view of an embodiment of a gasket;

Fig. 7 depicts a top view of the gasket of Fig. 6;

Fig. 8 depicts a cross-sectional view of an embodiment of a mold/gasket assembly;

Fig. 9 depicts a side view of a cured lens and molds after removal of a gasket;

Fig. 10 depicts an isometric view of an embodiment of a gasket;

Fig. 11 depicts a top view of the gasket of Fig. 10;

Fig. 12 depicts an isometric view of a mold assembly holder;

Fig. 13 depicts a cross sectional top view of a high-volume lens curing apparatus;

Fig. 14 depicts an isometric view of a conveyor system for a high-volume lens curing apparatus;

Fig. 15 depicts a side view of a high-volume lens curing apparatus;

Fig. 16 depicts a cross -sectional front view of a high-volume lens curing apparatus;

Fig. 17 depicts a schematic view of an embodiment of a system configured to collect and transmit eyeglass lens information over a computer network;

Fig. 18 depicts a flow chart illustrating an embodiment of a method for collecting and transmitting eyeglass lens information over a computer network;

Figs. 19, 20, and 21 depict embodiments of graphical user interfaces which may display eyeglass lens forming-related information;

Fig. 22 depicts an embodiment of a graphical user interface which may include a prescription input menu;

Fig. 23 depicts an embodiment of a graphical user interface which may include a prescription viewer display;

Fig. 24 depicts an embodiment of a graphical user interface which may include an alarm viewer display;

Fig. 25 depicts an embodiment of a graphical user interface which may include a maintenance viewer display;

Fig. 26 depicts an embodiment of a graphical user interface which may include a machine setup menu; and

Figs. 27 and 28 depict embodiments of graphical user interfaces which may include a configuration setup menu; and

Fig. 29 depicts chemical structures of acrylated amines.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Apparatus, operating procedures, equipment, systems, methods, and compositions for lens curing using activating light are available from Optical Dynamics Corporation in Louisville, Kentucky.

Referring to Fig. 1, a high-volume lens forming apparatus is generally indicated by reference numeral 800. As shown in Fig. 1, lens forming apparatus 800 includes at least a first lens curing unit 810 and a second lens curing unit 820. The lens forming apparatus may, optionally, include an anneal unit 830. In other embodiments, an anneal unit may be a separate apparatus which is not an integral part of the lens curing apparatus. A housing in which first lens curing unit 810, second lens curing unit 820, and anneal unit 830 may be disposed may be formed of an insulating material. In this manner, the housing may be configured to reduce heat transfer between the first lens curing unit, the second lens curing unit and the anneal unit. The lens forming apparatus also includes conveyance system 850 positioned within the first and/or second lens curing units. The conveyance system 850 may be configured to allow a mold assembly to be transported from the first lens curing unit 810 to the second lens curing unit 820. For example, the conveyance system may be configured to allow a plurality of mold assemblies, which may be filled with a lens forming composition, to be transported into, through, and out of the lens forming apparatus.

The lens forming apparatus may be configured to form an eyeglass lens in less than approximately one hour. In addition, the lens forming apparatus may be configured to form at least 25 prescription cast eyeglass lenses per hour by application of activating light to cure a liquid forming composition into a prescription cast eyeglass lens. Such a rate of production may also include a time required to anneal a prescription cast eyeglass lens.

Lens curing units 810 and 820 include activating light sources for producing activating light. The activating light sources disposed in units 810 and 820 direct activating light toward a mold assembly. Anneal unit 830 applies heat to at least partially relive or relax the stresses caused during the polymerization of the lens forming material. Anneal unit 830, in one embodiment, includes a heat source. A controller 840 may be a programmable logic controller, e.g., a computer. Controller 840 may be coupled to lens curing units 810 and 820 and, if present, an anneal unit 830, such that the controller is capable of substantially simultaneously operating the three units 810, 820, and 830.

First curing unit 810 is configured to direct activating light and, optionally, heat toward a mold assembly to initiate curing of a lens forming composition. As shown in Fig. 2, first curing unit 810 may include upper light source 812 and lower light source 814. Fig. 3 depicts a cut away top view of first curing unit 810. As shown in Fig. 3, light sources 812 and 814 of first curing unit 810 may include a plurality of activating light generating devices or lamps. In one embodiment, the lamps are oriented proximate each other to form a row of lights, as depicted in Fig. 3. While the lamps are depicted as substantially U-shaped, it should be understood that the lamps may be linear, circular, or any other shape that allows a uniform irradiation of a lens forming assembly placed in the first curing unit. In one embodiment, multiple lamps are positioned to provide substantially uniform radiation over the entire surface of the mold assembly to be cured. The lamps may generate activating light.

The lamps may be supported by and electrically connected to suitable fixtures 811. Lamps 812 and 114 may generate either ultraviolet light, actinic light, visible light, and/or infrared light. The choice of lamps is preferably based on the monomers used in the lens forming composition. In one embodiment, the activating light may be generated from a fluorescent lamp. The fluorescent lamp preferably has a strong emission spectra in the 380 to 490 nm region.

In some embodiments, the activating light sources may be turned on and off frequently during use. Fixture 811 may also include electronic hardware to allow a fluorescent lamp to be frequently turned on and off. Typically, when a fluorescent lamp is turned off the filaments in the lamp will become cool. When the lamp is subsequently turned on, the lamp intensity may fluctuate as the filaments are warmed. These fluctuations may effect the curing of a lens forming compositions. To minimize the intensity fluctuations of the lamps, a ballast may allow the startup of a fluorescent lamp and minimizes the time required to stabilize the intensity of the light produced by the fluorescent lamp.

A number of ballast systems may be used. Ballasts for fluorescent lamps typically serve two purposes. One function is to provide an initial high voltage arc that will ionize the gases in the fluorescent lamp (known herein as the "strike voltage"). After the gases are ionized, a much lower voltage will be required to maintain the ionization of the gases. In some embodiments, the ballast will also limit the current flow through the lamp. In some ballast systems, the filaments of a lamp may be preheated before the starting voltage is sent through the electrodes.

To allow more control over the heating of the filaments, a flasher ballast system may be used. A schematic drawing of an embodiment of a flasher ballast system is depicted in Fig. 4. In a flasher ballast system, a fluorescent lamp 712 is electrically coupled to a high frequency instant start ballast 714 and one or more transformers 716. The high frequency instant start ballast 714 may provide the strike voltage and perform the current limiting functions once the lamp is lighted. The transformers 716 may be electrically coupled to one or both of the filaments 718 to provide a low voltage (between about 2 to about 4 V) to the filaments. This low voltage may heat the filaments 718 to a temperature that is close to the operating temperature of the filaments 718. By heating the filaments before turning the lamp on, the intensity of light produced by the lamp may be stable because the filaments of the lamp are kept close to the optimum operating temperature. In one embodiment toroidal transformers may be used to supply low voltage to the filaments.

Because the instant start ballast 714 and the transformers 716 are separate units they may be operated independently of each other. A controller 711 may be coupled to both the instant start ballast 714 and the transformers 716 to control the operation of these devices. Controller 711 may be the controller of lens forming apparatus 800. The transformers 716 may be left on or off when the striking voltage is applied to the lamp. In some embodiments, controller 711 may turn off the transformers 716 just before the strike voltage is applied to the lamp. The controller 711 may also monitor the operation of the lamp. The controller 711 may be programmed to turn the transformers 716 on when the lamps are switched off, thus maintaining the lamps in a state of readiness. To conserve power, the filaments 718 may be warmed only prior to turning on the lamp. Thus, when the controller 711 receives a signal to turn the lamp on, the controller may turn on the transformers 716 to warm the filaments 718, and subsequently turn on the lamp by sending a striking voltage from the instant start ballast 714. The controller may be configured to turn the transformer off after a predetermined amount of inactivity of the lamps. For example, the controller may be configured to receive signals when the lamps are used in a curing process. If no such signals are received, the controller may turn off the lamps (by turning off the instant start ballast), but leave the transformer on. The lamps may be kept in a state of readiness for a predetermined amount of time. If no signals are received by the controller to turn on the lamp, the controller may turn the transformer off to conserve energy.

Referring back to Fig. 3, a barrier 815 may be placed between the lamps 811. The barrier may be configured to inhibit the passage of activating light from one set of lamps to the other. In this manner, the lamp sets may be optically isolated from each other. The lamps may be connected to separate ballast systems and a controller. In addition, the lamps may be coupled separately to fans. Thus, the lamps may be operated independently of each other. In addition, operation of the fans may be controlled by a controller to coincide with operation of the lamps.

For example, if a lamp is turned on by a controller, a fan may also be turned on by a controller. This may be useful when lenses that require different initial curing sequences are being processed at the same time. The barrier 815 may inhibit the passage of light from one set of lamps to a mold assembly positioned below the other set of lamps.

In some embodiments, at least four independently controllable lamps or sets of lamps may be disposed in the first curing unit. The lamps may be disposed within the first curing unit with a sliding rack which may maintain a position of the lamps within the first curing unit. The lamps may be disposed in left and right top positions and left and right bottom positions. A variety of different initial curing conditions may be required depending on the prescription. In some instances the left eyeglass lens may require initial curing conditions that are substantially different from the initial curing conditions of the right eyeglass lens. To allow both lenses to be cured substantially simultaneously, the four sets of lamps may be independently controlled. For example, the right set of lamps may be activated to apply light to the back face of the mold assembly only, while, at the same time, the left set of lamps may be activated to apply light to both sides of the mold assembly. In this manner a pair of eyeglass lenses whose left and right eyeglass prescriptions require different initial curing conditions may be cured at substantially the same time. Since the lenses may thus advantageously remain together in the same mold assembly holder throughout the process, the production process is simpler with minimized job tracking and handling requirements.

As shown in Fig. 5, a mold assembly 552 may include opposed mold members 578, separated by a gasket 510 to define a lens molding cavity 582. The opposed mold members 578 and the gasket 510 may be shaped and selected in a manner to produce a lens having a desired diopter.

The mold members 578 may be formed of any suitable material that will permit the passage of activating light. The mold members 578 are preferably formed of glass. Each mold member 578 has an outer peripheral surface 584 and a pair of opposed surfaces 586 and 588 with the surfaces 586 and 588 being precision ground. The mold members 578 have desirable activating light transmission characteristics. Both the casting surface 586 and non-casting surface 588 are polished such that they have no surface aberrations, waves, scratches or other defects as these may be reproduced in the finished lens.

Mold members 578 are held in a spaced apart relation to define a lens molding cavity 582 between the facing surfaces 586 thereof. The mold members 578 are held in a spaced apart relation by a flexible gasket 510 that seals the lens molding cavity 582 from the exterior of the mold members 578. In use, the gasket 510 may be supported on a portion of a mold assembly holder. In this manner, the upper or back mold member 590 has a convex inner surface 586 while the lower or front mold member 592 has a concave inner surface 586 so that the resulting lens molding cavity 582 is preferably shaped to form a lens with a desired configuration. Thus, by selecting the mold members 578 with a desired surface 586, lenses with different characteristics, such as focal lengths, may be produced.

Rays of activating light pass through the mold members 578 and act on a lens forming material disposed in the mold cavity 582 in a manner discussed below so as to form a lens. The rays of activating light may pass through a suitable filter before impinging upon the mold assembly 552.

Figs. 6 and 7 present an isometric view and a top view, respectively, of a gasket 510. Gasket 510 may be annular, and is configured to engage a mold set for forming a mold assembly. Gasket 510 includes at least four discrete projections 511. Gasket 510 has an exterior surface 514 and an interior surface 512. Projections 511 are arranged upon inner surface 512 such that they are substantially coplanar. The projections may be evenly spaced around the interior surface of the gasket The spacing along the interior surface of the gasket between each projection may be about 90 degrees. Although four projections are preferred, it is envisioned that more than four could be incorporated.

Gasket 510 may be formed of vinyl material that maintains sufficient flexibility at conditions throughout the lens curing process. The gasket 510 may be formed of a silicone rubber material such as GE SE6035 which is commercially available from General Electric. In another embodiment, the gasket 510 may be formed of copolymers of ethylene and vinyl acetate which are commercially available from E. I. DuPont de Nemours & Co. under the trade name ELVAX7. In another embodiment, the gasket 510 may be formed from polyethylene. In another embodiment, the gasket may be formed from a thermoplastic elastomer rubber. An example of a thermoplastic elastomer rubber that may be used is , DYNAFLEX G-2780 commercially available from GLS Corporation. Regardless of the particular material, gasket 510 may be prepared by conventional injection molding or compression molding techniques which are well-known by those of ordinary skill in the art.

As shown in Fig. 8, projections 511 are preferably capable of spacing mold members 526a and 526b of a mold set. Mold members 526a and 526b may be any of the various types and sizes of mold members that are well known in the art. A mold cavity 528 at least partially defined by mold members 526 and gasket 510, is capable of at retaining a lens forming composition. The seal between gasket 510 and mold members 526 is as complete as possible. The height of each projection 511 controls the spacing between mold members 526, and thus the thickness of the finished lens. By selecting proper gaskets and mold sets, lens cavities may be created to produce lenses of various powers.

Referring back to Figs. 6 and 7, locations where the steep axis 522 and the flat axis 524 of the back mold member 526b preferably lie in relation to gasket 510 have been indicated. In conventional gaskets, a raised lip may be used to space mold members. The thickness of this lip varies over the circumference of the lip in a manner appropriate with the type of mold set a particular gasket is designed to be used with. In order to have the flexibility to use a certain number of molds, an equivalent amount of conventional gaskets is typically kept in stock.

However, within a class of mold sets there may be points along the outer curvature of a the back mold member where each member of a class of back mold members is shaped similarly. These points may be found at locations along gasket 510, oblique to the steep and flat axes of the mold members. In a preferred embodiment, these points are at about 45 degree angles to the steep and flat axes of the mold members. By using discrete projections 511 to space the mold members at these points, an individual gasket could be used with a variety of mold sets. Therefore, the number of gaskets that would have to be kept in stock may be greatly reduced.

In addition, gasket 510 may include a recession 518 for receiving a lens forming composition. Lip 520 may be pulled back in order to allow a lens forming composition to be introduced into the cavity. Vent ports 516 may be incorporated to facilitate the escape of air from the mold cavity as a lens forming composition is introduced.

Gasket 510 may also include a projection 540. Projection 540 may extend from the side of the gasket toward the interior of the mold cavity when a first and second mold are assembled with the gasket. The projection is positioned such that a groove is formed in a plastic lens formed using the mold assembly. The groove may be positioned near an outer surface of the formed lens. In this manner the groove is formed near the interface between the mold members and the formed lens. Fig. 9 depicts a side view of a lens 550 disposed between two mold members 526 after curing and the removal of the gasket. A variety of indentations/grooves may be seen along the outer surface of the lens caused by the various projections from the gasket. Grooves 544 may be caused by the projections 511 of a gasket used to space the mold members at the appropriate distance. Groove 546 may be caused by the projection 540. The groove is positioned at the interface of the mold members and the formed lens. While depicted as near the interface of the upper mold member, it should be understood that the groove may also be positioned at the interface between the lower mold member and the formed lens. In one embodiment, the fill port 538 (see Figs. 10 and 11) may produce a groove near the interface of the upper mold member and the formed lens. The projection 511 may therefore be positioned at the interface between the lower mold member and the formed lens. In this manner, two grooves may be created at the interfaces between the formed lens and each of the mold members.

After the gasket is been removed, the molds may adhere to the formed lens. In some instances a sharp object may be inserted between the mold members and the formed lens to separate the formed lens from the mold members. The groove 546 may facilitate the separation of the mold members from the formed lens by allowing the insertion of a sharp object to pry the molds away from the formed lens.

Figs. 10 and 11 present an isometric view and a top view, respectively, of an alternate embodiment of a gasket. Gasket 530 may be composed of similar materials as gasket 510. Like gasket 510, gasket 530 may incorporate projections 531 in a manner similar to the projections 511 shown in Fig. 6. Alternatively, gasket 530 may include a raised lip along interior surface 532 or another method of spacing mold members that is conventional in the art.

Gasket 530 preferably includes a fill port 538 for receiving a lens forming composition while gasket 530 is fully engaged to a mold set. Fill port 538 preferably extends from interior surface 532 of gasket 530 to an exterior surface 534 of gasket 530. Consequently, gasket 530 need not be partially disengaged from a mold member of a mold set in order to receive a lens forming composition. In order to introduce a lens forming composition into the mold cavity defined by a conventional mold/gasket assembly the gasket is usually at least partially disengaged from the mold members. During the process of filling the mold cavity, lens forming composition may drip onto the backside of a mold member. Lens forming composition on the backside of a mold member may cause activating light used to cure the lens to become locally focused, and may cause optical distortions in the final product. Because fill port 538 allows lens forming composition to be introduced into a mold cavity while gasket 530 is fully engaged to a mold set, gasket 530 preferably avoids this problem. In addition, fill port 538 may be of sufficient size to allow air to escape during the introduction of a lens forming composition into a mold cavity; however, gasket 530 may also incorporate vent ports 536 to facilitate the escape of air.

A method for making a plastic eyeglass lenses using either gasket 510 or 530 is presented. The method preferably includes engaging the gasket with a first mold set for forming a first lens of a first power. The first mold set preferably contains at least a front mold member and a back mold member. A mold cavity for retaining a lens forming composition may be at least partially defined by the mold members and the gasket. Engaging the gasket with the mold set includes positioning the mold members such that each of the projections forms an oblique angle with the steep and flat axis of the back mold member. In a preferred embodiment, this angle is about 45 degrees. A lens forming composition may be introduced into mold cavity 528. The lens forming composition may be cured by exposing the composition to activating light and/or thermal radiation. After the lens is cured, the first mold set may be removed from the gasket and the gasket may then be engaged with a second mold set for forming a second lens of a second power. When using the gasket 530, the method further includes introducing a lens forming composition through fill port 538, wherein the first and second mold members remain fully engaged with the gasket during the introduction of the lens forming composition. The lens forming composition may then be cured by use of activating light and/or thermal radiation.

To facilitate the positioning and the conveyance of mold assemblies, a mold assembly holder may be used. An isometric view of a mold assembly holder 900 is depicted in Fig. 12. The mold assembly holder includes at least one, preferably two, portions 910 and 912 configured to hold a mold assembly 930. In one embodiment, the portions 910 and 912 are indentations machined into a plastic or metal block that is configured to hold a standard mold assembly. The mold assembly may be placed in the indentation. An advantage of such the indentations, is that the mold assemblies may be positioned in the optimal location for curing in the first and second curing units 810 and 820.

The indentations 910 and 912 may be sized to hold the mold assembly such that substantially all of the molds may be exposed to activating light when the mold assembly is positioned above or below an activating light source. The mold assembly holder may include an opening extending through the mold assembly holder. The opening may be positioned in the indentations 910 and 912 such that activating light may be shone through the mold assembly holder to the mold assembly. In some embodiments, the opening may be of a diameter that is substantially equal to the diameter of the molds. The opening will therefore allow substantially all of the surface area of the mold to be irradiated with activated light. In another embodiment, the diameter of the opening may be substantially less than a diameter of the molds. In this respect the opening may serve as an aperture which reduces the amount of light that contacts the outer edges of the molds. This may be particularly useful for curing positive lenses in which curing is initiated with more activating light being applied to the central portion of the molds than the edges. The indentations may extend in the body to a depth such that the mold assemblies, when placed in the indentations is even with or below the upper surface of the mold assembly holder. This imparts a low vertical profile to the mold assembly holder and allows the curing units of the high volume system to be constructed with a low vertical profile. In this manner, the size of the unit may be minimized.

The mold assembly holder 900 may also include further machined indentations for holding the unassembled pieces of the mold assembly (e.g., the molds and the gasket). For example, the mold assembly holder may be configured to hold at least two molds. During the assembly of the mold assembly, an operator typically will find and clean the molds and gasket before assembly. To minimize the possibility of mixing up the molds and gaskets, and to help minimize recontamination after the molds are cleaned, the mold assembly holder 900 includes sections to hold the various components. As depicted in Fig. 12, indentations 922, 924, 926, and 928 may also be formed in the mold assembly holder 900. The indentations may be labeled to facilitate the placement of the molds or gaskets. For example, indentation 922 may be labeled left lens, front mold, 924 may be labeled left lens, back mold, 928 may be labeled right lens, front mold, and 926 may be labeled right lens, back mold. Other variations of labeling and positioning of the indentations 922, 924, 926, and 928 may be used. This may help prevent operators from making mistakes due to use of incorrect molds to assemble the mold assemblies.

The mold assembly holder may also include a location for holding a job ticket. Job ticket may be placed in a holder mounted to a side of the mold assembly holder. Alternatively, the job ticket may have an adhesive that allows the ticket to be attached to the side of the mold assembly. The job ticket may include information such as: the prescription information, the mold ID numbers, the gasket ID numbers, the time, date, and type of lens being formed. The job ticket may also include a job number, the job number may correspond to a job number generated by the controller when an eyeglass lens prescription is entered into the controller. The job number may also be depicted using a UPC coding scheme. Use of a UPC code on the job ticket may allow the use of bar-code scanners to determine the job number corresponding to the mold assemblies placed on the mold assembly holder.

The mold assembly holder may also include at least one indicia or an identifying mark. An indicia may include a color, at least one alphanumeric character, at least one graphical character, a barcode, or a radio frequency emitter. The indicia of a mold assembly holder may vary depending on the intended use of the mold assembly holder. For example, the color of a mold assembly holder may vary depending on the type of lens which may be formed within the mold assembly holder. For example, a mold assembly holder having a first color may be suitable for forming a photochromic lens, and a mold assembly holder having a second color may be suitable for forming a non-photochromic lens. In addition, alphanumeric characters formed in, printed on, or attached to the mold assembly unit may include, for example, "PHOTOCHROMIC LENS" or "NON-PHOTOCHROMIC LENS" depending on the type of lens which may be formed within the mold assembly holder. A graphical character may also vary depending on the type of lens which may be formed within the mold assembly holder.

A radio frequency emitter may be commonly referred to as an "RF tag." A radio frequency emitter may be formed within or coupled to a mold assembly holder. A radio frequency emitter may be configured to generate a radio frequency signal at least periodically. The generated radio frequency signal may include a signature which may be characteristic of the type of lens which may be formed within the mold assembly holder. A radio frequency detector may be coupled to a lens forming apparatus and may be configured to detect a radio frequency signal generated by the radio frequency emitter. The type of lens which may be formed with the mold assembly holder may then be determined from the detected radio frequency signal. In addition, a system may include a lens forming apparatus and mold assemblies of at least two different forms of at least one of the indicia described above.

The mold assembly holder 900 may be used in combination with a conveyor system 850 to transfer mold assemblies from the first curing unit to the second curing unit. The second curing unit is configured to apply activating light and heat to the mold assemblies after the curing is initiated by the first curing unit. The use of two curing units in this manner facilitates the application of curing sequences such as the sequences outlined in Table 1 below. In these embodiments, the mold assembly is subjected to an initiating dose of activating light, followed by a post-cure dose of activating light and heat. The initial dose may last from about 7 to 90 seconds and may be applied to one or both sides of the mold assembly. After the initial dose is applied, the mold assembly is subjected to a combination of activating light and heat for about 5 to 15 minutes. In many instances, subjecting the mold assembly to longer times in the second curing unit does not significantly effect the quality of the formed lens. Thus, the second curing unit is designed such that the amount of time that the mold assemblies spend in the second unit is not less than about 5 minutes.

LENS INFORMATION			CURING INFORMATION			
Sphere	**Lens Type**	**Tinted**	**Filter**	**Initial Curing Time**	**Second Curing Time**	**Anneal Time**
+4.00 to +2.25	Clear	No	50 mm	90 Sec. Back and Front	13 Min.	7 Min.
+4.00 to +2.25	Clear	Yes	50 mm	90 Sec. Back and Front	15 Min.	7 Min.
+4.00 to +2.25	Photo		50 mm	90 Sec. Back and Front	13 Min.	7 Min.
+2.00 to -4.00	Clear	No	Clear Plate	7 Sec. Front	13 Min.	7 Min.
+2.00 to -4.00	Clear	Yes	Clear Plate	7 Sec. Front	15 Min.	7 Min.
+2.00 to plano	Photo		Clear Plate	15 Sec. Front	13 Min.	7 Min.
-0.25 to -4.00	Photo		Clear Plate	20 Sec. Back, w/ 7 Sec. Front starting @ 13 Sec. elapsed time.	13 Min.	7 Min.

Table 1

During operation, a mold assembly or mold assembly holder is placed on the conveyor system and the mold assembly is moved to a position within the first curing unit 810. In the first curing unit 810, the mold assemblies receive the initial dose of light based on the prescription of the lens, e.g., as outlined in Table 1. After the mold assemblies receive their initial dose, the mold assemblies are moved by the conveyor system 850 to the second curing unit. In the second curing unit, the mold assemblies are treated with activating light and heat. The time it takes for the mold assembly to pass entirely through the second curing unit may be equal to or greater than the post-cure time.

In one embodiment, the conveyor system may be a single continuous system extending from the first curing unit through the second curing unit. During the operation of the lens forming apparatus 800, a continuous stream of mold assemblies may be placed on the apparatus. Fig. 13 depicts a top cut away of a system in which a continuous stream of mold assembly holders 900 are moving through the first and second curing units. Because the curing for any given prescription lens is complete in the first curing unit in a time of 90 seconds or less, the second unit may be constructed as a rectangular shaped unit that will hold multiple mold assemblies, as depicted in Fig. 1. The length of the second cure unit is determined by the time required for each mold assembly in the first unit. Because the conveyor system is a single continuous unit, the molds will move through the second curing unit in increments equal to the amount of time spent in the first curing unit. Thus, the molds move only when the curing cycle of the first curing unit is complete and the mold assemblies or mold assembly holder is advanced to the second curing unit.

In one embodiment, the mold assemblies are placed on a mold assembly holder 900 as described above. The mold assembly holder may have a predetermined length (L_H). After the mold assemblies are loaded onto the mold assembly holder, the mold assembly holder may be placed on the conveyor system 850 and advanced to the first curing unit. The mold assembly holder will remain in the first curing unit for a predetermined minimum amount of time, e.g., the initiation time (T_I). After the initial cure is performed, the mold assembly holder is advanced to the second curing unit and another mold assembly holder is advanced to the first curing unit. To properly cure lens forming composition, the mold assemblies may need to remain in the second curing unit for a minimum amount of time, e.g., the post cure time (T_P). The required minimum length of the second curing unit (L_{SC}) may be calculated by these predetermined values using the following equation.

$$L_{SC} = L_H X (T_P/T_I)$$

By constructing the second curing unit to have a length based on this equation, the mold assembly holder will exit from the second curing unit after the correct amount of post-curing has occurred.

In practice there is a wide variation in the initiation times based on the prescription and the type of lenses being formed. For example, Table 1 discloses some typical initiation times that range from about 7 sec. to about 90 sec. In order to optimize the system, the length of the second curing unit may be altered based on the maximum predetermined initiation time. For example, the (T_I) rather than being the minimum time will be the maximum time possible for initiation of the curing. In practice, the conveyor system may be configure to advance a mold assembly holder from the first curing unit to the second curing unit at time intervals equal to the maximum possible initial curing cycle (e.g., about 90 sec. for the above-described compositions) To accommodate the different initial curing cycles, a controller may be coupled to the lamps of the first curing unit. The controller may be configured to turn on the lamps such that the initial curing cycle ends at the end of the maximum initial curing time. For example, if the maximum initial curing time is 90 sec., however the prescription and lens type calls for only a 7 sec, cure, the lamps are kept off until 7 sec. before the end of the 90 sec. time interval (i.e., for 83 seconds). The lamps are only activated for the last 7 sec. This may ensure that the time interval between the end of the completion of the initial cure and the entry into the second curing unit is the same regardless of the actual initiation dosage. The length of the second curing unit may be adjusted accordingly to accommodate this type of curing sequence.

In another embodiment, the conveyor system may include two independently operated conveyors. The first conveyor may be configured to convey the mold assembly holder or mold assemblies from the first curing unit to the second curing unit. A second conveyor may be positioned within the second curing unit. The second conveyor may be configured to convey the mold assemblies or the mold assembly holder through the second curing unit. As such, a speed of the first and second conveyors may be substantially different. For example, a speed of the first conveyor may be variable and a speed of the second conveyor may be substantially constant. In this manner, the second curing unit may be designed independently of the initial curing times. Instead the length of the second curing unit may be based on the time required for a typical post-cure sequence. Thus the length of the second curing unit may be determined by the rate at which the second conveyor system is operated and the amount of time required for a post-cure. This also allows an operator to operate the curing units independently of the other.

The conveyor system may be configured to convey either mold assemblies or a mold assembly holder (e.g., mold assembly holder 900) through the first and second curing units. A view of the conveyor system in which the curing units have been removed from the lens forming apparatus is depicted in Fig. 14. The conveyor system includes a platform for conveying a mold assembly holder. The platform may be configured to support the mold assembly holder 900 as it passes through the first and second curing units. In one embodiment, the platform is formed from two rails 852 that extend the length of the lens forming apparatus. The rails, 852 may be any width, however should be spaced apart from each other at a distance that allows activating light to pass past the rails 852 and to the mold assemblies on the mold assembly holder 900.

The conveyor system includes a flexible member 854 (e.g., a belt or chain) that is configured to interact with the mold assembly holder 900. The flexible member will interact with the mold assembly holder and pull or push the mold assembly holder along the platform. The flexible member may be formed of a chain or flexible materials such as a belt (e.g., a neoprene or rubber belt).

The flexible member 854 may be coupled to a pair of wheels or gears disposed at opposite ends of the lens forming apparatus. The wheels or gears may be manually turned or may be coupled to a motor. Fig. 15 depicts a lens forming apparatus in which a motor 851 is coupled to an end of the second curing unit. The motor may be coupled to the flexible member such that the flexible member may be moved by the operation of the motor. The motor 851 may either pull or push the flexible member along the length of the lens forming apparatus. In addition, the motor and the flexible member may be configured such that the flexible member may continue to move under a mold member holder even if movement of the mold member holder may be obstructed. In this manner, the flexible member may "slip" under a mold member holder if, for example, a mold member has reached a safety stop coupled to the first or second curing units. For example, a safety stop may be coupled to an end of each of the curing units to prevent tray from falling off the conveyance system.

The second curing unit may be configured to apply heat and activating light to a mold assembly as it passes through the second curing unit. The second curing unit may be configured to apply activating light to the top, bottom, or both top and bottom of the mold assemblies. As depicted in Figs. 2 and 16, the second curing unit may include a bank of activating light producing lamps 822 and heating systems 824. The bank of lamps may include one or more substantially straight fluorescent lamps that extend through the entire length of the second curing unit. The activating light sources in the second curing unit may produce light having the same spectral output as the activating light sources in the first curing unit (e.g., have a strong emission spectra in the 380 to 490 nm region). The spectral output refers to the wavelength range of light produced by a lamp, and the relative intensity of the light at the specific wavelengths produced. Alternatively, a series of smaller lamps may be disposed with the curing unit. In either case, the lamps are positioned such that the mold assemblies will receive activating light as they pass through the second curing unit. The heating unit may be a resistive heater, hot air system, hot water systems, or infrared heating systems. In this manner, a chamber temperature may be controlled by altering the adjusting the power to, for example, the resistive heater. An air distributor 826 (e.g., a fan) may be disposed within the heating system to aid in air circulation within the second curing unit. By circulating the air within the second curing unit, the temperature within the second curing may be more homogenous.

In some embodiments, an anneal unit may also be coupled to the lens forming apparatus. As depicted in Fig. 1, an anneal unit 830 may be placed above the second curing unit. Alternatively, the anneal unit may be placed below or alongside of the first or second curing units. The anneal unit is configured to apply heat and, optionally light, to anneal a demolded lens. When a lens, cured by the activating light, is removed from a mold assembly, the lens may be under a stressed condition. It is believed that the power of the lens can be more rapidly brought to a final resting power by subjecting the lens to an anneal treatment to relieve the internal stresses developed during the cure. Prior to annealing, the lens may have a power that differs from the desired final resting power. The anneal treatment is believed to reduce stress in the lens, thus altering the power of the lens to the desired final resting power. Preferably, the anneal treatment involves heating the lens at a temperature between about 200 □F to 225 □F for a period of up to about 10 minutes. It should be understood that the anneal time may be varied depending on the temperature of the anneal unit. Generally, the higher the temperature of the anneal unit, the faster the anneal process will be completed. The anneal process time is predetermined based on the amount of time, at a predetermined temperature, a formed lens will need to be annealed to be brought to its final resting power.

In the embodiment depicted in Fig. 1, the anneal unit may be constructed in a similar manner to the second curing unit. Turning to Fig. 9, the anneal unit may include a conveyor system 832 for moving a demolded lens through the anneal unit. The demolded lens may be placed in the same mold assembly holder that was used for the first and second curing units. The mold assembly holder 900 may be configured to hold either the mold assembly and/or a demolded lens. The anneal unit includes a heating element 834 (depicted in Fig. 2). The heating element may include a air distributor 836 for circulating air throughout the anneal unit.

The anneal unit may have a length that is determined by the rate at which the mold assembly holders are transported through the anneal unit and the time required for the anneal process. For example, in some of the compositions listed above, an anneal time of about 10 min. may be used to bring the lens to its final resting power. The conveyor system of the anneal unit may therefore be configured such that the demolded lenses spend about 10 minutes within the anneal unit as the lenses traverse the length of the unit. A conveyor system similar to the system described above for the first and second curing units may be used. The conveyor system in the anneal unit may also be configured to move through the anneal unit continuously.

The controller 840 may be configured to control operation of the lens-curing units. The controller may perform some and/or all of a number of functions during the lens curing process, including, but not limited to: (i) determining the initial dose of light required for the first curing unit based on the prescription; (ii) applying the activating light with an intensity and duration sufficient to equal the determined dose; (iii) applying the activating light with an intensity and duration sufficient to equal the determined second curing unit dose; (iv) turning the lamps sources on and off independently and at the appropriate times; and (v) triggering the movement of the proper light filters into the proper position based on the prescription. These functions may be performed in response to information read by the bar code reader from the job ticket positioned on the mold assembly holder. This information may include the prescription information and may be correlated with the initial curing conditions by the controller 840.

The controller may also control the flow of the mold assembly holder through the system. The controller may include a monitoring device for determining the job number associated with a mold assembly holder. Fig. 3 depicts a monitoring device 817 which is coupled to the lens forming apparatus proximate the first curing unit. The monitoring device may be a laser or infra-red reading device. In some embodiments, the monitoring device may be a bar code reader for reading a UPC bar code. The monitoring device may be positioned within the first curing unit. When a mold assembly holder is placed on the conveyer system, it may be moved to a position such that the monitoring device may read a job number printed on the job ticket. In one embodiment, the job number is in the form of a UPC bar code. The monitoring device may be coupled to the controller. The controller may use the job number, read from the mold assembly holder, to determine the curing conditions required for the job that is being transferred to the first curing unit. In addition, the controller may use the job number, read from the mold assembly holder, to determine when to apply light to the job being transferred to the first curing unit. As described before, the job number may correspond to a prescription that was previously entered into the controller. In this manner the proper curing conditions may be achieved without relying on the operator to input the correct parameters.

Another advantage of the monitoring of the job number is that accidental usage of the lamps may be avoided. If the monitoring device is positioned within the first cure unit, the controller may prevent the activation of the first cure unit lamps, until a job ticket is detected. The detection of a job ticket may indicate that a mold assembly holder is placed in the proper position within the first curing unit. Once the mold assembly holder is placed within the first curing unit, the lamps of the first curing unit may be activated to initiate curing and the conveyance system may begin to move. If no job ticket is detected, the apparatus may wait in a stand-by mode until the mold assembly holder is inserted into the first curing unit. In this manner, the lifetime of a lamp of a lens forming apparatus may be extended.

Alternatively, a monitoring device positioned within the first cure unit may include a photosensor which may commonly be referred to as a "photoeye". The photosensor may be configured to determine if a mold assembly holder is placed at the entrance of an initialization unit within the curing unit. The photosensor may, for example, monitor an intensity of a light beam. If a mold assembly holder is in front of the photosensor, then an intensity of the light beam may be reduced. Such a reduction in intensity may be detected by the photosensor and may be processed to determine that a mold assembly holder may have been placed in the curing unit. As described above, once a mold assembly holder may be detected within the first curing unit, the lamps of the first curing unit may be activated to initiate curing and the conveyance system within the first curing unit may begin to move.

In addition, a speed of the conveyance system may increase upon detection of a mold assembly holder within the first curing unit. In this manner, a mold assembly holder may be moved into position quickly once the mold assembly holder has been placed in the curing unit. Furthermore, the photosensor may be configured to monitor an intensity of the light beam periodically. In this manner, the photosensor may determine how long a mold assembly holder may be located at a position in the lens forming apparatus. In addition, if a mold assembly holder is moved out of the light beam of the photosensor, the photosensor may detect an increase in an intensity of the light beam. The photosensor may be further configured to send the detected intensity of the light beam to a controller computer. The controller computer may be configured to control the conveyor system in response to the detected intensity of the light beam. In this manner, the controller computer may be configured to prevent a mold assembly holder from entering the lens forming apparatus until an increase in an intensity of a light beam is received from the photosensor by controlling the conveyor system.

Furthermore, multiple such photosensors may be positioned at various locations throughout a curing unit. In this manner, a presence of the mold assembly holder may be detected at various positions through a curing unit. In addition, the output of the multiple photosensors may be used to monitor the operation of the curing unit. Such a photosensor, or a plurality of photosensors, may also be positioned within the second cure unit and may also be configured to determine a presence of a mold assembly holder in the second cure unit. Position of a tray within a curing unit may also be used to determine when light may be applied to the mold assembly holder in an initialization chamber. For example, the controller may determine delay time for applying initialization light from a speed of the conveyance system. In this manner, application of initialization light may be delayed until a last portion of the time in which the mold assembly holder may be in the initialization unit. Minimization of the delay between application of initialization light and curing light may increase the consistency of resulting eyeglass lenses because each lens forming composition in each processed mold assembly holder may get the same treatment.

As illustrated in Fig. 16, lens forming apparatus 2000 may be operable to direct light and/or heat to an eyeglass lens mold to form an eyeglass lens. Lens forming apparatus 2000 may be further configured as described in any of the above embodiments. Lens forming apparatus 2000 may include at least one controller computer 2002. Controller computer 2002 may be operable to monitor and control the lens forming apparatus. Alternatively, multiple controller computers may be coupled to the lens forming apparatus, and each of the multiple controller computers may be configured to monitor and control a subset of the equipment coupled to the lens forming apparatus.

Controller computer 2002 may operable to connect to a computer network 2004 such as a local area network which may include an Ethernet device. As used herein, "computer network" may also refer to any type of intranet or extranet network which connects computers and/or networks of computers together, thereby providing connectivity between various systems for communication there between, using various network communication protocols, such as TCP/IP, FTP, HTTP, HTTPS, etc. Controller computer 2002 may execute software to communicate with other computer systems connected to network 2004. In addition, a plurality of controller computers may be connected to network 2004. Each controller computer may be coupled to a lens forming apparatus that may be configured as described in above embodiments.

A receiver computer 2006 may also be connected to network 2004. Receiver computer 2006 may be configured to receive an eyeglass lens order from a user. The user may enter the eyeglass lens order by using an user input device such as a keyboard coupled to receiver computer 2006. Alternatively, receiver computer 2006 may be configured to receive an eyeglass lens order from a client. For example, a client may include a doctor, an optician, an optometrist, an ophthalmologist, a retailer of eyeglass lenses, an optical lab, or a wholesaler of eyeglass lenses, a franchise of a national or local retail chain, or another enterprise which supplies eyeglass lenses. Therefore, the client may be located remotely from receiver computer 2006. A user at a client site such as an employee of a doctor or an employee of a franchise may enter an eyeglass lens order into computer system 2008 located at the client site. The eyeglass lens order may include eyeglass lens information as described above. Computer system 2008 at the client site may be configured to send the eyeglass lens order to the receiver computer.

Computer system 2008 may be a computer system, network appliance, Internet appliance, personal digital assistant (PDA) or other system. Computer system 2008 may execute software to communicate with receiver unit 2006, thus facilitating transmission of eyeglass lens data from computer system 2008 to receiver computer 2006 and vice versa. For example, computer system 2008 may be coupled to receiver computer 2006 by connection mechanism 2007 as described above. In one embodiment, computer system 2008 may execute software operable to transmit eyeglass lens data via any of various communication protocols over a network to one or more recipient computer systems and to receive responses from the recipient computers. These protocols may include, but are not limited to, TCP/IP, FTP, HTTP, and HTTPS. For example, computer system 2008 at the client site may be coupled to receiver computer 2006 by computer network 2010 such as an extranet as described above. Alternatively, computer system 2008 at the client site may be coupled to receiver computer 2006 by computer network 2004 as described above. In addition, the information may be encrypted for security purposes as described above.

Receiver computer 2006 may store the received eyeglass lens order in a database. In addition, the database may be stored in memory of receiver computer 2006, controller computer 2002, and/or client computer system 2008. Therefore, the database may include a plurality of eyeglass lens orders. Each eyeglass lens order may include eyeglass lens information as described above. For example, each eyeglass lens order may include a patient name, a priority classification, a job type such as right and/or left lens, a lens type such as aspheric, flat top, and paradigm progressive, a monomer or tint type, and an eyeglass lens prescription. The database may also include a sorted list of the plurality of eyeglass lens orders. For example, the receiver computer may be configured to sort the database by patient name, priority classification, or job type. In addition, the receiver computer may be configured to send such a database through network 2004 such that the database may be stored on controller computer 2002 or client computer system 2008.

Receiver computer 2006 may also be configured to generate a job ticket in response to the received eyeglass lens information. For example, a job ticket may include a barcode representative of the received eyeglass lens information. The barcode may be generated by the receiver computer. The job ticket may also include a portion or any of the received eyeglass lens information as described above. Receiver computer 2006 may also be configured to store the generated barcode in the database as a field associated with the received eyeglass lens information. In this manner, the database may include a look-up-table that may be searched by barcode or by any of the eyeglass lens information as described above. In addition, receiver computer 2006 may be further configured to send the generated job ticket to printer 2009. Printer 2009 may be configured to print job tickets in addition to any other type of document. A printed job ticket may be attached to a mold assembly holder by a user. The mold assembly holder may be configured to support an eyeglass lens mold during a process performed by the lens forming apparatus.

Lens forming apparatus 2000 may include first barcode reader 2012. First barcode reader 2012 may be configured to scan a barcode printed on a job ticket. For example, first barcode reader 2012 may include a light source and a detector. The light source may be configured to scan a beam of light across a barcode. The detector may be configured to detect light reflected from the barcode. The job ticket may be generated by the receiver computer 2006 as described above. First barcode reader 2012 may be coupled to controller computer 2002 and may be configured to send information representative of the barcode such as the detected light to controller computer 2002 over a serial line connection. The controller computer may be configured to send the information representative of the barcode to receiver computer 2006 over network 2004.

In addition, receiver computer 2006 may be configured to search the database of eyeglass lens orders using the information representative of the barcode as described above. Alternatively, the receiver computer may process the information representative of the barcode to determine information representative of an eyeglass lens order. For example, the receiver computer may search a first database with the barcode to determine information representative of an eyeglass lens order associated with the barcode. In addition, the receiver computer may use the determined information representative of an eyeglass order to search a second database. Furthermore, receiver computer 2006 may be configured to send results of searching the database to controller computer 2002 over computer network 2004. Results of searching the database may include any of the information representative of an eyeglass lens order as described above and a barcode associated with the eyeglass lens order. For example, results of searching the database may include a job number, a patient name, a mold assembly holder number, a priority, a bin location, a lens location (i.e., left lens or right lens), a lens type, a monomer type and/or tint, a spherical power, a cylindrical power, axis, an add power, curing conditions. In addition, controller computer 2002 may be configured to at least temporarily store the information in a memory coupled to controller computer 2002.

The preparation of a mold assembly includes selecting the appropriate front and back molds for a desired prescription and lens type, cleaning the molds, and assembling the molds to form the mold assembly. The prescription of the lens determines which front mold, back mold, and gasket are used to prepare the mold assembly. In one embodiment, a chart which includes all of the possible lens prescriptions may be used to allow a user to determine the appropriate molds and gaskets. Such a chart may include thousands of entries, making the determination of the appropriate molds and gaskets time consuming.

Receiver computer 2006 may be configured to determine a front mold member identity and a back mold member identity from the information representative of the eyeglass lens order. In addition, receiver computer 2006 may be configured to send the determined front mold member identity and the determined back mold member identity to controller computer 2002. Alternatively, controller computer 2002 may be configured to determine the front mold member identity and the back mold member identity from information representative of an eyeglass lens order, which may be received from receiver computer 2006.

Controller computer 2002 may be further coupled to mold member storage array 2014. In addition, controller computer 2002 may be configured to send the determined front mold member identity and the determined back mold member identity to mold member storage array 2014. The mold member storage array may be configured to hold a plurality of eyeglass lens molds. In addition, the mold member storage array may be configured to determine a location of a front mold member and a back mold member and to generate a signal to indicate the determined locations. Alternatively, the location of front and back mold members may be determined by the controller computer. The mold member storage array may also be configured to display the generated signal to a user. The signal may be a visual and/or audible signal suitable for detection by a user. The mold member storage array may also be configured to generate and/or display the signal sequentially as described in above embodiments. As such, a generated signal may indicate an appropriate mold member to a user. The user may remove the appropriate mold member from the mold member storage array and may assemble an eyeglass lens mold in the mold assembly holder as described above. Assembly of the eyeglass lens mold may also include filling a space between two mold members with a lens forming composition. The lens forming composition may include any of the lens forming compositions as described in above embodiments.

Lens forming apparatus 2000 may be configured to receive a mold assembly holder and an assembled eyeglass lens mold in a first curing unit (not shown) as described in any of the above embodiments. For example, the first curing unit may be configured to direct light to the eyeglass lens mold to at least partially cure the lens forming composition. In addition, first curing unit may include second barcode reader 2016. Second barcode reader 2016 may be configured to scan a barcode on a job ticket as described in above embodiments. The job ticket may be attached to a mold assembly holder as described in above embodiments. In addition, the second barcode reader may be disposed within the first curing unit proximate to a location at which the mold assembly holder may be placed into the first curing unit by a user. Additional barcode readers may be disposed within the first curing unit proximate to a location at which the mold assembly holder may be removed from the first curing unit by a user and at various location through the first curing unit. As such, the second barcode reader may be configured to scan a barcode of job ticket on a mold assembly holder containing an assembled eyeglass lens mold prior to, during, or subsequent to at least partial curing of a lens forming composition disposed within the assembled eyeglass lens mold. In addition, second barcode reader 2016 may be coupled to controller computer 2002 and may configured to send information representative of the barcode such as detected light to controller computer 2002 over a serial line connection. In addition, controller computer 2002 may be configured to monitor the progress of mold assembly units through the first curing unit from output from at least one barcode reader. Further more, the controller computer may be configured to determine a throughput of the first curing unit from the output from at least one barcode reader.

The controller computer may be configured to determine an eyeglass lens order and/or eyeglass lens information from the information received from the second barcode reader as described in above embodiments. For example, the controller computer may be configured to search a database of eyeglass lens information, which may be sent to controller computer by the receiver computer. In addition, the controller computer may be configured to send the information received from the second barcode reader to receiver computer 2006 over network 2004. Receiver computer 2006 may be configured to determine an eyeglass lens order and/or eyeglass lens information from the information received from the second barcode reader as described in above embodiments. Receiver computer 2006 may be configured to send the determined eyeglass lens order and/or the determined eyeglass lens information to controller computer 2002.

In addition, controller computer 2002 may be configured to alter a parameter of an instrument coupled to lens forming apparatus 2000 in response to the determined eyeglass lens order and/or the determined eyeglass lens information. For example, controller computer 2002 may be coupled to a first curing unit of lens forming apparatus 2000. In addition, controller computer 2002 may be configured to alter a parameter of an instrument coupled to the first curing unit of lens forming apparatus 2000 to alter a duration of a light pulse generated by the first curing unit. In this manner, the duration of the light pulse which is provided to an assembled eyeglass lens mold by a first curing unit may vary depending on the eyeglass lens being formed.

Furthermore, controller computer 2002 may be configured to monitor a parameter of at least one instrument coupled to the first curing unit during curing of a lens forming composition in the first curing unit. In addition, the controller computer may be configured to compare the monitored parameter to an acceptable range for the parameter and to display an error message if the monitored parameter is outside of the acceptable range. In this manner, the controller computer may be configured to monitor a curing process in situ and to provide real-time information to a user of the lens forming apparatus.

Lens forming apparatus 2000 may also be configured such that an assembled eyeglass lens mold may be transported from the apparatus subsequent to being treated in the first curing unit. For example, lens forming apparatus 2000 may include a conveyor system (not shown) configured to transport mold assembly holders which may contain eyeglass lens molds through a first curing unit as described in above embodiments. Therefore, subsequent to treatment in a first curing unit, a user may remove the mold assembly holder and the assembled eyeglass lens mold contained within the mold assembly holder from a conveyor system. Furthermore, the user may place the mold assembly holder into a second curing unit (not shown) of lens forming apparatus 2000.

In addition, second curing unit may include third barcode reader 2018. Third barcode reader 2018 may be configured to scan a barcode on a job ticket as described in above embodiments. The job ticket may be attached to a mold assembly holder as described in above embodiments. In addition, the third barcode reader may be disposed within the second curing unit proximate to a location at which the mold assembly holder may be placed into the second curing unit by a user. An additional barcode reader may also be disposed within the second curing unit proximate to a location at which the mold assembly holder may be removed from the second curing unit by a user or at various locations within the second curing unit.

As such, the third barcode reader may be configured to scan a barcode on a job ticket attached to a mold assembly holder containing an assembled eyeglass lens mold prior to, during, or subsequent to curing of a lens forming composition disposed within the assembled eyeglass lens mold. In addition, third barcode reader 2018 may be coupled to controller computer 2002 and may be configured to send information representative of the barcode such as detected light to controller computer 2002 over a serial line connection. In addition, controller computer 2002 may be configured to monitor the progress of mold assembly units through the second curing unit from output from at least one barcode reader. The controller computer may also be configured to alter a parameter of an instrument coupled to the first curing unit from output from at least the one barcode reader. In this manner, the controller computer may be configured to control the first curing unit based on conditions present in the second curing unit. As such, curing of a lens forming composition in the first and the second curing unit may be synchronized and/or optimized by the controller computer. Furthermore, the controller computer may be configured to determine a throughput of the second curing unit from the output from at least one barcode reader.

The controller computer may be configured to determine an eyeglass lens order and/or eyeglass lens information from the information received from the third barcode reader as described in above embodiments. In addition, the controller computer may be configured to send the information received from the third barcode reader to receiver computer 2006 over network 2004. Receiver computer 2006 may be configured to determine an eyeglass lens order and/or eyeglass lens information from the information received from the third barcode reader as described in above embodiments. Receiver computer 2006 may be configured to send the determined eyeglass lens order and/or the determined eyeglass lens information to controller computer 2002.

In addition, controller computer 2002 may be configured to alter a parameter of an instrument coupled to lens forming apparatus 2000 in response to the determined eyeglass lens order and/or the determined eyeglass lens information. For example, controller computer 2002 may be coupled to a second curing unit of lens forming apparatus 2000. In addition, controller computer 2002 may be configured to alter a parameter of an instrument coupled to the second curing unit of lens forming apparatus 2000 to alter an intensity of light or a temperature of heat generated by the second curing unit. As such, the intensity of light or the temperature of heat which may be provided to an assembled eyeglass lens mold by a second curing unit may vary depending on the eyeglass lens being formed.

As described above, controller computer 2002 may be configured to monitor a parameter of at least one instrument coupled to the second curing unit during curing of a lens forming composition in the second curing unit. For example, the controller computer may be configured to monitor a temperature of a second curing unit. In addition, the controller computer may be configured to a speed of the conveyor system in response to the monitored temperature. In this manner, the controller computer may be configured to prevent a mold assembly holder from being introduced into the second curing unit until the temperature in within an acceptable range for curing a lens forming composition disposed within the mold assembly holder. In addition, the controller computer may be configured to compare the monitored parameter to an acceptable range for the parameter and to display an error message if the monitored parameter is outside of the acceptable range. In this manner, the controller computer may be configured to monitor a curing process in situ and to provide real-time information to a user of the lens forming apparatus.

Lens forming apparatus 2000 may also be configured such that an eyeglass lens may be transported from the apparatus subsequent to being treated in the second curing unit. For example, lens forming apparatus 2000 may include a conveyor system configured to transport mold assembly holders which may contain at least partially cured lens forming compositions through a second curing unit as described in above embodiments. Therefore, subsequent to treatment in a second curing unit, a user may remove the mold assembly holder from a conveyor system and the eyeglass lens contained within the mold assembly holder. A user may also disassemble the eyeglass lens mold assembly and may remove the at least partially cured lens forming composition from the eyeglass lens mold assembly. In addition, the user may place the at least partially cured lens forming composition into the mold assembly holder from which the at least partially cured lens forming composition was removed.

The user may place the at least partially cured lens forming composition contained within the mold assembly holder into an anneal unit. At least one barcode reader may be disposed within the anneal unit as described in any of the above embodiments. In addition, at least the one barcode reader within the anneal unit may be configured as described in any of the above embodiments. Each of the barcode reader within the anneal unit may also be coupled to a controller computer. The controller computer may also be configured as described in any of the above embodiments.

In addition, the controller computer may be configured to alter operation of the lens forming apparatus in response to a predetermined signal. A predetermined signal may include login by an operator or an engineer, a predetermined time, or reception of an eyeglass lens order. For example, an operator or an engineer may login at the beginning of a work shift. Upon receiving the login data, the controller computer may alter an operation of the lens forming apparatus. In this manner, upon receiving login data, a controller computer may supply power to lamps of a curing unit and may supply power to a monomer heating unit. Similarly, a controller computer may be configured to supply power to lamps of a curing unit or a monomer heating unit at a predetermined time at which a work shift may begin. The predetermined time may be set by an operator or an engineer using the controller computer. Alternatively, a controller computer may be configured to supply power to lamps of a curing unit or a monomer heating unit upon reception of an eyeglass lens order. In this manner, the supplied power may vary depending on the eyeglass lens which may be formed in response to the order. As such, the controller computer may be configured to "warm up" a lens forming apparatus which may increase throughput and decrease cost.

Lens forming apparatus 2000 may also include mold reader 2020. Mold reader 2020 may be configured to scan a mold member and to determine a mold member identity. For example, a user may disassemble an eyeglass lens mold subsequent to removing the eyeglass lens mold from the second curing unit as described above. In addition, a user may use mold reader 2020 to scan a front mold member and a back mold member of the disassembled eyeglass lens mold. For example, mold reader 2020 may include a light source and a detector. The light source may be configured to scan a beam of light across an eyeglass lens mold. The detector may be configured to detect light reflected from the eyeglass lens mold.

Mold reader 2020 may be coupled to controller computer 2002 and may configured to send information representative of a mold member identity such as detected light to controller computer 2002 over a serial line connection. Controller computer 2002 may be configured to determine an identity of the front mold member and the back mold member from the sent information. Alternatively, controller computer 2002 may be configured to send information generated by mold reader 2020 to receiver computer 2006 over a computer network. Receiver computer 2006 may be configured to determine an identity of the front mold member and the back mold member and to send the determined identities to the controller computer over the computer network. Alternatively, mold reader 2020 may be configured to determine an identity of a front mold member and an identity of a back mold member. In this manner, mold reader 2020 may also be configured to send determined identities of the front and back mold members to the controller computer.

Controller computer 2002 may be coupled to mold member storage array 2014 as described above. Controller computer 2002 may be configured to send the determined front mold member identity and the determined back mold member identity to mold member storage array 2014. In addition, the mold member storage array may be configured to determine an appropriate location for a mold member within the mold member storage array from a mold member identity and to generate a signal to indicate the determined location. The mold member storage array may also be configured to display the generated signal to a user. The signal may be visual and/or audible such that the signal may be detected by a user. The mold member storage array may also be configured to generate and/or display the signal sequentially as described in above embodiments. As such, a generated signal may indicate, to a user, an appropriate location for an eyeglass mold member having the determined identity. In this manner, a user may place a mold member into an appropriate location in a mold member storage array until an eyeglass lens order is received which requires use of the mold member.

Various embodiments further include receiving or storing instructions and/or data implemented in accordance with the foregoing description upon a carrier medium. Suitable carrier media include memory media or storage media such as magnetic or optical media, e.g., disk or CD-ROM, as well as signals such as electrical, electromagnetic, or digital signals, conveyed via a communication medium such as networks and/or a wireless link.

In an alternate embodiment, the receiver computer may be operable to upload eyeglass lens data directly to the controller computer, for example, by a communications link such as a serial data connection, wireless data link, modem, floppy drive, etc. The controller computer may be connected to a computer network, as may be the client computer system. In addition, the controller computer may have software executable to transmit eyeglass lens information to the client computer system and to receive response information back from the client computer system, and the client computer system may have software executable to receive eyeglass lens information and to transmit a response back to the controller computer or to one or more receiver computers.

In a further embodiment, the receiver computer may connect to a server (not shown), either directly, as with a communication link, or remotely, via a computer network. The server may be operable to receive and store eyeglass lens information and to make the eyeglass lens information available to client computer systems also connected to a network. The server may be any of a variety of servers. For example, the server may be a web server such that the server may be operable to maintain a web site accessible by the client computer systems with browser software. A use of the client computer system may include viewing and/or downloading eyeglass lens information from a server using the browser software. As another example, the server may be an FTP server, in which case a user of a client computer system may be able to transfer the eyeglass lens information from the server to the client computer system using an FTP software program. As yet another example, a server may allow remote login to an account by a client computer system. The account may have been established for use by a user of the client computer system. The user of the client computer system may then view, edit, or transfer eyeglass lens information as needed. The client computer system may also optionally transmit a response back to the server, which may then be accessed by the receiver computer. A client computer system may also transmit the response information to one or more additional client computer systems. In all of these embodiments, security measures may be employed to protect the identity of the users, as well as the privacy and integrity of the information. Such security measures may include secure login, encryption, private communication lines, and other security measures.

In one embodiment, a server may be a web server operable to maintain a web site. When a client computer system accesses the web site of the web server, the web server may provide various data and information to a client browser on a client computer system, possibly including a graphical user interface (GUI) that displays the information, descriptions of the information, and/or other information that might be useful to the users of the system.

In some embodiments, the receiver computer may include an electronic controller, as described herein. The electronic controller may allow the receiver computer to be operated by a client computer system that is coupled to the electronic controller. The client computer system may include software that provides the user information regarding the operation of the receiver computer. The software may allow the user of the client computer to issue commands that allow operation of the receiver computer from the electronic controller. The issued commands may be converted to control signals. The control signals may be received by the electronic controller. The electronic controller may operate components of the receiver computer in response to the received control signals.

The client computer system may be coupled directly to the receiver computer. Alternatively, the client computer system may be coupled to the receiver computer via a computer network. In this embodiment, an operator may be in a different location than the location of the receiver system. By sending control signals over the computer network, the operator may remotely control the operation of the receiver system. The receiver system may also be configured to transmit the obtained eyeglass lens information back to the client computer system via the computer network.

As illustrated in Fig. 18, an embodiment of a computer-implemented method for forming an eyeglass lens may include receiving an eyeglass lens order with a receiver computer as shown in step 2100. The eyeglass lens order may include eyeglass lens information as described above. A receiver computer may be configured as described in any of the above embodiments. Receiving an eyeglass lens order may include receiving an eyeglass lens order from a user. For example, a user may enter an eyeglass lens order by using an user input device such as a keyboard coupled to a receiver computer. Alternatively, receiving an eyeglass lens order may include receiving an eyeglass lens order from a client such as a doctor, an optician, an optometrist, an ophthalmologist, a retailer of eyeglass lenses, an optical lab, or a wholesaler of eyeglass lenses, a franchise of a national or local retail chain, or another enterprise which supplies eyeglass lenses. Therefore, receiving an eyeglass lens order may include receiving the eyeglass lens order with a computer system located remotely at a client site and sending the eyeglass lens order to the receiver computer.

A computer system located remotely at a client site may be coupled to a receiver computer via a server as described above. The client computer system may be configured to receive and/or transmit information to the receiver computer. In one embodiment, the receiver computer may be configured to receive control signals from the client computer system via the server. The operation of the receiver system and subsequently the controller computer and the lens forming apparatus may, therefore, be controlled via a client computer through a server. As discussed before, the receiver computer may also transmit eyeglass lens information back to the client computer system via the server. The eyeglass lens information may be encrypted as described in above embodiments.

The method may also include storing the received eyeglass lens order in a database. The database may be stored by a receiver computer as described in above embodiments. Alternatively, the database may be stored by the controller computer as described above. The database may include a plurality of eyeglass lens orders. Each eyeglass lens order may include eyeglass lens information as described above. The method may also include sorting the plurality of eyeglass lens orders such that the database may include a sorted list of the plurality of eyeglass lens orders.

The method may also include generating a job ticket in response to the received eyeglass lens information as shown in step 2102. A job ticket may include a barcode representative of the received eyeglass lens information as described in above embodiments. The barcode may be generated by a receiver computer or a controller computer. The method may also include storing the barcode in the database as a field associated with the received eyeglass lens information. In this manner, the database may include a look-up-table that may be searched by barcode or by any of the eyeglass lens information as described above. In addition, the method may include printing the generated job ticket. A printed job ticket may be attached to a mold assembly holder by a user. The mold assembly holder may be configured as described in any of the above embodiments.

As shown in step 2104, the method may include scanning a barcode printed on a job ticket. The method may also include sending information resulting from scanning the barcode to a controller computer over a serial line connection. The controller computer may be configured as described in any of the above embodiments. The method may further include sending the information representative of the barcode to a receiver computer.

In addition, the method may include determining information associated an eyeglass lens order associated with the scanned bar code. For example, the method may include searching a database of eyeglass lens orders using the information representative of the barcode. Alternatively, the method may include processing the information representative of the barcode to determine information representative of an eyeglass lens order. For example, the method may include searching a first database with the barcode to determine information representative of an eyeglass lens order associated with the barcode. In addition, the method may include searching a second database with the determined information representative of an eyeglass order. Furthermore, the method may include sending results of searching the database from a receiver computer to a controller computer over a computer network. Results of searching the database may include any of the information representative of an eyeglass lens order as described above and a barcode associated with the eyeglass lens order.

The method may also include determining a front mold member identity and a back mold member identity from the information representative of the eyeglass lens order, as shown in step 2106. In addition, the method may include sending the determined front mold member identity and the determined back mold member identity to a controller computer. The method may further include sending the determined front mold member identity and the determined back mold member identity to a mold member storage array. A mold member storage array may be configured as described in any of the above embodiments. In addition, the method may include generating a signal to indicate locations of mold members having the determined mold member identities. The method may also include displaying the generated signal to a user. For example, the generated signal may be displayed as a visual and/or audible signal suitable for detection by a user. Furthermore, the method may include generating and/or displaying the signal sequentially to indicate a location of a front mold member and a location of a second mold member. As such, a generated signal may indicate a location of an appropriate mold member to a user. The user may remove the appropriate mold member from the mold member storage array and may assemble an eyeglass lens mold containing a lens forming composition in a mold assembly holder as described above. The lens forming composition may include any of the lens forming compositions as described in above embodiments.

The method may further include scanning a bar code on a job ticket subsequent to placing a mold assembly holder including an assembled eyeglass lens mold in a first curing unit of a lens forming apparatus, as shown in step 2108. Scanning the bar code may include scanning the barcode with a second barcode reader, which may be configured as described in above embodiments. For example, the second barcode reader may be disposed within a first curing unit proximate to a location at which the mold assembly holder may be placed into the first curing unit by a user. The second barcode reader, however, may also be disposed within the first curing unit proximate to a location at which the mold assembly holder may be removed from the first curing unit or throughout the first curing unit. As such, step 2108 may include scanning a barcode of job ticket on a mold assembly holder containing an assembled eyeglass lens mold prior to, during, or subsequent to curing at least a portion of a lens forming composition disposed within the assembled eyeglass lens mold. In addition, the method may include sending information representative of the barcode to a controller computer over a serial line connection.

As shown in step 2110, the method may include determining parameters of an instrument of the first curing unit from information representative of the barcode. The parameters of the instrument of the first curing unit may define operating conditions for at least partial curing of a lens forming composition. In addition, the method may include altering a parameter of an instrument coupled to a first curing unit in response to the determined parameters. For example, altering a parameter of an instrument may include altering a duration of a light pulse generated by the first curing unit. In this manner, the duration of the light pulse, which may be provided to an assembled eyeglass lens mold by a first curing unit, may vary depending on the eyeglass lens being formed.

Subsequent to treatment in a first curing unit, a user may remove the mold assembly holder and the assembled eyeglass lens mold contained within the mold assembly holder from a conveyor system. Furthermore, the user may place the mold assembly holder into a second curing unit of a lens forming apparatus.

In addition, the method may include scanning a barcode on a job ticket with a third barcode reader subsequent to placing a mold assembly holder in a second curing unit, as shown in step 212. The job ticket may be attached to a mold assembly holder as described in above embodiments. The second curing unit and a third barcode reader may be configured as described in any of the above embodiments. In addition, the third barcode reader may be disposed within the second curing unit proximate to a location at which the mold assembly holder may be placed into, moved through, or removed from the second curing unit by a user. As such, the method may include scanning a barcode on a job ticket attached to a mold assembly holder containing an at least partially cured lens forming composition prior to, during, or subsequent to curing of a lens forming composition. In addition, the method may include sending information representative of the barcode such as detected light to a controller computer over a serial line connection.

In addition, the method may include determining an eyeglass lens order and/or eyeglass lens information from the information received from the third barcode reader with a controller computer. In addition, the method may include sending the information received from the third barcode reader to a receiver computer over a computer network. The method may include determining an eyeglass lens order and/or eyeglass lens information from the information received from the third barcode reader with a receiver computer. As such, the method may include sending the determined eyeglass lens order and/or the determined eyeglass lens information from the receiver computer to a controller computer.

In addition, the method may include determining a parameter of an instrument coupled to a second curing unit in response to the determined eyeglass lens order and/or the determined eyeglass lens information, as shown in step 2114. For example, the method may include determining parameters of an instrument coupled to a second curing unit, which may define operating conditions for post curing of a lens forming composition. In addition, the method may include altering a parameter of an instrument coupled to a second curing unit in response to the determined eyeglass lens order and/or the determined eyeglass lens information. For example, altering a parameter of an instrument coupled to a second curing unit may include altering a temperature of heat generated by the second curing unit. As such, the temperature of heat, which may be provided to an at least partially cured lens forming composition, by a second curing unit may vary depending on the eyeglass lens being formed.

A user may disassemble the eyeglass lens mold and may remove the at least partially cured lens forming composition. In addition, the user may place the at least partially cured lens forming composition into the mold assembly holder from which the at least partially cured lens forming composition was removed. The user may also place the at least partially cured lens forming composition disposed within the mold assembly holder into an anneal unit. At least one barcode reader may also be coupled to the anneal unit as described in any of the above embodiments. In addition, at least the one barcode reader may be configured as described in any of the above embodiments. Furthermore, a controller computer may be coupled to at least the one barcode reader coupled to the anneal unit. The controller computer may be configured as described in any of the above embodiments.

The method may also include scanning a mold member as shown in step 2116. The mold member may include a mold member which may have been disassembled by a user subsequent to removing the eyeglass lens mold from the second curing unit as described above. In addition, the method may include scanning a front mold member and a back mold member of a disassembled eyeglass lens mold. For example, a mold member may be scanned with a mold reader.

In an alternative embodiment, the method may also include determining a mold member identity with the mold reader. The method may also include sending information representative of a mold member identity from a mold reader to a controller computer over a serial line connection. In addition, the method may include determining an identity of the front mold member and the back mold member with the controller computer. Alternatively, the method may include sending information representative of a mold member identity from a controller computer to a receiver computer over a computer network. In this manner, the method may include determining an identity of the front mold member and the back mold member with the receiver computer and sending the determined identities from the receiver computer to a controller computer over a computer network. The method may also include determining an identity of a front mold member and an identity of a back mold member.

In addition, the method may include sending the determined front mold member identity and the determined back mold member identity to a mold member storage array. A controller computer may be coupled to a mold member storage array as described above. A mold member storage array may be configured as described in any of the above embodiments. For example, the mold member storage array may include a plurality of drawers or locations configured to hold a mold member. In addition, the method may include determining an appropriate location for a mold member in a mold member storage array, as shown in step 2118. The method may further include generating a signal to indicate the determined location. In addition, the method may include displaying the generated signal to a user. The signal may be visual and/or audible such that the signal may be detected by a user. The method may also include generating and/or multiple signals sequentially as described in above embodiments. As such, a generated signal may indicate, to a user, an appropriate location for an eyeglass mold member having the determined identity. In this manner, a user may place a mold member into an appropriate location in a mold member storage array until an eyeglass lens order is received which requires use of the mold member.

Fig. 19 shows an embodiment of graphical user interface ("GUI") 2200 which may display eyeglass lens forming-related information on a front panel of controller computer 2002. GUI 2200, as illustrated in Fig. 19, may also be displayed on a front panel of receiver computer 2006. The controller computer and the receiver computer may be configured as described in any of the above embodiments. The controller computer and/or the receiver computer may include an output device and at least one input device. A variety of input devices may be used. Some input devices include pressure sensitive devices (e.g., buttons or screens), movable data entry devices (e.g., rotatable knobs, a mouse, a trackball, or moving switches), voice data entry devices (e.g., a microphone), light pens, or a computer coupled to the controller computer and/or the receiver computer. The GUI preferably displays controller and/or receiver computer data requests and responses. The output device may be a monitor cathode ray tube, an LCD panel, a plasma display screen, or a touch-sensitive screen.

GUI 2200 may include a main menu and may be displayed by a controller computer or a receiver computer when initially powered. If the main menu is not displayed, a user may access the main menu by clicking a button, which may be labeled Main Menu, on a displayed GUI with a mouse. In response to activating the Main Menu button, the controller and/or receiver computer may cause the main menu screen to be displayed. As depicted in Fig. 19, a GUI may offer a number of initial options on the main menu. The options may include Job Entry 2202, Job Viewer 2204, Alarm Log 2206, Start 2208, Stop 2210, and Exit 2212. Selection of some of the options such as Job Entry 2202, Job Viewer 2204 and Alarm Log 2206 may cause the display screen to change to a different GUI. Selection of other options such as Start 2008 and Stop 2210 may alter an operation of the lens forming apparatus. For example, selecting Start 2208 may cause the lens forming apparatus to begin a process such as curing a lens forming composition. The main menu may also offer other options which allow the user to access machine status information and instrument setup menus such as Maintenance 2214, Machine Setup 2216, and Configuration 2218. Any one of the options may be selected by a user by clicking an appropriate button with a mouse. Alternatively, the screen may be a touch sensitive screen and the selections made by placing, for example, a finger proximate to the desired selection.

GUI 2200 may also display machine status-related information on the main menu. For example, GUI 2200 may include a graphical icon or a display listing properties of a lens forming apparatus in graphic and/or alphanumeric format. A graphical icon or a display may appear or may be altered on GUI 2200 in response to a change in status of lens forming apparatus 2000. For example, as shown in Fig. 20, icon 2220 representative of a mold assembly holder, as described in above embodiments, may appear on GUI 2200 when a mold assembly holder is placed in a first curing unit or a second curing unit of lens forming apparatus 2000. A position of icon 2220 on the GUI may also indicate a unit within which the mold assembly holder is disposed and a position of the mold assembly holder within the unit. For example, a position of the mold assembly holder within the unit may be determined from a time of initial detection and a speed of the conveyor system. In this manner, the position of icon 2220 on the GUI may correspond to the determined position of the mold assembly holder within the unit.

In addition, an icon may be altered in color to indicate a change in status of a lens forming apparatus. For example, an icon, which may represent a signal tower of a lens forming apparatus, may include series of icons 2222 of different colors. Upon a change in status of the apparatus or in an alarm coupled to the apparatus, a color of one of series of icons 2222 may be altered on GUI 2200. For example, a color intensity of two of series of icons 2222 of signal tower may be altered to indicate 1) that an alarm may be present and 2) that the machine may be running. Alternatively, a color of only one of series of icons 2222 may be altered to indicate that the machine may be running. In addition, alphanumeric characters 2224 may appear on GUI 2200 proximate one of the series of icons representing the signal tower to indicate a change in status of the machine corresponding to a change in color of one of the series of icons.

As shown in Fig. 19, upon activation of an alarm, display 2226 of GUI 2200 may display machine-status information in alphanumeric format. Display 2226 of GUI 2200 may include a list of properties to indicate that, for example, "Lower Left Init Filter Not In Place" and "Job Not Found in Database" in addition to any other status-related information. GUI 2200 may also include an option such as Acknowledge 2228 arranged proximate text block 2226. A user may select Acknowledge 2228 to access and/or remove machine-status information from text block 2226.

Fig. 21 shows an alternate embodiment of graphical user interface ("GUI") 2228 which may display eyeglass lens forming-related information on a front panel of controller computer 2002. GUI 2228, as illustrated in Fig. 21, may also be displayed on a front panel of receiver computer 2006 or on a front panel of client computer system 2008. The controller computer, the receiver computer, and the client computer system may be configured as described in above embodiments. GUI 2228 may display controller and/or receiver computer data requests and responses. GUI 2228 may include a main menu and may be displayed by a controller computer or a receiver computer when initially powered. GUI 2228 may also be displayed by a client computer system upon request from a user.

As depicted in Fig. 21, GUI 2228 may offer a subset of the initial options displayed on GUI 2200. For example, GUI 2228 may be displayed to a user who may have limited access to information and/or control of lens forming apparatus 2200. A user may be required to obtain a user id to access the system. Access granted to a user may vary depending on the user. For example, access granted to a user may be determined from information provided by a user upon request for a user id. For example, an operator or an engineer, who may operate and/or maintain a lens forming apparatus, may be granted more access to information and control of the apparatus than a client. Therefore, the options which may be displayed either on GUI 2200 or GUI 2228 may be determined by a user id provided by a user during a login routine. A login routine may also require a user to enter a password. In this manner, access to the system through either GUI 2200 or GUI 2228 may be controlled and/or monitored to protect the identity of the users, as well as the privacy and integrity of the information. A user may also be required to enter a password upon selecting Exit 2212 from either GUI 2200 or GUI 2228 for privacy and integrity purposes.

For example, upon login by an operator, GUI 2200 may be displayed on a controller computer or on a receiver computer. Upon login by a client, however, GUI 2228 may be displayed on a client computer system to provide a limited number of options such as Job Entry 2202, View Jobs 2204, Configure 2218, and Exit 2212. As described above, any one of the options may be selected by a user by clicking an appropriate button with a mouse. In addition, selection of a similar option from either GUI 2200 or GUI 2228 may cause the display screen to change to substantially the same GUI. Therefore, regardless of whether Job Entry or View Jobs is selected from GUI 2200 or GUI 2228, respectively, the display screen may be changed to a prescription input menu.

Selection of Job Entry 2202 may cause the display screen to change to prescription input GUI 2230, an embodiment of which is shown in Fig. 22. GUI 2230 may be displayed on a controller computer, a receiver computer, and/or a client computer system. The controller computer, the receiver computer, and the client computer system may be configured as described in any of the above embodiments. Prescription input GUI 2230 may preferably allow a user to enter data pertaining to a new lens order. The prescription input menu may include a number of menu items which may be configured to collect information from a user. For example, the prescription input menu may include a number of input windows 2232 which may be configured to receive alphanumeric input from a user. In addition, the system may be configured to generate and display a signal to the user upon an invalid entry in an input window.

In addition, the prescription input menu may include a number of selection menus which may include radio buttons 2234 and/or pull-down menus 2236. A radio button may be an item that may be selected or deselected, and which displays its state to a user. In addition, in a menu of radio buttons, typically only one radio button may be selected at a time. For example, upon selection of one radio button in a menu, each of the other radio buttons in the menu may be shaded to indicate that these selections are unavailable. Furthermore, additional menu items displayed on a GUI may be altered upon selection of a radio button. For example, if a user selects a radio button to indicate that a new lens order includes a right lens and a left lens, then pull down menus may appear on the GUI to accept prescription information for both the right and the left lens. A pull down menu may include a number of options which may be viewed by selecting the pull down menu. In addition, a user may select one of the number of options from the pull down menu. A selected option may appear in a text box of the pull-down menu subsequent to selection by a user. Additional pull down menus may be altered upon a selection from a pull down menu. For example, upon selection of zero cylindrical power, a pull down menu for a cylinder axis power may be removed from GUI 2230 or may be shaded to indicate that the pull down menu is currently inactive (i.e., the menu may not accept input from a user).

Each of the menu items allows entry of a portion of the lens prescription. The lens prescription information may include, but is not limited to, job number, patient name, mold assembly holder number, priority, bin location, lens location (i.e., left lens or right lens), lens type, monomer type and/or tint, spherical power, cylindrical power, axis, and add power. The monomer selection may include choices for example, either clear or photochromic lenses. The lens type item may allow selection between spheric single vision, aspheric single vision lenses, flattop bifocal lenses, and asymmetrical progressive lenses. The sphere item allows the sphere power of the lens to be entered. The cylinder item allows the cylinder power to be entered. The axis item allows the cylinder axis to be entered. The add item allows the add power for multifocal prescriptions to be added. Since the sphere power, cylinder power, cylinder axis, and add power may differ for each eye, and since the molds and gaskets may be specific for the location of the lens (i.e., right lens or left lens), the GUI preferably allows separate entries for right and left lenses.

A user may cancel a new lens order at any time by selecting an option such as Cancel Entry 2238 which may be displayed on prescription input GUI 2230. In addition, a user may submit a new lens order by selecting an option such as Create Job 2240 which may also be displayed on prescription input GUI 2230. Upon selection of Create Job 2240, the new lens order submitted by the user may be sent to a receiver computer or a controller computer. In addition, the new lens order may be stored in a database of eyeglass lens orders as described in above embodiments. Furthermore, each entry of the new lens order may be compared to valid entries for an eyeglass lens order. If any of the entries do not match valid entries, GUI 2230 may display an error message to the user. For example, a new lens order submitted by a user may not be filled by a lens forming apparatus if the lens forming apparatus does not include appropriate molds to form the ordered lens. In this manner, GUI 2230 may display an error message to the user such as "Prescription Not Available". In addition, an entry may be determined to be invalid if the entry may have been left blank by a user. An appearance of an invalid entry may be altered on GUI 2230 to indicate the invalid entry to a user. For example, if a mold is not available for the left lens, pull down menus for prescription information for this lens may be highlighted, may be indicated with a graphical icon, or may be indicated by alphanumeric characters. GUI 2230 may also be configured to allow a user to alter the invalid entry and to provide a user with additional options such as Cancel Entry 2238 and Create Job 2240.

After the data relating to the prescription has been added, the controller computer, the receiver computer, or the client computer system may prompt the user to enter a job number to save the prescription type. The job number preferably allows the user to recall a prescription type without having to reenter the prescription data. The job number may also be used by the controller computer to control the curing conditions for the lens. The curing conditions typically vary depending on the type and prescription of the lens. By allowing the controller computer access to the prescription and type of lens being formed, the controller computer may automatically set up the curing conditions without further input from the user.

Selection of Job Viewer or View Jobs 2204 may cause the display screen to change to an embodiment of prescription viewer GUI 2242, an embodiment of which is shown in Fig. 23. GUI 2242 may be displayed on a controller computer, a receiver computer, and/or a client computer system. The controller computer, the receiver computer, and the client computer system may be configured as described in any of the above embodiments. Prescription viewer GUI 2242 may preferably allow a user to select an eyeglass lens order and to view data pertaining to the selected eyeglass lens order. For example, GUI 2242 may include input windows, radio buttons, and/or pull down menus as described in above embodiments to allow a user to enter information which may be associated with an eyeglass lens order. For example, GUI 2242 may include pull down menu 2244. The pull down menu may include a list of job numbers which may be viewed by selecting the pull down menu. In addition, a user may select one of the job numbers from the pull down menu. A selected job number may appear in a text box on of the pull-down menu subsequent to selection by a user. In addition, GUI 2242 may include input window 2246 which may be configured to receive alphanumeric characters representative of an eyeglass lens order. For example, a user may enter a patient's name into an input window on GUI 2242. GUI 2242 may also be configured such that additional information related to an eyeglass lens order may be entered by a user.

The information entered by the user may be used to determine additional information related to the eyeglass lens order. The additional information may be determined by a client computer system, a receiver computer, or a controller computer, all of which may be configured as described in above embodiments. For example, the additional information may be determined by processing the input from the user and searching a database of information stored on the client computer system, the receiver computer, or the controller computer. The additional information may be displayed on GUI 2242 such that a user may view the additional information. In addition, GUI 2242 may include a number of options which may be available to the user. For example, GUI 2242 may include options such as Re-Print 2248 and Close 2250. In this manner, the user may select to print the information displayed in GUI 2242 or to close GUI 2242 and return to the previous menu displayed on the user's computer.

Selection of Alarm Log 2206 may cause the display screen to change to an embodiment of alarm viewer GUI 2252, an embodiment of which is shown in Fig. 24. GUI 2252 may be displayed on a controller computer and/or a receiver computer. The controller computer and the receiver computer may be configured as described in any of the above embodiments. Alarm viewer GUI 2252 may preferably allow a user to view information related to alarms which may have occurred during operation of a lens curing apparatus. Information related to alarms may be presented in tabular format and may include several columns. For example, as shown in Fig. 24, GUI 2252 may include column 2254 which may include alphanumeric characters representative of a date and a time at which an alarm occurred. In addition, GUI 2252 may include column 2256 which may include alphanumeric characters representative of a description of an alarm. GUI 2252 may also include additional columns which may include additional information related to an alarm such as a classification and a priority of the alarm.

A user may also select one of the alarms displayed in GUI 2252. Selection of one of the displayed alarms may cause the GUI to display additional information related to the alarm or to display additional options related to the alarm and/or operation of the lens forming apparatus. For example, upon selection of a displayed alarm, a user may further select to delete the selected alarm or to restart the lens forming apparatus. GUI 2252 may also include a number of options which may be available to the user. For example, GUI 2252 may include options such as Purge Log 2258 and Close 2260. In this manner, the user may select to delete all of the information displayed in GUI 2252 or to close GUI 2252 and return to the previous menu displayed on the user's computer.

Selection of Maintenance 2214 may cause the display screen to change to an embodiment of maintenance viewer GUI 2262, an embodiment of which is shown in Fig. 25. GUI 2262 may be displayed on a controller computer and/or a receiver computer. The controller computer and the receiver computer may be configured as described in any of the above embodiments. Maintenance viewer GUI 2262 may preferably allow a user to view information related to operational status of a lens curing apparatus. Operational status of a lens curing apparatus may be determined by parameters of a number of instruments coupled to the lens curing apparatus. For example, instruments coupled to the lens curing apparatus may include, but are not limited to, thermocouples, timing devices, light detection devices such as photodiodes, and electrical measurement devices. Therefore, parameters of an instrument may include, for example, output of a thermocouple, a timing device, a light detection device, or an electrical measurement device. In this manner, information related to operational status of lens curing apparatus may include, but may not be limited to, temperatures of a post-cure chamber, time, light intensity, and electrical currents being drawn by lamps coupled to the lens curing apparatus. As such, information which may be displayed on the maintenance viewer may include lamp current draws, current upper and lower limits for the current draw, and lamp life remaining.

Information related to operational status of a lens curing apparatus may be displayed in alphanumeric and graphical format. For example, as shown in Fig. 24, GUI 2262 may include output windows 2264 which may include alphanumeric characters representative of information related to operational status of a lens curing apparatus as described above. In addition, GUI 2252 may include a plurality of digital inputs 2266 which may include alphanumeric characters describing an operational status of a lens curing apparatus and a corresponding graphical icon. For example, alphanumeric characters may be used to describe an operation or a process which may be performed by a lens forming apparatus. A graphical icon corresponding to the alphanumeric characters may indicate if the operation or process is currently being performed by the lens forming apparatus or if the operation or process is being performed satisfactorily. For example, if the air pressure within a lens forming apparatus is within operational limits, a graphical icon corresponding to alphanumeric characters such as "Air Pressure OK" may appear as a solid shape such as a circle. Alternatively, if the air pressure within a lens forming apparatus is outside of operational limits, a graphical icon corresponding to alphanumeric characters such as "Air Pressure OK" may appear as an outlined shape such as a circle. The graphical icons may also be altered depending if various equipment of the lens forming apparatus is on or off. In an additional example, the maintenance viewer may also include digital inputs which may indicate if a lamp current draw is too high or too low and if an alarm is currently activated for the lamp current draw, thereby indicating lamp failure. As such, the maintenance viewer may provide comprehensive information related to the current operational status and setpoints for equipment of a lens forming apparatus.

GUI 2262 may also include a number of options which may be available to the user. For example, GUI 2262 may include options such as More... 2268 and Close 2270. In this manner, the user may select to view more digital inputs as described above by selecting More... 2268 or to close GUI 2262 and return to the previous menu displayed on the user's computer by selecting Close 2270.

Selection of Machine Setup 2216 may cause the display screen to change to an embodiment of machine setup menu GUI 2272, an embodiment of which is shown in Fig. 26. GUI 2272 may be displayed on a controller computer and/or a receiver computer. The controller computer and the receiver computer may be configured as described in any of the above embodiments. Machine Setup GUI 2272 may preferably allow a user to view information related to setpoints and upper and lower limits for parameters of a number of instruments coupled to the lens curing apparatus. As described above, instruments coupled to the lens curing apparatus may include, but are not limited to, thermocouples, timing devices, light detection devices such as photodiodes, and electrical measurement devices. A thermocouple may be configured to measure a temperature of a curing unit or an anneal unit. For example, a thermocouple may be disposed in an air intake vent of a curing unit or an anneal unit. Therefore, parameters of an instrument may include, for example, output of a thermocouple, a timing device, a light detection device, and an electrical measurement device. In this manner, information related to setpoints and limits for parameters of a number of instruments coupled to the lens curing apparatus may include, but may not be limited to, a temperature of a cure unit, a temperature of an anneal unit, time, light intensity, and electrical currents being drawn by lamps coupled to the lens curing apparatus. For example, a user may user the machine setup menu to enter a setpoint and upper and lower alarm limits for lamp current draws. A temperature of a curing unit may have upper and lower alarm limits of, for example, approximately 150 °F and approximately 150 °F, respectively. A temperature of an anneal unit may have upper and lower alarm limits of, for example, approximately 200 °F and approximately 250 °F, respectively.

The machine setup menu may include a number of menu items which may be configured to collect information from a user. For example, the machine setup menu may include a number of input windows 2274 which may be configured to receive alphanumeric input from a user. In addition, the system may be configured to generate and display a signal to the user upon an invalid entry in an input window. As such, a user may view and alter setpoints and upper and lower limits for a number of instruments coupled to the lens curing apparatus.

In addition, the machine setup menu may include a number of input boxes 2276 which may selected by the user. Upon selection of an input box, a "check" may appear in the input box to indicate to a user that the input box has been selected. The input boxes may include a number of maintenance operations which may be performed by an operator. In this manner, after performing a maintenance operation such as replacing top initialization lamps, replacing bottom initialization lamps, and/or replacing post-cure lamps, a user may access the machine setup menu and may select an appropriate input box. In addition, the system may be configured to store a date and a time at which an input box is selected and the maintenance operation corresponding to the selected input box in a memory. The stored information may also be stored in a database such as a maintenance log, which may also be viewed by a user through an appropriate GUI.

GUI 2272 may also include a number of options which may be available to the user. For example, GUI 2272 may include options such as Save Changes 2278 and Cancel Changes 2280. A user may submit changes to setpoints and upper and lower limits by selecting an option such as Save Changes 2278. Upon selection of Save Changes 2278, the changes to the setpoints and upper and lower limits may be sent to a receiver computer or a controller computer. In addition, the changes to the setpoints and upper and lower limits may be stored in a database as described in above embodiments. Furthermore, each change to a setpoint or an upper and lower limit may be compared to valid entries for the setpoint or the upper and lower limit. If any of the entries do not match valid entries, GUI 2272 may display an error message to the user. In this manner, GUI 2272 may display an error message to the user such as "Setpoint Out Of Range". In addition, an appearance of an invalid entry may be altered on GUI 2272 to indicate the invalid entry to a user. For example, if a temperature setpoint for an anneal conveyor is out of range, an appearance of an input window for this information may be altered, may be indicated with a graphical icon, or may be indicated with alphanumeric characters. GUI 2272 may also be configured to allow a user to alter the invalid entry and to provide a user with additional options such as Cancel Changes 2280 and Save Changes 2278. A user may cancel changes to setpoints and upper and lower limits at any time by selecting the Cancel Changes option.

Selection of Configuration or Configure 2218 may cause the display screen to change to an embodiment of configuration setup menu GUI 2282, an embodiment of which is shown in Fig. 27. GUI 2282 may be displayed on a controller computer and/or a receiver computer. The controller computer and the receiver computer may be configured as described in any of the above embodiments. Configuration GUI 2282 may preferably allow a user to view information related to filepath names of various databases and/or directories of information. For example, the GUI may include various windows which may include filepath names of Recipe DB (database) 2284, Job DB (database) 2286, and Ticket Dir (directory) 2288. Each of the filepath names may be used by a computer system, such as a controller computer or a receiver computer, to find, open, and/or use a database or a directory. The Recipe DB may include a plurality of program instructions which may be computer-executable to implement a method for forming an eyeglass lens. The Job DB may include information related to lens forming processes which may have been performed by a lens forming apparatus. In addition, the Ticket Dir may include information related to job tickets which may have been entered by a plurality of users. In addition, the GUI may include an option such as Browse... 2290, which a user may select to search for additional available files which may be used for each database or directory. For example, a user may browse through a memory medium coupled to a computer to search for an alternate file that may be used as a database or directory. Alternatively, a user may enter a filepath name into an input window.

The GUI may also include additional windows which may include a numeric characters which may define a Ticket Poll Rate 2292, a Ticket Print Scale 2294, and a frequency for archiving jobs. Ticket Poll Rate 2292 may serve to define a frequency at which a system may be checked for new files such as job tickets. Ticket Print Scale 2294 may serve to define a size of a printed job ticket. In this manner, a size of a printed job ticket may be defined as a percentage of a page on which the job ticket may be printed.

As depicted in Fig. 28, GUI 2296 may offer a subset of the initial options displayed on GUI 2282. For example, GUI 2296 may be displayed to a user who may have limited access to information and/or control of lens forming apparatus 2200. As defined above, a user may be required to obtain a user id to access the system. Access granted to a user may vary depending on the user. For example, access granted to a user may be determined from information provided by a user upon request for a user id. For example, an operator or an engineer, who may operate and/or maintain a lens forming apparatus, may be granted more access to information and control of the apparatus than a client. Therefore, the options which may be displayed either on GUI 2282 or GUI 2296 may be determined by a user id provided by a user during a login routine. For example, upon login by an operator, GUI 2282 may be displayed on a controller computer or on a receiver computer. Upon login by a client, however, GUI 2296 may be displayed on a client computer system to provide a limited number of options such as Job DB (database) 2286, and Ticket Dir (directory) 2288. GUI 2296, however, may also be displayed on a controller computer and/or a receiver computer depending on the user id entered by a user. In addition, GUI 2296 may include an option such as Browse... 2290, which a user may select to search for additional available files.

The formation of lenses involves: 1) Preparing the mold assembly; 2) Filling the mold assembly with the lens forming composition; 3) Curing the lens; 4) Post-curing the lens; and 5) Annealing the lens. Optionally, the lens may be coated after formation or using an in-mold process. The formation of lenses may be accomplished using the plastic lens curing apparatus described above.

In an embodiment, the inner surface, i.e., the casting face, of the front mold member may be coated with one or more hardcoat layers before the mold assembly is prepared. Preferably, two hardcoat layers are used so that any imperfections, such as pin holes in the first hardcoat layer, are covered by the second hardcoat layer. The resulting double hardcoat layer is preferably scratch resistant and protects the subsequently formed eyeglass lens to which the double hardcoat layer adheres. The hardcoat layers are preferably applied using a spin coating unit 20. The mold member is preferably placed in the spin coating unit and the coating material applied to the mold while spinning at high speeds (e.g., between about 900 to 1000 RPM). After a sufficient amount of coating material has been applied, the coating material may be cured by the activating light source disposed in the cover. The cover is preferably closed and activating light is preferably applied to the mold member while the mold member is spinning at relatively low speeds (e.g., between about 150 to 250 RPM). Preferably control of the spinning and the application of activating light is performed by controller 50. Controller 50 is preferably configured to prompt the operator to place the mold members on the coating unit, apply the coating material to the mold member, and close the cover to initiate curing of the coating material.

In an embodiment, the eyeglass lens that is formed may be coated with a hydrophobic layer, e.g. a hardcoat layer. The hydrophobic layer preferably extends the life of the photochromic pigments near the surfaces of the lens by preventing water and oxygen molecules from degrading the photochromic pigments.

In a preferred embodiment, both mold members may be coated with a cured adhesion-promoting composition prior to placing the lens forming composition into the mold cavity. Providing the mold members with such an adhesion-promoting composition is preferred to increase the adhesion between the casting surface of the mold and the lens forming composition. The adhesion-promoting composition thus reduces the possibility of premature release of the lens from the mold. Further, it is believed that such a coating also provides an oxygen and moisture barrier on the lens which serves to protect the photochromic pigments near the surface of the lens from oxygen and moisture degradation. Yet further, the coating provides abrasion resistance, chemical resistance, and improved cosmetics to the finished lens.

In an embodiment, the casting face of the back mold member may be coated with a material that is capable of being tinted with dye prior to filling the mold cavity with the lens forming composition. This tintable coat preferably adheres to the lens forming composition so that dyes may later be added to the resulting eyeglass lens for tinting the lens. The tintable coat may be applied using the spin coating unit as described above.

The clean molds are placed on the gasket to form a mold assembly. The front mold is preferably placed on the gasket first. For single vision prescriptions, the front mold does not have to be placed in any particular alignment. For flat-top bifocal or progressive front molds, the molds are preferably aligned with alignment marks positioned on the gasket. Once the front mold has been placed into the gasket, the back mold is placed onto the gasket. If the prescription calls for cylinder power, the back mold must be aligned with respect to the front mold. If the prescription is spherical (e.g., the lens has no cylinder power), the back mold may be placed into the gasket without any special alignment. Once assembled the mold assembly will be ready for filling.

The controller may prompt the user to obtain the appropriate lens forming composition. In one embodiment, the controller will inform the user of which chemicals and the amounts of each chemical that is required to prepare the lens forming composition. Alternatively, the lens forming compositions may be preformed. In this case the controller may indicate to the operator which of the preformed lens forming compositions should be used.

In an embodiment, dyes may be added to the lens forming composition. It is believed that certain dyes may be used to attack and encapsulate ambient oxygen so that the oxygen may be inhibited from reacting with free radicals formed during the curing process. Also, dyes may be added to the composition to alter the color of an unactivated photochromic lens. For instance, a yellow color that sometimes results after a lens is formed may be "hidden" if a blue-red or blue-pink dye is present in the lens forming composition. The unactivated color of a photochromic lens may also be adjusted by the addition of non-photochromic pigments to the lens forming composition.

The lens forming composition is typically stored at temperatures below about 100 □F. At these temperatures, however, the lens forming composition may be relatively viscous. The viscosity of the solution may make it difficult to fill a mold cavity without creating bubbles within the lens forming composition. The presence of bubbles in the lens forming composition may cause defects in the cured eyeglass lens. To reduce the viscosity of the solution, and therefore reduce the incidence of air bubbles during filling of the mold cavity, the lens forming composition may be heated prior to filling the mold cavity. In an embodiment, the lens forming composition may be heated to a temperature of about 70 □F to about 220 □F, preferably from about 130 □F to about 170 □F prior to filing the mold cavity.. Preferably, the lens forming composition is heated to a temperature of about 150 □F prior to filling the mold cavity.

The lens forming composition may be heated by using an electric heater, an infrared heating system, a hot air system, a hot water system, or a microwave heating system.

For plastic eyeglass lenses, formed from the materials described above, a portion of the light incident upon the lenses may be reflected from the eyeglass lens rather than transmitted through the eyeglass lens. For plastic eyeglass lenses up to about 15% of the incident light may be reflected off the eyeglass lens surfaces. To reduce the reflection of light from a plastic eyeglass lens, a thin film may be applied to the lens. Such films may be referred to as antireflective coating films. Antireflective coatings may reduce the reflectance of light from a surface (i.e., increase light transmittance through the film/substrate interface). Antireflective coatings may be applied after the lens is formed or to the molds prior to forming the lens.

Lens Forming Compositions

The lens forming material may include any suitable liquid monomer or monomer mixture and any suitable photosensitive initiator. As used herein "monomer" is taken to mean any compound capable of undergoing a polymerization reaction. Monomers may include non-polymerized material or partially polymerized material. When partially polymerized material is used as a monomer, the partially polymerized material preferably contains functional groups capable of undergoing further reaction to form a new polymer. The lens forming material preferably includes a photoinitiator that interacts with activating light. In one embodiment, the photoinitiator absorbs ultraviolet light having a wavelength in the range of 300 to 400 nm. In another embodiment, the photoinitiator absorbs actinic light having a wavelength in the range of about 380 nm to 490 nm.

Those skilled in the art will recognize that once the cured lens is removed from a lens molding cavity, the lens may be further processed in a conventional manner, such as by grinding its peripheral edge.

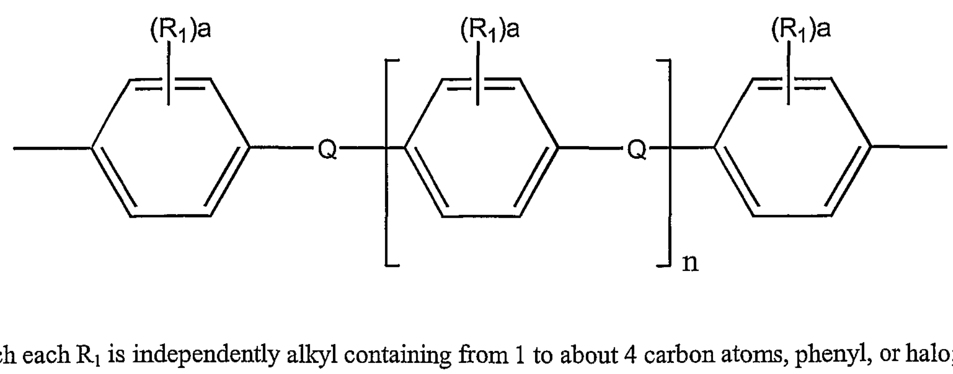
A polymerizable lens forming composition includes an aromatic-containing bis(allyl carbonate)-functional monomer and at least one polyethylenic-functional monomer containing two ethylenically unsaturated groups selected from acrylyl or methacrylyl. In a preferred embodiment, the composition further includes a suitable photoinitiator. In other preferred embodiments, the composition may include one or more polyethylenic-functional monomers containing three ethylenically unsaturated groups selected from acrylyl or methacrylyl, and a dye. The lens forming composition may also include activating light absorbing compounds such as ultraviolet light absorbing compounds and photochromic compounds.

In another embodiment, an ophthalmic eyeglass lens may be made from a lens forming composition comprising a monomer composition and a photoinitiator composition.

The monomer composition preferably includes an aromatic containing polyethylenic polyether functional monomer. In an embodiment, the polyether employed is an ethylene oxide derived polyether, propylene oxide derived polyether, or mixtures thereof. Preferably, the polyether is an ethylene oxide derived polyether. The aromatic polyether polyethylenic functional monomer preferably has the general structure (I), depicted below where each R_2 is a polymerizable unsaturated group, m and n are independently 1 or 2, and the average values of j and k are each independently in the range of from about 1 to about 20. Common polymerizable unsaturated groups include vinyl, allyl, allyl carbonate, methacrylyl, acrylyl, methacrylate, and acrylate.

$$R_2\text{-}[CH_2\text{-}(CH_2)_m\text{-}O]_j\text{-}A_1\text{-}[O\text{-}(CH_2)_n\text{-}CH_2]_k\text{-}R_2 \qquad (I)$$

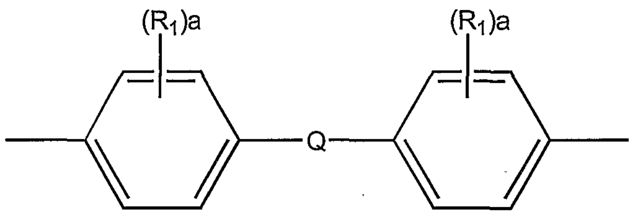
A_1 is the divalent radical derived from a dihydroxy aromatic-containing material. A subclass of the divalent radical A_1 which is of particular usefulness is represented by formula (II):



(II)

in which each R_1 is independently alkyl containing from 1 to about 4 carbon atoms, phenyl, or halo; the average value of each (a) is independently in the range of from 0 to 4; each Q is independently oxy, sulfonyl, alkanediyl having from 2 to about 4 carbon atoms, or alkylidene having from 1 to about 4 carbon atoms; and the average value of n is in the range of from 0 to about 3. Preferably Q is methylethylidene, viz., isopropylidene.

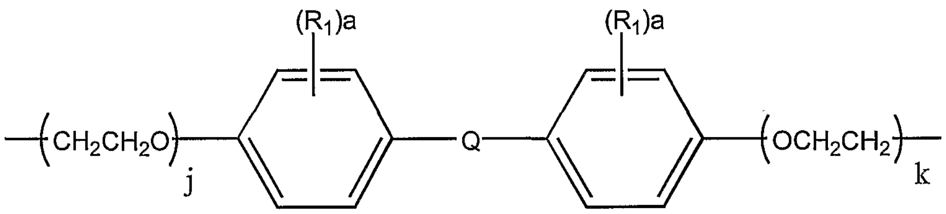
Preferably the value of n is zero, in which case A_1 is represented by formula (III):



(III)

in which each R_1, each a, and Q are as discussed with respect to Formula II. Preferably the two free bonds are both in the ortho or para positions. The para positions are especially preferred.

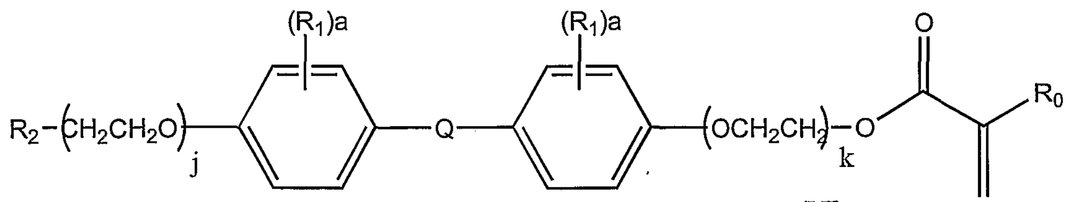
In an embodiment, when para, para-bisphenols are chain extended with ethylene oxide, the central portion of the aromatic containing polyethylenic polyether functional monomer may be represented by the formula:



(IV)

where each R_1, each a, and Q are as discussed with respect to Formula II, and the average values of j and k are each independently in the range of from about 1 to about 20.

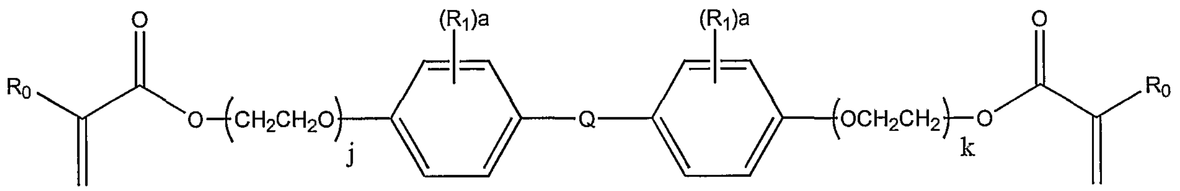
In another embodiment, the polyethylenic functional monomer is an aromatic polyether polyethylenic functional monomer containing at least one group selected from acrylyl or methacrylyl. Preferably the aromatic polyether polyethylenic functional monomer containing at least one group selected from acrylate and methacrylate has the general structure (VI), depicted below where R_0 is hydrogen or methyl, where each R_1, each a, and Q are as discussed with respect to Formula II, where the values of j and k are each independently in the range of from about 1 to about 20, and where R_2 is a polymerizable unsaturated group (e.g., vinyl, allyl, allyl carbonate, methacrylyl, acrylyl, methacrylate, or acrylate).



(VI)

In one embodiment, the aromatic containing polyether polyethylenic functional monomer is preferably an ethoxylated bisphenol A di(meth)acrylate. Ethoxylated bisphenol A di(meth)acrylates have the general structure

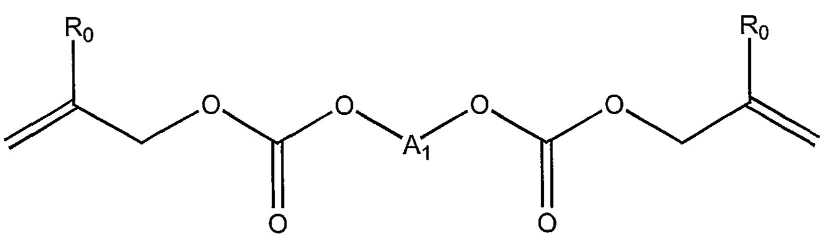
(VII) depicted below where each R_0 is independently hydrogen or methyl, each R_1, each a, and Q are as discussed with respect to Formula II, and the values of j and k are each independently in the range of from about 1 to about 20.



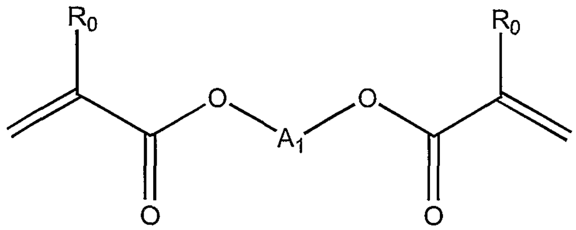
(VII)

Preferred ethoxylated bisphenol A dimethacrylates include ethoxylated 2 bisphenol A diacrylate (where j + k = 2, and R_0 is H), ethoxylated 2 bisphenol A dimethacrylate (where j + k = 2, and R_0 is Me), ethoxylated 3 bisphenol A diacrylate (where j + k = 3, and R_0 is H), ethoxylated 4 bisphenol A diacrylate (where j + k = 4, and R_0 is H), ethoxylated 4 bisphenol A dimethacrylate (where j + k = 4, and R_0 is Me), ethoxylated 6 bisphenol A dimethacrylate (where j + k = 6, and R_0 is Me), ethoxylated 8 bisphenol A dimethacrylate (where j + k = 8, and R_0 is Me), ethoxylated 10 bisphenol A diacrylate (where j + k = 10, and R_0 is H), ethoxylated 10 bisphenol A dimethacrylate (where j + k = 10, and R_0 is Me), ethoxylated 30 bisphenol A diacrylate (where j + k = 30, and R_0 is H), ethoxylated 30 bisphenol A dimethacrylate (where j + k = 30, and R_0 is Me). These compounds are commercially available from Sartomer Company under the trade names PRO-631, SR-348, SR-349, SR-601, CD-540, CD-541, CD-542, SR-602, SR-480, SR-9038, and SR-9036 respectively. Other ethoxylated bisphenol A dimethacrylates include ethoxylated 3 bisphenol A dimethacrylate (where j + k = 3, and R_0 is Me), ethoxylated 6 bisphenol A diacrylate (where j + k = 30, and R_0 is H), and ethoxylated 8 bisphenol A diacrylate (where j + k = 30, and R_0 is H). In all of the above described compounds Q is $C(CH_3)_2$.

The monomer composition preferably may also include a polyethylenic functional monomer. Polyethylenic functional monomers are defined herein as organic molecules which include two or more polymerizable unsaturated groups. Common polymerizable unsaturated groups include vinyl, allyl, allyl carbonate, methacrylyl, acrylyl, methacrylate, and acrylate. Preferably, the polyethylenic functional monomers have the general formula (VII) or (VIII) depicted below, where each R_0 is independently hydrogen, halo, or a C_1-C_4 alkyl group and where A_1 is as described above. It should be understood that while general structures (VII) and (VIII) are depicted as having only two polymerizable unsaturated groups, polyethylenic functional monomers having three (e.g., tri(meth)acrylates), four (e.g., tetra(meth)acrylates), five (e.g., penta(meth)acrylates), six (e.g., hexa(meth)acrylates) or more groups may be used.



(VII)



(VIII)

Preferred polyethylenic functional monomers which may be combined with an aromatic containing polyethylenic polyether functional monomer to form the monomer composition include, but are not limited to, ethoxylated 2 bisphenol A dimethacrylate, tris(2-hydroxyethyl)isocyanurate triacrylate, ethoxylated 10 bisphenol A dimethacrylate, ethoxylated 4 bisphenol A dimethacrylate, dipentaerythritol pentaacrylate, 1,6-hexanediol dimethacrylate, isobornyl acrylate, pentaerythritol triacrylate, ethoxylated 6 trimethylolpropane triacrylate, and bisphenol A bis allyl carbonate.

In one embodiment, the photoinitiator composition preferably includes phenyl bis(2,4,6-trimethylbenzoyl) phosphine oxide (IRG-819) which is commercially available from Ciba Additives under the trade name of Irgacure 819. The amount of Irgacure 819 present in a lens forming composition preferably ranges from about 30 ppm by weight to about 2000 ppm by weight. In another embodiment, the photoinitiator composition may include a mixture of photoinitiator. Preferably, a mixture of Irgacure 819 and 1-hydroxycyclohexylphenyl ketone, commercially available from Ciba Additives under the trade name of Irgacure 184 (IRG-184), is used. Preferably, the total amount of photoinitiators in the lens forming composition ranges from about 50 ppm to about 1000 ppm.

In another embodiment, an ophthalmic eyeglass lens may be made from lens forming composition comprising a monomer composition, a photoinitiator composition, and a co-initiator composition. The lens forming composition, in liquid form, is preferably placed in a mold cavity defined by a first mold member and a second mold member. It is believed that activating light which is directed toward the mold members to activate the photoinitiator composition causes the photoinitiator to form a polymer chain radical. The co-initiator may react with a fragment or an active species of either the photoinitiator or the polymer chain radical to produce a monomer initiating species. The polymer chain radical and the monomer initiating species may react with the monomer to cause polymerization of the lens forming composition.

The monomer composition preferably includes an aromatic containing polyethylenic polyether functional monomer having a structure as shown above. Preferably, the polyethylenic functional monomer is an aromatic polyether polyethylenic functional monomer containing at least one group selected from acrylyl or methacrylyl.

More preferably, the polyethylenic functional monomer is an ethoxylated bisphenol A di(meth)acrylate. The monomer composition may include a mixture of polyethylenic functional monomers, as described above. The photoinitiators which may be present in the lens forming composition have been described above.

The lens forming composition preferably includes a co-initiator composition. The co-initiator composition preferably includes amine co-initiators. Co-initiators include ethanolamines. Examples of ethanolamines include but are not limited to N-methyldiethanolamine (NMDEA) and triethanolamine (TEA) both commercially available from Aldrich Chemicals. Aromatic amines (e.g., aniline derivatives) may also be used as co-initiators. Example of aromatic amines include, but are not limited to, ethyl-4-dimethylaminobenzoate (E-4-DMAB), ethyl-2-dimethylaminobenzoate (E-2-DMAB), n-butoxyethyl-4-dimethylaminobenzoate, *p*-dimethylaminobenzaldehyde, N, N-dimethyl-*p*-toluidine, and octyl-*p*-(dimethylamino)benzoate.

Acrylyl amines may also be used as coinitiators. Acrylyl amines have the general structures depicted in Fig. 29, where R_0 is hydrogen or methyl, n and m are 1 to 20, preferably 1-4, and R_1 and R_2 are independently alkyl containing from 1 to about 4 carbon atoms or phenyl. Monoacrylyl amines may include at least one acrylyl or methacrylyl group (see compounds (A) and (B) in Fig. 29). Diacrylyl amines may include two acrylyl, two methacrylyl, or a mixture of acrylyl or methacrylyl groups (see compounds (C) and (D) in Fig. 29). Acrylyl amines are commercially available from Sartomer Company under the trade names of CN-381, CN-383, CN-384, and CN-386, where these co-initiators are monoacrylyl amines, diacrylyl amines, or mixtures thereof. Other acrylyl amines include dimethylaminoethyl methacrylate and dimethylaminoethyl acrylate. In one embodiment, the co-initiator composition preferably includes a mixture of CN-384 and CN-386. Preferably, the total amount of co-initiators in the lens forming composition ranges from about 50 ppm to about 7 % by weight.

The lens forming composition may also include activating light absorbing compounds. These compounds may absorb at least a portion of the activating light which is directed toward the lens forming composition during curing. One example of activating light absorbing compounds are photochromic compounds. Photochromic compounds which may be added to the lens forming composition have been previously described. Preferably, the total amount of photochromic compounds in the lens forming composition ranges from about 1 ppm to about 1000 ppm. Examples of photochromic compounds which may be used in the lens forming composition include, but are not limited to Corn Yellow, Berry Red, Sea Green, Plum Red, Variacrol Yellow, Palatinate Purple, CH-94, Variacrol Blue D, Oxford Blue and CH-266. Preferably, a mixture of these compounds is used.

The lens forming composition may also include other activating light absorbing compounds such as UV stabilizers, UV absorbers, and dyes. UV stabilizers, such as Tinuvin 770 may be added to reduce the rate of degradation of the formed lens caused by exposure to ultraviolet light. UV absorbers, such as 2-(2H-benzotriazol-2-yl)-4-(1,1,3,3,-tetramethylbutyl)phenol, may be added to the composition to provide UV blocking characteristics to the formed lens. Small amounts of dyes, such as Thermoplast Blue 684 and Thermoplast Red from BASF may be added to the lens forming composition to counteract yellowing.

In an embodiment, a UV absorbing composition may be added to the lens forming composition. The UV absorbing composition preferably includes a photoinitiator and a UV absorber. Photoinitiators and UV absorbers have been described in greater detail in previous sections. Typically, the concentration of UV absorber in the lens forming composition required to achieve desirable UV blocking characteristics is in the range from about 0.1 to about 0.25 % by weight. For example, 2-(2H-benzotriazol-2-yl)-4-(1,1,3,3,-tetramethylbutyl)phenol may be added to the lens forming composition as a UV absorber at a concentration of about 0.17 %.

Further modifications and alternative embodiments of various aspects of the invention will be apparent to those skilled in the art in view of this description. Accordingly, this description is to be construed as illustrative only and is for the purpose of teaching those skilled in the art the general manner of carrying out the invention. It is to be understood that the forms of the invention shown and described herein are to be taken as the presently preferred embodiments. Elements and materials may be substituted for those illustrated and described herein, parts and processes may be reversed, and certain features of the invention may be utilized independently, all as would be apparent to one skilled in the art after having the benefit of this description of the invention. Changes may be made in the elements described herein without departing from the spirit and scope of the invention as described in the following claims.

WHAT IS CLAIMED IS:

1. A system for preparing an eyeglass lens, comprising:
a lens curing unit configured to direct activating light toward a mold assembly during use, wherein the system is configured to produce greater than about 25 eyeglass lenses per hour.

2. The system of claim 1, wherein the lens curing unit comprises;
a first lens curing unit comprising a first activating light source, wherein the first lens curing unit is configured to produce activating light directed toward the mold assembly during use; and
a second lens curing unit, the second curing unit comprising a second activating light source and heating system, wherein the activating light source is configured to direct activating light toward the mold assembly during use; and wherein the heating system is configured to heat the interior of the second lens curing unit.

3. The system of claim 2, wherein the first and second activating light sources have substantially the same spectral output.

4. The system of claim 1, wherein the lens curing unit comprises an activating light source, wherein the activating light source is an ultraviolet light source.

5. The system of claim 1, wherein the lens curing unit comprises an activating light source, wherein the activating light source is an actinic light source.

6. The system of claim 1, wherein the lens curing unit comprises an activating light source, wherein the activating light source comprises a fluorescent lamp, and wherein the activating light source further comprises a flasher ballast system coupled to the fluorescent lamp.

7. The system of claim 1, wherein the lens curing unit comprises an activating light source, wherein the activating light source has a peak light intensity at a range of between about 380 nm to about 490 nm.

8. The system according to one or more of claims 4 to 7, further comprising a filter disposed directly adjacent to the activating light source, the filter being configured to vary an intensity of the activating light emanating from the activating light source such that the intensity of activating light contacting the surface of the mold assembly varies across the surface of the mold assembly.

9. The system according to claim 2, wherein the first activating light source comprises two or more lamps, and wherein the lamps are independently operable.

10. The system according to one or more of claims 1 to 9, further comprising an air distributor positioned within the lens curing unit, the air distributor being configured to circulate air within the lens curing unit during use.

11. The system according to one or more of claims 1 to 10, further comprising an anneal unit, the anneal unit comprising an anneal unit heating system, wherein the anneal unit heating system is configured to heat the interior of the anneal unit.

12. The system of claim 11, wherein the anneal unit heating system is configured to heat the interior of the anneal unit to a temperature of up to about 250 °F.

13. The system according to claims 11 or 12, wherein the anneal unit further comprises an anneal unit conveyor system configured to convey the mold assembly through the anneal unit.

14. The system according to one or more of claims 1 to 13, further comprising a programmable controller.

15. The system of claim 14, wherein the programmable controller is configured to control operation of the lens curing unit as a function of the eyeglass lens prescription.

16. The system according to one or more of claims 1 to 15, further comprising one or more conveyor systems configured to convey the mold assembly through the lens curing unit.

17. The system of claim 2, further comprising a conveyor system, wherein the conveyor system comprises a continuous flexible member extending from the first curing unit through the second curing unit, wherein the flexible member is configured to interact with the mold assembly to convey the mold assembly through the first curing unit, to the second curing unit, and through the second curing unit.

18. The system of claim 2, further comprising a conveyor system, wherein the conveyor system comprises two discrete conveyors, wherein the first conveyor is configured to convey the mold assembly from the first curing unit to the second curing unit, and wherein the second conveyor is configured to convey the mold assemblies through the second curing unit.

19. The system according to one or more of claims 16 to 18, wherein the conveyor system comprises a flexible member configured to interact with the mold assembly, and wherein the flexible member is coupled to a motor configured to move the flexible member through the conveyor system.

20. The system according to one or more of claims 1 to 19, wherein the mold assembly resides on a mold assembly holder, the mold assembly holder comprising a body and an indentation formed in the body, wherein the indentation is complementary to the shape of the mold assembly.

21. The method of claim 20, wherein the indentation of the mold assembly holder defines an opening, and wherein the opening is positioned such that activating light passes through the opening and onto the mold assembly during use.

22. The method according to one or more of claims 20, wherein a portion of the mold assembly holder is configured to hold a job ticket.

23. The method according to one or more of claims 20, wherein the indentation in the mold assembly holder extends into the body to a depth such that an upper surface of the mold assembly is positioned at or below the upper surface of the body.

24. The system of claim 20, wherein the body further comprises indicia, wherein the indicia is representative of the type of lens being formed by the mold assembly.

25. The system according to claims 20 or 24, wherein the mold assembly holder further comprises a second and third indentation formed in the body, wherein the second and third indentations are complementary to the shape of a mold member.

26. The system of claim 2, further comprising a conveyor system configured to convey a mold assembly holder from the first lens curing unit into and through the second lens curing unit.

27. The system of claim 26, further comprising:

a controller coupled to the conveyor system, the controller being configured to control the movement of the conveyor system; and

a sensor disposed in the first lens curing unit, wherein the sensor is configured to sense when the mold assembly enters the first curing unit, and wherein the sensor produces a control signal to the controller, and wherein the controller controls the movement of the conveyor system in response to receiving the control signal.

28. The system according to claims 26, further comprising:

a gating device coupled to the conveyor system, wherein the gating device is configured to inhibit movement of the mold assembly from the first curing unit to the second curing unit during use; and

a controller coupled to the gating device, the controller being configured to control the operation of the gating device, and wherein the controller is configured to operate the gating device to control the flow of mold assemblies from the first curing unit to the second curing unit during use.

29. The system of claims 1 to 28, further comprising:

a reader coupled to the curing unit, the reader being configured to read eyeglass lens prescription information from a mold assembly holder placed proximate to the first curing unit; and

a controller coupled to the curing unit and the reader, wherein the controller is configured to control the operation of the curing unit in response to the eyeglass lens prescription information read by the reader.

30. The system of claim 1 to 26, further comprising:

a first computer system for receiving the eyeglass lens prescription; and a second computer system coupled to the curing unit and the first computer system, wherein the second computer system is configured to control the operation of the curing unit in response to the eyeglass lens prescription entered into the first computer system.

31. The system of claim 2, wherein the second activating light source is coupled to a movable member positioned within the curing unit, and wherein the movable member is positionable to a position outside the second curing unit.

32. The system of claim 2, wherein the heating system comprises a heater unit, the heater unit comprising a heat element and a fan.

33. The system of claim 2, further comprising:

a first sensor disposed in the first lens curing unit, wherein the sensor is configured to sense when the mold assembly enters the first curing unit, and

a second sensor disposed in the second curing unit, wherein the wherein the second sensor is configured to sense when the mold assembly enters the second curing unit;

wherein the first and second sensors are configured to produce signals that allow the progress of the mold assembly through the apparatus to be monitored.

34. The system according to one or more of claims 1 to 33, further comprising a controller computer, wherein the controller computer comprises controller software executable on the controller computer, wherein the controller software is operable to:

receive an eyeglass prescription;

identify first and second mold members that will produce an eyeglass lens having the eyeglass prescription; and

determine curing conditions based on the received eyeglass prescription.

35. The system of claim 34, further comprising:

a job ticket printing device, wherein the job ticket printing device is coupled to the controller computer, and wherein the job ticket printing device is configured to receive prescription information from the controller computer and print a job ticket having the prescription information; and

and wherein the lens curing unit comprises a controller computer and a reader, the reader being configured to read information from a job ticket and transfer the information to the controller computer, wherein the controller computer is configured to determine curing conditions for producing the eyeglass prescription and control the lens curing system to produce the curing conditions.

36. A method of preparing an eyeglass lens, comprising:

placing a lens forming composition in a mold cavity of a mold assembly;

placing the mold assembly in a system for curing an eyeglass lens as described in one or more of claims 1 to 35;

applying light and heat to the mold assembly with the lens curing unit to at least partially cure the lens forming composition.

37. The method according to claim 36, further comprising directing activating light toward at least one mold member for a time of less than 100 seconds prior to applying light and heat to the mold assembly.

38. The method according to claims 36 to 37, further comprising

demolding the cured lens forming composition from the mold assembly; and

applying heat to the lens in the absence of activating light, subsequent to directing activating light and heat toward at least one mold member.

39. The method according to one or more of claims 36 to 38, further comprising

heating the lens forming composition prior to placing the heated lens forming composition in the mold cavity.

40. The method according to one or more of claims 36 to 39, further comprising:

turning off components of the lens curing unit when the lens curing unit is not used for a predetermined amount of time.

41. The method according to one or more of claims 36 to 40, further comprising:

placing a job ticket in a portion of the lens curing unit, wherein the job ticket includes prescription information;

reading the prescription information from the job ticket;

placing the mold assembly comprising the lens forming composition into the lens curing unit; and

operating the lens curing apparatus to produce curing conditions, the curing conditions being determined by the read prescription information.

42. The method according to one or more of claims 36 to 40, further comprising:

placing the mold assembly on a mold assembly holder,

coupling a job ticket to a portion of the mold assembly holder, wherein the job ticket includes prescription information;

reading the prescription information from the job ticket;

placing the mold assembly comprising the lens forming composition into the lens curing unit; and

operating the lens curing apparatus to produce curing conditions, the curing conditions being determined by the read prescription information.

43. The method according to one or more of claims 36 to 42, further comprising a computer-implemented method for controlling the system for curing an eyeglass lens, the computer-implemented method comprising:

receiving prescription information from a reader coupled to the system for forming an eyeglass lens, wherein the prescription information defines an eyeglass prescription;

determining curing conditions based on the prescription information; and

controlling the lens curing unit to produce the curing conditions.

44. The method according to one or more of claims 36 to 42, further comprising a computer-implemented method for controlling the system for curing an eyeglass lens, the computer-implemented method comprising:

receiving prescription information, wherein the prescription information defines an eyeglass prescription;

determining curing conditions based on the prescription information; and

controlling the lens curing unit to produce the curing conditions.

45. The method according to claim 44, wherein receiving prescription information comprises obtaining prescription information from a reader coupled to the system for forming an eyeglass lens.

46. The method according to claim 44, wherein the computer-implemented method further comprises:

monitoring the status of the components of the curing unit; and

displaying the status of the components of the curing unit on a display device.

47. The method according to claim 44, wherein the computer-implemented method further comprises:

monitoring the position of the mold assembly holder in the lens forming system; and

displaying the position of the mold assembly holder within the lens forming system on a display device.

48. The method according to claim 44, wherein the computer-implemented method further comprises:

displaying menu items that are configured to collect prescription information from a user; and

saving the collected prescription information as a job in a database.

49. The method according to claim 44, wherein the computer-implemented method further comprises:

receiving prescription information, wherein the prescription information defines an eyeglass prescription;

verifying that the eyeglass prescription can be formed in a lens curing apparatus;

displaying a warning message if the eyeglass prescription can not be formed in the lens curing apparatus; and

determining a front mold identification marking, a back mold identification marking, and a gasket identification marking of an appropriate front mold, back mold and gasket for producing the eyeglass lens in response to the prescription information, if the eyeglass prescription can be formed in the lens curing apparatus;

wherein the front mold, the back mold and the gasket together are operable to produce the mold cavity, the mold cavity being configured to hold the lens forming composition which is curable to produce the eyeglass lens from the prescription, the front mold member comprising the front mold identification marking, the back mold member comprising the back mold identification marking, and the gasket member comprising the gasket identification marking.

50. The method according to one or more of claims 36 to 49, further comprising:

placing a first mold assembly filled with a first lens forming composition in a first mold assembly holder;

placing the first mold assembly holder in a first lens curing unit;

initiating curing of the lens forming composition by applying activating light to the first mold assembly;

advancing the first mold assembly holder to a second curing unit;

placing a second mold assembly filled with a second lens forming composition in a second mold assembly holder;

placing the second mold assembly holder in a first lens curing unit;

initiating curing of the second lens forming composition by applying activating light to the second mold assembly, wherein the activating light is applied at a time based on the position of the first mold assembly holder in the second curing unit; and

advancing the second mold assembly holder from the first curing unit, to the second curing unit.

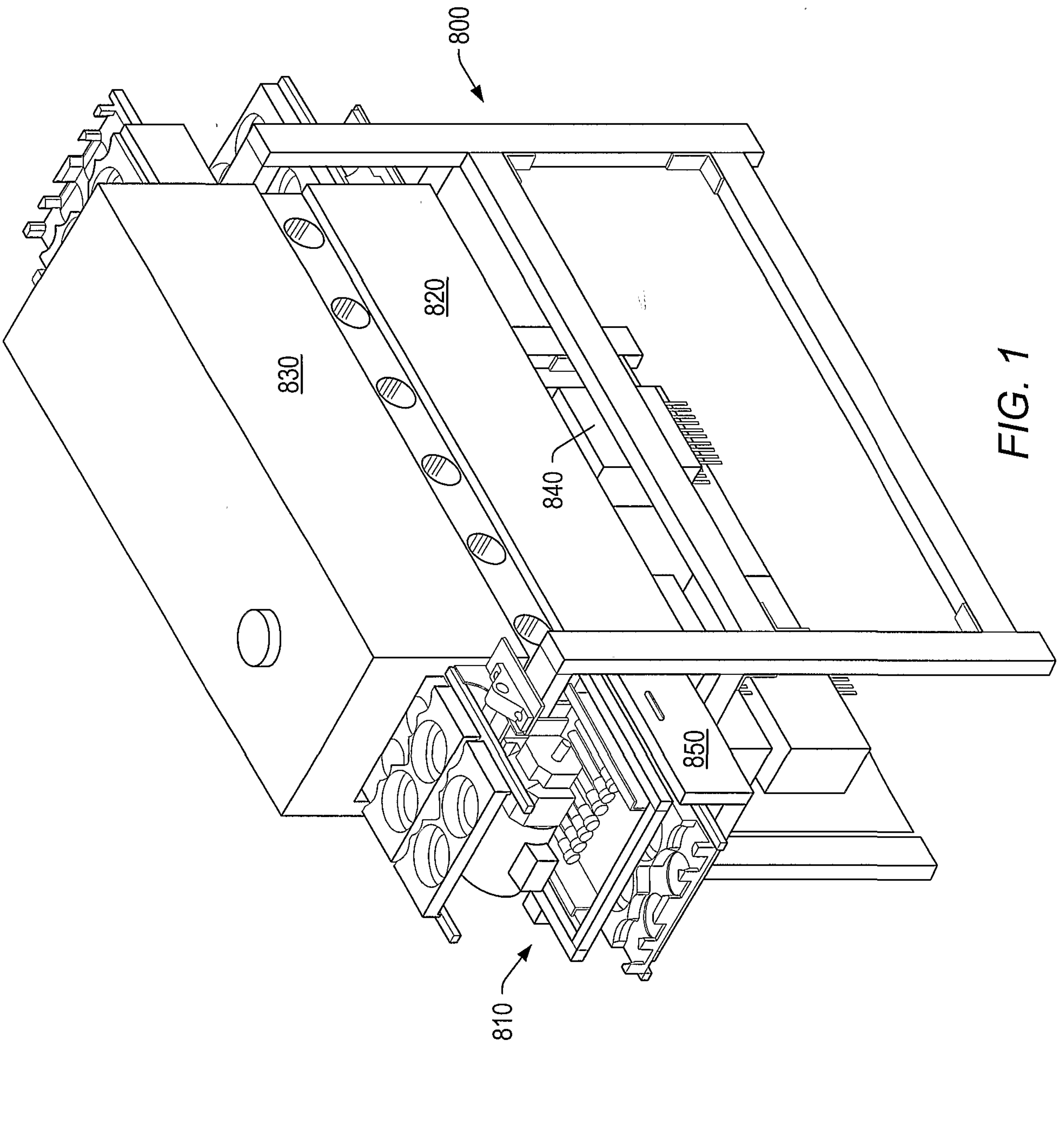


FIG. 1

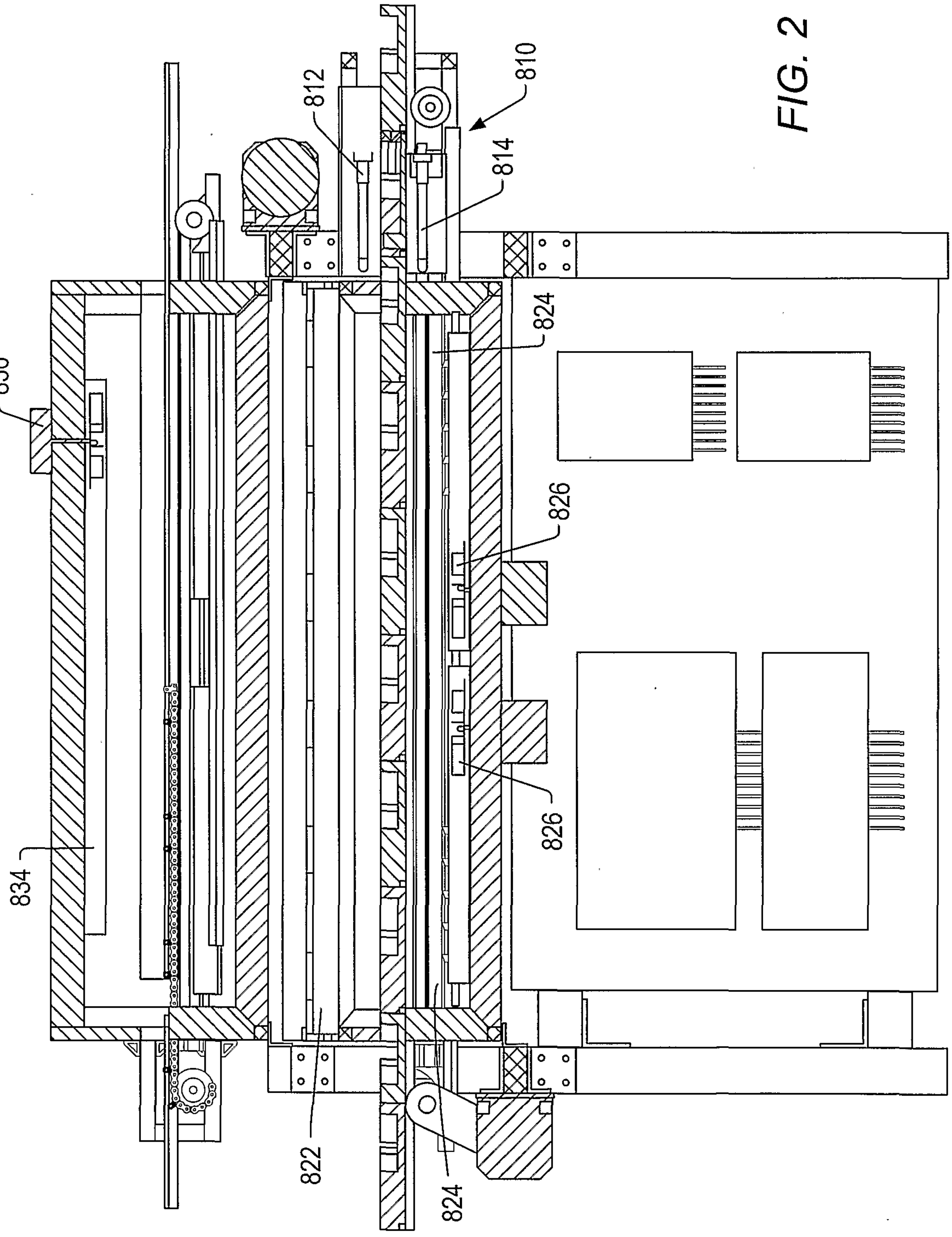


FIG. 2

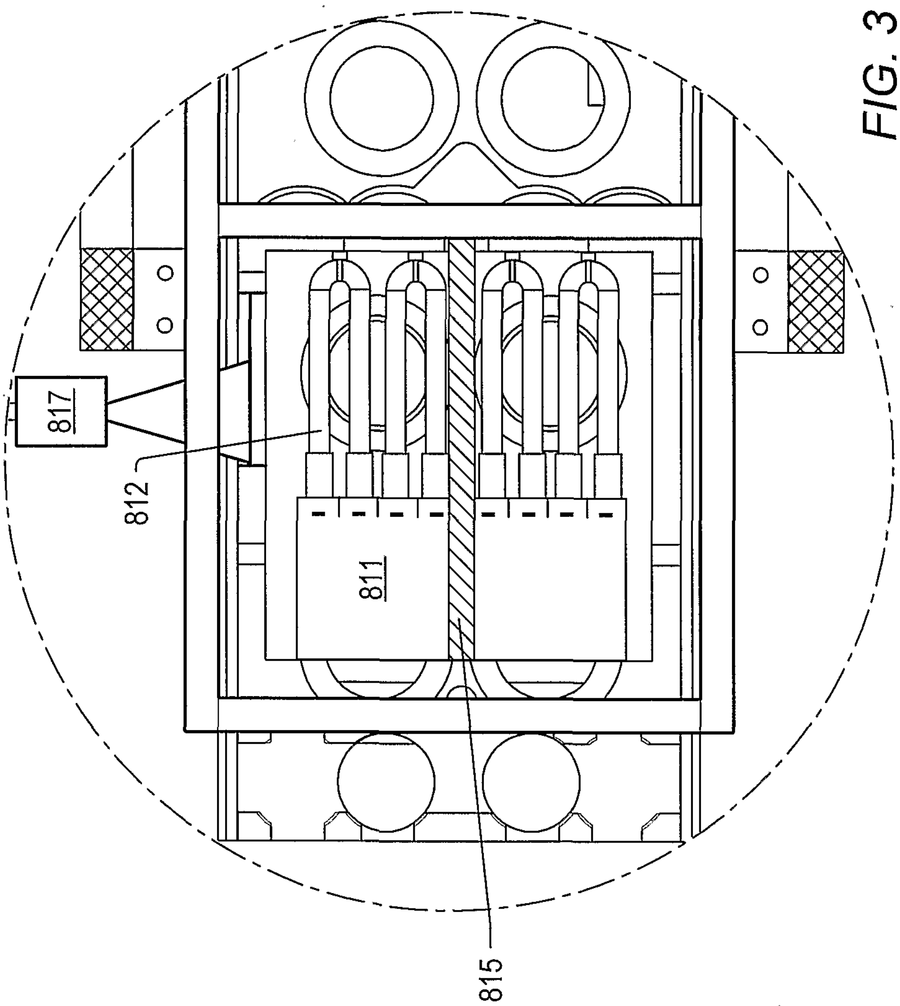


FIG. 3

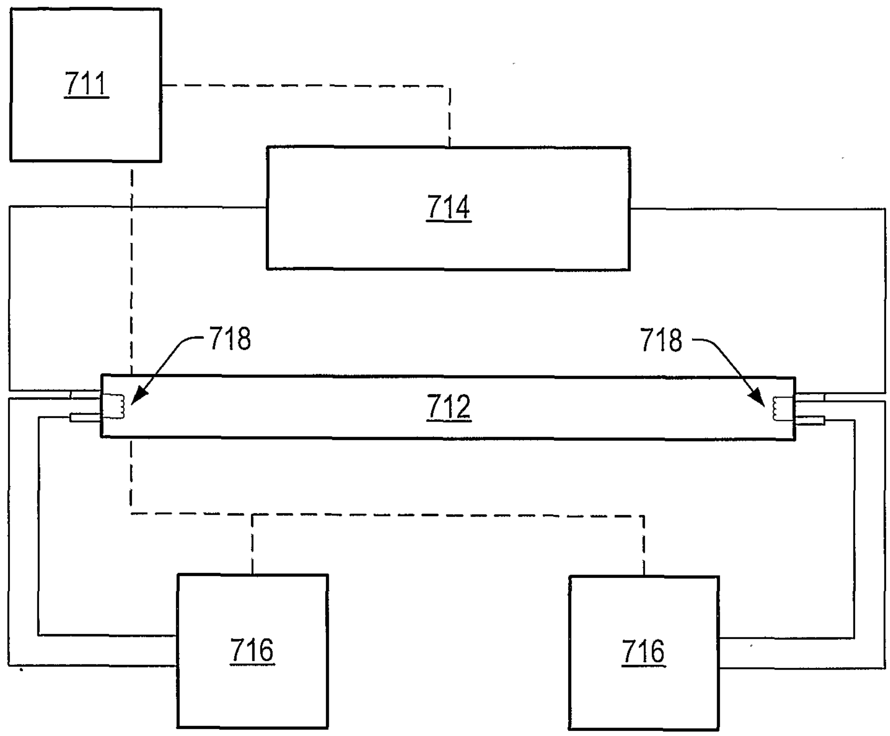

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FIG. 4

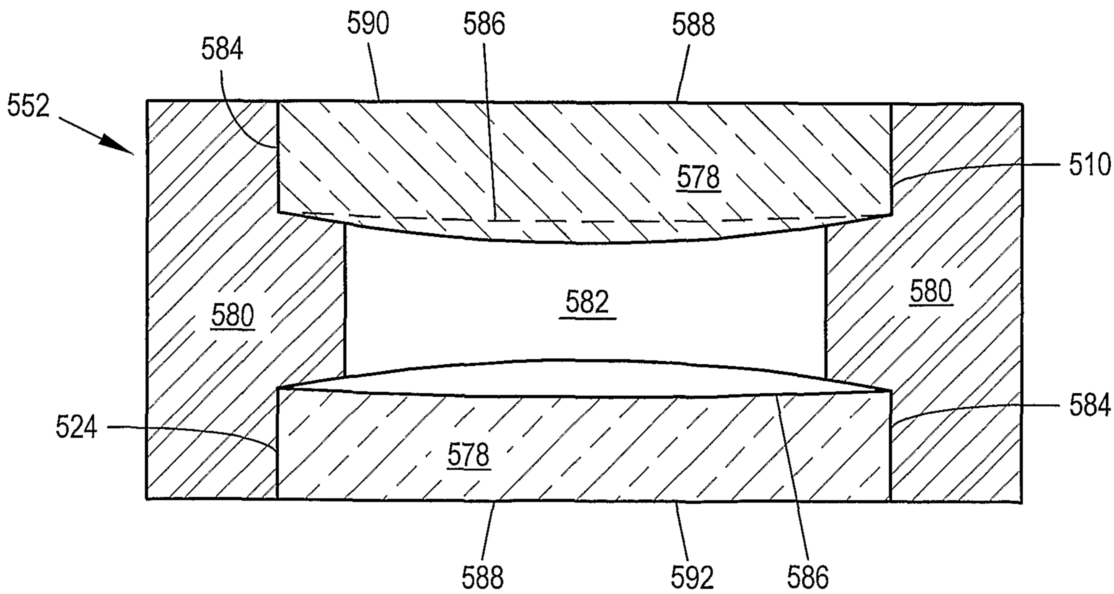
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FIG. 5

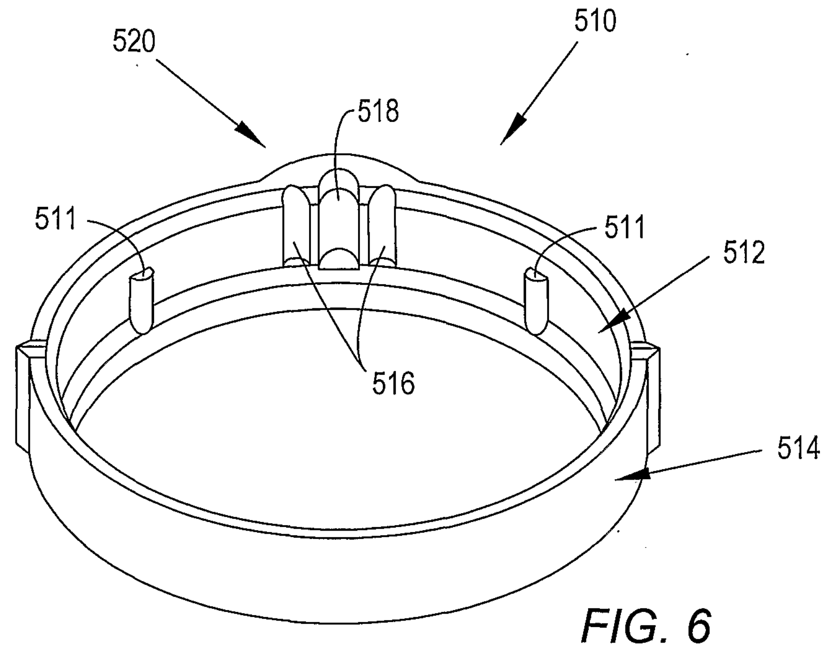
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FIG. 6

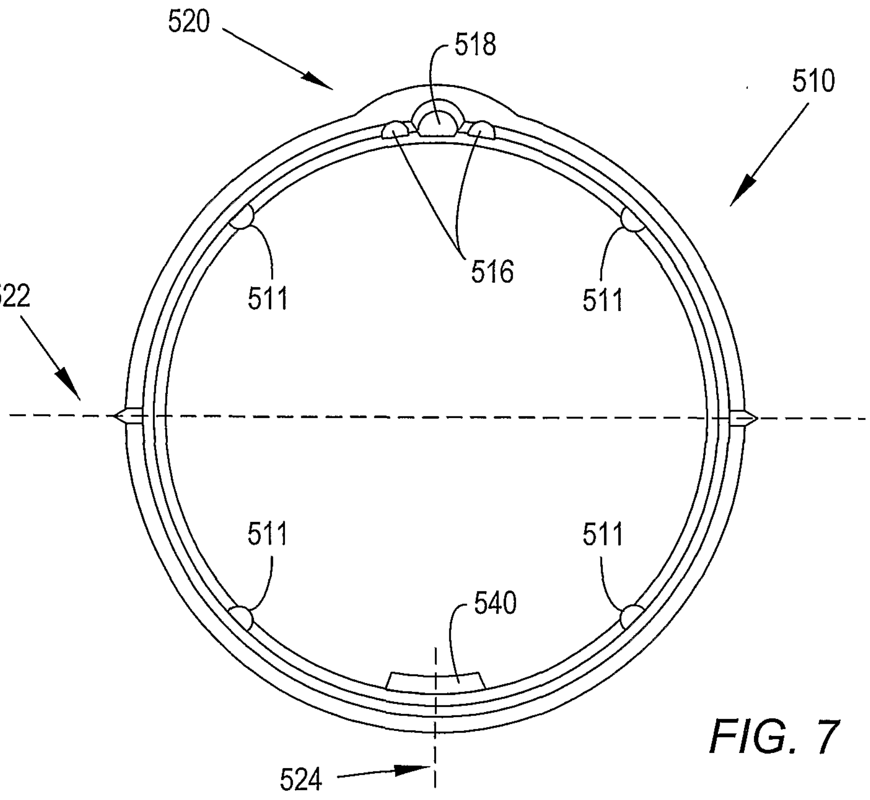
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FIG. 7

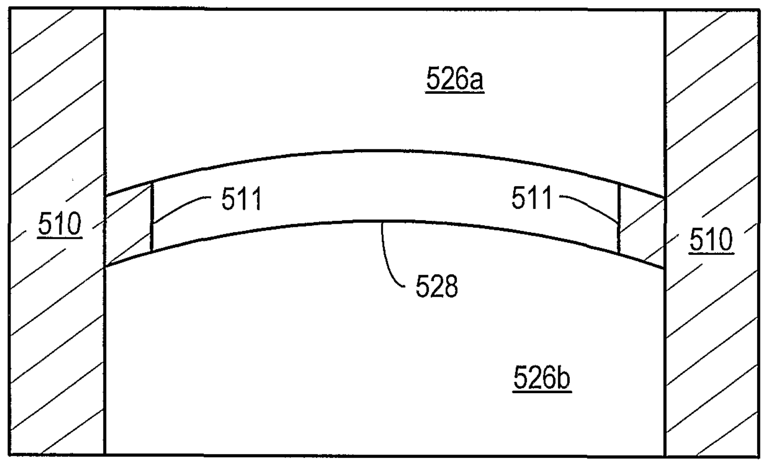

FIG. 8

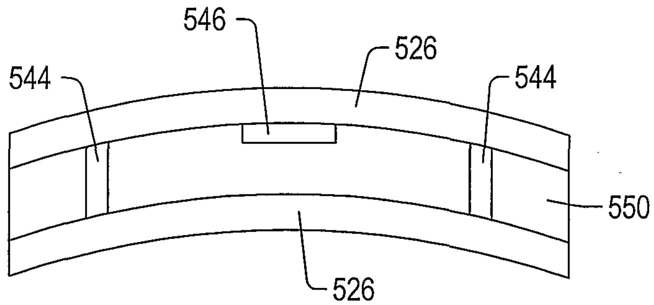

FIG. 9

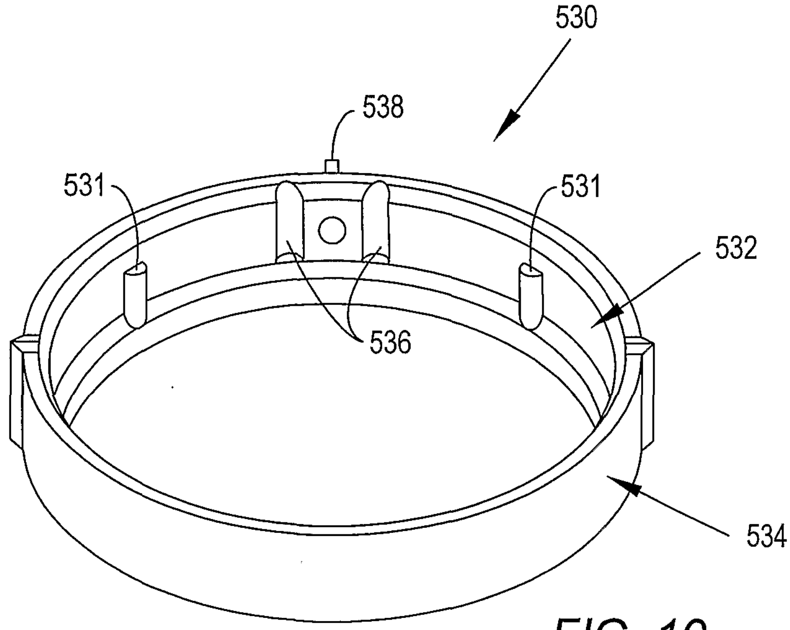
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FIG. 10

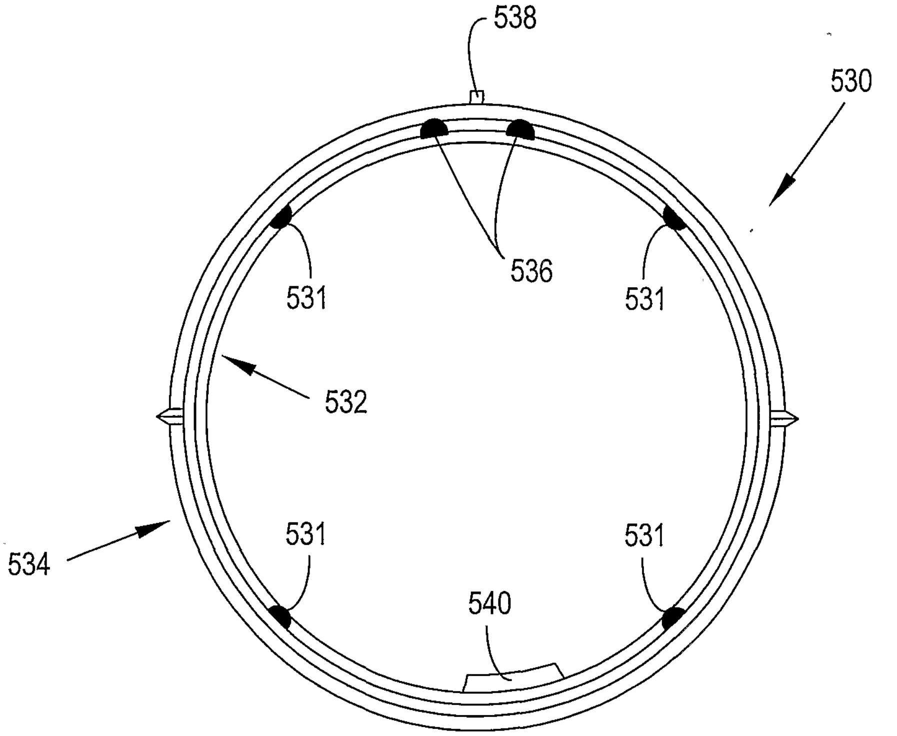
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FIG. 11

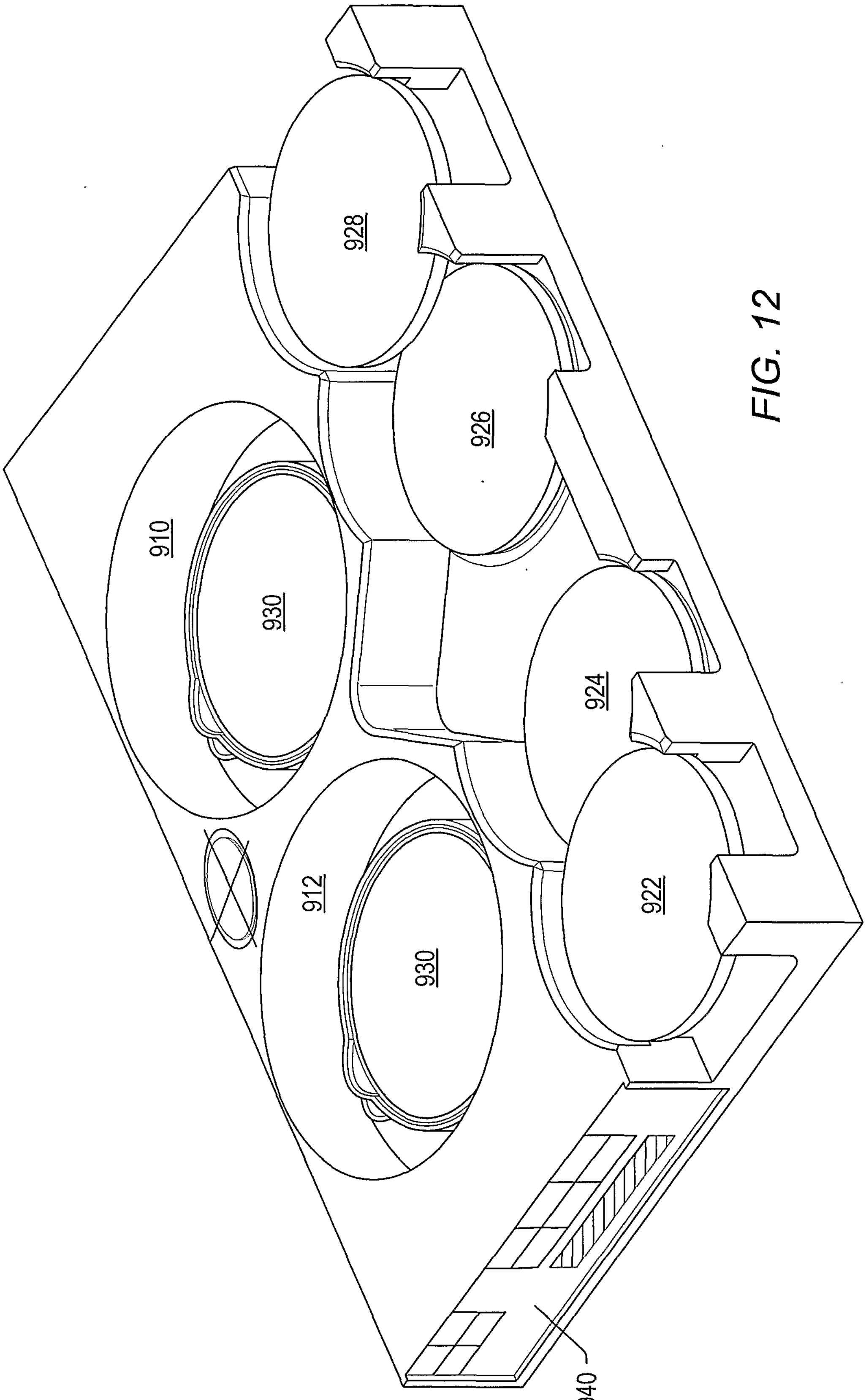


FIG. 12

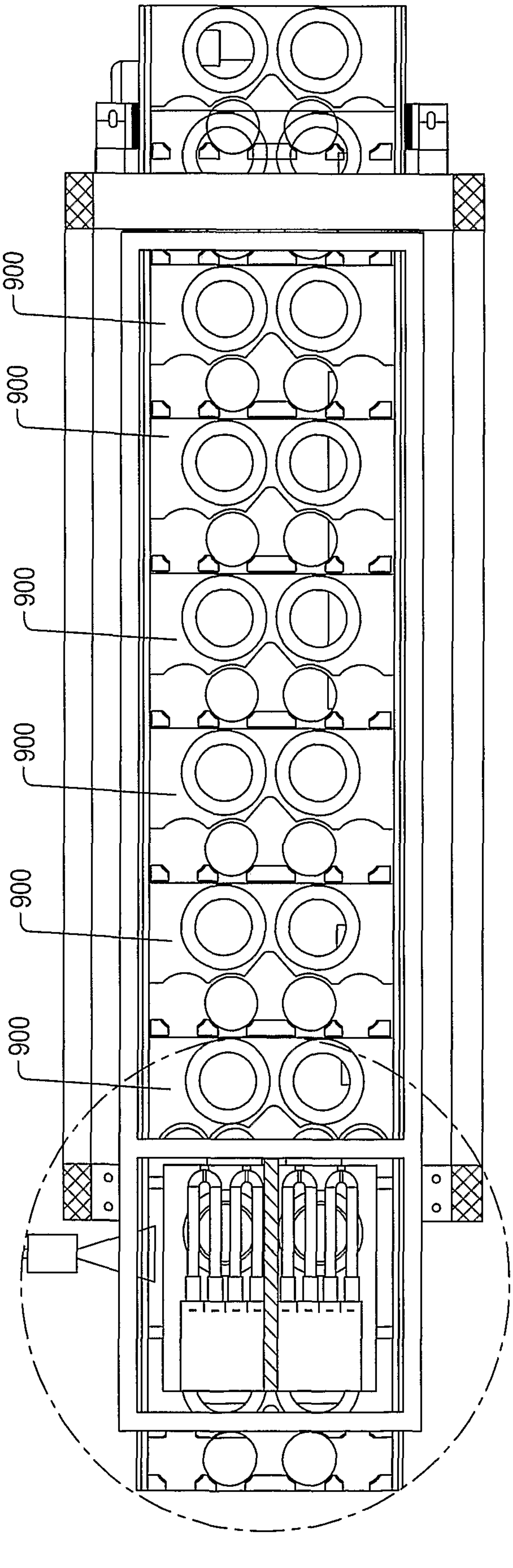


FIG. 13

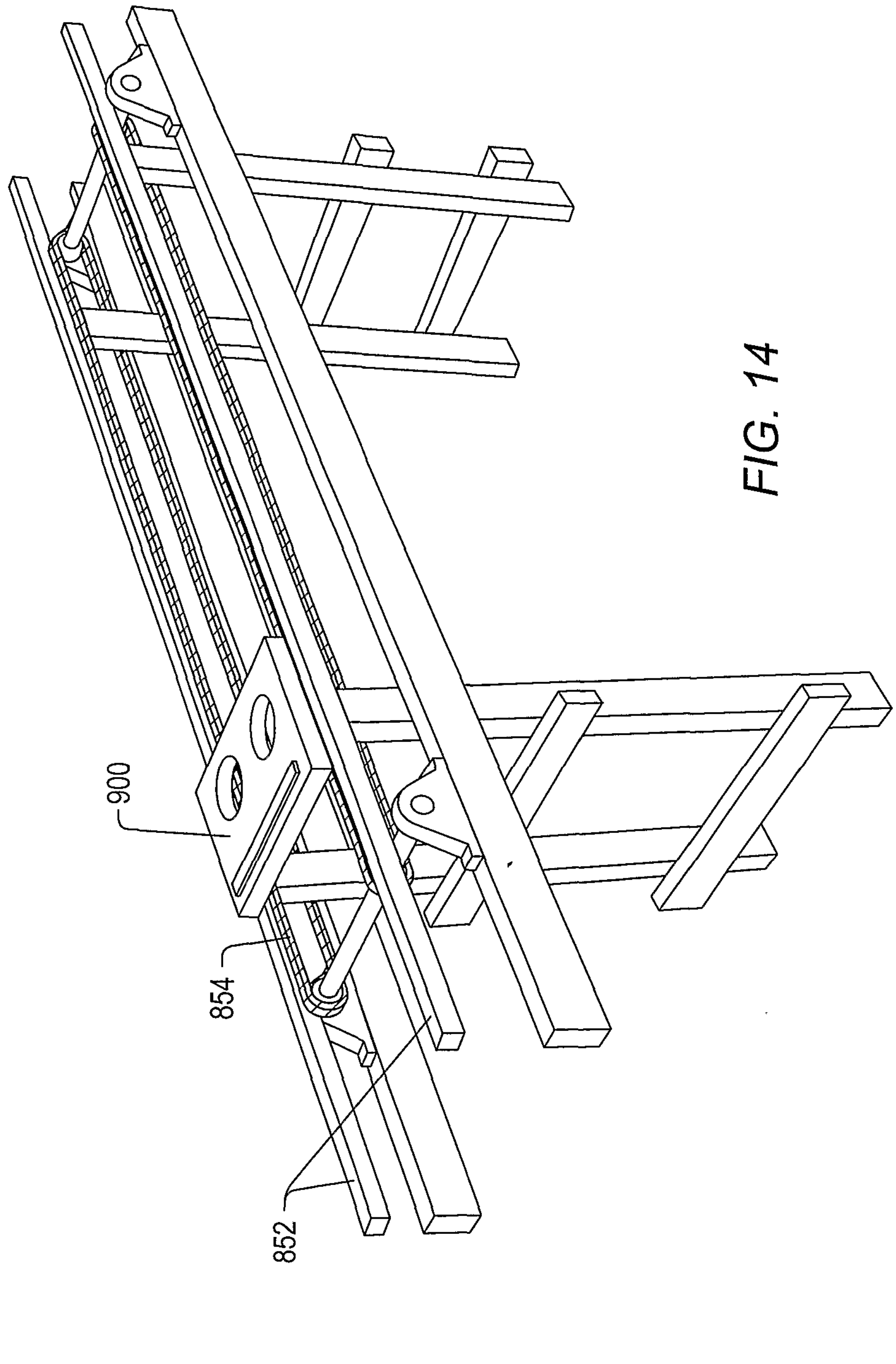


FIG. 14

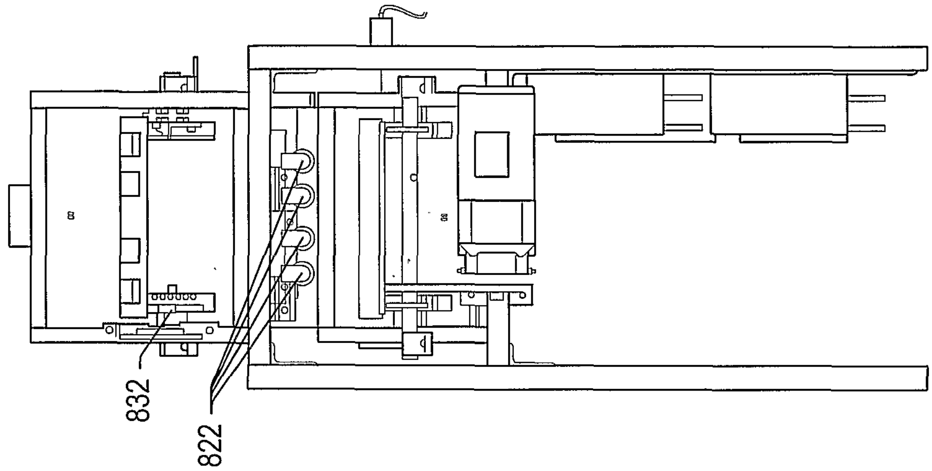


FIG. 16

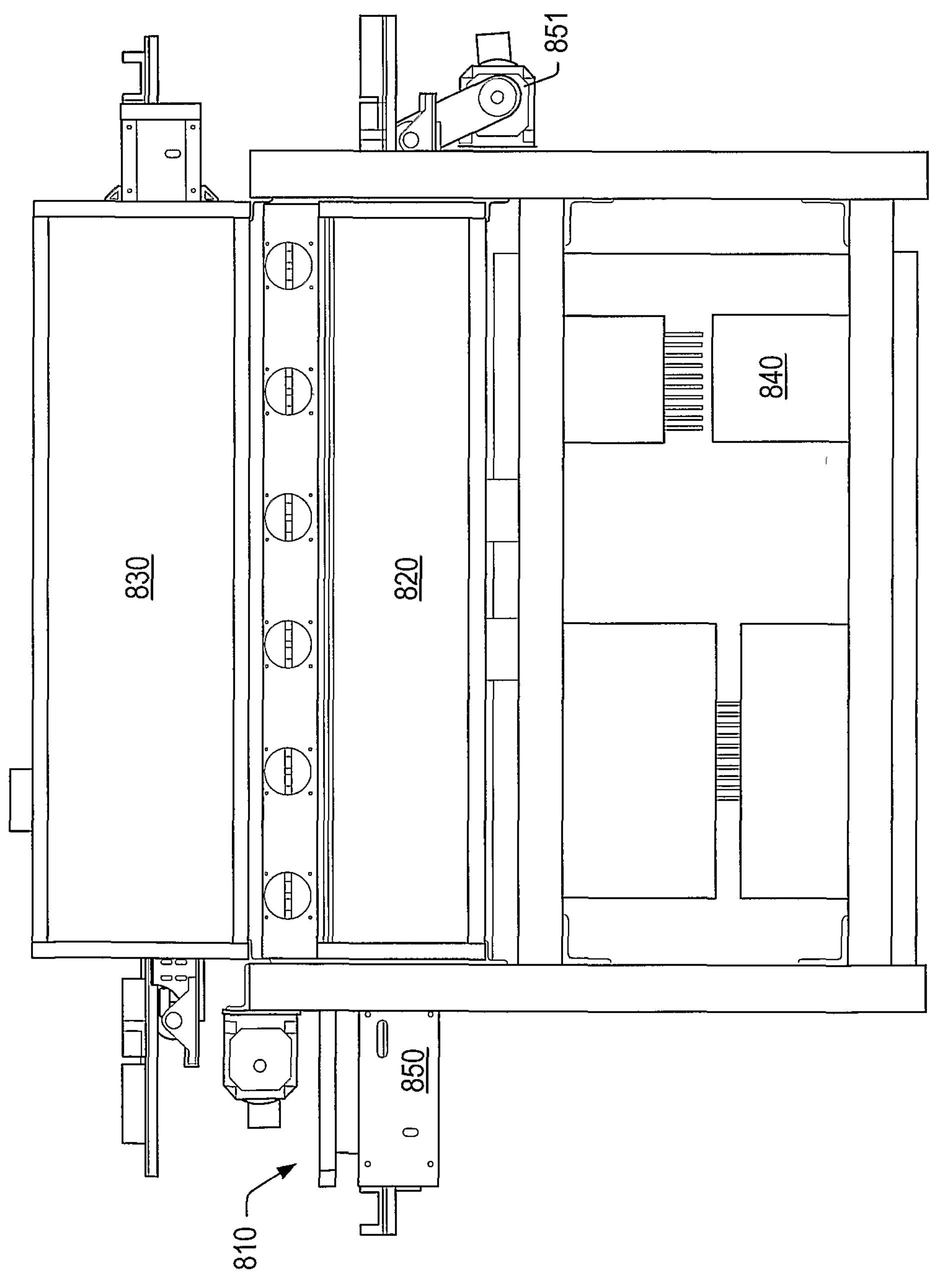
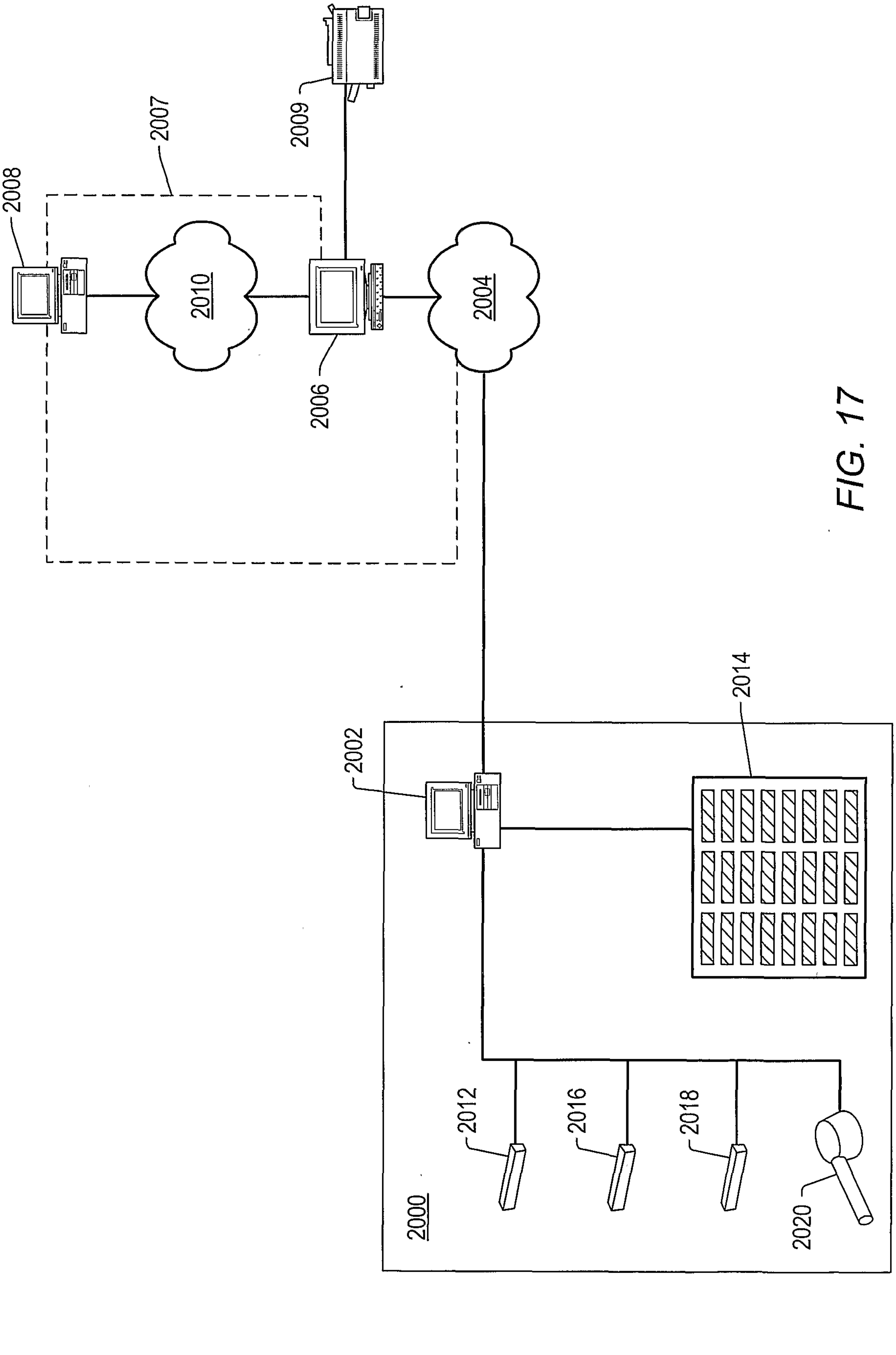


FIG. 15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2000

FIG. 17

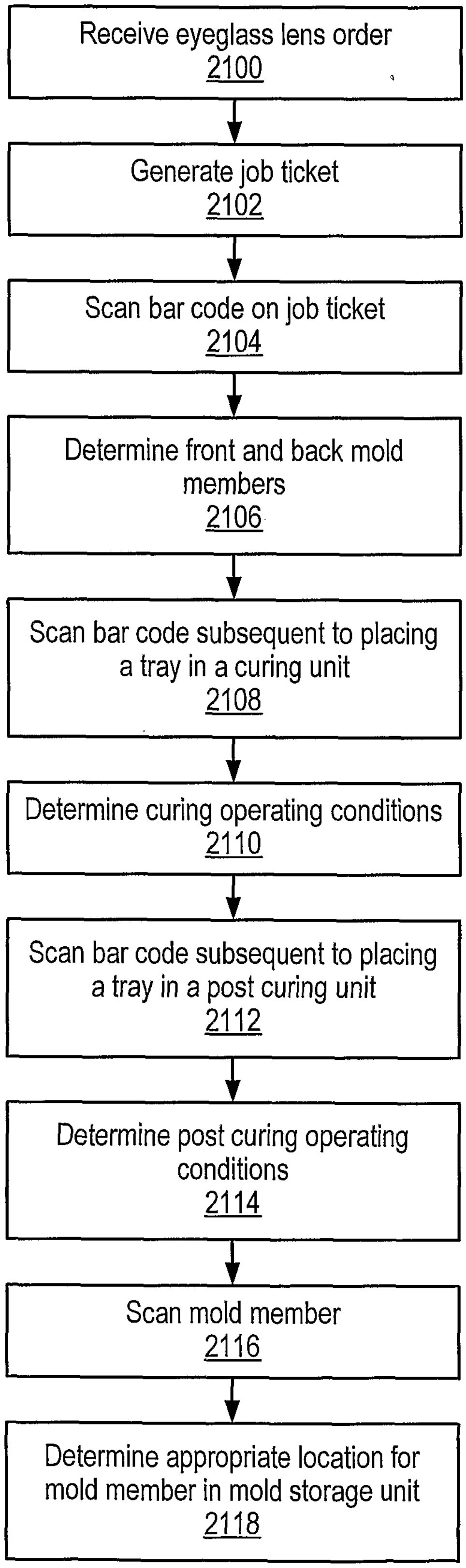
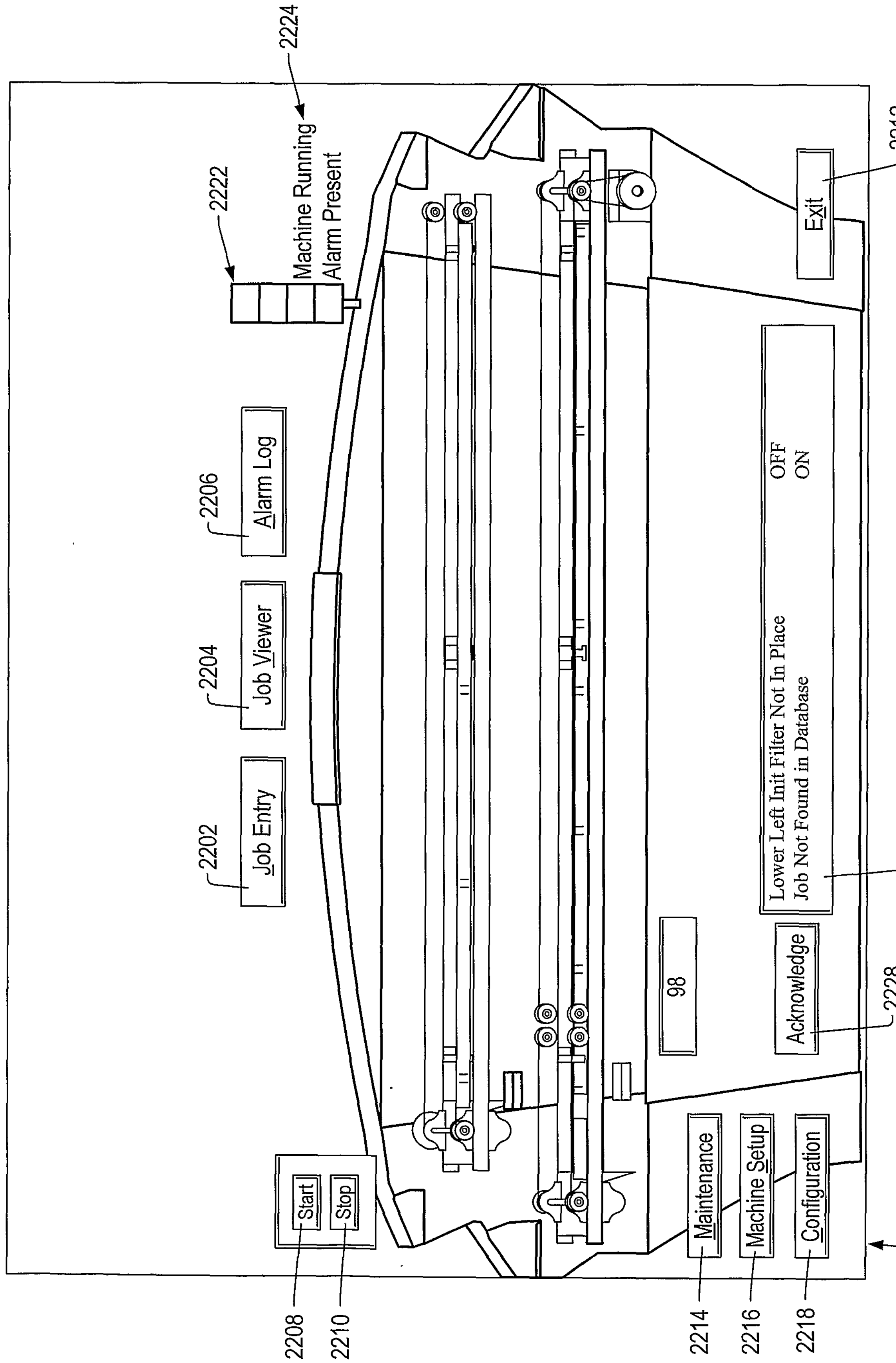

Receive eyeglass lens order 2100
Generate job ticket 2102
Scan bar code on job ticket 2104
Determine front and back mold members 2106
Scan bar code subsequent to placing a tray in a curing unit 2108
Determine curing operating conditions 2110
Scan bar code subsequent to placing a tray in a post curing unit 2112
Determine post curing operating conditions 2114
Scan mold member 2116
Determine appropriate location for mold member in mold storage unit 2118

FIG. 18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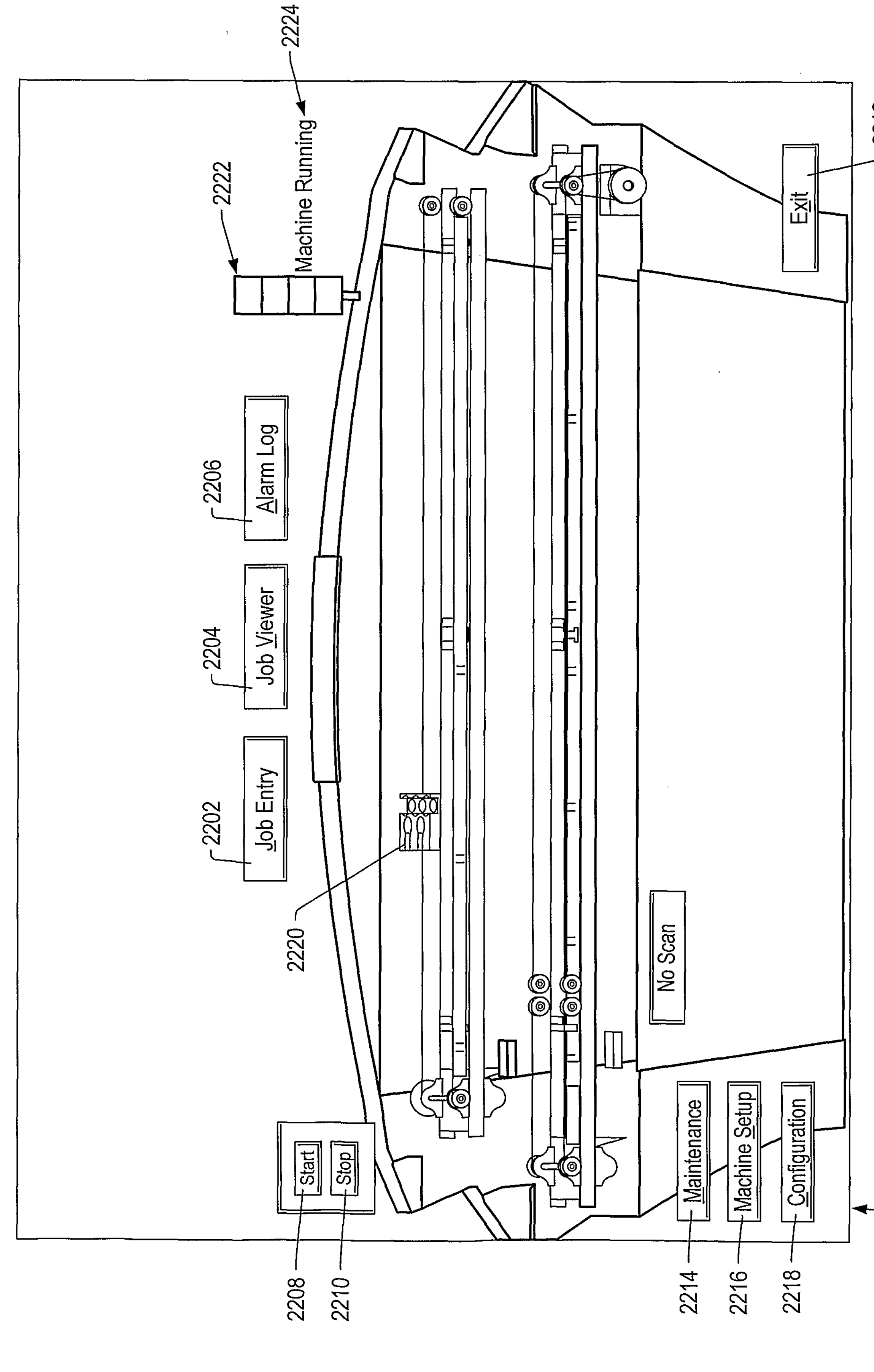
Alarm Present
2222
2212
Exit
2206
Alarm Log
2204
Job Viewer
2202
Job Entry
Lower Left Init Filter Not In Place OFF
Job Not Found in Database ON
2226
98
Acknowledge
2228
Start
Stop
2208
2210
Maintenance
Machine Setup
Configuration
2214
2216
2218
2200

FIG. 19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2222
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Job Viewer
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Maintenance
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2218
2200

FIG. 20

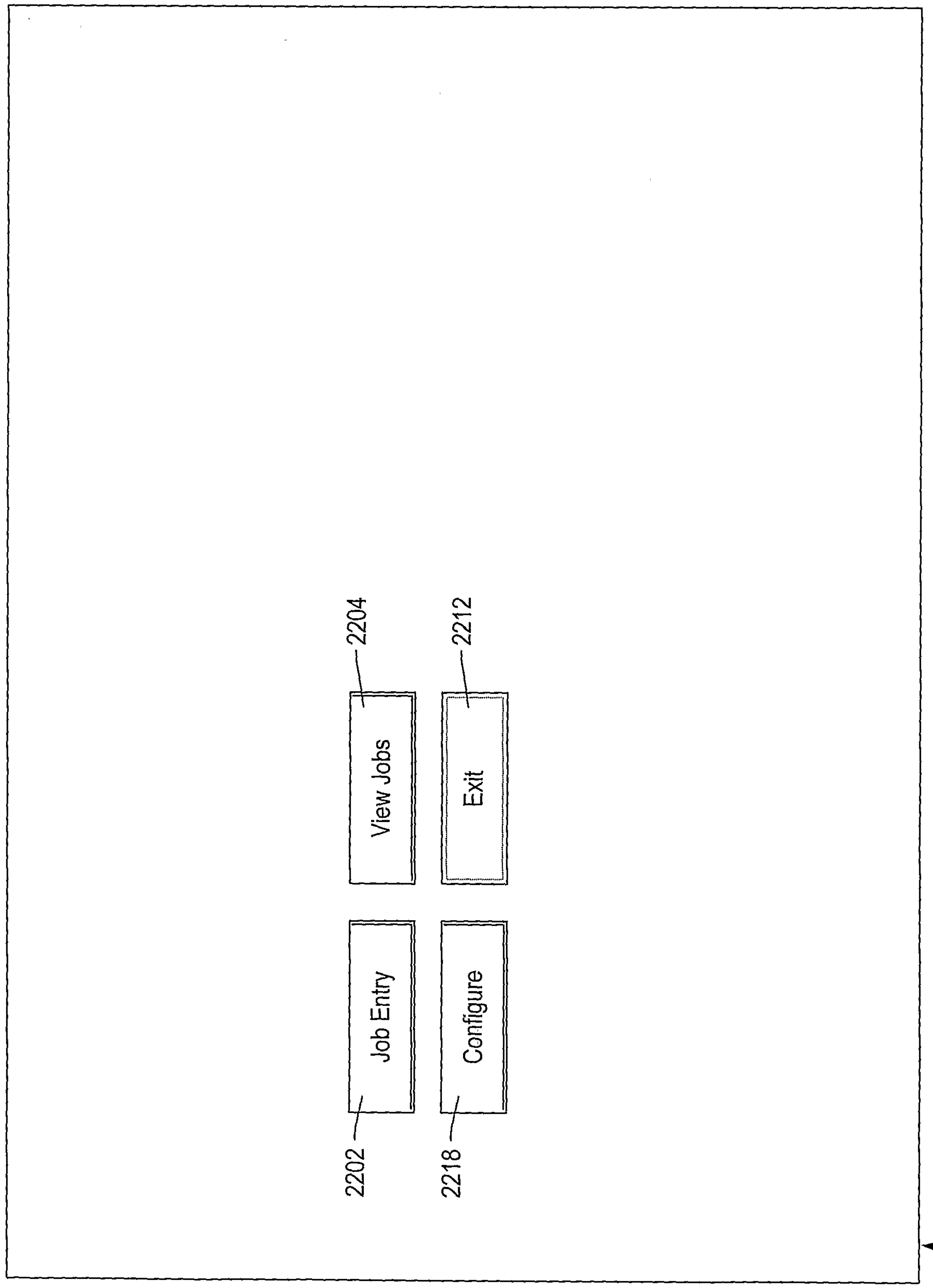
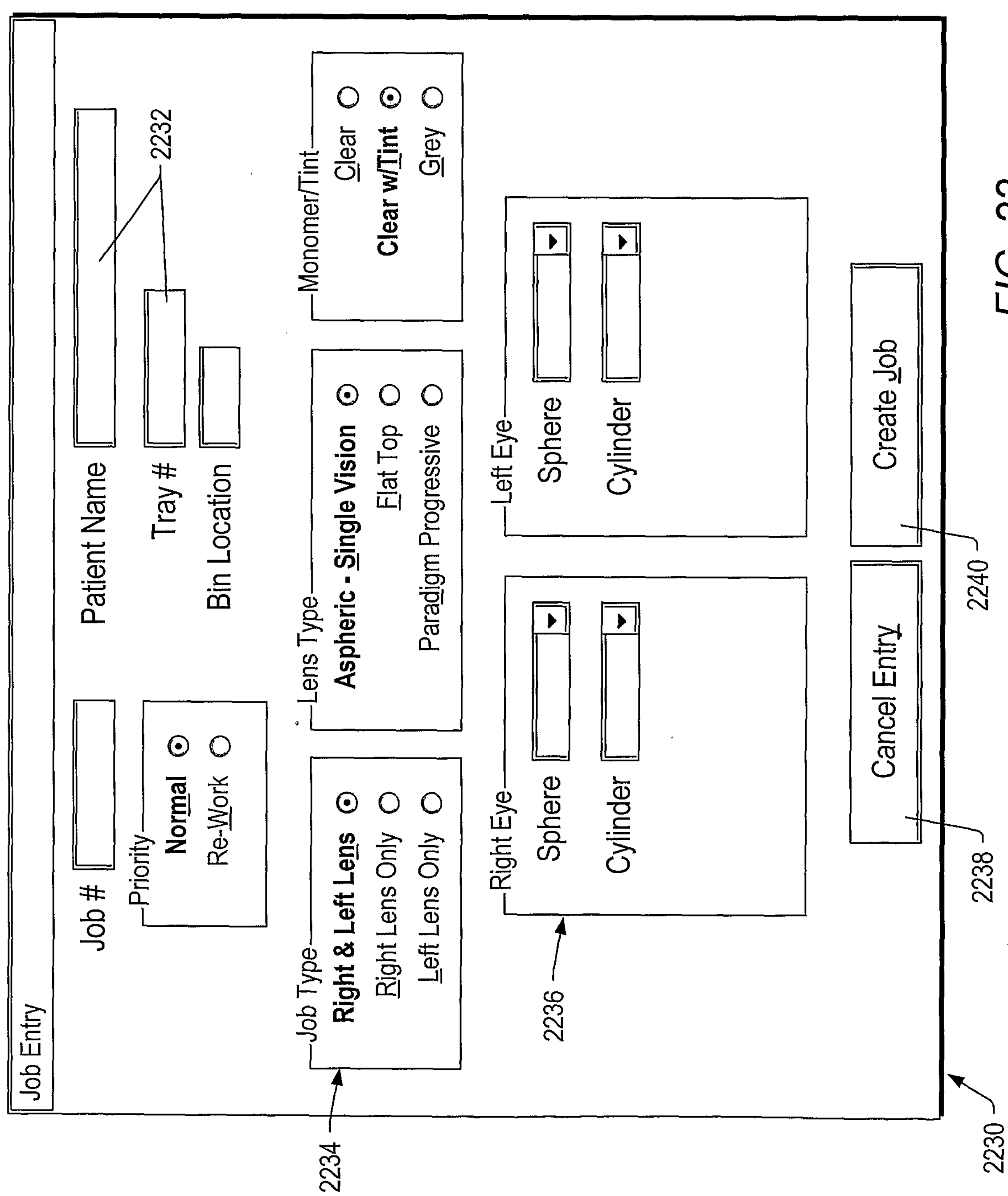


FIG. 21


Job Entry
Job #
Patient Name
Tray #
Bin Location
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Priority
Normal
Re-Work
Job Type
Right & Left Lens
Right Lens Only
Left Lens Only
Lens Type
Aspheric - Single Vision
Flat Top
Paradigm Progressive
Monomer/Tint
Clear
Clear w/Tint
Grey
Right Eye
Sphere
Cylinder
Left Eye
Sphere
Cylinder
Cancel Entry
Create Job
2234
2236
2238
2240
2230

FIG. 22

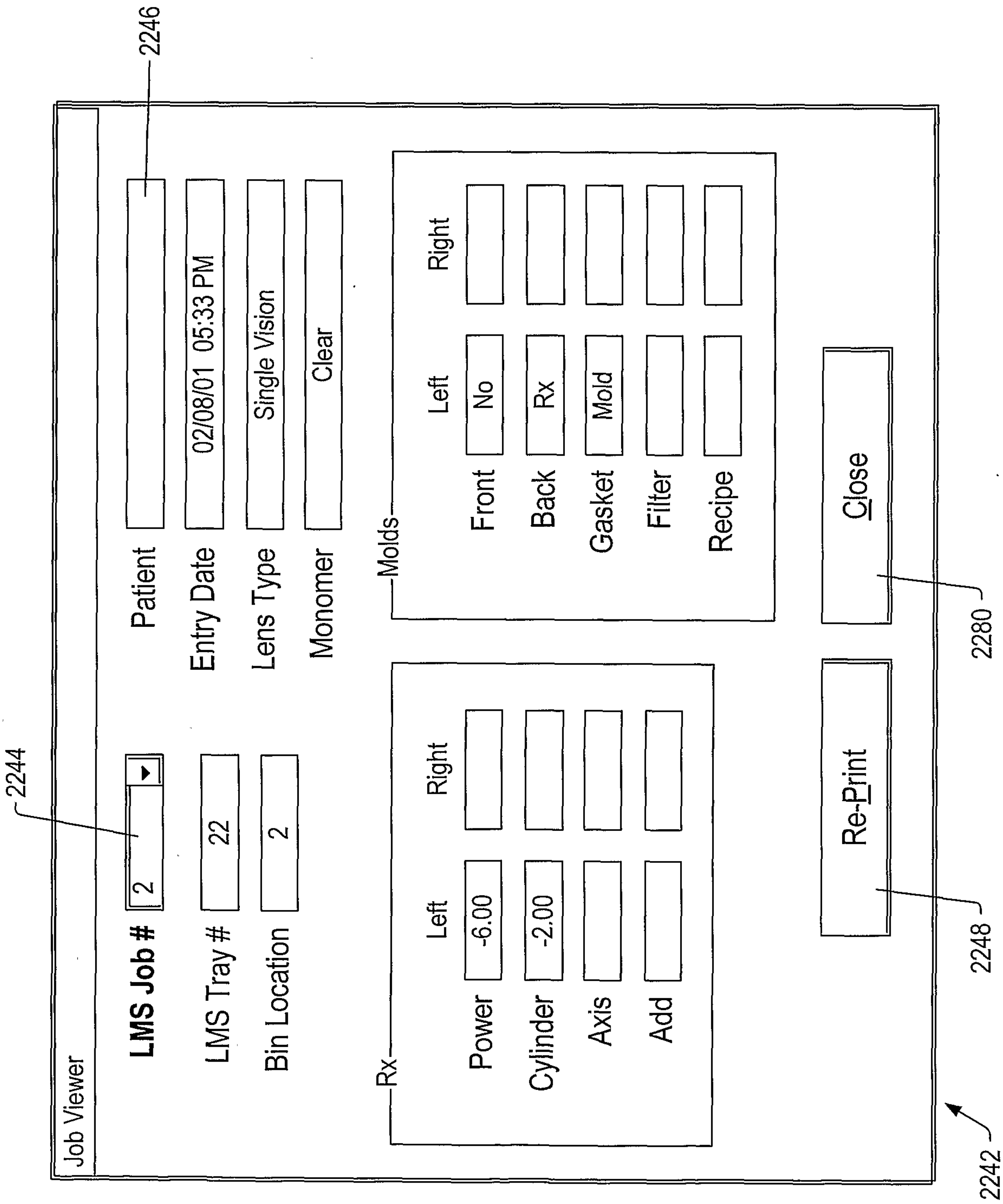

Job Viewer
LMS Job #
2
LMS Tray #
22
Bin Location
2
Patient
Entry Date
02/08/01 05:33 PM
Lens Type
Single Vision
Monomer
Clear
Rx
Left
Right
Power
-6.00
Cylinder
-2.00
Axis
Add
Molds
Left
Right
Front
No
Back
Rx
Gasket
Mold
Filter
Recipe
Re-Print
Close
2242
2244
2246
2248
2280

FIG. 23

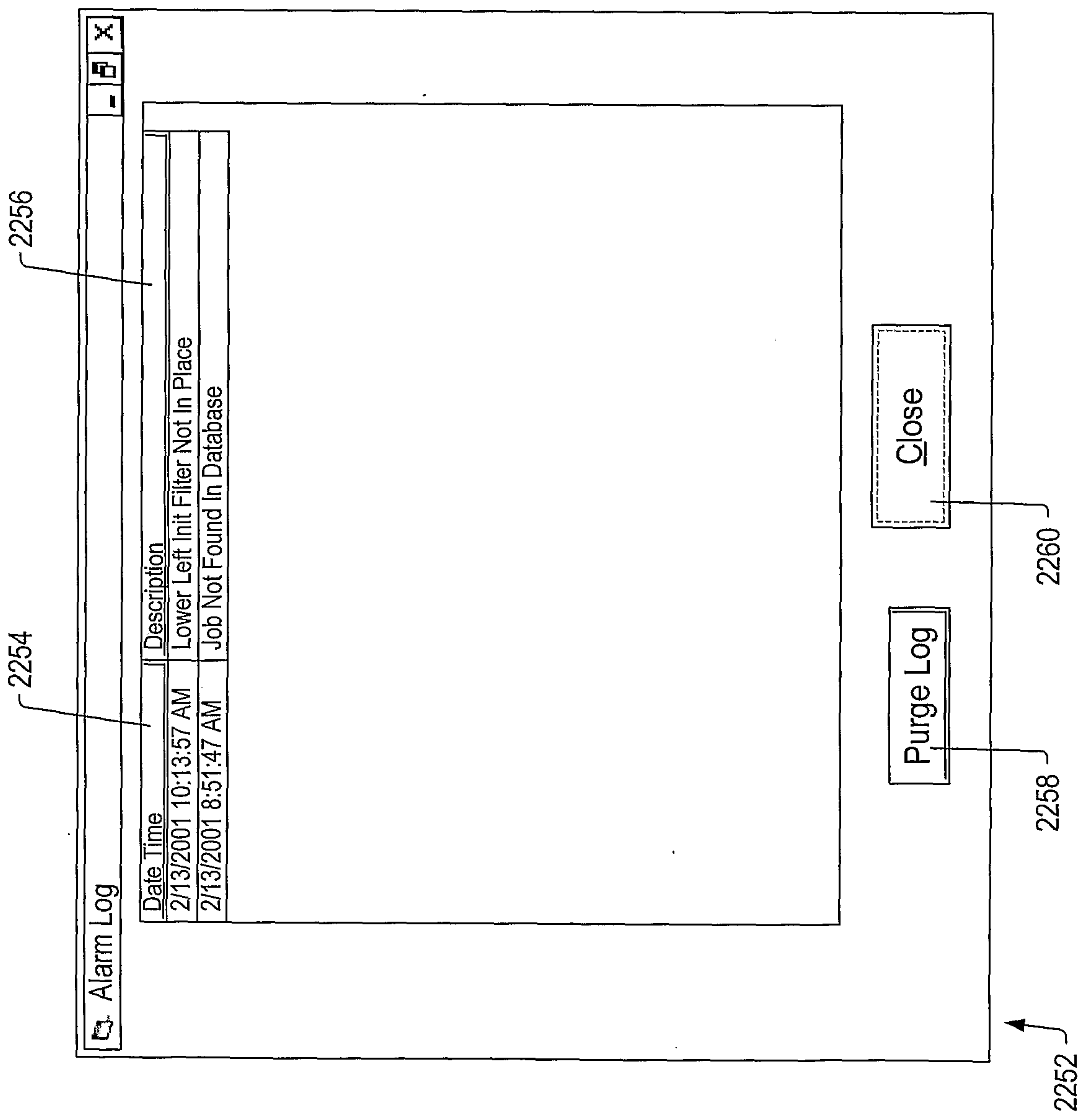

Alarm Log
Date Time
Description
2/13/2001 10:13:57 AM
Lower Left Init Filter Not In Place
2/13/2001 8:51:47 AM
Job Not Found In Database
Purge Log
Close
2252
2254
2256
2258
2260

FIG. 24

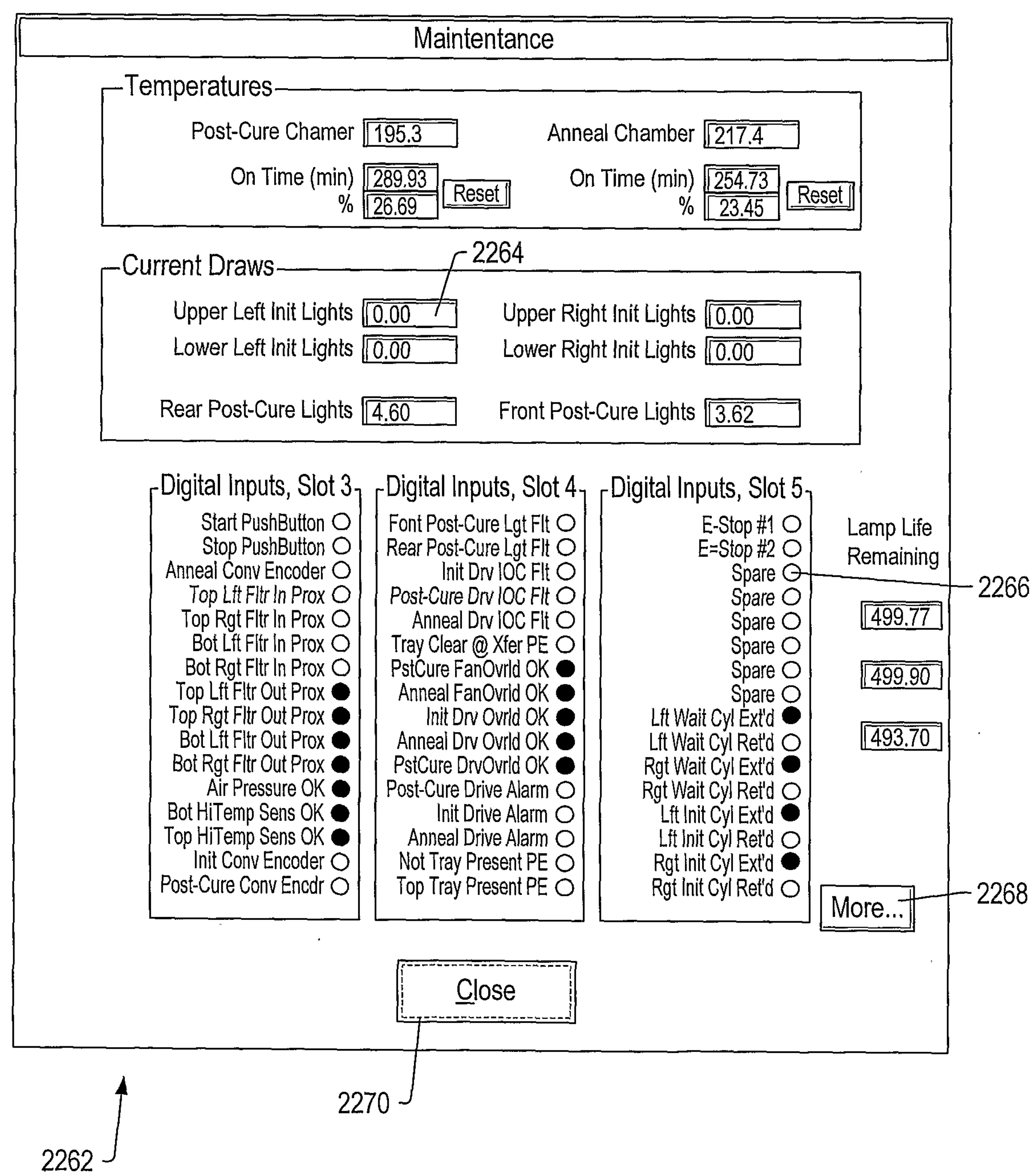

Maintentance
Temperatures
Post-Cure Chamer
195.3
Anneal Chamber
217.4
On Time (min)
289.93
%
26.69
Reset
On Time (min)
254.73
%
23.45
Reset
Current Draws
2264
Upper Left Init Lights
0.00
Upper Right Init Lights
0.00
Lower Left Init Lights
0.00
Lower Right Init Lights
0.00
Rear Post-Cure Lights
4.60
Front Post-Cure Lights
3.62
Digital Inputs, Slot 3
Start PushButton
Stop PushButton
Anneal Conv Encoder
Top Lft Fltr In Prox
Top Rgt Fltr In Prox
Bot Lft Fltr In Prox
Bot Rgt Fltr In Prox
Top Lft Fltr Out Prox
Top Rgt Fltr Out Prox
Bot Lft Fltr Out Prox
Bot Rgt Fltr Out Prox
Air Pressure OK
Bot HiTemp Sens OK
Top HiTemp Sens OK
Init Conv Encoder
Post-Cure Conv Encdr
Digital Inputs, Slot 4
Font Post-Cure Lgt Flt
Rear Post-Cure Lgt Flt
Init Drv IOC Flt
Post-Cure Drv IOC Flt
Anneal Drv IOC Flt
Tray Clear @ Xfer PE
PstCure FanOvrld OK
Anneal FanOvrld OK
Init Drv Ovrld OK
Anneal Drv Ovrld OK
PstCure DrvOvrld OK
Post-Cure Drive Alarm
Init Drive Alarm
Anneal Drive Alarm
Not Tray Present PE
Top Tray Present PE
Digital Inputs, Slot 5
E-Stop #1
E=Stop #2
Spare
Spare
Spare
Spare
Spare
Spare
Lft Wait Cyl Ext'd
Lft Wait Cyl Ret'd
Rgt Wait Cyl Ext'd
Rgt Wait Cyl Ret'd
Lft Init Cyl Ext'd
Lft Init Cyl Ret'd
Rgt Init Cyl Ext'd
Rgt Init Cyl Ret'd
Lamp Life Remaining
499.77
499.90
493.70
2266
More...
2268
Close
2270
2262

FIG. 25

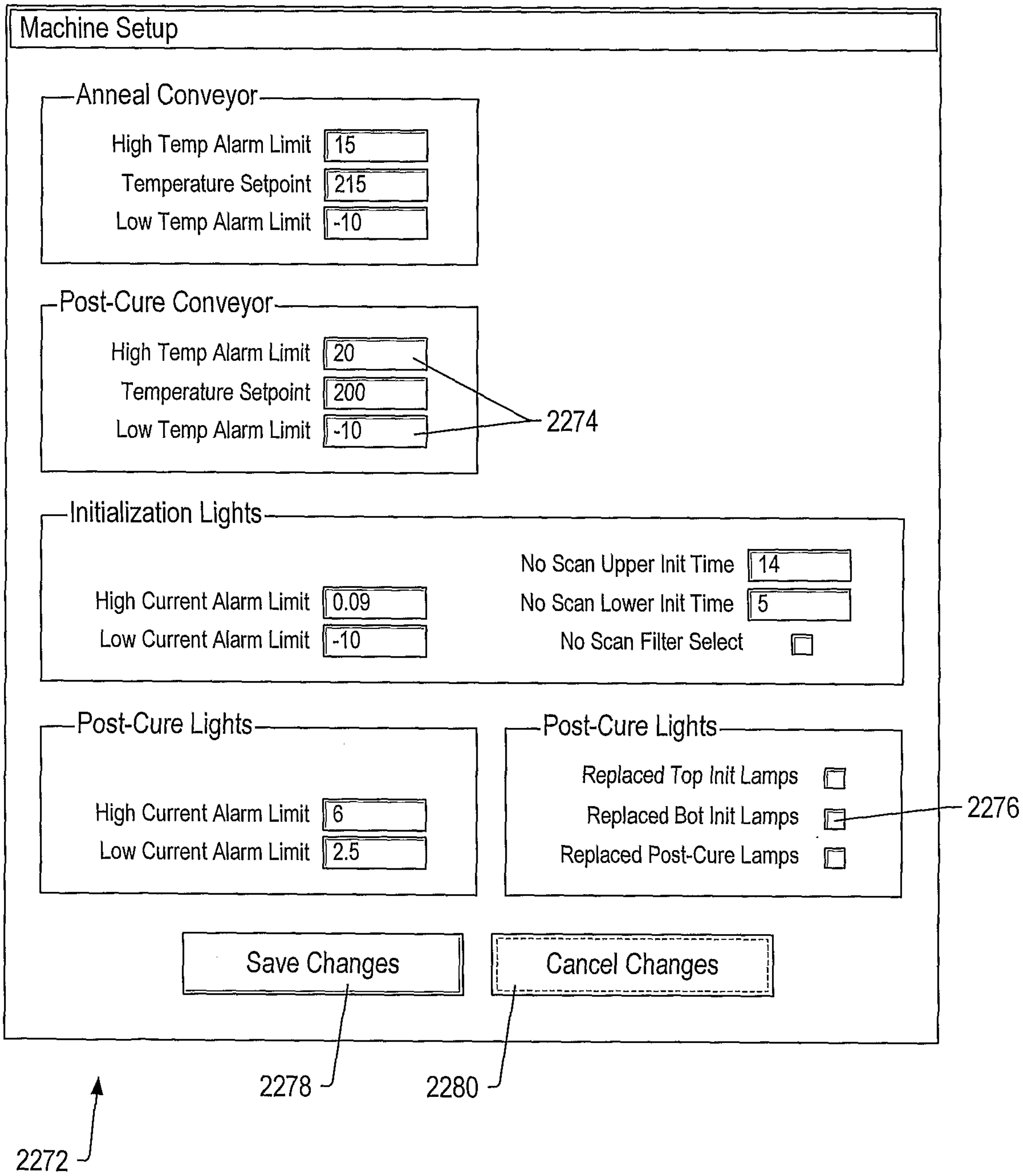

Machine Setup
Anneal Conveyor
High Temp Alarm Limit
15
Temperature Setpoint
215
Low Temp Alarm Limit
-10
Post-Cure Conveyor
High Temp Alarm Limit
20
Temperature Setpoint
200
Low Temp Alarm Limit
-10
2274
Initialization Lights
No Scan Upper Init Time
14
High Current Alarm Limit
0.09
No Scan Lower Init Time
5
Low Current Alarm Limit
-10
No Scan Filter Select
Post-Cure Lights
High Current Alarm Limit
6
Low Current Alarm Limit
2.5
Post-Cure Lights
Replaced Top Init Lamps
Replaced Bot Init Lamps
Replaced Post-Cure Lamps
2276
Save Changes
Cancel Changes
2278
2280
2272

FIG. 26

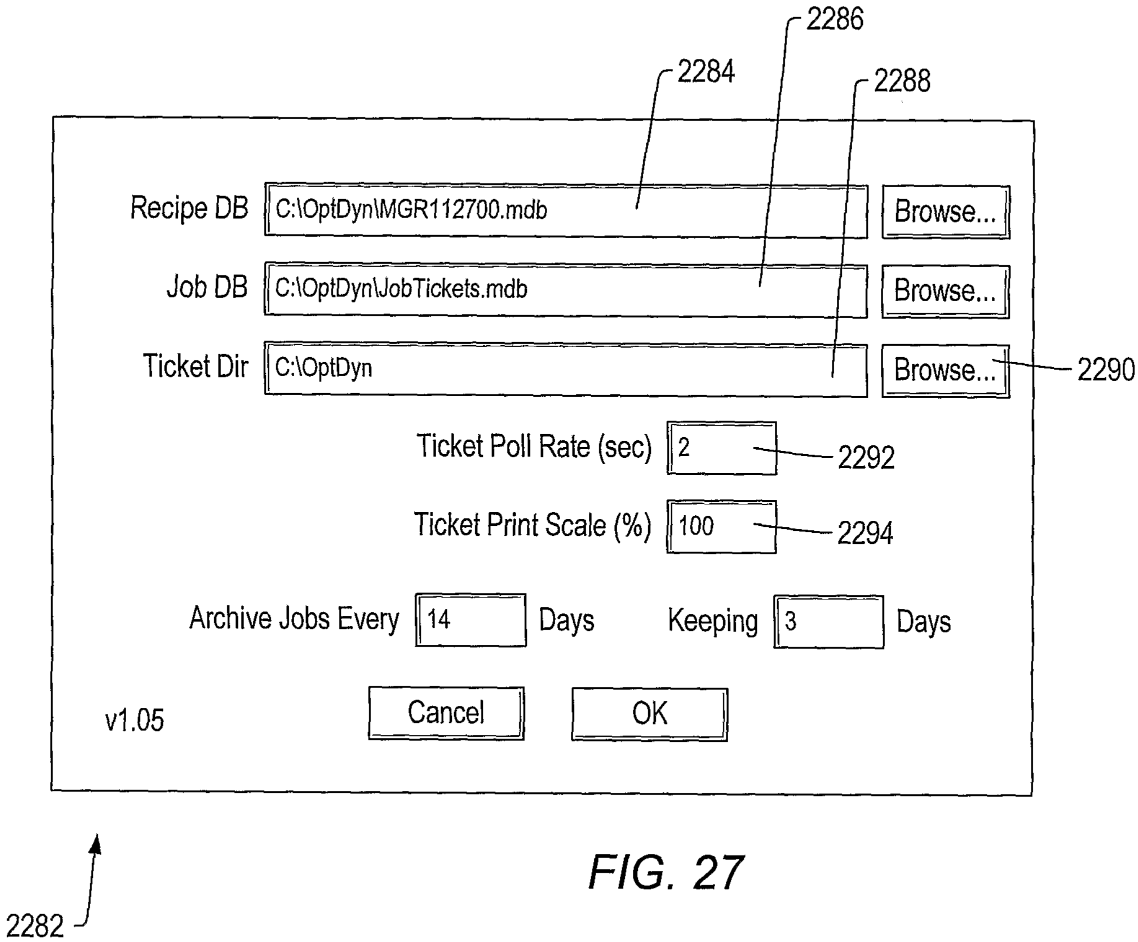

2286
2284
2288
Recipe DB
C:\OptDyn\MGR112700.mdb
Browse...
Job DB
C:\OptDyn\JobTickets.mdb
Browse...
Ticket Dir
C:\OptDyn
Browse...
2290
Ticket Poll Rate (sec)
2
2292
Ticket Print Scale (%)
100
2294
Archive Jobs Every
14
Days
Keeping
3
Days
v1.05
Cancel
OK
2282

FIG. 27

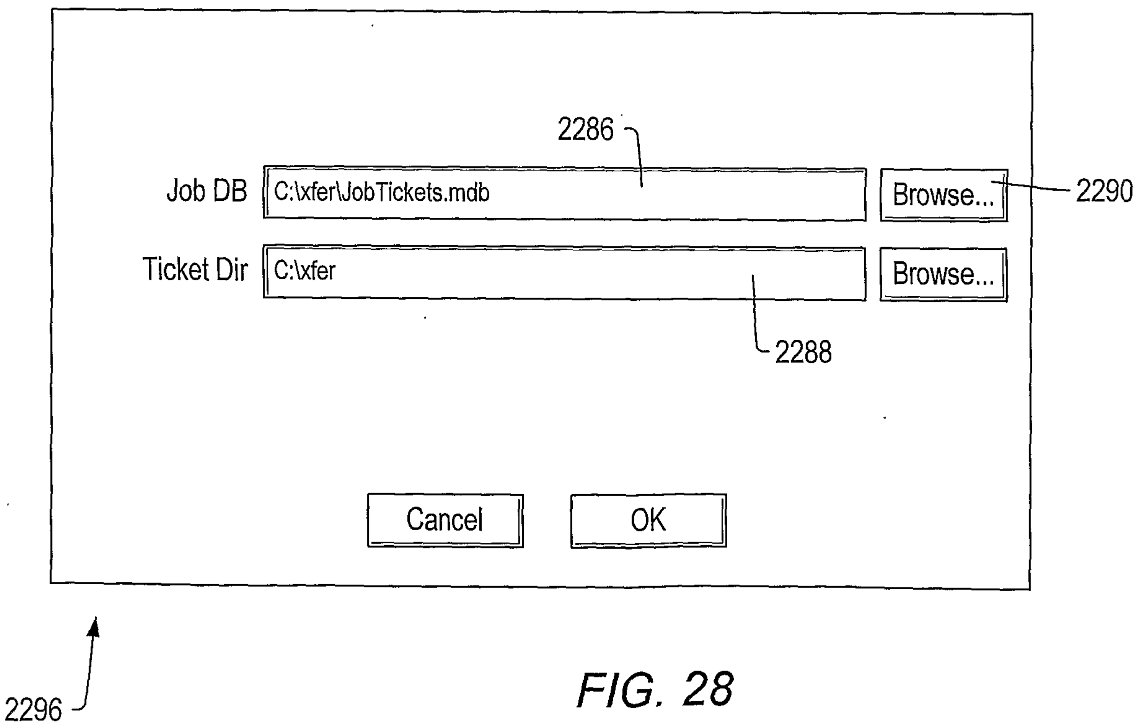
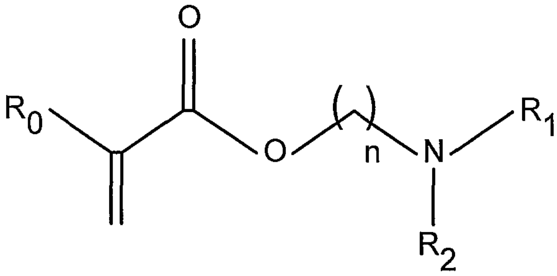
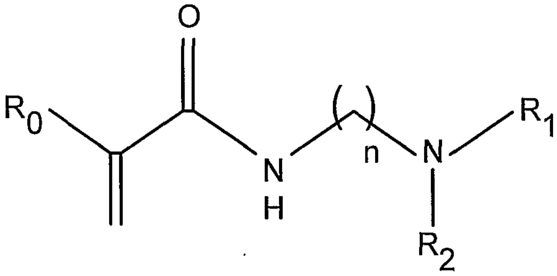

2286
Job DB
C:\xfer\JobTickets.mdb
Browse...
2290
Ticket Dir
C:\xfer
Browse...
2288
Cancel
OK
2296

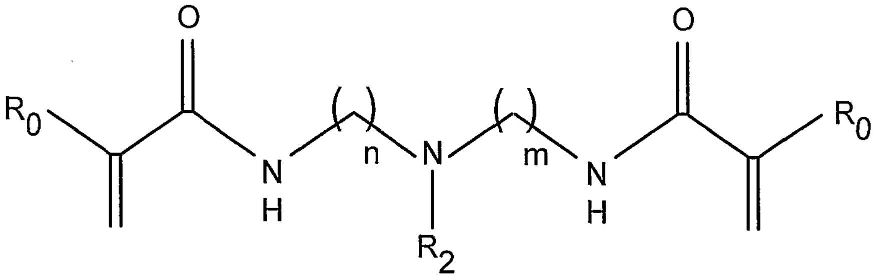
FIG. 28



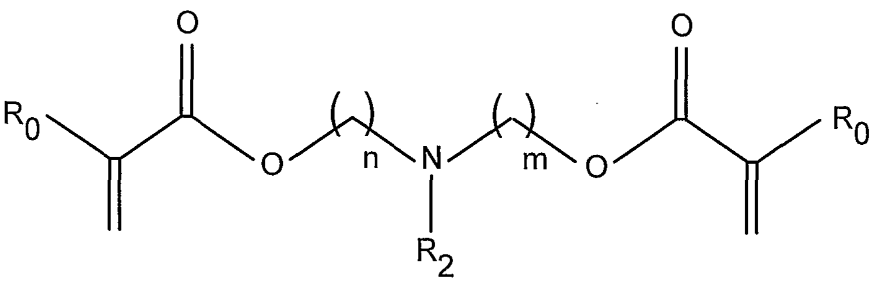
(A)



(B)



(C)



(D)

FIG. 29