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(54) Title: METHOD FOR BLOCKING A LENS BLANK, ADHESIVE COMPOSITION AND USE OF THE LATTER IN LENS BLOCKING

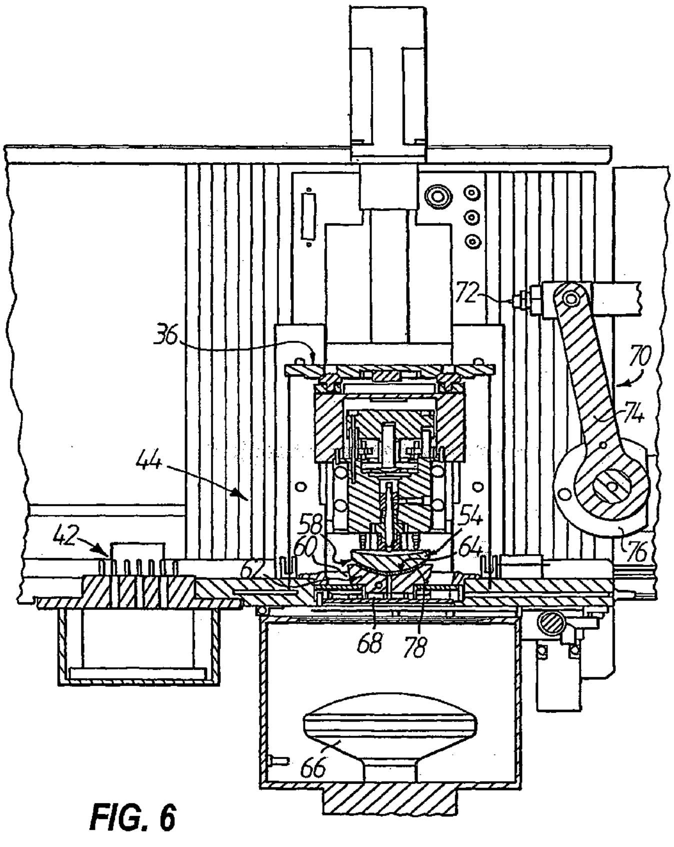

FIG. 6

(57) Abstract: A new lens blocking material (adhesive composition 78) is proposed that essentially overcomes the drawbacks of previous blocking materials. This new material combines traditional UV and/or visible light (VIS) curable polymer materials with specially selected filler (s) as a non polymerizing solid in order to achieve or improve certain desirable material properties, including those of low shrinkage, low exothermic heat of polymerization, and improving the ability to deblock, while simultaneously reducing the high cost associated with such UV/VIS radiation curable materials. The new material is being used in methods for blocking a lens blank (54) onto a lens block (62) with a lens mounting face (64) that has a predetermined block curve, in which the number of different block curves required to cover the full range of standard lenses is minimized.

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METHOD FOR BLOCKING A LENS BLANK, ADHESIVE COMPOSITION AND USE OF THE LATTER IN LENS BLOCKING

TECHNICAL FIELD OF THE INVENTION

The present invention generally relates to the bonding of an ophthalmic lens blank to a lens support block ("lens block") for supporting the lens blank during a lens generating process, as applied in prescription workshops in masses, that is to say production workshops for manufacturing individual spectacle lenses from customary materials (polycarbonate, mineral glass, CR 39, HI index, etc.) according to a prescription.

More particularly the present invention relates to a method for blocking a lens blank, the use in lens blocking of an adhesive composition and the adhesive composition itself, wherein a radiation cured material is being used in each case as a bonding agent. A "radiation cured material" in the context of the present application refers to liquid chemical resin compounds chemically sensitive to certain electromagnetic radiation wavelengths which will cause the resin to cure, i.e. polymerize to become a solid when the material is irradiated with these "photo active" waves. In other words the material will phase change from liquid to solid upon being exposed to the electromagnetic radiation in question, in particular light in the ultraviolet ("UV") and high visible spectrum ("VIS").

BACKGROUND OF THE INVENTION AND PRIOR ART

An ophthalmic lens blank generally has a first face with a predetermined curvature and a second face, opposite the first face on which a desired surface contour is generated by a machining process. The overall process is generally referred to as "lens surfacing" and the overall object is to yield a finished spectacle lens wherein the first and second face curvatures cooperate to yield desired optical properties.

In prescription workshops, the following main process steps are usually carried out: Firstly, a suitable right and/or left ophthalmic lens blank is removed from a semifinished product store. The term "semifinished" is used to mean that the ophthalmic lens blanks, which are usually round or oval in plan view and have not yet been edged, have already been machined or in another way contoured on one of their two optically active faces. The ophthalmic lens blanks are then prepared for the blocking operation, namely by applying a suitable protective film or a suitable protective lacquer to protect the optically active face which has already been machined or contoured, i.e. the first face or blocking face.

The so-called "blocking" of the ophthalmic lens blanks then takes place. During this, the ophthalmic lens blank is joined to a suitable lens block, for example a lens block according to German standard DIN 58766. To this end, the lens block is firstly brought into a predefined position with respect to the protected first face of the ophthalmic lens blank, and then in this position the space between lens block and ophthalmic lens blank is filled with a molten material (normally a metal alloy or wax). Once this material has solidified, the lens block forms a holder or support for machining the second face of the ophthalmic lens blank. The lens block is grasped by chuck or other suitable coupling means during lens generation to provide in particular secure mounting to the profiling machine while avoiding damage to the lens.

Lens surfacing is carried out then using profiling machines which typically have a cutter of some type that is moved across the second face of the ophthalmic lens blank to give the second face its macrogeometry according to the prescription. The lens blank may be stationary or rotating during the cutting operation, depending on the particular profiling machine which is being used. Typical machining processes for surfacing ophthalmic lenses include single point diamond turning, diamond tool fly-cutting, milling, and grinding processes, applied depending on the lens material.

Usually fine machining of the ophthalmic lenses then takes place, in which the pre-machined second face of the respective ophthalmic lens blank is given the desired microgeometry. Depending on inter alia the material of the ophthalmic lenses, the fine machining process is divided into a fine grinding operation and a subsequent polishing operation, or includes only a polishing operation if a polishable second face has already been produced during the pre-machining stage.

Only after the polishing operation is the ophthalmic lens separated from the lens block ("deblocking") before cleaning steps and possibly further refining steps are carried out, e.g. anti-reflection coating or hard coating of the ophthalmic lenses. The lens block accordingly remains on the ophthalmic lens (at least) for a number of machining operations and must remain reliably thereon during said operations.

Recently other bonding materials have been proposed for lens blocking in order to overcome certain disadvantages - the long time required for setting before the blocked lens can be safely released to subsequent processing operations, distortion problems with the lens caused by the heat associated with the molten material, and possible contamination of the lens, just to name a few - carried by the use of metal alloy or wax as the classical bonding agent. These other bonding materials include radiation curable materials.

In this connection document US 2005/0139309 A discusses the use of a UV light curable blocking material designed to reduce polymerization induced shrinkage. Although this development has been a significant step forward in allowing the use of UV curable materials for use in lens blocking, it still exhibits shrinkage of the order of 3%. This amount of shrinkage is generally not serious when the UV curable adhesive is used in a relatively thin (typically less than 3 mm) and uniform thickness; however it has serious limitations when thicker sections of adhesive are needed.

The shrinkage problem becomes even more apparent when blocking lenses having strongly non-uniform cross sections so that non-uniform sections of adhesive are needed. An example of this can be seen in FIG. 10 which shows a flat top bifocal lens blank 10 having a step discontinuity 12 between a bifocal segment 14 and a base curve 16, blocked on a lens block 18 by means of an UV cured adhesive 20. As is evident from FIG. 10 shrinkage can be a problem when the gap 22 between the bifocal segment 14 and the lens block 18 is significantly different than the gap 24 directly above the bifocal segment 14. In this instance the difference in shrinkage caused by the difference in thickness of the UV cured adhesive 20 can cause critical/unwanted distortion directly above the bifocal segment 14.

In an attempt to overcome the shrinkage problems remaining with the above UV light curable blocking material it has been proposed to use numerous (7 or 8) different block base curves to approximately match the conceivable lens base curves, and thereby keep the adhesive thickness sufficiently uniform to minimize residual shrinkage effects. FIG. 11 illustrates the prior art using numerous lens blocks 18 each comprising a lens mounting face 26 that has a pre-determined block curve, wherein the block curves of different lens blocks 18 differ from each other. In the example shown the lens blocks 18 comprise essentially spherical lens mounting faces 26 that have block curves of a) 0.5 diopters, b) 2 diopters, c) 6 diopters, and d) 10 diopters, respectively, generally matching the lens curves, i.e. the respective curvature of the blocking faces 28 of the blocked lens blanks 10. It is to be noted that only four different lens blocks 18 are shown in FIG. 11 to simplify the illustration; actually however this system used seven or eight different lens blocks, as mentioned before. As becomes apparent from FIG. 11 the UV cured adhesive 20 between lens blank 10 and lens block 18 in each case has a relatively thin and substantially uniform thickness so that there is no critical distortion due to shrinkage of the UV cured adhesive 20.

However the approach of using numerous different block base curves does not help in the situation shown in FIG. 10. A further problem associated with multiple block base curves is the management of these numerous curves. The proper lens blocks initially need to be selected to match the lens curves, then, after deblocking, (assuming the lens blocks are reused), they need to be properly sorted according to curve, and stored in separate holding/dispensing containers. Using multiple block curves thus adds to the complexity of the manufacturing process, increases the probability of error, and as a result increases the cost of lens manufacturing.

OBJECT OF THE INVENTION

The object of the present invention is to provide a method for blocking a lens blank in which the number of block curves required to cover the full range of standard lenses is minimized, and which also addresses the problems associated with shrinkage of a radiation cured material as the bonding agent. The object of the invention further encompasses the provision of an adhesive composition for lens blocking that can be cured by radiation and serves the above purpose.

SUMMARY OF THE INVENTION

The above object is solved by the features specified in claims 1, 3, 7 and 8, respectively. Advantageous and appropriate developments of the invention form the subject matter of claims 2, 4 to 6 and 9 to 16.

According to one aspect of the present invention there is provided a method for blocking a lens blank having a blocking face of pre-determined curvature, which method comprises the steps of:

(a) providing a plurality of lens blocks each comprising a lens mounting face that has a pre-determined block curve, wherein said lens blocks all have the same block curve;

(b) taking out one of said lens blocks of said plurality of lens blocks;

(c) mixing an adhesive composition comprising in an unpolymerized state a liquid adhesive curable by UV or visible light and a filler as a non polymerizing solid;

(d) applying to at least one of said blocking face of said lens blank and said lens mounting face of said lens block said adhesive composition;

(e) urging said lens blank toward said lens block with said blocking face of said lens blank facing said lens mounting face of said lens block; and

(f) generating UV or visible light and transmitting the light to said adhesive composition, said light being of a wavelength and an intensity and applied for a time interval sufficient to cause setting of said adhesive composition;

(g) wherein a mixing ratio of said adhesive and said filler is selected to have a dimensional change and exothermic heat of polymerization of said adhesive composition upon setting low enough so that the adhesive composition is capable of setting without imparting undue stresses on said lens blank and without de-bonding of said lens blank from said adhesive composition.

According to a further aspect of the present invention there is provided a method for blocking a lens blank having a blocking face of pre-determined curvature, which method comprises the steps of:

(a) providing a plurality of lens blocks each comprising a lens mounting face that has a pre-determined block curve, wherein said lens blocks have a few different block curves only;

(b) selecting a lens block having a specific block curve depending on said curvature of said blocking face of said lens blank so that said block curve matches said curvature of said blocking face as best as possible;

(c) mixing an adhesive composition comprising in an un-polymerized state a liquid adhesive curable by UV or visible light and a filler as a non polymerizing solid;

(d) applying to at least one of said blocking face of said lens blank and said lens mounting face of said lens block said adhesive composition;

(e) urging said lens blank toward said lens block with said blocking face of said lens blank facing said lens mounting face of said lens block; and

(f) generating UV or visible light and transmitting the light to said adhesive composition, said light being of a wavelength and an intensity and applied for a time interval sufficient to cause setting of said adhesive composition;

(g) wherein a mixing ratio of said adhesive and said filler is selected to have a dimensional change and exothermic heat of polymerization of said adhesive composition upon setting low enough so that the adhesive composition is capable of setting without imparting undue stresses on said lens blank and without de-bonding of said lens blank from said adhesive composition.

First of all, as compared to the above prior art, both methods have in common a reduction of the number of block curves. Whereas the first of the above methods in which only one block curve is being used represents the ideal situation, even using a few different block curves according to the second method, e.g. 2 or 3 block curves, is felt to be significantly better than using 7 or 8 block curves in terms of decreasing the complexity of the manufacturing process, the probability of error, and the cost of lens manufacturing.

Further, as compared to the above prior art again, the methods according to the present invention have in common the use in lens blocking of an adhesive composition comprising in an un-polymerized state a liquid adhesive curable by UV or visible light and a filler as a non polymerizing solid, wherein in particular the mixing ratio of the adhesive and the filler is selected to have a dimensional change and exothermic heat of polymerization of the adhesive composition upon setting low enough so that the adhesive composition is capable of setting without imparting undue stresses on the lens blank and without de-bonding of the lens blank from the adhesive composition.

In this connection the use of the filler offers several advantages. Since a significant portion of the shrinkage comes from material structural changes during polymerization, one can physically introduce the filler as a non polymerizing solid into the liquid (un-polymerized) compound, and thereby reduce shrinkage by at least the volume percentage of filler material introduced.

Further, typical UV or light radiation cured materials, although they are considered relatively "low °T" curing, exhibit a certain level of exothermic heat during the curing process. In some cases, and especially when the volume of UV/VIS material is high, this exothermic reaction can raise the temperature of the material 20 to 40°C above the initial liquid temperature. These higher process temperatures in turn could cause thermal stresses in the lens blank due to different CTEs (Coefficients of Thermal Expansion) between lens blank, lens block, and adhesive. Therefore, in addition to reducing the shrinkage coming from polymerization, the reduction in volume of UV/VIS curable material by the introduction of filler in turn reduces the exothermic component of the curing reaction, thereby resulting in a lower final process temperature, and lower thermal expansion.

The combined effect of reducing both sources of shrinkage (structural changes during polymerization and exothermic heat of polymerization) simultaneously is seen to be very beneficial to the ability to successfully block lenses using non-constant UV/VIS material thicknesses, as is the case inevitably when one or a few block curves only are being used for blocking the full range of standard lenses.

A further important benefit to using filler is that of cost reduction by reducing the amount of UV/VIS curable material. The UV/VIS curable materials use relatively expensive chemical components - in particular the photoinitiators used to initiate electromagnetic radiation (UV/VIS) curing tend to be very expensive - and as such result in relatively high costs of blocking compound. In addition to this, once cured the compound cannot be returned to its liquid (un-polymerized) state. This means that it cannot be recycled by re-melting in a way similar to wood metal or blocking wax (or other thermoplastics such as e-Caprolactone).

In the first of the above methods, i.e. in the case in which lens blocks are provided that all have one and the same block curve, the lens blocks preferably all have an essentially spherical lens mounting face comprising the same block curve selected in accordance with a distribution of the blocking face curvature of lens blanks to be blocked for a given population. This takes into account advantageously that different populations may present different distributions, and therefore require different block curves to minimize material usage. For example certain Asian populations are known to skew more to the lower (flatter) base curves when compared to Western European or North American populations. This would result in the selection of a slightly lower block curve in order to better optimize (minimize) material usage, and/or final optical performance.

In the second of the above methods, i.e. in the case in which lens blocks are provided that have a few different block curves only, preferably the lens blocks all have an essentially spherical lens mounting face, wherein lens blocks of two different block curves are provided, namely lens blocks comprising a concave block curve within the range of 0 to 4 diopters, and lens blocks comprising a concave block curve within the range of 4 to 8 diopters. Depending on the geometry of the blocking faces of the lens blanks to be blocked however the block curves could also be convex.

In one preferred embodiment of the second method, the step of selecting a lens block is carried out to the effect that, in the blocked state of the lens blank, a gap between the lens mounting face of the lens block and the blocking face of the lens blank is minimized in a central region of the lens block. As a result the absolute shrinkage of the adhesive composition is (even more) minimized at center so that very small stresses if any are induced in the blocked lens blank, especially in the vicinity of the MRP (major reference point).

In principle, lens blocks may be used that are opaque or even impervious to light of all kind, wherein the UV or visible light is transmitted to the adhesive composition through the lens blank to cause setting of the adhesive composition. However, preference is given to the use of lens blocks that are capable of transmitting UV or visible light, wherein the step of generating UV or visible light and transmitting the light to the adhesive composition in all methods preferably includes then transmitting the light to the adhesive composition through the lens block.

According to the present invention an adhesive composition for use in lens blocking is also provided. The adhesive composition comprises (a) an adhesive curable by UV or visible light that is liquid in an un-polymerized state, and (b) a filler as a non polymerizing solid, wherein the mixing ratio of the adhesive and the filler is in a range between 70% by weight adhesive versus 30% by weight filler and 30% by weight adhesive versus 70% by weight filler. As tests have shown, a mixing ratio within this range is effective to cause a dimensional change and exothermic heat of polymerization of the adhesive composition upon setting low enough so that the adhesive composition is capable of setting without imparting undue stresses on the lens blank and without de-bonding of the lens blank from the adhesive composition. The adhesive composition including the filler, when used in lens blocking, also leads to cost reduction as compared to the use of conventional radiation cured blocking material, as already explained above. Again, such adhesive composition finally represents a "vehicle" for the reduction of the number of block curves required in lens generation to cover the full range of standard lenses (cf. the above explanations).

Preferably the filler consists of solid particles that provide for sufficient rigidity of the cured adhesive composition to prevent full or partial flexing and movement of the blocked lens.

The preferred filler particle geometry is generally spherical however cylindrical or irregular geometries can also work well. The advantage to the spherical geometry is one of improved (lower) viscosity in the liquid state of the adhesive composition.

The filler particle sizes generally need to be smaller than the minimum gap between the lens blank to be blocked and the designated lens block. Minimum gaps of 2 mm are currently preferred so this means the largest particles should be smaller than 2 mm, and preferably equal to or less than 1 mm.

To facilitate deblocking it is preferred for the filler to contain a small amount of metal fibers, granules, or powder, preferably aluminum fibers in a quantity of 1 to 2% by weight of the composition in total. Such quantity of fibers provides sufficient absorption of microwave energy to significantly accelerate heating of the cured blocking material by microwave energy whereby the blocking material can be "softened" prior to deblocking.

Preferably the filler material is transparent and/or translucent to photo active wavelengths of UV and/or visible light in order to accelerate curing of the adhesive composition.

The filler material may further have low moisture absorption properties which is of importance if and when a complete blocked lens is introduced into a vacuum chamber typically used in thin film coating processes.

Continuing the concept of the invention, the filler material may have a Glass Transition Temperature (Tg) between 25° and 80°C. By using such filler material certain mechanical properties - sufficient stiffness and hardness for instance - can be achieved at surfacing process temperatures (typically close to room temperature), which can then be changed by raising the temperature above Tg in order to facilitate deblocking. In this connection the upper limit of 80°C assures that, to facilitate deblocking, there is no need to raise the temperature of the cured blocking material above temperatures that could permanently damage a surfaced lens.

It is finally preferred for the filler material to be selected from a group comprising the UV or visible light cured adhesive in a reground state, and plastic materials including e-Caprolactone, Terpolymer derived from Ethyl-Methyl-Acrylate-Acrylic Acid, Polycarbonate, Polyethylene (PET), High Methacrylate Resin, Ethyl Methacrylate Resin, Methacrylate Copolymer Resin, Butyl Methacrylate Resin, and Methyl/ n-Butyl Methacrylate Copolymer Resin. Among other things the respective advantages of such filler materials will become apparent from the following description of the preferred embodiments of the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

Hereinbelow, the invention will be explained in more detail on the basis of preferred examples of embodiment and with reference to the appended, partially schematic drawings. In the drawings:

FIG. 1 is a perspective view of an ophthalmic lens blocking apparatus that may be utilized in the blocking methods according to the present invention;

FIG. 2 is a section on line II-II of FIG. 1;

FIG. 3 is a partially cut away perspective view illustrating a lens blank being held over a lens block by a lens transporter;

FIG. 4 is a partially cut away perspective view illustrating lens blank placement on a lens block and also illustrating an adhesive composition dispenser in a retracted position;

FIG. 5 is a partially cut away perspective view illustrating a lens transporter before picking up a lens blank and illustrating an adhesive composition dispenser in its deployed position;

FIG. 6 is a sectional view on line VI-VI of FIG. 4;

FIG. 7 shows, by way of sectional views, four lens blanks each having a blocking face of different predetermined curvature, that were blocked using a first method according to the invention in which identical lens blocks and an adhesive composition comprising in an un-polymerized state a liquid UV/VIS curable adhesive and a filler as a non polymerizing solid are utilized;

FIG. 8 shows, by way of sectional views, four lens blanks each having a blocking face of different predetermined curvature, that were blocked using a second method according to the invention in which lens blocks with two different block curves only and an adhesive composition comprising in an unpolymerized state a liquid UV/VIS curable adhesive and a filler as a non polymerizing solid are utilized;

FIG. 9 is a diagram illustrating a typical distribution of ophthalmic lens front curves for a given population;

FIG. 10 shows, by way of a plan view and a sectional view on line X-X, respectively, an ophthalmic lens blank comprising a bifocal segment (left side) that is blocked on a lens block (right side) in a conventional manner; and

FIG. 11 shows, by way of sectional views, four lens blanks each having a blocking face of different predetermined curvature, that were blocked using a conventional method, in which a plurality of different lens blocks is utilized that have different block curves each closely matching the blocking face curvature of the assigned lens blank.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS OF THE INVENTION

An apparatus for blocking an ophthalmic lens is generally indicated by reference 30 in the accompanying illustrations. The blocking apparatus 30 includes a cabinet having a top 32 and a hood structure 34 for partially enclosing the top 32. A lens transporter 36 is moveably mounted on a first linear actuator 38 affixed to the top 32. The first linear actuator 38 has a first servo motor or stepper motor unit for moving the lens transporter 36 therealong and for monitoring its position.

The blocking apparatus 30 has, aligned with the first linear actuator 38 and incorporated into the top 32 of the cabinet, an imaging station 40, a probing station 42 and a lens blocking station 44. The blocking apparatus 30 encloses (cf. FIG. 2) a camera 46 focused on the imaging station 40, an adhesive composition reservoir 48 and a pumping unit 50 for pumping the adhesive composition to the lens blocking station 44. The blocking apparatus 30 further includes a controller in the form of a central processing unit 52 for controlling its operation.

The imaging station 40 is utilized for lens orientation to ensure that a lens blank 54 is property aligned and oriented at the outset of the lens blocking process, with the aid of a screen 56 for displaying lens orientation information generated by the central processing unit 52 on the basis of image information received from the camera 46. As to further structural and functional details of the imaging station 40 reference is made to document US 2005/0139309 A.

Once orientation and positional parameters of the lens blank 54 have been determined, the lens blank 54 is transported by the lens transporter 36 from the imaging station 40 to the probing station 42 for probing the blocking face 58 of the lens blank 54. Again, further details as regards structure and function of the lens transporter 36 and the probing station 42 can be taken from document US 2005/0139309 A.

Once the blocking face 58 of the lens blank 54 has been probed, the lens blank 54 is transported by the lens transporter 36 from the probing station 42 to the lens blocking station 44. The lens blocking station 44 includes a UV and visible light transmissive lens block support 60 for receiving and supporting a lens block 62 with a lens mounting face 64 of the lens block 62 facing upwardly. In this instance the lens block 62 should be of a transparent material capable of transmitting at least light in the UV spectrum and preferably also in the visible spectrum. As to further structural and functional features of the lens block 62, in particular the clamping portion of the lens block 62 via which the lens block 62 can be held in the lens blocking station 44 and later fixed on a spindle of a surfacing machine (not shown), reference is made to document US 2005/0250430 A.

A UV light source 66 (see FIG. 6) is associated with the lens block support 60 in that it is mounted so as to direct light through an aperture 68 in the lens block support 60 which in turn directs the UV light through the UV transmissive lens block 62. A light source actuator which may form part of the central processing unit 52 is connected to the UV light source 66 to control activation and de-activation of the UV light source 66. The UV light source 66 could incorporate a flash lamp which emits a pulse of high intensity short duration light within the UV spectrum and in the visible spectrum.

A dispenser for dispensing an adhesive composition curable by UV/visible light is generally indicated by reference 70. The dispenser 70 has a dispenser nozzle 72 at one end of a dispenser arm 74. An arm actuator - which may be a motor such as illustrated by reference 76 or a linear or other actuator - may be provided to move the dispenser arm 74 from a deployed position adjacent the lens mounting face 64 (FIG. 5) to a retracted position clear of the lens mounting face 64 (FIG. 4) and the lens transporter 36 (and vice versa) so as not to interfere with the placement of the lens blank 54 over the lens mounting face 64 of the lens block 62.

The dispenser arm 74 merely controls position of the dispenser nozzle 72. Accordingly the dispenser arm 74 can be telescopic rather than rotatable as illustrated and possibly controlled by a linear actuator such as a fluid pressure actuated piston within a cylinder.

The dispenser nozzle 72 fluidly communicates with the adhesive composition reservoir 48 through the pumping unit 50 which supplies the adhesive composition to the dispenser nozzle 72. Alternatively, the adhesive composition reservoir 48 may be pressurized thereby obviating the need for a pump.

It should be noted here that in the embodiment shown the adhesive composition reservoir 48 as a - preferably replaceable - pre-filled unit already contains the ready-mixed adhesive composition comprised of an un-polymerized, i.e. liquid UV/VIS curable adhesive and a suitable filler as a non polymerizing solid. As an alternative to this however the blocking apparatus may be equipped with a mixing unit for preparing the adhesive composition from the above components that could be stored in appropriate containers replaceably mounted to the blocking apparatus 30.

The dispenser nozzle 72 is equipped with a valve or other shut-off mechanism which communicates with the central processing unit 52 to control dispensing of the adhesive composition through the dispenser nozzle 72 when the dispenser nozzle 72 is in the deployed position. Different control arrangements may be used. A simple form of control is to monitor the time that the dispenser nozzle 72 is held open. Other controls such as a metering pump may be utilized. Generally whatever control is selected should dispense a measured amount of adhesive composition which will substantially fill the gap between the blocking face 58 of the lens blank 54 and the lens mounting face 64 of the lens block 62.

In use, a measured amount of UV/VIS curable adhesive composition is dispensed via the dispenser nozzle 72 of the dispenser 70 on the lens mounting face 64 of the lens block 62. The lens blank 54 is moved by means of the lens transporter 36 over the lens block 62 with the blocking face 58 of the lens blank 54 facing the lens mounting face 64. The lens transporter 36 then moves the lens blank 54 toward to the lens mounting face 64 and into the liquid adhesive composition 78 (see FIG. 6) until the blocking face 58 of the lens blank 54 is a predetermined distance from the lens mounting face 64 of the lens block 62.

Because the geometry and spatial relationships between the blocking face 58 and the lens mounting face 64 are known, the amount of adhesive composition 78 required can be calculated and dispensed automatically without operator intervention.

At this stage, UV light is generated by the UV light source 66 and transmitted through the lens block 62 at a wavelength, and intensity and for a duration sufficient to cause the adhesive composition 78 to cure thereby bonding the lens blank 54 to the lens block 62.

As a final step, the lens block 62 with the lens blank 54 attached thereto would be removed from the lens blocking station 44 and released from the lens transporter 36.

FIG. 7 illustrates blocking results obtained by a blocking process that comprises the following steps:

(a) providing a plurality of lens blocks 62 each comprising a lens mounting face 64 that has a pre-determined block curve, wherein the lens blocks 62 all have the same block curve - in the example shown the lens blocks 62 all have an essentially spherical lens mounting face 64 with a block curve of 5 diopters;

(b) taking out one of the lens blocks 62 of the plurality of lens blocks 62 - in a prescription workshop the lens blocks 62 usually are stored in a holding/dispensing container from which individual lens blocks 62 can be taken out; in this instance no selection is necessary since the lens blocks 62 are identical;

(c) mixing an adhesive composition 78 comprising in an un-polymerized state a liquid UV/VIS curable adhesive and a filler as a non polymerizing solid, wherein a mixing ratio of the adhesive and the filler is selected to have a dimensional change and exothermic heat of polymerization of the adhesive composition 78 upon setting low enough so that the adhesive composition 78 is capable of setting without imparting undue stresses on the lens blank 54 and without de-bonding of the lens blank 54 from the adhesive composition 78 - as indicated earlier such mixing may take place shortly before dispensing the adhesive composition 78 for blocking purposes, possibly even in the blocking apparatus 30, or as an alternative to this at an earlier time, perhaps outside the prescription workshop already;

(d) applying to preferably the lens mounting face 64 of the lens block 62 the liquid adhesive composition 78;

(e) urging the lens blank 54 toward the lens block 62 - or vice versa or both; obviously the relative movement between lens blank 54 and lens block 62 is important - with the blocking face 58 of the lens blank 54 facing the lens mounting face 64 of the lens block 62; and

(f) generating UV or visible light and transmitting the light to the adhesive composition 78, the light being of a wavelength and an intensity and applied for a time interval sufficient to cause setting of the adhesive composition 78.

As compared with FIG. 11 illustrating the prior art, FIG. 7 shows the same lens blanks 54 as those of FIG. 11 in terms of blocking face curvature (a) 0.5 diopters, b) 2 diopters, c) 6 diopters, and d) 10 diopters), however now blocked on only one block curve of 5 diopters in this instance. This helps illustrate the issues associated with a reduced number of block curves, and why the proposed solution is felt to be advantageous.

In FIG. 7 it first appears as though the usage of blocking material will be considerably greater than that seen to be used in FIG. 11. The amount of blocking material used is however not as great as one would initially think, given the reason that the single block curve can be chosen to best fit the majority of spectacle lenses in a statistical distribution of lens base curves.

In this connection FIG. 9 illustrates a typical base (front) curve distribution for a given population. Because of this distribution, and also considering proper selection of an optimal block curve, the blocking material usage is only increased by 10 to 15% when using one block curve compared to 7 block curves. If two block curves are used, then the increase in blocking material usage is calculated at only 6% more than with 7 block curves. This marginal increase in blocking material consumption is easily compensated by the cost reduction associated with managing only one or two block curves versus the high number of curves typically encountered.

One of the issues raised when using a low number of block curves becomes clear from FIG. 7 a), b), and d). This is the issue of uneven shrinkage associated with the non-constant blocking material thickness. Shrinkage is mainly caused by the polymerization of the UV/VIS curable adhesive, but can also come from thermal effects when this material is cured.

Depending on what type of chemistry is used, and what temperatures are reached during curing it is possible to see material shrinkage ranging between 2 to 10% or even more. High temperatures can come from energy of the curing radiation, but also from the exothermic heat generation caused by the chemical reaction during polymerization. Temperatures ranging between 10 and 40°C above the initial room temperature can easily be reached; and when the block assembly cools back down to room temperature it will shrink according to the different CTEs (Coefficients of Thermal Expansion) and mechanical properties of the final assembly. This shrinkage will be internally constrained and can cause unwanted mechanical (thermal) stresses in the final assembly.

Although shrinkage is a three dimensional effect, the amount of axial shrinkage at a given point is generally considered to be proportional to the thickness of the UV/VIS curable adhesive at that point. One can clearly see that this, given sufficient shrinkage, would result in a change of blocking material geometry. This change can have two undesired effects: The first is de-bonding of the lens blank from the blocking material caused by the blocking material "pulling away" from the lens blank. In FIG. 7 a) de-bonding would tend to happen more at the center of the lens blank 54, whereas in FIG. 7 d) one would see this more at the edge. The worst situation in this case is seen in FIG. 7 a), where any de-bonding at the center could cause unacceptable distortion at the center due to lack of support of the lens blank 54 during surfacing. In addition to this, even if no de-bonding is present, because of the final thin center lens geometry, shrinkage at the center would tend to modify the final curvature at the center, thereby introducing power errors. The case seen in FIG. 7 d) is much less critical related to power errors since the center of the lens is expected to stay relatively thick (positive power) therefore of high rigidity, and able to better withstand stresses coming from shrinkage.

To address among other things the above issues a specially selected filler(s) as a non polymerizing solid is added to the UV/VIS curable blocking material as will be explained in more detail below.

Turning now to Fig. 8 it illustrates blocking results obtained by a further blocking process that comprises the following steps:

(a) providing a plurality of lens blocks 62 each comprising a lens mounting face 64 that has a pre-determined block curve, wherein the lens blocks 62 have a few different block curves only - in this instance, again, the lens blocks 62 all have an essentially spherical lens mounting face 64, and there are provided lens blocks 62 of two different block curves only, namely lens blocks 62 comprising a concave block curve of 0.5 diopters (FIG. 8 a) and b)), and lens blocks 62 comprising a concave block curve of 5 diopters (FIG. 8 c) and d)); and

(b) selecting a lens block 62 having a specific block curve depending on the curvature of the blocking face 58 of the lens blank 54 so that the block curve matches the curvature of the blocking face 58 as best as possible - in the example shown this step was carried out to the effect that, in the blocked state of the lens blank 54, a gap between the lens mounting face 64 of the lens block 62 and the blocking face 58 of the lens blank 54 is minimized in a central region of the lens block 62 in order to minimize or even suppress the induction of stresses into the blocked lens blank 54; so the 0.5 base lens blocks 62 were assigned to the 0.5 and 2 base lens blanks 54 (FIG. 8 a) and b)), whereas the 5 base lens blocks 62 were assigned to the 6 and 10 base lens blanks 54 (FIG. 8 c) and d)).

The remaining steps in this process alternative are the same as steps (c) to (f) discussed above in connection with FIG. 7.

As to the material requirements which should be met by the adhesive composition 78 comprising the adhesive curable by UV or visible light that is liquid in the un-polymerized state, and the filler as a non polymerizing solid, the following is to be noted.

Generally it is desirable to achieve certain mechanical and thermal properties in the cured material. These properties are such that good lens support is achieved, while maintaining or even enhancing the ability to deblock the lens upon demand. In this context "deblocking" means to release the adhesive bond between lens and adhesive composition through chemical, thermal, mechanical or some other means or any practical combination thereof.

Multifunctional fillers or special combinations of fillers can be used to either maintain or modify the material properties while simultaneously reducing shrinkage, exothermic heat of reaction, and cost. Another potential function of the filler is to modify the adhesive properties under certain controlled conditions to permit easier deblocking.

The cured material typically needs to be sufficiently rigid to prevent flexing and movement of the lens or the area of the lens in the immediate vicinity of the cutting tool during the machining process. Having a flexible blocking material however makes it easier to "peel" this material off the lens during the deblocking process. A hard and brittle material is difficult to peel off, and tends to break into smaller pieces, whereas a soft pliable and cohesive material will more easily peel off in one piece.

If mechanical peeling is chosen over other deblocking methods, the preferred material will have either a rigidity level sufficiently high to allow surfacing while being sufficiently low for deblocking, or it could be subjected to a "softening" process prior to deblocking. This "softening" process could for example be heating of the blocking material by immersion in warm water, or exposure to other forms and/or wavelengths of radiation such as IR or microwaves. In this case the adhesive composition should be designed to better support deblocking with certain modifiable properties such as reduction in hardness, possibly also combined with reduction in adhesiveness.

A small amount of metal fibers, granules, or powder can be added to the filler to enhance heating of the cured blocking material in microwave energy. A small quantity (1 or 2% by weight of the composition in total) of fine aluminum fibers mixed with the liquid adhesive are not enough to prevent curing since the UV radiation can still easily penetrate the adhesive, but yet provides sufficient absorption of microwave energy to significantly accelerate heating of the material. A microwave exposure time of 15 seconds is all that is needed to raise the material temperature from 30°C by 25° as compared to 20 seconds without the aluminum fibers.

Other possibilities for accelerated heating of the cured blocking material to facilitate deblocking by "softening" the cured blocking material would be to add a small percentage (1 to 5% by weight of the filler in total) of metal particles having generally high electrical resistance, and use induction heating elements to induce electrical currents into the particles. The electrical resistance to current flow in turn generates heat in the particles, which then transmits to the surrounding material, thus heating the blocking compound. Other non-metallic, yet conductive materials such as carbon, and certain semi-conductive particles could also be used with induction heating technology.

One example of a multifunctional filler material that can be used to maintain or improve hardness and rigidity at normal surfacing process temperatures, yet enhance the flexibility during deblocking is e-Caprolactone. E-Caprolactone (also Polycaprolactone) is a thermoplastic monomer, and is sufficiently translucent to allow UV and/or visible light transmission, and therefore allow curing of a matrix of liquid UV adhesive and e-Caprolactone particles as a non polymerizing solid filler. Fill ratios as high as 65% by weight of e-Caprolactone were successfully cured and tested for hardness and adhesion to the lens blank and lens block. At room temperature this material can be selected to be quite hard (e.g., between 50 and 70 Shore D), then, after surfacing, the cured blocking material can be heated and allowed to reach a point where the e-Caprolactone particles are soft (e.g., between 10 and 40 shore D) however not liquid. These temperatures are sufficiently low (between 35° and 60°C for instance) so as to not damage the lens. The UV/VIS cured adhesive component in the matrix stays solid, but the e-Caprolactone particles, being significantly softer at these temperatures, cause the whole matrix to be softer, and thus considerably improve the ease of removal of the blocking material from the lens. E-Caprolactone has a relatively low Glass Transition Temperature (Tg) so all processing would be done at higher than Tg in this case. Other materials similar to e-Caprolactone can also be identified.

Another variation is to use a filler material with a Tg above surfacing process temperatures (typically close to room temperature), yet lower than temperatures that could permanently damage a surfaced lens (80°C). The MatWeb database (www.matweb.com) has listed 235 polymer materials with a Tg between 25° and 80°C. These can be used to achieve certain mechanical properties at process temperatures (e.g., high stiffness and hardness), then change these mechanical properties by raising the temperature above Tg. One such material of interest is *ExxonMobil "Escor AT320 EMA-AA Terpolymer"*. This is an Ethyl-Methyl-Acrylate-Acrylic Acid. It is solid at room temperature and can be mixed in solid particle form with the liquid UV/VIS curable adhesive material. It provides an excellent surface for bonding to acrylate based UV/VIS curable adhesive materials since it is itself acrylate based.

Another material family that has been shown to have many desirable functionalities as fillers for this application is that marketed by *Lucite International Specialty Polymers Ltd.*, under the trade name of "*ELVACITE®*". These materials can for example be High Methacrylate Resins, Ethyl Methacrylate Resins, Methacrylate Copolymer Resins, or Butyl Methacrylate Resins. Their properties range from low to very high molecular weights, and Tukon hardness between 1 and 20 (Knoop No.), and Tg between 15°C and 110°C. One of these materials that has proven effective for this application is "*ELVACITE® 2550*" (Methyl/ n-Butyl methacrylate copolymer) with a Tg of 36°C. It is relatively soft with Knoop hardness number of 4 but capable, if used with rather high fill percentages (60% to 70%), to ensure sufficient stiffness for surfacing, while facilitating deblocking due to the relatively low hardness and particular thermal properties. An added benefit to these products is that they can be directly purchased in a small diameter spherical bead form. The typical bead diameters are between 10 to 200 microns, which makes them directly usable without pre-processing to grind larger pellets down to an acceptable size.

Filler should also be non abrasive, and non destructive to cutter tools. If one cuts through the cured blocking material with a cutting or grinding tool it should not damage the tool. Some increased wear can be acceptable in certain circumstances however the amount of increased wear tolerated by the customer is typically driven by total process economics.

The preferred filler particle geometry (generally spherical) and size (smaller than 2 mm, more preferably equal to or less than 1 mm) have been discussed already. Another important property of the filler is that it must not prevent or unduly slow down the curing process by blocking or somehow inhibiting the UV and/or visible electromagnetic energy from reaching the photoinitiators imbedded in the UV/VIS curable adhesive material. Thus transparency and/or translucency to the photo active wavelengths is considered very important for the selection of a compatible filler.

A still further desirable feature or function of the filler material is to reduce outgassing by incorporating a very low outgassing material(s), and thus significantly reduce the "vacuum pumping times" if and when a complete blocked lens is introduced into a vacuum chamber typically used in thin film coating processes. Three major sources of outgassing can be VOC emissions (Volatile Organic Compounds) from solvents, uncured remainders of liquid resin, and water moisture trapped within the blocking material. All three of these materials can vaporize in a vacuum and create a situation where it is difficult or slower than desired to reach the level of vacuum required for the coating process.

In the case of solvents the preferred approach is to avoid introducing any solvents in the liquid compound. This means it is generally preferred to use 100% solids type resins to guarantee no solvent stays in absorption in the cured blocking material. Incomplete cure can be a cause for the liquid resin remaining within the "cured" material. This problem is generally addressed by again providing a UV/VIS transparent/ translucent filler, and providing better curing technology, such as a better focussed high powered light source to scan the lens block, or ultra high energy XENON flash lamp technology. The third situation is that of moisture content. In this case it becomes important to choose low moisture absorption material(s) for the filler. Examples of such materials are polycarbonate and PET based materials just to name two.

Finally, a strongly preferred approach is to directly re-use the UV/VIS cured adhesive material in a reground state as a filler. What is proposed is that as lenses are deblocked, instead of discarding the cured UV blocking material, the operator can simply put it into a small grinder designed to regrind the material to the proper particle size. This reground material is then mixed with new uncured UV/VIS curable adhesive material in the proper mixing ratio using known measuring technology and apparatus and methods. Metering screws using a mixing nozzle is one approach. The preferred mixing ratios are between 40%/60% and 70%/30% filler granulate vs. liquid UV/VIS curable adhesive material. This concept allows continuous or on demand mixing of the two components in relatively accurate mixing ratios, and can also be used to deliver the correct amount of mixed adhesive composition to the lens block. Another simpler approach is to simply weigh the correct amount of components for a batch, and mix with a powered hand mixer such as a hand drill assisted paint mixer.

One of the main advantages to using reground material is that all the shrinkage and exothermic heat reduction are obtained that would normally be expected with other fillers, while simultaneously reducing cost even more than if these other fillers were used. The cured blocking material would normally end up in disposal, so recycling 50% to 70% of it has both economic and environmental benefits. Cost benefits are realized since its cost is near zero. The only costs are those of handling, grinding, and mixing. Environmental benefits come from the fact that the disposal volumes are significantly reduced. Another advantage is that new uncured material bonds very well to the cured material due to chemical similarity between the two. Still another benefit is that any variation in mixing ratios will not affect the final mechanical and thermal properties such as temperature dependent hardness/flexibility, softening point, etc. This simplifies mixing and quality control of the mixed adhesive composition since tolerances to mixing errors are much greater. Other advantages are those of consistent and predictable UV transmissibility, "all in one" compound design not affected by foreign or not completely compatible fillers, no filler quality variation, etc.

It is to be noted here that the last two paragraphs assume using "pure" uncured and unfilled UV/VIS curable adhesive material to start with, then after this material has been cured it is ground and used as a filler with new liquid (uncured) material. From this point forward, when a lens is deblocked, the UV/VIS cured blocking material is recycled by grinding and mixed as a non polymerizing solid filler into new uncured UV/VIS curable material.

EXAMPLE 1

A mixture of 60% by weight *Solvay "Polycaprolactone C6500"* with a particle size of 3 mm, and 40% by weight *"General #3"* UV curable blocking compound (PL110284-02, MFG. DATE: Jan 23,06-01) containing acrylate resins, monomers and photoinitiators, and sold by *MotionFab* (609891 NB Ltd.) of Moncton, New

Brunswick, Canada was tested. (The *General #3* blocking compound was formerly known as "*ULTRAGRIP®*" sold by *Micro Optics Design Corporation* of Moncton, New Brunswick, Canada). As in the following examples the individual components of the adhesive composition, i.e. the liquid UV curable adhesive and the solid filler particles were mixed thoroughly by hand.

The mixed product cured successfully due to the fact that the "white" *C6500* particles transmitted enough of the photo active wavelengths to obtain complete curing after 10 seconds of exposure time using a "*Fusion*" UV lamp (which can be obtained from *Fusion UV Systems, Inc.* 910 Clopper Road Gaithersburg, Maryland 20878-1357 USA) mounted with a "D" type bulb.

The main disadvantages to this material seemed to be the large particle size, and the relatively high cost of the *C6500*. The hardness at room temperature of the mixed and cured sample was measured to be in the range of 39 to 55 Shore D which very closely matches the hardness of cured *General #3* (38 Shore D) and *C6500* measured at 57 Shore D. A multiple reading average gave a value of 45.6 Shore D. The reason for the large variance and close correlation to the hardness's of each component has been attributed to the large particle size and the probability of measuring with the gage point directly over a *C6500* particle, or in between particles. Also, the *C6500* particles were covered by a non uniform thickness of *General #3*, which further added to the unpredictability of the measurements.

A softening of the cured adhesive composition measured as a reduction in average hardness to 35 shore D at a deblocking temperature of 50°C was however clearly seen, and facilitated deblocking.

The large particle size of the *C6500* was seen to be a problem for two major reasons; the first was that this increases the minimum gap achievable between the lens blank and the lens block, therefore increasing the quantity of material needed for blocking. The second problem was seen to be irregular shrinkage causing a small ripples or variation in optical power in very thin lenses. This is explained by shrinkage between granules being greater than the shrinkage directly over a granule, with another possible contributing factor being the variance in hardness causing a variation in support stiffness provided by the cured blocking material.

EXAMPLE 2

A mixture of "*Elvacite® 2550*" (Methyl/ n-Butyl methacrylate copolymer) obtained from *Lucite International Specialty Polymers Ltd.* and *General #3* was prepared at a ratio of 60% by weight *Elvacite® 2550* to 40% by weight UV compound, i.e. *General #3*. This increased the overall hardness of the cured adhesive composition to 40.4 Shore D, and resulted to a much lower variance in hardness.

The particular sample of *Elvacite® 2550* used had generally spherical or ellipsoidal particles of irregular diameters ranging from 15 to 460 microns, with an average particle size of 350 microns.

The low Tg (36°C) and relatively low hardness of 28 Shore D of the cured mixture at 50°C deblocking temperature gave a good combination of stiffness at processing (surfacing) temperatures and high flexibility at deblocking temperatures. The 350 micron particle size was also seen to be a benefit for providing uniform shrinkage and support in addition to minimum gaps of less than 0.5 mm being possible. And finally the UV transparent/translucent properties of the *Elvacite® 2550* filler made it very easy to cure the adhesive composition with all the different light sources that were tested.

EXAMPLE 3

A third compound was prepared using *ExxonMobil "Escor AT320 EMA-AA Terpolymer"*. The 60% by weight of *Escor AT320* filler to 40% by weight of *General #3* was again used.

The particle geometry of this filler was irregular, and the particle size was such that it passed through a 1.5 mm screen.

This adhesive composition is seen to be an advantageous material from the thermal properties perspective, and was tested for support at a surface processing temperature of 23°C and deblocking temperature between 55°C and 60°C. Hardness reduced on a slope of 0.4 Shore D per °C, but started at a relatively low 25 Shore D hardness at 25°C. This hardness is lower than the *General# 3* hardness of 38 Shore D so it is felt that other products from this filler material family may provide better stiffness at surface processing temperatures between 20 and 25°C.

EXAMPLE 4

A fourth compound was prepared and tested using a filler made from cured, i.e. polymerized pure *General #3* at 50% by weight and liquid (uncured) *General #3* at 50% by weight. In this instance the final cured adhesive composition is always *General #3* since the filler is also the same *General #3*.

The cured material was ground to have particle sizes between 0.5 and 1.5 mm, and an average size of 1 mm. These particles were very irregular in shape due to the grinding process used. Higher fill ratios were difficult to obtain, possibly due to the irregular particle geometries.

This material had all of the advantages of other filled materials tested; namely lower shrinkage, and lower exothermic heat of polymerization. In the polymerized state, i.e. as a non polymerizing solid filler it is UV transparent and forms a very coherent solid mass of material with identical mechanical and thermal properties to that of the unfilled material. Major advantages of this approach to recycling the blocking material itself are those of low cost and of reduced material wastage.

EXAMPLE 5

A fifth blocking material was prepared from the uncured adhesive composition according to EXAMPLE 4 above by adding 2% by weight of the filler in total of small aluminum fibers ("*Aluminiumfasern Al Mg S Kurzfaser F35*") purchased from *Alroko GmbH & Co. KG*, of Hamburg, Germany.

The fibers were very irregular in size and shape. They ranged in length from 0.5 mm to 3 mm, and varied in diameter from 0.1 to 0.5 mm.

The purpose of the added fibers was simply to shorten the heating time using microwave energy. This proved to be very effective for this purpose.

A new lens blocking material (adhesive composition) is proposed that essentially overcomes the drawbacks of previous blocking materials. This new material combines traditional UV and/or visible light (VIS) curable polymer materials with specially selected filler(s) as a non polymerizing solid in order to achieve or improve certain desirable material properties, including those of low shrinkage, low exothermic heat of polymerization, and improving the ability to deblock, while simultaneously reducing the high cost associated with such UV/VIS radiation curable materials. The new material is being used in methods for blocking a lens blank onto a lens block with a lens mounting face that has a pre-determined block curve, in which the number of different block curves required to cover the full range of standard lenses is minimized.

LIST OF REFERENCE NUMERALS

10	lens blank
12	step discontinuity
14	bifocal segment
16	base curve
18	lens block
20	UV cured adhesive
22	gap
24	gap
26	lens mounting face
28	blocking face
30	blocking apparatus
32	top
34	hood structure
36	lens transporter
38	first linear actuator
40	imaging station
42	probing station
44	lens blocking station
46	camera
48	adhesive composition reservoir
50	pumping unit
52	central processing unit
54	lens blank
56	screen
58	blocking face
60	lens block support
62	lens block
64	lens mounting face
66	UV light source
68	aperture
70	dispenser
72	dispenser nozzle
74	dispenser arm

76	motor
78	adhesive composition

CLAIMS:

1. A method for blocking a lens blank (54) having a blocking face (58) of pre-determined curvature, said method comprising the steps of:

(a) providing a plurality of lens blocks (62) each comprising a lens mounting face (64) that has a pre-determined block curve, wherein said lens blocks (62) all have the same block curve;

(b) taking out one of said lens blocks (62) of said plurality of lens blocks (62);

(c) mixing an adhesive composition (78) comprising in an un-polymerized state a liquid adhesive curable by UV or visible light and a filler as a non polymerizing solid;

(d) applying to at least one of said blocking face (58) of said lens blank (54) and said lens mounting face (64) of said lens block (62) said adhesive composition (78);

(e) urging said lens blank (54) toward said lens block (62) with said blocking face (58) of said lens blank (54) facing said lens mounting face (64) of said lens block (62); and

(f) generating UV or visible light and transmitting the light to said adhesive composition (78), said light being of a wavelength and an intensity and applied for a time interval sufficient to cause setting of said adhesive composition (78);

(g) wherein a mixing ratio of said adhesive and said filler is selected to have a dimensional change and exothermic heat of polymerization of said adhesive composition (78) upon setting low enough so that the adhesive composition (78) is capable of setting without imparting undue stresses on said lens blank (54) and without de-bonding of said lens blank (54) from said adhesive composition (78).

2. The method according to claim 1, wherein said lens blocks (62) all have an essentially spherical lens mounting face (64) comprising the same block curve selected in accordance with a distribution of said blocking face (58) curvature of lens blanks (54) to be blocked for a given population.

3. A method for blocking a lens blank (54) having a blocking face (58) of pre-determined curvature, said method comprising the steps of:

(a) providing a plurality of lens blocks (62) each comprising a lens mounting face (64) that has a pre-determined block curve, wherein said lens blocks (62) have a few different block curves only;

(b) selecting a lens block (62) having a specific block curve depending on said curvature of said blocking face (58) of said lens blank (54) so that said block curve matches said curvature of said blocking face (58) as best as possible;

(c) mixing an adhesive composition (78) comprising in an un-polymerized state a liquid adhesive curable by UV or visible light and a filler as a non polymerizing solid;

(d) applying to at least one of said blocking face (58) of said lens blank (54) and said lens mounting face (64) of said lens block (62) said adhesive composition (78);

(e) urging said lens blank (54) toward said lens block (62) with said blocking face (58) of said lens blank (54) facing said lens mounting face (64) of said lens block (62); and

(f) generating UV or visible light and transmitting the light to said adhesive composition (78), said light being of a wavelength and an intensity and applied for a time interval sufficient to cause setting of said adhesive composition (78);

(g) wherein a mixing ratio of said adhesive and said filler is selected to have a dimensional change and exothermic heat of polymerization of said adhesive composition (78) upon setting low enough so that the adhesive composition (78) is capable of setting without imparting undue stresses on said lens blank (54) and without de-bonding of said lens blank (54) from said adhesive composition (78).

4. The method according to claim 3, wherein said lens blocks (62) all have an essentially spherical lens mounting face (64), there being provided lens blocks (62) of two different block curves only, namely lens blocks (62) comprising a concave block curve within the range of 0 to 4 diopters, and lens blocks (62) comprising a concave block curve within the range of 4 to 8 diopters.

5. The method according to claim 3 or 4, wherein said step of selecting a lens block (62) is carried out to the effect that, in the blocked state of said lens blank (54), a gap between said lens mounting face (64) of said lens block (62) and said blocking face (58) of said lens blank (54) is minimized in a central region of said lens block (62).

6. The method according to one of the preceding claims, wherein said lens blocks (62) are capable of transmitting UV or visible light, and wherein said step of generating UV or visible light and transmitting the light to said adhesive composition (78) includes transmitting the light to said adhesive composition (78) through said lens block (62).

7. The use in lens blocking of an adhesive composition (78) comprising:

an adhesive curable by UV or visible light that is liquid in an un-polymerized state; and

a filler as a non polymerizing solid.

8. An adhesive composition (78) for lens blocking comprising:

an adhesive curable by UV or visible light that is liquid in an un-polymerized state; and a filler as a non polymerizing solid;

wherein the mixing ratio of said adhesive and said filler is in a range from 70%/30% to 30%/70% by weight adhesive vs. filler.

9. The method, use and adhesive composition (78), respectively, according to one of the preceding claims, wherein said filler consists of solid particles.

10. The method, use and adhesive composition (78), respectively, according to claim 9, wherein the filler particle geometry is generally spherical.

11. The method, use and adhesive composition (78), respectively, according to claim 9 or 10, wherein the filler particle size is smaller than 2 mm, preferably equal to or less than 1 mm.

12. The method, use and adhesive composition (78), respectively, according to one of the preceding claims, wherein the filler contains a small amount of metal fibers, granules, or powder, preferably aluminum fibers in a quantity of 1 to 2% by weight of the composition in total.

13. The method, use and adhesive composition (78), respectively, according to one of the preceding claims, wherein the filler material is transparent and/or translucent to photo active wavelengths of UV and/or visible light.

14. The method, use and adhesive composition (78), respectively, according to one of the preceding claims, wherein the filler material has low moisture absorption properties.

15. The method, use and adhesive composition (78), respectively, according to one of the preceding claims, wherein the filler material has a Glass Transition Temperature (Tg) between 25° and 80°C.

16. The method, use and adhesive composition (78), respectively, according to one of the preceding claims, wherein the filler material is selected from a group comprising:

the UV or visible light cured adhesive in a reground state; and

plastic materials including e-Caprolactone, Terpolymer derived from Ethyl-Methyl-Acrylate-Acrylic Acid, Polycarbonate, Polyethylene (PET), High Methacrylate Resin, Ethyl Methacrylate Resin, Methacrylate Copolymer Resin, Butyl Methacrylate Resin, and Methyl/ n-Butyl Methacrylate Copolymer Resin.

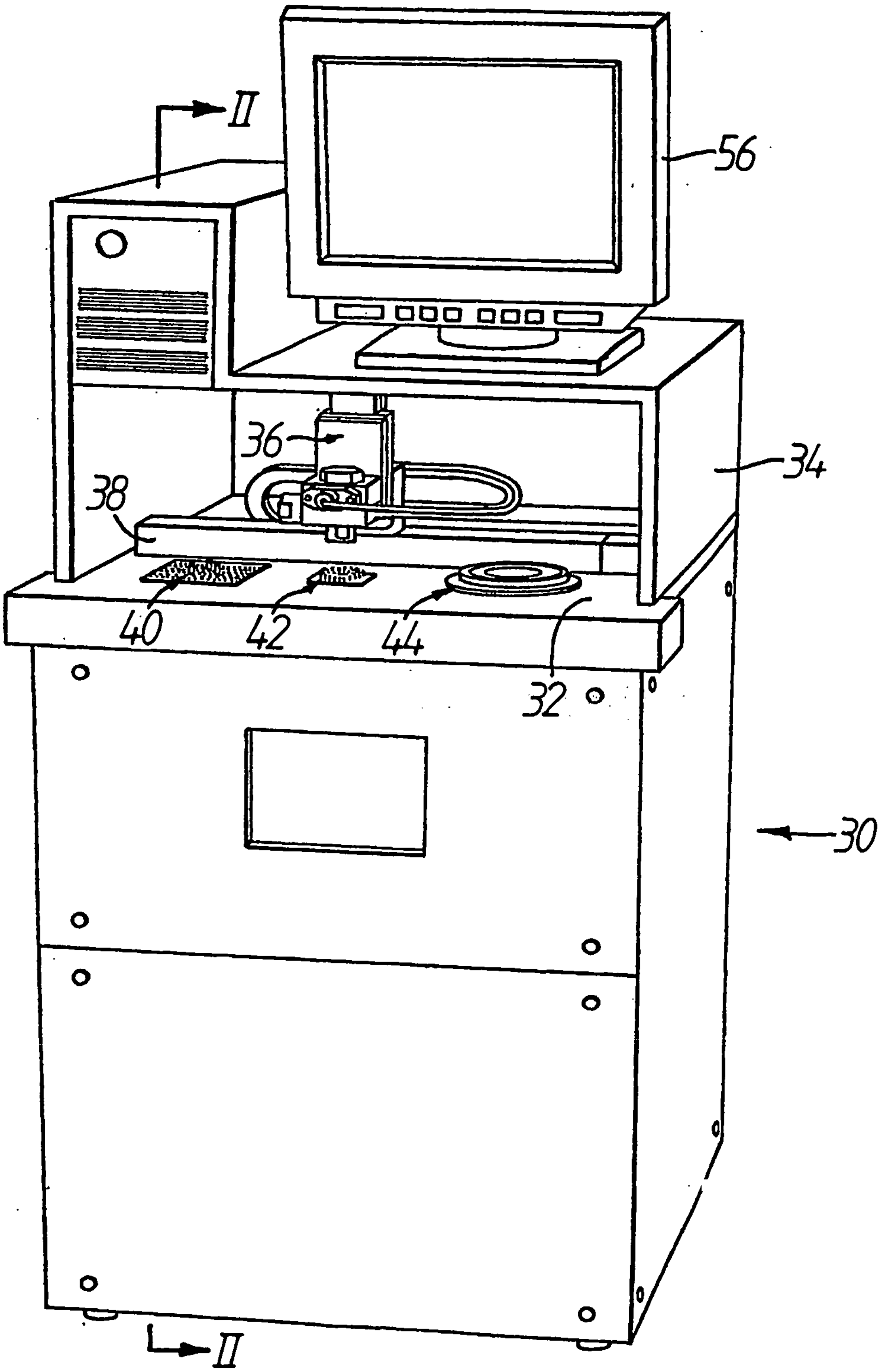


FIG. 1

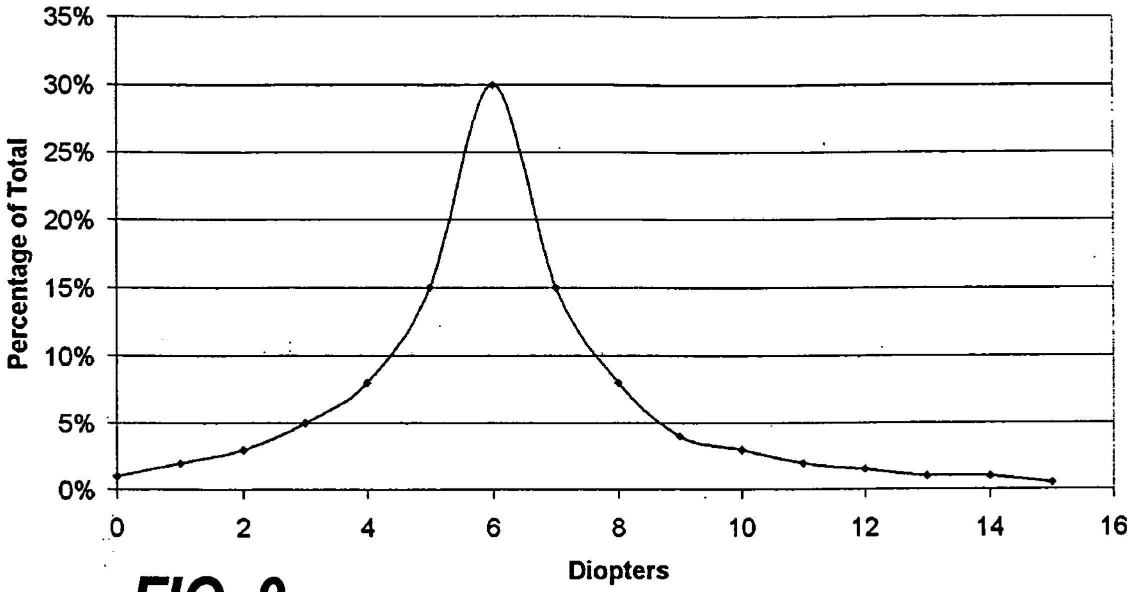

35%
30%
25%
20%
15%
10%
5%
0%
Percentage of Total
0
2
4
6
8
10
12
14
16
Diopters

FIG. 9

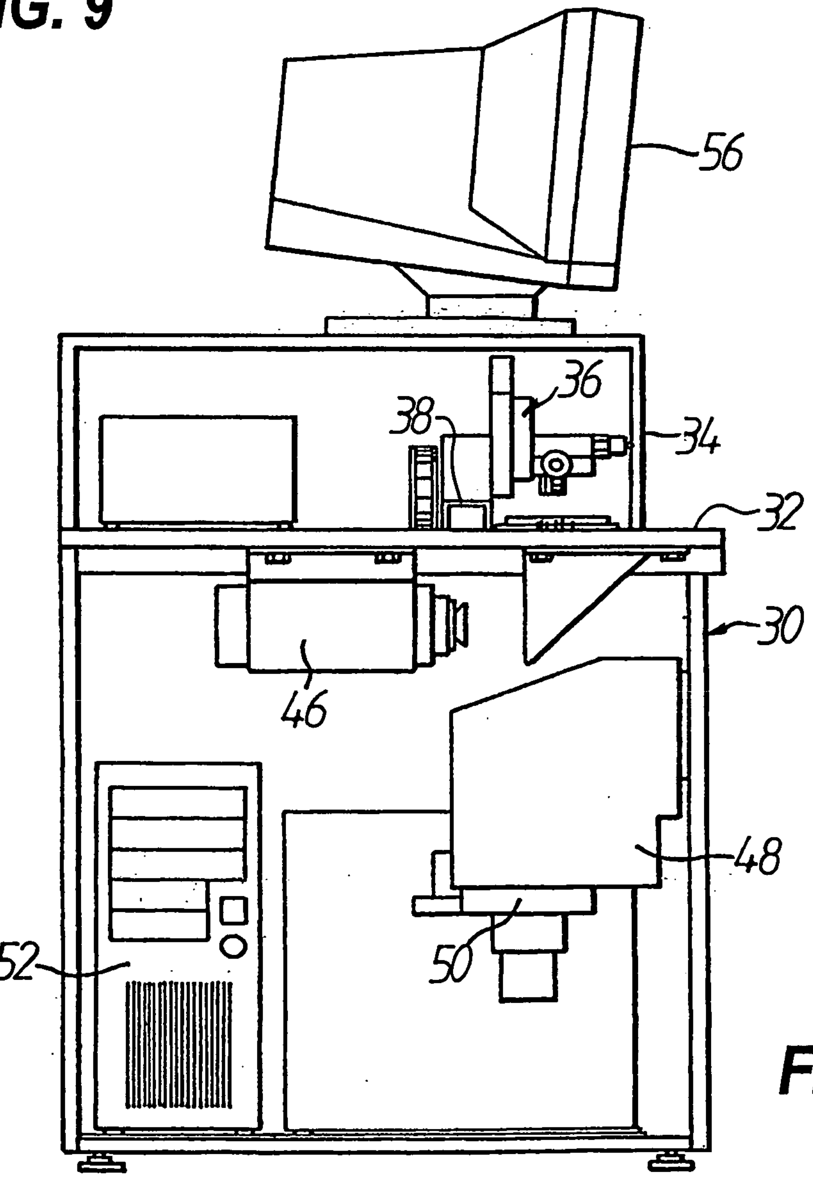
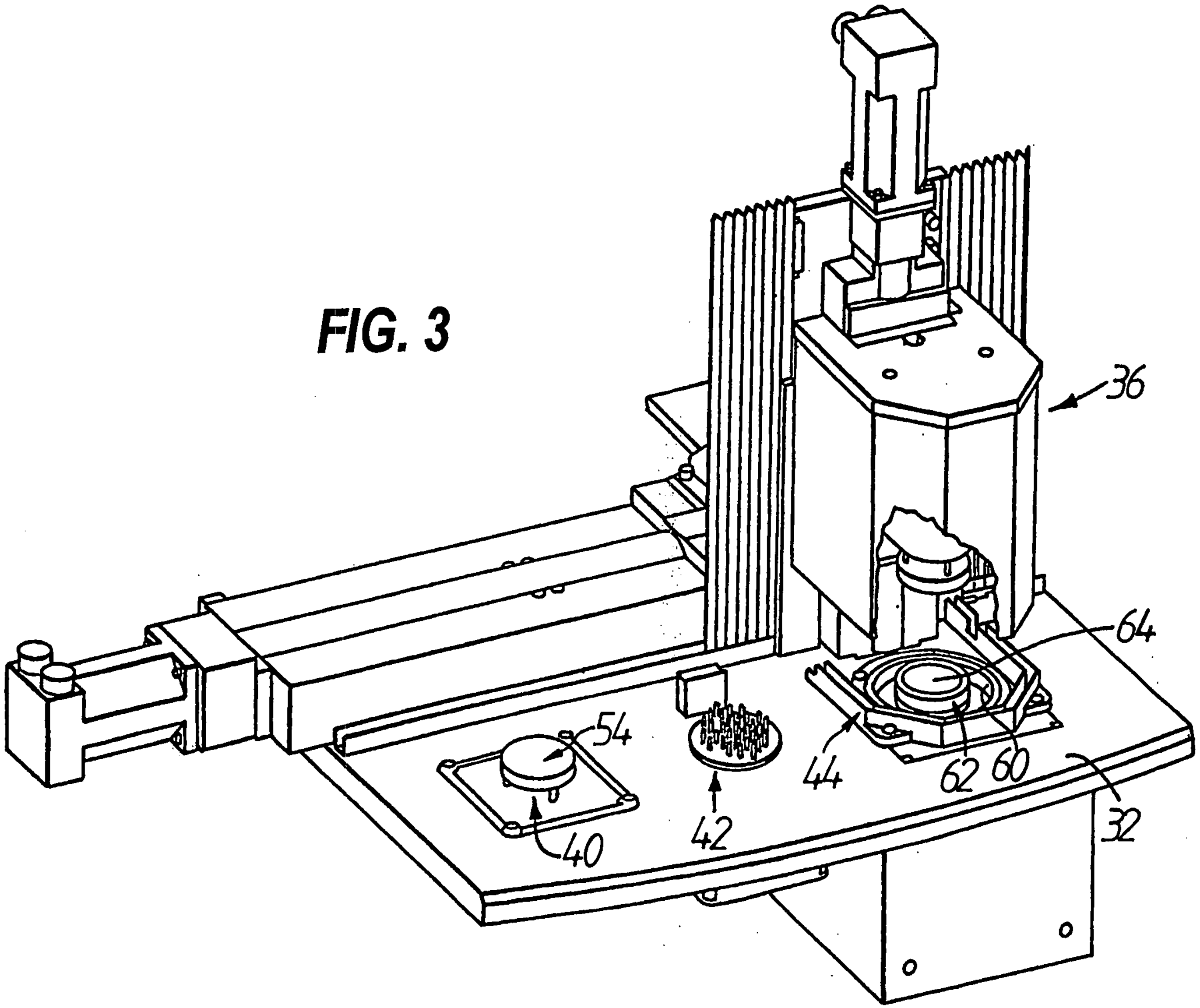

56
36
38
34
32
30
46
48
52
50

FIG. 2

FIG. 3



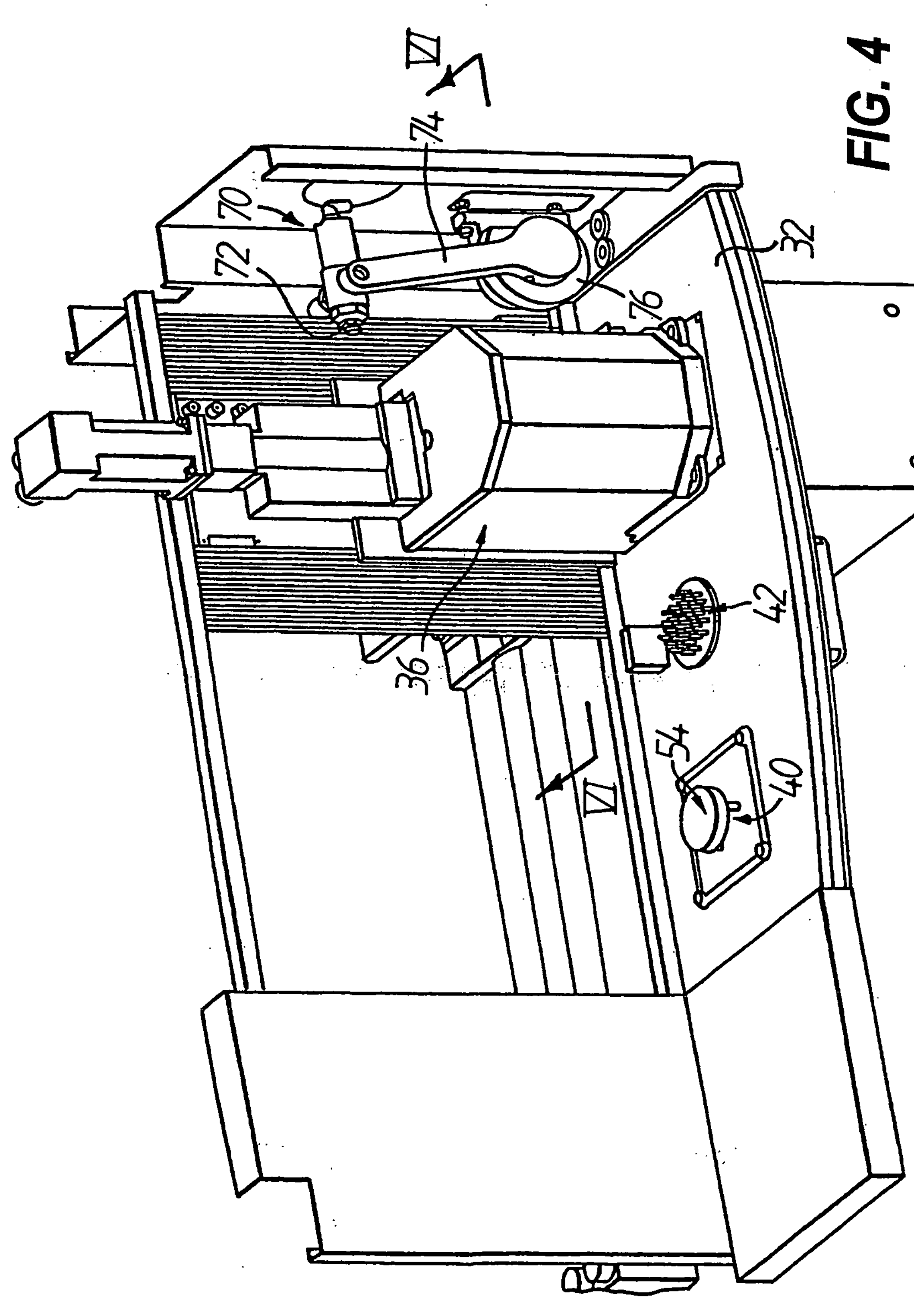


FIG. 4

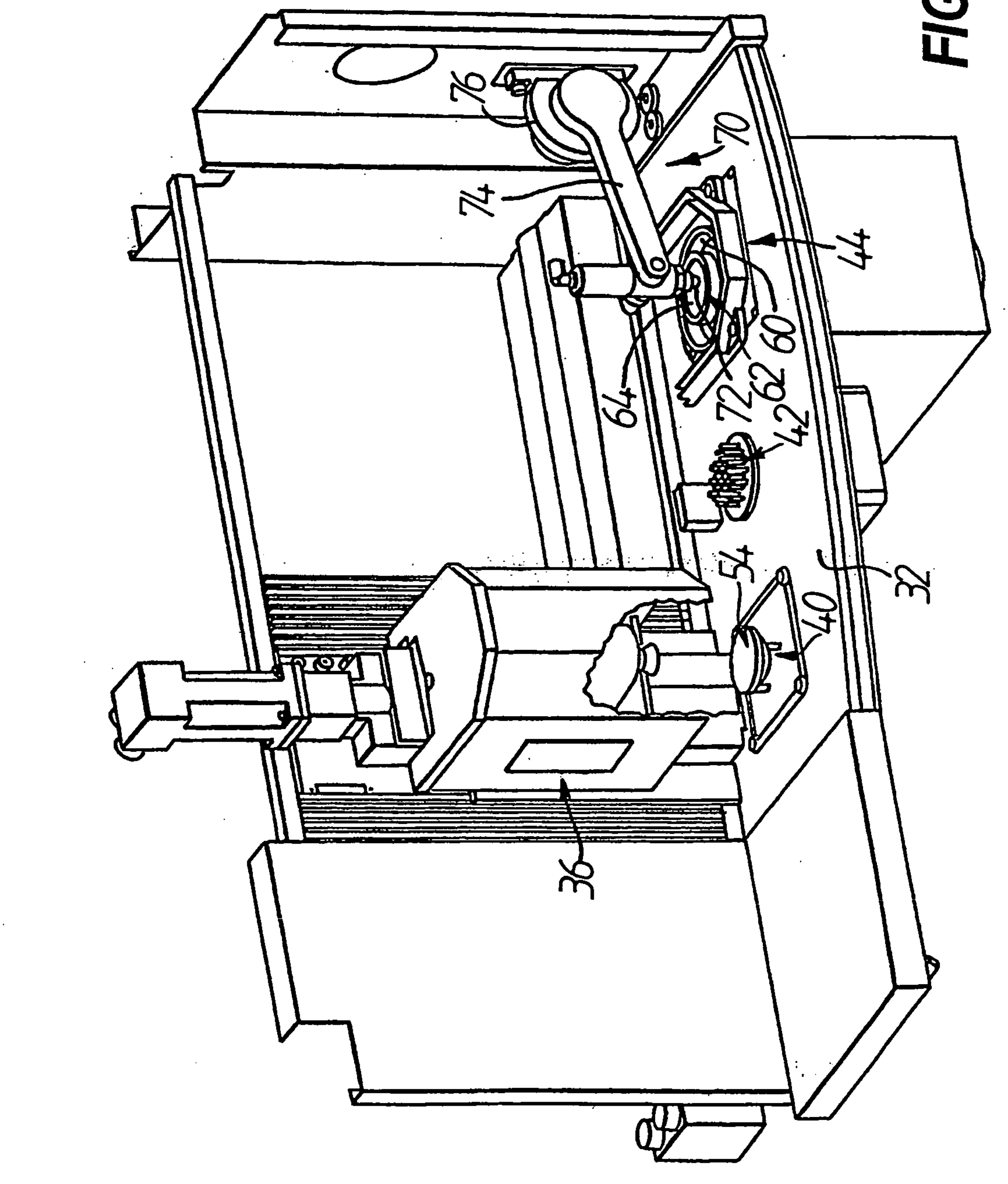


FIG. 5

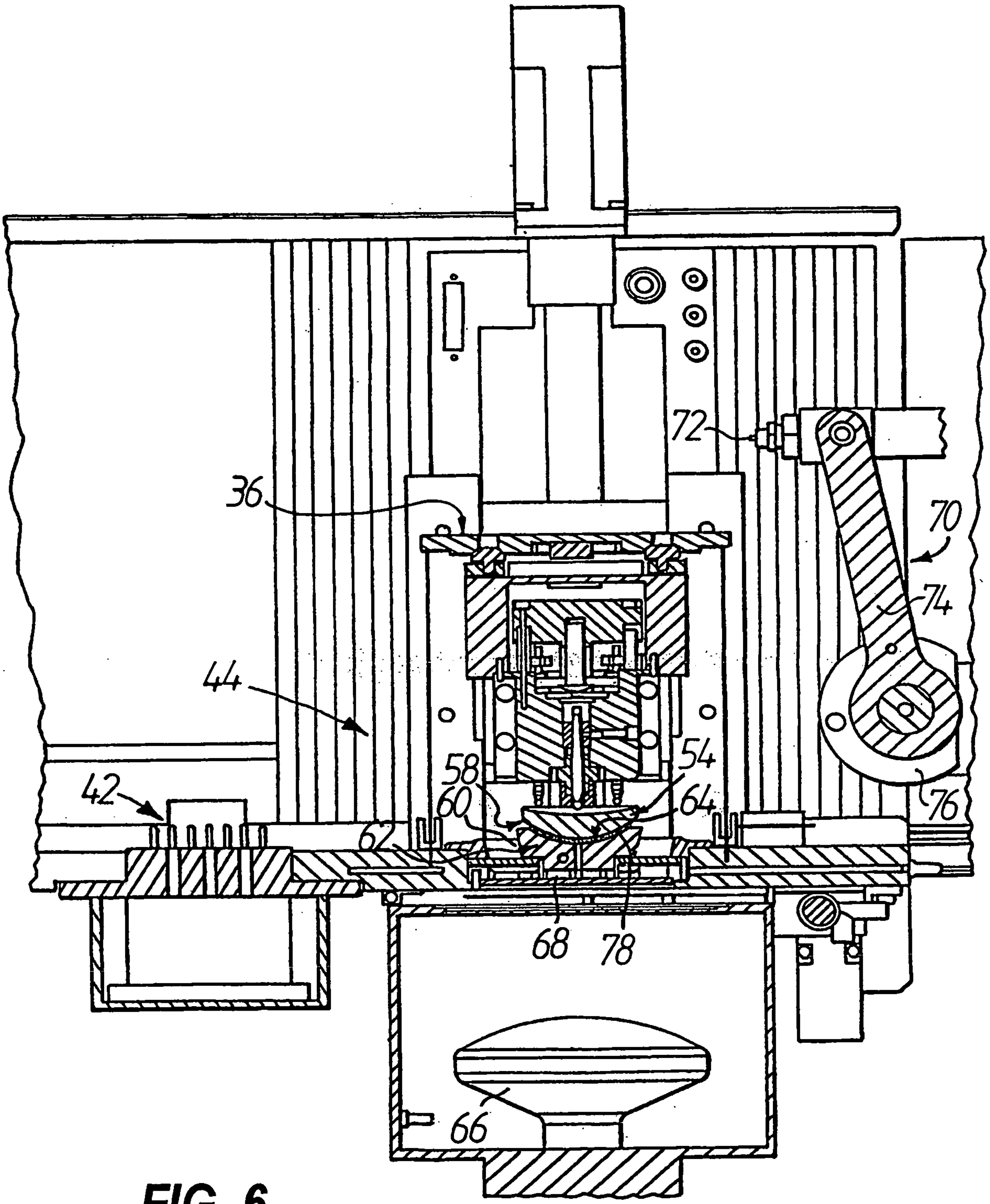
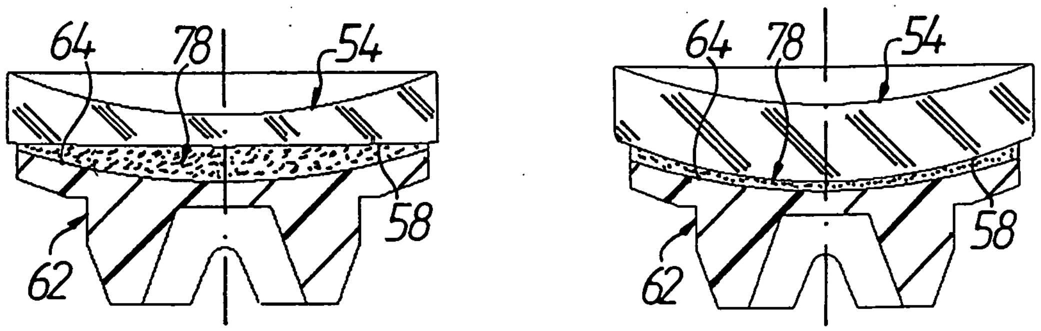
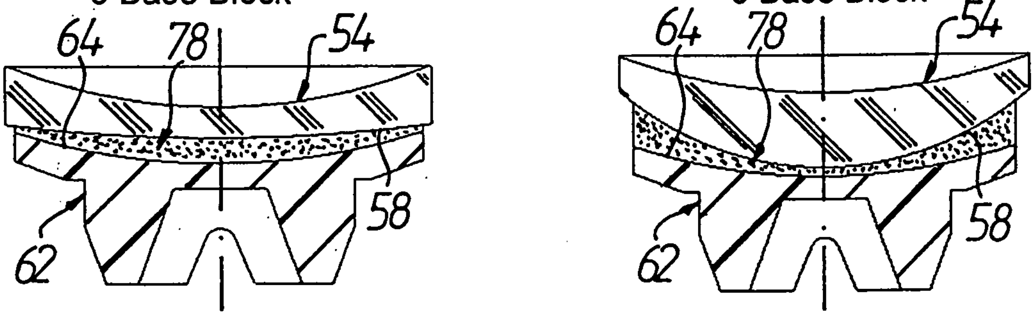


FIG. 6



a) 0.5 Base Lens &
5 Base Block

c) 6 Base Lens &
5 Base Block

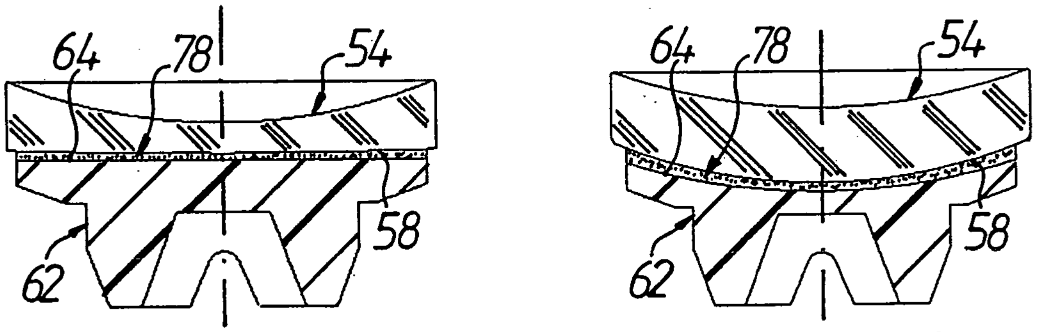


b) 2 Base Lens &
5 Base Block

d) 10 Base Lens &
5 Base Block

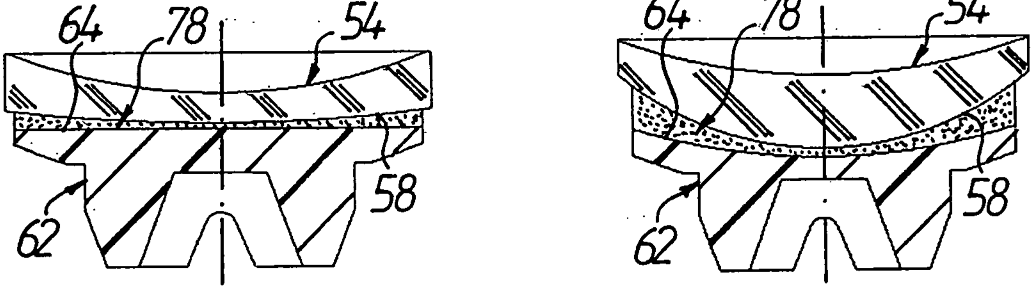
FIG. 7

FIG. 8



a) 0.5 Base Lens &
0.5 Base Block

c) 6 Base Lens &
5 Base Block



b) 2 Base Lens &
0.5 Base Block

d) 10 Base Lens &
5 Base Block

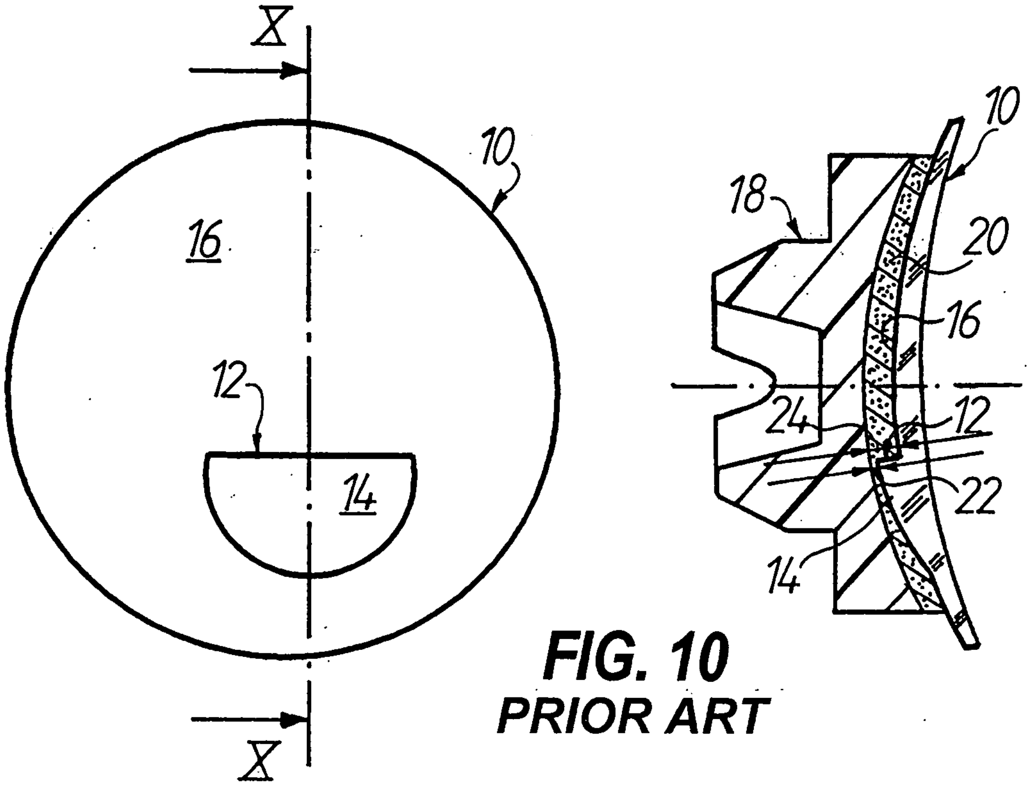
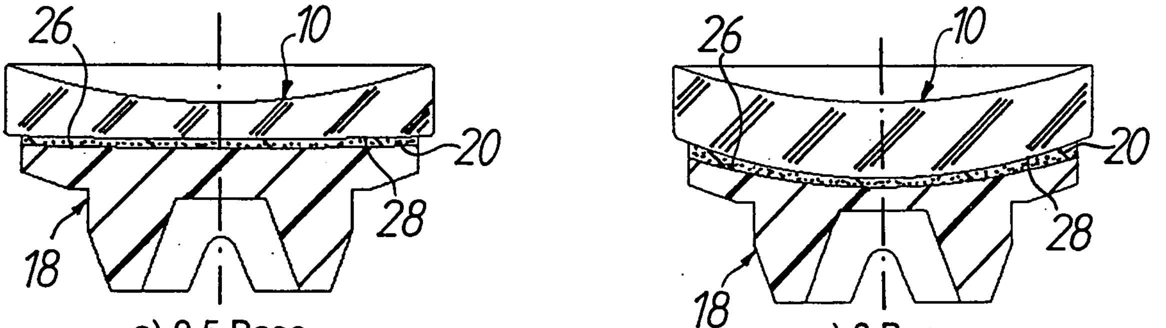
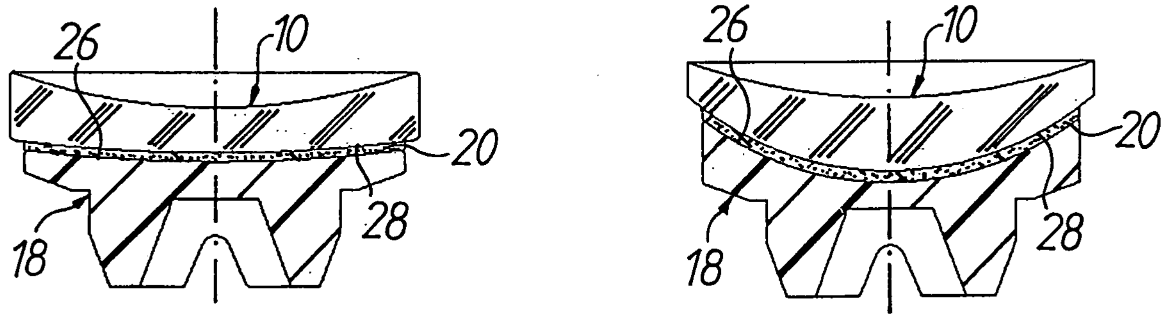


FIG. 10
PRIOR ART



a) 0.5 Base

c) 6 Base



b) 2 Base

d) 10 Base

FIG. 11
PRIOR ART

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2008/005306

A. CLASSIFICATION OF SUBJECT MATTER
INV. B24B13/005 B29D11/00 C08F290/08 C09D175/16 C09J151/00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
B24B B29D C08F C09D C09J

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	WO 94/08788 A (LOCTITE CORP [US]) 28 April 1994 (1994-04-28) page 4, line 10 - page 5, line 35	1,3,7,8
A	US 2005/139309 A1 (SAVOIE MARC [CA] ET AL) 30 June 2005 (2005-06-30) cited in the application paragraph [0018] - paragraph [0068]	1,3,7,8

☐ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search 16 October 2008	Date of mailing of the international search report 28/10/2008
Name and mailing address of the ISA/ European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Authorized officer Eschbach, Dominique

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/EP2008/005306

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 9408788 A	28-04-1994	DE 69323741 D1 DE 69323741 T2 EP 0641281 A1 HK 1005128 A1 JP 7502461 T	08-04-1999 07-10-1999 08-03-1995 17-03-2000 16-03-1995
US 2005139309 A1	30-06-2005	WO 03018254 A2 CA 2356579 A1 EP 1423234 A2 JP 2004538170 T	06-03-2003 28-02-2003 02-06-2004 24-12-2004

[19] 中华人民共和国国家知识产权局

[12] 发明专利申请公布说明书

[21] 申请号 200880018160.1

[51] Int. Cl.
B24B 13/005 (2006.01)
B29D 11/00 (2006.01)
C08F 290/08 (2006.01)
C09D 175/16 (2006.01)
C09J 151/00 (2006.01)

[43] 公开日 2010 年 3 月 24 日

[11] 公开号 CN 101678526A

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[21] 申请号 200880018160.1
[30] 优先权
[32] 2007.7.5 [33] EP [31] 07013158.6
[86] 国际申请 PCT/EP2008/005306 2008.6.28
[87] 国际公布 WO2009/003660 英 2009.1.8
[85] 进入国家阶段日期 2009.11.30
[71] 申请人 萨特隆股份公司
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代理人 刘 佳

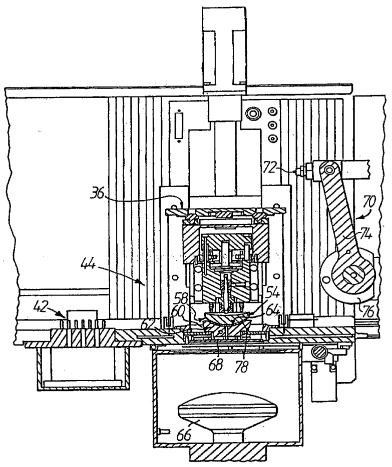
权利要求书 4 页 说明书 24 页 附图 8 页

[54] 发明名称

粘合镜片毛坯的方法，粘结剂组合物及其在镜片粘合中的用途

[57] 摘要

本发明提供了一种新的镜片粘合材料(粘结剂组合物 78)，它基本上克服了以往粘合材料的缺点。这种新材料结合了传统的 UV 和/或可见光(VIS)固化聚合物材料与专门选择的作为非聚合固体的填料，以便获得或改善某些期望的材料性能，包括收缩率低、聚合放热低，且改善了解块能力，同时降低了与这种 UV/VIS 辐射固化材料相关的高成本。这种新材料可以用在用于将镜片毛坯(54)粘合在镜片坯块(62)上的方法中，所述镜片坯块包括具有预定坯块曲线的镜片安装面(64)，其中用于覆盖全范围的标准镜片所需的坯块曲线的数量最小。



1、一种粘合镜片毛坯（54）的方法，所述镜片毛坯的粘合面（58）具有预定的曲率，该方法包括以下步骤：

（a）提供多个镜片坯块（62），每个镜片坯块的镜片安装面（64）具有一个预定的坯块曲线，其中所述镜片坯块（62）都具有相同的坯块曲线；

（b）从所述多个镜片坯块（62）中取出一个镜片坯块（62）；

（c）混合粘结剂组合物（78），所述粘结剂组合物（78）包括在未聚合状态的且可由紫外或可见光固化的液态粘结剂和作为非聚合固体的填料；

（d）将上述粘结剂组合物（78）施加到上述镜片毛坯（54）的粘合面（58）和上述镜片坯块（62）的镜片安装面（64）中的至少一个面上；

（e）将上述镜片毛坯（54）推向上述镜片坯块（62），其中上述镜片毛坯（54）的粘合面（58）面对上述镜片坯块（62）的镜片安装面（64）；和

（f）产生紫外线或可见光，并将上述光传送到所述粘结剂组合物（78），所述光的波长和强度以及施加的持续时间足以固化所述粘结剂组合物（78）；

（g）其中所述粘结剂和所述填料的混合比例被选择为，使所述粘结剂组合物（78）在固化时的聚合放热和尺寸变化足够低，使得所述粘结剂组合物（78）能够被固化而不会在所述镜片毛坯（54）上产生不适当的应力且不会使所述镜片毛坯（54）从所述粘结剂组合物（78）脱胶。

2．根据权利要求1的方法，特征在于所述镜片坯块（62）都具有一个基本球面形的镜片安装面（64），所述镜片安装面包括同一坯块曲线，所述同一坯块曲线根据特定人群的将被粘合的镜片毛坯（54）的粘合面（58）曲率的分布而选择。

3．一种粘合镜片毛坯（54）的方法，所述镜片毛坯的粘合面（58）具有预定的曲率，该方法包括以下步骤：

（a）提供多个镜片坯块（62），每个镜片坯块的镜片安装面（64）

具有一个预定的坯块曲线，其中所述镜片坯块（62）仅具有几个不同的坯块曲线；

（b）根据上述镜片毛坯（54）的粘合面（58）的上述曲率，选择具有特定坯块曲线的一个镜片坯块（62），使得所述坯块曲线与所述粘合面（58）的曲率尽可能好地匹配；

（c）混合包括在未聚合状态的、紫外或可见光固化的液态粘结剂和作为非聚合固体的填料的粘结剂组合物（78）；

（d）将上述粘结剂组合物（78）施加到上述镜片毛坯（54）的粘合面（58）和上述镜片坯块（62）的镜片安装面（64）中的至少一个上；

（e）将上述镜片毛坯（54）推向上述镜片坯块（62），其中上述镜片毛坯（54）的粘合面（58）面对上述镜片坯块（64）的镜片安装面（64）；和

（f）产生紫外线或可见光，并将上述光传送到所述粘结剂组合物（78），所述光的波长和强度以及施加的持续时间足以固化所述粘结剂组合物（78）；

（g）其中所述粘结剂和所述填料的混合比例被选择为，使所述粘结剂组合物（78）在固化时的聚合放热和尺寸变化足够低，使得所述粘结剂组合物（78）能够被固化而不会在所述镜片毛坯（54）上产生不适当的应力且不会使所述镜片毛坯（54）从所述粘结剂组合物（78）脱胶。

4. 根据权利要求3的方法，特征在于所述镜片坯块（62）都具有一个基本球面形的镜片安装面（64），其中提供了具有仅两个不同坯块曲线的镜片坯块（64），即具有在0至4屈光度范围的凹坯块曲线的镜片坯块（62）和具有在4至8屈光度范围的凹坯块曲线的镜片坯块（62）。

5. 根据权利要求3或4的方法，特征在于所述选择镜片坯块（62）的步骤要达到的效果是，在所述镜片毛坯（54）的粘合状态中，在所述镜片坯块（62）的镜片安装面（64）和所述镜片毛坯（54）的粘合面（58）之间的间隙在镜片坯块（62）的中心区域最小。

6. 根据任一前述权利要求的方法，特征在于所述镜片坯块（62）可以透过紫外线或可见光，其中所述产生紫外线或可见光和将上述光传送到粘结剂组合物（78）的步骤包括将光通过镜片坯块（62）传送到所述粘结

剂组合物（78）。

7．一种粘结剂组合物（78）在镜片粘合中的用途，所述粘结剂组合物包括：

在未聚合状态是液态的、可由紫外线或可见光固化的粘结剂，和

作为非聚合固体的填料。

8．一种用于镜片粘合的粘结剂组合物（78），包括：

在非聚合状态是液态的、紫外线或可见光固化的粘结剂，和

作为非聚合固体的填料；

其中所述粘结剂和填料的混合比例是粘结剂:填料在70%/30%（重量）和30%/70%（重量）百分比的范围中。

9．根据任一前述权利要求的方法、用途或粘结剂组合物（78），特征在于所述填料由固体颗粒组成。

10．根据权利要求9的方法、用途或粘结剂组合物（78），特征在于所述填料颗粒的几何形状通常是球形的。

11．根据权利要求9或10的方法、用途或粘结剂组合物（78），特征在于所述填料的粒度小于2毫米，最好是等于或小于1毫米。

12．根据任一前述权利要求的方法、用途或粘结剂组合物（78），特征在于所述填料含有少量的金属纤维、颗粒或粉末，最好是数量占组合物总量1-2%重量百分比的铝纤维。

13．根据任一前述权利要求的方法、用途或粘结剂组合物（78），特征在于所述填料材料对于紫外线和/或可见光的光激活波长是透明的和/或半透明的。

14．根据任一前述权利要求的方法、用途或粘结剂组合物（78），特征在于所述填料材料具有低的吸湿性。

15．根据任一前述权利要求的方法、用途或粘结剂组合物（78），特征在于所述填料的玻璃转变温度（Tg）在25℃和80℃之间。

16．根据任一前述权利要求的方法、用途或粘结剂组合物（78），特征在于所述填料材料选自由以下材料组成的组中：

在重磨状态的紫外线或可见光固化粘结剂；和

塑料材料，包括：e-己内酯、由乙基-甲基-丙烯酸酯-丙烯酸衍生的三

元共聚物、聚碳酸酯、聚乙烯（PET）、高甲基丙烯酸树脂、甲基丙烯酸乙酯树脂、甲基丙烯酸酯共聚物树脂、甲基丙烯酸丁酯树脂和甲基丙烯酸甲酯/正丁酯共聚物树脂。

粘合镜片毛坯的方法，粘结剂组合物及其在镜片粘合中的用途

技术领域

本发明一般涉及将光学玻璃眼镜片毛坯（blank）粘结到镜片支架坯块（block）（“镜片坯块”），以在镜片生产过程中支撑所述镜片毛坯，如在配镜车间--即根据处方从定制的材料（聚碳酸酯、矿物玻璃、CR39、高折射率（HI index）等）制造个别眼镜片的制造车间--中大规模应用的。

更具体地，本发明涉及一种粘合（blocking）镜片毛坯的方法，一种粘结剂组合物在镜片粘合中的用途及该粘结剂组合物本身，其中一种辐射固化材料在每种情况下被用作粘结剂。在本申请的上下文中“辐射固化材料”指对某些电磁辐射波长化学敏感的液态化学树脂化合物，所述波长会导致所述树脂固化，即所述材料在被这些“光激活”波照射时会聚合成为固体。换句话说，所述材料在被暴露在上述电磁辐射尤其是紫外线（“UV”）和高可见光谱（“VIS”）中时将从液态相变为固态。

背景技术

光学玻璃眼镜片毛坯一般包括具有预定曲率的第一面和与第一面相对的第二面，其上通过加工工艺产生期望的表面轮廓。整个工艺通常称为“镜片表面加工”，总体目标是产生一个成品光学玻璃眼镜片，其中第一和第二面的曲率相配合以产生预期的光学特性。

在配镜车间（prescription workshop），通常进行以下几个主要加工步骤：首先，从半成品产品库中移出一个适当的右和/或左光学玻璃眼镜片毛坯。术语“半成品”用于表示：其平面图通常为圆形或椭圆形且尚未磨边的光学玻璃眼镜片毛坯，在它们的两个光学激活面之一上已经被加工

或以其它方式形成了轮廓。然后光学玻璃眼镜片毛坯准备进行粘合操作，即施加适当的保护膜或适当的保护漆，以保护已经被加工或形成轮廓的光学激活面，即第一面或粘合面。

然后进行光学玻璃眼镜片毛坯的所谓“粘合”。在此期间，光学玻璃眼镜片毛坯被连接到一个合适的镜片坯块，例如按照德国标准 DIN 58766 的镜片坯块。为此，首先将镜片坯块相对于光学玻璃眼镜片毛坯的被保护的第一面放入一个预定位置，然后在这个位置在镜片坯块和光学玻璃眼镜片毛坯之间的空间被填入熔融材料（通常是金属合金或蜡）。一旦所述熔融材料固化，所述镜片坯块就形成了用于加工所述光学玻璃眼镜片毛坯的第二面的一个保持器或支架。所述镜片坯块在镜片生产过程中用夹盘或其它适当的耦合装置抓住，以对外形加工机（profiling machine）提供特别稳固的安装，同时避免损坏镜片。

然后使用外形加工机进行镜片表面加工，所述外形加工机通常具有某种类型的切割机，所述切割机移动经过光学玻璃眼镜片毛坯的第二面，使所述第二面的宏观几何形状（macrogeometry）符合处方的要求。依赖于所使用的具体外形加工机，所述镜片毛坯在上述切割操作中可以是静止的或转动的。用于表面加工光学玻璃眼镜片的典型加工工艺，包括单点金刚石切削加工工艺、金刚石车刀快速切削工艺、铣削工艺、研磨工艺，其使用依赖于镜片材料。

然后通常对光学玻璃眼镜片进行精细加工，其中相应的光学玻璃眼镜片毛坯的预加工的第二面被形成所需的微观几何形态（microgeometry）。除其它之外，根据所述光学玻璃眼镜片的材料，所述精细加工工艺分为精细研磨操作和随后的抛光操作，或者如果在预加工阶段已经产生可抛光的第二面的话，则只包括抛光操作。

在执行清洗步骤和可能的进一步精细加工步骤（例如对光学玻璃眼镜片施加抗反射涂层或硬化涂层）之前，仅在抛光步骤之后就将光学玻璃眼镜片与晶片坯块分开（“解块”，deblock）。因此，在（至少）多个加工操作步骤中，所述镜片坯块保留在上述光学玻璃眼镜片上，且必须在这些操作期间可靠地保留在其上。

最近已提出了一些用于镜片粘合的其它粘结材料，以克服由使用作为经典粘结剂的金属合金或蜡所产生的某些缺点—在将被粘合的镜片安全地释放到随后的加工操作之前用于固化所需的太长时间，由与熔融材料相关的热量造成的镜片畸变问题，和可能污染镜片，只列出其中一部分缺点。这些其它的粘结材料包括辐射固化材料。

在这一方面，专利文献US2005/0139309A描述了一种UV光固化的粘合材料，用于减少由聚合引起的收缩率。尽管这一发展是向允许UV固化材料用于镜片粘合方面迈出的一个重大步骤，它仍然表现出了3%量级的收缩率。当UV固化粘结剂用在较薄（通常小于3毫米）和厚度均匀的情况时，这种收缩量一般不严重；但在需要较厚剖面的粘结剂时，它有严重的限制。

当粘合具有非常不均匀剖面的镜片、因而需要使用不均匀剖面的粘结剂时，收缩问题变得更加明显。这方面的一个例子如图10所示，其中显示了具有位于双光区段14和基线（base curve）16之间的一个不连续台阶12的平顶双光镜片毛坯10，通过UV固化粘结剂20粘合在镜片坯块18上。如图10明显示出的，当在双光区段14和镜片坯块18之间的间隙22与直接位于双光区段14上方的间隙24明显不同时，收缩成为一个问题。在这一情况下，由UV固化后的粘结剂20的厚度差异造成的收缩差异能够导致直接位于双光区段14上方的严重的/不期望的畸变。

在试图克服与上述UV线光固化粘合材料有关的收缩问题时，有人提出用大量的（7或8）不同坯块曲线来近似地匹配想象的镜片基线，从而保持粘结剂厚度足够均匀以尽量减少剩余收缩的影响。图11显示了使用多个镜片坯块18的现有技术，每个镜片坯块18的镜片安装面26具有预定的坯块曲线，其中不同镜片坯块18的坯块曲线各不相同。在所示的例子中，镜片坯块18包括基本球面形的镜片安装面26，它们的坯块曲线分别是a）0.5屈光度，b）2屈光度，c）6屈光度和d）10屈光度，基本上与镜片曲线即被粘合的镜片毛坯10的粘合面28的相应曲率匹配。应当指出的是，图11中为简化说明，只显示了4种不同的镜片坯块18；但该系统实际上使用了7或8块不同的镜片坯块，如上所述。从图11中明显

可见，在每种情况下位于镜片毛坯10和镜片坯块18之间的UV固化粘结剂20具有较薄且基本均匀的厚度，使得不存在由UV固化粘结剂20的收缩所导致的严重畸变。

然而，使用大量的不同坯块基线的方法，对图10所示的情况没有帮助。与多个坯块基线相关的另一个问题是对这些大量基线的管理。最初需要选择正确的镜片坯块与镜片曲线相匹配，然后在解块之后，（假设镜片坯块被重复使用），需要根据曲线将它们妥善地分类，并存储在各个保存器/分配器中。因此，所述使用多个坯块曲线的方案增大了生产过程的复杂性，增大了出错的可能性，并因此增大了镜片的制造成本。

发明内容

本发明的目的是为提供一种粘合镜片毛坯的方法，其中覆盖标准镜片的全部范围所需的坯块曲线的数量被最小化，并且它解决了与将辐射固化材料作为粘结剂引起的收缩有关的问题。本发明的目的还包括提供一种用于粘合镜片的粘结剂组合物，它能够被辐射固化且实现上述目的。

上述目的分别由权利要求1、3、7和8中限定的特征达到。本发明的优点和适当发展形成权利要求2、4-6及9-16的主题。

根据本发明的一个方面，提供了一种粘合镜片毛坯的方法，所述镜片毛坯的粘合面具有预定的曲率，该方法包括以下步骤：

（a）提供多个镜片坯块，每个镜片坯块的镜片安装面具有一个预定的坯块曲线，其中所述镜片坯块都具有相同的坯块曲线；

（b）从所述多个镜片坯块中取出一个镜片坯块；

（c）混合包括在未聚合状态的、可被UV或可见光固化的液态粘结剂和作为非聚合固体的填料的粘结剂组合物；

（d）将上述粘结剂组合物施加到上述镜片毛坯的粘合面和上述镜片坯块的镜片安装面中的至少一个上；

（e）将上述镜片毛坯推向上述镜片坯块，其中上述镜片毛坯的粘合面面对上述镜片坯块的镜片安装面；和

（f）产生UV或可见光，并将上述光传送到所述粘结剂组合物，所

述光的波长和强度以及施加的持续时间足以固化所述粘结剂组合物；

（g）其中所述粘结剂和所述填料的混合比例被选择为，使所述粘结剂组合物在固化时的聚合放热和尺寸变化足够低，使得所述粘结剂组合物能够被固化而不会在所述镜片毛坯上产生不适当的应力且不会使所述镜片毛坯从所述所述粘结剂组合物脱胶（de-bonding）。

根据本发明的另一个方面，提供了一种粘合镜片毛坯的方法，所述镜片毛坯的粘合面具有预定的曲率，该方法包括以下步骤：

（a）提供多个镜片坯块，每个镜片坯块的镜片安装面具有一个预定的坯块曲线，其中所述镜片坯块仅具有几个不同的坯块曲线；

（b）根据上述镜片毛坯的粘合面的上述曲率，选择具有特定坯块曲线的一个镜片坯块，使得所述坯块曲线与所述粘合面的曲率尽可能好地匹配；

（c）混合包括在未聚合状态的、可被UV或可见光固化的液态粘结剂和作为非聚合固体的填料的粘结剂组合物；

（d）将上述粘结剂组合物施加到上述镜片毛坯的粘合面和上述镜片坯块的镜片安装面中的至少一个上；

（e）将上述镜片毛坯推向上述镜片坯块，其中上述镜片毛坯的粘合面面对上述镜片坯块的镜片安装面；和

（f）产生UV或可见光，并将上述光传送到所述粘结剂组合物，所述光的波长和强度以及施加的持续时间足以固化所述粘结剂组合物；

（g）其中所述粘结剂和所述填料的混合比例被选择为，使所述粘结剂组合物在固化时的聚合放热和尺寸变化足够低，使得所述粘结剂组合物能够被固化而不会在所述镜片毛坯上产生不适当的应力且不会使所述镜片毛坯从所述所述粘结剂组合物脱胶。

首先，与上述现有技术相比，这两种方法的共同之处是减少了坯块曲线的数量。上述只使用了一种坯块曲线的第一个方法是理想的情况，即使按照第二个方法使用了几个不同的坯块曲线，例如2或3种坯块曲线，它在降低生产过程的复杂性、出错的概率以及镜片制造成本方面也被认为明显优于使用7或8种坯块曲线的方法。

此外，再与上述现有技术相比，根据本发明的方法的共同之处是使用了包括在未聚合状态的、可被UV或可见光固化的液态粘结剂和作为非聚合固体的填料的粘结剂组合物，特别是其中所述粘结剂和所述填料的混合比例被选择为，使所述粘结剂组合物在固化时的聚合放热和尺寸变化足够低，使得所述粘结剂组合物能够被固化而不会在所述镜片毛坯上产生不适当的应力且不会使所述镜片毛坯从所述粘结剂组合物脱胶。

在这方面，填料的使用有几个好处。由于有相当大部分的收缩来自于聚合过程中的材料结构变化，可以将作为非聚合固体的填料物理地引入液态（未聚合）化合物中，从而以至少所引入的填料材料的体积百分比使收缩减少。

此外，尽管典型的UV或光辐射固化材料被认为是相对“低°T”固化的，它们在固化过程中仍具有一定水平的放热。在某些情况下，特别是在UV/VIS材料的体积很高时，该放热反应可以将材料温度提高到比初始液态温度高20至40℃。这些更高的工艺温度相应地会由于镜片毛坯、镜片坯块和粘结剂之间的不同CTE（热膨胀系数）而在镜片毛坯中产生热应力。因此，除了减少由聚合引起的收缩之外，通过引入填料而使UV/VIS固化材料的体积降低，相应地降低了固化反应的放热成分，从而获得较低的最终工艺温度和较低的热膨胀。

同时减少两个收缩源（聚合过程中的结构变化和聚合放热）的共同效果，对于使用非恒定UV/VIS材料厚度成功地粘合镜片的能力是非常有利的，特别是在只有一个或几个坯块曲线被用于粘合全范围的标准镜片的情况下。

使用填料的另一个重要好处是通过减少UV/VIS固化材料的数量而降低了成本。UV/VIS固化材料使用相对昂贵的化学品，特别是用于启动电磁辐射（UV/VIS）固化的光引发剂往往非常昂贵，结果是粘合化合物的成本相对较高。除此之外，一旦固化之后，化合物不能回复到液态（未聚合）状态。这意味着它不能再以与伍氏合金（wood metal）或封蜡（blocking wax）（或如e-己内酯的其它热塑性塑料）类似的方式通过再熔化而循环使用。

在上述第一种方法中，即在其中所有镜片坯块具有同一坯块曲线的情况下，镜片坯块最好都具有一个基本球面形的镜片安装面，所述镜片安装面包括根据将被粘合的镜片毛坯的粘合面曲率对于特定人群的分布所选择的同一坯块曲线。这有利地考虑到不同的人群可出现不同的分布，因此需要不同的坯块曲线以将材料使用最小化。例如，与西欧或北美人群相比，某些亚洲人群已知是偏向于较低（较平坦）的基线。这将导致选择稍低的坯块曲线，以便更好地优化（最小化）材料使用，和/或最终的光学性能。

在上述第二种方法中，即在其中镜片坯块只具有几个不同的坯块曲线的情况下，镜片坯块最好都具有一个基本球面形的镜片安装面，其中提供了两个不同坯块曲线的镜片坯块，即具有在0至4屈光度范围的凹坯块曲线的镜片坯块和具有在4至8屈光度范围的凹坯块曲线的镜片坯块。然而，根据将被粘合的镜片毛坯的粘合面的几何结构，上述坯块曲线也可以是凸的。

在第二种方法的一个优选实施例中，选择镜片坯块的步骤被执行，其效果是，在所述镜片毛坯的粘合状态中，在所述镜片坯块的镜片安装面和所述镜片毛坯的粘合面之间的间隙在镜片坯块的中心区域最小。因此，该粘结剂组合物的绝对收缩率在中心被（甚至更加）最小化，使得在被粘合的镜片毛坯中引起的应力（如果有的话）非常小，特别是在MRP（主要参考点，major reference point）附近。

原则上，所使用的镜片坯块可以是不透明的，甚至不能透过所有种类的光线，其中UV或可见光穿过镜片毛坯传送到粘结剂组合物，引起粘结剂组合物的固化。但是，优选方案是使用能够传输UV或可见光的镜片坯块，其中在所有方法中，所述产生UV或可见光和将上述光传送到粘结剂组合物的步骤则最好包括将光通过镜片坯块传送到粘结剂组合物。

根据本发明，还提供了在镜片粘合中使用的粘结剂组合物。所述粘结剂组合物包括：（a）在聚合状态是液态的、可由UV或可见光固化的粘结剂，和（b）作为非聚合固体的填料，其中粘结剂和填料的混合比例是在70％重量的粘结剂比30％重量的填料和30％重量的粘结剂比70％重

量的填料的范围之间。测试表明，此范围内的混合比例有效地导致所述粘结剂组合物在固化时的聚合放热和尺寸变化足够低，使得所述粘结剂组合物能够被固化而不会在所述镜片毛坯上产生不适当的应力且不会使所述镜片毛坯从所述粘结剂组合物脱胶。与使用传统的辐射固化粘合材料相比，所述包括填料的粘结剂组合物在用于镜片粘合时也导致成本的降低，如上面已经解释的。并且，这种粘结剂组合物最后代表了减少在镜片制造中覆盖标准镜片的全部范围所需的坯块曲线的数量的一种“前进方向”（参见以上的解释）。

所述填料最好由能对固化的粘结剂组合物提供足够刚度的固体颗粒组成，以防止被粘合镜片的全部或部分弯曲和移动。

优选地填料颗粒的几何形状一般是球形的，但圆柱形或不规则的几何形状也同样适用。球形几何形状的优点是改善（降低）了液态粘结剂组合物的粘性。

填料的粒度一般需要比在将被粘合的镜片毛坯和指定的镜片坯块之间的最小间隙更小。2毫米的最小间隙是目前优选的，这意味着最大的颗粒应小于2毫米，最好是等于或小于1毫米。

为方便解块，优选地在填料中含有少量的金属纤维、颗粒或粉末，最好是数量占组合物总量1-2%重量百分比的铝纤维。这种数量的纤维提供了对微波能量的足够吸收，明显加快了微波能量对固化的粘合材料的加热，由此使粘合材料在被解块之前被“软化”。

优选地，所述填料材料对于UV和/或可见光的光激活波长是透明的和/或半透明的，以便加速粘结剂组合物的固化。

所述填料材料还可以具有低的吸湿特性，如果或在一个完全粘合的镜片被放入到薄膜涂层工艺中常用的真空室中时，这是非常重要的。

继续本发明的概念，填料材料可以具有在25℃和80℃之间的玻璃化转变温度（Tg）。通过使用这种填料材料，可以在表面加工工艺的温度（通常接近室温）获得某些机械特性--例如足够的刚度和硬度，然后这些特性可以通过将温度提高到Tg以上而被改变，以便于解块。在这一方面，80℃的上限可以确保，为了便于解块，没有必要将固化的粘合材料的温度

提高到高于可能使被表面加工的镜片出现永久性损坏的温度。

最后优选的是，所述填料材料选自包括在重磨（reground）状态的UV或可见光固化粘结剂和塑料材料的组，所述塑料材料包括：e-己内酯，由乙基-甲基-丙烯酸酯-丙烯酸衍生的三元共聚物，聚碳酸酯，聚乙烯（PET），高甲基丙烯酸树脂，甲基丙烯酸乙酯树脂，甲基丙烯酸酯共聚物树脂，甲基丙烯酸丁酯树脂和甲基丙烯酸甲酯/正丁酯共聚物树脂。除此之外，从对本发明优选实施例的以下说明中可以清楚理解上述填料材料的相应优点。

附图说明

下面基于优选实施例并参考附图更详细地解释本发明。在附图中：

图 1 是可在根据本发明的粘合方法中使用的光学玻璃眼镜片粘合装置的透视图。

图 2 是沿图 1 中 II-II 线的剖视图。

图 3 是局部透视图，用于说明镜片毛坯通过镜片传输器被支撑在镜片坯块上。

图 4 是局部透视图，用于说明镜片毛坯被放置在镜片坯块上，并说明处于收缩位置的粘结剂组合物分配器。

图 5 是局部透视图，用于说明在拾取镜片毛坯之前的镜片传输器，并说明在展开位置的粘结剂组合物分配器。

图 6 是沿图 4 中 VI-VI 线的剖视图。

图 7 以剖视图显示了 4 个镜片毛坯，每个镜片毛坯的粘合面各有不同的预定曲率，它们按照本发明的第一种方法被粘合，其中使用了相同的镜片坯块和粘结剂组合物，所述粘结剂组合物包括在未聚合状态的液态UV/VIS 固化粘结剂和作为非聚合固体的填料。

图 8 以剖视图显示了 4 个镜片毛坯，每个镜片毛坯的粘合面各有不同的预定曲率，它们按照本发明的第二种方法被粘合，其中使用的镜片坯块仅具有两种不同的粘合曲线，而其中使用的粘结剂组合物包括在未聚合状态的液态 UV/VIS 固化粘结剂和作为非聚合固体的填料。

图 9 是说明给定人群的光学玻璃眼镜片前弧的典型分布的图。

图 10 分别通过平面图和沿 X-X 线的剖视图显示一个光学玻璃眼镜片毛坯，它包括以传统方式粘合在镜片坯块（右侧）上的一个双光区段（左侧）。

图 11 以剖视图显示了 4 个镜片毛坯，每个镜片毛坯的粘合面各有不同的预定曲率，它们按照传统方法被粘合，其中使用各有不同粘合曲线的多个不同的镜片坯块，以与所分配的镜片毛坯的粘合面曲率紧密匹配。

具体实施方式

用于粘合光学玻璃眼镜片的装置在附图中一般以标号 30 表示。粘合装置 30 包括具有顶部 32 和用于部分地包围所述顶部 32 的罩结构 34 的机柜。镜片传输器 36 可动地安装在固定于所述顶部 32 的第一线性驱动器 38 上。第一线性驱动器 38 具有第一伺服电机或步进电机单元，用于相应地移动镜片传输器 36 或监测它的位置。

粘合装置 30 具有，与第一线性驱动器 38 对准且被装在上述机柜顶部 32 中的，一个成像台 40、一个探测台 42 和一个镜片粘合台 44。所述粘合装置 30 中装有（参见图 2）一个聚焦在成像台 40 上的摄像头 46、一个粘结剂组合物储存器 48 和一个用于将粘结剂组合物泵到所述镜片粘合台 44 的泵单元 50。所述粘合装置 30 还包括用于控制其运作的、采用中央处理单元 52 形式的控制器。

借助于一个用于显示由中央处理单元 52 以从摄像头 46 收到的图像信息为基础所产生的镜片定向信息的屏幕 56，成像台 40 用于镜片定向，以确保镜片毛坯 54 从粘合工艺的一开始就被适当地对准和定向。对于成像台 40 的结构和功能的进一步的细节，请参照专利文献 US 2005/0139309。

一旦镜片毛坯 54 的定向和位置参数已经被确定，用镜片传输器 36 将镜片毛坯 54 从镜片成像台 40 传送到探测台 42 以探测镜片毛坯 54 的粘合面 58。同样地，对于镜片传输器 36 以及探测台 42 的结构和功能的进一步细节，可参照专利文献 US 2005/0139309。

一旦镜片毛坯54的粘合面58已经被探测，用镜片传输器36将镜片毛坯54从探测台42 传送到镜片粘合台44。该镜片粘合台44包括一个能透射UV和可见光的镜片坯块支架60，它用于接收和支撑镜片坯块62，其中镜片坯块62的镜片安装面64面向上。在这种情况下，镜片坯块62应当是透明的材料，能够透射至少在紫外光谱的光，最好是也能透射在可见光谱中的光。对于镜片坯块62的进一步的结构和功能特征，特别是使镜片坯块62能够被保持在镜片粘合台44中进而被固定在表面加工机（未示出）的一个主轴上的镜片坯块62的夹持部分，请参照专利文献US2005/0250430。

UV光源66（见图6）与镜片坯块支架60相关联，所述光源被安装为将光传导通过镜片坯块支架60中的一个孔径68，然后再将UV光传导通过透射的镜片坯块62。光源驱动器可以形成中央处理单元52的一部分，且被连接到紫外线光源66以控制UV光源66的激活和去激活。UV光源66可以包含一个闪光灯，它发出在紫外线光谱和可见光谱范围内的高强度、短持续时间的光脉冲。

一种用于分配UV/可见光固化粘结剂组合物的分配器一般以标号70表示。分配器70具有位于分配器臂74一端的一个分配器器喷嘴72。配备了一个臂驱动器-它可以是如标号76所示的电机或线性驱动器或其它驱动器，用于将分配器臂74从邻近镜片安装面64的一个展开位置（图5）移动到使镜片安装面64和镜片传输器36露出的收缩位置（图4），以免干扰将镜片毛坯54安装在镜片坯块62的镜片安装面64上（反之亦然）。

分配器臂74仅控制分配器喷嘴72的位置。因此，分配器臂74可以是伸缩的，而不是图示的旋转的，并可由线性驱动器控制，如汽缸中液压驱动的活塞。

分配器喷嘴72通过泵单元50与粘结剂组合物储存器48流体连通，泵单元50将粘结剂组合物输送到分配器喷嘴72。可替换地，粘结剂组合物储存器48可以是加压的，从而避免了对泵的需要。

应当指出的是，在所示的实施例中，所述粘结剂组合物储存器48是

-优选为可更换的-预装的单元，已经包含了混合好的由未聚合（即液态）UV/VIS 固化粘结剂和作为非聚合固体的适当填料组成的粘结剂组合物。但是，作为一种替代方案，所述粘合装置可以配备一个用于从上述组分制备所述粘结剂组合物的混合单元，而上述组分可以分别存储在可更换地安装在粘合装置 30 上的适当容器内。

分配器喷嘴 72 装有一个阀或其它关断机构，它与中央处理单元 52 相连接以在分配器喷嘴 72 位于展开位置时控制粘结剂组合物通过喷嘴 72 的分配。可以使用不同的控制结构。一种简单的控制方式是监测喷嘴 72 保持打开的时间。也可使用其它控制器如计量泵。总的来说，无论选择任何控制，都应当分配测定数量的粘结剂组合物，随后所述粘结剂组合物将填充在镜片毛坯 54 的粘合面 58 与镜片坯块 62 的镜片安装面 64 之间的间隙。

在使用时，测定数量的 UV/VIS 固化粘结剂组合物通过分配器 70 的分配器喷嘴 72 分配在镜片坯块 62 的镜片安装面 64 上。镜片毛坯 54 通过镜片传输器 36 移动到镜片坯块 62 之上，使镜片毛坯 54 的粘合面 58 面对所述镜片安装面 64。然后镜片传输器 36 将镜片毛坯 54 向镜片安装面 64 移动并进入液态粘结剂组合物 78（见图 6），直到镜片毛坯 54 的粘合面 58 距离镜片坯块 62 的镜片安装面 64 为预定距离为止。

由于粘合面 58 和镜片安装面 64 之间的几何结构和空间关系是已知的，所需的粘结剂组合物 78 的量可以自动计算和分配，无需操作员介入。

在这个阶段，由 UV 光源 66 产生 UV 光并传输通过镜片坯块 62，其波长、强度和持续时间足以使粘结剂组合物 78 固化，从而将镜片毛坯 54 粘结到镜片坯块 62。

作为最后的步骤，镜片坯块 62 及其上粘附的镜片毛坯 54 可以从镜片粘合台 44 上取下和从镜片传输器 36 释放。

图 7 说明由包括以下步骤的粘合工艺所取得的粘合结果：

（a）提供多个镜片坯块 62，每个镜片坯块的镜片安装面 64 具有一个预定的坯块曲线，其中所述镜片坯块 62 具有相同的坯块曲线，-- 在所

示的实施例中所述镜片坯块 62 全部具有坯块曲线为 5 屈光度的、基本球面形的镜片安装面 64；

（b）从所述多个镜片坯块 62 中取出一个镜片坯块 62--在配镜车间，镜片坯块 62 通常存储在一个保存/分配容器中，从该容器中可以取出各个镜片坯块 62；在这种情况下没有必要进行选择，因为镜片坯块 62 都相同；

（c）混合包括在未聚合状态的、可由 UV 或 VIS 固化的液态粘结剂和作为非聚合固体的填料的粘结剂组合物 78，其中所述粘结剂和填料的混合比例被选择为，使所述粘结剂组合物 78 在固化时的聚合放热和尺寸变化足够低，使得所述粘结剂组合物 78 能够被固化而不会在所述镜片毛坯 54 上产生不适当的应力且不会使所述镜片毛坯 54 从所述粘结剂组合物 78 脱胶—如前所述，这种混合可以在分配用于粘合目的的粘结剂组合物 78 不久之前进行，甚至可以在粘合装置 30 中进行，或作为替代的方案在更早的时候，也可能在配镜车间外已经完成；

（d）优选地将上述粘结剂组合物 78 施加到上述镜片坯块 62 的镜片安装面 64；

（e)将上述镜片毛坯 54 推向上述镜片坯块 62--反之亦然或从两边推；显然，镜片毛坯 54 和镜片坯块 62 之间的相对运动是重要的--其中上述镜片毛坯 54 的粘合面 58 面对上述镜片坯块 62 的镜片安装面 64；和

（f）产生 UV 或可见光，并将上述光传送到所述粘结剂组合物 78，所述光的波长和强度以及施加的持续时间足以固化所述粘结剂组合物；

与图 11 描述的现有技术相比，图 7 显示的镜片毛坯 54 具有与图 11 相同的粘合面曲率：（a）0.5 屈光度，（b）2 屈光度，（c）6 屈光度，和（d）10 屈光度，但在本发明情况下它们现在都被粘合在只有一个 5 屈光度的坯块曲线上。这有助于说明与坯块曲线的减少数量相关的问题，以及为什么所提议的方案被认为是有利的。

从图 7 中首先可见的是，虽然粘合材料的用量明显多于图 11 中使用的，但是所使用的粘合材料量并没有最初看起来那么多，原因在于所述单个坯块曲线可以选择为最佳适合在镜片基线的统计分布中的大部分眼镜

片。

在这个方面，图 9 说明了给定人群的一个典型的基线（前弧）分布。由于这种分布并考虑到正确选择最佳的坯块曲线，与使用 7 个坯块曲线相比，在使用 1 个坯块曲线的方案中粘合材料的使用只增加了 10 至 15%。如果使用两个坯块曲线，那么使用的粘合材料经过计算比使用 7 个坯块曲线增多仅 6%。与通常所见的使用大量曲线的情况相比，这种粘合材料消耗中的略有增加，很容易被与管理仅 1 或 2 个坯块曲线相关的成本降低所补偿。

从图 7a）、b）和 d）可以明显得到在使用少量坯块曲线时引起的一个问题。它是与非恒定的粘合材料厚度相关的收缩不均的问题。收缩主要是由 UV/VIS 固化粘结剂的聚合产生的，但也可以来自这些材料固化时的热效应。根据使用的化学品类型以及在固化过程中达到的温度，可以看到在 2-10%甚至更大的范围内的材料收缩。高温可以来自固化辐射的能量，但也可以来自聚合过程中化学反应产生的放热。可以很容易地到达比初始室温高 10 至 40℃的温度；而当粘合的组件冷却到室温时，根据最终组件的不同 CTE（热膨胀系数）和机械特性，它将收缩。这种收缩是内部限制的，并可能在最终组件中引起不希望的机械（热）应力。

虽然收缩是三维效应，一般认为在给定点的轴向收缩与该点的 UV/VIS 固化粘结剂的厚度成正比。可以清楚地看到，如果有足够的收缩，会导致粘合材料的几何结构的变化。这种变化可以有两个不良后果：一是由于粘合材料被从镜片毛坯“拉开”所造成的镜片毛坯从粘合材料脱胶。在图 7a）中脱胶更有可能在镜片毛坯 54 的中心出现，而在图 7d）中可以看到它更有可能在边缘发生。在这种情况下图 7a）被认为是最糟糕的情况，其中在中心处的任何脱胶可能会由于镜片毛坯 54 在表面加工过程中失去支撑而在中心处产生不可接受的畸变。除此之外，即使没有出现脱胶，因为最终薄中心的镜片几何结构，在中心处的收缩会倾向于修改在中心处的最终曲率，从而引入折光度误差。图 7d）中看到的情况较少产生与折光度误差有关的严重问题，因为镜片的中心保持较厚（正折光度），因此具有高的刚性，并能够更好地承受收缩带来的应力。

为了解决上述问题，除了其它措施以外，本发明将一个特别选定的填料作为非聚合固体添加到UV/VIS固化材料中，这将在下面详细解释。

现在参照图8，它说明由包括以下步骤的另一个粘合工艺所获得的粘合结果：

（a）提供多个镜片坯块62，每个镜片坯块的镜片安装面64具有一个预定的坯块曲线，其中所述镜片坯块62仅具有几个不同的坯块曲线；--同样地，在这个实施例中所述镜片坯块62全部具有基本球面形的镜片安装面64，且上述镜片坯块62仅具有两种不同的坯块曲线，即包含0.5屈光度的凹坯块曲线的镜片坯块62（图8a）和b）），以及包含5屈光度的凹坯块曲线的镜片坯块62（图8c）和d））；和

（b）根据上述镜片毛坯54的粘合面58的上述曲率，选择具有特定坯块曲线的一个镜片坯块62，使得所述坯块曲线与所述粘合面58的曲率尽可能好地匹配—在所示的实施例中，执行该步骤的效果是：在镜片毛坯54的粘合状态，上述镜片坯块62的镜片安装面64和上述镜片毛坯54的粘合面58之间的间隙在镜片坯块62的中心区域最小，以便使引入到被粘合的镜片毛坯54中的应力最小或甚至被抑制；因此0.5基线的镜片坯块62被分配给0.5和2基线的镜片毛坯54（图8a）和b）），而5基线的镜片坯块62被分配给6和10基线的镜片毛坯54（图8c）和d））。

该替代工艺的其余步骤与以上参照图7讨论的步骤c）-（f）相同。

至于包含在未聚合状态下为液态的、可由UV或VIS固化的粘结剂和作为非聚合固体的填料的粘结剂组合物78需满足的材料条件，以下是需要注意的。

通常希望在固化的材料中获得一定的机械和热特性。这些特性包括，可以实现良好的镜片支撑，同时保持甚至提高在需要时使镜片解块的能力。在本申请中“解块”表示通过化学、热学、机械或其它手段或它们的任何实用的组合来解除镜片和粘结剂组合物之间的粘结结合。

多功能填料或填料的特殊组合可以用来维持或改善材料特性，同时降低收缩、反应放热和成本。填料的另一个潜在的功能是在一定的控制条件下改善粘接特性，以使解块更容易。

固化材料通常需要有足够的刚度，防止在加工工艺过程中紧邻切割工具附近的镜片或镜片区域的弯曲或移动。然而，柔性的粘合材料可以在解块工艺中更容易地将该材料“剥离”镜片。硬而脆的材料难以被剥离，并往往分裂成较小的部分，而软的柔韧和粘着材料更容易被整件剥落。

如果选择机械剥离而不是其它解块方法，优选材料的刚度值将是足够高的以能够被表面加工，同时又要是足够低的以被解块，或者优选材料在解块之前要经受一种“软化”工艺。这种“软化”工艺，可以是例如通过在温水中浸泡，或暴露到其它形式和/或波长的辐射如红外线或微波中，来加热粘合材料。在这种情况下，为更好地支持解块，粘结剂组合物应被设计为具有某些可修改的属性，如硬度的降低，也可能同时包括粘性的降低。

少量的金属纤维、颗粒或粉末可以添加到填料中，以加强微波能量对固化粘合材料的加热。混和在液态粘结剂中的少量（全部组合物的1-2%重量百分比）精细铝纤维不足以阻止固化，因为UV辐射仍然可以轻易穿透粘结剂，但仍提供了对微波能量的充分吸收以显著加快材料的加热。15秒的微波曝光时间是将材料温度从30℃升高25℃所需的全部时间，而在没有铝纤维时是20秒。

使固化的粘合材料被加速加热以通过“软化”固化的粘合材料来便于解块的其它可能方案是，加入少量（全部填料的1-5%重量百分比）的通常高电阻的金属颗粒，并使用感应加热元件以在颗粒中感应电流。所述对电流的高电阻会相应地在颗粒中产生热，然后热被传递到周围的材料，从而加热粘合化合物。其它非金属的导电材料如碳，和某些半导电颗粒也可以用于感应加热技术。

可在常规表面加工工艺的温度用于维持或改善硬度和刚性、但在解块过程中增强柔韧性的多功能填充材料的一个例子是e-己内酯。e-己内酯（也称为聚己内酯）是一种热塑性单体，并且是足够透明的以透射UV和/或可见光，从而允许包含液态UV粘结剂和作为非聚合固体填料的e-己内酯颗粒的基体固化。填充比例高达65%重量百分比的e-己内酯已被成功地固化，并且测试了与镜片毛坯和镜片坯块的粘附力和硬度。在室温下

这种材料可以选择为是相当硬的（例如，肖氏 D 硬度为 50 至 70），然后在表面加工之后，固化的粘合材料可被加热并允许达到使 e-己内酯变软（例如肖氏 D 硬度为 10 至 40）但没有变为液态的程度。这些温度足够低（例如在 35℃和 60℃之间），从而不会损坏镜片。在基体中的 UV/可见光固化粘结剂成分仍保持为固体，但 e-己内酯颗粒在这些温度下已经明显较柔软，导致整个基体都较柔软，从而显著改善了从镜片去除粘合材料的容易性。e-己内酯具有较低的玻璃化转变温度（Tg），因此在这种情况下所有的加工工作都要在高于 Tg 的温度完成。也可以确定与 e-己内酯类似的其它材料。

另一个变型是使用 Tg 高于表面加工工艺温度（通常接近室温）但低于可能使被表面加工的镜片出现永久性损坏的温度（80℃）的填充材料。MatWeb 的（www.matweb.com）数据库列出了 235 种 Tg 在 25℃-80℃之间的聚合物材料。它们可用于实现在工艺温度下的某些机械特性（例如高的刚度和硬度），然后通过将温度升高到 Tg 以上而改变这些机械特性。一种所讨论的这种材料是埃克森美孚（ExxonMobile）的“Escor AT320 EMA 三元共聚物”。它是乙基-甲基-丙烯酸酯-丙烯酸。它在室温下是固体，可以固体颗粒形式与液态 UV/VIS 固化粘结剂材料混合。因为它本身是丙烯酸基的，它为丙烯酸基的 UV/VIS 固化粘结剂材料提供了一个良好的粘结表面。

另一种已被证明具有作为本申请的填料的许多期望功能的材料系是由 Lucite 国际特殊共聚物有限公司（Lucite International Specialty Copolymer）出售的商标为“ELVACITE®”的材料。这些材料可以是例如高甲基丙烯酸树脂、甲基丙烯酸乙酯树脂、甲基丙烯酸酯共聚物树脂或甲基丙烯酸丁酯树脂。它们的特性包括从低到高的分子量范围，图康硬度（Tukon hardness）在 1 到 20（Knoop No.，努普氏硬度值）之间，且 Tg 在 15℃和 110℃之间。已经证明对本申请有效的这种材料之一是 Tg 为 36℃的“ELVACITE® 2550”（ 甲基丙烯酸甲酯/正丁酯共聚物）。它比较柔软，努普硬度值是 4，但如果以相当高的填充比例（60%至 70%）来使用，则能够确保有足够的硬度以供表面加工，同时由于相对较低的硬度和

特定的热性能而便于解块。这些产品的一个额外好处是，它们可以直接以一个小直径球珠的形式购买。典型的珠子直径为 10 至 200 微米，这使得它们可被直接使用，无需一个用于将较大的颗粒磨碎为可接受尺寸的预处理工艺。

填料也应当是对切割工具无磨损和非破坏的。如果用一个切割或研磨工具切过固化的粘合材料，它应当不会损坏工具。但某些情况下有些增加的磨损是可以接受的，客户可以容忍的增加磨损的量通常由总体工艺经济性决定。

前面已经讨论过优选的填料颗粒的几何结构（一般为球形）和尺寸（小于 2 毫米，更优选地等于或小于 1 毫米）。填料的另一个重要特性是，它决不能通过阻断或以某种方式禁止 UV 和/或可见光电磁能量到达嵌在 UV/VIS 固化粘结剂材料中的光引发剂，而妨碍或不适当减慢固化过程。因此，对于选择兼容的填料来说，对光激活波长透明和/或半透明的特性被认为是非常重要的。

填料材料的另一个期望的特点或功能是通过纳入非常低排气性的材料而降低排气，从而大大减少了“抽真空时间”，如果和在一个完全粘合的镜片被引入通常用于薄膜涂层工艺的真空室时。排气的三种主要来源是溶剂的 VOC（挥发性有机化合物）散发、液态树脂的未固化剩余物和被困在粘合的材料中的水分。所有这三种材料可以在真空中气化且造成这样一种情况：很难或比预计较慢达到涂层工艺所要求的真空水平。

对于有机溶剂的情况，优选的方法是避免在液态化合物中引入任何溶剂。这意味着，一般倾向于使用 100%固体型树脂，以保证没有溶剂被吸收留在固化的粘合材料中。不彻底的固化可以是在液态树脂留在“固化”材料中的一个原因。这个问题通常这样解决：再提供 UV/VIS 透明/半透明的填料，并提供更好的固化技术，例如更好聚焦的大功率光源以扫描镜片坯块，或超高能氙气闪光灯技术。第三种情况是水分含量。在这种情况下，对填料选择低吸湿性材料就变得很重要。这类材料的例子是聚碳酸酯和 PET（聚酯）基材料，仅举两个。

最后，强烈优选的方法是直接地重复使用重磨状态的 UV/VIS 固化的

粘结剂材料作为填料。所提议的是，在镜片被解块后，不是丢掉固化的UV粘合材料，而是将它简单地投入一个设计用于将该材料重磨到适当的颗粒尺寸的小研磨机中。然后使用已知的测量技术及装置和方法，将该重磨的材料与用新的未固化UV/VIS固化粘结剂材料以适当的混合比例混合。使用混合喷嘴的计量螺杆是一种方案。优选的混合比例是填料颗粒:液态UV/VIS固化粘结剂材料在40%/60%和70%/ 30%之间。这个方案允许连续或按需求对两种成分以比较准确的比例混合，并且也可以用来将正确数量的混合粘结剂组合物传送到镜片坯块。另一种更简单的方案是简单地分批称重正确数量的各种成分，并用供电的手持搅拌机混合，如手钻协助搅拌器。

使用重磨材料的主要优点之一是其它填料通常所期望的收缩和减少放热都能获得，同时比使用这些其它填料的情况更大地降低了成本。固化的粘合材料通常最终会被丢弃，因此将它回收50%至70%具有经济效益和环境效益。成本效益得以实现是因为其成本接近零。唯一的成本是处理、研磨和混合的成本。环境效益来自于丢弃量明显减少。另一个优点是，因为两者之间的化学相似性，新的未固化材料与已固化材料粘结得非常好。还有一个好处是，混合比例的任何变化不会影响最终的机械性能和热性能，如与温度相关的硬度/柔韧性、软化点等。这将简化对混合的粘结剂组合物的混合和质量控制，因为对混合错误的公差大得多。其它优点包括具有一致的和可预测的UV透射率，不会被异质的或不完全兼容的填料影响的“一体化（all-in-one）”化合物设计，没有填料质量变化等。

需要在此指出的是，上述最后两段假设在一开始时使用“纯粹”的未固化和未加入填料的UV/VIS固化粘结剂材料，然后在该材料已经被固化之后，它被研磨和用作新的液态（未固化）材料的填料。从这一点来说，当一个镜片解块时，UV/VIS固化的粘合材料通过被研磨和作为非聚合固体填料混合到新的未聚合UV/VIS固化材料中而被循环使用。

例1

对由60%重量百分比、粒径3毫米的苏威（Solvay）“聚己内酯C6500

”，与40%重量百分比的、含丙烯酸树脂、单体和引发剂的“General #3”UV固化粘合化合物（PL110284 - 02，生产日期：1月23日，06 - 01）组成的混合物进行了测试，该混合物由位于加拿大纽布伦士维克省（New Brunswick）Moncton市的MotionFab公司（609891 NB Ltd.）出售。（General #3粘合化合物以前称为“ULTRAGRIP®”，由位于加拿大纽布伦士维克省Moncton市的微型光学设计公司（Micro Optics Design Corporation）出售）。在下面的例子中，粘结剂组合物的各个组分即液态UV固化粘结剂和固体填料颗粒被手工彻底混合。

在使用安装有“D”型灯泡的“Fusion”UV灯（可从Fusion UV系统公司获得，美国马里兰州Gaithersburg市Clopper路910号，20878-1357）进行10秒的曝光时间之后，由于“白”C6500颗粒对光激活波长足够透明以获得完全的固化，上述混合产品被成功地固化了。

这种材料的主要缺点似乎是颗粒尺寸太大以及C6500的成本相对较高。在室温时混合和固化的样本的硬度被测量为在39至55肖氏D硬度之间，与固化的General#3（38肖氏D硬度）和经测量为57肖氏D硬度的C6500的硬度非常密切地匹配。一种多读数平均给出了45.6肖氏D硬度值。每种组分硬度的大的变化和密切相关的理由归因于大的颗粒尺寸，和测量点直接在C6500颗粒之上或颗粒之间进行测量的概率。此外，C6500颗粒被不均匀厚度的General#3覆盖，这进一步增加了测量的不可预测性。

但是可以清楚地看到，在50℃的解块温度，所测量的固化的粘结剂组合物被软化，平均硬度降低到35肖氏D硬度，便于进行解块。

C6500的大颗粒尺寸被认为是一个问题，主要因为以下两个原因：第一，这增大了在镜片毛坯和镜片坯块之间可实现的最小间隙，因此增加了粘合所需材料的数量；第二个问题被认为是不规则的收缩，在非常薄的镜片中造成折光度的小波纹或变化。这可以由颗粒之间的收缩大于直接在颗粒上的收缩所解释，另一种可能的贡献因素是硬度的变化造成了固化的粘合材料所提供的支持刚度中的变化。

例 2

将由 Lucite 国际特殊共聚物有限公司提供的“Elvacite® 2550”（甲基丙烯酸甲酯/正丁酯共聚物）和 General ＃3 按照 60％重量百分比的 Elvacite® 2550 比 40％重量百分比的 UV 化合物的比例制备混合物。这将固化后的粘结剂组合物的整体硬度增加至 40.4 肖氏 D 硬度，并获得低得多的硬度差异。

所使用的 Elvacite® 2550 的特别样本是通常为球形或椭圆形的颗粒，它们的不规则直径在 15 至 460 微米之间，平均粒径为 350 微米。

在 50℃的解块温度下固化的混合物的低 Tg（36℃）和相对低的 28 肖氏 D 硬度，具有在工艺（表面加工）温度的刚度和在解块温度的高柔韧性的良好结合。350 微米的颗粒大小也被认为具有提供均匀的收缩和支撑以及可能获得小于 0.5 毫米的最小间隙的优点。最后，Elvacite® 2550 填料的 UV 透明/半透明的特性，使得在被测试的所有不同的光源下都很容易固化粘结剂组合物。

例 3

使用埃克森美孚的“Escor AT320 EMA-AA Terpolymer（三元共聚物）”制备第三种化合物。再次使用 60％重量百分比的 Escor AT320 填料比 40％重量百分比的 General #3。

该填料颗粒的几何结构不规则，其粒径为可以通过 1.5 毫米的网筛。

这种粘结剂组合物从热特性角度被认为是一种优选的材料，并在 23℃的表面加工温度和在 55℃至 60℃之间的解块温度测试其支持性。其硬度在 25℃时为较低的 25 肖氏 D 硬度，以 0.4 肖氏 D 硬度每℃的斜率下降。该硬度低于 General #3 的 38 肖氏 D 硬度，因此一般认为，该填料材料家族中的其它产品可在 20 至 25℃之间的表面加工温度提供更好的刚度。

例 4

使用 50％重量百分比的由固化的(即聚合后的)制造的纯 General ＃3 作为填料和 50％重量百分比的液态（未固化）General ＃3 制备和测试

第四种化合物。在这种情况下，最后固化的粘结剂组合物都是 General #3，因为填料也同样是 General#3。

固化的材料被研磨为颗粒尺寸在 0.5 至 1.5 毫米之间，平均尺寸为 1 毫米。由于所使用的研磨工艺，这些颗粒的形状非常不规则。可能是由于不规则的颗粒几何结构，很难获得更高的填料比例。

这种材料具有其它已测试的填料的所有优点，包括收缩率低和聚合放热低。在聚合状态中即作为非聚合固体的填料是 UV 透明的，且与具有相同的机械性能和热性能的未填充材料形成一个非常相干的固体材料块。这种对粘合材料本身循环使用的方法的主要优点是成本低和减少了材料的浪费。

例 5

通过将填料总量 2%重量百分比的、购自德国汉堡 Alroko GmbH & Co. KG 公司的小铝纤维（“Aluminiumfasern Al Mg S Kurzfaser F35”），加入到根据上述例 4 制备的未固化粘结剂组合物中，制备第五种粘合材料。

该纤维的形状和尺寸是非常不规则的。它们的长度在 0.5 毫米至 3 毫米之间和直径在 0.1 到 0.5 毫米之间。

加入纤维的目的仅是为了利用微波的能量而缩短加热时间。为此目的，这被证明是非常有效。

本发明提供了一种新的镜片粘合材料（粘结剂组合物），它基本上克服了以往粘合材料的缺点。这种新材料结合了传统的 UV 和/或可见光（VIS）固化聚合物材料与作为非聚合固体的专门选择的填料，以便获得或改善某些期望的材料性能，包括收缩率低、聚合放热低，且改善了解块能力，同时降低了与这种 UV/VIS 辐射固化材料相关的高成本。这种新型材料可以用在用于将镜片毛坯粘合在镜片坯块上的方法中，所述镜片坯块的镜片安装面具有预定的坯块曲线，其中用于覆盖全范围的标准镜片所需的坯块曲线的数量最小。

参考标号清单：

10 镜片毛坯
12 不连续台阶
14 双光区段
16 基线
18 镜片坯块
20 UV 固化的粘结剂
22 间隙
24 间隙
26 镜片安装面
28 粘合面
30 粘合装置
32 顶部
34 罩结构
36 镜片传输器
38 第一线性驱动器
40 成像台
42 探测台
44 镜片粘合台
46 摄像头
48 粘结剂组合物储存器
50 泵单元
52 中央处理单元
54 镜片毛坯
56 网筛
58 粘合面
60 镜片坯块支架
62 镜片坯块

64 镜片安装面

66 UV 光源

68 孔径

70 分配器

72 分配器喷嘴

74 分配器臂

76 电机

78 粘结剂组合物

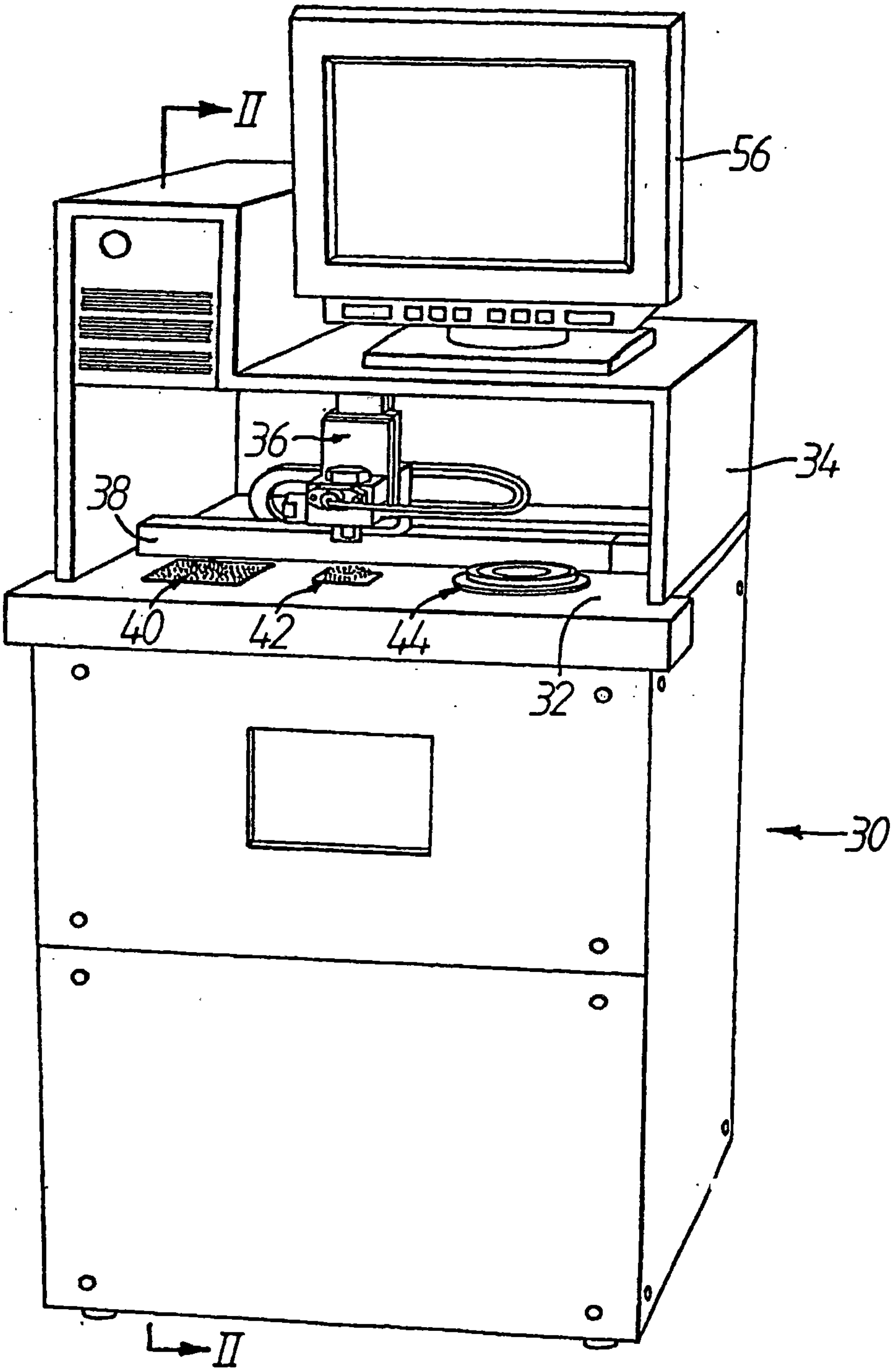
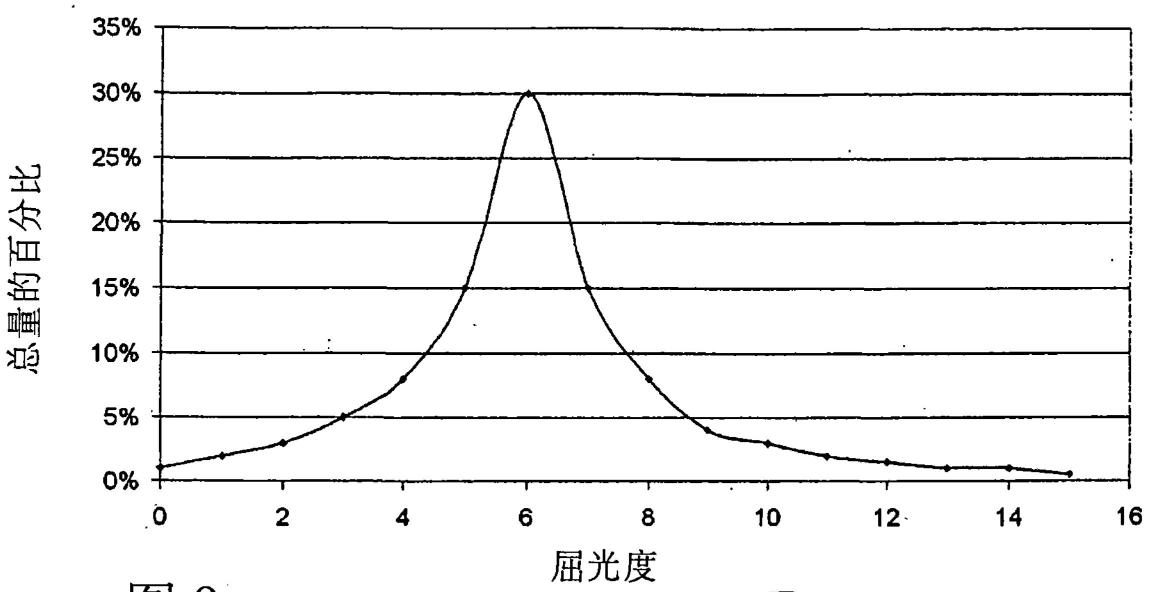


图 1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30%
25%
20%
15%
10%
5%
0%
0
2
4
6
8
10
12
14
16
屈光度

图 9

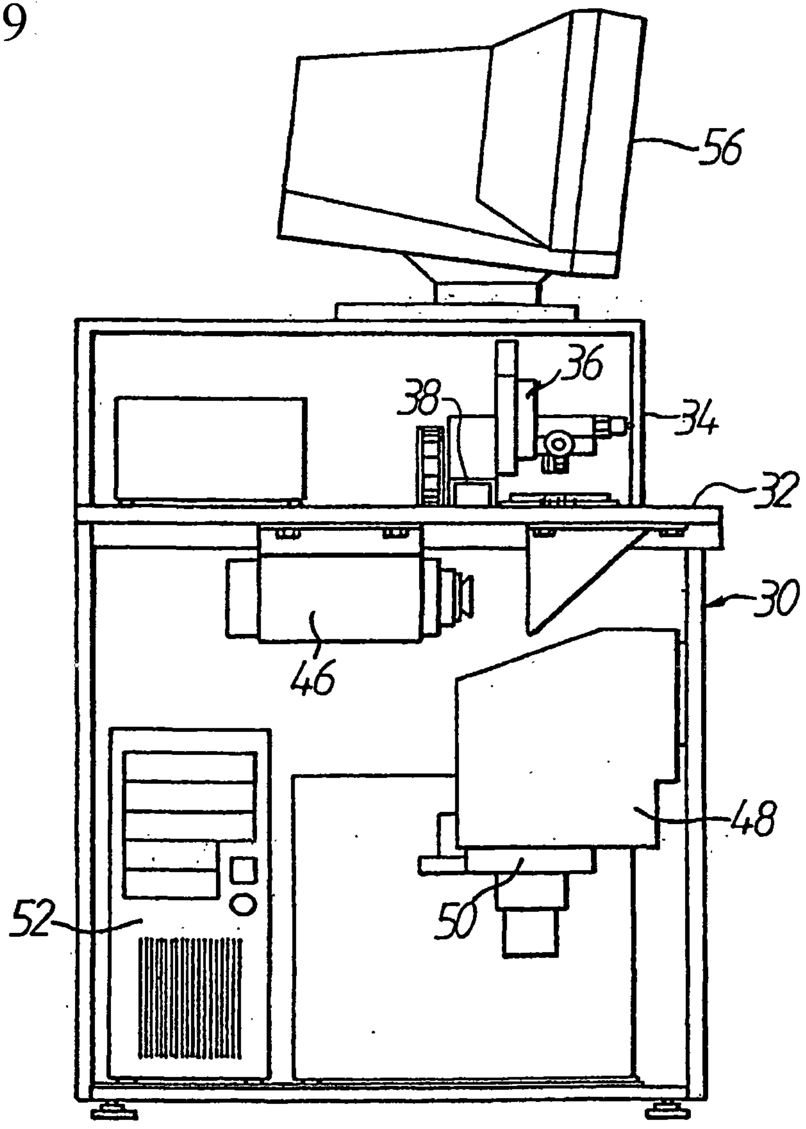
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图 2

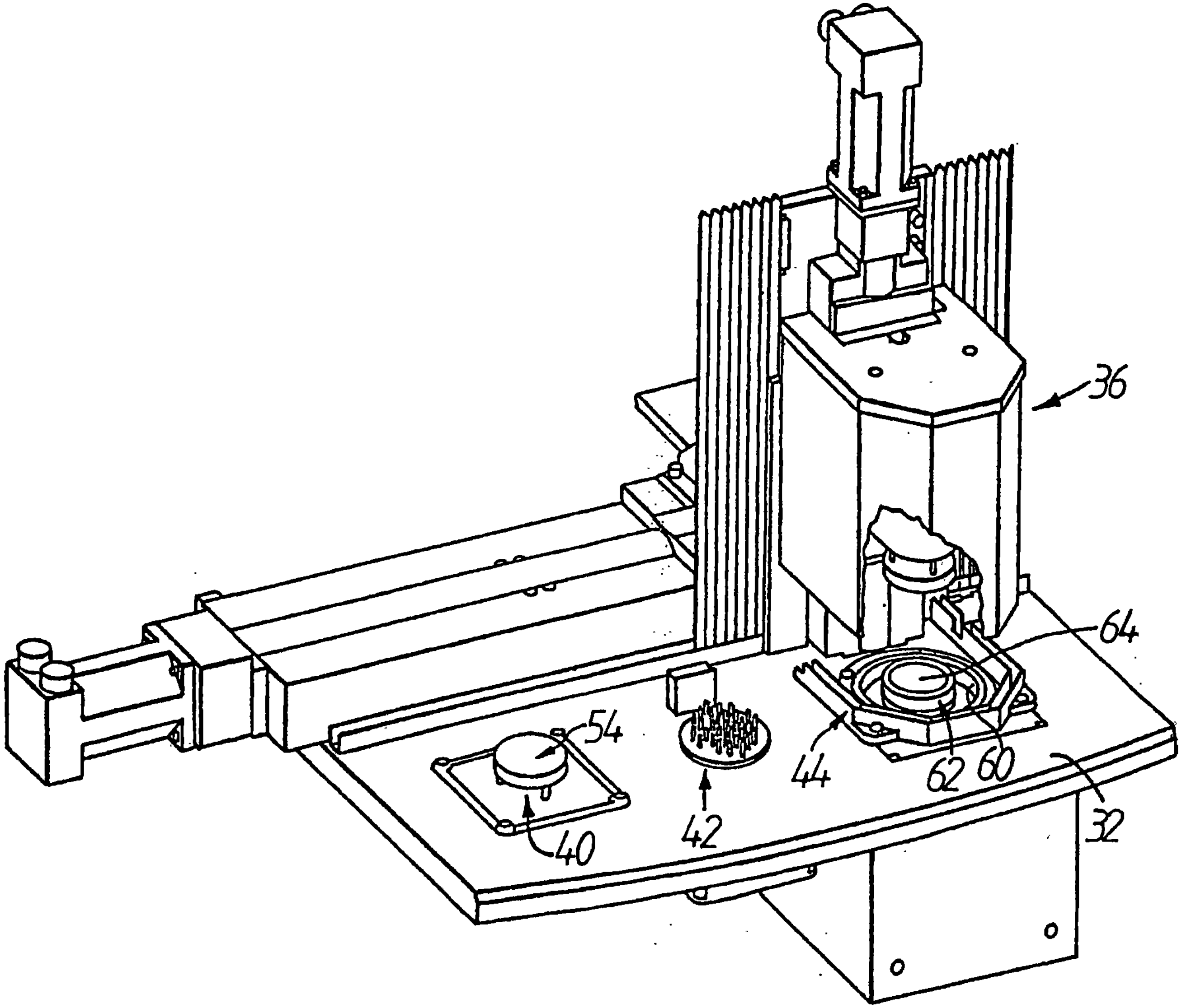


图 3

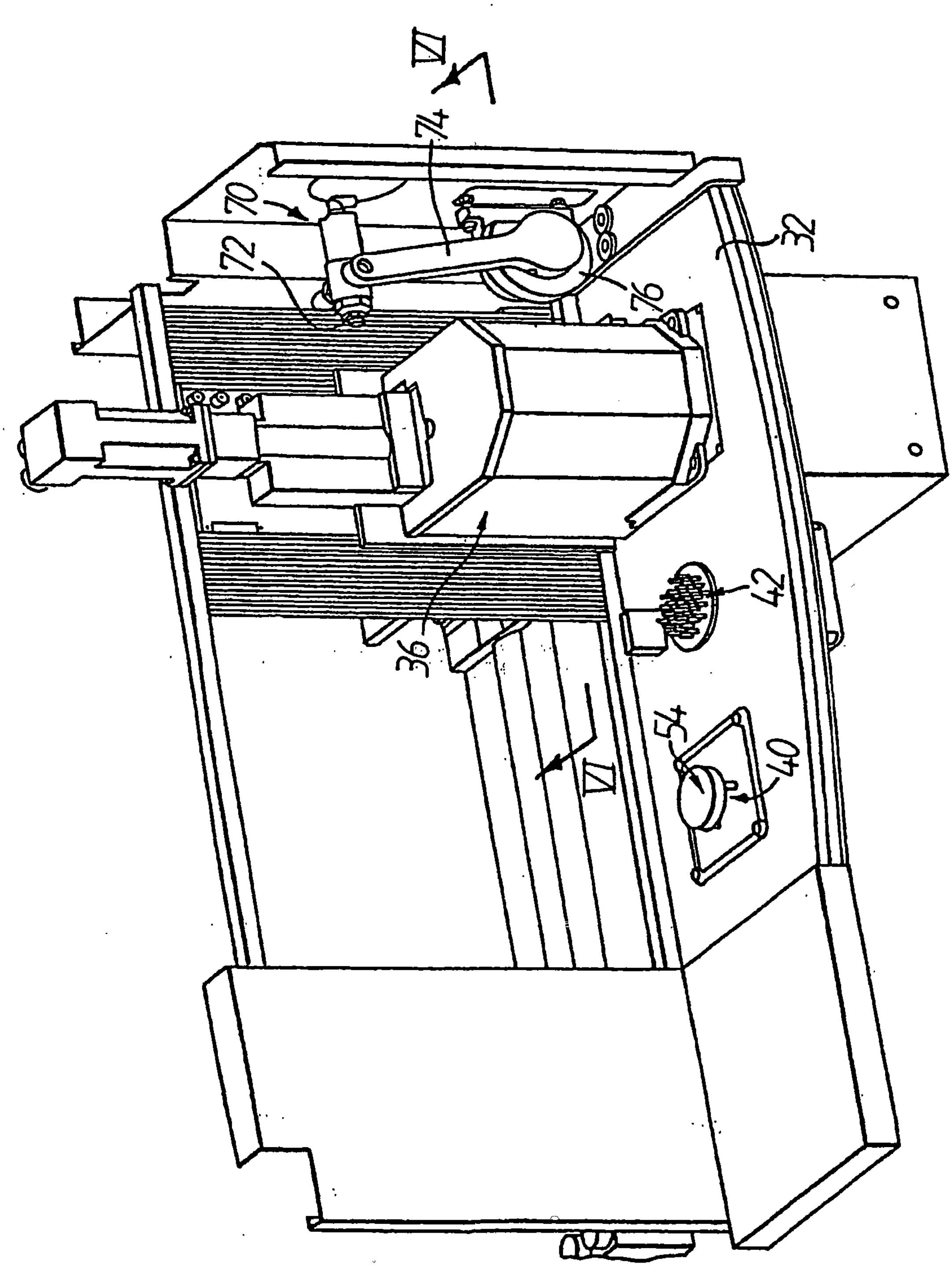


图 4

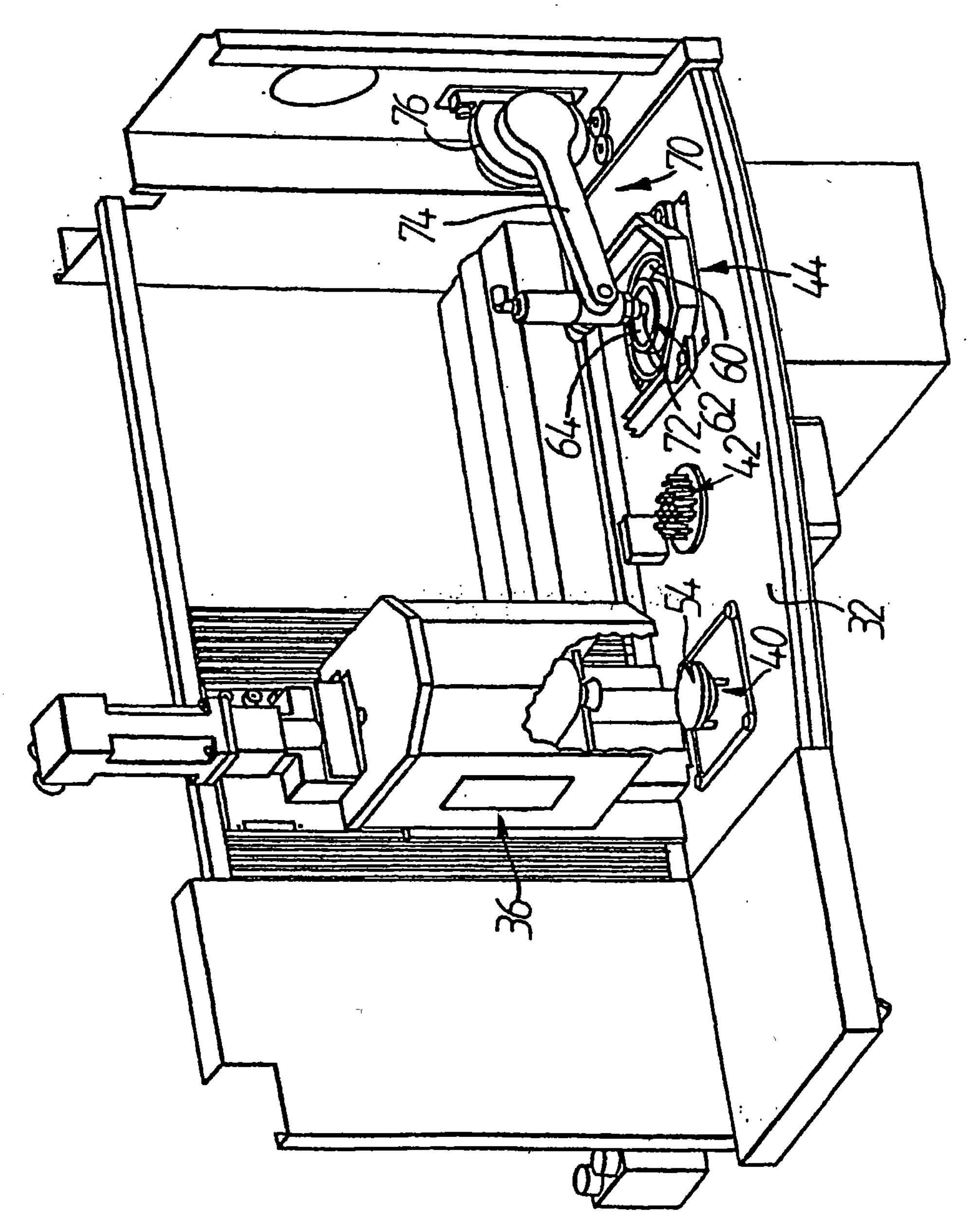


图 5

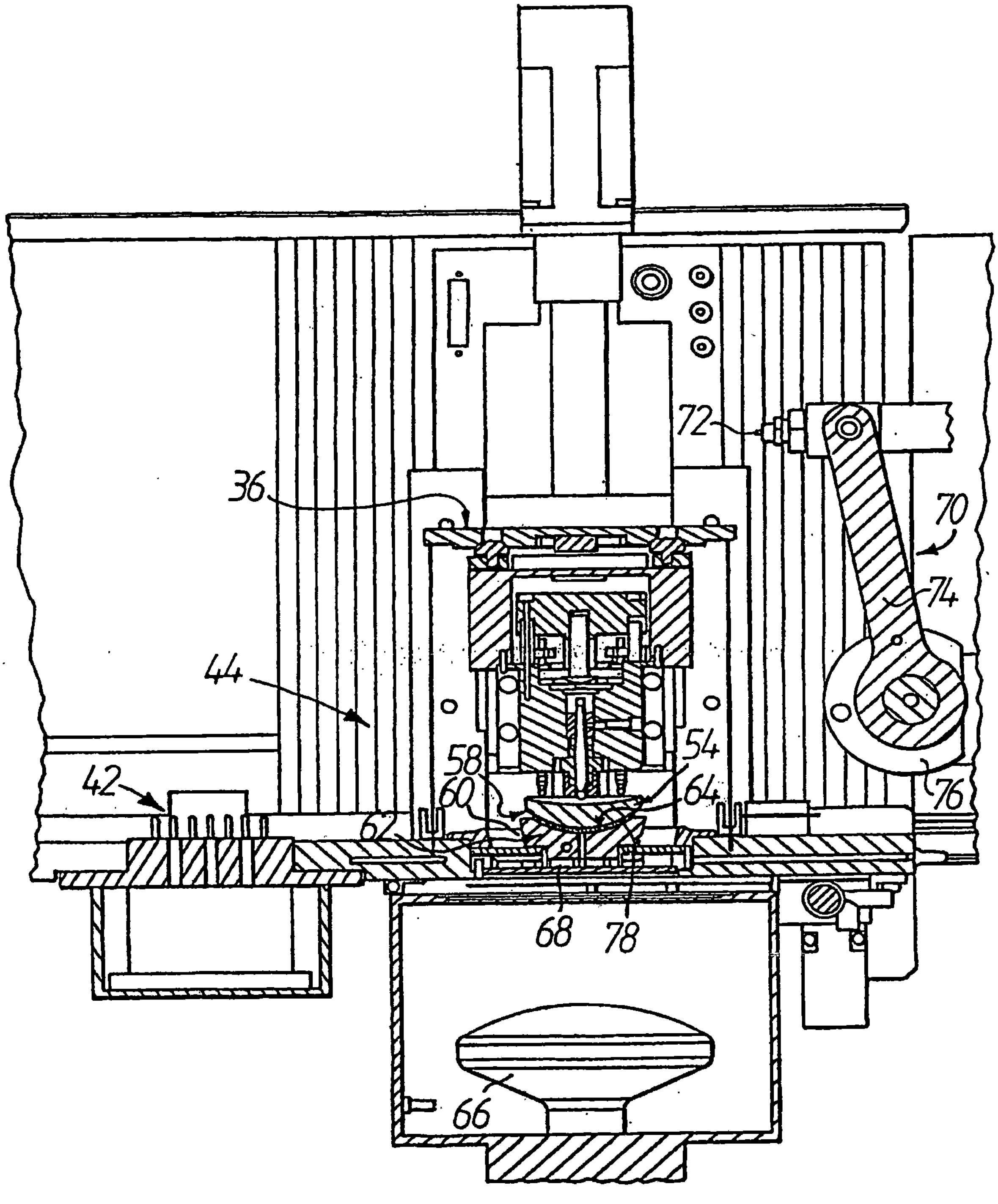
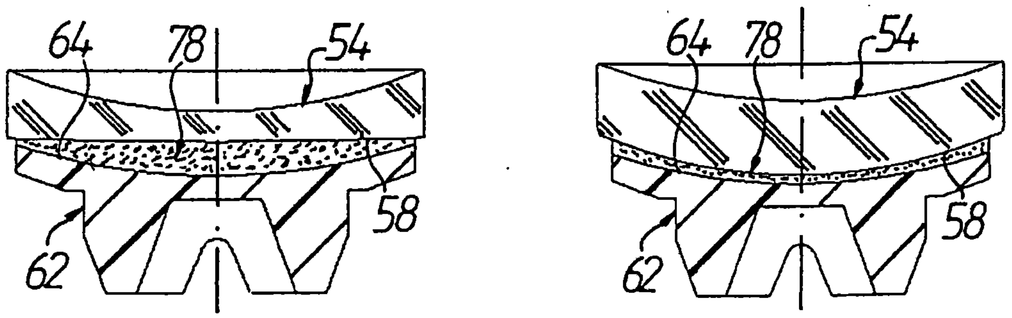
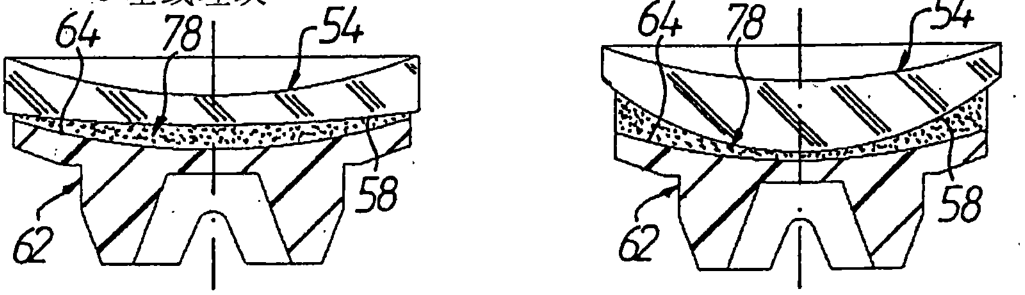


图 6



a) 0.5 基线镜片 &
5 基线坯块

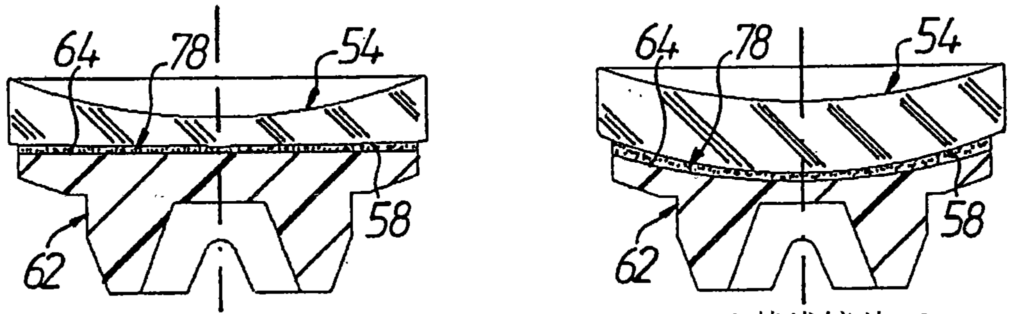
c) 6 基线镜片 &
5 基线坯块



b) 2 基线镜片 &
5 基线坯块

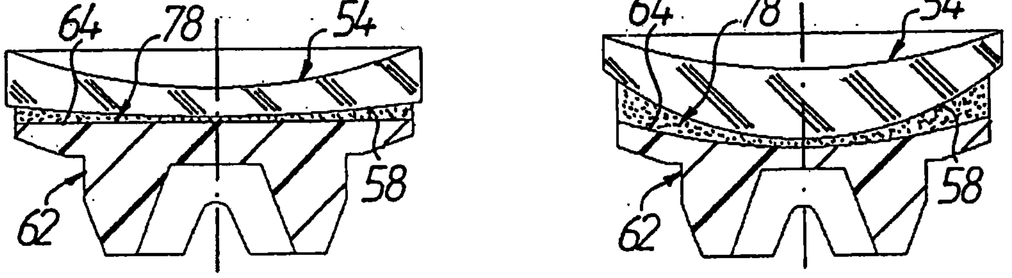
d) 10 基线镜片 &
5 基线坯块

图 7



a) 0.5 基线镜片 &
0.5 基线坯块

c) 6 基线镜片 &
5 基线坯块



b) 2 基线镜片 &
0.5 基线坯块

d) 10 基线镜片 &
5 基线坯块

图 8

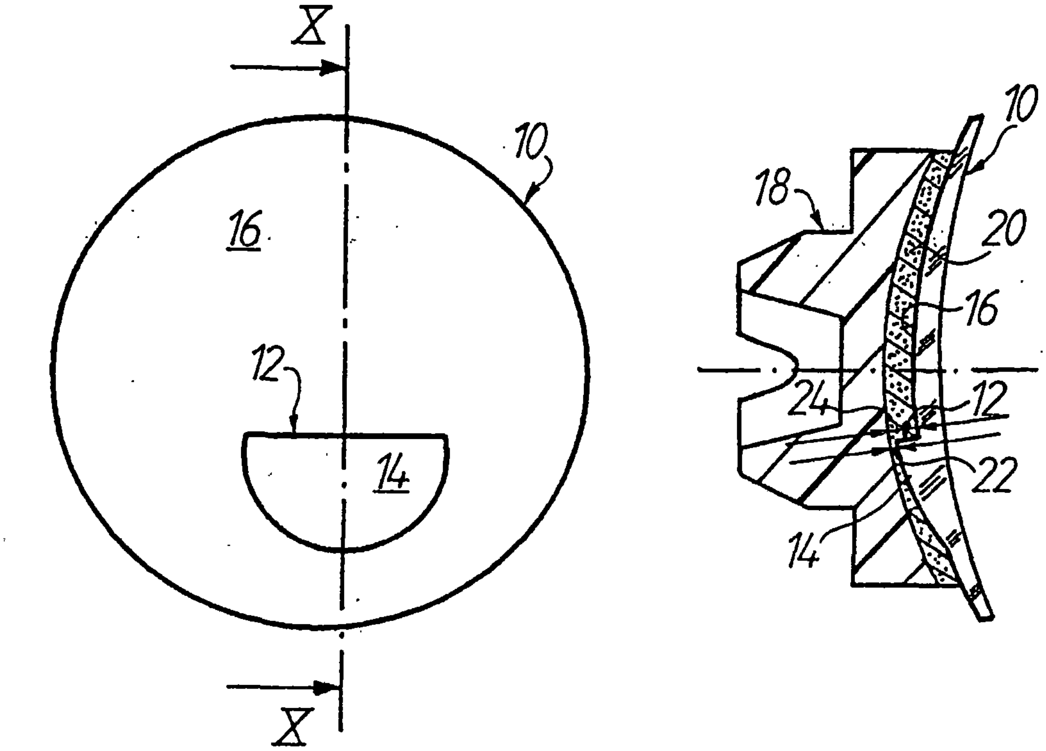
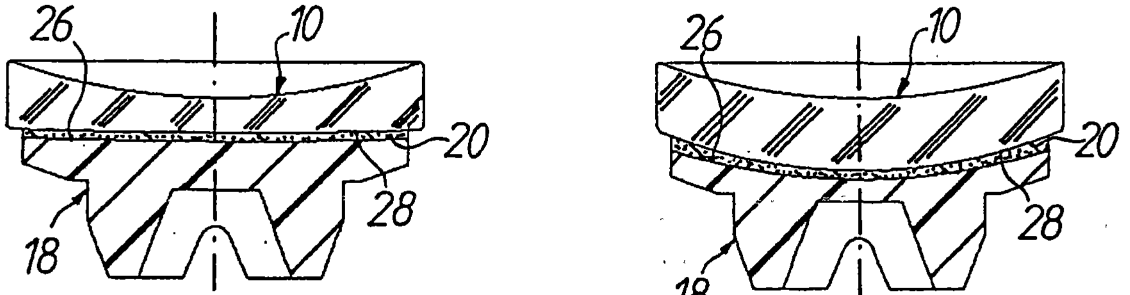
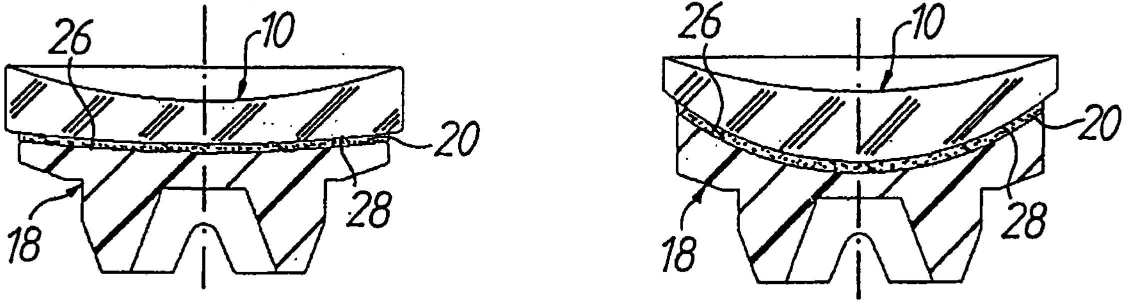


图 10



a) 0.5 基线

c) 6 基线



b) 2 基线

d) 10 基线

图 11