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(54) EYEGLASS COMPONENT ENGRAVING DEVICE

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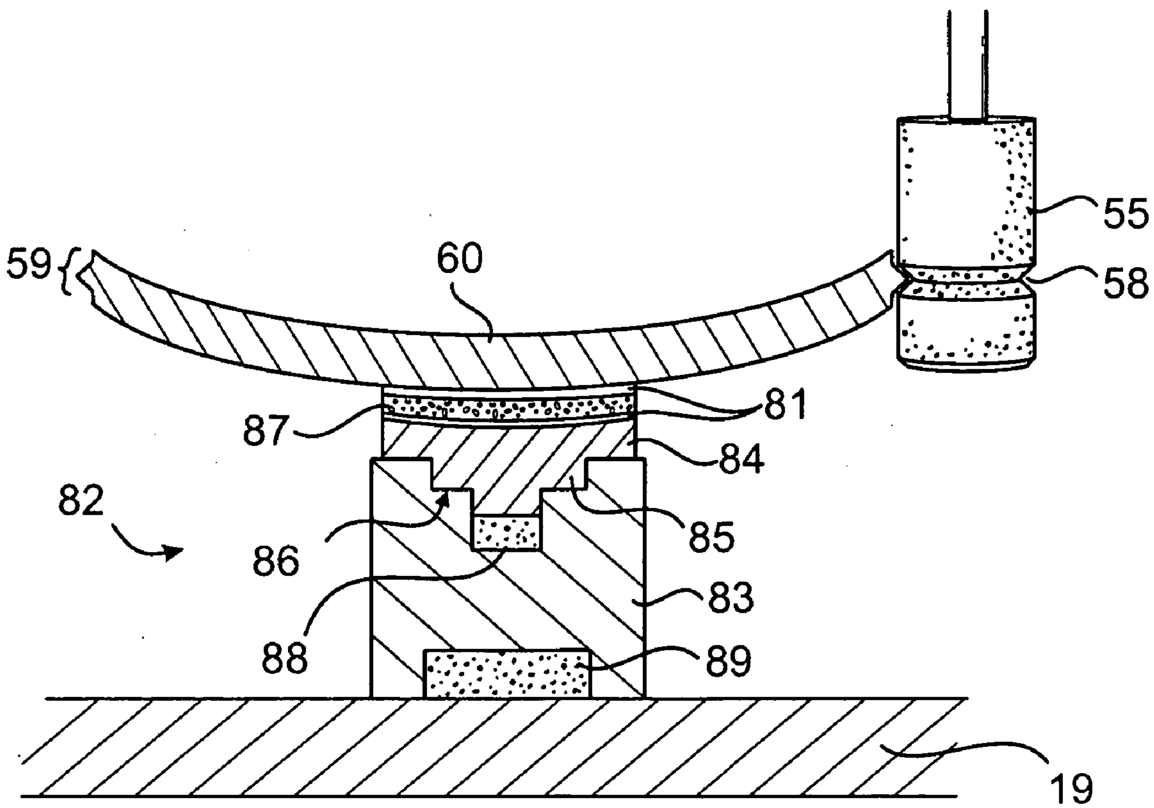
(57) **ABSTRACT**

A laser cutting tool whose position, aiming direction and cutting duration are controlled by a programmable microprocessor, is housed in a cabinet above a platen equipped with a number of component-holding stations. Each of the stations has a plurality of vises sized to grasp an eyeglass component including lenses or lens blanks, a eyeglass frame, temple pieces, a nose bridge, a carrying case or a lens cleaning swatches. Program data sets specify the edging out of blanks of a particular optical property, and the engraving of the lens and other components with decorative patterns. A cylindrical cutting wheel mounted on a position-controlled carriage has a circular groove is also programmed to bevel the edges of the lenses.



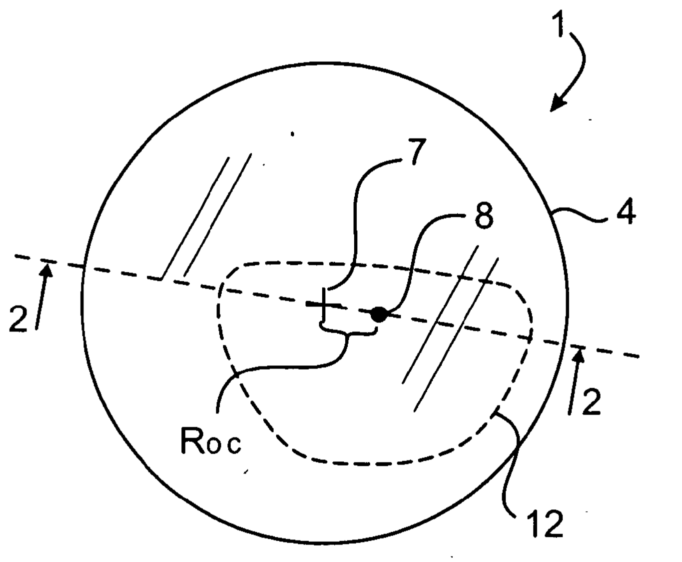


FIG. 1
PRIOR ART

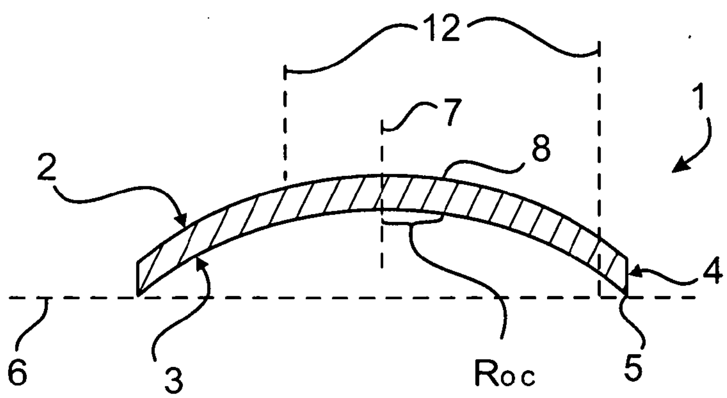


FIG. 2
PRIOR ART

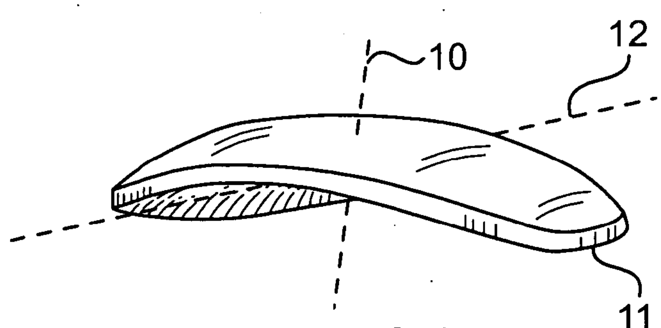
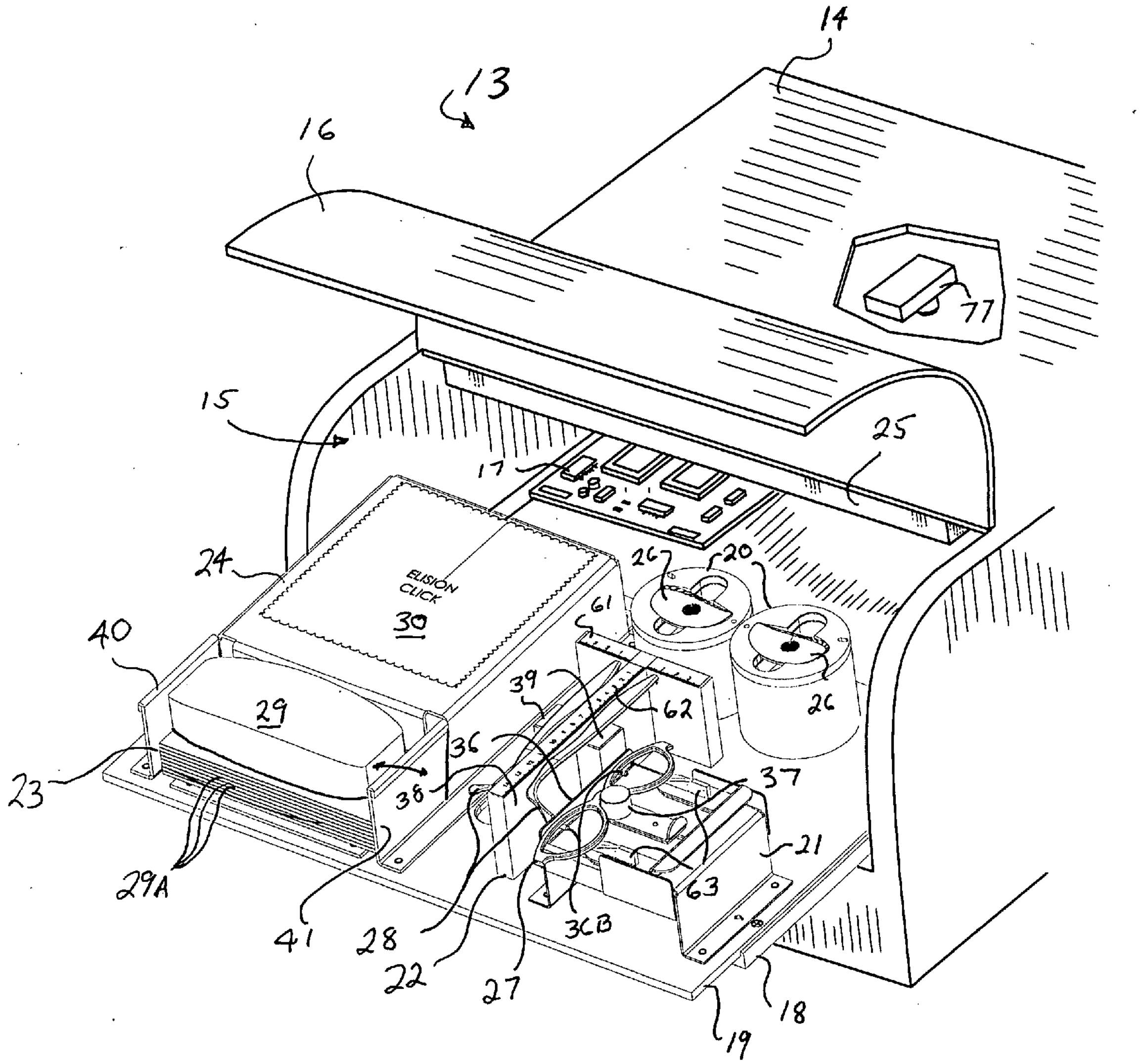


FIG. 3
PRIOR ART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ELISION CLICK
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29A
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FIG. 4

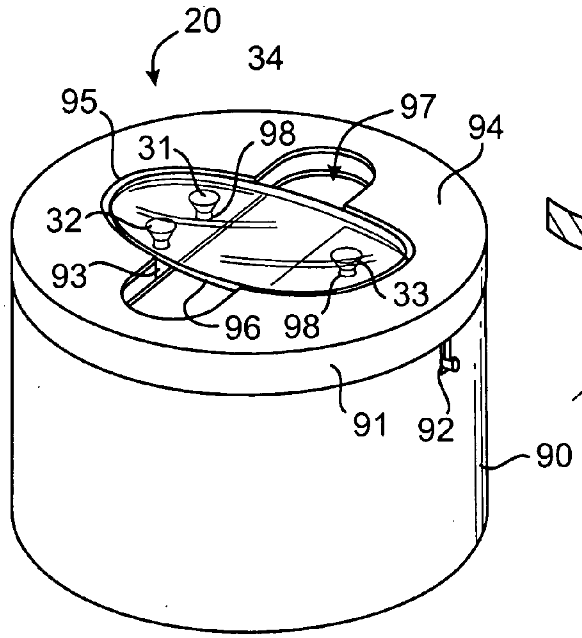


FIG. 5

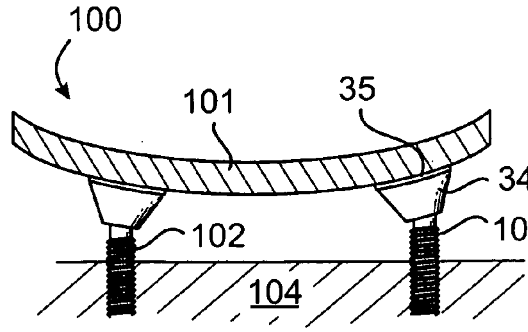


FIG. 6

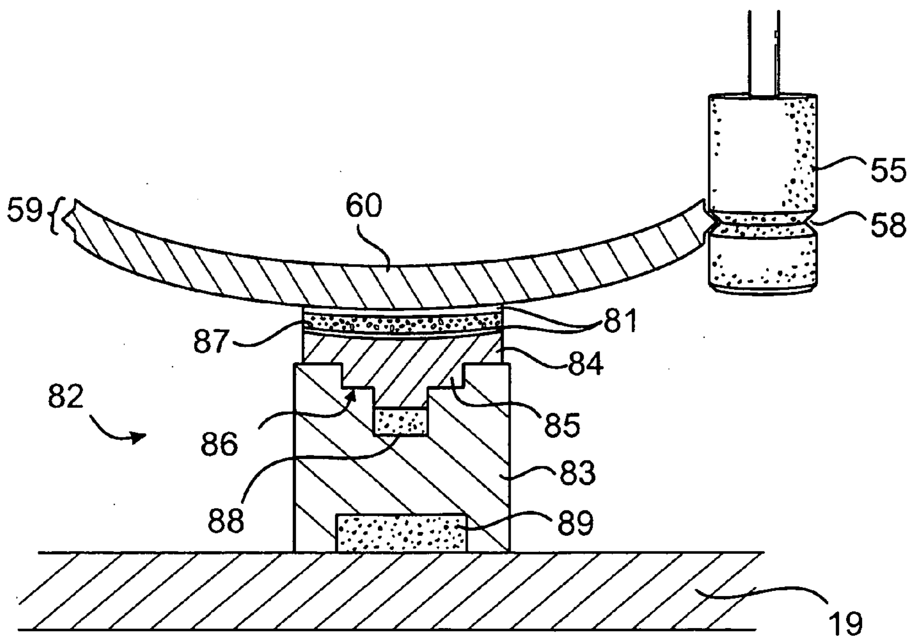
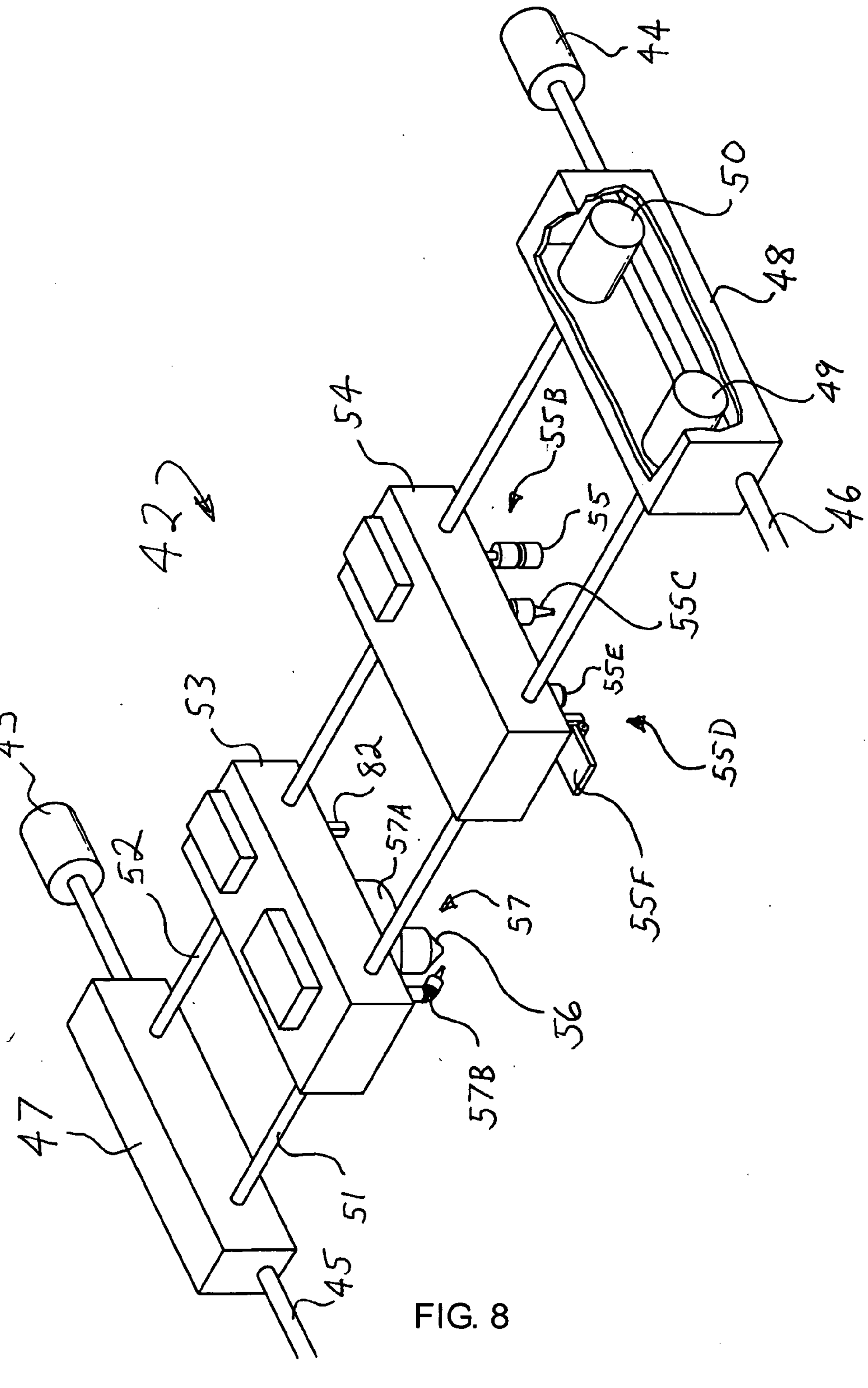


FIG. 7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55B
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55C
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55D
55F
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57A
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57B
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FIG. 8

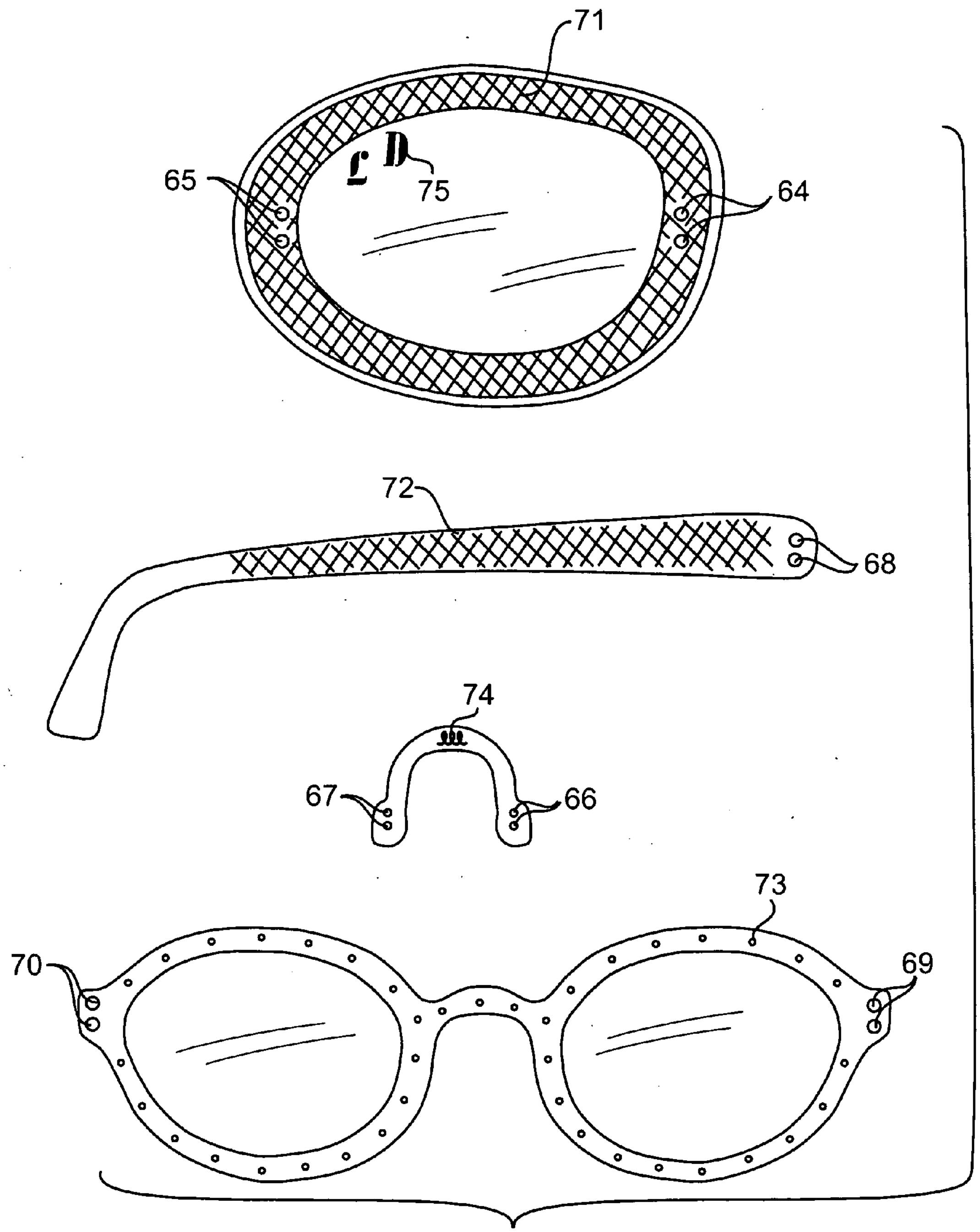

FIG. 9

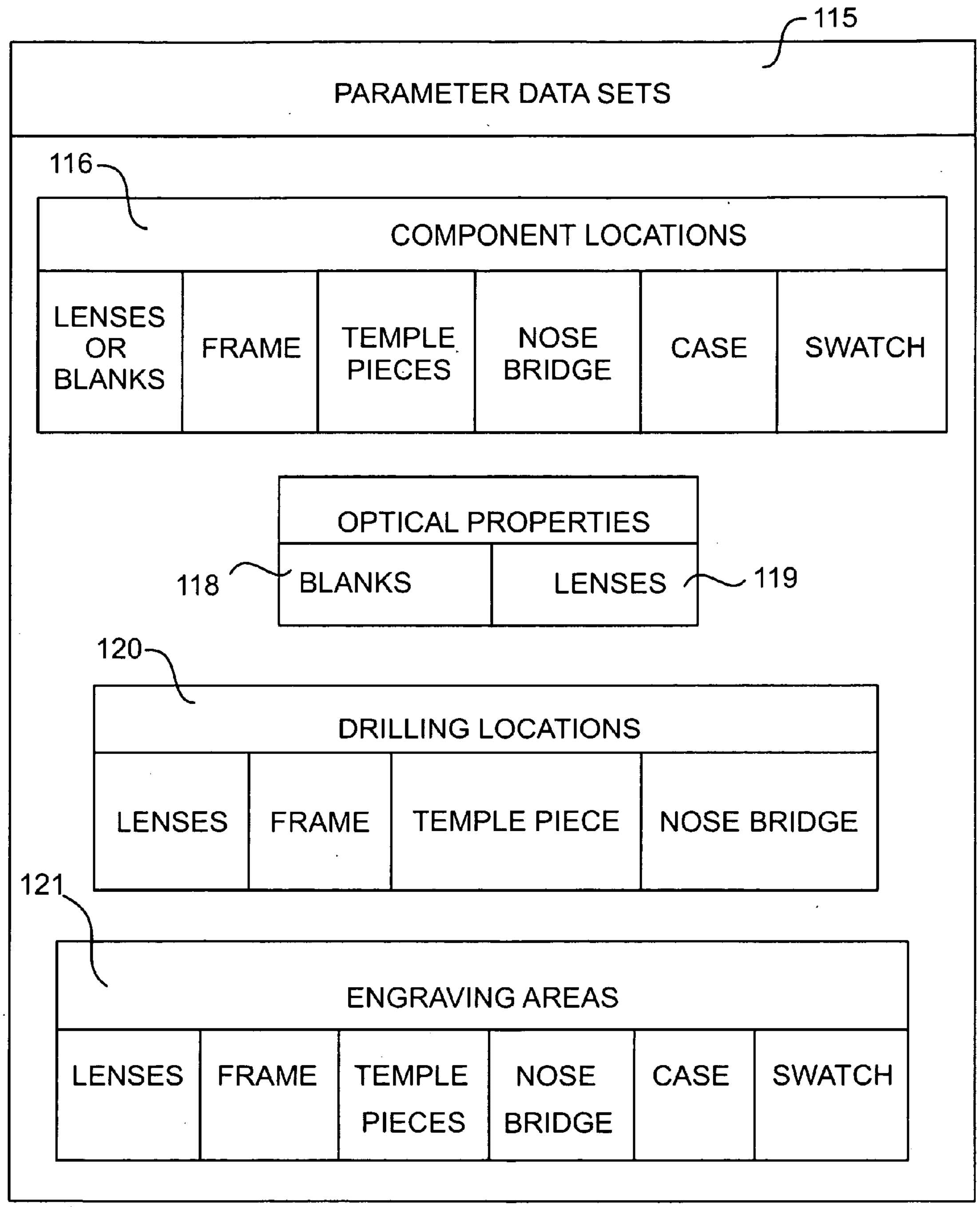
115
PARAMETER DATA SETS
116
COMPONENT LOCATIONS
LENSES OR BLANKS
FRAME
TEMPLE PIECES
NOSE BRIDGE
CASE
SWATCH
OPTICAL PROPERTIES
118
BLANKS
LENSES
119
120
DRILLING LOCATIONS
LENSES
FRAME
TEMPLE PIECE
NOSE BRIDGE
121
ENGRAVING AREAS
LENSES
FRAME
TEMPLE PIECES
NOSE BRIDGE
CASE
SWATCH

FIG. 10

EYEGLASS COMPONENT ENGRAVING DEVICE

PRIOR APPLICATIONS

[0001] This application is a continuation-in-part of co-pending U.S. patent application Ser. No. 10/889,798 filed Jul. 13, 2004, and a continuation-in-part of co-pending PCT Application No. PCT/US05/24663 filed Jul. 13, 2005.

FIELD OF THE INVENTION

[0002] This invention relates to the machining of eyeglass components including the edging of lenses out of lens blanks, and the decorative engraving of lenses, frames, temple pieces, nose bridges, carrying cases and cleaning swatches.

BACKGROUND

[0003] The manufacture of eyeglass lenses is a time-consuming, multi-step process which generally includes the measuring of a patient's condition to derive a prescription for each eye, the measuring or tracing of the size and shape of the desired eyeglass frame, the selection of a lens blank for each eye which will accommodate the prescription for that eye and the frame, measuring or otherwise determining the optical parameters of each blank such as its power, and for cylindrical lenses, its optical axis orientation, and blocking or otherwise properly orienting each lens blank according to its optical parameters and the prescription parameters in a machine or number of machines which can further process the blank into the final lens. The processing includes edging or cutting away material from the lens blank so that the finished lens may fit the selected eyeglass frame, beveling or grooving the peripheral edge to snugly fit the frame, drilling attachment holes for temples or earpieces and nose bridges for so-called "rimless" eyeglasses, and tinting the lenses for sunglasses.

[0004] In general, most eyeglass lenses fall into two categories, namely spherical lenses and cylindrical lenses, each being suited to correct different patient conditions. Referring now to **FIGS. 1 and 2**, a spherical lens blank **1** is typically shaped to have a convex front surface **2**, a concave rear surface **3**, and a circular perimeter **4** having a lower edge **5** which lies substantially within a plane **6** substantially perpendicular to a central axis **7** which can be spaced apart a distance R_{oc} from the optical center **8** in spherical lens blanks having a decentration of greater than zero. Each spherical lens blank is sized to be about 7.5 centimeters (3 inches) in diameter and has a thickness contour which allows it to serve as the lens stock for a wide variety of eyeglass frames.

[0005] Referring now to **FIG. 3**, cylindrical lenses differ from spherical lenses in that the curvature of its surfaces can change according to meridian or angular direction from the central axis **10**. As such, the lower edge **11** may have a saddle shape. The meridian or direction of least curvature can be defined as the cylindrical or optical axis **12** of a cylindrical lens.

[0006] Each lens blank, whether spherical or cylindrical in type is characterized by its lens blank parameters which can include the material from which the blank is made such as glass, acrylic or polycarbonate plastic materials, and the optical parameters which define the shape contour of the front and rear surfaces, which can include its diopter values, decentration of the optical center and cylindrical axis orientation. Even non-prescription lens blanks can be said to have such parameters though they may have zero values such as zero optical power values. The parameters which describe the lens blank are collectively referred to as "lens blank parameters". A difference in even one parameter may result in a different type of lens blank. Such lens blanks are commercially available from a number of sources such as the Sola Lens company of Pensacola, Fla., or the Younger Optical company of Torrance, Calif. Depending on the prescription, a "stock" lens blank may have to be "customized" or further ground and polished to provide the desired front and back surface shapes. It has been found that most prescriptions can be filled by commercially available finished lens blanks without further grinding and polishing of the optical surfaces.

[0007] Referring back to **FIGS. 1 and 2**, the lens blank **1** is then "edged" or cut along a path **12** whose shape is generally defined by the shape of the selected frame. Eyeglass frames come in numerous shapes, primarily dictated by fashion. The translational and rotational position of the path on the lens blank is determined by the lens blank parameters and the eventual user's prescription. As disclosed in Kennedy U.S. Pat. No. 5,462,475, incorporated herein by this reference, accounting for the lens blank parameters generally requires the so-called "blocking" or holding of the lens blank in a specific orientation so that proper "edging" can occur. This is a time-consuming process which requires special skill by the operator who will typically use a lensometer to determine the lens blank parameters, temporarily mark the blank with one or more ink dots to represent the location and or orientation of those parameters, and precisely attaching a temporary blocking or holding structure in accordance with the markings. Attempts have been made to further automate the edging process by providing machines known as "self-blocking" devices which analyze a blank to determine its optical parameters, and "block" the blank automatically. Such devices tend to be expensive and handle lenses individually.

[0008] So called "rimless" eyeglasses have recently gained popularity. Rimless eyeglasses are typically formed by drilling through-holes in the peripheral edge portions of each of the edged lenses to facilitate the fastening of nose bridge and temple or earpiece structures thereon. A significant advantage of "rimless" lenses is that they do not require quite as accurate edging in order to adequately fit a given frame. However, because of the absence of the structurally stiffening and strengthening surrounding frame, many "rimless" designs can have a greater susceptibility to damage than their "rimmed" counterparts. Another disadvantage is that the mechanical drilling of the through-holes can cause stress damage to the lenses.

[0009] Another disadvantage of "rimless" eyeglasses is that they typically do not offer the same potential for frame ornamentation that "rimmed" eyeglasses do.

[0010] Lasers and abrasive water jet-type cutting devices have been used in the past to machine manufactured parts made from a number of different materials such as metal and plastic. Laser and abrasive jet machining typically requires time consuming programming for each part shape being made. Further, use of lasers and abrasive jets can induce heat and residual artifacts which can damage parts or require further machining.

[0011] It is often desirable to mark eyeglasses with a monogram or other identifying indicium in order to guard against theft or as a fashion feature. Some fashionable styles also requires engraving the various components of eyeglasses including the frame, the temple pieces and the nose bridge with decorative patterns, sometimes customly specified by the purchaser. Today there is no device or process that can fulfill these various tasks.

[0012] Therefore, there is a need for the more automated and economical edging of eyeglass and sunglass lenses which address some or all of the above described disadvantages.

SUMMARY

[0013] The instant invention provides a eyeglass component machining device that is programmed to edge prescription lenses out of standard blanks, bevel the edges of the lenses, drill attachment holes in lenses, frames, temple pieces and nose bridges. The device can engrave the periphery of the lenses and all the other eyeglass components with decorative of identifying designs. The device groups in a single enclosure, a laser cutting tool, a grinding tool, a platen equipped with a plurality of eyeglass component holding structures, and a programmable microprocessor. The tools are mounted on a position controllable carriage positioned above the platen. The microprocessor is programmed with edging, grinding, drilling and engraving routines that operate as a function of various parameters data sets including component location parameters, blank optical parameters, lens prescription optical parameters, and decoration parameters. Multiple tasks are performed on a complete array of eyeglass component in a single machining session.

[0014] Some embodiments provide a device for machining eyeglass components including lenses, frames, temple pieces, nose bridges, cases and cleaning swatches, which comprises: a holding platen including a plurality of component holding stations; each of said stations being shaped and dimensioned to fixedly hold one of said components; an electronic controlled cutting tool mounted about said platen; and a programmable microprocessor adapted to control the location, aim and cutting duration of said tool with respect to said stations according to component parameter data sets.

[0015] In some embodiments said machining of eyeglass lenses comprises edging lenses out of cylindrical or spherical lens blanks along edging paths selected as a function of defined optical parameters; and wherein said component parameter data sets comprise lens blank parameters and lens optical parameters.

[0016] In some embodiments said data set comprise lens engraving parameters. In some embodiments said data sets comprise frame engraving parameters. In some embodiments said data sets comprises temple piece engraving parameters. In some embodiments said data sets comprise eyeglass case engraving parameters. In some embodiments said data sets comprise cleaning swatch engraving parameters. In some embodiments said data sets comprises lens, frame, temple piece, nose bridge, case, and cleaning swatch engraving parameters. In some embodiments said data sets further comprise lens, frame, temple piece, nose bridge, case and cleaning swatch engraving parameters.

[0017] In some embodiments the machining device further comprises a position controllable grinding tool mounted about said platen; and wherein said programmable microprocessor is adapted to apply said grinding tool to peripheral areas of lenses.

[0018] In some embodiments said grinding tool comprises a cylindrical abrasive head having an axial spinning movement and a peripheral groove. In some embodiments said groove is shaped and dimensioned to bevel the edges of lenses.

[0019] In some embodiments said data sets comprise lens edging, beveling and engraving parameters. In some embodiments said lens engraving data sets comprise program routines for creating a dye-retaining tooth pattern in a marginal peripheral zone of said lenses.

[0020] In some embodiments said machining of lenses comprises drilling component attachment holes through said lenses; and said data sets comprise drill location parameters.

[0021] In some embodiments said platen comprises a plurality of vises sized to grasp a plurality of said components.

BRIEF DESCRIPTION OF THE DRAWING

[0022] **FIG. 1** is a prior art top plan view of a lens blank;

[0023] **FIG. 2** is a prior art cross-sectional side view of the blank of **FIG. 1** taken along line **2-2**;

[0024] **FIG. 3** is a prior art diagrammatic perspective view of a cylindrical lens blank;

[0025] **FIG. 4** is a perspective view of an exemplary embodiment of an eyeglass component machining device;

[0026] **FIG. 5** is a perspective view of the lens blank or lens-holding structure;

[0027] **FIG. 6** is a cross-sectional frontal view of an alternate lens-holding structure;

[0028] **FIG. 7** is a frontal view of an alternate lens-holding structure and lens beveling tool;

[0029] **FIG. 8** is a perspective view of a machining instrument carriage;

[0030] **FIG. 9** is a top plan view of engraved lens components; and

[0031] **FIG. 10** is a map of the machining parameter data sets.

DESCRIPTION OF THE PREFERRED EMBODIMENT

[0032] With further reference to the drawing, there is shown in **FIG. 4** an eyeglass component machining device **13** housed in a cabinet **14** provided with an access opening **15** closed by a flap-door **16**. A programmable microprocessor **17** is packaged in the bottom part of the enclosure. A pull-out tray **18** carries a platen **19** equipped with a plurality of eyeglass component-holding structures **20-24**. A processing tool assembly **25** including a laser-cutting tool, a grinding tool, and an inking tool among others is mounted in the upper part of the cabinet **14**.

[**0033**] It should be noted that the holding structures of the platen are positioned and dimensioned to fixedly hold the top surfaces of the various components—lens blanks or pre-edged lenses **26**, frame **27**, temple pieces **28**, carrying case **29** and cleaning swatch **30**—in about the same horizontal plane in order to facilitate access by the processing tools such as cutting, grinding and inking tools.

[**0034**] As illustrated in **FIG. 5**, each of the two lens-holding structures **20** comprises a substantially hollow cylindrical base **90**. A "cookie-cutter" style lens-holding template piece **91** is secured elevationally and angularly to the top of the base by a bayonet style releasable connector **92**. A pit **93** is set into the upper surface **94** of the template piece having a peripheral edge **95** shaped similarly to the pre-edged lens **96** and slightly oversized to accept and indicate a unique angular orientation of the lens. A set of three adjustable lens-supporting posts **31**,**32**,**33** project vertically from the bottom of the pit **93**. An oval slot **97** through the upper surface and bottom of the pit allows the lens to be readily grasped along its top and bottom edges by the thumb and finger of an operator. The posts are threaded into mating threaded holes **98** so that their height can be adjusted by a screwing motion. It should be noted that the posts can be adjusted to support a pre-edged lens in the "concave-side-up" or "convex-side-up" orientation depending on the surfaces to be processed. Each post **31**,**32**,**33** is capped by a lens-supporting capital **34** having a top surface **35** made from a layer of an elastomeric material. Each capital is rockingly mounted on its post so that it will conveniently adjust the geometry of the bottom surface of the supported component. The top surface is optionally coated with a tacky substance that provides detachable adhesion to the lens.

[**0035**] It should be noted that for processing a single pair of eyeglass components the two lens-holding templates will have pits which are essentially mirror images of each other. Further, it shall be understood that a set of interchangeable template pieces are provided, each having a differently shaped pit so that the set can accommodate a number of different pre-edged lens shapes.

[**0036**] As shown in **FIG. 6**, an alternate lens-holding structure **100** is provided without a template piece. Instead posts **102**,**103** having rockingly mounted capitals support either a pre-edged lens or a lens blank **101** above a surface **104** of the lens-holding structure. A sensing tool senses the orientation and lens parameters during processing.

[**0037**] Referring now to **FIG. 7**, there is shown an alternate lens-holding structure which is adapted to releasably secure a pre-edged lens or lens blank **60** in either a "concave-surface-up" or "convex-surface-up" orientation. The lens is temporarily mounted to a blocking structure **82** having a generally cylindrical body **83** and an arcuate cup portion **84** often referred to as the "block" fastened to the top. The bottom surface of the cup portion is preferably shaped to have a keyed prominence **85** which engages a correspondingly shaped depression **86** in the top of the body in a specified angular orientation. A magnet **88** located adjacent to and below the depression releasably secures the ferro-magnetic material cup portion to the body.

[**0038**] The use of an angularly keyed interlocking structure between the cup portion and the body allows a lens blank to be optically "blocked" or just merely held in place by the blocking structure. If the blank is optically "blocked", some of the lens blank parameters can be ignored during processing. The cup supports an arcuate leap pad **87** made of resilient material such as foam rubber. The top and bottom surfaces of the pad have sticky layers **81** for contacting the blank and cup, and securing them against unwanted relative movement. The blocking structure is releasably bonded to the platen **19** by means of a magnet **89** located at the bottom end of the body where the platen is made at least partially from a ferro-magnetic material.

[**0039**] Referring back to **FIG. 4**, the frame-holding structure **21** is essentially a vise which clamps the frame **27** between a back ledge **36** and a post **37** sized to nest against the nose bridge of the frame. A pair of height adjustable prongs **36**B extend from the back ledge and support the frame. In the case of a rimless set of eyeglasses, the holding structure **21** is used to simply hold a nose bridge. It should be noted that the positioning of the frame **27** can be adjusted by moving a pair of wedge elements **63** which, as they progress under the frame force it to tilt upward. Optionally, an additional pair of wedge elements may be provided to extend from the back ledge **36** in place of the support prongs **36**B to prove further adjustment of the part of the frame opposite the first pair of wedge elements **63**.

[**0040**] The temple piece holding structure **22** consists essentially of twin vises in which each temple piece is clamped between a central wall **38** and a pair of jaws **39** astride the wall **38**.

[**0041**] The case-holding structure **23** consists essentially of two resiliently flexible plates **40**, **41** between which the case **29** is clamped. Alternately, or in addition to the plates, a number of spacers **29**A can be used to adjust the height of the case. The cleaning swatch holding structure **24** consists essentially in a horizontal table.

[**0042**] As illustrated in **FIG. 7**, the cylindrical wheel **55** of the grinding tool has a circular, peripheral groove **58** whose profile is configured to form a double bevel **59** on the periphery of a lens **60**.

[**0043**] A pair of rulers **61**, **62** mounted orthogonally to one another on the platen in the working plane of the top surface of the various components provide a convenient reference for mapping the location of the various components about the platen by way of a locator program that analyses a digital image provided by a camera **77** mounted over the platen.

[**0044**] The tool assembly **25** includes a X-Y carriage **42** as illustrated in **FIG. 8**. The front-to-back movement of the carriage is provided by two synchronized motors **43**, **44** driving a pair of threaded stems **45**,**46** through supporting blocks **47**,**48**. One of the blocks **48** holds two synchronized motors **49**,**50** driving two threaded shafts **51**,**52** orthogonal to the aforesaid threaded stems **45**,**46**. The two shafts engage a first platform **53** carrying a laser-cutting tool **57**, a vacuum tool **57**B for extracting fumes, and an ink jet tool **82**, and a second platform **54** carrying a grinding tool **55**B, a dry air blower tool **55**C for cleaning off dust and debris, an optional sensor tool **55**D comprising a measurement laser or camera **55**E for locating various components or component features and a removable/replaceable automated protective dust cover **55**F. It is understood that any of the tools may utilize an automatically retractable protective cover if necessary to avoid dust or debris fouling the tool head.

[0045] Each of the platforms has a internal clutch that allows it to be optionally engaged with the shafts **51**, **52**. Accordingly, by coordinating the operation of the various motors and internal clutches, any or all of the tools can be positioned at any coordinate location above the components held on the platen **19**. The grinding tool is also provided with a depth adjustment mechanism whereby a cylindrical abrasive grinding wheel **55** that spins axially can be accurately lowered against the edges of the lenses.

[0046] The head **56** of the laser cutting tool is mounted on a controllable universal joint **57**A that allows the laser beam to be accurately aimed toward its target.

[0047] The aforesaid machining device **13** can perform a variety of edging, engraving, beveling, sensing, cleaning and drilling operations of which exemplary results are illustrated in **FIG. 9**.

[0048] The laser-cutting tool **57** can be used to edge a pair of eyeglass lenses from lens blanks as a function of lens location parameters, the optical property parameters of the blanks and of the desired lens according to the techniques described in the background of this specification. Additionally, and in the case of rimless eyeglasses, the laser tool can drill attachment holes **64**, **65** on either side of the lens. The laser tool can also be used to drill holes **66**, **67** in the nose bridge. The tool can also be used to drill holes **68** in the temple pieces and holes **69**, **70** in the frame.

[0049] The laser tool **54** can also be used to engrave the surface of a peripheral marginal zone **71** of a lens with a fine tooth that will retain a dye into which the lens is later dipped, or retain ink deposited by the ink jet head **82**. The colored zone provides a decorative element which, in the case of a frame-less eyeglass assembly, simulates a frame around the lens. Alternately, the engraving can create a decorative pattern consisting of cross-hatching **72**, series of circles or stars **73** or other whimsical designs **74** on either or all of the peripheral zones of the lenses, the sides of the temple pieces, the frame or the nose bridge. A monogram **75** can also be engraved in a corner of one of the lenses.

[0050] In order to perform the various above-described machining tasks the microprocessor **17** is programmed with a number of routines including a routine for edging lenses, a routine for beveling the edge of a lens, a routine for etching a dye-retaining or ink-retaining tooth on the surface of a lens or components, routines for engraving the surface of components, routines for ink-jet printing on the surface of lenses or components, routines for cleaning the surface of lenses or components, hole drilling routines, and routines for protecting unused tool head against fouling. The microprocessor also stores the parameter data sets **115** that are listed on the map of **FIG. 10**. The data base of the computer must be provided with component location parameters **116** that define the coordinates of each of the various components that constitute the work piece for the cutting, grinding or coloring tool. These component locations are preferably obtained by processing a digital picture of the fully loaded platen taken by a digital camera **77** mounted against the ceiling of the enclosure **14** as shown in **FIG. 4**, or by the sensing tool **55**D if present. The picture is scanned to define the coordinates of shape-defining-pixels for each component. These coordinates are then used to direct the position and aim of the laser-cutting tool **57** and the position and height of the grinding tool **55**, and the position of the inking tool **82**.

[0051] In the case where lenses must be cut from blanks, the data base must include the optical characteristics of the blanks **118**, the desired optical properties **119** of the lens, and a definition of the edging path to be followed by the cutting tool.

[0052] The data base must also include the exact drilling location coordinates **120** for the various work pieces.

[0053] Finally, the coordinates of the areas to be engraved **121** of the various components must also be provided.

[0054] While the preferred embodiment of the invention has been described, modifications can be made and other embodiments may be devised without departing from the spirit of the invention and the scope of the appended claims.

What is claimed is:

1. A device for machining eyeglass components including lenses, frames, temple pieces, nose: bridges, cases and cleaning swatches, which comprises:

a holding platen including a plurality of component holding stations;

each of said stations being shaped and dimensioned to fixedly hold one of said components;

an electronic controlled cutting tool mounted about said platen; and

a programmable microprocessor adapted to control the location, aim and cutting duration of said tool with respect to said stations according to component parameter data sets.

2. The device of claim 1, wherein said machining of eyeglass lenses comprises edging lenses out of cylindrical or spherical lens blanks along edging paths selected as a function of defined optical parameters; and

wherein said component parameter data sets comprise lens blank parameters and lens optical parameters.

3. The device of claim 1, wherein said data set comprise lens engraving parameters.

4. The device of claim 1, wherein said data sets comprise frame engraving parameters.

5. The device of claim 1, wherein said data sets comprises temple piece engraving parameters.

6. The device of claim 1, wherein said data sets comprise eyeglass case engraving parameters.

7. The device of claim 1, wherein said data sets comprise cleaning swatch engraving parameters.

8. The device of claim 1, wherein said data sets comprises lens, frame, temple piece, nose bridge, case, and cleaning swatch engraving parameters.

9. The device of claim 2, wherein said data sets further comprise lens, frame, temple piece, nose bridge, case and cleaning swatch engraving parameters.

10. The device of claim 1 which further comprises a position controllable grinding tool mounted about said platen; and

wherein said programmable microprocessor is adapted to apply said grinding tool to peripheral areas of lenses.

11. The device of claim 10, wherein said grinding tool comprises a cylindrical abrasive head having an axial spinning movement and a peripheral groove.

12. The device of claim 11, wherein said groove is shaped and dimensioned to bevel the edges of lenses.

13. The device of claim 12, wherein said data sets comprise lens edging, beveling and engraving parameters.

14. The device of claim 3,wherein said lens engraving data sets comprise program routines for creating a dye-retaining tooth pattern in a marginal peripheral zone of said lenses.

15. The device of claim 1, wherein said machining of lenses comprises drilling component attachment holes through said lenses; and

said data sets comprise drill location parameters.

16. The device of claim 1, wherein said platen comprises a plurality of vises sized to grasp a plurality of said components.

* * * * *