United States Patent [19]

Bloxsom

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[54] **CONTOUR GRINDER**

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[52] **U.S. Cl.** ..... **51/101 LG,** 51/127, 90/13.9

[51] **Int. Cl.** **B24b 9/14,** B23c 1/18

[58] **Field of Search** ..... 51/101 R, 101 LG, 127; 90/13.9

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[57] **ABSTRACT**

An industrial shaping system to form various articles including eyeglass lenses. The invention specifically discloses an eyeglass frame pattern generator and edge grinder for shaping eyeglass lenses to fit a particular frame. A sensing wheel makes contact with the internal frame groove which is designed to hold the lens. The frame pattern generator controls an edge cutter by means of a servo system to shape the lens so that it will fit into the frame groove after the grinding operation. A computing device in the frame pattern generator is arranged to correct for the inherent errors generally present in all contour devices employing a tracing mechanism and a grinding cutter where grinding is done along the circumference of the grinding wheel.

9 Claims, 3 Drawing Figures

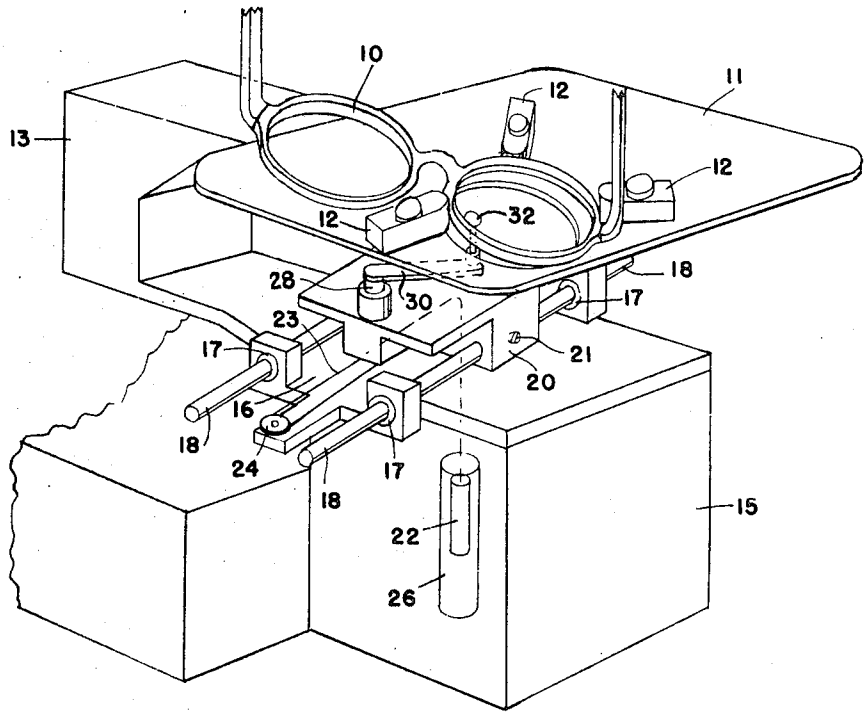


FIG. 1

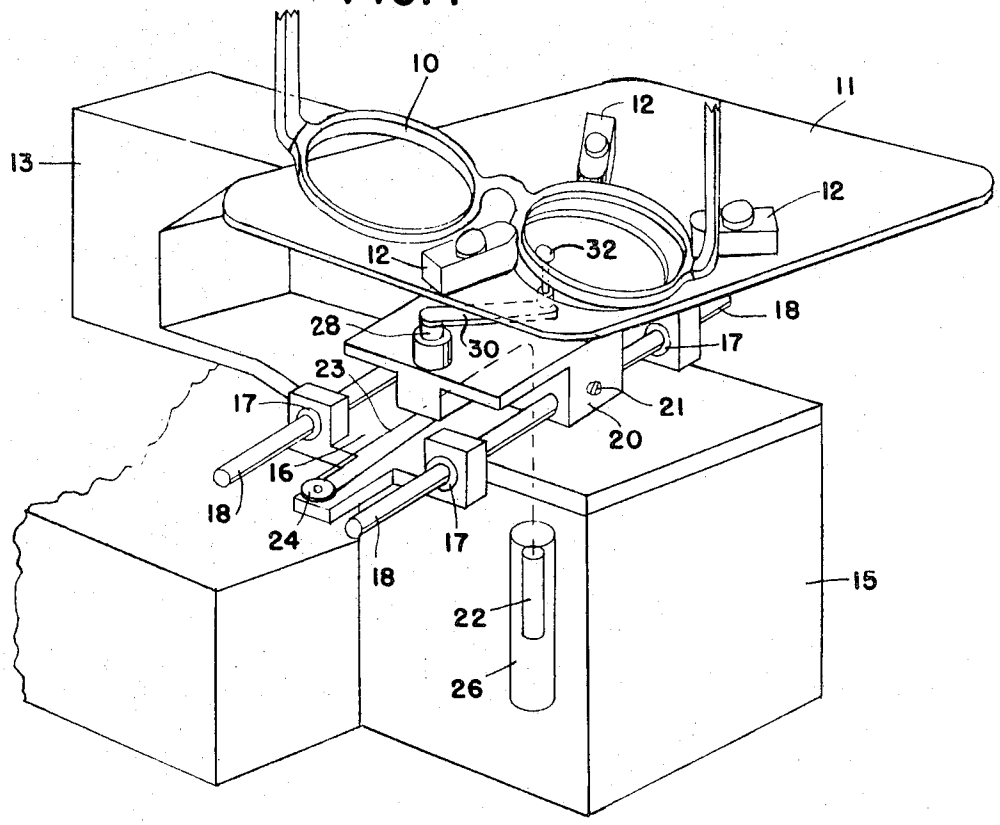

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FIG. 2

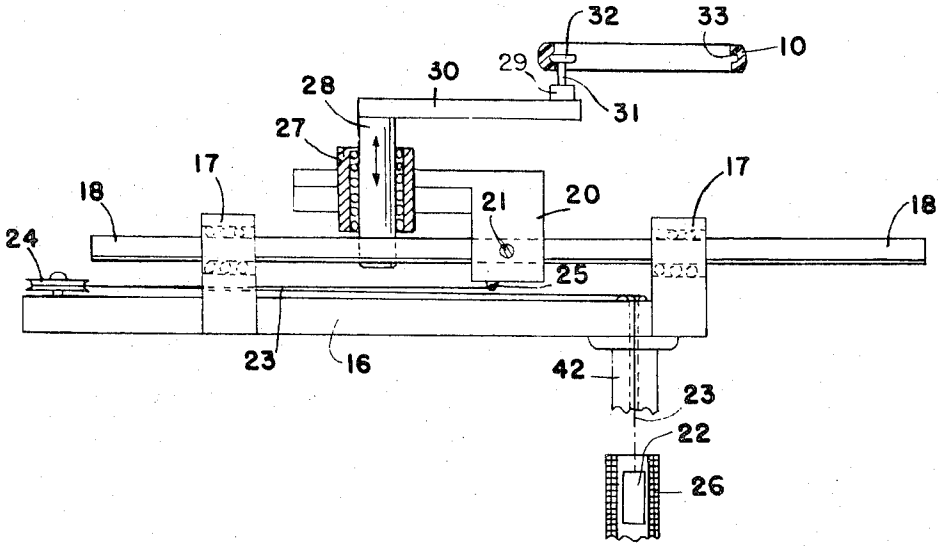
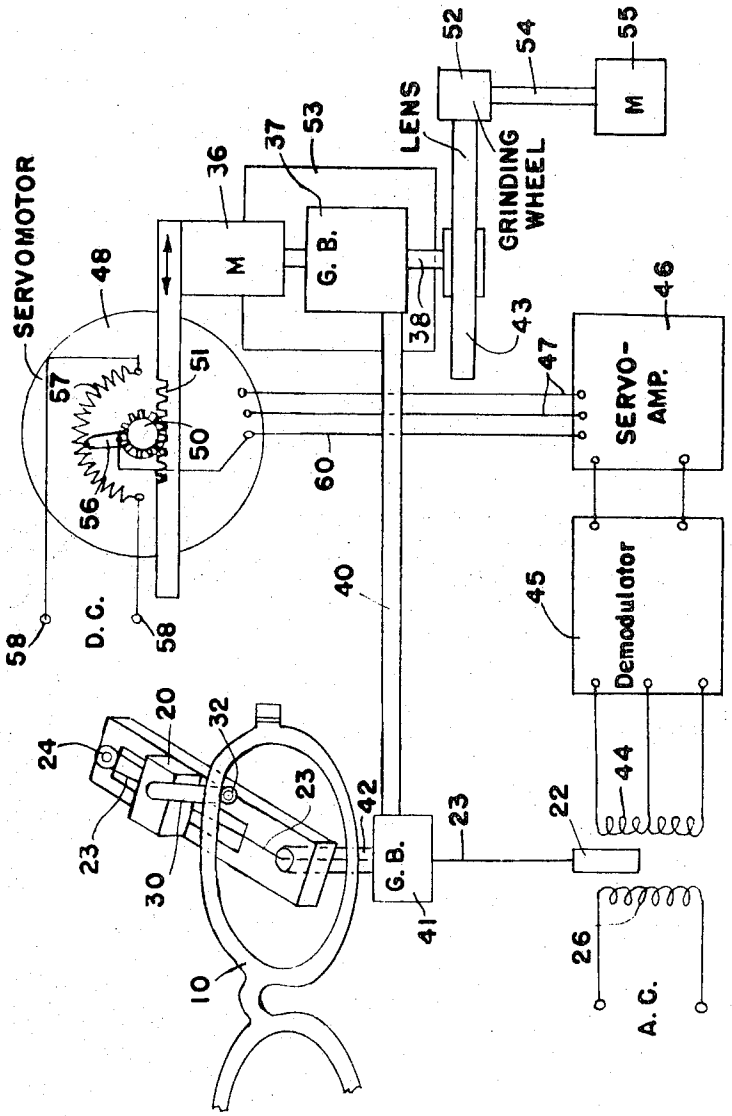

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FIG. 3


SERVOMOTOR
48
57
51
50
56
58
D.C.
58
36
M
37
53
G.B.
LENS
52
54
55
M
GRINDING WHEEL
38
43
46
SERVO-AMP.
47
60
40
45
Demodulator
44
20
32
24
23
30
42
G.B.
23
22
41
26
A.C.
10

CONTOUR GRINDER

BACKGROUND OF THE INVENTION

Eyeglass lenses or other objects are generally furnished by a supplier such as a lens grinder in a standard size which is designed to be larger than any of the frames in current use. It is then the duty of the local optometrist or optician to fit the frame owned or selected by the wearer. In the past a large number of metal patterns were available, each pattern having the shape and size of a particular frame groove. The pattern was secured to a profile and the lens edged to the desired shape and size. The invention hereinafter will be referred to as applied to eye-glasses. However, it is equally applicable with small modification to various other articles of manufacture.

During recent years, the number of frame shapes has increased to such an extent that it is no longer feasible to stock all the pattern shapes. The present invention uses no patterns but instead derives the shape and size of the lens from the frame lens opening itself.

The invention comprises two principal parts; a frame pattern generator and a lens edger. The frame pattern generator derives information from the eyewire lens opening and this information is used to position a servosystem coupled to the lens edger for the proper shaping of the lens to fit the eyewire lens opening.

The coordinate system used for the frame pattern generator is analoguous to the coordinate system used for the lens edger. If the scale and origins of the two systems are equal, as they are in the present invention, then any geometrical shape will have identical shape and size in the two systems.

The frame is securely mounted on a platform, and a small sensing wheel on the end of a rockable lever is run around the eyewire groove, and a grinding wheel, coupled to the sensing wheel, edges the lens to the desired shape along the circumference of the grinding wheel. In other simple coupling mechanisms of this type, an error is always introduced where the grinding is done along the circumference of the grinding wheel. The rockable lever, holding the sensing wheel, is continuously positioned from the line of motion of the principal axis and these angular settings compensate for the errors, in this type of grinding operation.

The present invention also includes a sliding support for the rockable lever, this support being mounted on linear ways secured to a platform which is fixed to a rotary shaft whose axis is aligned with the approximate center of the eyeglass eyewire lens opening. A string is secured to the movable portion of the sliding support and is threaded through an axial hole in the rotary shaft, terminating on a magnetic core. This core is movable between two electric windings, one of which is supplied with a steady alternating current from an external power source. The second winding acts as the secondary winding of a transformer and its available current depends upon the position of the movable core. The terminals of the second winding are connected to a servosystem having an output servomotor which controls the position of the lens with respect to the edge grinding wheel.

One of the features of the invention is the use of an eyeglass frame with an eyeglass pattern generator which can be coupled to a lens edge grinder to grind the edge of a lens so that the lens can be fitted into the lens opening of the eyewire.

Another feature of the invention is the eyeglass frame pattern generator which converts tracing information which is used to control a servosystem for positioning the lens edger.

Another feature of the invention is the adaptability of the eyeglass frame pattern generator whereby a wide range of shapes and sizes can be employed.

Another feature of the invention is the use of the plane polar coordinate system whereby the polar angle is generated by a motion which is common to the frame pattern generator and the lens edger.

Another feature of the invention is the use of a rockable tracing arm which follows the lens groove in the eyewire when the groove is a three dimensional curve.

Still another feature of the invention is the use of a linear variable differential transformer coupled between the pattern generator and the servosystem whereby the direct electrical connections between these components is eliminated.

Another feature of the invention is the mechanism for removing the weight of the mechanical computer from the sensing wheel.

Another feature of the invention is the use of a mechanical computer mechanism whereby the proper projection component on the radius vector is obtained for the control information to the servosystem for positioning the lens edger.

Another feature of the invention is the positioning mechanism for the mechanical computer mechanism.

Other features and additional details of the invention will be disclosed in the following description, taken in connection with the accompanying drawings.

BRIEF DESCRIPTION OF THE FIGURES

FIG. 1 is a perspective view of a portion of the device showing the frame sensing table, the rotary sliding support, the container which houses the lens holder, and the motor for the angle drive.

FIG. 2 is a detailed side view of the sensing wheel, the mechanical computer, and the sliding support. Some parts are shown in section.

FIG. 3 is a schematic diagram of connections showing the coupling means between the sensing wheel, the mechanical compensator, the servoamplifier, the servomotor, and the edge grinding wheel. The feedback generation and control connection are shown in this figure.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now to the figures, an eyeglass frame **10** is secured to a table **11** by a clamping mechanism **12.** The table **11** is secured to a supporting means **13.** The lower portion of support **13** forms the top of a container **15** which houses the motor for the angular drive and a lens holder.. Between table **11** there is a base **16** which includes four linear ball bushings **17** supporting two parallel shafts **18.**

The mechanism can be operated in either one of two modes since the basic requirement depends upon the relative motion of the eyeglass frame and the sensing wheel, also the relative motion of the lens and the edge grinding wheel. In the following description the device will be described as a rotary sensing means and a rotary

lens. It is to be understood that similar results can be achieved if the eyeglass frame, along with supports **11** and **13**, are rotated about a common axis. In this case, the grinding wheel will also move around the lens which will be stationary.

The parallel shafts **18** are connected to a bridge type block **20** secured to both shafts by set screws **21**. It is evident that block **20** and the two shafts **18** can be moved horizontally in the linear bushings **17**, this movement controlled by the sensing device composed of wheel **32**, shaft **31**, in bearing **29**, arm **30**, shaft **28**, and linear bearing **27**. The movement is transmitted by a flexible string **23** to a ferromagnetic core **22** positioned within a transformer winding **26**. The string **23** is threaded around a pulley **24** and its upper end is secured to a ring **25** on the lower part of block **20**. In this manner the movement of block **20** is coupled to the core **22** and winding **26**.

Block **20** supports the rotatable linear bearing and a short vertical shaft **28**. The linear ball bearing **27** permits a vertical movement of shaft **28** as well as a rotary motion. The vertical motion is necessary to allow for frame grooves which may not be entirely positioned in a horizontal plane. The top end of the shaft **28** is secured to a short lever arm **30** which carries a sensing shaft **31** and sensing wheel **32**. The sensing wheel in one embodiment was one-eighth inch in diameter and is designed to track in eyewire grooves **33** of the eyeglass frame **10**. The core **22** holds the sensing wheel **32** in contact with groove **33** by means of its weight via string **23**, pulley **24** and ring **25**.

The operation of this portion of the device is evident from the above description. The frame **10** is secured to table **11** by clamps **12** and the sensing wheel **32** is placed in groove **33**. Then a motor **36** (FIG. 3) is started and, acting through a gear reduction box **37**, both the lens **43** is rotated and shaft **40** is turned at the same speed. Shaft **40** acts through a gear box **41** to turn vertical shaft **42** and the sensing and computing device at the same speed. Gear box **41** is equipped with an optional reversing mechanism so that shaft **42** may be set to turn in the same direction as shaft **38** in which case the device will shape the lens so that it will fit in the eyeglass frame being sensed. If the gear box **41** is reversed, the sensing mechanism will rotate in the opposite direction and the lens will be ground to fit the other eyeglass frame.

As shaft **42** rotates about its axis, the sensing wheel moves around groove **33**, and the arm **30**, which carries the sensing wheel, changes its angular position so that arm **30** is always perpendicular to the tangent of the groove at the point of contact with the wheel **32**.

The purpose of the mechanical computer is to obtain the projection of the position of the sensing wheel **32** in groove **33** along the direction of travel of rods **18** as well as projecting the eyewire groove onto the horizontal plane. The distance from the axis of shaft **28** to the edge of sensing wheel **32** nearest to the axis of shaft **28** as measured along lever arm **30** is equal to the radius of the grinding wheel **52**. The axis of shaft **28** is analgous to the center of the grinding wheel. The distance from the line passing through the axis of shaft **28** to the geometric axis of the eyewire lens opening (and perpendicular to them) will be called the principal radius. Similarly, the distance from the line passing through the center of the grinding wheel to the axis of the glass lens holder in the lens edger (and perpendicular to it) will be called the secondary radius. The lens edge grinder has its axis positioned along the secondary radium by a distance equal to the length of the principal radius.

The extremum values of the positions of the sensing wheel **32** correspond to the points of grinding of the lens on the grinding wheel. Lever arm **30** projects these positions on the principal radius (whose direction of travel of rods **18**) and the displacements of rods **18** are measured by the displacements of core **22** relative to winding **26**. The core **22** transfers a measured amount of magnetic flux to the secondary winding **44** (see FIG. **3**) and the result is applied to demodulator **45**. The core **22** rotates when the base **16** is turned. Because the displacement of core **22** is sensed by electromagnetic field coupling, the electronic circuitry remains stationary in space and does not participate in the rotary motion of plate **16**.

The servosystem shown in FIG. **3** contains components well known in the art. The components used and the complete servosystem have been described in a book "Electronic Instruments" by Greenwood, Holdam and Macrae, published by McGraw-Hill in 1948, incorporated herein by reference. The winding **44** applies a variable AC to the demodulator **45**. The demodulator **45** provides full wave rectification to the imput signal and applies a direct current input to the servoamplifier **46**. The output of the amplifier **46** is applied over conductors **47** to a direct current motor **48**. This output motor turns gear **50** and rack **51** to move the lens system toward or away from an edge grinding wheel **52**. The complete motor system moved by rack **51** includes the motor **36**, the gear box **37**, and the lens **43**. These components may be secured to a common base **53** which moves on a slide or rollers (not shown). The grinding wheel **52** is mounted on the end of a shaft **54** turned at relatively high speed by a motor **55**.

The servomotor shaft which turns gear **50** also turns a contact blade **56**, the end of which makes contact with a circular resistor **57**. Resistor **57** is supplied with direct current from terminals **58** and as the contact blade **56** moves along resistor **57**, the DC potential on it and its connecting conductor **60** varies in accordance with the blades position.

When the servosystem is operated, the motor **48** turns clockwise or counter clockwise depending upon the polarity of the DC potential on conductors **47**. As the motor **48** turns, the potential on conductor **60** is varied until this potential is equal to the DC voltage applied to the input of the servoamplifier **46** by the demodulator **45**. When this balance is attained, both the input and output voltages of the servoamplifier are balanced and the grinding wheel **52** is correctly positioned to remove the desired amount of glass from the lens **43**.

Many other mechanical and electrical modifications and variants will be readily apparent from a reading of the above, and all are within the concept of the invention as described and claimed.

While my invention has been described in detail as applied to an eyeglass frame, it should be understood that the apparatus could be used for many other industrial purposes all within the disclosed inventive concept.

The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:

1. A contour edger for an object to be ground comprising: (a) a sensing means for determining the size and shape of the groove which is to retain the edge ground object, said sensing means including a rotatable base having an axis of rotation in alignment with the approximate center of a frame the object is to fit, a slidable block mounted on the rotatable base, a rockable arm mounted on said block and including a sensing wheel at the end of the arm which makes contact with the groove in the frame, a ferromagnetic core coupled to the slidable block by flexible means, said core also in alignment with the axis of said rotatable base, and a transformer having a primary winding connected to a source of AC power and a secondary winding, both windings surrounding said core and in alignment therewith;

b. a servomotor system connected to the secondary of said transformer, said system including a servomotor connected to a means for moving the object toward and away from a grinder wheel; and

c. an edge grinding means for grinding the edge of an object to a desired size and shape, said grinding means including a rotatable support for the object, said support coupled to the rotatable base for rotation in synchronism therewith, an edge grinding wheel turned by a grinder motor, and means for moving the rotatable support toward and away from said grinding wheel in accordance with the variations of the sensing means.

2. A contour edger as claimed in claim 1 wherein a variable contact arm is secured to the servomotor for rotation therewith, said arm engaging a voltage divider whose ends are connected to a source of direct current, said contact arm connected to input terminals of the servoamplifier.

3. A contour edger for eyeglass lenses comprising: (a) a sensing means for determining the size and shape of the groove which is to retain the edge ground lens, said sensing means including a rotatable base having an axis of rotation in alignment with the approximate center of an eyeglass frame the lens is to fit, a slidable block mounted on said rotatable base, a rockable arm mounted on said slidable block, a sensing wheel at the end of the rockable arm which makes contact with the groove in the frame, a ferromagnetic core coupled to the slidable block by a flexible string, said core also in alignment with the axis of said rotatable base, and a transformer having a primary winding connected to a source of AC power and a secondary winding, both windings surrounding said core and in alignment therewith;

b. a servomotor system connected to the secondary of said transformer, said system including a servomotor connected to a means for moving the lens toward and away from a grinder wheel; and

c. an edge grinding means for grinding the edge of an eyeglass lens to a desired size and shape, said grinding means including a rotatable support for the eyeglass lens, said support coupled to the rotatable base for rotation in synchronism therewith, an edge grinding wheel turned by a grinder motor, and means for moving the rotatable support toward and away from said grinding wheel in accordance with the variations of the sensing means.

4. A contour edger as claimed in claim 3 wherein the flexible string is threaded through an axial hole in a shaft which turns the rockable arm.

5. A contour edger as claimed in claim 3 wherein said primary and secondary windings are positioned in axial alignment with the movement of the core.

6. A contour edger as claimed in claim 3 wherein said servomotor system includes an amplifier coupled between the transformer secondary winding and the servomotor.

7. A contour edger as claimed in claim 3 wherein the servomotor is coupled to the support for the eyeglass lens by a rack and pinion.

8. A contour edger as claimed in claim 6 wherein said servomotor system includes a demodulator which receives an alternating voltage from the transformer secondary winding and delivers a direct current to the amplifier.

9. A contour edger as claimed in claim 3 wherein a variable contact arm is secured to the servomotor for rotation therewith, said arm engaging a voltage divider whose ends are connected to a source of direct current, said contact arm connected to input terminals of the servoamplifier.

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