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METHOD OF GRINDING THE EDGES OF LENSES

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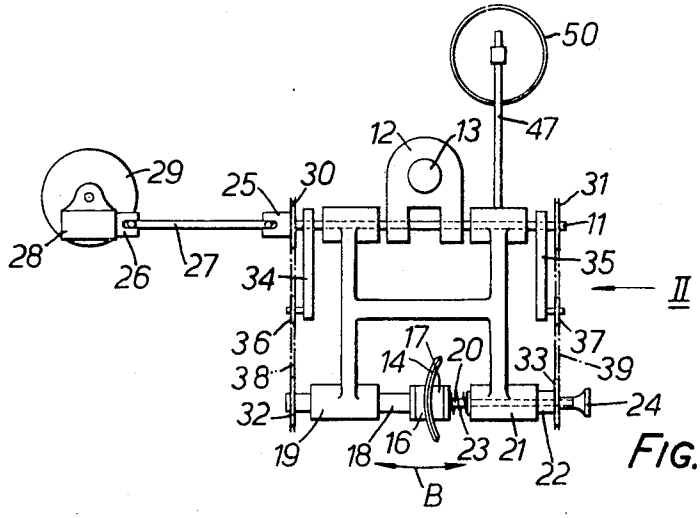


FIG. 1.

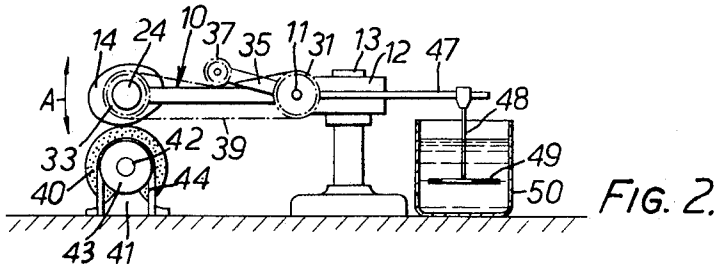


FIG. 2.

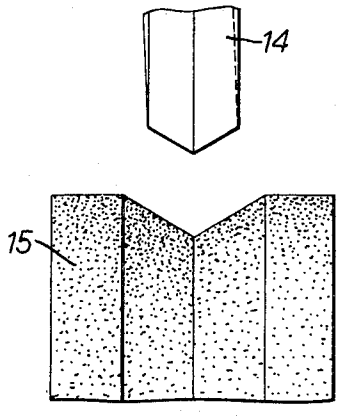


FIG. 3.

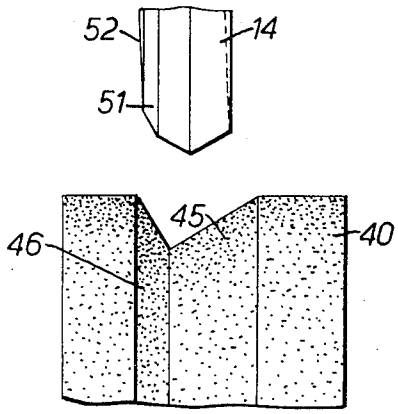


FIG. 4.

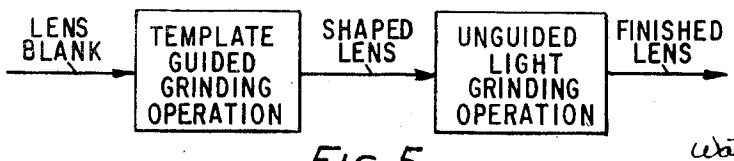


FIG. 5

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METHOD OF GRINDING THE EDGES OF LENSES

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ABSTRACT OF THE DISCLOSURE

For smoothly grinding the edge of a lens a first template-guided grinding operation is carried out in a conventional manner, followed by a second grinding operation in a lightweight machine devoid of template guidance.

This invention relates to a method of grinding the edges of lenses, for example spectacle lenses.

The conventional method, as described for example in British patent specification No. 788,471, is to press the edge of the lens against a revolving abrasive wheel while slowly rotating the lens about an axis, the distance between this axis and the axis of rotation of the abrasive wheel being controlled by a template which determines the ultimate size and shape of the lens. The cross-section of the ground edge of the lens is determined by the shape of that part of the periphery of the abrasive wheel which comes into contact with the lens.

When the abrasive medium is relatively coarse, as is usually the case, especially with diamond particles which are often used for this purpose, there is a corresponding coarseness of the ground surface of the edge of the lens. This coarseness is manifest in two ways. Firstly, it is apparent on any part of the edge of the lens which has been ground approximately flat, such as bevel faces. Secondly, it is apparent on the continuous peripheral line where the ground edge of the lens meets the clear front or rear surface of the lens. The latter effect is usually the more important, particularly in the case of spectacle lenses.

The main object of the invention is to provide a method for reducing such coarseness of the ground edge of the lens.

Other objects will be apparent to those skilled in the art from the following description.

According to the invention, these and other objects are achieved by carrying out a template-guided first edge grinding operation in a grinding machine, e.g. in the conventional manner, and then subjecting the lens to a second edge grinding operation in another grinding machine free from template guidance and in which a lighter contact pressure is applied than in the first grinding operation.

Owing to the light pressure applied in the second operation, only a small amount of material is removed, so template control is unnecessary, the edge of the lens itself providing sufficient guidance.

The force with which the lens is held against the abrasive wheel may be due solely to the weight of the lens and its holding mechanism, and no additional loading need be provided as would normally be the case in the template-controlled first edge grinding operation. Indeed, if desired, the force could be reduced even further, for example by supporting some of the weight of the said parts by a spring or counterweight.

The second edge grinding operation may be carried out with the same or a different abrasive wheel to that used in the first operation. Preferably, a different abrasive wheel is used, the surface of which is such that a variation in the cross-section of the ground edge is thereby produced. For example, if the cross section of the lens edge

produced by the first operation is a V of 120° included angle, the second operation may provide smaller included angle of, say, 90°. It is not essential for the modified cross-section to apply to both sides of the lens, since the effect of the coarseness of the first grinding operation is normally most apparent at the edge of a convex lens surface. For example, in the case of a lens of convex-concave form the edge may first be ground to a V cross-section of 120° included angle, the V being symmetrical. The second grinding operation may be performed on a grinding wheel having a V groove one flank of which is at the same angle as the rear flank of the V, i.e. 60° from a plane normal to the wheel axis, but with its front flank inclined at a steeper angle, say 30°, from the said plane, so that a chamfer or bevel is ground at the peripheral edge between the convex surface of the lens and the front face of the original 120° V.

Preferably the groove of the grinding wheel of this machine has an included angle of less than 120°, which groove may be asymmetrical with respect to a plane normal to the axis of the grinding wheel.

Since the lens is only lightly pressed against the grinding wheel and is free from template control, in some cases there may be a risk of vibration of the lens. The apparatus may include a vibration damping device operative on the lens-supporting head to smooth out vibration of the head and hence of the lens, thereby providing a more even contact with the grinding wheel and a yet smoother finish.

The invention may be performed in various ways, and a specific embodiment will now be described by way of example with reference to the accompanying drawings, in which:

FIG. 1 is a plan view of an edge grinding machine used in the second stage of the method embodying the invention;

FIG. 2 is a side view looking in the direction of the arrow II in FIG. 1;

FIG. 3 is an enlarged fragmentary view of a grinding wheel for grinding a V on the edge of a lens in a conventional manner; and

FIG. 4 is an enlarged fragmentary view of a grinding wheel in the machine used to carry out the present invention; and FIG. 5 is a block diagram illustrating the method according to the present invention.

Referring to FIGS. 1 and 2, the machine comprises a lens mounting head **10** which is of lightweight construction of generally H shape configuration in plan. It is pivoted on a horizontal shaft **11** so as to be movable up and down in the direction of the arrow A in FIG. 2. The horizontal shaft **11** is supported in a yoke **12** which is pivotally mounted on a vertical post **13** so that the head **10** can swing laterally in the direction of the arrow B in FIG. 1.

The lens **14** has already had a V section edge ground thereon, this edge having an included angle of 120°. It has been ground in a conventional edge-grinding machine using a grinding wheel **15** (FIG. 3) having therein a symmetrical groove of 120° included angle. The conventional machine in question grinds the V section edge by applying the lens **14** to the grinding wheel **15**, the lens being slowly rotated about its optical axis and the grinding wheel being rotated at high speed. The lens is applied to the grinding wheel **15** with substantial pressure, and a template shaped to correspond with the desired profile of the lens limits the extent to which the lens can be ground away and so determines the shape of the lens. Thus this first grinding operation is under template control or guidance.

For the finishing operation in the machine as illustrated in FIGS. 1 and 2 the lens **14** is clamped between two pads **16** and **17** in the front of the head **10**. The pad **16**

is mounted on the inner end of a shaft **18** which is journalled in a portion **19** of the head so as to be rotatable therein but not movable axially. The other pad **17** is mounted on a shaft **20** which is journalled in a formation **21** of the head so as to be rotatable therein together with an outer tubular shaft **22**, and to be movable axially. The pad **17** and its shaft **20** are urged to the left in FIG. 1 by means of a light coil spring **23**, and can be withdrawn towards the right in FIG. 1 to release the lens **14** by pulling a knob **24** attached to the end of the shaft **20**.

Th shaft **11** is rotatable and at its left hand end in FIG. 1 is connected by means of universal joints **25** and **26** and a somewhat flexible shaft **27** to reduction gearing **28** associated with an electric motor **29**. During operation of the machine the motor **29** rotates the shaft **11** slowly at a uniform speed, the transmission shaft arrangement **25, 26, 27** permitting lateral movements of the head **10** in the direction of the arrow B.

Fixed to the shaft **11** at each side of the head **10** are sprockets **30** and **31**. Corresponding sprockets **32** and **33** are fixed to the shafts **18** and **22** respectively. Pivotally mounted on the shaft **11** are arms **34** and **35** which carry at their forward ends idler sprockets **36** and **37**. A chain **38** connects the sprockets **30** and **32**, the upper run of the chain being tensioned by the idler sprocket **36**, while another chain **39** connects the sprockets **31** and **33**, the upper run of this chain being tensioned by the idler sprocket **37**. Thus the slow rotation of the shaft **11** produces corresponding slow rotation of the shafts **18** and **20** and of the lens **14** clamped between the pads **16** and **17**. Below the front of the head **10** there is a grinding wheel **40** the shaft of which is supported in bearing blocks **41**. This shaft **42** carries a belt pulley **43** which is connected by a belt **44** and a corresponding pulley to an electric motor (not shown) which rotates the grinding wheel **40** at high speed.

As shown in FIG. 4 the grinding wheel **40** has a circumferential groove the right-hand flank **45** of which makes an angle of 60° to a vertical plane through the base of the groove, the slope of this flank thus corresponding to the slope of the right-hand flank of the grinding wheel **15** in FIG. 3. The left-hand flank **40**, on the other hand, makes an angle of only 30° with this vertical plane, in contrast to the 60° angle of the left-hand flank in FIG. 3.

Extending rearwardly from the head **10** is a rod **47**, and pivotally attached thereto is a vertical rod **48** carrying at its lower end a disc **49**. This disc is immersed in a viscous liquid in a container **50**. These parts constitute a damping device whereby any tendency to rapid vertical vibration of the head **10** will be resisted by the viscosity of the liquid whereas slow movements such as are produced by the slow rotation of the non-circular lens **14** are not appreciably resisted.

In operation, the slowly rotating lens **14**, upon which a 120° bevel has already been formed by coarse grinding on the wheel **15**, is allowed to come into contact with the

rapidly rotating grinding wheel **40**. The rear right-hand or flank of the V-shaped edge of the lens **14** will make line contact with the flank **45** of the groove in the wheel **40** since both have the same angle of slope. The left-hand or front flank of the lens edge, however, is at a different angle of slope from the left-hand flank **46** of the groove in the wheel **40** so that this flank will grind away a bevel or chamfer **51** on the front peripheral edge of the lens **14**, i.e. where the front flank of the V-shaped edge meets the convex front surface **52** of the lens. This bevel or chamfer **51** will eliminate coarseness at the said peripheral edge. Such an operation is shown schematically in FIG. 5 of the drawings.

A lubricant such as water can be applied to the grinding surfaces during the grinding operation in a conventional manner.

What I claim is:

1. A method of grinding the edge of a lens which comprises carrying out a template-guided first edge grinding operation on said lens in a grinding machine using a first grinding wheel having a V-section groove in its periphery and then subjecting said lens to a second edge grinding operation in another grinding machine using a second grinding wheel having a V-section groove in its periphery, said lens being supported in a lens holder and a lighter contact pressure being applied in said second edge grinding operation than in said first edge grinding operation.

2. A method according to claim **1** in which said V-section groove of said second grinding wheel used in carrying out said second edge grinding operation has a smaller including angle than said V-section groove in said first grinding wheel.

3. A method according to claim **2** in which only one flank of said V-section groove in said second grinding wheel used in said second grinding operation is at a different slope from the corresponding flank of said V-section groove in said first grinding wheel used in said first grinding operation.

4. A method according to claim **3** applied to a lens having a convex surface on one side and a concave surface on the other side, the convex surface of said lens being on the same side as said flank of different slope in said second grinding operation.

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U.S. Cl. X.R.

51—101, 105