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(54) **Method and apparatus for measuring the edge thickness of a spectacle lens.**

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Description

BACKGROUND OF THE INVENTION:

Field of the Invention

This invention relates to methods for measuring the edge thickness of a spectacle lens.

Description of the Prior Art:

An example of a conventional method and apparatus for measuring the edge thickness of a lens is in detail described in Japanese Patent Application No. SHO 60-115079 as a component of a lens grinding apparatus disclosed by the same applicant as in the present application.

This conventional apparatus for measuring the edge thickness is constituted such that the thickness can be measured based on the lens rim shape of the spectacle frame measured by the frame shape measuring device 10 as shown schematically in Fig. 6. The edge thickness measuring apparatus is shown as a block diagram in Fig. 7.

The frame shape measuring apparatus 10 has a symmetric rotator with hexagon-sectional shapes shaped feeler 11 mounted rotatably in the tip. The feeler 11 is connected with a feeler arm 12, which is rotatable about the axis of the perpendicular line As through the edge of contact 11a of the feeler 11, supported by a feeler supporting base 13. And the base 13 is mounted on the rail 14 turned round by a pulse motor 16 and movable by elasticity of a spring 15 fixed to another edge (not shown) of the rail 14. The pulse motor 16 can work by the pulse from a pulse generator 17.

When the edge of contact 11a of the feeler 11 is abutted on the V-edge groove Vf, the moving amount ρ_i of the feeler 11 is detected by a detector 19 constituted of either an encoder or a position sensor. The detected moving amount ρ_i is memorized in a lens rim shape memory 18 together with a supply pulse θ_i to the pulse motor 16.

The moving amount ρ_i of the feeler and the rotational amount of the arm, i.e. the radius vector angle θ_i are memorized as a radius vector information (ρ_i, θ_i) (i = 0,1,2,3...N) of the lens rim F in the lens rim shape memory 18. The moving amount ρ_i of the feeler is measured over the V-edge groove all around of the lens rim F.

As shown in Fig. 7, the edge thickness measuring apparatus comprises an edge thickness sensor portion 20 and an electric circuit portion 30. The sensor portion 20 includes a lens feeler supporting member 22, which is moved on the guide rail 21 by the driving of a feed screw 26. The screw 26 is rotated by the pulse motor 25. A material lens L is held between lens rotating shafts 28,28 and then the lens L is rotated by the rotation of the shafts 28,28 caused by the driving of the pulse motor 29. The lens feeler supporting member 22 includes lens feelers 23A,23B and detectors 24A,24B. The detectors 24A,24B are constituted of springs 25A,25B for pulling the lens feelers 23A,24B, and encoders or position sensors for detecting the moving amount of the feelers 23A,23B.

The pulse based on the length ρ_i of the radius vector of the radius vector information (ρ_i, θ_i) of the lens rim F is supplied into the pulse motor 25, and the feelers 23A,23B moves inside the lens feeler supporting member 22. This movement determines the position of the lens feelers 23A,23B at the point having the length ρ_i of the radius vector from the axis of rotation of the lens rotating shafts. The length ρ_i of the radius vector is memorized in the lens rim shape memory 18. On the other hand, the pulse based on the rotary angle (radius vector angle) θ_i is supplied to the pulse motor 29 and then the lens rotating shafts 28,28 are rotated. This rotation of the shafts 28,28 produces the rotation of the material lens L by the rotary angle θ_i from the reference position. The lens feeler 23A is moved by the elasticity of the spring 25A and then abutted on the front side refraction surface lF of the material lens L. The moving amount ${}_fZ_i$ is detected by the detector 24A and memorized in a lens data memory 31. In the same way, the lens feeler 23B is moved by the elasticity of the spring 25B and then abutted on the back side refraction surface LB and the moving amount ${}_bZ_i$ is detected by the detector 24B and memorized in a lens data memory 31. This detection is carried out as to all the radius vector informations (ρ_i, θ_i) (i = 0,1,2,3,...N), and the front side refraction surface position information (${}_fZ_i$, θ_i) and the back side refraction surface position information (${}_bZ_i$, θ_i) (i = 0,1,2,3,...N) on the radius vector shaped locus (ρ_i, θ_i) of the lens rim are memorized in the lens data memory 31.

A first arithmetic circuit 32 of an electric circuit portion 30 mounted in the edge thickness sensor portion 20 calculates the edge thickness information (Δ_i, θ_i) (i = 0,1,2,3,...N) of the lens L on the radius vector shaped locus (ρ_i, θ_i) based on the front side refraction position information (${}_fZ_i$, θ_i) and the back side refraction position information ($_bZ_i$, θ_i). Furthermore, the maximum edge thickness Δ_{max} and the minimum edge thickness Δ_{min} are counted up from the edge thickness information (Δ_i, θ_i), and a beveled V-edge (groove) apex position information ($_kZ_i$, ρ_i, θ_i) (i = 0,1,2,3,...N) to form a V-edge in the edge surface of the lens is automatically calculated based on the two values Δ_{max} and Δ_{min}. In the above mentioned way, the lens L is automatically ground. And formed is a configuration that the sectional shape of the lens L is graphically displayed on a display 33.

As shown in Fig. 7, the positions of the contact of the lens feelers 23A,23B with the lens L is taken on the tangent line Q through the V-edge apex Y formed in the V-edge grinding of the lens. And the edge thickness Δ_i on the tangent line Q is calculated by the first arithmetic circuit 32.

The radius of curvature R of the front surface of the lens L is different from that of the back(rear)-surface, and the edge thickness of the base B of the edge surface of the lens L to form a V-edge is exactly Δ_i'. Therefore the calculation of the treated V-edge apex position information ($_kZ_i$, ρ_i, θ_i) not based on the edge thickness Δ_i' of the base B is inaccurate.

And thus, the positions of the lens feelers 23A,23B are moved to those of 23A′ ,23B′ when the edge thickness is measured, as shown in Fig. 8. More detailedly, the positions of the lens feelers 23A,23B on the radius vector locus (ρ_i, θ_i) is moved to the positions $\rho_i' = \rho_i$-Hwhere ρ_i is the length of the radius vector and H is the depth (or height) of the peripheral ridge, because the V-edge groove bottom YG and the base YB of the V-edge grinder G of a lens grinding apparatus are already known. By this movement, measured is the edge thickness of the base B of the edge surface formed in the lens L at the time when the lens L is ground with the V-edge grinder G. And V-edge apex position information ($_kZ_i$, ρ_i, θ_i) is calculated based on the edge thickness Δ_i' when the lens is ground with the grinder G. As shown in Fig. 9, however, there is a problem that the V-edge (V-ridge) formed actually on the lens L is an inadequate V-edge in case the edge thickness is smaller than the width (W) of V-edge groove of the grinder G, because the edge surface K of the lens L to grind actually is displaced from the position of the measured edge surface KM owing to the difference between the radius of curvature R_f of the front surface of the lens L and the radius of curvature R_b of the back surface, in case even if the V-edge apex position information ($_kZ_i$, ρ_i, θ_i) is obtained based on the edge thickness Δ_i' measured by the above method such that the V-edge apex Y is formed at the point where the edge thickness is divided in the ratio of one to one, for example.

Japan patent abstracts vol. 11, No 135 (M-585) [2582], April 28, 1987, and JP-A-61 274 860 (Tokyo Optical Co. Ltd), December 5, 1986, describe a lens shape measuring device and a lens grinding apparatus. On a lens measuring device are provided feelers contacting respectively the front and rear surfaces of a workpiece lens and magnetic encoders for detecting the displacements of the feelers. And movable stages move the feelers along a measure locus on the lens in a predetermined relationship with a supposed edge locus obtained from the shape data of a lens frame of an eye glass frame into which is inserted the lens or the shape data of the lens profiled according to a template. Further, a calculating means provided in the measuring device figures out the edge thickness of lens after mortar working on the basis of the detecting information of the encoders when the feelers are moved on the measured locus.

SUMMARY OF THE INVENTION

The present invention concerns a method for measuring the edge thickness of a spectacle lens comprising the steps of:

inputting an all round radius vector information (ρi, θi) of a spectacle frame lens rim for framing said lens (with i = 0, 1, 2, 3... N)

obtaining an all round measuring radius vector information (ρi', θi) by subtracting a V-groove depth (H) of a grinder (G) from the length (ρi) of the radius vector of said all round radius vector information (ρi, θi); and

obtaining an edge thickness information (Δi, θi) corresponding to said all round measuring radius vector information (ρi', θ i) by measuring a front side refractive position information (fZi, θi) and a back side refractive position information (bZi, θi) of said lens corresponding to said measuring radius vector information (ρi', θi) in order to obtain an edge thickness information (Δi, θi) at the grinding position and a V-edge apex position information (kZi, ρi, θi) when the edge of said lens is ground with said grinder (G);

characterised by:

a first step of comparing a width (W) of a grinding base of said grinder (G) with said measured edge thickness (Δi) and selectively obtaining a partial measuring radius vector information (ρj', θj) (j ≦ i) of said lens where a narrower edge thickness (Δj) than said width (W) is measured;

a second step of obtaining, by presuming that an edge thickness (Δj') in the position of an again measuring radius vector length (ρj'') of a partial and again measuring radius vector information (pj'', θj) (with j≦i) for forming a V-edge of said lens by said V-groove of said grinder (G) in a position corresponding to said partial measuring radius vector information (ρj', θj) is approximately equal to said edge thickness (Δj), a measuring radius vector length (ρj'') of said partial measuring radius vector (ρj', θj) from said partial measuring radius vector information (ρj'', θj) (j ≦ i) as follows:

$$\rho j'' = \rho j' + dj$$
$$dj = (1-\Delta j/W).H$$

(with j ≦ i); and

a third step of measuring said front side refractive position information (fZi', θi) and said back side refractive position information (bZi', θi) of said lens in such a manner as to correspond to said partial and again measuring radius vector information (ρj'', θj) which are used for obtaining said V-edge apex position information for grinding the edge of that portion of said lens having said edge thickness (Δj) with said grinder (G).

the present invention concerns also a method for measuring the edge thickness of a spectacle lens comprising the steps of:

inputting all round radius vector information (ρi, θi) of a spectacle frame lens rim for framing the lens (with i = 0, 1, 2, 3...N);

obtaining all round measuring radius vector information (ρi', θi) by subtracting a V-groove depth (H) of a grinder (G) from the length (ρi) of the radius vector of said all round radius vector information (ρi, θi); and

obtaining an edge thickness information (Δi, θi) corresponding to said all round measuring radius vector information (ρi', θi) by measuring a front side refractive position information (fZi, θi) and a back side refractive position information (bZi, θi) of said lens corresponding to said measuring radius vector information (ρi', θi) in order to obtain an edge thickness information (Δi, θi) in the grinding position and a V-edge apex position information (kZi, ρi, θi) when the edge of said lens is ground with said grinder (G);

characterised by:

a first step of comparing a width (W) of a grinding base of said grinder (G) with an edge thickness (Δi) of said edge thickness information (Δi, θi) to obtain partial measuring radius vector information (ρj', θj) (with j ≦ i) in which a measured edge thickness (Δj) is less than said width (W) of the grinding base;

a second step of obtaining a compensation value t1 according to the following formula:

$$t1 = (1-\frac{\Delta j}{W})\bullet H$$

on the supposition that, if said measured edge thickness (Δj) less than said width (W) is obtained from j-th partial measuring radius vector information (ρj', θj) of a j-th measurement ("-th" is a suffix representing an ordinate number), an edge thickness of j + 1-th partial measuring radius vector information (ρj + 1', θj + 1) is defined as (Δj') and, in addition, the edge thickness (Δj') is approximately equal to said measured edge thickness (Δj);

a third step of obtaining a compensating radius vector length (τj + 1), which corresponds to a length (ρj + 1') of the measuring radius vector of said j + 1-th partial measuring radius vector information (ρj + 1', θj + 1), according to the following formula:

$$\tau j + 1 = \rho j + 1' + t1$$

and obtaining compensating measuring radius vector information (τ j + 1, θj + 1) about said compensating radius vector length (τj + 1) and about a radius vector angle (θj + 1) of said j + 1-th partial measuring radius vector information (ρj + 1', θj + 1);

a fourth step of measuring an edge thickness (Δj + 1) by measuring front and back side refractive position information of said lens according to said compensating measuring radius vector information (τj + 1, θj + 1);

a fifth step of comparing said measured edge thickness (Δ j + 1) with said preceding measured edge thickness (Δj), and, if said measured edge thickness (Δj + 1) is less than said preceding measured edge thickness (Δj), obtaining a compensation value tm according to the following formula:

$$t_m = \sum_m (1 - \frac{\Delta j+m}{\Delta j+m-1}) \cdot H$$

where $\Delta j+m$ is an edge thickness of measuring radius vector information ($\rho j+m'$, $\theta j+m$) and $\Delta j+m-1$ is an edge thickness of measuring radius vector information ($\rho j+m-1'$, $\theta j+m-1$) precedent to said measuring radius vector information ($\rho j+m'$, $\theta j+m$) (with $m=2,3,4,\cdots M, M<N$), the edge thickness ($\Delta j+m$) being approximately equal to said edge thickness ($\Delta j+m-1$);

a sixth step of obtaining a compensating radius vector length ($\tau j+m$), which corresponds to a length ($\rho j+m'$) of the measuring radius vector of said measuring radius vector information ($\rho j+m'$, $\theta j+m$), according to the following formula:

$$\tau j+m = \rho j+m'+tm$$

and obtaining compensating measuring radius vector information ($\tau j+m$, $\theta j+m$) about said compensating radius vector length ($\tau j+m$) and about a radius vector angle ($\theta j+m$) of said measuring radius vector information ($\rho j+m'$, $\theta j+m$); and

a seventh step of successively measuring front and back side refractive position information of said lens according to said compensating measuring radius vector information ($\tau j+m$, $\theta j+m$).

The advantages of the present invention will be well appreciated upon reading of the following description of the invention when taken in conjunction with the attached drawings with understanding that some modifications, variations and changes of the same could be made by the skilled person in the art to which the invention pertains without departing from the scope of claims appended hereto.

BRIEF DESCRIPTION OF THE ATTACHED DRAWINGS

Fig. 1 is a block diagram showing an embodiment of an edge thickness measuring apparatus according to the present invention;
Fig. 2 is a partly diagrammatic sectional view showing a measuring radius vector, a partial re-measuring radius vector, a lens feeler, and a relation between a measured edge thickness and a grinder's shape, each for describing a first embodiment of an edge measuring method according to the present invention;
Figs. 3A and 3B are schematic illustrations showing a measuring radius vector, and a relation among the partial re-measuring radius vector and the measured radius vector locus and the partial re-measured radius vector locus, each for explaining the first embodiment of a edge thickness measuring method;
Fig. 4 is a schematic illustration showing the measuring radius vector, and a relation among the compensated measuring radius vector and the measured radius vector locus and the compensated measured radius vector locus, each for explaining the second embodiment of an edge thickness measuring method;
Fig. 5 is a schematic illustration showing the compensated measured points and the lens feeler at the points, and a relation between the measured edge thickness and the shape of the grinder, each for explaining the second embodiment of an edge thickness measuring method;
Fig. 6 is a block diagram showing a constitution of a conventional frame shape measuring apparatus;
Fig. 7 is a block diagram showing a constitution of a conventional edge thickness measuring apparatus;
Fig. 8 is a schematic illustration showing the measuring radius vector and the lens feeler, and a relation between the measured edge thickness and the shape of the grinder for explaining a conventional edge thickness measuring method;
Fig. 9 is a schematic diagram showing a relation between the measured edge thickness and the edge shape ground by the grinder according to a conventional edge thickness measuring method.

DESCRIPTION OF THE PREFERRED EMBODIMENT

The preferred embodiment of the present invention will be described hereinafter with reference to the accompanying drawings.

Fig. 1 is a block diagram showing a constitution of the embodiment of the edge thickness measuring apparatus according to the present invention. In this embodiment, employed are the identical characters to the same of similar components as the components in the conventional edge thickness measuring apparatus (mentioned above) disclosed in Japanese Patent Application No. SHO 60-115079, in order to avoid duplication of the explanation. A first arithmetic circuit 32 in Fig. 1 calculates an edge thickness information (Δ_i, θ_i) from a front and back surface position informations ($_fZ_i$, θ_i), ($_bZ_i$, θ_i) of a material lens L as a lens to grind which is detected by detectors 24A,24B. This first arithmetic circuit 32 also connects with a comparison circuit 41. The comparison circuit 41 connects with a grinder shape memory 42 which keeps memorizing an already-known V-edge base width W and a V-edge height H.

The second arithmetic circuit 43 connects with a lens rim shape memory 18 of a frame shape measuring apparatus 10, the comparison circuit 41, and the grinder shape memory 42. The lens rim shape memory 18 memorizes the all round radius vector information (hereinafter referred to as radius vector information, for brevity) (ρ_i, θ_i) (with i = 0,1,2,3,...N) can be identical with a value measured by the frame shape measuring apparatus 10 such as the conventional apparatus disclosed in Japanese Patent Publication No. SHO 60-115079, or with data memorized in a memory means such as a floppy disk or an IC card, or with data from a framemaker or the agent by the on-line information processing system.

The length ρ_i of the radius vector of the radius vector information (ρ_i, θ_i) (with i = 0,1,2,3,...N) of the lens rim from the lens rim shape memory 18 is input in a second arithmetic circuit 43, which subtracts the V-edge height H memorized in the grinder shape memory 42 from the length ρ_i and obtains, as shown in Fig. 2, the length ρ_i' of the measuring radius vector of the all round measuring radius vector information (hereinafter referred to as measuring radius vector information) (ρ_i', θ_i) by the following formula:

$$\rho_i' = \rho_i - H \quad (1)$$

The memory 18 and the second arithmetic circuit 43 act as an input means and an arithmetic means, respectively.

The length (ρ_i') obtained is input in a pulse motor 29. The pulse motors 25,29 are driven and controlled by the second arithmetic circuit 43, corresponding to the measuring radius vector information (ρ_i', θ_i). The driving of the pulse motors 25,29 makes the lens feelers 23A,23B move to position them (23A,23B) at the measuring point ρ_i (as shown in Figs. 3A,3B). The feelers 23A,23B positioned there abut on the lens L by elasticity of the springs 25A,25B.

The moving amount of the lens feelers 23A,23B is detected in terms of the front and back surface position informations (${}_fZ_i$, θ_i), (${}_bZ_i$, θ_i) of the lens L by the detectors 24A,24B. And then, as shown in Figs. 3A,3B, the first arithmetic circuit 32 calculates the Δ_i of the edge thickness information (Δ_i, θ_i) of the lens L at the measuring point i on the basis of the information (${}_fZ_i$, θ_i), (${}_bZ_i$, θ_i) as follows:

$$\Delta_i = {}_bZ_i - {}_fZ_i \quad (2)$$

The measurement of the edge thickness is carried out over the all round of the radius vector locus S to be measured, that is, all of the measuring points from the 0-th measuring point to the N-th measuring point. The first arithmetic circuit 32 acts as an edge thickness measuring means.

The edge thickness information (Δ_i, θ_i) (with i = 0,1,2,3,...N) calculated by the first arithmetic circuit 32 is compared with the width (W) of the V-edge base of the V-edge grinder G memorized in the grinder shape memory 42 by the comparison circuit 41. And selected is a measuring radius vector having an edge thickness narrower than the width W. The grinder shape memory 42 acts as a memorizing means and the comparison circuit 41 acts as a comparing means.

Fig. 3A shows the lens L as a minus lens. In this case, selected are a partial measuring radius vector information (Δ_j', θ_j) (with j = a,a + 1,a + 2,...b-1,b) which defines the partial measuring locus S_1 of measuring points P_a and P_b, and a partial measuring radius vector information (ρ_j', θ_j) (with j = c,c + 1,c + 2,...d-1,d) which defines the partial measuring locus S_2 of a measuring points P_c and P_d.

Fig. 3B shows the lens L as a plus lens. In this case, selected are a partial measuring radius vector information (ρ_j', θ_j) (with j = c,c + 1,c + 2,...d-1,d) which defines a partial measuring locus S_2 of measuring points P_c and P_d, and a partial measuring radius vector information (ρ_j', θ_j) (with j = g,g + 1,g + 2,...h-1,h) which defines a partial measuring locus S_4 of measuring points P_g and P_h. And these measuring radius vector lengths ρ_j' and edge thicknesses Δ_j are input into the second arithmetic circuit 43.

Referring to Fig. 2, if the edge thickness Δ_j is approximately equal to the edge thicknesses Δ_j', the proportion of H to W is:

$$H:W = (H-d_j):\Delta_j \quad (3)$$

where H is a V-edge height and W is a V-edge base width of a V-edge grinder G and d_j is a compensated amount. And therefore, the amount d_j is:

$$d_J = \left(1 - \frac{\Delta_J}{W}\right) \cdot H \quad \cdots\cdots (4)$$

The second arithmetic circuit 43 obtains the length ρ_j'' of a re-measuring radius vector of the partial re-measuring radius vector information (ρ_j'', θ_j) by employing the length ρ_j' and the above amount d_j as follows:

$$\rho_j'' = \rho_j' + d_j \qquad (5)$$

And then the second circuit 43 inputs the re-measuring radius vector length ρ_j'' to the pulse motor 25 and the re-measuring radius vector angle θ_j to the pulse motor 29. The pulse motors 25,29 driven and controlled based on these inputs move the lens feelers 23A and 23B to the positions 23A′, 23B′ as shown in Fig. 2. By this movement, the lens feelers 23A and 23B measure the front and back surface position informations ($_fZ_j'$, θ_j), ($_bZ_j'$, θ_j) of the lens L on the partial re-measuring loci S_1' through S_4' as shown in Figs. 3A and 3B.

After the measurement of the informations, the calculation of the V-edge apex position, the display of the image, the determination of the radius vector for grinding, and the grinding are each carried out in the circuit (not shown), as disclosed in the above mentioned Japanese Patent Application No. SHO 60-115079.

Figs. 4 and 5 are schematic illustration showing another edge thickness measuring method with the above mentioned edge thickness measuring apparatus.

First, all kinds of the length of the radius vector of the radius vector information (ρ_i, θ_i) (with i = 0,1,2,...N) from the lens rim shape memory 18 are input to the second arithmetic circuit 43. The second circuit 43 obtains the measuring radius vector information (ρ_i', θ_i) (with i = 0,1,2,...N) by the formula (1), that is, by subtracting the V-edge height memorized in the grinder shape memory from all (ρ_i) s.

Second, the second arithmetic circuit 43 inputs the 0-th measuring radius vector (ρ_0') in the pulse motor 25 and the 0-th radius vector angle (θ_0). The driving of the pulse motors 25,29 makes the lens feelers 23A,23B move to the measuring point P_0 (see Figs. 3A and 3B). The lens feelers 23A,23B at the point P abut on the lens L by elasticity of the springs 25A,25B. The moving amount of the lens feelers 23A,23B are detected as the 0-th front surface position information ($_fZ_0$, θ_0) and the 0-th back surface position information ($_bZ_0$, θ_0) of the lens L by the detectors 24A,24B. The first arithmetic circuit 32 calculates the Δ_0 of the 0-th edge thickness information (Δ_0, θ_0) at the 0-th measuring point P_0 from the informations ($_fZ_0$, θ_0), ($_bZ_0$, θ_0). The calculation is performed by the following formula similar to the (2) :
’)"\

$$\Delta_0 = {}_bZ_0 - {}_fZ_0 \qquad (2')$$

And then, the 0-th edge thickness information (Δ_0, θ_0) calculated by the first circuit 32 is compared with the V-edge base width W of the V-edge grinder G memorized in the grinder shape memory 42.

The 0-th edge thickness Δ_0 is broader than the V-edge base width W in the example of Fig. 4. Therefore, the second arithmetic circuit 43 inputs the length ρ_1' of the 1st measuring radius, vectorwhich follows the 0-th thickness into the pulse motor 25 and the first radius vector angle θ_1, into the pulse motor 29. And the lens feelers 23A,23B are moved to and placed at the first measuring position P_1.

The moving amounts of the lens feelers 23A,23B are detected in terms of the first front surface position information ($_fZ_1$, θ_1) and the first back surface position information ($_bZ_1$, θ_1) of the lens L by the detectors 24A,24B. And the first arithmetic circuit 32 calculates the Δ_1 of the first edge thickness information (Δ_1, θ_1) at the first measuring point P_1 from the information ($_fZ_1$, θ_1), ($_bZ_1$, θ_1) the same as (2′).

Next, the first edge thickness information (Δ_1, θ_1) calculated by the first arithmetic circuit 32 is compared with the V-edge base width W of the V-edge grinder G memorized in the grinder shape memory 42 by the comparison circuit 41. The first edge thickness Δ_1 is broader than the V-edge base width W in the example of Fig. 4. The same procedures are in order followed to the j-th measuring radius vector information (ρ_j', θ_j) judged that the edge thickness Δ_j is narrower than the V-edge base width W. If the comparison circuit 41 judges that the j-th edge thickness Δ_j in the j-th measuring radius vector information (ρ_j', θ_j) is narrower than the V-edge base width W as shown in Fig. 5(a), the second arithmetic circuit 43 changes the length ρ_{j+1}' of the (j + 1)th measuring radius vector of the (j + 1)th measuring radius vector information (ρ_{j+1}, θ_{j+1}) into the first compensated radius vector length τ_{j+1} as shown in Fig. 4.

The first compensated amount t_1 is obtained the same as the formula (4):

$$t_1 = \left(1 - \frac{\Delta_J}{W}\right) \cdot H \; \ldots . (6)$$

where W is the width of the V-edge base of the V-edge grinder G and H is the V-edge height. And the first compensated radius vector length τ_{j+1} is :

$$\tau_{j+1} = \rho_{j+1}' + t_1 \qquad (7)$$

The second arithmetic circuit 43 inputs the first compensated radius vector length τ_{j+i} into the pulse motor 25 and the first compensated radius vector angle θ_{j+i} (equivalent to the (j + i)th measuring radius vector angle θ_{j+i}) into the pulse motor 29. And the lens feelers 23A and 23B are moved to the position of the first compensated measuring point T_{j+1} in Figs. 4 and 5(b) based on these inputs.

And then the first arithmetic circuit 32 obtains the j + 1 edge thickness Δ_{j+1} from the front and back surface position informations of the lens L at the first compensated measuring point T_{j+1}. The comparison circuit 41 compares the (j + 1)th edge thickness Δ_{j+1} with the j-th edge thickness Δ_j preceding to Δ_{j+1}.

If the (j + 1)th edge thickness Δ_{j+1} is narrower than the j-th edge thickness Δ_j just before the Δ_{j+1} as shown in Fig. 5(b), the second arithmetic circuit 43 changes the following (j + 2)th measuring radius vector length ρ_{j+2}' of the (j + 2)th measuring radius vector information (ρ_{j+2}', θ_{j+2}) into the second compensated radius vector length τ_{j+2} as shown in Fig. 4.

Therefore, the second compensated amount t_2 is obtained the same as the formula (6). That is :

$$t_2 = \left(1 - \frac{\Delta_{j+1}}{\Delta_j}\right) \cdot H \;\ldots\ldots (8)$$

and the second compensated radius vector length τ_{j+2} is:

$$\tau_{j+2} = \rho_{j+2}' + (t_1 + t_2) \qquad (9)$$

The second arithmetic circuit 43 inputs the second compensated radius vector length τ_{j+2} into the pulse motor 25 and the second compensated radius vector angle θ_{j+2} (equivalent to the (j + 2)th measuring radius vector angle θ_{j+2}) into the pulse motor29, respectively. The lens feelers 23A,23B move to the second compensated measuring point T_{j+2} shown in Fig. 4 and Fig. 5(c) based on these inputs.

After the measurement of the front and back surface position informations of the lens L at the second compensated measuring point T_{j+2}, the first arithmetic circuit 32 obtains the (j + 2)th edge thickness Δ_{j+2}. The comparison circuit 41 compares the (j + 2)th edge thickness Δ_{j+2} with the (j + 1)th edge thickness preceding to the (j + 2)th thickness.

If the (j + 2)th edge thickness Δ_{j+2} is narrower than the preceding (j + 1)th edge thickness as shown in Fig. 5(c), the second arithmetic circuit 43 changes the following (j + 3)th measuring radius vector length ρ_{j+3}' of the (j + 3)th measuring radius vector information (ρ_{j+3}', θ_{j+3}) into the third compensated radius vector length τ_{j+3}.

And the third compensated amount t_3 is obtained the same as in the formula (6). That is :

$$t_3 = \left(1 - \frac{\Delta_{j+2}}{\Delta_{j+1}}\right) \cdot H \;\ldots\ldots\ldots (10)$$

where H is the V-edge height of the V-edge grinder G and the Δ_{j+2}, Δ_{j+1} are the edge thicknesses. And the third compensated radius vector length τ_{h+3} is :

$$\tau_{j+3} = \rho_{j+3}' + (t_1 + t_2 + t_3) \qquad (11)$$

The second arithmetic circuit 43 inputs the third compensated radius vector length τ_{j+3} into the pulse motor 25 and the third compensated radius vector angle θ_{j+3} (equivalent to the (j + 3)th measuring radius vector angle θ_{j+3}) into the pulse motor29, respectively. And then the lens feelers 23A,23B are moved to the third compensated measuring point T_{j+3} as shown in Figs. 4 and 5(d). And then the lens feelers 23A,23B are moved to the third compensated measuring point T_{j+3} as shown in Figs. 4 and 5(d).

The front and back surface position information s of the lens L as the third compensated measuring point T_{j+3} are measured, and then the first arithmetic circuit 32 calculates the (j + 3)th edge thickness Δ_{j+3}. And the comparison circuit 41 compares the (j + 3)th edge thickness Δ_{j+3} with the preceding (j + 2)th edge thickness Δ_{j+2}.

If the (j+3)th edge thickness Δ_{j+3} is broader than the preceding (j+2)th edge thickness and narrower than the V-edge base width W of the V-edge grinder as shown in Fig. 5(d), the second arithmetic circuit 43 changes the following (j+4)th measuring radius vector length ρ_{j+4}' of the (j+4) measuring radius vector information (ρ_{j+4}', θ_{j+4}) into the fourth compensated radius vector length τ_{j+4} as shown in Fig. 4.

And the fourth compensated amount t_4 is obtained the same as in the formula (6). That is :

$$t_4 = (1 - \frac{\Delta_{J+3}}{\Delta_{J+2}}) \cdot H \ .... (12)$$

where H is the V-edge height of the V-edge grinder G and the Δ_{j+3}, Δ_{j+2} are the edge thicknesses. And the fourth compensated radius vector length τ_{j+4} is :

$$\tau_{j+4} = \rho_{j+4}' + (t_1 + t_2 + t_3 + t_4) \qquad (13)$$

where t_4 is the negative number.

The second arithmetic circuit 43 inputs the fourth compensated radius vector length τ_{j+4} into the pulse motor 25 and the fourth compensated radius vector angle θ_{j+4} (equivalent to the (j+4)th measuring radius vector angle θ_{j+4}) into the pulse motor29, respectively. And then the lens feelers 23A,23B are moved to the fourth compensated measuring point T_{j+4} as shown in Figs. 4 and 5(e).

The front and back surface position information s of the lens L as the fourth compensated measuring point T_{j+4} are measured,and then the first arithmetic circuit 32 calculates the (j+4)th edge thickness Δ_{j+4}.

And the comparison circuit 41 compares the (j+4)th edge thickness Δ_{j+4} with the preceding (j+3)th edge thickness Δ_{j+3}.

If the (j+4)th edge thickness Δ_{j+4} is equal to or broader than the V-edge base width W of the V-edge grinder G as shown in Fig. 5(e), the following (j+5)th measuring radius vector information (ρ_{j+5}', θ_{j+5}) does not need to be changed,and the measuring of the edge thickness at the measuring point T_{j+5} on the measuring radius vector locus S as shown in Fig. 5(f) is carried out.

As mentioned above, in case the measuring edge thickness Δ_j first turns narrower than the V-edge base width W, the following first compensated measuring radius vector length τ_{j+1} for the (j+1)th measuring radius vector ρ_{j+1}' is changed from the first compensated amount t_1 of the formula (6) to the formula (7):

$$t_1 = (1 - \frac{\Delta_J}{W}) \cdot H \ .... (6)$$

$$\tau_{j+1} = \rho_{j+1}' + t_1 \qquad (7)$$

And the (j+1)th edge thickness is measured at the (j+1)th measuring point T_{j+1} as a changed position.

Referring to the measurement following to the (j+i)th, the second compensated measuring radius vector length τ_{j+2} and the measuring edge thickness Δ_{j+m-1} preceding to the τ_{j+2} is changed into the (m)th compensated measuring radius vector length τ_{j+m} broader than the V-edge base width W.

The (m)th compensated amount tm in a generalized formula of the formulas (8) through (13) is expressed as follows :

$$t_m = \Sigma (1 - \frac{\Delta_{J+m}}{\Delta_{J+m-1}}) \cdot H \ .... (14)$$

And the (m)th compensated measuring radius vector length τ_{j+m} is:

$$\tau_{j+m} = \rho_{j+m}' + t_m \qquad (15)$$

(with m = 2,3,4,...M. M<N, in both (14) and (15))

In case the measured edge thickness is narrower than the width W of the V-edge base of the V-edge grinder G as mentioned above, the measurement of the thickness is carried out at the compensated measuring point on the compensated locus S′ shown with the stitch line in Fig. 4.

And thus,the present invention can provide a method and an apparatus for measuring the edge thickness of a spectacle lens, which has an advantage to measure more accurately the edge thickness of the lens narrower than the width of the V-edge base of the V-edge grinder in comparison with the prior art.

Claims

1. A method for measuring the edge thickness of a spectacle lens comprising the steps of:

inputting an all round radius vector information (ρi, θi) of a spectacle frame lens rim for framing said lens (with i = 0, 1, 2, 3... N)

obtaining an all round measuring radius vector information (ρi', θi) by subtracting a V-groove depth (H) of a grinder (G) from the length (ρi) of the radius vector of said all round radius vector information (ρi, θi) ; and

obtaining an edge thickness information (Δi, θi) corresponding to said all round measuring radius vector information (ρi', θ i) by measuring a front side refractive position information (fZi, θi) and a back side refractive position information (bZi, θi) of said lens corresponding to said measuring radius vector information (ρi', θi) in order to obtain an edge thickness information (Δi, θi) at the grinding position and a V-edge apex position information (kZi, ρi, θi) when the edge of said lens is ground with said grinder (G);

characterised by:

a first step of comparing a width (W) of a grinding base of said grinder (G) with said measured edge thickness (Δi) and selectively obtaining a partial measuring radius vector information (ρj', θj) (j ≦ i) of said lens where a narrower edge thickness (Δj) than said width (W) is measured;

a second step of obtaining, by presuming that an edge thickness (Δj') in the position of an again measuring radius vector length (ρj'') of a partial and again measuring radius vector information (ρj'', θj) (with j≦i) for forming a V-edge of said lens by said V-groove of said grinder (G) in a position corresponding to said partial measuring radius vector information (ρj', θj) is approximately equal to said edge thickness (Δj), a measuring radius vector length (ρj'') of said partial measuring radius vector (ρj', θj) from said partial measuring radius vector information (ρj'', θj) (j ≦ i) as follows:

$$\rho j'' = \rho j' + dj$$
$$dj = (1 - \Delta j/W).H$$

(with j ≦ i); and

a third step of measuring said front side refractive position informatin (fZi', θi) and said back side refractive position information (bZi', θi) of said lens in such a manner as to correspond to said partial and again measuring radius vector information (ρj'', θj) which are used for obtaining said V-edge apex position information for grinding the edge of that portion of said lens having said edge thickness (Δj) with said grinder (G).

2. A method for measuring the edge thickness of a spectacle lens comprising the steps of:

inputting an all round radius vector information (ρi, θi) of a spectacle frame lens rim for framing the lens (with i = 0, 1, 2, 3...N);

obtaining an all round measuring radius vector information (ρi', θi) by subtracting a V-groove depth (H) of a grinder (G) from the length (ρi) of the radius vector of said all round radius vector information (ρi, θi); and

obtaining an edge thickness information (Δi, θi) corresponding to said all round measuring radius vector information (ρi', θi) by measuring a front side refractive position information (fZi, θi) and a back side refractive position information (bZi, θi) of said lens corresponding to said measuring radius vector information (ρi', θi) in order to obtain an edge thickness information (Δi, θi) in the grinding position and a V-edge apex position information (kZi, ρi, θi) when the edge of said lens is ground with said grinder (G) ;

characterised by:

a first step of comparing a width (W) of a grinding base of said grinder (G) with an edge thickness (Δi) of said edge thickness information (Δi, θi) to obtain partial measuring radius vector information (ρj',

θj) (with $j \leqq i$) in which a measured edge thickness (Δj) is less than said width (W) of the grinding base;

a second step of obtaining a compensation value t1 according to the following formula:

$$t1 = (1 - \frac{\Delta j}{W}) \cdot H$$

on the supposition that, if said measured edge thickness (Δj) less than said width (W) is obtained from j-th partial measuring radius vector information ($\rho j'$, θj) of a j-th measurement ("-th" is a suffix representing an ordinate number), an edge thickness of j+1-th partial measuring radius vector information ($\rho j+1'$, $\theta j+1$) is defined as ($\Delta j'$) and, in addition, the edge thickness ($\Delta j'$) is approximately equal to said measured edge thickness (Δj);

a third step of obtaining a compensating radius vector length ($\tau j+1$), which corresponds to a length ($\rho j+1'$) of the measuring radius vector of said j+1-th partial measuring radius vector information ($\rho j+1'$, $\theta j+1$), according to the following formula:

$$\tau j+1 = \rho j+1' + t1$$

and obtaining compensating measuring radius vector information (τ j+1, $\theta j+1$) about said compensating radius vector length ($\tau j+1$) and about a radius vector angle ($\theta j+1$) of said j+1-th partial measuring radius vector information ($\rho j+1'$, $\theta j+1$);

a fourth step of measuring an edge thickness ($\Delta j+1$) by measuring front and back side refractive position information of said lens according to said compensating measuring radius vector information ($\tau j+1$, $\theta j+1$);

a fifth step of comparing said measured edge thickness (Δ j+1) with said preceding measured edge thickness (Δj), and, if said measured edge thickness ($\Delta j+1$) is less than said preceding measured edge thickness (Δj), obtaining a compensation value tm according to the following formula:

$$tm = \sum_{m} (1 - \frac{\Delta j+m}{\Delta j+m-1}) \cdot H$$

where $\Delta j+m$ is an edge thickness of measuring radius vector information ($\rho j+m'$, $\theta j+m$) and $\Delta j+m-1$ is an edge thickness of measuring radius vector information ($\rho j+m-1'$, $\theta j+m-1$) precedent to said measuring radius vector information ($\rho j+m'$, $\theta j+m$)(with $m=2,3,4,\cdots M, M<N$), the edge thickness ($\Delta j+m$) being approximately equal to said edge thickness ($\Delta j+m-1$);

a sixth step of obtaining a compensating radius vector length ($\tau j+m$), which corresponds to a length ($\rho j+m'$) of the measuring radius vector of said measuring radius vector information ($\rho j+m'$, $\theta j+m$), according to the following formula:

$$\tau j+m = \rho j+m' + tm$$

and obtaining compensating measuring radius vector information (τ j+m, $\theta j+m$) about said compensating radius vector length ($\tau j+m$) and about a radius vector angle ($\theta j+m$) of said measuring radius vector information ($\rho j+m'$, $\theta j+m$); and

a seventh step of successively measuring front and back side refractive position information of said lens according to said compensating measuring radius vector information ($\tau j+m$, $\theta j+m$).

Patentansprüche

1. Verfahren zum Messen der Randdicke einer Brillenglaslinse, folgende Schritte umfassend: Eingeben einer Rundum-Radiusvektorinformation ($\rho i,\Theta i$) eines Brillenrahmenlinsenrandes zum Rahmen der Linse (mit $i=0,1,2,3...N$),
Erhalten einer Rundum-Meßradiusvektorinformation ($\rho i',\Theta i$), indem eine V-Nuttiefe (H) eines Schleifers (G) von der Länge (ρi) des Radiusvektors der Rundum-Vektorinformation ($\rho i,\Theta i$) subtrahiert wird,
und Erhalten einer Randdickeninformation ($\Delta i,\Theta i$) entsprechend der Rundum-Meßradiusvektorinformation ($\rho i',\Theta i$) durch Messen einer Vorderseiten-Brechungspositionsinformation ($fZi,\Theta i$) und einer Rückseiten-Brechungspositionsinformation ($bZi,\Theta i$) der Linse entsprechend der Meßradiusvektorinformation ($\rho i',\Theta i$), um eine Randdickeninformation ($\Delta i,\Theta i$) an der Schleifposition und eine V-Kanten-Scheitelposi-

tionsinformation (kZi,ρi,Θi) zu erhalten, wenn der Rand der Linse mit dem Schleifer (G) geschliffen wird, **gekennzeichnet durch**,
einen ersten Schritt des Vergleichens einer Breite (W) einer Schleifbasis mit der gemessenen Randdicke (Δi) und des selektiven Erhaltens einer Teilmeßradiusvektorinformation (ρj',Θj) (j≦i) der Linse, wo eine schmalere Randdicke (Δj) als die Breite (W) gemessen wird;
einen zweiten Schritt des Erhaltens einer Meßradiuslänge (ρj'') des Teilmeßradiusvektors (ρj',Θj) aus der Teilmeßradiusvektorinformation (ρj'',Θj)(j≦i) unter der Annahme, daß eine Randdicke (Δj') in der Position einer nochmaligen Meßradiusvektorlänge (ρj'') einer Teil- und nochmaligen Meßradiusvektorinformation (ρj'',Θj) (mit j≦i) zum Bilden einer V-Kante der Linse durch die V-Nut des Schleifers (G) in einer Position entsprechend der Teilmeßradiusvektorinformation (ρj',Θj) ungefähr gleich der Randdicke (Δj) ist, wie folgt:

$$\rho j'' = \rho j' + dj$$
$$dj = (1-\Delta j/W)H$$

(mit j≦i) und
einen dritten Schritt des Messens der Vorderseiten-Brechungspositionsinformation (fZi',Θi) und der Rückseiten-Brechungspositionsinformation (bZi',Θi) der Linse in der Weise, daß sie der Teil- und nochmaligen Meßradiusvektorinformation (ρj'',Θj) entspricht, die zum Erhalten der V-Kanten-Scheitelpositionsinformation für das Schleifen des Randes dieses Bereiches der Linse mit der Randdicke (Δj) durch den Schleifer (G) verwendet werden.

2. Verfahren zum Messen der Randdicke einer Brillenlinse, folgende Schritte umfassend:
Eingeben einer Rundum-Radiusvektorinformation (ρi,Θi) eines Brillenrahmenlinsenrandes zum Rahmen der Linse (mit i = 0,1,2,3...N),
Erhalten einer Rundum-Meßradiusvektorinformation (ρi',Θi), indem eine V-Nuttiefe (H) eines Schleifers (G) von der Länge (ρi) des Radiusvektors der Rundum-Vektorinformation (ρi,Θi) subtrahiert wird,
und Erhalten einer Randdickeninformation (Δi,Θi) entsprechend der Rundum-Meßradiusvektorinformation (ρi',Θi) durch Messen einer Vorderseiten-Brechungspositionsinformation (fZi,Θi) und einer Rückseiten-Brechungspositionsinformation (bZi,Θi) der Linse entsprechend der Meßradiusvektorinformation (ρi',Θi), um eine Randdickeninformation (Δi,Θi) an der Schleifposition und eine V-Kanten-Scheitelpositionsinformation (kZi,ρi,Θi) zu erhalten, wenn der Rand der Linse mit dem Schleifer (G) geschliffen wird,
gekennzeichnet durch,
einen ersten Schritt des Vergleichens einer Breite (W) einer Schleifbasis des Schleifers (G) mit einer Randdicke (Δi) der Randdickeninformation (Δi,Θi), um eine Teilmeßradiusvektorinformation (ρj',Θj) (mit j≦i) zu erhalten, bei der eine gemessene Randdicke (Δj) kleiner ist als die Breite (W) der Schleifbasis,
einen zweiten Schritt des Erhaltens eines Kompensationswertes t1 entsprechend der folgenden Formel:

$$t1 = \left(1 - \frac{\Delta j}{W}\right) H$$

unter der Annahme, daß, wenn die gemessene Randdicke (Δj) kleiner als die Breite, aus der j-ten Teilmeßradiusvektorinformation (ρj',Θj) einer j-ten Messung ("-ten" ist ein Zusatz, der die Ordnungszahl anzeigt) erhalten wird, eine Randdicke der j + 1-ten Teilmeßradiusvektorinformation (ρj'',Θj + 1) als (Δj') definiert ist, und zusätzlich die Randdicke (Δj') ungefähr gleich der gemessenen Randdicke (Δj) ist,
einen dritten Schritt des Erhaltens einer Kompensationsradiusvektorlänge (τj + 1), die einer Länge (ρj + 1') des Meßradiusvektors der j + 1-ten Teilradiusvektorinformation (ρj + 1',Θj + 1) entspricht, nach der folgenden Formel:

$$\tau j + 1 = \rho j + 1' + t1$$

und des Erhaltens einer Kompensationsmeßradiusvektorinformation (τj + 1,Θj + 1) über die Kompensationsradiusvektorlänge (τj + 1) und über einen Radiusvektorwinkel (Θj + 1) der j + 1-ten Teilmeßradiusvektorinformation (ρj + 1',Θj + 1),
einen vierten Schritt des Messens einer Randdicke (Δj + 1) durch Messen von Vorderseiten- und Rückseiten-Brechungspositionsinformation der Linse entsprechend der Kompensationsmeßradiusinformation (τj + 1,Θj + 1),

einen fünften Schritt des Vergleichens der gemessenen Randicke ($\Delta j+1$) mit der zuvor gemessenen Randdicke (Δj) und, wenn die gemessene Randdicke ($\Delta j+1$) kleiner als die zuvor gemessene Randdicke (Δj) ist, des Erhaltens eines Kompensationswertes tm entsprechend der folgenden Formel:

$$tm = \sum_{m} \left(1 - \frac{\Delta j+m}{\Delta j+m-1}\right) H$$

wobei Δ j + m eine Randdicke der Meßradiusvektorinformation ($\rho j+m', \Theta j+m$) ist und $\Delta j+m-1$ eine Randdicke der Meßradiusvektorinformation ($\rho j+m-1', \Theta j+m-1$) ist, die vor der Meßradiusvektorinformation ($\rho j+m, \Theta j+m$) mit m=2,3,4,...M, M<N) liegt, und wobei die Randdicke ($\Delta j+m$) ungefähr gleich der Randdicke ($\Delta+m-1$) ist,

einen sechsten Schritt des Erhaltens einer Kompensationsradiusvektorlänge ($\tau j+m$), die einer Länge ($\rho j+m'$) des Meßradiusvektors der Meßradiusvektorinformation ($\rho j+m', \Theta j+m$) entspricht, nach der folgenden Formel:

$$\tau j+m = \rho j+m' + tm$$

und des Erhaltens einer Kompensationsmeßradiusvektorinformation ($\tau j+m, \Theta j+m$) über die Kompensationsvektorlänge ($\tau j+m$) und über einen Radiusvektorwinkel ($\Theta j+m$), der Meßradiusvektorinformation ($\rho+m', \Theta j+m$); und

einen siebenten Schritt des aufeinanderfolgenden Messens von Vorder- und Rückseiten-Brechungspositionsinformation der Linse entsprechend der Kompensationsmeßradiusvektorinformation ($\tau j+m, \Theta j+m$).

Revendications

1. Procédé pour mesurer l'épaisseur de bord d'un verre de lunette comprenant les étapes suivantes :

entrée des informations de vecteur de rayon de tout le tour (ρ_i, θ_i) d'un entourage de verre de monture de lunette pour enchâsser ledit verre (avec i = 0, 1, 2, 3, ... N) ;

obtention d'informations de vecteur de rayon de mesure de tout le tour (ρ_i', θ_i) en soustrayant une profondeur de rainure en forme de V (H) d'un dispositif de meulage (G) de la longueur (ρ_i) du vecteur de rayon desdites informations de vecteur de rayon de tout le tour (ρ_i, θ_i) ; et

obtention d'informations d'épaisseur de bord (Δ_i, θ_i) correspondant auxdites informations de vecteur de rayon de mesure de tout le tour (ρ_i', θ_i) en mesurant des informations de position réfringente latérale avant (${}_fZ_i$, θ_i) et des informations de position réfringente latérale arrière (${}_bZ_i$, θ_i) dudit verre correspondant auxdites informations de vecteur de rayon de mesure (ρ_i', θ_i) afin d'obtenir des informations d'épaisseur de bord (Δ_i, θ_i) au niveau de la position de meulage et des informations de position de sommet de bord en forme de V (${}_kZ_i$, ρ_i, θ_i) lorsque le bord dudit verre est meulé avec ledit dispositif de meulage (G) ;

caractérisé par :

une première étape de comparaison d'une largeur (W) d'une base de meulage dudit dispositif de meulage (G) avec ladite épaisseur de bord mesurée (Δ_i) et l'obtention, de manière sélective, d'informations de vecteur de rayon de mesure partiel (ρ_j', θ_j) ($j \leqq i$) dudit verre lorsqu'une épaisseur de bord plus étroite (Δ_j) que ladite largeur (W) est mesurée ;

une seconde étape d'obtention, en supposant qu'une épaisseur de bord (Δ_j'), dans la position d'une nouvelle longueur de vecteur de rayon de mesure (ρ_j'') de nouvelles informations de vecteur de rayon de mesure partiel (ρ_j'', θ_j) (avec $j \leqq i$) pour former un bord en forme de V dudit verre par ladite rainure en forme de V dudit dispositif de meulage (G) dans une position correspondant auxdites informations de vecteur de rayon de mesure partiel (ρ_j', θ_j), soit approximativement égale à ladite épaisseur de bord (Δ_j), d'une longueur de vecteur de rayon de mesure (ρ_j'') dudit vecteur partiel de rayon de mesure (ρ_j', θ_j) en provenance desdites informations de vecteur de rayon de mesure partiel (ρ_j'', θ_j) ($j \leqq i$) de la manière suivante :

$$\rho_j'' = \rho_j' + d_j$$
$$d_j = (1 - \Delta_j / W) \,.\, H$$

(avec $j \leqq i$) ; et

une troisième étape de mesure desdites informations de position réfringente latérale avant (${}_fZ_i'$, θ_i) et desdites informations de position réfringente latérale arrière (${}_bZ_i'$, θ_i) dudit verre de façon à correspondre auxdites nouvelles informations de vecteur de rayon de mesure partiel (ρ_j'', θ_j) qui sont utilisées pour obtenir lesdites informations de position de sommet de bord en forme de V pour meuler le bord de cette partie dudit verre ayant ladite épaisseur de bord (Δ_j) avec ledit dispositif de meulage (G).

2. Procédé pour mesurer l'épaisseur de bord d'un verre de lunette comprenant les étapes suivantes :

entrée des informations de vecteur de rayon de tout le tour (ρ_i, θ_i) d'un entourage de verre de monture de lunette pour enchâsser le verre (avec i = 0, 1, 2, 3, ... N) ;

obtention des informations de vecteur de rayon de mesure de tout le tour (ρ_i', θ_i) en soustrayant une profondeur de rainure en forme de V (H) d'un dispositif de meulage (G) à partir de la longueur (ρ_i) du vecteur de rayon desdites informations de vecteur de rayon de tout le tour (ρ_i, θ_i) ; et

obtention des informations d'épaisseur de bord (Δ_i, θ_i) correspondant auxdites informations de vecteur de rayon de mesure normal (ρ_i', θ_i) en mesurant des informations de position réfringente latérale avant (${}_fZ_i$, θ_i) et des informations de position réfringente latérale arrière (${}_bZ_i$, θ_i) dudit verre correspondant auxdites informations de vecteur de rayon de mesure (ρ_i', θ_i) afin d'obtenir des informations d'épaisseur de bord (Δ_i, θ_i) dans la position de meulage et des informations de position de sommet de bord en forme de V (${}_kZ_i$, ρ_i, θ_i) lorsque le bord dudit verre est meulé avec ledit dispositif de meulage (G) ;

caractérisé par :

une première étape de comparaison d'une largeur (W) d'une base de meulage dudit dispositif de meulage (G) avec une épaisseur de bord (Δ_i) desdites informations de vecteur de bord (Δ_i, θ_i) pour obtenir des informations de vecteur de rayon de mesure partiel (ρ_j', θ_j) (avec $j \leqq i$) dans lequel une épaisseur de bord mesurée (Δ_j) est inférieure à ladite largeur (W) de la base de meulage ;

une seconde étape d'obtention d'une valeur de compensation t_1 selon la formule suivante :

$$t_1 = \left(1 - \frac{\Delta_j}{W}\right) . H$$

en supposant que, si ladite épaisseur de bord mesurée (Δ_j) inférieure à ladite largeur (W) est obtenue à partir des j-ièmes informations de vecteur de rayon de mesure partiel (ρ_j', θ_j) d'une j-ième mesure ("-ième" est un terme représentant un nombre ordinal), une épaisseur de bord de j+1-ièmes informations de vecteur de rayon de mesure partiel (ρ_{j+1}', θ_{j+1}) est définie en tant que (Δ_j') et, de plus, l'épaisseur de bord (Δ_j') est à peu près égale à ladite épaisseur de bord mesurée (Δ_j) ;

une troisième étape d'obtention d'une longueur de vecteur de rayon de compensation (τ_{j+1}), qui correspond à une longueur (ρ_{j+1}') du vecteur de rayon de mesure desdites j+1-ièmes informations de vecteur de rayon de mesure partiel (ρ_{j+1}', θ_{j+1}), selon la formule suivante :

$$\tau_{j+1} = \rho_{j+1}' + t_1$$

et l'obtention d'informations de vecteur de rayon de mesure de compensation (τ_{j+1}, θ_{j+1}) concernant ladite longueur de vecteur de rayon de compensation (τ_{j+1}) et concernant un angle de vecteur de rayon (θ_{j+1}) desdites j+1-ièmes informations de vecteur de rayon de mesure partiel (ρ_{j+1}', θ_{j+1}) ;

une quatrième étape de mesure d'une épaisseur de bord (Δ_{j+1}) en mesurant les informations de positions réfringentes latérales avant et arrière dudit verre selon lesdites informations de vecteur de rayon de mesure de compensation (τ_{j+1}, θ_{j+1}) ;

une cinquième étape de comparaison de ladite épaisseur de bord mesurée (Δ_{j+1}) avec ladite épaisseur de bord mesurée précédente (Δ_j), et, si ladite épaisseur de bord mesurée (Δ_{j+1}) est inférieure à ladite épaisseur de bord mesurée précédente (Δ_j),obtention d'une valeur de compensation t_m selon la formule suivante :

$$t_m = \sum_m \left(1 - \frac{\Delta_{j+m}}{\Delta_{j+m-1}}\right) . H$$

où Δ_{j+m} est une épaisseur de bord des informations de vecteur de rayon de mesure (ρ_{j+m}', θ_{j+m}) et où Δ_{j+m-1} est une épaisseur de bord des informations de vecteur de rayon de mesure (ρ_{j+m-1}', θ_{j+m-1}) antérieures auxdites informations de vecteur de rayon de mesure (ρ_{j+m}', θ_{j+m}) (avec m = 2, 3, 4, ... M, M < N), l'épaisseur de bord (Δ_{j+m}) est à peu près égale à ladite épaisseur de bord (Δ_{j+m-1}) ;

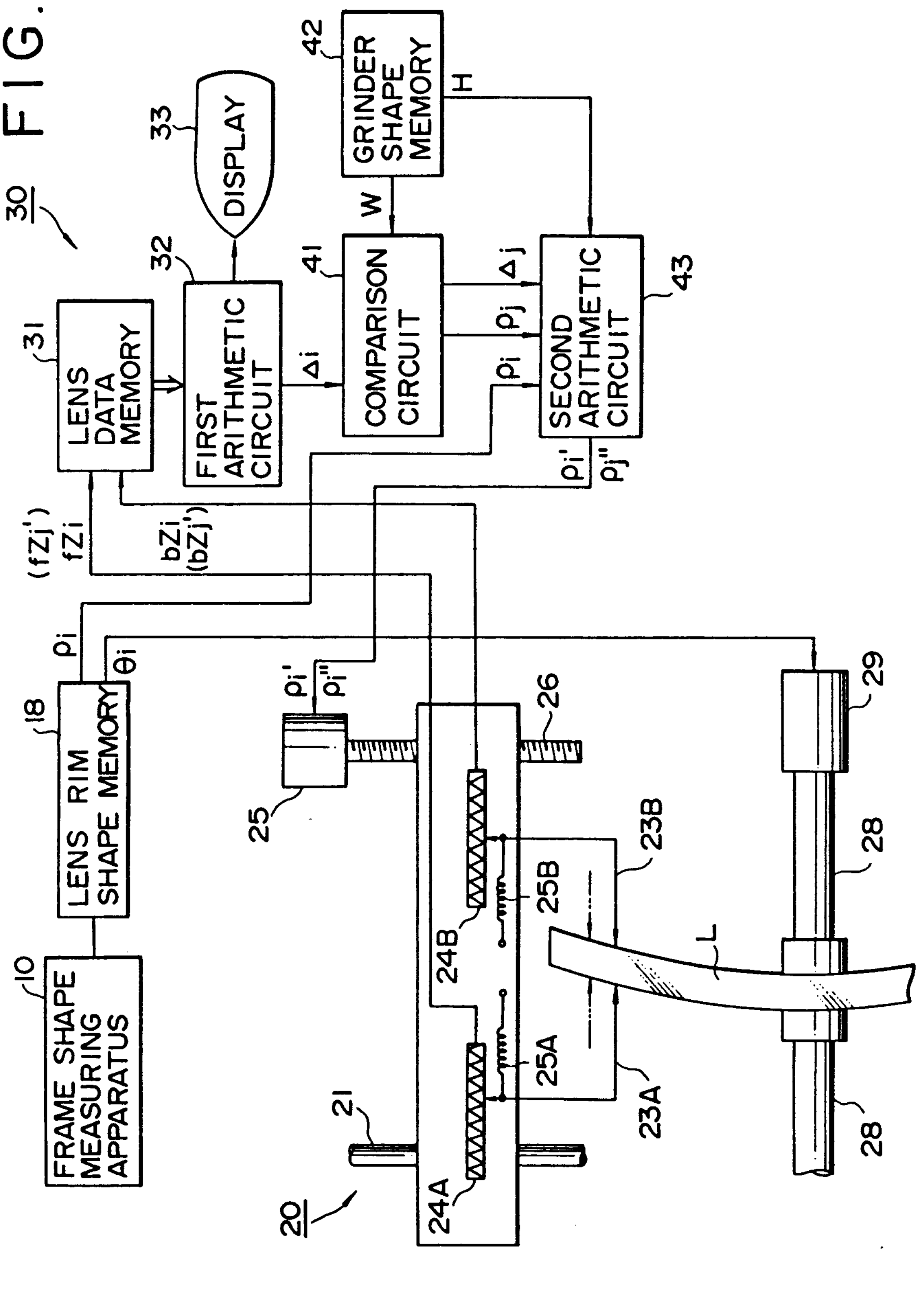
une sixième étape d'obtention d'une longueur de vecteur de rayon de compensation (τ_{j+m}), qui correspond à une longueur (ρ_{j+m}') du vecteur de rayon de mesure desdites informations de vecteur de rayon de mesure (ρ_{j+m}', θ_{j+m}), selon la formule suivante :

$$\tau_{j+m} = \rho_{j+m}' + t_m$$

et obtention des informations de vecteur de rayon de mesure de compensation (τ_{j+m}, θ_{j+m}) concernant ladite longueur de vecteur de rayon de compensation (τ_{j+m}) et concernant un angle de vecteur de rayon (θ_{j+m}) desdites informations de vecteur de rayon de mesure (ρ_{j+m}', θ_{j+m}) ; et

une septième étape de mesures successives des informations de positions réfringentes latérales avant et arrière dudit verre selon lesdites informations de vecteur de rayon de mesure de compensation (τ_{j+m}, θ_{j+m}).

FIG. 1



30
10
FRAME SHAPE MEASURING APPARATUS
18
LENS RIM SHAPE MEMORY
ρi
θi
31
LENS DATA MEMORY
(fZj')
fZi
bZi
(bZj')
32
FIRST ARITHMETIC CIRCUIT
33
DISPLAY
Δi
41
COMPARISON CIRCUIT
42
GRINDER SHAPE MEMORY
W
H
Δj
ρj
ρi
43
SECOND ARITHMETIC CIRCUIT
ρi'
ρj''
ρi'
ρi''
20
21
24A
25A
23A
24B
25B
23B
25
26
L
28
28
29

FIG. 2

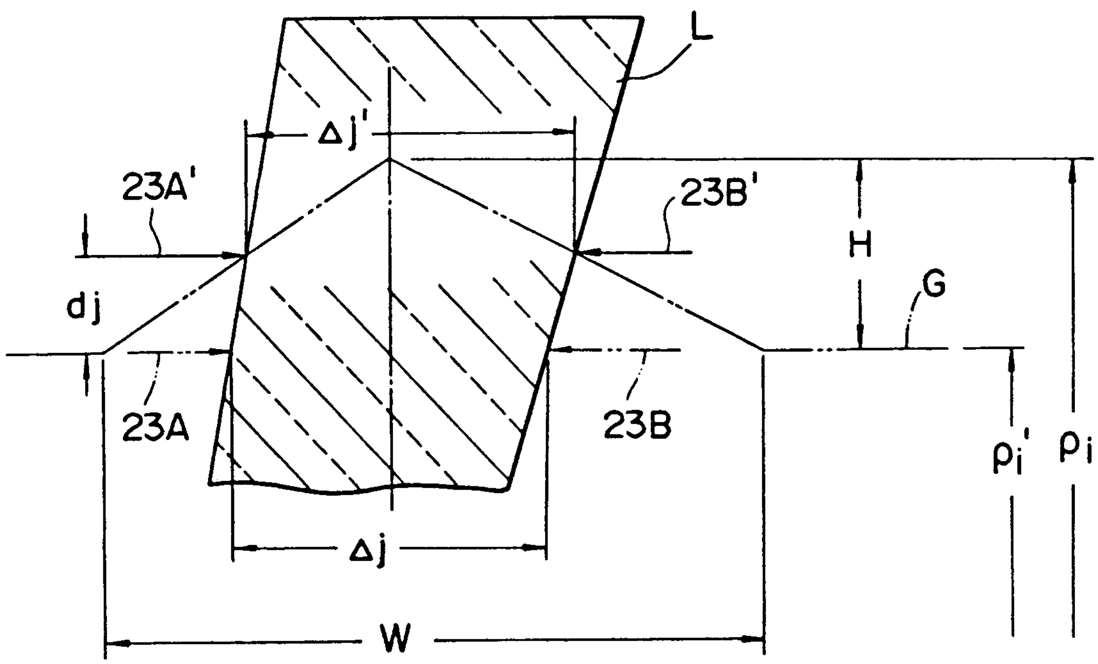


FIG.3A

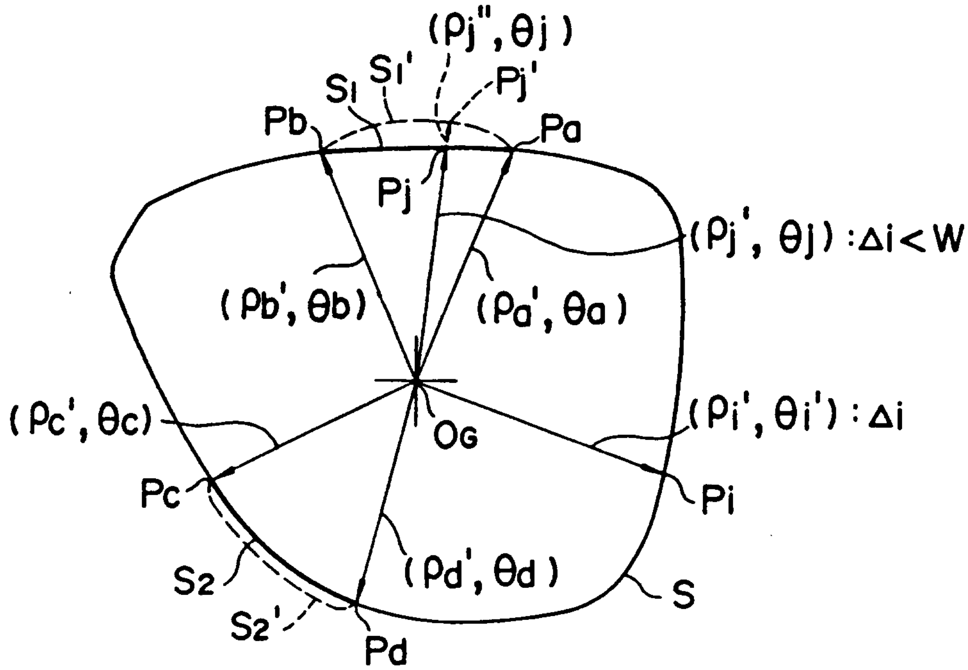

(ρj", θj)
S1'
Pj'
S1
Pb
Pa
Pj
(ρj', θj) : Δi<W
(ρb', θb)
(ρa', θa)
(ρc', θc)
OG
(ρi', θi') : Δi
Pc
Pi
S2
(ρd', θd)
S
S2'
Pd

FIG.3B

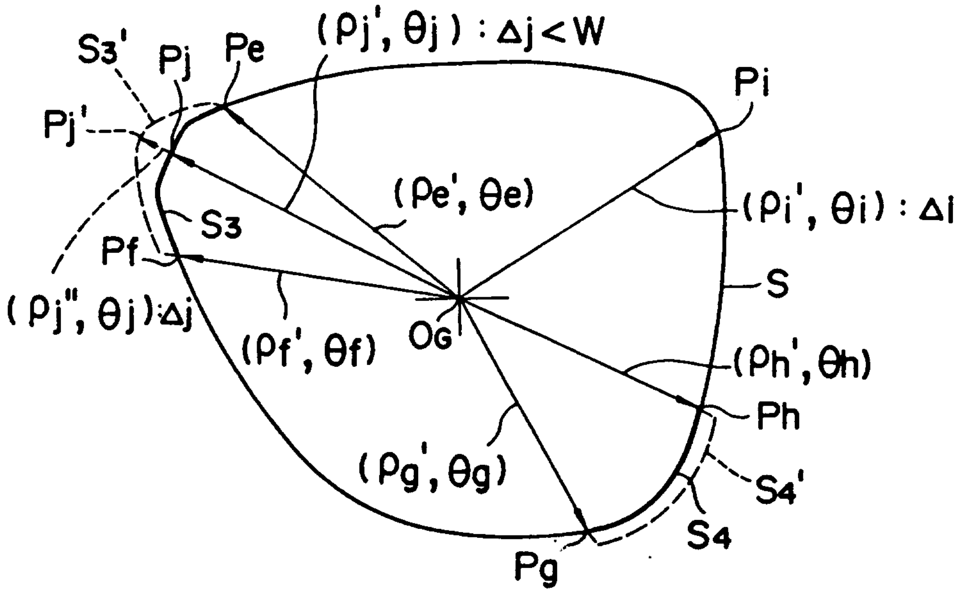

(ρj', θj) : Δj<W
S3'
Pj
Pe
Pi
Pj'
(ρe', θe)
(ρi', θi) : Δi
S3
Pf
S
(ρj", θj):Δj
(ρf', θf)
OG
(ρh', θh)
Ph
(ρg', θg)
S4'
S4
Pg

FIG. 4

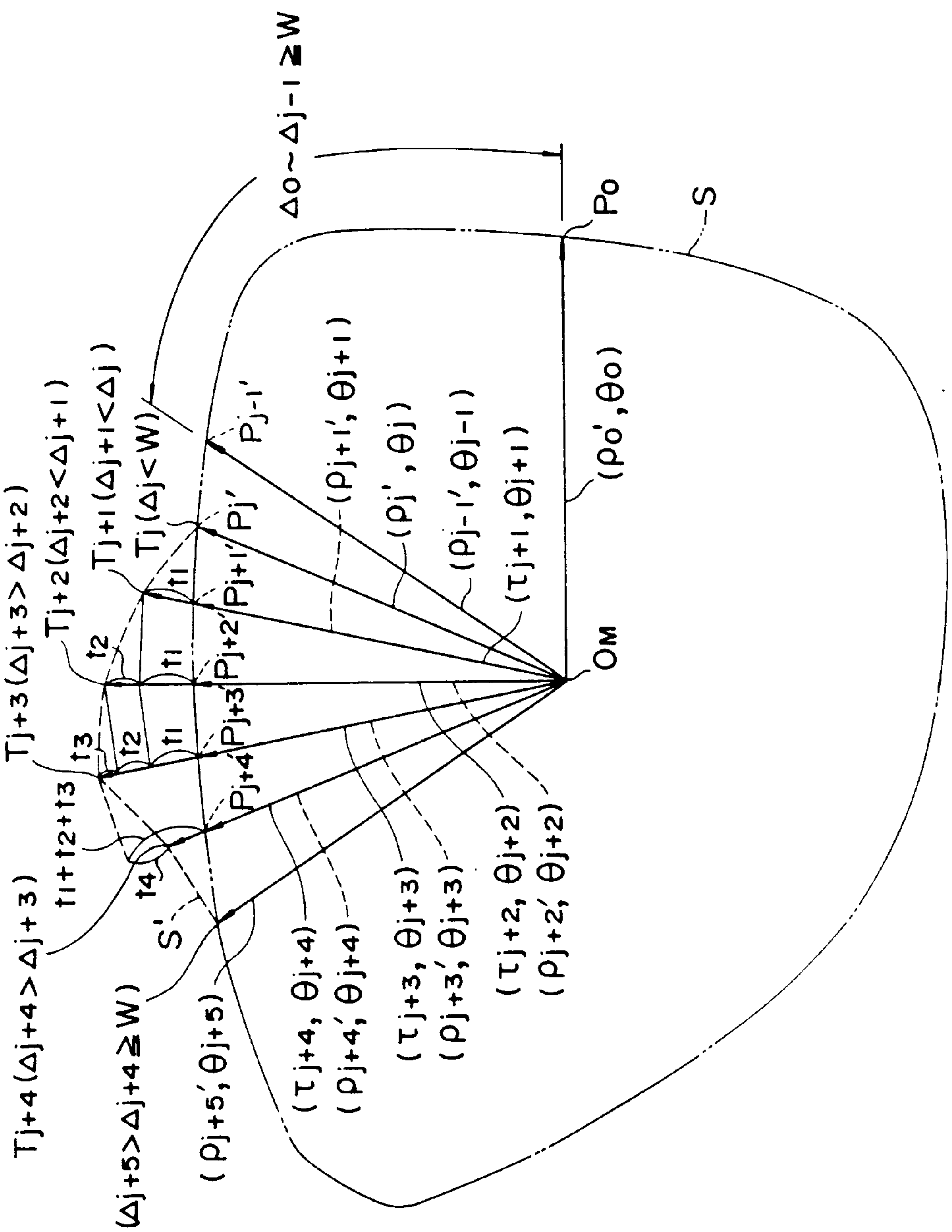

Δo～Δj-1 ≧ W
Po
S
(ρo', θo)
OM
Pj-1'
Pj'
Pj+1'
Pj+2'
Pj+3'
Pj+4'
S'
Tj(Δj<W)
Tj+1(Δj+1<Δj)
Tj+2(Δj+2<Δj+1)
Tj+3(Δj+3>Δj+2)
Tj+4(Δj+4>Δj+3)
Tj+5(Δj+5>Δj+4 ≧ W)
t1
t2
t3
t4
t1+t2+t3
(ρj+1', θj+1)
(ρj', θj)
(ρj-1', θj-1)
(τj+1, θj+1)
(τj+2, θj+2)
(ρj+2', θj+2)
(τj+3, θj+3)
(ρj+3', θj+3)
(τj+4, θj+4)
(ρj+4', θj+4)
(ρj+5', θj+5)

FIG. 5

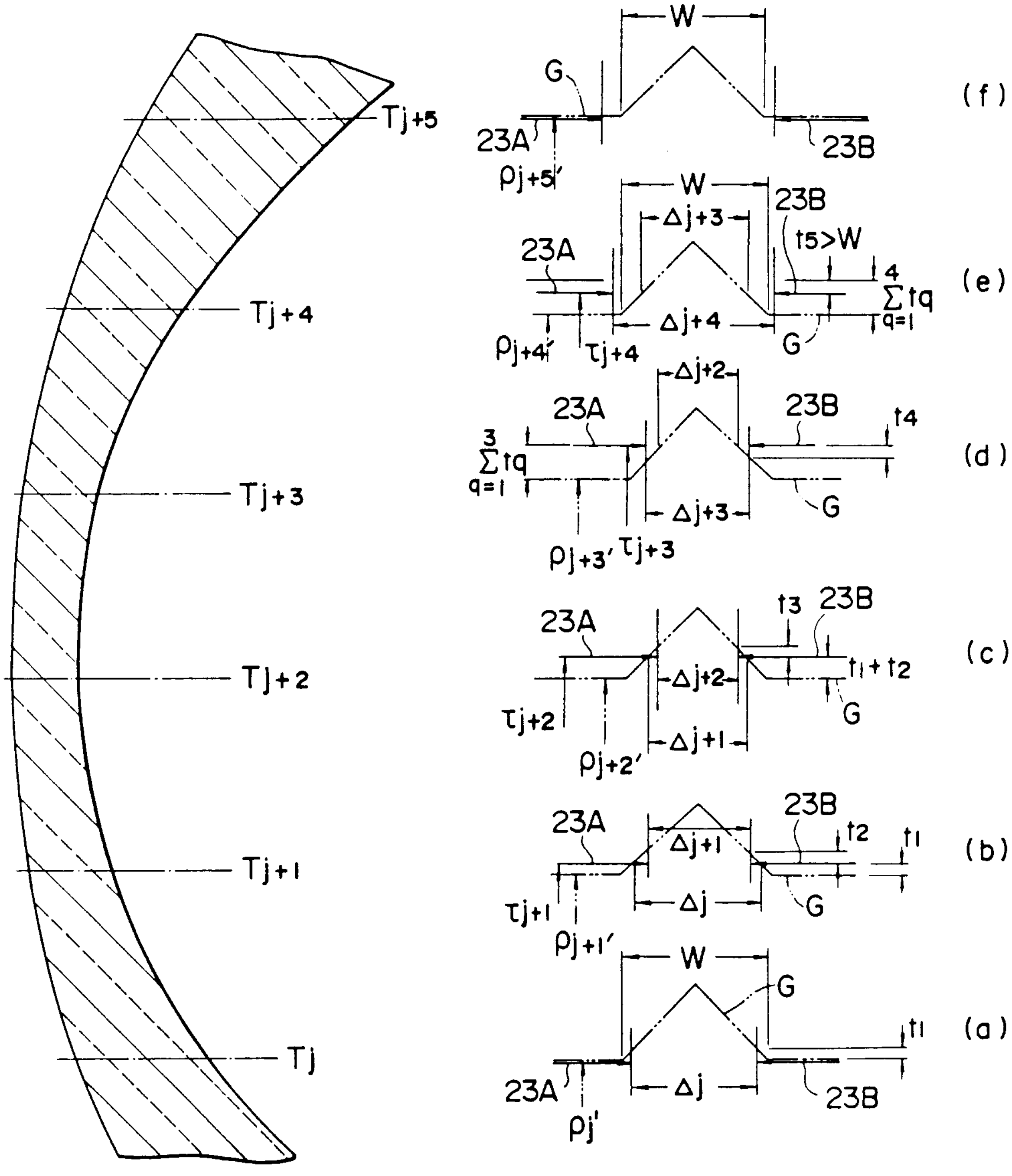
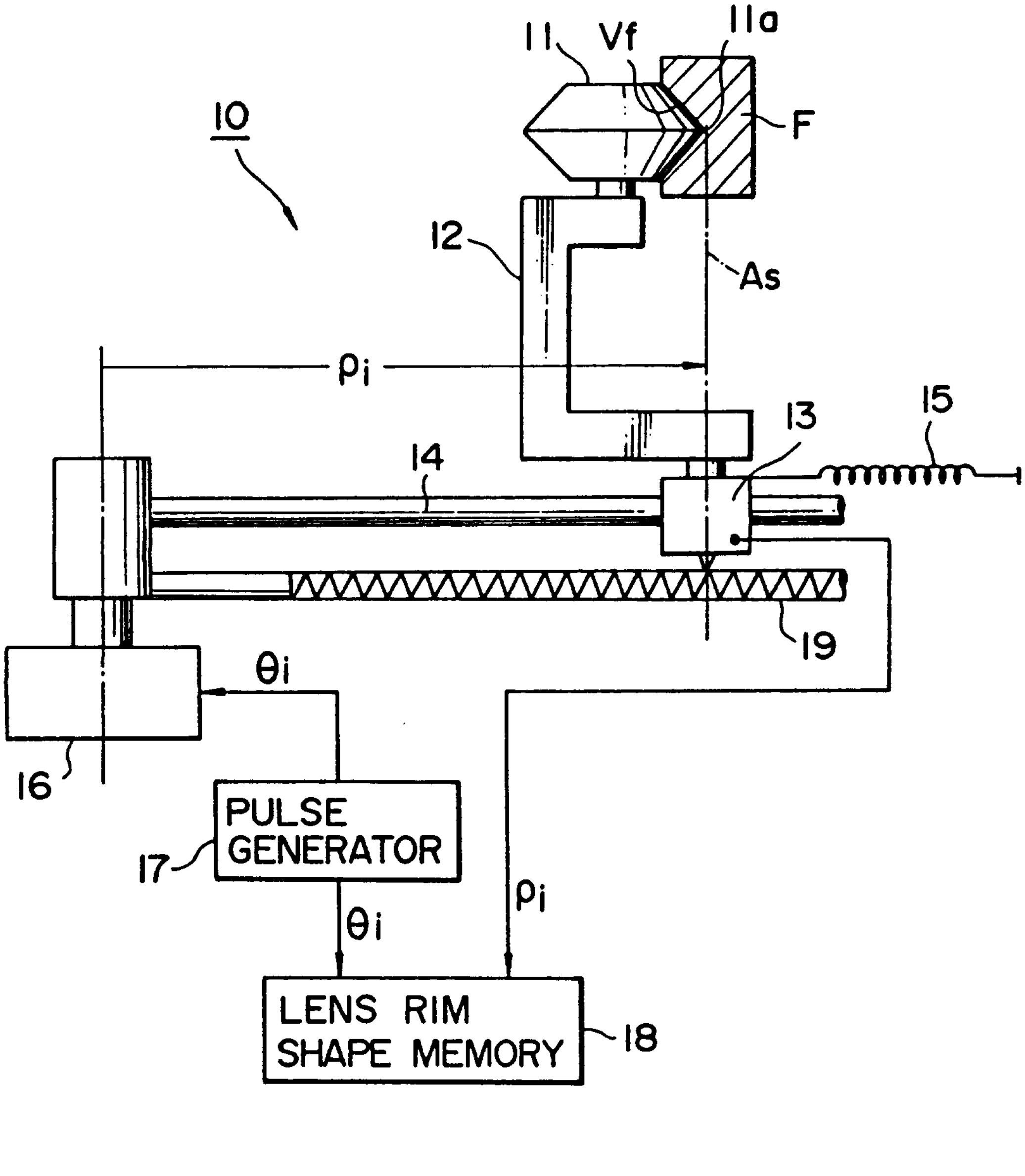

Tj+5
Tj+4
Tj+3
Tj+2
Tj+1
Tj
W
G
23A
23B
ρj+5'
(f)
Δj+3
t5>W
Δj+4
ρj+4'
τj+4
(e)
Δj+2
t4
ρj+3'
τj+3
(d)
t3
t1+t2
τj+2
ρj+2'
Δj+1
(c)
t2
t1
Δj
τj+1
ρj+1'
(b)
ρj'
(a)

FIG. 6


11
Vf
11a
F
10
12
As
ρi
13
15
14
19
θi
16
PULSE
GENERATOR
17
θi
ρi
LENS RIM
SHAPE MEMORY
18

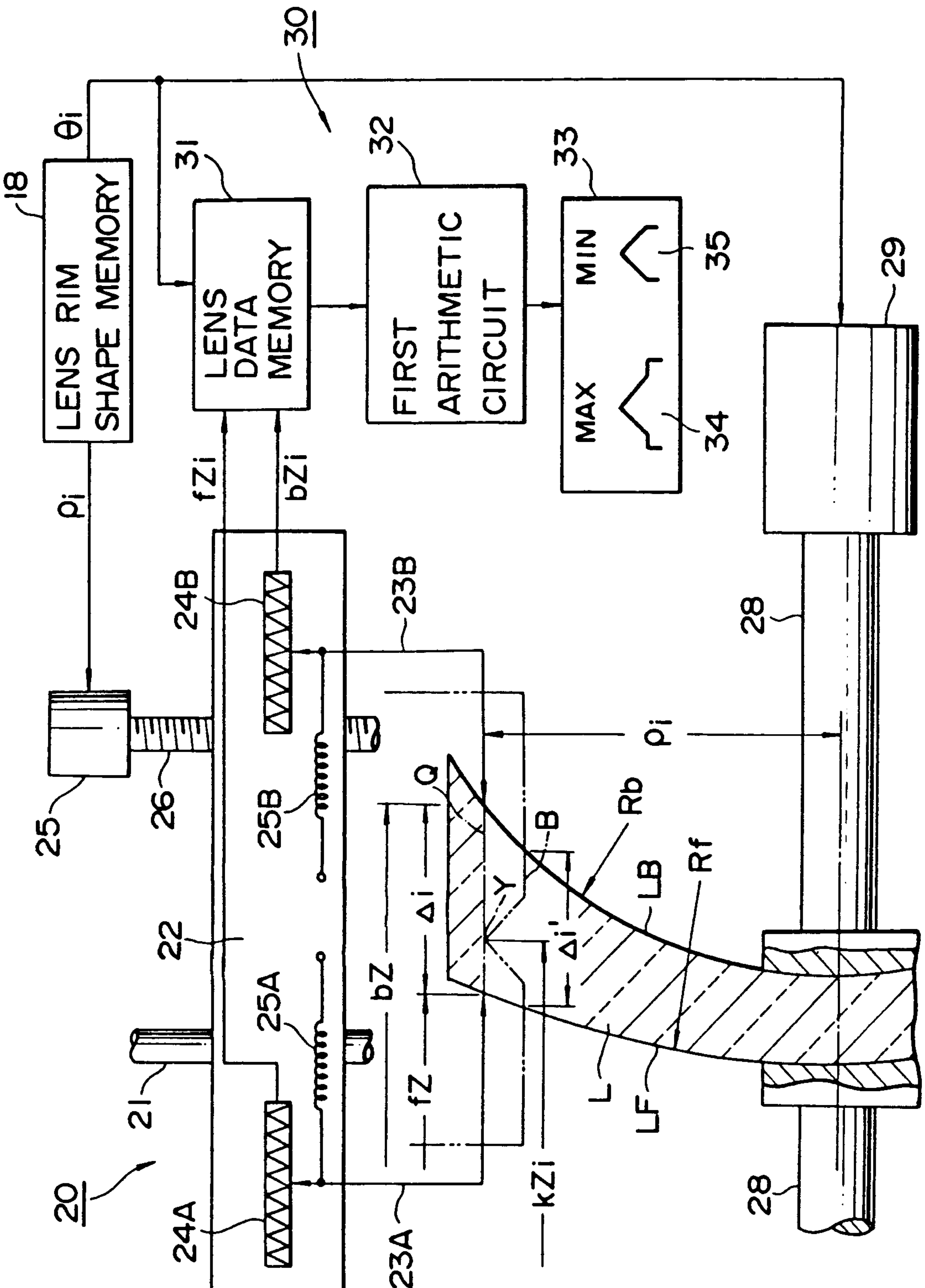

LENS RIM SHAPE MEMORY
18
θi
ρi
30
31
LENS DATA MEMORY
fZi
bZi
32
FIRST ARITHMETIC CIRCUIT
33
MAX
MIN
34
35
29
28
25
26
24B
23B
25B
22
25A
21
20
24A
23A
kZi
fZ
bZ
Δi
Δi'
Q
Y
B
Rb
LB
Rf
L
LF

FIG. 7

FIG.8

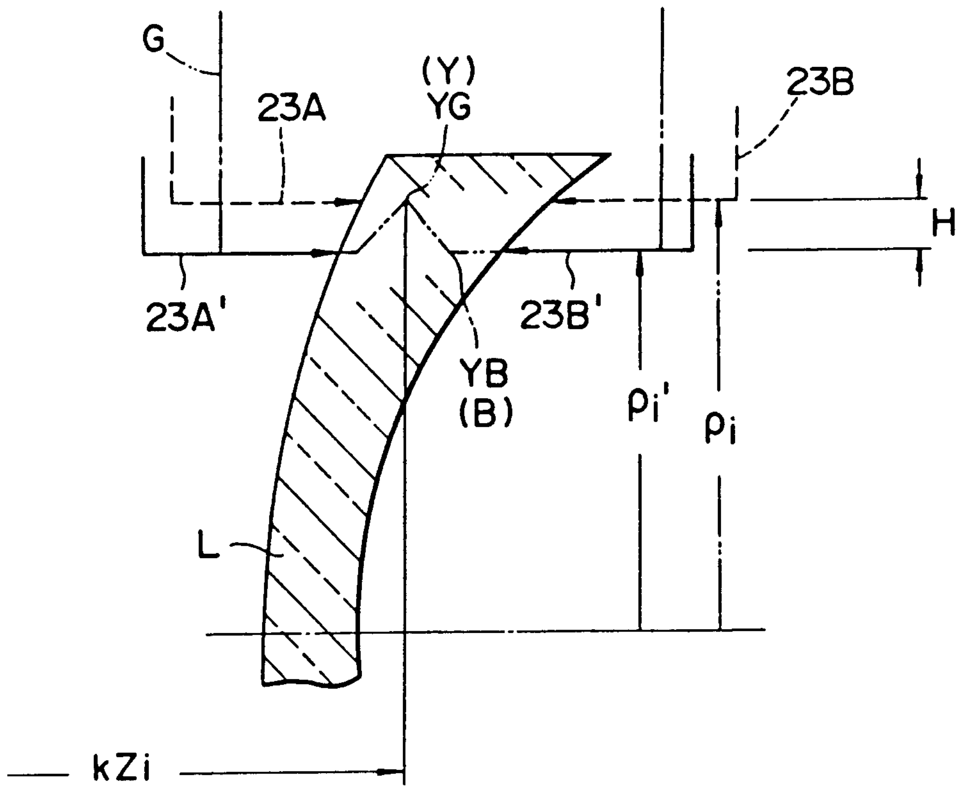


FIG.9