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(54) Method for grinding a lens and apparatus thereof.

(57) A lens grinding method of the present invention includes a first step for finding a lens-edge thickness over the entire circumference of a lens-edge vector radius locus of a lens to be cut , a second step for finding a lens-edge vertex position information for dividing the lens-edge into a desired ratio over the entire circumference thereof, and a third step for V-edge edging the lens-edge based on the V-edge vertex position information. Also, a lens grinding apparatus of the present invention includes measuring means for finding a lens-edge thickness over the entire circumference of a lens-edge vector radius locus of a lens to be cut , input means for inputting a desired ratio, calculating means for finding a positional information of a V-edge vertex for dividing the lens-edge at the input ratio over the entire circumference thereof, and controlling means for V-edge edging the lens-edge based on the V-edge vertex positional information.

And according to the lens grinding method and the apparatus for carrying out the method, as the lens-edge thickness is measured over the entire circumference of the lens-edge and the movement of the lens in the Z-axis direction is controlled such that the V-edge is formed at a desired ratio over the entire circumference of the lens-edge, the V-edge can be desirably positioned even if a lens having an aspherical refracting surface like a progressive multifocus lens.

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METHOD FOR GRINDING A LENS AND APPARATUS THEREOF

BACKGROUND OF THE INVENTION

Field of the Invention:

This invention relates to a lens grinding method for grinding an uncut lens in such a manner as to correspond to the shape of a lens frame of a spectacle frame in order to fit the lens into the lens frame, and an apparatus for carrying out the method.

Description of the Prior Art:

The present applicant has previously filed, under Japanese patent application No. Sho 60-115079, a lens grinding apparatus in which the thickness of the edge of a lens to be cut is measured in such a manner as to correspond to the shape locus (ρ_i, θ_i) [i = 1, 2, 3, ... N] of a lens frame of a spectacle frame, a V-edge locus Y is calculated based on such obtained information of the thickness of the lens-edge, and the V-edge locus can be automatically formed on the surface of the lens-edge.

In the above-mentioned conventional apparatus, firstly, the lens-edge thickness Δ_i of an uncut lens L, as shown in Figs. 7A and 7B, is measured in accordance with the radius vector (ρ_i, θ_i) of the locus 1 of the lens shape in order to obtain the maximum lens-edge thickness Δ_{max} and the mini

SR S 419 mum lens-edge thickness Δ_{min}. And the spherical radius eR including the V-edge locus Y or focus Y for dividing the both lens-edge thicknesses at a desired ratio 1:m is obtained by calculation. Then, the amount required for moving the lens L in the Z-axis direction (the direction of the optical axis of the lens), that is, the V-edge cutting information (eZ_i, ρ_i, θ_i) is found from such obtained radius eR and the lens frame shape locus (ρ i, θ i) in order to bring the vertex of the V-edge onto the V-edge locus Y when the lens is subjected to the V-edge cutting.

In the above-mentioned method and apparatus, it is the premise that the V-edge locus Y is included on the spherical surface of the radius eR. Therefore, as is shown in Fig. 8, for example, it has such a disadvantage as that in a progressive multifocus lens L', a portion for seeing a near place or near sight portion having an aspherical surface NS, if a V-edge y is going to be formed on the lens-edge of a portion for seeing a far place or far sight portion in a position at the ratio of 1:m, the V-edge cannot be formed on the lens-edge of the near sight portion.

SUMMARY OF THE INVENTION

It is therefore the object of the present invention to provide a lens grinding method and an apparatus for carrying out the method which is capable of overcoming the disadvantage inherent in the conventional method and apparatus.

Under this object, a lens grinding method of the present invention includes a first step for finding a lens-edge thickness over the entire circumference of a lens-edge vector radius locus of a lens to be cut , a second step for finding a lens-edge vertex position information for dividing said lens-edge into a desired ratio over the entire circumference thereof, and a third step for V-edge edging said lens-edge based on said V-edge vertex position information. Said lens-edge vector radius is given from said vector radius information of a lens frame of a spectacle frame into which said lens is to be fitted. Said first step finds said lens-edge thickness of said lens which is uncut. Said vector radius locus is an locus of a cut lens-edge obtained by grinding using a template which has a pattern formed as same as the shape of said spectacle. Said first step finds said lens-edge thickness of a lens-edge which is cut.

Also, a lens grinding apparatus according to the present invention includes measuring means for finding a lens-edge thickness over the entire circumference of a lens-edge vector radius locus of a lens to be cut , input means for inputting a desired ratio, calculating means for finding a positional information of a V-edge vertex for dividing said lens-edge at said input ratio over the entire circumference thereof, and controlling means for V-edge edging said lens-edge based on said V-edge vertex positional information. Said lens-edge vector radius is given from said vector radius information of a lens frame of a spectacle frame into

which said lens is to be fitted. Said first step finds said lens-edge thickness of said lens which is uncut. Said vector radius locus is an locus of a cut lens-edge obtained by grinding using a template which has a pattern formed as same as the shape of said spectacle. Said first step finds said lens-edge thickness of a lens-edge which is cut.

These and other objects, features and 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 spirit of the invention or the scope of claims appended hereto.

BRIEF DESCRIPTION OF THE ATTACHED DRAWINGS

Fig. 1 is a block diagram showing a lens-edge thickness measuring apparatus portion of a lens grinding apparatus of the present invention.

Fig. 2 is a block diagram simultaneously showing a first and a second embodiments of a V-edge edging apparatus portion of a lens grinding apparatus of the present invention.

Fig. 3 is a schematic view showing the relationship between the lens-edge thickness and the V-edge vertex position.

Fig. 4 is a schematic view showing the relationship between the lens vector radius and the lens.

Fig. 5 is a side view showing the lens after being subjected to V-edge edging.

Fig. 6 is a schematic view showing a second embodiment of the lens-edge thickness measuring portion of a lens grinding apparatus of the present invention.

Fig. 7A and 7B are illustrations for explaining the method for finding a V-edge locus of the Prior Art lens grinding apparatus.

Fig. 8 is a vertical sectional view of a lens for pointing out the disadvantage of the prior art.

DESCRIPTION OF THE PREFERRED EMBODIMENT

The embodiment of the present invention will be described hereinafter with reference to Figs. 1 through 6.

Fig.s 1 and 2 are block diagrams showing the first embodiment of the present invention.

In Fig. 1, the numeral 10 denotes a frame shape measuring apparatus, and 12 denotes a lens-edge thickness measuring apparatus.

This frame shape measuring apparatus 10 has the same construction and operation as the apparatus described in the application previously filed by the present applicant, i.e., Japanese Patent Application No. Sho 60-287491. This frame shape measuring apparatus 10 measures the shape of the lens frame of a spectacle frame into which a lens L is to be fitted as a vector radius information (ρ_i, θ_i) and input the same into a memory 11.

The lens-edge thickness measuring apparatus 12 has the same construction and operation as the one described in detail in Japanese Patent Application No. Sho 60-115079 previously filed by the present applicant. This lens-edge thickness measuring apparatus 12 includes a pulse motor 120, fillers 123 and 124 to be abutted against front and rear refracting surfaces of the lens L to be cut, encoders 121 and 122 for measuring the moving amounts of the fillers 123 and 124, and a supporting table 125 for supporting the fillers 123 and 124 and the encoders 121 and 122 mounted thereon and moved by the pulse motor 120. Also, the lens L is held by a lens rotating axis 13 of a carriage C (see Fig. 2) and rotated about the optical axis therof by a pulse motor 14.

The radius ρ_i of the vector radius information (ρ_i, θ_i)of the lens frame stored in the memory 11 is input into the pulse motor 120, and the pulse motor 120 moves the supporting table 125 in accordance with this input. As a consequence, the fillers 123 and 124 can be abutted against the refracting surfaces of the uncut lens L in the position of the radius ρ i.

On the other hand, the angle information θ i is input into the pulse motor 14 and the pulse motor 14 rotates the lens rotating axis 13 by θ_i in accordance with this input. As a result, the lens L is rotated by .θ_i Such established respective moving amounts a_i and b_i of the fillers 123 and 124 in the vector radius position (ρ_i, θ_i) (see Figs. 3 and 4) are input into the calculating apparatus 15.

In this calculating apparatus 15, the lens-edge thickness Δ_i[i = 1, 2, 3, ...], as shown in Fig. 3, is calculated from the following relation.

$\Delta i = ai - bi$ (1)

Then, based on a desired V-edge ratio, i.e., the ratio $\underline{1}$:m at which the V-edge vertex divides the lens-edge and which is input beforehand, a V-edge vertex position Z_i is found by a V-edge ratio inputting apparatus 16 as follows.

$$Z_i = a_i \frac{\Delta_i \cdot \underline{1}}{\underline{1}+m} \quad \cdots \cdots \cdots \cdots \cdots \cdots \cdots (2)$$

And this Z_i is corresponded to the vector radius information ρ_i, θ_i of the lens frame , i.e., such measured lens-edge position input into the calculating apparatus 15 and the V-edge position information (ρ_i, θ_i, Z_i) [i = 1, 2, 3, ...] is output so as to be stored in the memory 17.

The V-edge edging of the lens L is carried out by a cutting apparatus shown in Fig. 2. A carriage C for holding the lens L is moved in the direction Z by a pulse motor 21 and a feed screw 21a. Also, the distance between the lens rotating axis 13 and the grinding surfaces of the grinders G1 and G2 is controlled by the movement of a stopper 23 in the direction X. The movement of the stopper 23 carried out by a pulse motor 22 and a feed screw 22a. The detailed construction and operation of this cutting apparatus are described in the above-mentioned Japanese Patent Application No. Sho 60-115079.

Only the lens frame vector radius (ρ_i, θ_i) is read from the memory 17 by a controller 20 first and this lens frame vector radius (ρ_i, θ_i) is input into the pulse motors 14 and 22. And the lens L is roughly ground into a shape corresponding to the vector radius (ρ_i, θ_i) by the grinder G1. Then, the controller 20 reads the V-edge vertex information (ρ_i, θ_i , Z_i) and inputs the angular information θ_i into the pulse motor 14, then inputs the radius information ρ_i into the pulse motor 22 and inputs Z-direction information Z_i into the pulse motor 21 respectively in order to form the V-edge y in the lens L by a edging grinder G2 (see Fig. 5).

By this, as is shown in Fig. 5, the V-edge y is formed as such that the V-edge vertex is located in a position of a desired V-edge ratio $\underline{1}$:m over the entire V-edge surface of the lens.

[Second Embodiment]

Although the lens-edge thickness measuring apparatus 12 of the first embodiment is constructed such that the lens-edge thickness Δ_i corresponding to the lens frame shape can be measured in the state where the lens L is uncut (before being subjected to rough grinding), the present invention is not limited to this. For example, the lens-edge thickness Δ_i of the lens after being subjected to rough grinding may be measured as shown in Fig. 6.

In Fig. 6, a lens-edge thickness measuring apparatus 30 includes encoders 34 and 35, etc. for measuring the moving amounts of truncated cone shaped tops 32, 33 thrusted into a rod 31 abutted against the lens edge of the lens. The lens-edge thickness Δ_i can be found by sandwiching the both ends of the lens edge of the lens L after the lens L is subjected to rough grinding between the shoulders 32a and 33a of the tops 32 and 33. The construction and operation of this lens-edge thickness measuring apparatus 30 are described in detail in the Japanese Patent Application No. Sho 58-225198 previously filed by the present applicant.

The grinding method of the lens L is not necessarily a direct taking or grinding method in which the grinding is carried out based on the vector radius information of the lens frame which is measured beforehand. Instead, it may be performed by using a template which has pattern formed as same as the shape of the lens frame as in a conventional lens grinder.

In case this copy grinding method is used, the template T, as shown in the left-hand side of Fig. 2, is mounted on the end portion of the lens rotating axis 13 of the carriage C, and the stopper 23 is fixed to the height of the grooved bottom of the edging grinder G2. Moreover, the V-edge vertex position information may be found as a set (Z_i , θ_i) with the angular information θ_i of the lens rotational axis.

As described in the foregoing, according to the present invention, the lens-edge thickness is measuring over the entire circumference of the lens-edge of a lens to be ground, and the movement of the lens in the Z-axis direction is controlled in such a manner as to form a V-edge over the entire circumference at a desired V-edge ratio. Accordingly, even such a lens as having an aspherical refracting surface like a progressing multifocus lens can be put in a desired position.

Claims

1. A lens grinding method including
a first step for finding a lens-edge thickness over the entire circumference of a lens-edge vector radius locus of a lens to be cut ;
a second step for finding a lens-edge vertex position information for dividing said lens-edge into a desired ratio over the entire circumference thereof; and
a third step for V-edge edging said lens-edge based on said V-edge vertex position information.

2. A lens grinding method according to claim 1, wherein said lens-edge vector radius is given from said vector radius information of a lens frame of a spectacle frame into which said lens is to be fitted.

3. A lens grinding method according to claim 2, wherein said first step finds said lens-edge thickness of said lens which is uncut.

4. A lens grinding method according to claim 1, wherein said vector radius locus is an locus of a cut lens-edge obtained by copy grinding using a template which has a pattern formed as same as the shape of said spectacle.

5. A lens grinding method according to claim 4, wherein said first step finds said lens-edge thickness of a lens-edge which is cut.

6. A lens grinding apparatus including
measuring means for finding a lens-edge thickness over the entire circumference of a lens-edge vector radius locus of a lens to be cut ;
input means for inputting a desired ratio;
calculating means for finding a positional information of a V-edge vertex for dividing said lens-edge at said input ratio over the entire circumference thereof; and
controlling means for V-edge edging said lens-edge based on said V-edge vertex positional information.

7. A lens grinding apparatus according to claim 6, wherein said lens-edge vector radius is given from said vector radius information of a lens frame of a spectacle frame into which said lens is to be fitted.

8. A lens grinding apparatus according to claim 7, wherein said first step finds said lens-edge thickness of said lens which is uncut.

9. A lens grinding apparatus according to claim 8, wherein said vector radius locus is an locus of a cut lens-edge obtained by grinding using a template which has a pattern formed as samed as the shape of said spectacle.

10. A lens grinding apparatus according to claim 9, wherein said first step finds said lens-edge thickness of a lens-edge which is cut.

FIG. 1

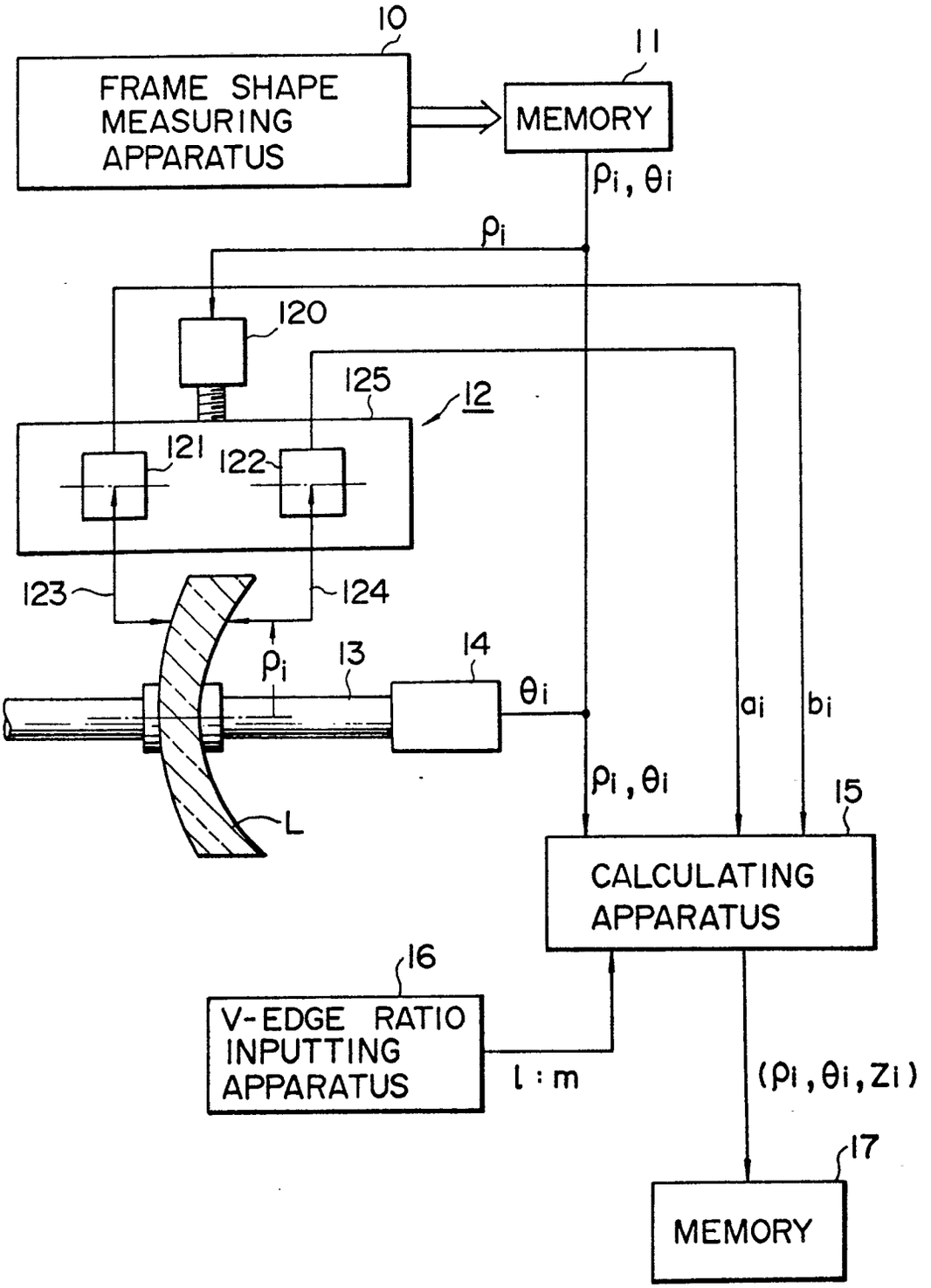
10
FRAME SHAPE MEASURING APPARATUS
11
MEMORY
ρi, θi
ρi
120
125
12
121
122
123
124
ρi
13
14
θi
ai
bi
ρi, θi
15
L
CALCULATING APPARATUS
16
V-EDGE RATIO INPUTTING APPARATUS
l : m
(ρi, θi, Zi)
17
MEMORY

FIG. 2

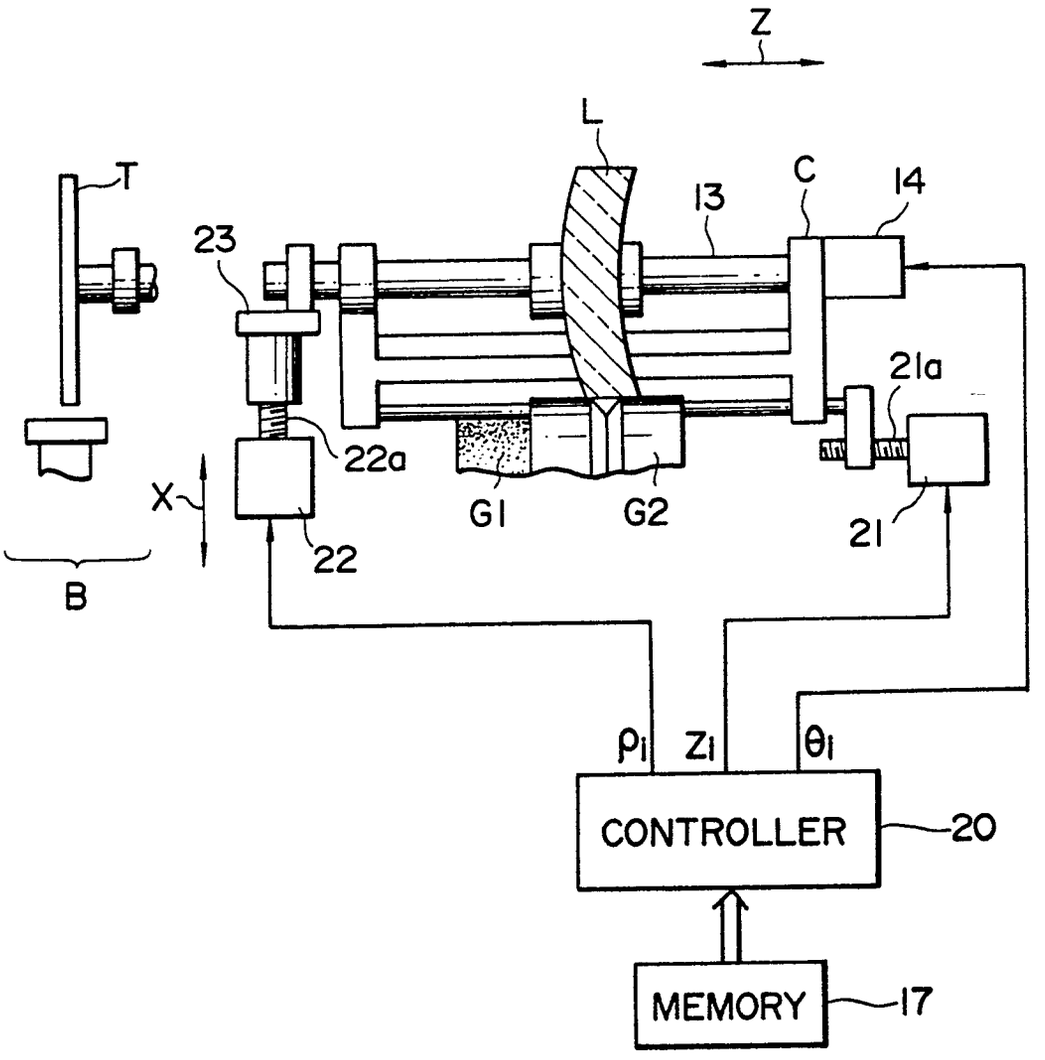
Z
L
T
23
13
C
14
21a
22a
X
G1
G2
21
22
B
ρi
Zi
θi
CONTROLLER
20
MEMORY
17

FIG. 3

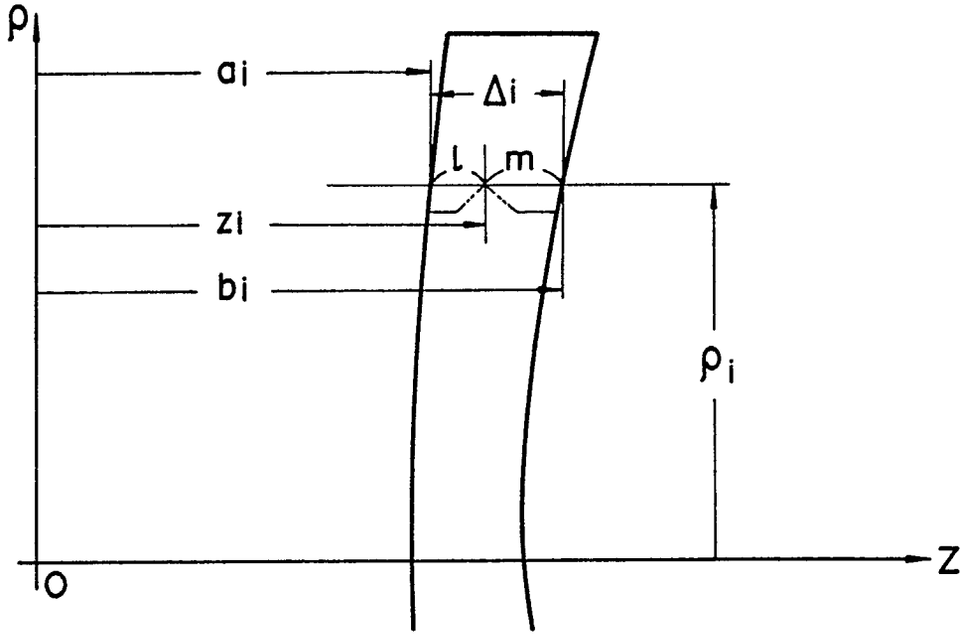

FIG. 4

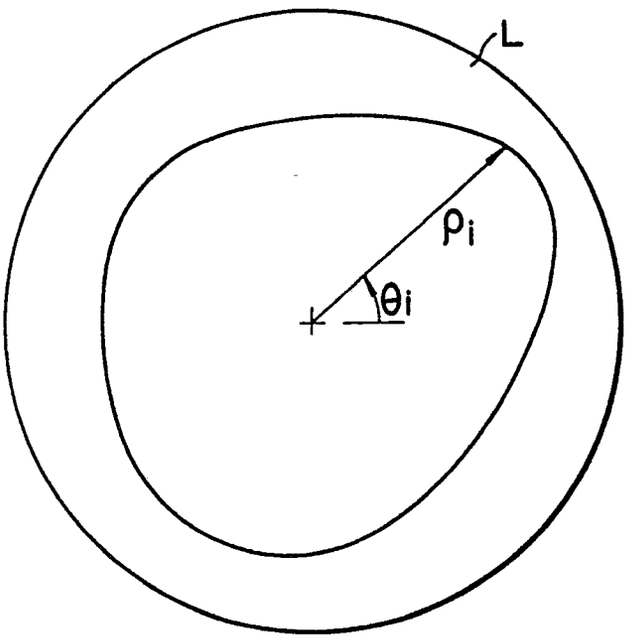

FIG. 5

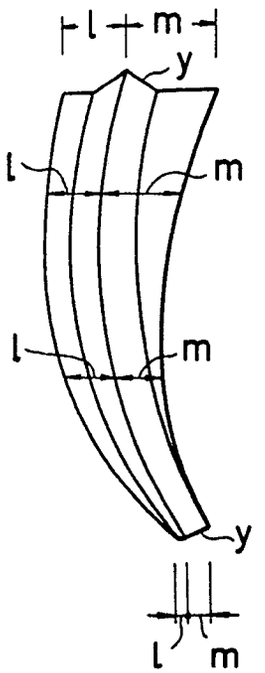
l
m
y
l
m
l
m
y
l
m

FIG. 6

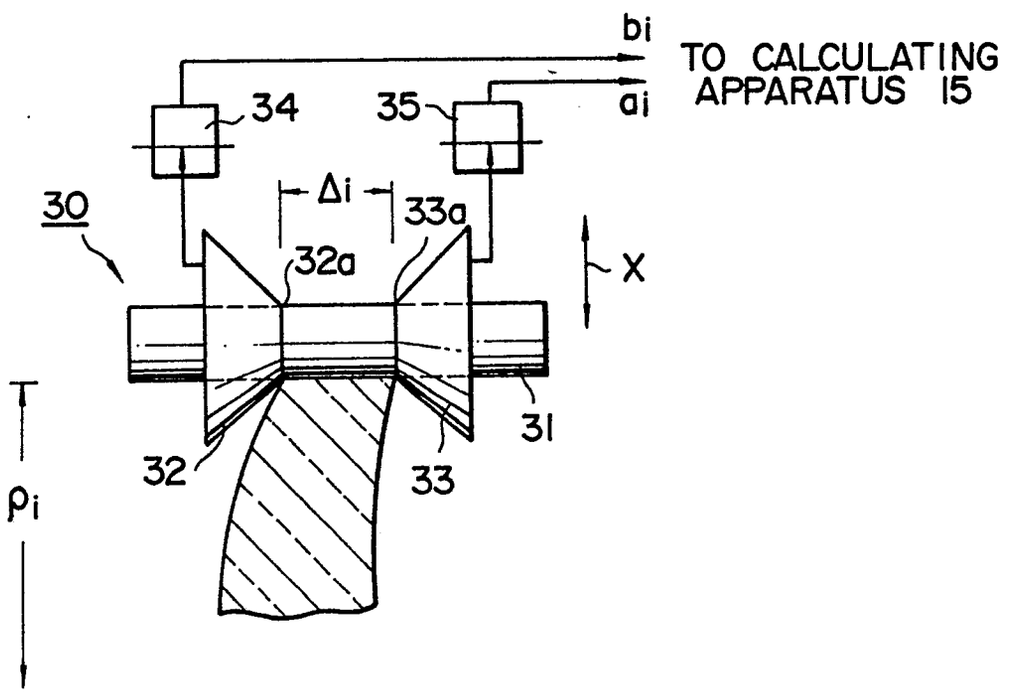
bi
TO CALCULATING APPARATUS 15
ai
34
35
Δi
33a
30
32a
X
31
32
33
ρi

FIG. 7A

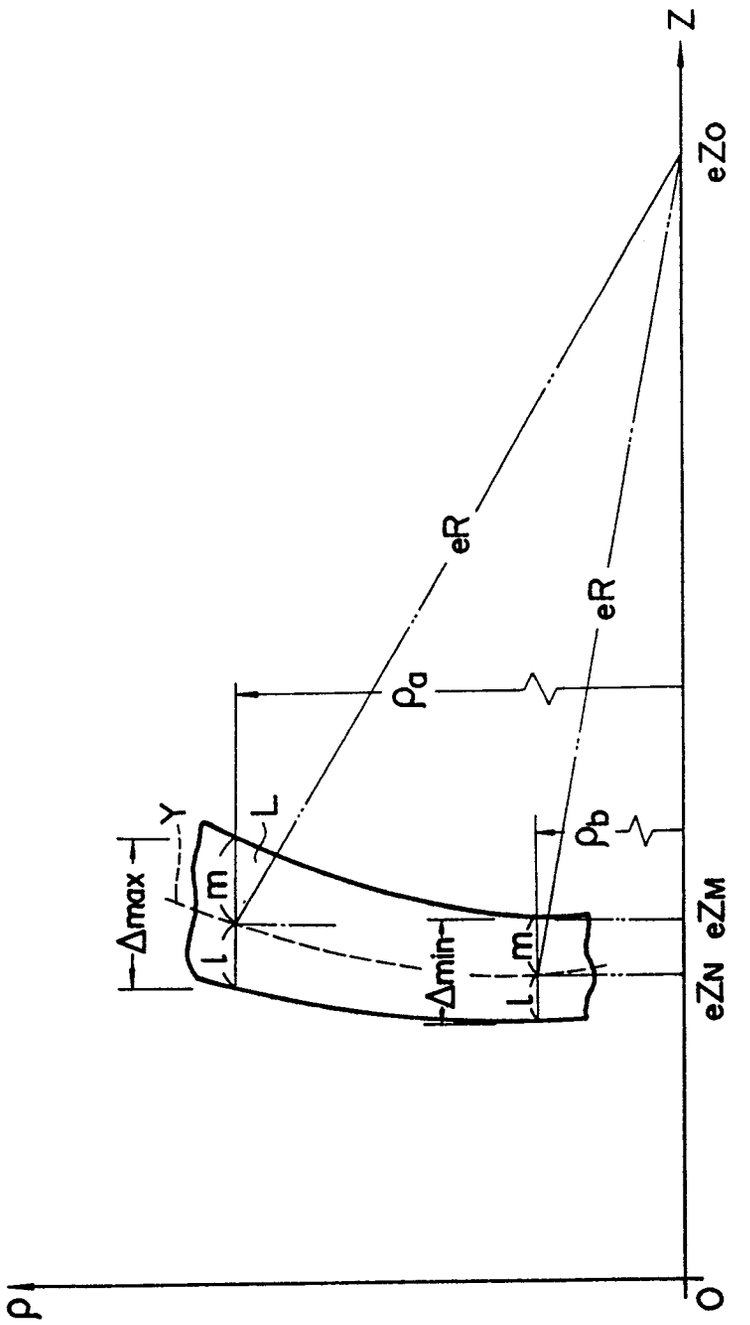

FIG. 7B

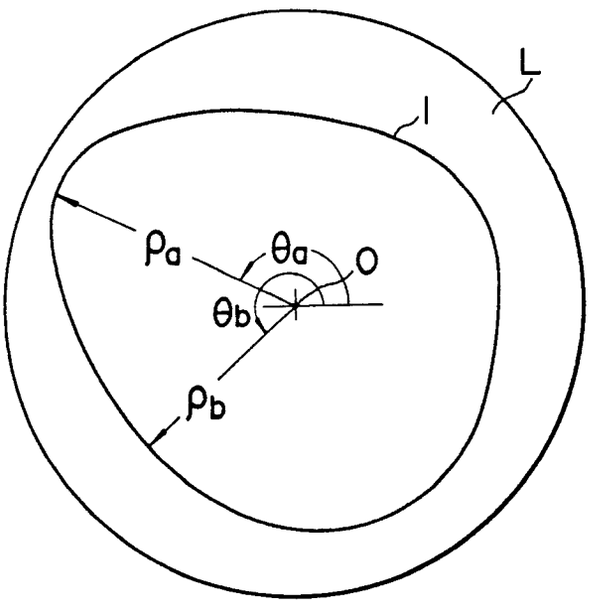

FIG. 8