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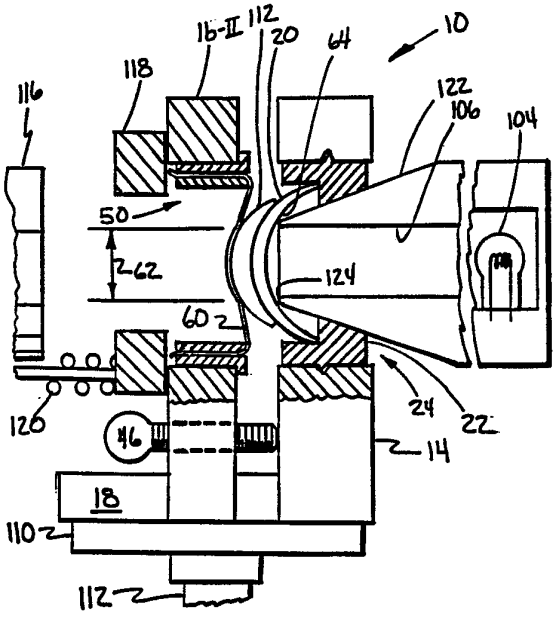
(54) Title: METHOD AND APPARATUS FOR EXAMINING AND MEASURING SOFT CONTACT LENSES

(57) Abstract

A method and apparatus (10) for examining and accurately measuring optical characteristics of soft contact lenses (12). The method has the steps of placing the soft lens (12) upon a convex rigid lens (20) and holding the soft lens (12) against the rigid lens (20) tautly with an imperforate resilient film membrane (60), with examination of the soft lens (12) being done visually through the rigid lens (20) and the membrane (60). The apparatus (10) has a convex surfaced rigid lens (20) upon which the soft lens (12) is to be placed, a resilient transparent film membrane (60) for pressing the optically used central portion of the soft lens (12) tautly against the rigid lens (20), structure (46) for adjusting and fixing the position and tautness of the membrane (60) with respect to the rigid lens (20) and a soft lens (12), and the rigid lens (20) is rotatable for determination of soft lens (12) axis. This method and apparatus (10) are usable in a conventional lensometer (100) for extremely accurate and repeatable concise examination and measurement of the optical characteristics of soft contact lenses (12) by examination of the soft lenses (12) directly through the taut membrane (60).



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METHOD AND APPARATUS FOR EXAMINING AND MEASURING SOFT CONTACT LENSES

FIELD OF THE INVENTION

This invention pertains to a method and apparatus for examining and measuring the optical characteristics of soft contact lenses.

THE PRIOR ART

Methods and apparatus for measuring the optical characteristics of eyeglass lenses and hard contact lenses have been well developed, are extremely accurate and reliable, and are well diffused and in regular use.

Soft contact lenses are an entirely different product and present entirely different problems for which there presently is no solution.

At present there exists no accurate means for the contact lens practitioner to accurately and reliably measure the power of a soft contact lens. Customarily, spectacle lenses as well as contact lenses of the hard variety are measured on an instrument called a lensometer. The nature of soft lens material prevents it's being accurately measured in this manner. When lensometer measurements are attempted on soft contact lenses, only a blurred inaccurate measurement can be taken.

Attempts to remedy this problem have been by way of "wet cell" and also by dabbing the lens somewhat dry before measuring. Wet cell measurements are carried out in a transparent, thin chamber filled with saline in which the soft lens is then placed. The lens is then measured on the

lensometer. The lens measured in such a way produces false readings and varies from one manufacturers lens to another. Computations are necessary to adjust for measurements of the lens suspended in a liquid surrounded by planar surfaces as well as the difference in indexes of refraction between air and liquid.

Attempts at lens measurement by first dabbing the lens dry are most frequently used. Unfortunately this method also results in blurred, inaccurate measurements and also exposes the lens to lint and debris and is time consuming and awkward to carry out. This method also requires manual holding of the lens, and sanitation problems for both the practictioner and lens wearer.

Soft lenses are manufactured in centralized factories and distributed far and wide. All lenses should be verified and examined when received from the manufacturer. Unlike hard lenses, soft lenses have a somewhat limited verification procedure. Base curve and peripheral curve measurements cannot be easily attained by the average lens fitter, and in this situation the fitter must trust the manufacturer.

In use, soft lenses may chip and nick or the lens may change its parameters and become steeper or flatter. An important function of the practitioner is to recheck and verify all lenses that have been worn for some time.

There is considerable error in the presently available cumbersome methods of examining soft lenses, and any results

are not specifically reliable. Soft lenses from different manufacturers vary and produce different results in identical examination techniques. It is an accepted fact that quality control of soft lenses is not up to the standards of hard lenses.

The end users of soft lenses, i.e. the using public, are for the most part, totally unaware of these problems. They, in turn, must blindly and obliviously trust both the practitioner and the manufacturer.

OBJECT OF THE INVENTION

It is an object of this invention to provide a new and improved method and apparatus for examining and determining the optical characteristics of soft contact lenses.

It is an object of this invention to provide a new and improved method and apparatus for holding soft contact lenses during examination.

It is an object of this invention to provide a greatly improved standard of quality control in the providing of soft contact lenses.

It is an object of this invention to provide a new and improved method and apparatus for measuring soft contact lenses, which provides accuracy and repeatability that are essentially the same as what is enjoyed with hard lenses.

It is an object of this invention to provide a new and improved method and apparatus for measuring soft contact lenses which is not dependant upon individual technique and idiosyncrasies.

It is an object of this invention to provide a new method and apparatus for accurately and repeatedly measuring soft contact lenses on a standard lensometer.

SUMMARY OF THE INVENTION

A method of examining soft contact lenses has the steps of providing a rigid lens having a convex surface, mounting the soft lens conformally upon the rigid lens, moving an examination structure into proximity with the soft lens, and visually examining the soft lens through the rigid lens.

A method of holding a soft contact lens for examination has the steps providing a generally hemispherical rigid lens having a convex side and a concave side, mounting the soft lens on the convex side, inserting a lensometer into the concave side of the rigid lens, illuminating the soft lens through the rigid lens, and examining the soft lens while the lensometer is inside the concave side of the rigid lens.

Apparatus for examining soft contact lenses has a holder frame, a rigid lens in the holder frame, a second frame, a slide connected to both frames and enabling the frames to move in and out with respect to each other, and examining means carried on the second frame for enabling examination of a soft lens mounted on the rigid lens.

A soft contact lens examining apparatus has a transparent film membrane, and a membrane holder for presenting the membrane tauntly against the convex surface of a soft contact lens.

A soft contact lens holder has a ring, a generally hemispherical rigid lens having a convex surface facing outward from a first side of the ring, and structure on a second side of the ring for mounting the ring and rigid lens upon a lensometer.

A method of measuring soft contact lenses has the steps of placing the soft lens upon and conformally against a convex rigid lens, holding the soft lens against the rigid lens with an elastic film membrane, placing the rigid lens and soft lens and membrane into a lensometer, pushing against a membrane holder and biasing the rigid and soft lens into a proper examination position, and maintaining a proper pressure between the membrane and soft lens by adjusting and fixing the position of the membrane with respect to the rigid lens.

Many other advantages, features and additional objects of the present invention will become manifest to those versed in the art upon making reference to the detailed description and accompanying drawings in which the preferred embodiment incorporating the principles of the present invention is set forth and shown by way of illustrative example.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a side elevational view of a soft contact lens and an examination holder for the soft lens;

FIG. 2 is the view of FIG. 1 with the soft lens mounted on the holder, with an examination viewing device;

FIG. 3 is a front elevational view taken through lines III-III of FIG. 2;

FIG. 4 is a front elevational view of the viewing device shown in FIG. 2;

FIG. 5 is a side elevational view of the structure of FIG. 1 with a further examination viewing device;

FIG. 6 is a front elevational view of FIG. 5;

FIG. 7 is a side elevational view of the structure of FIG. 5, with the viewing device in an operative position;

FIG. 8 is a side elevational view of the structure of FIG. 5 being used in a lensometer;

FIG. 9 is a cross sectional elevational view taken through lines IX-IX of FIG. 3;

FIG. 10 is a cross sectional elevational view taken through lines X-X of FIG. 6;

FIG. 11 is an enlarged cross sectional view of the structure of FIG. 8 showing the apparatus in use and showing the practice of the method of the present invention; and

FIG. 12 is an enlarged cross-sectional view of part of the apparatus in FIG. 11, with an alternative preferred structure enabling usage of the examination device upon any one of a variety of lensometers.

DESCRIPTION OF THE PREFERRED EMBODIMENT

A complete lensometer 100 is shown in FIG. 8 and within it is shown the apparatus for holding and examining a soft contact lens, hereinafter referred to as the lens tool and referred to in general by the numeral 10. The lens tool 10 is specifically for holding a soft contact lens 12, referred to hereafter as the soft lens 12.

The tool 10 as shown in FIGURES 1 - 7 includes a first frame 14, at least one and preferrably two second frames 16-I, 16-II and some type of a registering slide structure 18 enabling the frames 14, 16 to be moved toward each other and away from each other while in registry. The slide structure 18 shown is a dovetail slide with matching recesses. The first frame 14 may be fixed to the slide 18 and the second frames 16 are interchangably removable on and off of the slide 18.

A generally hemispherical transparent rigid lens 20 is mounted in the first frame 14. The rigid lens 20 is preferrably mounted in a ring 22 which is shown in detail in FIG. 9, and the rigid lens 20 and ring 22 together form a soft contact lens holder generally indicated by the numeral 24. The lens holder 24 preferrably snaps into the first frame 14 and is held in by detents 26. The lens holder 24 is preferrably selectively removable and installable. The first frame 14 is provided with a handle side 28 and an access opening or notch 30 enabling the snuggly fitted ring 22 to be turned in the first frame 14 with a finger. The ring 22 has an axis mark 32 and the first frame 14 has an axis scale 34 around the lens holder 24. The rigid lens 20 is preferrably ground glass or very hard plastic and is adhesively secured in a centering pocket 35 in the ring 22. The rigid lens 20 preferrably has an examination surface 36 formed by a constant radius convex exterior surface or side 36 facing away from the ring 22 and an interior constant radius concave surface or

side 38 facing the ring 22. The radii of each side 36, 38 of the rigid lens 20 are constant, and preferrably identical. The loci of each radii are on a common centerline or axis 40 shared with the outside diameter of the ring 22.

A specific preferred constant radii for both rigid lens surfaces 36, 38 is in the range of 8.0 to 9.0mm and a preferred diameter of the rigid lens 20 is 15mm. Specific radii are 8.4, 8.7, and 8.9mm; these radii are preferrably smaller than the radii of the concave side of the soft lens 12. Therefore the preferred spherical included angle of the rigid lens 20 is in the range of 120 to 160 degrees. The rigid lens 20 has a preferred thickness of 0.5mm at the axis 40; therefore the radii loci are spaced 0.5mm from each other. The rigid lens 20 preferrably has plano power for normal examination purposes but may be of other powers for specific other examination functions. The opposite side of the ring 22 has a mounting surface 42 for piloting and locating the rigid lens 20 to the lensometer 100. The second frame 16-I shown in FIGS. 2 and 4 has a magnifying glass 44 and an adjustment screw 46 for precise location of the magnifying glass 44 from the rigid lens 20.

The structure thus far described operates and is used as follows. The soft lens 12 is placed upon the rigid lens 20. If the soft lens 12 has astigmatic correction, there will be a hash mark 48 at relative zero on the soft lens 12. The second frame 16-I and magnifying glass 44 are brought into focus and used to find the soft lens hash mark 48. The hash mark 48 is then aligned with the axis mark 32 to zero out the

soft lens 12 in the lens holder 24, and the lens holder 24 and soft lens 12 can then be co-rotated as a unit to a known predetermined axis, or for determination of the axis of the soft lens 12, by using the axis scale 34 during examintion. The ring 22 is preferrably clear and transparent to enhance orientation of the hash mark 48.

The second frame 16-I and magnifying glass 44 are then removed and the other second frame 16-II as shown in FIGS. 5 and 6 is placed upon the slide structure 18 as is shown in FIG. 7.

This second frame 16-II has a soft lens examining structure which is generally indicated by the numeral 50 and which will hereinafter be referred to as the membrane cartridge 50. The cartridge 50 is best shown in FIG. 10 and is an important feature of this invention. The cartridge 50 has an outer ring 52 with an annular outer flange 54 and outer detents 56, and an inner ring 58 which is pressed into the outer ring 52. An imperforate film membrane 60 is held between the inner ring 58 and outer ring 52 and is preferrably held taunt and flat within the cartridge 50. The film membrane 60 is preferrably transparent, clear, of constant thickness and is resiliently elastic in all directions. The film membrane 60 is preferrably a thermoplastic film of a material such as SARAN (trademark of DuPont) and has a thickness in the range of .0005 to .005 inch. The membrane 60 end of the cartridge 50 faces toward the rigid lens 20. The diameter of the membrane 60 is preferrably at least equal to

the diameter of the rigid lens 20, and the outer diameters of the rings 22, 52, are preferrably identical to enable the future use of essentially identical frames 14, 16-I, 16-II. The membrane cartridge 50 is a snap fit in the second frame 16-II and is relatively easily replacable in the event of damage to a membrane 60, or for changing to a different membrane 60. The second frame 16-II with the membrane cartridge 50 also has an adjustable position screw or device 46 to be used as will be explained.

The lensometer 100 as seen in FIG. 8 has a chassis 102, an illumination light 104, an illumination aperture 106, an axis adjustor 108, a lens platform 110, a platform elevator 112, a magnification adjustor 114, and a focal piece 116. The lensometer 100 also has a pressure pad 118 and a pressure spring 120 for biasing the lens tool 10. The outer end of illumination aperture 106 has a nipple 122 and a lens stop surface 124 shorn in FIG. 11 & 12. All of the hardware in and on the lensometer 100 is standard commonly available and used material, other than the new lens tool 10 which is the subject of this invention.

The operation and use of the lens tool 10 and the practice of the method of the present invention are best explained with reference to FIG. 11. The soft lens 12 is placed upon the examination surface 36 of the rigid lens 20 with the concave posterior surface of the soft lens 12 being essentially in complete conformal contact with the rigid lens 20. The radius of the convex surface 36 is preferrably larger

than the radius of the posterior surface of the soft contact lens 12. The second frame 16-II and membrane 60 are then brought into position with the membrane 60 being tauntly pushed against the convex anterior surface of the soft lens 12 to produce a central diametric contact area 62 between the soft lens 12 and the membrane 60 having a diameter in the range of 7 to 10mm. When the membrane 60 first contacts the soft lens 12, the membrane 60 contacts the very center of the softlens 12. As cotact is increased and the contact area 62 is increased in size, all liquid is squeezed from the center outward between the soft lens 12, the rigid lens 20 and the membrane 60. The membrane 60 is pushed forward toward the rigid lens 20 until the adjustment device 46 makes contact. The adjustment device 46 may then be manipulated to move the membrane 60 in or out to enlarge or reduce the examination contact area 62 to attain an optimal contact area 62 for the particuar soft lens 12 being examined. The tool 10 loaded with the soft lens 12 is then placed into the lensometer 100 as best shown in FIGS. 8 & 10 and the mounting surface 42 is placed upon the nipple 122 of the illumination aperture 106 as best shown in FIG. 11. The mounting surface 42 is sized and shaped so that the aperture 106, nipple 122 and stop 124 project through the ring 22 and into the concave side 38 of the rigid lens 20, and to provide a zero or very small minimumal clearance 64 which results in the soft lens 12 being placed as close as is possible to the nipple 122 and stop 124 and therefore minimize the vertex distance to enable the most

accurate measurement. The platform 110 and elevator 112 may be used to raise or lower the lens tool 10. The spring loaded pressure pad 118 is then brought to bear against the second frame 16-II to bias membrane 60 toward and against the soft lens 12 and the rigid lens 20. However, the biasing force of the pressure pad 118 and spring 120 is taken by the adjustment device 46 and not by the membrane 60 and soft lens 12. The adjustment device 46 can again be used to adjust the relative position of the membrane 60 and the diameter of the contact area 62. The light 104 is turned on and a light beam is focused through the rigid lens 20, the soft lens 12 and the contact area of the membrane 60 for visual examination at the focal piece 116. By conventional manipulation of the lensometer 100, extremely accurate and reliable examination and measurement of the optical characteristics of any soft lens 12 can now be made. There is no distortion of the soft lens 12 and there is no "fuzziness" in the examination images. The soft lens 12 is being handled very gently and there is little or no risk of damage. This examination is extremely sterile and clean and there is no necessity for the soft lens 12 to be touched by the practitioner. Toric measurements of astigmatic correcting soft lens 12 are now easily and accurately determined with the method and lens tool 10 infthe lensometer 100.

The adjustment and stop mechanism 46 is an important feature when replacing the membrane 60, for measuring thicker or thinner soft lens 12, and for attainment of the preferred

contact area 62 size which is at least equal to the diameter of the lensometer aperture 106.

It is anticipated that the membrane cartridge 50 will be an irreversibly assembled cartridge 50, and if and when the membrane 60 is damaged, complete replacement of the cartridge 50 will be done.

The small compact size of this lens tool 10 is extremely important. The lens tool 10 is about 0.6 inch (15mm) thick and easily fits within a standard lensometer 100 without modification of the lensometer 100. This lens tool 10 and new method also enable the further and extended use of the very high quality and expensive lensometers 100 now presently in use, and a major investment in new equipment and training is not needed. The benefits in improved accuracy, reliability, cleanliness and speed, provide great value for this new method and apparatus of measuring soft contact lenses 12 both to the practitioner and the wearer of soft lenses 12.

FIG. 12 shows an alternative and optional preferred lens holder 24A. There are many different brands of lensometers 100, and these brands offer different models. These various lensometers 100 have many different geometrics of structure at the examining aperture 16, nipple 122 and lens stop surface 124. It is desirable to have a single lens holder 24A that will successfully mount to most and if possible all of the variety of lensometers in use. To this end, the optional lens holder 34A has a ring 22A with an adaptor mounting surface 42A. This alternative adaptor

surface 42A is resilient and may be embodied in an elastomeric or thermoplastic elastomer (TPE) adaptor 68 which is appropriately secured to the ring 22A. The illustrated adaptor 68 is grommeted to the ring 22A and may easily be removed and re-installed to enhance cleaning of the lens stop surface 38 of the rigid lens 20. With this adaptor 68 and resilient surface 42A, the rigid lens 20 can be centered on most any geometry of lensometer nipple 122 and the rigid lens 20 can now be brought into actual contact with the lens stop surface 124 to minimize the clearance gap 64 at zero.

Although other advantages will almost certainly be found and realized and various modifications to my preferred method and apparatus will be suggested by those versed and knowledgeable in the art, be it understood that I embody within the scope of the patent warranted hereon and that I do claim, all such modifications embodiments as reasonably and properly come within the scope of my contribution to the art.

I CLAIM AS MY INVENTION;

1. A method of examining a soft contact lens comprising the steps of

   a) providing a rigid lens having an examination surface;

   b) mounting a first side of the soft lens comformally upon and in contact with the examination surface of the rigid lens;

   c) moving an imperforate flexible transparent film membrane examination structure into physical contact with a second side of the soft lens; and

   d) visually examining the soft lens through the rigid lens and through the membrane.

2. Apparatus for examining a soft contact lens, comprising

   a) a holder frame;

   b) a rigid lens secured to said frame, said rigid lens having an examination surface for accepting the soft contact lens thereon;

   c) a second frame;

   d) a slide operatively connected to both frames, said slide enabling sliding of the frames nearer toward and further from each other; and

e) an imperforate transparent membrane means carried on said second frame for enabling examination and quantification of said soft lens through said membrane means, when said soft lens is pushed against said rigid lens by said membrane means.

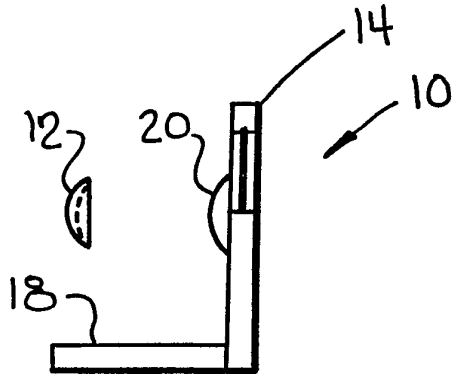


FIG.1

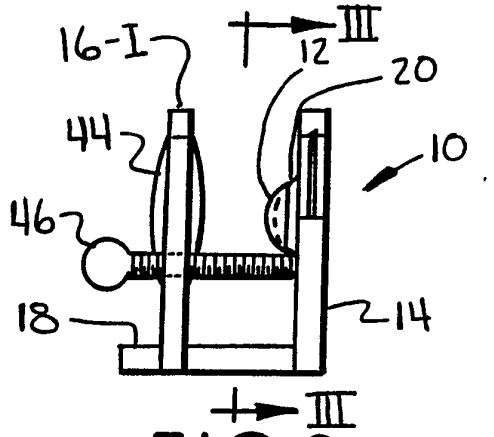


FIG.2

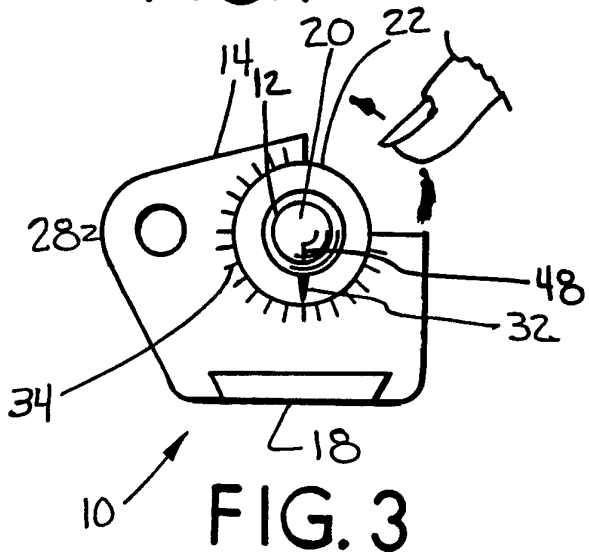


FIG.3

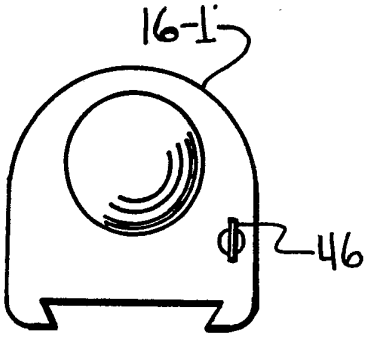


FIG.4

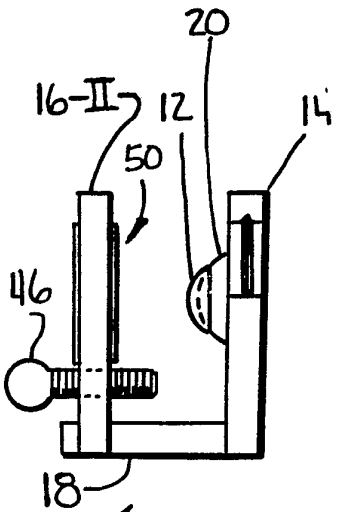


FIG.5

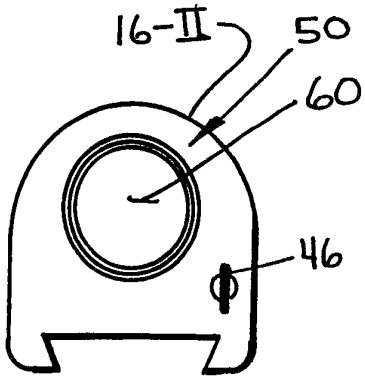


FIG.6

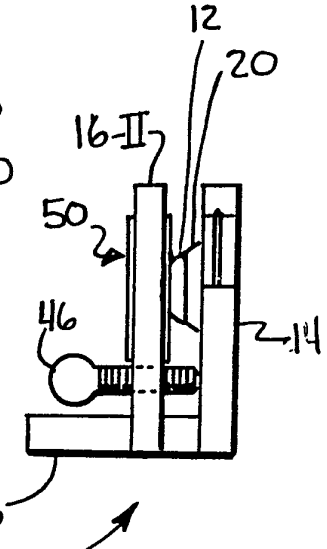


FIG.7

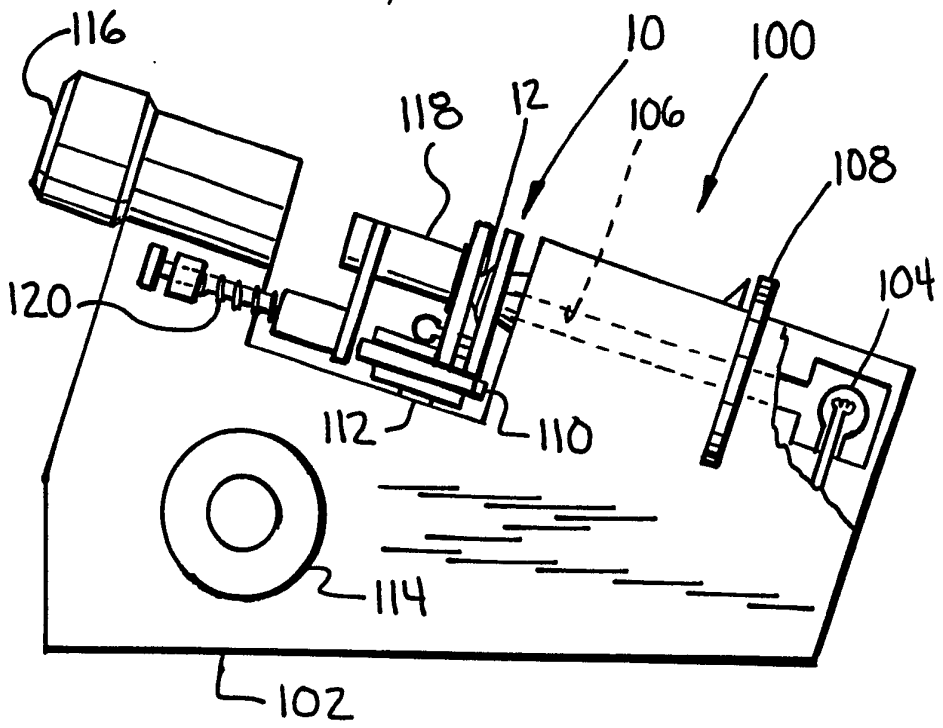


FIG.8

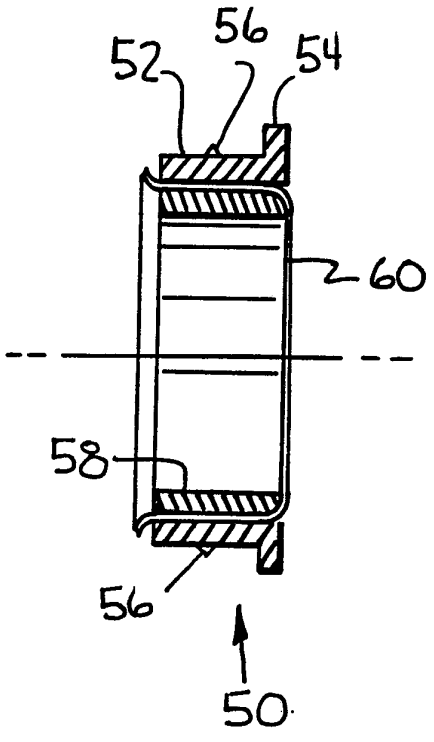


FIG.10

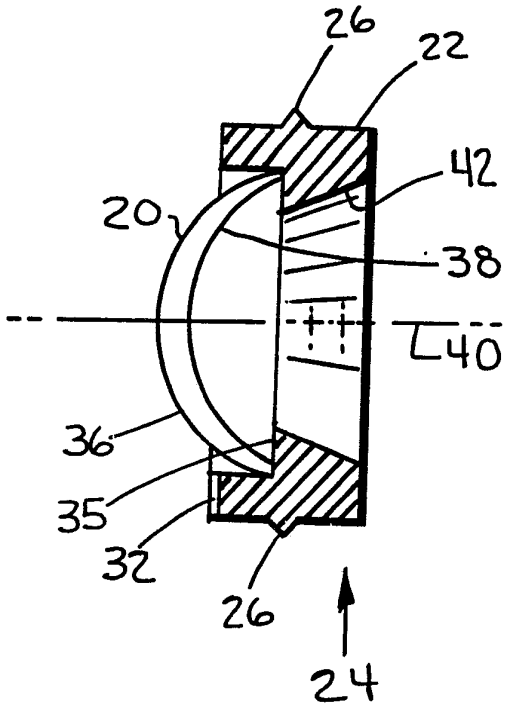
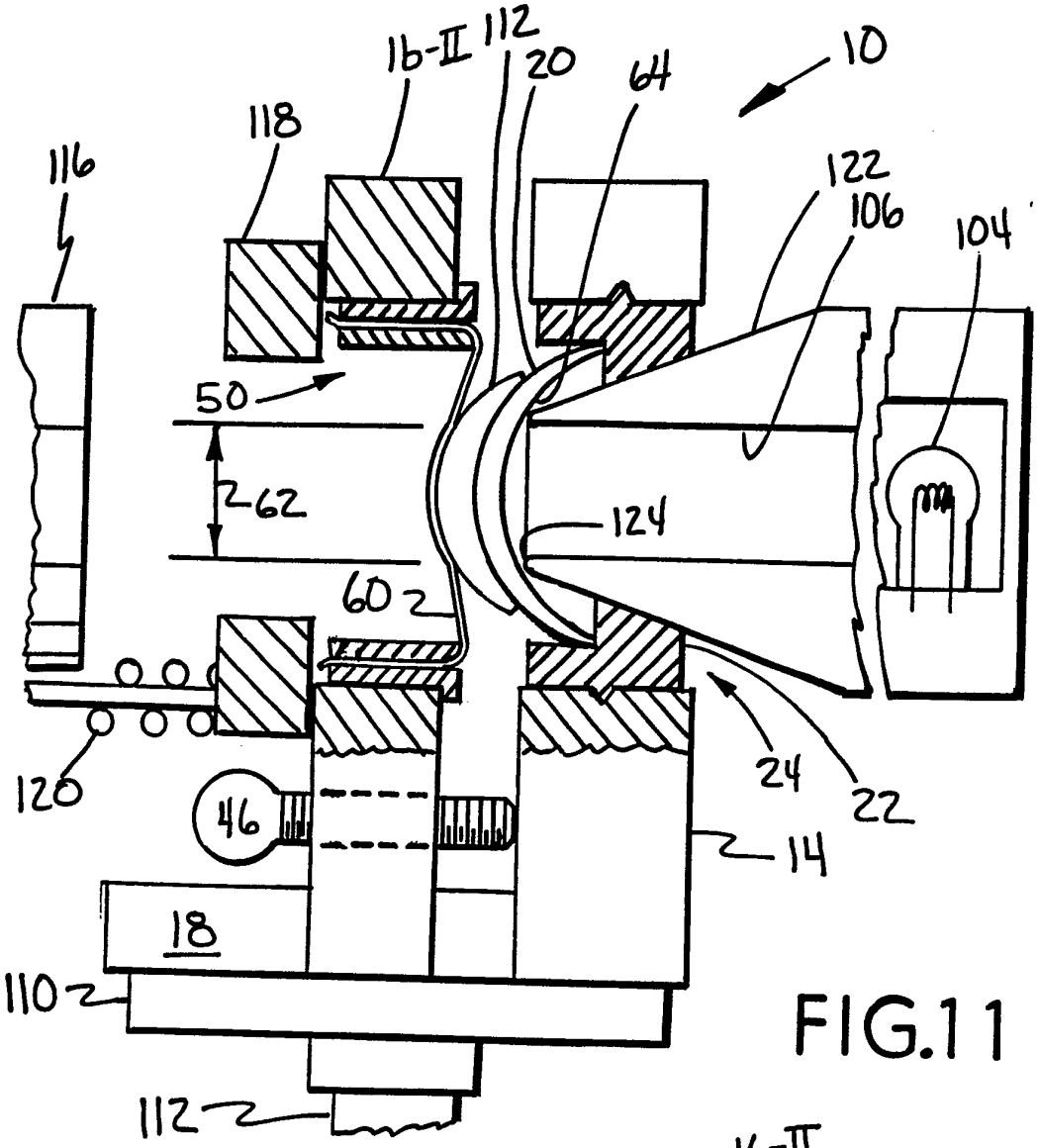


FIG.9


16-II
112
20
64
10
118
116
122
106
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62
124
60
120
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24
22
14
18
110
112

FIG.11

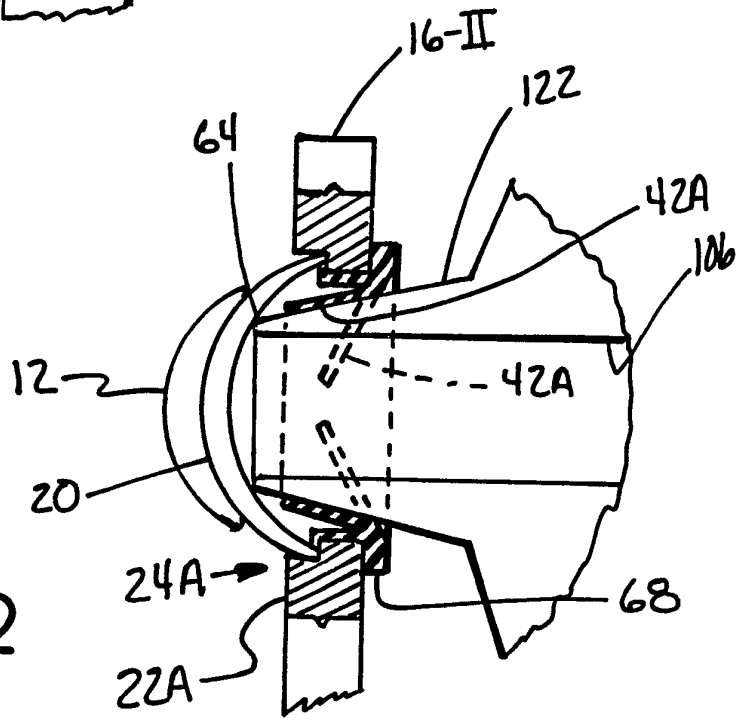
16-II
122
64
42A
106
12
42A
20
24A
68
22A

FIG.12

INTERNATIONAL SEARCH REPORT

International Application No PCT/US90/02901

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) [3]

According to International Patent Classification (IPC) or to both National Classification and IPC

IPC(5) G01B 9/00; G02C 7/04; G01N 21/01
US CL. 356/124; 356/125; 356/244; 351/162

II. FIELDS SEARCHED

Minimum Documentation Searched [4]

Classification System [5]	Classification Symbols
U.S.	356/124, 125, 126, 127, 244, 246, 351/162

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched [6]

III. DOCUMENTS CONSIDERED TO BE RELEVANT [14]

Category * [15]	Citation of Document, [16] with indication, where appropriate, of the relevant passages [17]	Relevant to Claim No. [18]
Y	US, A 4,395,120 TAKAHASHI 26 July 1983 Columns 2,11-13; figures 6,7	1,2
A	US, A 4,496,243 MACHIDA 29 January 1985 Figures 2; column 3.	1,2

* Special categories of cited documents: [15]

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"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

IV. CERTIFICATION

Date of the Actual Completion of the International Search [2]	Date of Mailing of this International Search Report [2]
06 AUGUST 1990	19 SEP 1990
International Searching Authority [1]	**Signature of Authorized Officer [11]**
ISA/US	for HOA PHAM Ngoc Ho Nguyen NGUYEN NGOC-HO INTERNATIONAL DIVISION

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