



US006201640B1

(12) **United States Patent**
Caplan et al.

(10) **Patent No.:** **US 6,201,640 B1**
(45) **Date of Patent:** **Mar. 13, 2001**

(54) **MAGNIFICATION VIEWER**

(75) Inventors: **Charles Howard Caplan**, Middleton, WI (US); **Richard Alfred Buchroeder**, Tucson, AZ (US); **Frederick Nicholas Bushroe**, Tucson, AZ (US); **Anthony Ralph Ford**, Tucson, AZ (US)

(73) Assignee: **Surgical Acuity, Inc**

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

1,507,111	*	9/1924	Erfle	359/744
1,688,113	*	10/1928	Bornkessel	359/815
2,456,521	*	12/1948	Maxwell	359/431
2,550,962	*	5/1951	Brandon	359/425
2,986,969	*	6/1961	Muncheryan	359/480
3,273,456	*	9/1966	Feinbloom	351/158
3,865,468	*	2/1975	Holcomb	359/815
3,877,793	*	4/1975	Nakagawa	359/701
4,273,423	*	6/1981	Uesugi	359/701
5,076,682	*	12/1991	Pasfield	351/158
5,088,809	*	2/1992	Portney	351/158
5,627,690	*	5/1997	Caplan et al.	359/744
5,680,195	*	10/1997	Pekar et al.	359/407

FOREIGN PATENT DOCUMENTS

1645925	*	4/1991	(RU)	359/407
---------	---	--------	------------	---------

* cited by examiner

Primary Examiner—Thong Nguyen

(74) *Attorney, Agent, or Firm*—Sheridan Ross P.C.

(57) **ABSTRACT**

A housing for a magnification loupe is provided having a body portion for an eyepiece lens and a nose portion for an objective lens. The body portion for the eyepiece lens includes outer circumferential threads over which the objective nose portion fits. The objective nose portion includes a pin slot defining an arc across the body of the nose. The arc is configured such that a pin may be secured through the holes in the nose piece to co-act with the threads of the eyepiece body such that radial movement is prohibited.

(21) Appl. No.: **09/062,936**

(22) Filed: **Apr. 20, 1998**

Related U.S. Application Data

(60) Provisional application No. 60/069,496, filed on Dec. 15, 1997.

(51) **Int. Cl.**⁷ **G02B 23/00**; G02B 27/02

(52) **U.S. Cl.** **359/418**; 359/362; 359/480; 351/158

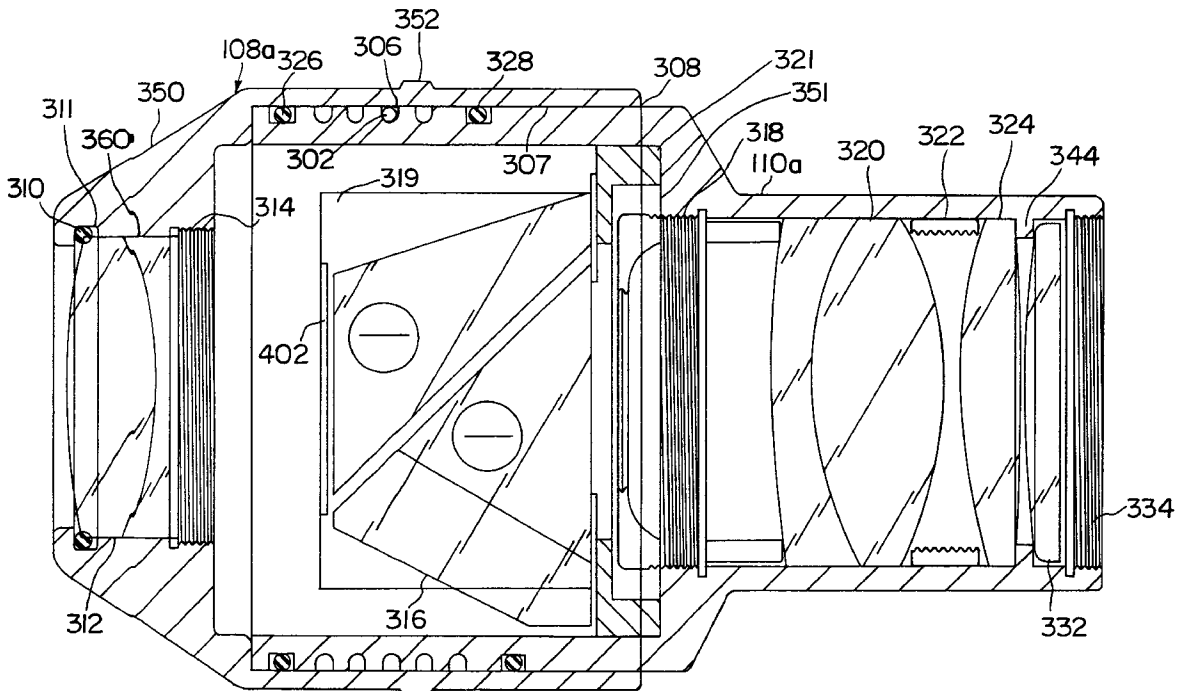
(58) **Field of Search** 359/362, 399, 359/407, 425-429, 432, 811, 816, 900, 744, 645, 694-700; 351/158, 41-45

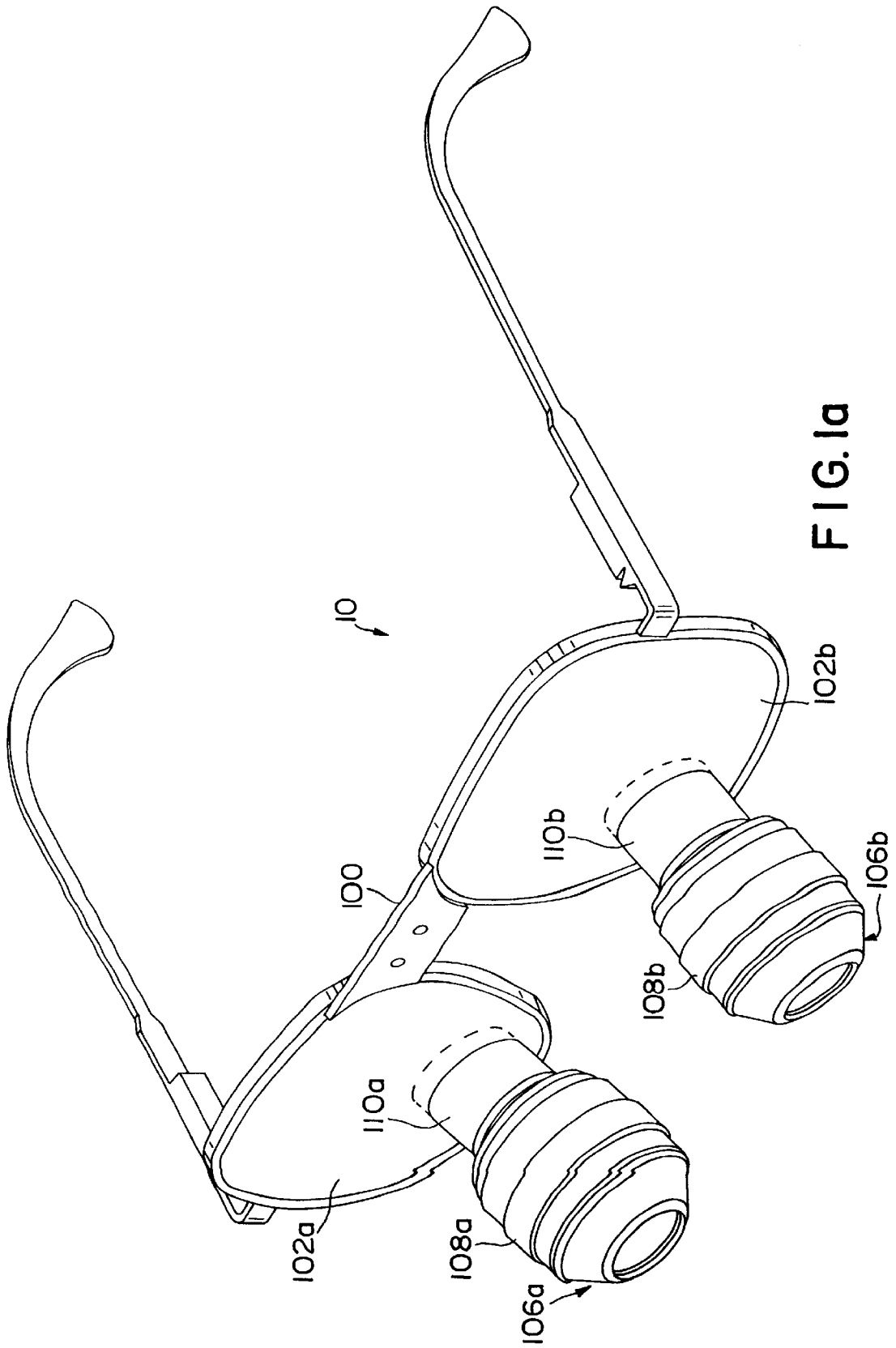
(56) **References Cited**

U.S. PATENT DOCUMENTS

1,159,233	*	11/1915	Konig	359/645
-----------	---	---------	-------------	---------

5 Claims, 17 Drawing Sheets





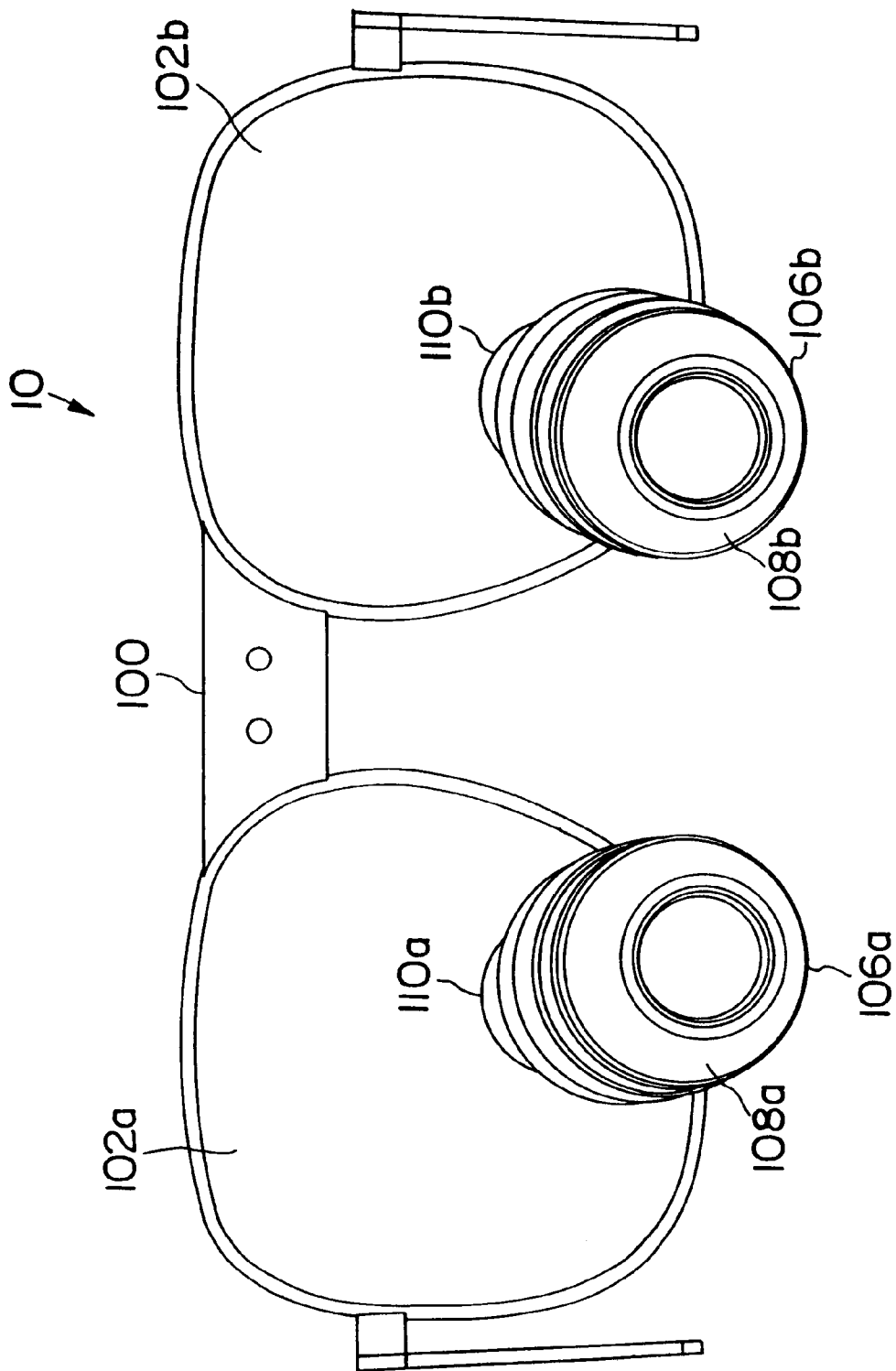


FIG. 1b

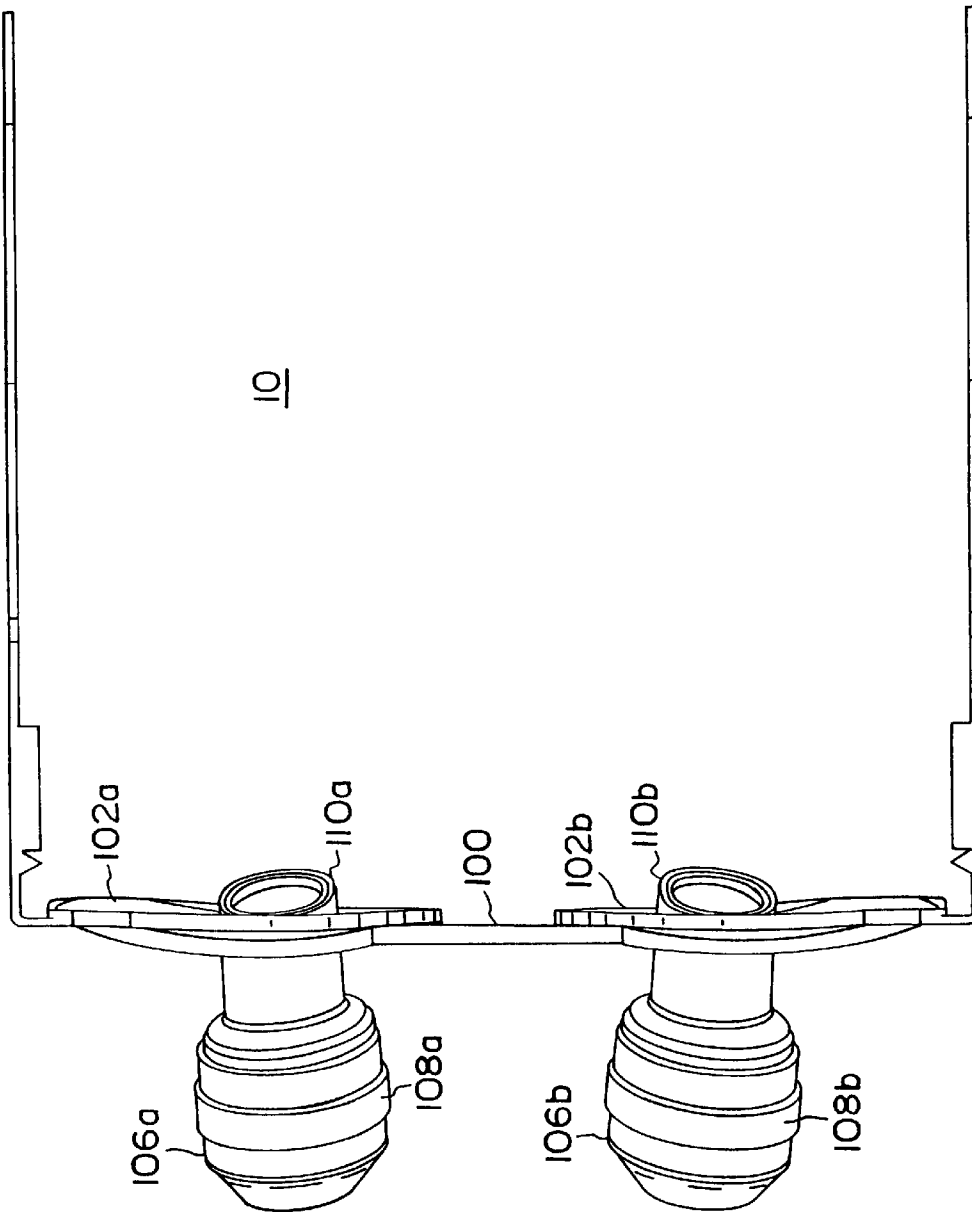


FIG. 1c

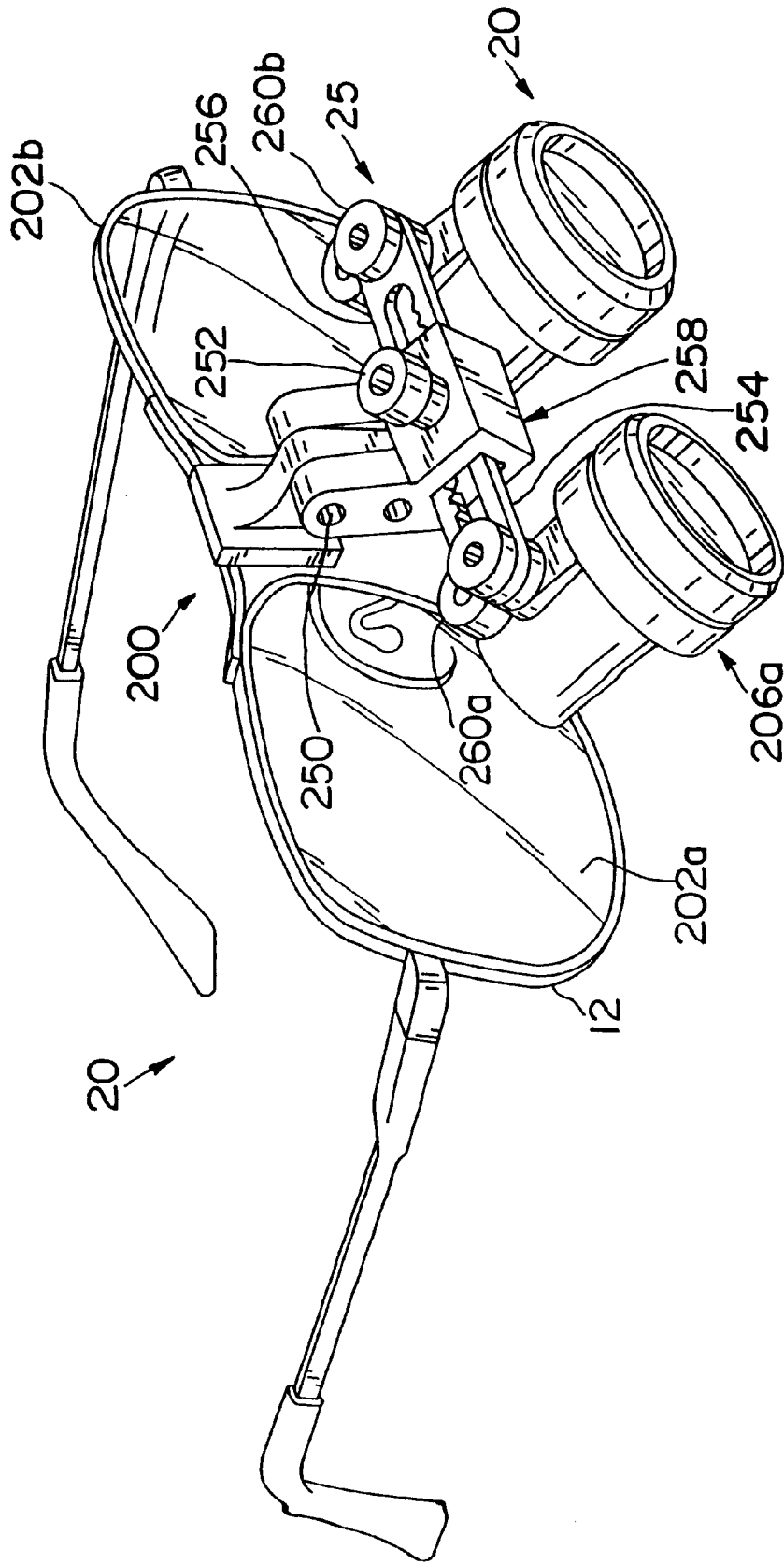


FIG. 2

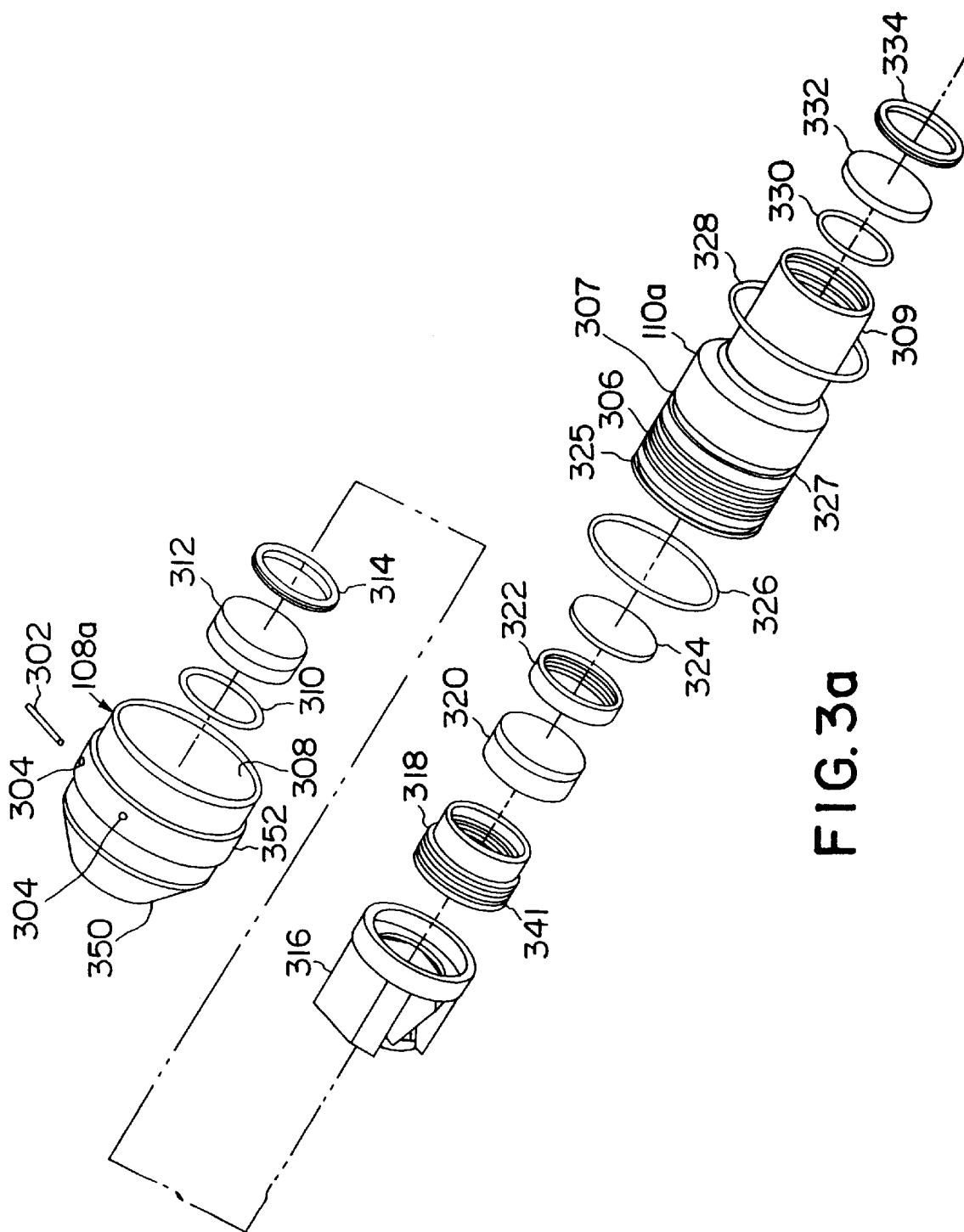


FIG. 3a

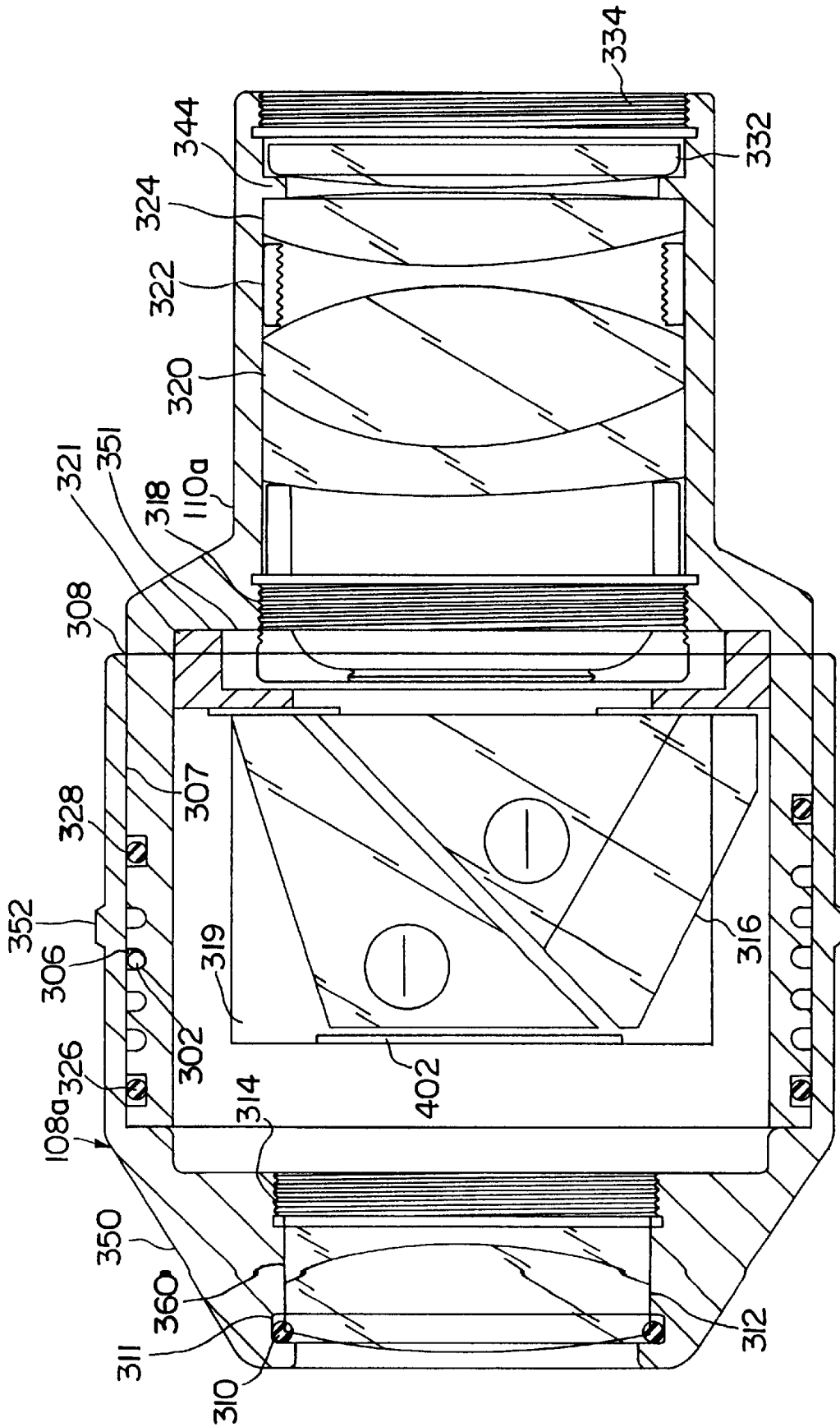


FIG. 3b

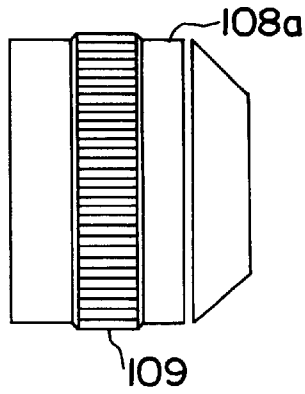


FIG. 4

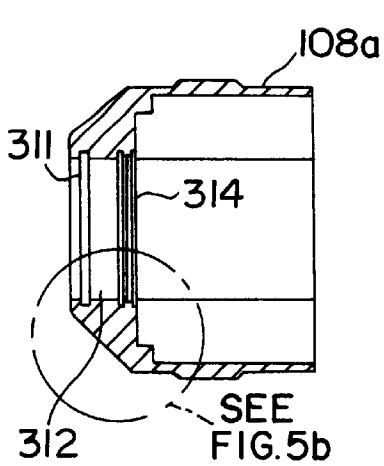


FIG. 5a

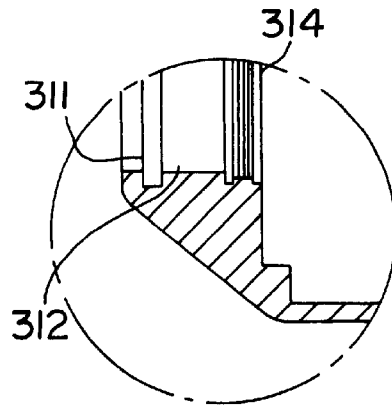


FIG. 5b

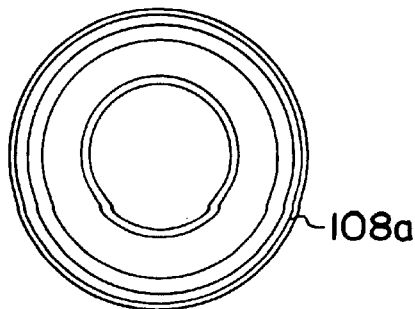


FIG. 6

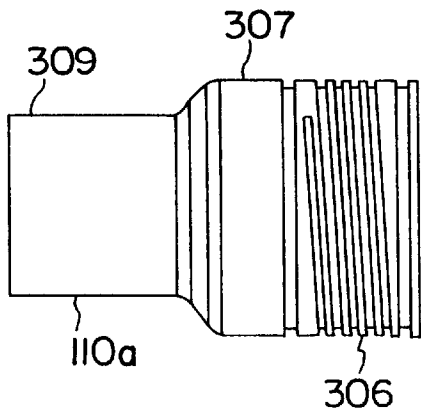


FIG. 7

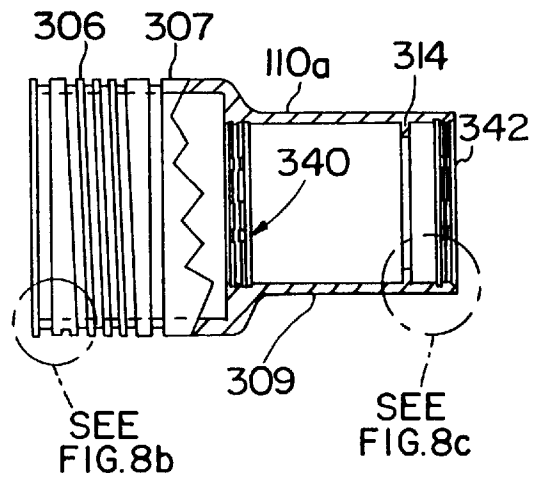


FIG. 8a

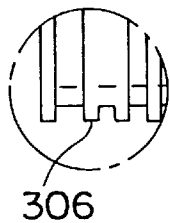


FIG. 8b

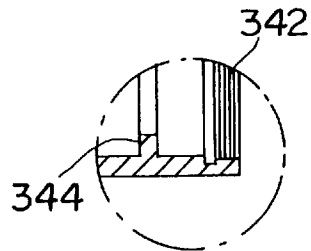


FIG. 8c

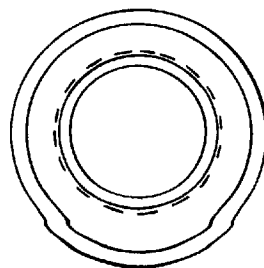


FIG. 9

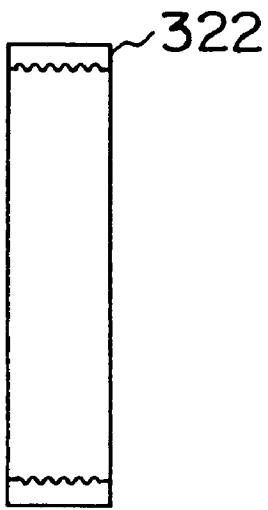


FIG. 10

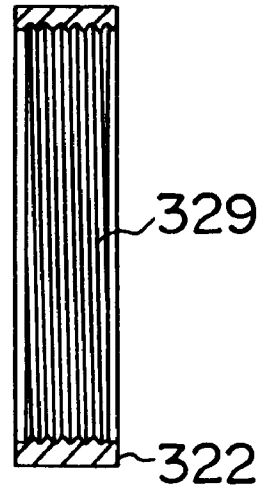


FIG. 11

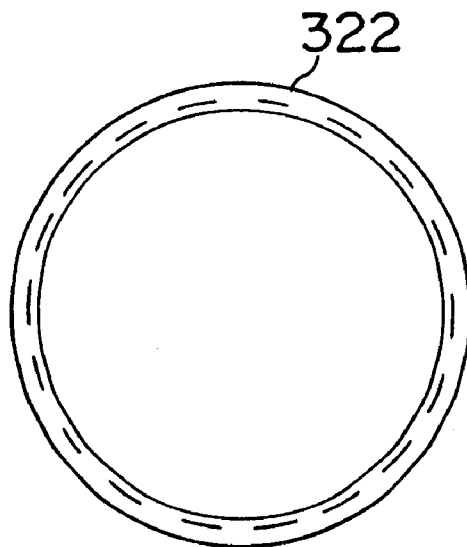


FIG. 12

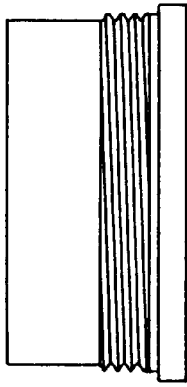


FIG. 13

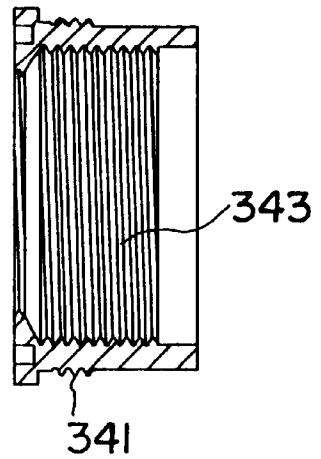


FIG. 14

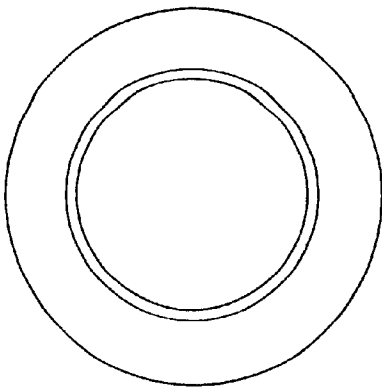


FIG. 15



FIG. 16



FIG. 17

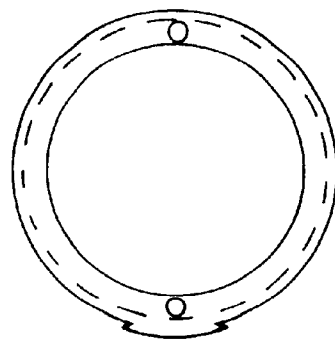


FIG. 18

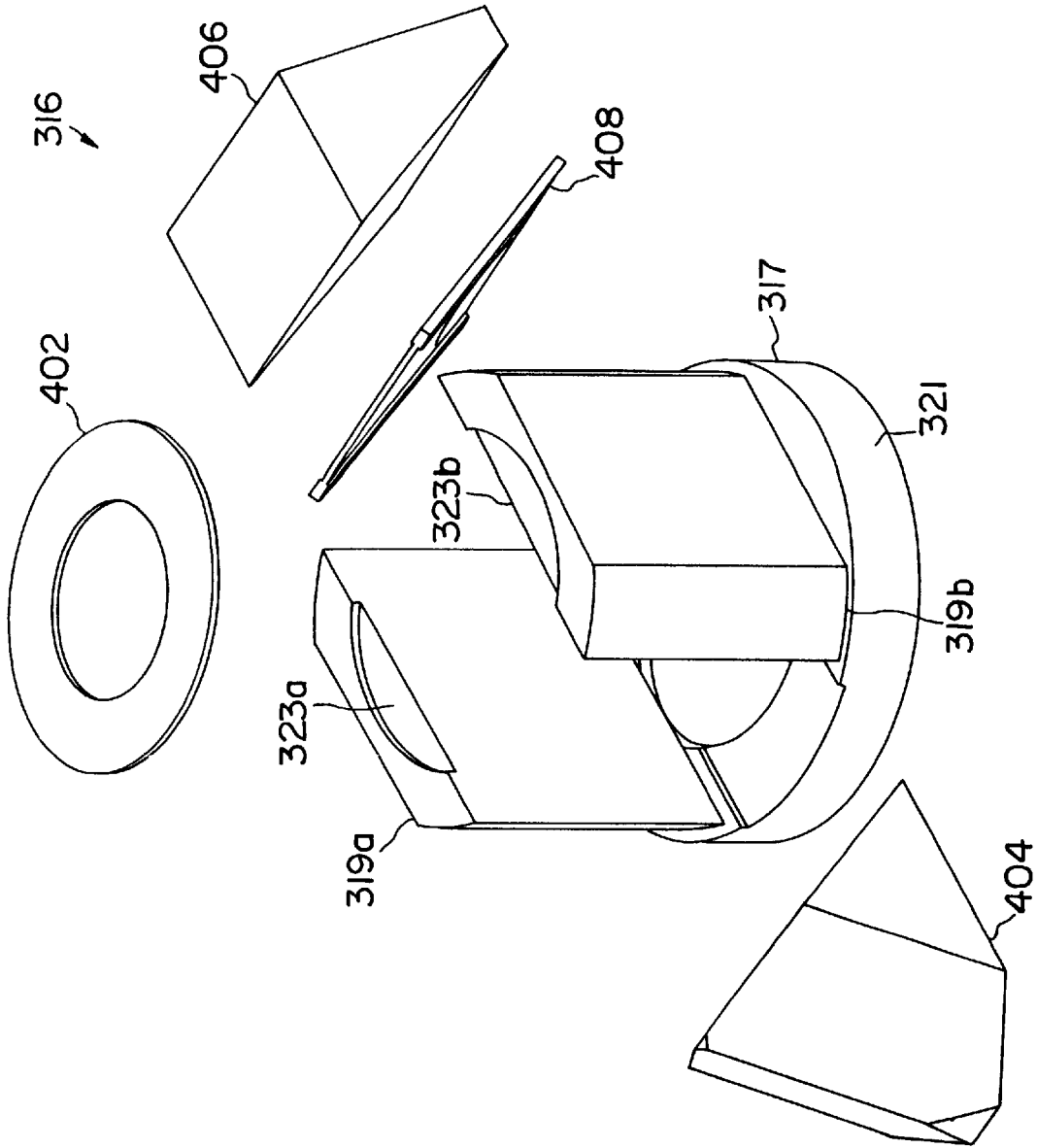


FIG. 19a

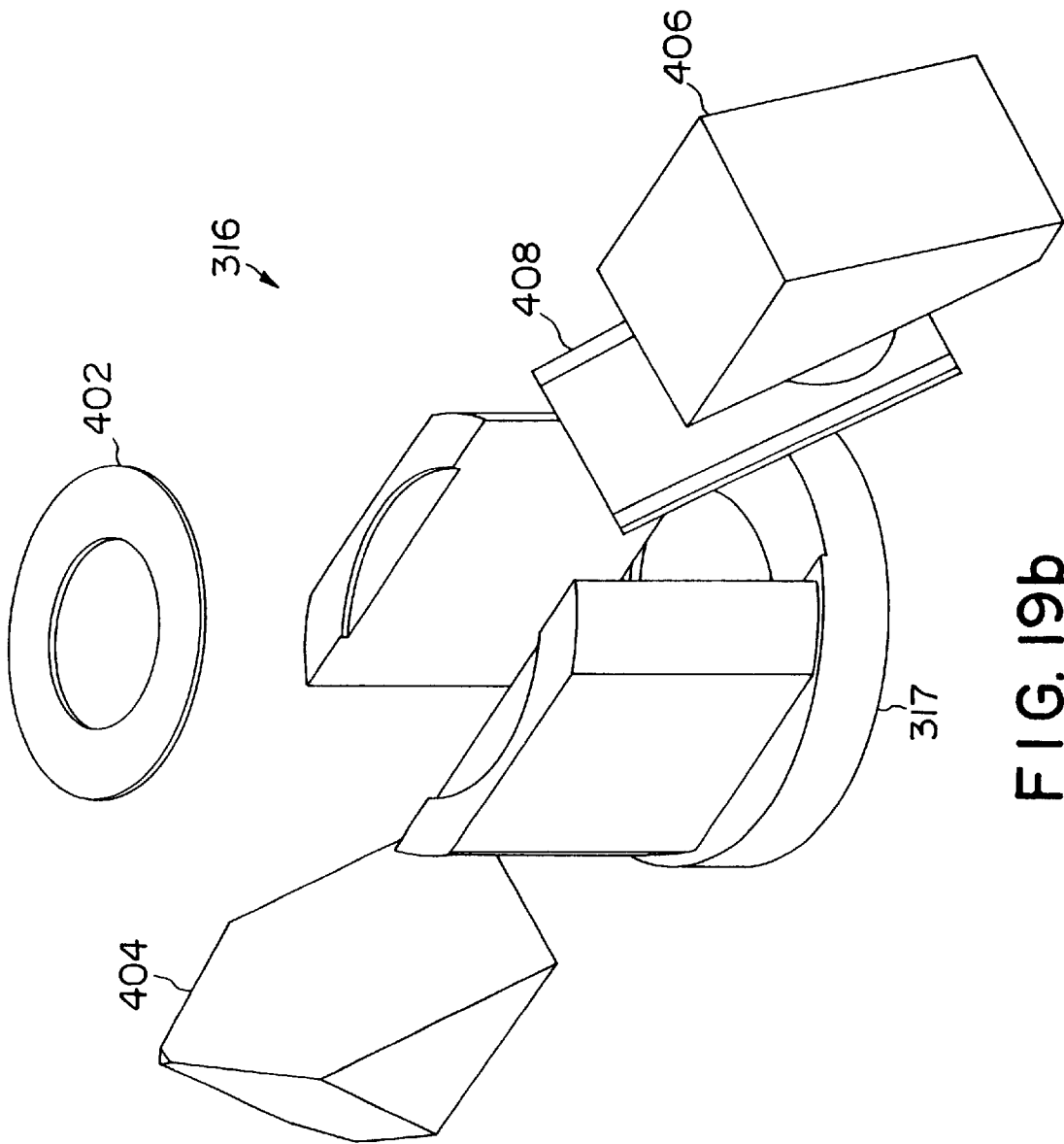


FIG. 19b

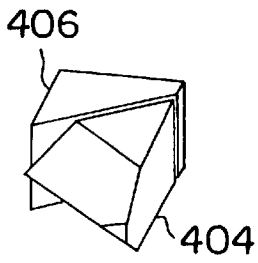


FIG. 20a

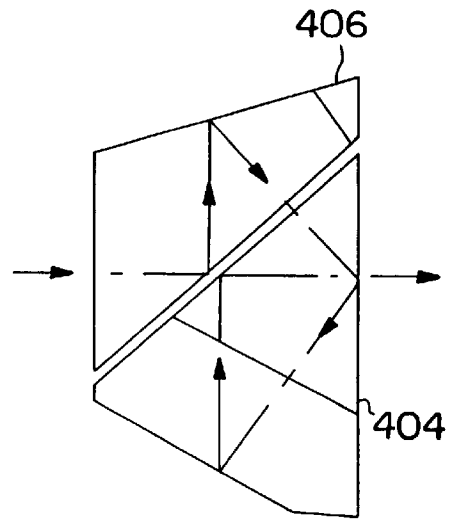


FIG. 20b

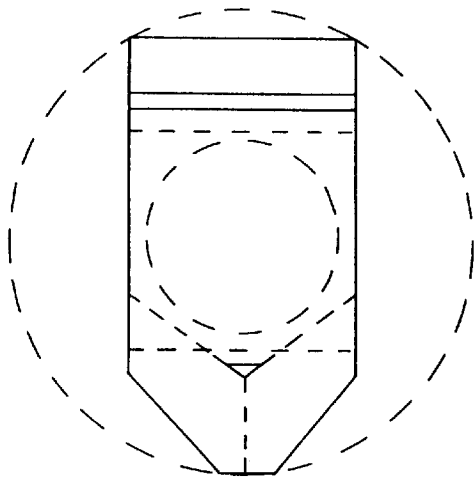


FIG. 21

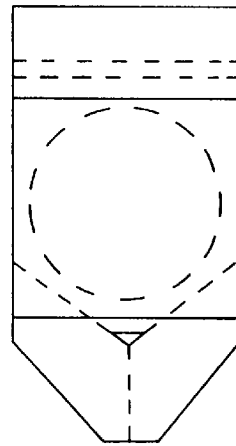


FIG. 22

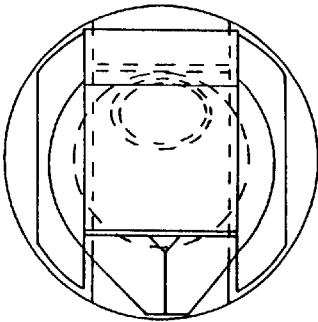


FIG. 23

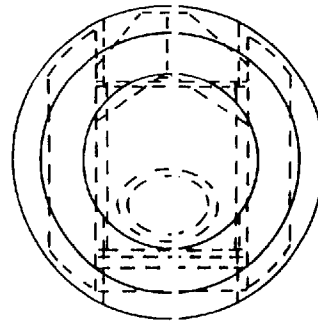


FIG. 24

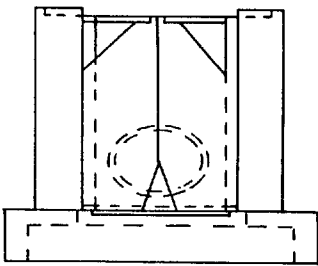


FIG. 25

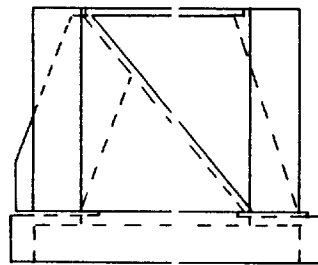


FIG. 26

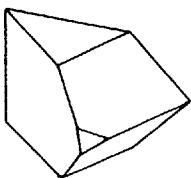


FIG. 27

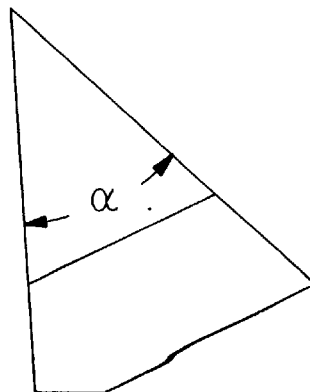


FIG. 28

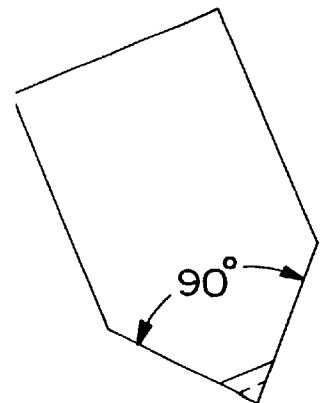


FIG. 29

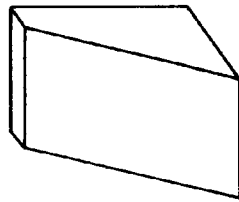


FIG. 30

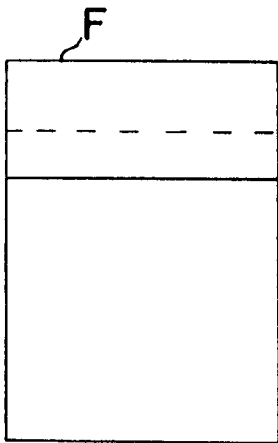


FIG. 31

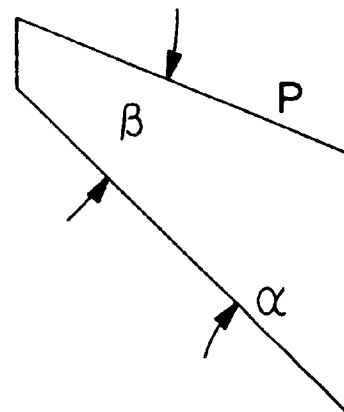


FIG. 32

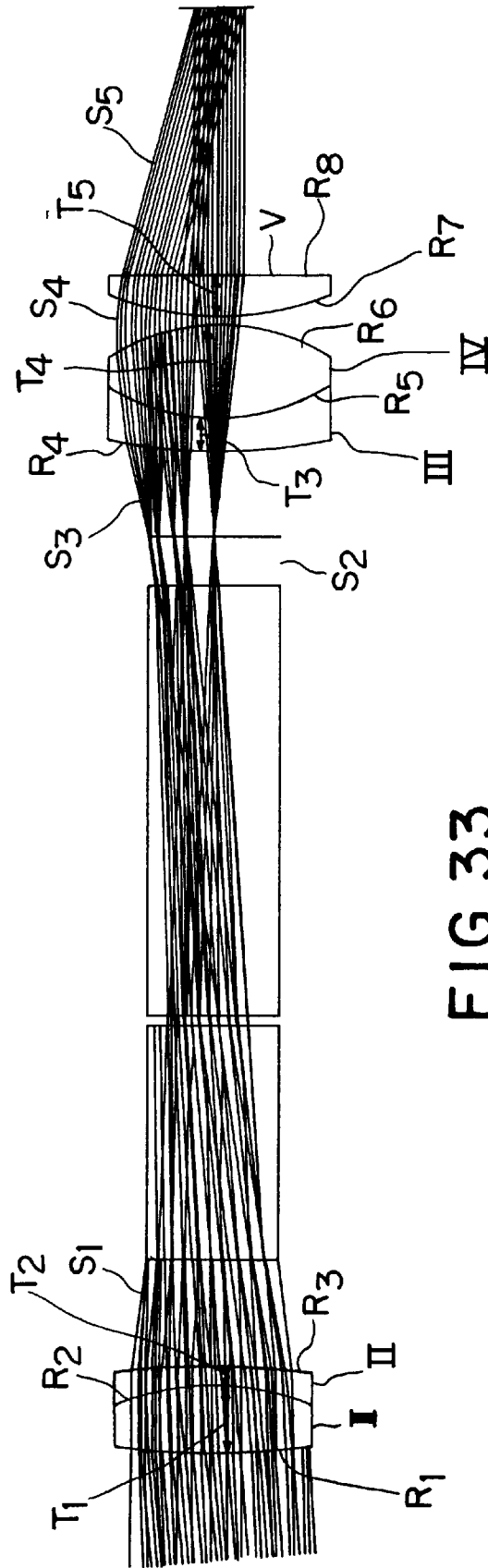


FIG. 33

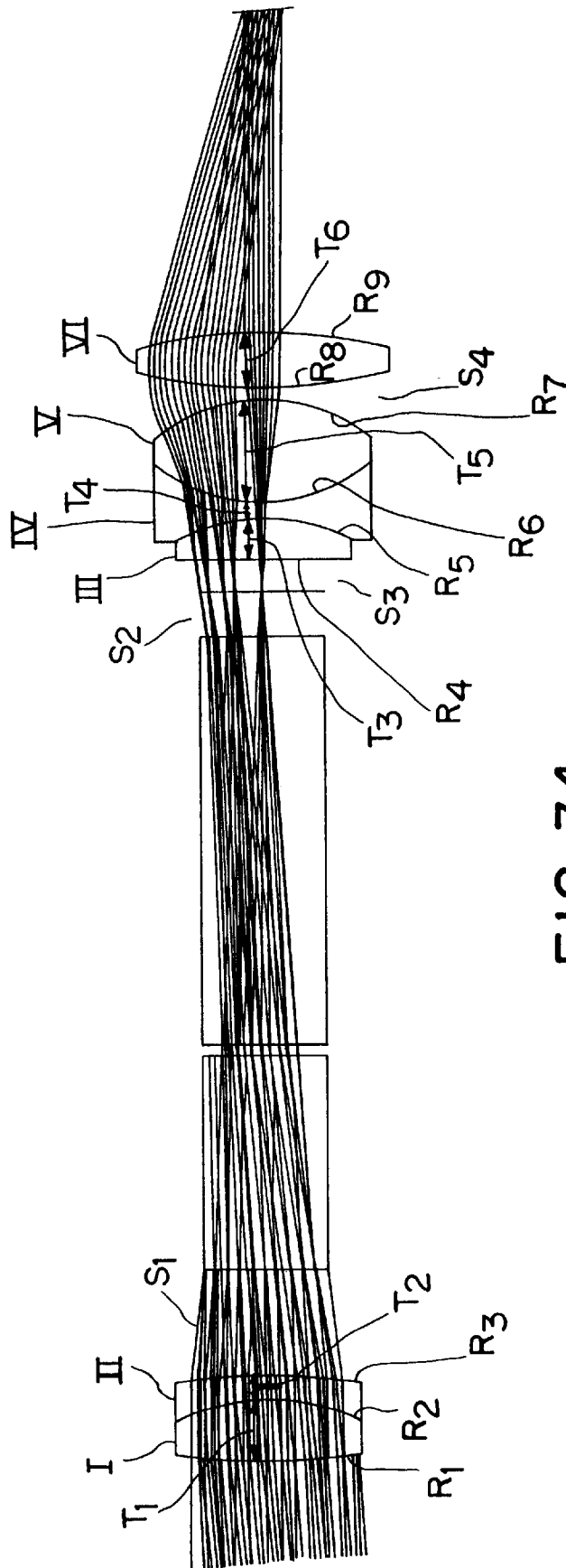


FIG. 34

MAGNIFICATION VIEWER

CROSS-REFERENCE TO RELATED APPLICATION

This application is based on and claims priority of Provisional Application Serial No. 60/069,496, filed Dec. 15, 1997.

BACKGROUND OF TEE INVENTION

1. Field of the Invention

The present invention relates to magnification viewers worn by surgeons and dentists. In particular, the invention relates to an assembly for optical viewers or loupes which allow a user to adjust an objective lens at a predetermined distance from an eyepiece lens to vary the focal point.

2. Description of the Related Art

Magnification viewers generally including pairs of magnification loupes, are worn by dentists and surgeons for extended periods of time during clinical procedures, so as to provide clarity of view while avoiding a hunched-over position that can result in debilitating neck and back strain, which can have an adverse effect on the success of the operation. The viewers permit the clinician to operate at a greater working distance from the patient. Higher magnification viewers also reduce the clinician's exposure to aerosols. Because clinicians use magnification viewers during surgery and other procedures requiring manual precision, it is important that they be light-weight, comfortable and have good clarity and wide field of vision while providing high magnification and good depth of field.

Surgical telescopes may be attached to a spectacle frame in one of two manners: outside-the-carrier or prescription lens ("outside-the-lens"), on an adjustment mechanism that provides for adjustment of the interpupillary distance and convergent angle variability, or through-the-lens, permanently cemented and fixed in place. As noted above, magnification viewers used by surgeons and dentists typically have a predetermined magnification. Neither the working distance nor the magnification may be changed without a tedious process of replacing either individual lens elements or the entire optical loupes themselves. Accordingly, there is a need for a simple method for changing the magnification of viewers being worn by a surgeon or dentist, as well as for altering the working distance of viewers having a particular magnification.

SUMMARY OF THE INVENTION

In accordance with one embodiment of the invention, a housing for a magnification loupe is provided having an eyepiece portion for an eyepiece lens and a nose portion for an objective lens. The body portion for the eyepiece lens includes outer circumferential threads over which the objective nose portion fits to enable the distance between the lenses in the body and nose portions to be varied in order to vary the working distance of the loupe. The objective nose portion includes a pair of apertures for receiving a pin. The apertures are configured such that the pin forms a chord across the body of the nose portion and co-acts with the threads of the eyepiece body forming an axial mechanical stop to prevent the nose portion from being removed during adjustment.

Magnification loupes according to the present invention include a nose housing for an objective lens and a body housing for an eyepiece lens. The system is configured such that the magnification of the magnification loupe may be changed simply by removing the nose housing and replacing it with another. The working distance for a particular magnification level may be adjusted by threading or unthreading the nose housing.

BRIEF DESCRIPTION OF THE DRAWINGS

A better understanding of the present invention is obtained when the following detailed description is considered in conjunction with the following drawings in which:

FIGS. 1a-1c are perspective views of a magnification loupe in accordance with the present invention illustrating the connection of a pair of magnification loupes according to an embodiment of the present invention secured through the lenses of a pair of spectacles forming a magnification viewer in accordance with the present invention;

FIG. 2 is a perspective view of magnification loupes according to the present invention secured to an adjustable nose piece for securing to a pair of spectacles;

FIG. 3a is an exploded perspective view of the magnification loupe assembly for the magnification loupes of FIGS. 1 and 2;

FIG. 3b is a side cross-sectional view of the magnification loupe of FIG. 3a;

FIG. 4 is a side-elevation view of a nose housing forming a portion of the magnification viewers of FIGS. 1 and 2;

FIGS. 5a and 5b are side-cross-sectional views and detail side-cross-sectional views, respectively, of the housing of FIG. 4;

FIG. 6 is a top plan view of the nose housing of FIGS. 4 and 5;

FIG. 7 is a side elevational view of the eyepiece housing of FIGS. 1 and 2;

FIGS. 8a-8c are side cross-sectional views of the housing of FIG. 7, including details thereof;

FIG. 9 is a top plan view of the eyepiece housing of FIGS. 7 and 8;

FIG. 10 is side elevational view of a spacer for the magnification loupes of FIGS. 1 and 2;

FIG. 11 is a side cross-sectional view of the spacer of FIG. 10;

FIG. 12 is a top elevational view of the spacer of FIGS. 10 and 11;

FIG. 13 is a side elevational view of a field stop of the magnification viewer of FIGS. 1a-3b;

FIG. 14 is a side cross-sectional view of the field stop of FIG. 13; FIG. 15 is a top plan view of the field stop of FIGS. 13 and 14;

FIG. 16 is a side elevational view of an objective lens retainer ring of the magnification loupes of FIGS. 1a-3b;

FIG. 17 is side cross-sectional view of the objective retainer of FIG. 16;

FIG. 18 is a top plan view of the objective retainer of FIGS. 16 and 17;

FIGS. 19a and 19b are exploded perspective views of a prism assembly for the magnification loupes of FIGS. 1a-3b;

FIGS. 20a, 20b and 21-22 illustrate a prism for the prism assembly of FIGS. 19a and 19b;

FIGS. 23-26 illustrate the prism assembly of, FIGS. 19a and 19b;

FIGS. 27-29 illustrate the roof prism of the prism assembly of FIGS. 19a and 19b;

FIGS. 30-32 illustrate the second prism of the prism assembly of FIGS. 19a and 19b;

FIG. 33 is a diagram of the optical layout of the magnification loupe of FIGS. 1c, 3a and 3b; and

FIG. 34 is an optical layout diagram of the optical loupe of FIGS. 1a, 1b and 1c according to an alternate embodiment.

DETAILED DESCRIPTION OF THE INVENTION

Turning now to the drawings and with particular attention to FIGS. 1a and 1b a magnification viewer 10 including a

pair of spectacles **100** with through-the-lens magnification loupes **106a**, **106b**. As illustrated, the magnification loupes **106a**, **106b** are of the Keplerian design. The spectacles **100** include carrier lenses **102a**, **102b**. The carrier lenses **102a**, **102b** may be either plano lenses or prescription lenses. The magnification loupes **106a**, **106b** are fixed in the carrier lenses **102a**, **102b** to provide stereoscopic vision. The magnification loupes **106a**, **106b** are set at the user's interpupillary distance converging to a desired working distance, for example, anywhere from 12 to 24 or 13–21 inches. As will be discussed in greater detail below, from a selected working distance, the user has the option to vary the viewing distance by rotating the objective lens housing or nose housing **108a**, **108b** of each magnification loupe **106a**, **106b** to the desired focus. As will be discussed in more detail below, one of the objective lens housings **108a**, **108b** formed and the eyepiece housings **110a**, **110b** are formed with threads, which cooperate with a pin attached to the other housing to form a threaded coupling. The eyepiece housings, **110a**, **110b**, in turn, are secured to the carrier lenses **102a**, **102b** by various techniques, including a friction fit on with an adhesive, such as epoxy. Alternatively, the eyepiece housings **110a**, **110b** may be secured to the carrier lenses **102a**, **102b** by way of known threading on the outside of the eyepiece housings **110a**, **110b** matching threading on the carrier lenses **102a**, **102b**.

As will be discussed in greater detail below, magnifications of 3.3x, 3.8x, 4.3x and 4.8x are possible according to one embodiment of the invention to provide a wide range of selection. For each magnification, working distances of about 12", 16" and 24" may be provided. The carrier lenses **102a**, **102b** normally enable a user to focus comfortably at 500 mm, about -2D, a typical reading distance. The magnification loupes **106a**, **106b**, as will be discussed in greater detail below, further include a prism system (FIGS. 19–32). Each magnification loupe uses an identical prism and eyepiece lens system. For different magnifications, only the objective lenses are changed. The user may create depth of field by adjusting the focal distance of each eye depending upon the operation being performed. The focuses of each of the magnification loupes **106a**, **106b** may be changed independently. The aperture for the objective lens has been reduced in size to provide an increase in depth of field at high magnifications while still providing substantial light.

Turning now to FIG. 2, an alternative configuration of the magnification loupes **106a**, **106b** of FIGS. 1a and 1b is illustrated. It is noted that for the lens system **20** of FIG. 2, the optical configurations of the magnification loupes **206a**, **206b** are different from the through-the-lens configuration of FIG. 1, but the barrels or housings are similar in that only the objective lens need be changed to provide different magnifications. The prism and eyepiece remain the same. The optical system **20** of FIG. 2 includes a pair of spectacles **200** including a pair of carrier lenses **202a**, **202b** and a binocular magnification viewer **25**, including a pair of magnification loupes **206a**, **206b**. As discussed in U.S. Pat. No. 5,667,291, the binocular magnification viewer **25** may be attached to the spectacles **200** by a pivot member **250**. Alternatively, the magnification loupes **206a**, **206b**, may be mounted close to the spectacle lenses, for example, about 0.5 mm from the carrier lenses **202a**, **202b**. The pivot member **250** in turn, is attached to a bridge **258** which includes a bridge adjustment knob **252** for adjusting a pair of extension of arms **254**, **256** to enable the interpupillary distances of the loupes **206a**, **206b** to be adjusted. The interpupillary distance of the magnification loupes **206a**, **206b** may further be adjusted by knobs **260a**, **260b**. The binocular magnification viewer **25** may be secured to the spectacles **200** by way of a clip, screws, glue or other known methods.

MECHANICAL CHARACTERISTICS

Turning now to FIG. 3a, an exploded perspective view of the magnification loupes **106** in accordance with the present

invention are shown. The magnification loupes **106a**, **106b** include a nose or objective housing **108a** and a body or eyepiece housing **110a**. As illustrated, the objective housing **108a** includes a frusto-conical front portion **350** and a generally cylindrical rear portion **352**. It is noted that the housing **108** may be of different shapes; thus, FIG. 3 is exemplary only. The objective housing **108a** includes a pair of apertures **304**. The apertures **304** are configured to receive a pin **302** such that the pin **302** defines a chord across the cylindrical rear portion **352** of the objective housing **108a**. More particularly with reference to FIG. 3B, the objective housing **108a** includes an interior surface **308** which, engages an exterior surface **307** of the eyepiece housing **110a**. Spiral threads **306** re formed into the surface of the eyepiece housing **111a**. The apertures **304** are located in the objective housing **108a** so that the pin **302** engage the spiral or threads **306**. The pin **302** enables a threaded coupling between the two housing **108a** and **108a** even though only one housing **110a** is formed with threads. The threaded coupling between the housings **106a** and **108a** permits the working distance of the loupes **106a**, **106b** to be adjusted by relating the objective housing **108a** relative to the eyepiece housing **110a**, which in turn, varies the distance between the eyepiece and objective lenses which varies the working distance of the loupes **106a**, **106b**.

Another important aspect of the invention, is that the configuration allows the magnification of the loupes **106a**, **106b** to be rather easily changed. More particularly, the pin **302** may be removably mounted relative to the objective housing **108a** or fixedly mounted with the use of epoxy. Depending on the embodiment, the magnification of the loupe can be rather easily changed at the factory or by the user or both. In particular, as will be discussed in more detail below, the magnification of the loupe **106a**, **106b** is changed simply by changing the objective lens in the loupe **106a**, **106b**. The objective lenses are easily changed by removing the pin **302** which enables the objective housing **108a** to be removed so that the objective lens **312** can be removed and replaced. As will be discussed in more detail below, an important aspect of the invention relates to the ability to vary the magnification of the loupe **106a**, **106b**.

As best illustrated in FIG. 3b, the objective lens **312** is configured to rest within a first interior portion **360** of the objective housing **108a**. The interior portion **360** includes a circumferential slot **311** for seating an O-ring **310** therein. The objective lens **312** rests against the O-ring **310** and is engaged in place-by a threaded retainer ring **314**. The retainer ring **314** includes external threads to engage corresponding threads on the interior portion **360** of the objective housing **108a**.

Additional details concerning the objective housing **108a** are illustrated in FIGS. 4–6. For example, the exterior of the objective housing **108a** may include a knurled portion **109** for easy engagement of the objective housing **108a** to the eyepiece housing **110a**.

The eyepiece housing **110a**, illustrated in greater detail in FIGS. 7–9, includes a forward engagement portion **307** and a rear cylindrical portion **309**. As discussed above, the forward engagement portion **307** includes threads **306** for engagement with the pin **302**. It is noted that according to one embodiment of the invention, the threads **306** are circular threads rather than notched or V-shaped threads so as to more effectively engage the pin **302**. The eyepiece housing **110a** includes internal threads **340** positioned where the engagement housing **307** meets the rear cylindrical portion **309**. The threads **340** are configured to engage the threads **341** of the field stop **318** (FIGS. 3a, 3b). The rear cylindrical portion **309** of the eyepiece housing **110a** further includes a circumferential platform **344**, configured to receive a lens **332** for example, a prescription lens. The lens

332 is held in place against the platform 344 in contact with a prescription lens O-ring 330 and a retainer ring 334, which has external threads that engage the internal threads 342 of the eyepiece housing 110a. In the embodiment illustrated, the rear cylindrical portion 309 of the housing 110a is configured to be fastened to the carrier lens 102a by way of a suitable adhesive, such as epoxy. In an alternative embodiment, however, the rear cylindrical portion 309 may be provided with threads to engage similar threads in the carrier lens.

The forward engagement portion 307 of the eyepiece housing 110a is further configured to receive a prism assembly 316 (FIGS. 19a, 19b). The prism assembly 316 includes a prism holder 317 including a pair of arms 319a, 319b, a base portion 321, and is adapted to fit within the housing 110a. The forward portions of the arms 319a, 319b include circular cutout portions 323a, 323b respectively, to engage a holder ring 402. The holder ring 402 is configured, when attached in place (such as by an adhesive), to secure the prism elements 404, 406, 408. According to one embodiment, the prism elements (FIGS. 20a–22) form a roof-pechan prism separated by a spacer 408. The spacer 408 is formed, for example, of a blackened ridge metal with a six millimeter diameter hole centered on the optical axis. The prism surfaces on opposite sides of the spacer are generally parallel. The individual elements of the roof pechan prism 404, 406 and 408 are illustrated in FIGS. 25–27 and 28–30, respectively. The prism elements are formed from Schott BAK4 or LAK10 glass.

Turning back to FIGS. 3a–3b, the base of the prism assembly 316 is configured to rest against a rear wall 351 of the forward engagement portion 307 at approximately the position where it engages the rear cylindrical portion 309. A field stop 318 (FIGS. 13–15) having external threads 341 engages the corresponding internal threads 340 of the housing 110a. The field stop 318 further includes internal grooves 343. The rear cylindrical portion 309 of the housing 110a further houses the eyepiece lens elements. As shown, in FIG. 36 the eyepiece lens includes elements 320 and 324, separated by a spacer 322. The spacer 322 is illustrated in FIGS. 10–12 and may include internal concentric grooves 329 which form a light baffle. Finally, the eyepiece lens 324 rests against the platform 344.

As shown in FIGS. 3a and 3b, the exterior of the engagement housing 307 includes a pair of concentric circumferential grooves 325, 327 configured to receive the O-rings 326, 328 respectively. The O-rings 326, 328 additionally function to self-center the objective housing 108a and hence, the objective lens 312 relative to the eyepiece housing 110a.

While the configuration described and shown with regard to FIGS. 3a–3b relates to a through-the-lens viewer, a similar configuration may be used in the outside-the-lens system shown in FIG. 2. Such a system may be used without a prescription lens and, as will be described in greater detail below, a different eyepiece system.

OPTICAL CHARACTERISTICS

Turning now to FIG. 33, a diagram illustrating the optical layout of the magnification loupe 106a, 106b of FIGS. 1a, 1b, 3a and 3b is shown. The magnification loupe 106a, 106b as illustrated in FIG. 33 includes a two-element objective lens including elements I-II and including a three-element eyepiece including elements III-V. R1, R2 etc., represent the radii of respective refractive surfaces; S1–S5 represent the thickness of the air spaces; and T1, T2, etc., represent the thicknesses of the lens elements. As discussed above,

according to one embodiment of the invention, magnifications of 3.3×, 3.8×, 4.3× and 4.8× are provided. All magnifications use the same prism and eyepiece lens system. As shown in FIGS. 28 and 32, the prior angle α may be used in the range 45°–49°, preferably 48° to increase the optical performance of the device while the prism angle B (FIG. 32) may be selected to be 24°. Thus, a common eyepiece housing 110a and optical elements included therein may be used for all of the magnifications. As discussed above, only the objective lens needs to be changed in order to alter the magnification.

The user may create a depth of field by adjusting the focal distance of each eye differently depending on the operation being performed. For example, a heart surgeon may wish to view the entire depth of the heart at high magnification previously unattainable in conventional magnification systems where depth of field is limited. This can be accomplished by adjusting the focus of the left eye one-inch beyond the right. When both eyes are then opened, the heart can be viewed in its entirety. However, a dentist may only require the depth of the coronal portion of the tooth to be in focus and thus, would only separate the focus by a millimeter or two. Alternatively, both magnification loupes can be precisely focused at the same distance for procedures requiring the highest resolution. The following exemplary fields of view may be provided:

93 mm@3.3×@16"WD
82 mm@3.3×@16"WD
72 mm@3.3×@16"WD
65 mm@3.3×@16"WD

Exemplary construction data for a magnification loupe built according to the embodiment shown in FIGS. 1a–3b are given in Tables I–XII. The radii, thickness, and separation dimensions are given in millimeters. Roman numerals identify the lens elements in their respective order from the objective side to the eyepoint side; nd represents the refractive index of each element; v_d is the abbe dispersion number; R1, R1, etc., represent the radii of the respective refractive surfaces in order from the objective side to the eyepoint side; T1, T2, etc., represent the thicknesses of the lens elements from the objective side to the eyepoint side; S1, S2 represent the thicknesses of air spaces respectively from the objective side to the eyepoint side measured along the optical centerline. Again, it is noted that the prism/objective distance 51, can differ by about 2.5 mm if BAK4 glass is used, rather than LAK10, as in the tables.

FIG. 34 illustrates an embodiment of the present invention having long eye relief characteristics. Again, the system shown in FIG. 34 employs the same prism and eyepieces, but separate objective doublets for each level of magnification. The objective doublets and the prism, however, are the same as for the through-the-lens embodiment shown in FIG. 33. Additionally, only the eyepiece lens is changed from the through-the-lens configuration. As compared the embodiment of FIG. 33, eye relief—the distance to exit pupil—has been improved from about 17.8 mm to about 22.8 mm.

In particular, the viewer according to FIG. 34 includes the two-element or doublet objective including elements I-II and a four-element eyepiece lens including elements III-VI. R1, R2, etc., again represent the radii of respective refractive surfaces; S1 and S2 represent the thicknesses of the air spaces; and T1, T2, etc., represent the thicknesses of the lens elements.

Exemplary construction data for loupes according to the embodiment of FIG. 34 are given in Tables XIII–XXIV.

TABLE I

3.3X (12" WD)							
Element	Glass	nd	vd	Radius	Thickness	Diameter	Sep.
I	Ohara BAH 27	1.7015	41.2	R ₁ = 42.19 R ₂ = 12.45	3.5	13.4	
II	Ohara PBH6W	1.8052	25.4	R ₂ = 12.45 R ₃ = 36.00	1.5	13.4	
Prism A	BAK4 LAK10	1.5688 1.7200	56.13 50.41				S ₁ = 6.96 S ₂ = 3.41 S ₃ = 7.04
Prism B	BAK4 LAK10	1.5688 1.7200	56.13 50.41				S ₄ = 0.05 S ₅ = 17.86
III	Ohara PBH6W	1.8052	25.4	R ₃ = 44.00 R ₄ = 13.00	2.0	15.4	
IV	Ohara FSL5	1.4875	70.2	R ₅ = 13.00 R ₆ = 13.00	6.5	15.4	
V	Ohara BAH10	1.6700	47.3	R ₇ = 15.59 R ₈ = 94.04	3.0	15.4	

TABLE II

3.3X (16" WD)							
Element	Glass	nd	vd	Radius	Thickness	Diameter	Sep.
I	Ohara BAH 27	1.7015	41.2	R ₁ = 42.19 R ₂ = 12.45	3.5	13.4	
II	Ohara PBH6W	1.8052	25.4	R ₂ = 12.45 R ₃ = 36.00	1.5	13.4	
Prism A	BAK4 LAK10	1.5688 1.7200	56.13 50.41				S ₁ = 5.01 S ₂ = 3.41 S ₃ = 7.04
Prism B	BAK4 LAK10	1.5688 1.7200	56.13 50.41				S ₄ = 0.05 S ₅ = 17.86
III	Ohara PBH6W	1.8052	25.4	R ₃ = 44.00 R ₄ = 13.00	2.0	15.4	
IV	Ohara FSL5	1.4875	70.2	R ₅ = 13.00 R ₆ = 13.00	6.5	15.4	
V	Ohara BAH10	1.6700	47.3	R ₇ = 15.59 R ₈ = 94.04	3.0	15.4	

TABLE III

3.3X (24" WD)							
Element	Glass	nd	vd	Radius	Thickness	Diameter	Sep.
I	Ohara BAH 27	1.7015	41.2	R ₁ = 42.19 R ₂ = 12.45	3.5	13.4	
II	Ohara PBH6W	1.8052	25.4	R ₂ = 12.45 R ₃ = 36.00	1.5	13.4	
Prism A	BAK4 LAK10	1.5688 1.7200	56.13 50.41				S ₁ = 3.63 S ₂ = 3.41 S ₃ = 7.04
Prism B	BAK4 LAK10	1.5688 1.7200	56.13 50.41				S ₄ = 0.05 S ₅ = 17.86
III	Ohara PBH6W	1.8052	25.4	R ₃ = 44.00 R ₄ = 13.00	2.0	15.4	
IV	Ohara FSL5	1.4875	70.2	R ₅ = 13.00 R ₆ = 13.00	6.5	15.4	
V	Ohara BAH10	1.6700	47.3	R ₇ = 15.59 R ₈ = 94.04	3.0	15.4	

TABLE IV

3.8X (12" WD)							
Element	Glass	nd	vd	Radius	Thickness	Diameter	Sep.
I	Ohara BAH 27	1.7015	41.2	$R_1 = 42.04$ $R_2 = 14.61$	4.0	13.4	
II	Ohara PBH6W	1.8052	25.4	$R_2 = 14.61$ $R_3 = 36.00$	1.5	13.4	
Prism A	BAK4 LAK10	1.5688 1.7200	56.13 50.41				$S_1 = 12.38$ $S_2 = 3.41$ $S_3 = 7.04$
Prism B	BAK4 LAK10	1.5688 1.7200	56.13 50.41				$S_4 = 0.05$ $S_5 = 17.86$
III	Ohara PBH6W	1.8052	25.4	$R_3 = 44.00$ $R_4 = 13.00$	2.0	15.4	
IV	Ohara FSL5	1.4875	70.2	$R_5 = 13.00$ $R_6 = 13.00$	6.5	15.4	
V	Ohara BAH10	1.6700	47.3	$R_7 = 15.59$ $R_8 = 94.04$	3.0	15.4	

TABLE V

3.8X (16" WD)							
Element	Glass	nd	vd	Radius	Thickness	Diameter	Sep.
I	Ohara BAH 27	1.7015	41.2	$R_1 = 42.19$ $R_2 = 14.61$	4.0	13.4	
II	Ohara PBH6W	1.8052	25.4	$R_2 = 14.61$ $R_3 = 36.00$	1.5	13.4	
Prism A	BAK4 LAK10	1.5688 1.7200	56.13 50.41				$S_1 = 9.92$ $S_2 = 3.41$ $S_3 = 7.04$
Prism B	BAK4 LAK10	1.5688 1.7200	56.13 50.41				$S_4 = 0.05$ $S_5 = 17.86$
III	Ohara PBH6W	1.8052	25.4	$R_3 = 44.00$ $R_4 = 13.00$	2.0	15.4	
IV	Ohara FSL5	1.4875	70.2	$R_5 = 13.00$ $R_6 = 13.00$	6.5	15.4	
V	Ohara BAH10	1.6700	47.3	$R_7 = 15.59$ $R_8 = 94.04$	3.0	15.4	

TABLE VI

3.8X (24" WD)							
Element	Glass	nd	vd	Radius	Thickness	Diameter	Sep.
I	Ohara BAH 27	1.7015	41.2	$R_1 = 42.04$ $R_2 = 14.61$	4.0	13.4	
II	Ohara PBH6W	1.8052	25.4	$R_2 = 14.61$ $R_3 = 36.00$	1.5	13.4	
Prism A	BAK4 LAK10	1.5688 1.7200	56.13 50.41				$S_1 = 8.02$ $S_2 = 3.41$ $S_3 = 7.04$
Prism B	BAK4 LAK10	1.5688 1.7200	56.13 50.41				$S_4 = 0.05$ $S_5 = 17.86$
III	Ohara PBH6W	1.8052	25.4	$R_3 = 44.00$ $R_4 = 13.00$	2.0	15.4	
IV	Ohara FSL5	1.4875	70.2	$R_5 = 13.00$ $R_6 = 13.00$	6.5	15.4	
V	Ohara BAH10	1.6700	47.3	$R_7 = 15.59$ $R_8 = 94.04$	3.0	15.4	

TABLE VII

4.3X (12" WD)							
Element	Glass	nd	vd	Radius	Thickness	Diameter	Sep.
I	Ohara	1.7015	41.2	$R_1 = 50.15$	4.0	13.4	
	BAH 27			$R_2 = 16.00$			
II	Ohara	1.8052	25.4	$R_2 = 16.00$	1.5	13.4	
	PBH6W			$R_3 = 47.79$			
Prism A	BAK4	1.5688	56.13				$S_1 = 18.07$
	LAK10	1.7200	50.41				$S_2 = 3.41$
Prism B	BAK4	1.5688	56.13				$S_3 = 7.04$
	LAK10	1.7200	50.41				$S_4 = 0.05$
III	Ohara	1.8052	25.4	$R_3 = 44.00$	2.0	15.4	$S_5 = 17.86$
IV	PBH6W			$R_4 = 13.00$			
	Ohara	1.4875	70.2	$R_5 = 13.00$	6.5	15.4	
V	FSL5			$R_6 = 13.00$			
	Ohara	1.6700	47.3	$R_7 = 15.59$	3.0	15.4	
	BAH10			$R_8 = 94.04$			

TABLE VIII

4.3X (16" WD)							
Element	Glass	nd	vd	Radius	Thickness	Diameter	Sep.
I	Ohara	1.7015	41.2	$R_1 = 50.15$	4.0	13.4	
	BAH 27			$R_2 = 16.00$			
II	Ohara	1.8052	25.4	$R_2 = 16.00$	1.5	13.4	
	PBH6W			$R_3 = 47.79$			
Prism A	BAK4	1.5688	56.13				$S_1 = 15.56$
	LAK10	1.7200	50.41				$S_2 = 3.41$
Prism B	BAK4	1.5688	56.13				$S_3 = 7.04$
	LAK10	1.7200	50.41				$S_4 = 0.05$
III	Ohara	1.8052	25.4	$R_3 = 44.00$	2.0	15.4	$S_5 = 17.86$
IV	PBH6W			$R_4 = 13.00$			
	Ohara	1.4875	70.2	$R_5 = 13.00$	6.5	15.4	
V	FSL5			$R_6 = 13.00$			
	Ohara	1.6700	47.3	$R_7 = 15.59$	3.0	15.4	
	BAH10			$R_8 = 94.04$			

TABLE IX

4.3X (24" WD)							
Element	Glass	nd	vd	Radius	Thickness	Diameter	Sep.
I	Ohara	1.7015	41.2	$R_1 = 50.15$	4.0	13.4	
	BAH 27			$R_2 = 16.00$			
II	Ohara	1.8052	25.4	$R_2 = 16.00$	1.5	13.4	
	PBH6W			$R_3 = 47.79$			
Prism A	BAK4	1.5688	56.13				$S_1 = 13.13$
	LAK10	1.7200	50.41				$S_2 = 3.41$
Prism B	BAK4	1.5688	56.13				$S_3 = 7.04$
	LAK10	1.7200	50.41				$S_4 = 0.05$
III	Ohara	1.8052	25.4	$R_3 = 44.00$	2.0	15.4	$S_5 = 17.86$
IV	PBH6W			$R_4 = 13.00$			
	Ohara	1.4875	70.2	$R_5 = 13.00$	6.5	15.4	
	FSL5			$R_6 = 13.00$			

TABLE IX-continued

4.3X (24" WD)							
Element	Glass	nd	vd	Radius	Thickness	Diameter	Sep.
V	Ohara BAH10	1.6700	47.3	R ₇ = 15.59 R ₈ = 94.04	3.0	15.4	

TABLE X

4.8X (12" WD)							
Element	Glass	nd	vd	Radius	Thickness	Diameter	Sep.
I	Ohara BAH 27	1.7015	41.2	61.12	4.0	13.4	
II	Ohara SFL6	1.8052	25.4	16.98	1.5	13.4	
Prism A	BAK4	1.5688	56.13				S ₁ = 25.16
	LAK10	1.7200	50.41				S ₂ = 3.41
Prism B	BAK4	1.5688	56.13				S ₃ = 7.04
	LAK10	1.7200	50.41				S ₄ = 0.05
III	Ohara PBH6W	1.8052	25.4	R ₃ = 44.00 R ₄ = 13.00	2.0	15.4	S ₅ = 17.86
IV	Ohara FSL5	1.4875	70.2	R ₅ = 13.00 R ₆ = 13.00	6.5	15.4	
V	Ohara BAH10	1.6700	47.3	R ₇ = 15.59 R ₈ = 94.04	3.0	15.4	

TABLE XI

4.8X (16" WD)							
Element	Glass	nd	vd	Radius	Thickness	Diameter	Sep.
I	Ohara BAH 27	1.7015	41.2	61.12	4.0	13.4	
II	Ohara SFL6	1.8052	25.4	16.98	1.5	13.4	
Prism A	BAK4	1.5688	56.13				S ₁ = 21.23
	LAK10	1.7200	50.41				S ₂ = 3.41
Prism B	BAK4	1.5688	56.13				S ₃ = 7.04
	LAK10	1.7200	50.41				S ₄ = 0.05
III	Ohara PBH6W	1.8052	25.4	R ₃ = 44.00 R ₄ = 13.00	2.0	15.4	S ₅ = 17.86
IV	Ohara FSL5	1.4875	70.2	R ₅ = 13.00 R ₆ = 13.00	6.5	15.4	
V	Ohara BAH10	1.6700	47.3	R ₇ = 15.59 R ₈ = 94.04	3.0	15.4	

TABLE XII

4.8X (24" WD)							
Element	Glass	nd	vd	Radius	Thickness	Diameter	Sep.
I	Ohara BAH 27	1.7015	41.2	61.12	4.0	13.4	
II	Ohara	1.8052	25.4	16.98	1.5	13.4	

TABLE XII-continued

		4.8X (24" WD)					
Element	Glass	nd	vd	Radius	Thickness	Diameter	Sep.
Prism A	SFL6						
	BAK4	1.5688	56.13				S ₁ = 18.22
	LAK10	1.7200	50.41				S ₂ = 3.41
Prism B	BAK4	1.5688	56.13				S ₃ = 7.04
	LAK10	1.7200	50.41				S ₄ = 0.05
III	Ohara	1.8052	25.4	R ₃ = 44.00	2.0	15.4	S ₅ = 17.86
	PBH6W			R ₄ = 13.00			
IV	Ohara	1.4875	70.2	R ₅ = 13.00	6.5	15.4	
	FSL5			R ₆ = 13.00			
V	Ohara	1.6700	47.3	R ₇ = 15.59	3.0	15.4	
	BAH10			R ₈ = 94.04			

20

TABLE XIII

		3.3X (12" WD)					
Element	Glass	nd	vd	Radius	Thickness	Diameter	Sep.
I	Ohara	1.7015	41.2	R ₁ = 42.19	3.5	13.4	
	BAH 27			R ₂ = 12.45			
II	Ohara	1.8052	25.4	R ₃ = 12.45	1.5	13.4	
	PBH6W			R ₃ = 36.00			
Prism A	BAK4	1.5688	56.13				S ₁ = 6.96
	LAK10	1.7200	50.41				S ₂ = 3.41
Prism B	BAK4	1.5688	56.13				S ₃ = 2.33
	LAK10	1.7200	50.41				S ₄ = 0.5
III	Ohara	1.5410	47.2	R ₄ = PLANO	3.0	12.0	S ₅ = 22.8
	S-TIL2			R ₅ = 12.61			
IV	Ohara	1.923	21.3	R ₅ = 12.61	1.5	15.4	
	PBH71			R ₆ = 12.61			
V	SCHOTT	1.5168	64.2	R ₇ = 10.06	7.1	15.4	
	BK7			R ₆ = 12.61			
VI	SCHOTT	1.744	44.8	R ₈ = 25.11	4.7	17.5	
	S-LAM2			R ₉ = 25.11			

TABLE XIV

		3.3X (16" WD)					
Element	Glass	nd	vd	Radius	Thickness	Diameter	Sep.
I	Ohara	1.7015	41.2	R ₁ = 42.19	3.5	13.4	
	BAH 27			R ₂ = 12.45			
II	Ohara	1.8052	25.4	R ₂ = 12.45	1.5	13.4	
	PBH6W			R ₃ = 36.00			
Prism A	BAK4	1.5688	56.13				S ₁ = 5.1
	LAK10	1.7200	50.41				S ₂ = 3.41
Prism B	BAK4	1.5688	56.13				S ₃ = 2.33
	LAK10	1.7200	50.41				S ₄ = .5
III	Ohara	1.5410	47.2	R ₄ = PLANO	3.0	12.0	S ₅ = 22.8
	S-TIL2			R ₅ = 12.61			
IV	Ohara	1.923	21.3	R ₅ = 12.61	1.5	15.4	
	PBH71			R ₆ = 12.61			
V	SCHOTT	1.5168	64.2	R ₇ = 10.06	7.1	15.4	
	BK7			R ₆ = 12.61			

TABLE XIV-continued

				3.3X (16" WD)			
Element	Glass	nd	vd	Radius	Thickness	Diameter	Sep.
VI	SCHOTT S-LAM2	1.744	44.8	R ₈ = 25.11 R ₉ = 25.11	4.7	17.5	

TABLE XV

				3.3X (24" WD)			
Element	Glass	nd	vd	Radius	Thickness	Diameter	Sep.
I	Ohara BAH 27	1.7015	41.2	R ₁ = 42.19 R ₂ = 12.45	3.5	13.4	
II	Ohara PBH6W	1.8052	25.4	R ₃ = 12.45 R ₃ = 36.00	1.5	13.4	
Prism A	BAK4 LAK10	1.5688 1.7200	56.13 50.41				S ₁ = 3.63 S ₂ = 3.41 S ₃ = 2.33
Prism B	BAK4 LAK10	1.5688 1.7200	56.13 50.41				S ₄ = .5 S ₅ = 22.8
III	Ohara S-TIL2	1.5410	47.2	R ₄ = PLANO R ₅ = 12.61	3.0	12.0	
IV	Ohara PBH71	1.923	21.3	R ₅ = 12.61 R ₆ = 12.61	1.5	15.4	
V	SCHOTT BK7	1.5168	64.2	R ₇ = 10.06 R ₆ = 12.61	7.1	15.4	
VI	SCHOTT S-LAM2	1.744	44.8	R ₈ = 25.11 R ₉ = 25.11	4.7	17.5	

TABLE XVI

				3.8X (12" WD)			
Element	Glass	nd	vd	Radius	Thickness	Diameter	Sep.
I	Ohara BAH 27	1.7015	41.2	R ₁ = 42.19 R ₂ = 12.45	3.5	13.4	
II	Ohara PBH6W	1.8052	25.4	R ₂ = 12.45 R ₃ = 36.00	1.5	13.4	
Prism A	BAK4 LAK10	1.5688 1.7200	56.13 50.41				S ₁ = 12.38 S ₂ = 3.41 S ₃ = 2.33
Prism B	BAK4 LAK10	1.5688 1.7200	56.13 50.41				S ₄ = .5 S ₅ = 22.8
III	Ohara S-TIL2	1.5410	47.2	R ₄ = PLANO R ₅ = 12.61	3.0	12.0	
IV	Ohara PBH71	1.923	21.3	R ₅ = 12.61 R ₆ = 12.61	1.5	15.4	
V	SCHOTT BK7	1.5168	64.2	R ₇ = 10.06 R ₆ = 12.61	7.1	15.4	
VI	SCHOTT S-LAM2	1.744	44.8	R ₈ = 25.11 R ₉ = 25.11	4.7	17.5	

TABLE XVII

3.8X (16" WD)							
Element	Glass	nd	vd	Radius	Thickness	Diameter	Sep.
I	Ohara BAH 27	1.7015	41.2	R ₁ = 42.19 R ₂ = 12.45	3.5	13.4	
II	Ohara PBH6W	1.8052	25.4	R ₂ = 12.45 R ₃ = 36.00	1.5	13.4	
Prism A	BAK4 LAK10	1.5688 1.7200	56.13 50.41				S ₁ = 9.92 S ₂ = 3.41 S ₃ = 2.33
Prism B	BAK4 LAK10	1.5688 1.7200	56.13 50.41				S ₄ = .5 S ₅ = 22.8
III	Ohara S-TIL2	1.5410	47.2	R ₄ = PLANO R ₅ = 12.61	3.0	12.0	
IV	Ohara PBH71	1.923	21.3	R ₅ = 12.61 R ₆ = 12.61	1.5	15.4	
V	SCHOTT BK7	1.5168	64.2	R ₇ = 10.06 R ₆ = 12.61	7.1	15.4	
VI	SCHOTT S-LAM2	1.744	44.8	R ₈ = 25.11 R ₉ = 25.11	4.7	17.5	

TABLE XVIII

3.8X (24" WD)							
Element	Glass	nd	vd	Radius	Thickness	Diameter	Sep.
I	Ohara BAH 27	1.7015	41.2	R ₁ = 42.19 R ₂ = 12.45	3.5	13.4	
II	Ohara PBH6W	1.8052	25.4	R ₂ = 12.45 R ₃ = 36.00	1.5	13.4	
Prism A	BAK4 LAK10	1.5688 1.7200	56.13 50.41				S ₁ = 8.02 S ₂ = 3.41 S ₃ = 2.33
Prism B	BAK4 LAK10	1.5688 1.7200	56.13 50.41				S ₄ = .5 S ₅ = 22.8
III	Ohara S-TIL2	1.5410	47.2	R ₄ = PLANO R ₅ = 12.61	3.0	12.0	
IV	Ohara PBH71	1.923	21.3	R ₅ = 12.61 R ₆ = 12.61	1.5	15.4	
V	SCHOTT BK7	1.5168	64.2	R ₇ = 10.06 R ₆ = 12.61	7.1	15.4	
VI	SCHOTT S-LAM2	1.744	44.8	R ₈ = 25.11 R ₉ = 25.11	4.7	17.5	

TABLE XIX

4.3X (12" WD)							
Element	Glass	nd	vd	Radius	Thickness	Diameter	Sep.
I	Ohara BAH 27	1.7015	41.2	R ₁ = 42.19 R ₂ = 12.45	3.5	13.4	
II	Ohara PBH6W	1.8052	25.4	R ₂ = 12.45 R ₃ = 36.00	1.5	13.4	
Prism A	BAK4 LAK10	1.5688 1.7200	56.13 50.41				S ₁ = 18.7 S ₂ = 3.41 S ₃ = 2.33
Prism B	BAK4 LAK10	1.5688 1.7200	56.13 50.41				S ₄ = .5 S ₅ = 22.8
III	Ohara S-TIL2	1.5410	47.2	R ₄ = PLANO R ₅ = 12.61	3.0	12.0	
IV	Ohara	1.923	21.3	R ₅ = 12.61	1.5	15.4	

TABLE XIX-continued

4.3X (12" WD)							
Element	Glass	nd	vd	Radius	Thickness	Diameter	Sep.
V	PBH71	1.5168	64.2	$R_6 = 12.61$	7.1	15.4	
	SCHOTT BK7			$R_7 = 10.06$			
VI	SCHOTT S-LAM2	1.744	44.8	$R_6 = 12.61$	4.7	17.5	
				$R_8 = 25.11$ $R_9 = 25.11$			

TABLE XX

4.3X (16" WD)							
Element	Glass	nd	vd	Radius	Thickness	Diameter	Sep.
I	Ohara BAH 27	1.7015	41.2	$R_1 = 42.19$ $R_2 = 12.45$	3.5	13.4	
II	Ohara PBH6W	1.8052	25.4	$R_2 = 12.45$ $R_3 = 36.00$	1.5	13.4	
Prism A	BAK4	1.5688	56.13				$S_1 = 15.56$
	LAK10	1.7200	50.41				$S_2 = 3.41$ $S_3 = 2.33$
Prism B	BAK4	1.5688	56.13				$S_4 = .5$
	LAK10	1.7200	50.41				$S_5 = 22.8$
III	Ohara S-TIL2	1.5410	47.2	$R_4 = \text{PLANO}$ $R_5 = 12.61$	3.0	12.0	
IV	Ohara PBH71	1.923	21.3	$R_5 = 12.61$ $R_6 = 12.61$	1.5	15.4	
V	SCHOTT BK7	1.5168	64.2	$R_7 = 10.06$	7.1	15.4	
				$R_6 = 12.61$			
VI	SCHOTT S-LAM2	1.744	44.8	$R_8 = 25.11$	4.7	17.5	
				$R_9 = 25.11$			

TABLE XXI

4.3X (24" WD)							
Element	Glass	nd	vd	Radius	Thickness	Diameter	Sep.
I	Ohara BAH 27	1.7015	41.2	$R_1 = 42.19$ $R_2 = 12.45$	3.5	13.4	
II	Ohara PBH6W	1.8052	25.4	$R_2 = 12.45$ $R_3 = 36.00$	1.5	13.4	
Prism A	BAK4	1.5688	56.13				$S_1 = 13.13$
	LAK10	1.7200	50.41				$S_2 = 3.41$ $S_3 = 2.33$
Prism B	BAK4	1.5688	56.13				$S_4 = .5$
	LAK10	1.7200	50.41				$S_5 = 22.8$
III	Ohara S-TIL2	1.5410	47.2	$R_4 = \text{PLANO}$ $R_5 = 12.61$	3.0	12.0	
IV	Ohara PBH71	1.923	21.3	$R_5 = 12.61$ $R_6 = 12.61$	1.5	15.4	
V	SCHOTT BK7	1.5168	64.2	$R_7 = 10.06$	7.1	15.4	
				$R_6 = 12.61$			
VI	SCHOTT S-LAM2	1.744	44.8	$R_8 = 25.11$	4.7	17.5	
				$R_9 = 25.11$			

TABLE XXII

4.8X (12" WD)							
Element	Glass	nd	vd	Radius	Thickness	Diameter	Sep.
I	Ohara BAH 27	1.7015	41.2	R ₁ = 42.19 R ₂ = 12.45	3.5	13.4	
II	Ohara PBH6W	1.8052	25.4	R ₂ = 12.45 R ₃ = 36.00	1.5	13.4	
Prism A	BAK4 LAK10	1.5688 1.7200	56.13 50.41				S ₁ = 25.16 S ₂ = 3.41 S ₃ = 2.33
Prism B	BAK4 LAK10	1.5688 1.7200	56.13 50.41				S ₄ = .5 S ₅ = 22.8
III	Ohara S-TIL2	1.5410	47.2	R ₄ = PLANO R ₅ = 12.61	3.0	12.0	
IV	Ohara PBH71	1.923	21.3	R ₅ = 12.61 R ₆ = 12.61	1.5	15.4	
V	SCHOTT BK7	1.5168	64.2	R ₇ = 10.06 R ₆ = 12.61	7.1	15.4	
VI	SCHOTT S-LAM2	1.744	44.8	R ₈ = 25.11 R ₉ = 25.11	4.7	17.5	

TABLE XXIII

4.8X (16" WD)							
Element	Glass	nd	vd	Radius	Thickness	Diameter	Sep.
I	Ohara BAH 27	1.7015	41.2	R ₁ = 42.19 R ₂ = 12.45	3.5	13.4	
II	Ohara PBH6W	1.8052	25.4	R ₂ = 12.45 R ₃ = 36.00	1.5	13.4	
Prism A	BAK4 LAK10	1.5688 1.7200	56.13 50.41				S ₁ = 21.23 S ₂ = 3.41 S ₃ = 2.33
Prism B	BAK4 LAK10	1.5688 1.7200	56.13 50.41				S ₄ = .5 S ₅ = 22.8
III	Ohara S-TIL2	1.541	47.2	R ₄ = PLANO R ₅ = 12.61	3.0	12.0	
IV	Ohara PBH71	1.923	21.3	R ₅ = 12.61 R ₆ = 12.61	1.5	15.4	
V	SCHOTT BK7	1.5168	64.2	R ₇ = 10.06 R ₆ = 12.61	7.1	15.4	
VI	SCHOTT S-LAM2	1.744	44.8	R ₈ = 25.11 R ₉ = 25.11	4.7	17.5	

50

55

60

65

TABLE XXIV

		4.8X (24" WD)					
Element	Glass	nd	vd	Radius	Thickness	Diameter	Sep.
I	Ohara	1.7015	41.2	R ₁ = 42.19	3.5	13.4	
	BAH 27			R ₂ = 12.45			
II	Ohara	1.8052	25.4	R ₂ = 12.45	1.5	13.4	
	PBH6W			R ₃ = 36.00			
Prism A	BAK4	1.5688	56.13				S ₁ = 18.22
	LAK10	1.7200	50.41				S ₂ = 3.41
Prism B	BAK4	1.5688	56.13				S ₃ = 2.33
	LAK10	1.7200	50.41				S ₄ = .5
III	Ohara	1.5410	47.2	R ₄ = PLANO	3.0	12.0	S ₅ = 22.8
	S-TIL2			R ₅ = 12.61			
IV	Ohara	1.923	21.3	R ₅ = 12.61	1.5	15.4	
	PBH71			R ₆ = 12.61			
V	SCHOTT	1.5168	64.2	R ₇ = 10.06	7.1	15.4	
	BK7			R ₆ = 12.61			
VI	SCHOTT	1.744	44.8	R ₈ = 25.11	4.7	17.5	
	S-LAM2			R ₉ = 25.11			

The invention described in the above detailed description is not intended to be limited to the specific form set forth herein, but, on the contrary, is intended to cover such alternatives, modifications and equivalents as can reasonably be included within the spirit and scope of the appended claims.

What is claimed is:

1. A magnification loupe carried by spectacles having a pair of lenses comprising:
 - an eyepiece lens housing having at least one eyepiece lens mounted therein, said eyepiece lens housing being smaller than a lens of said spectacles and including threads thereon;
 - an objective lens housing having at least one objective lens mounted therein and including a pin aperture and a pin received in said pin aperture engaging said threads such that said objective lens housing is rotatably adjustable relative to said eyepiece lens housing to enable a distance between said eyepiece lens housing and said objective lens housing to be varied.
2. A magnification loupe according to claims, wherein said objective lens housing is removable to permit substitution by a second objective lens housing carrying an objective lens of different magnification.
3. A magnification loupe carried by spectacles having a pair of lenses comprising:
 - an eyepiece lens housing having at least one eyepiece lens mounted therein, said eyepiece lens housing being smaller than a lens of said spectacles and including threads thereon;
 - an objective lens housing having at least one objective lens mounted therein and including a pin aperture; and adjustable means for moving said objective lens housing relative to said eyepiece lens housing to vary a distance between said objective lens housing and said eyepiece lens housing;
 - an optic element disposed on said loupe for increasing a light path length between said at least one objective lens and said at least one eyepiece lens;
 - wherein said adjustable means includes a pin aperture in said objective lens housing, threads on said eyepiece lens housing opposing said pin aperture, and a pin received in said pin aperture for engaging said threads.
4. A magnification loupe carried by spectacles having a pair of lenses comprising:

- an eyepiece lens housing having at least one eyepiece lens mounted therein, said eyepiece lens housing being smaller than a lens of said spectacles and including threads thereon;
 - an objective lens housing having at least one objective lens mounted therein and including a pin aperture; and adjustable means for moving said objective lens housing relative to said eyepiece lens housing to vary a distance between said objective lens housing and said eyepiece lens housing;
 - an optic element disposed on said loupe for increasing a light path length between said at least one objective lens and said at least one eyepiece lens, wherein said optic element is a roof-penchan prism; and wherein said adjustable means includes a pin aperture in said objective lens housing, threads on said eyepiece lens housing opposing said pin aperture, and a pin received in said pin aperture for engaging said threads.
5. A magnification loupe carried by spectacles having a pair of lenses comprising:
 - an eyepiece lens housing having at least one eyepiece lens mounted therein, said eyepiece lens housing being smaller than a lens of said spectacles and including threads thereon;
 - an objective lens housing having at least one objective lens mounted therein and including a pin aperture; and adjustable means for moving said objective lens housing relative to said eyepiece lens housing to vary a distance between said objective lens housing and said eyepiece lens housing;
 - an optic element disposed on said loupe for increasing a light path length between said at least one objective lens and said at least one eyepiece lens wherein the optic element is a roof-penchan prism that includes two prisms separated by a spacer having an aperture centered on an optical axis of said loop; and wherein said adjustable means includes a pin aperture in said objective lens housing, threads on the surface of said eyepiece lens housing opposing said pin aperture, and a pin received in said pin aperture for engaging said threads.

* * * * *

UNITED STATES PATENT AND TRADEMARK OFFICE
CERTIFICATE OF CORRECTION

PATENT NO. : 6,201,640 B1
DATED : March 13, 2001
INVENTOR(S) : Caplan, et al.

Page 1 of 1

It is certified that error appears in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

Column 25,

Line 44, please delete the word "claims" and insert therefor -- Claim 1 --.

Signed and Sealed this

Sixth Day of November, 2001

Attest:

Nicholas P. Godici

Attesting Officer

NICHOLAS P. GODICI
Acting Director of the United States Patent and Trademark Office