IN THE UNITED STATES DISTRICT COURT
NORTHERN DISTRICT OF TEXAS
DALLAS DIVISION

HOYA CORPORATION, HOYA SURGICAL OPTICS, INC., HOYA LAMPHUN LTD., and HOYA MEDICAL SINGAPORE PTE LTD., Plaintiffs, v. ALCON INC., ALCON LABORATORIES, INC., ALCON RESEARCH, LLC, and ALCON VISION, LLC, Defendants.	**Civil Action No. 3:20-cv-03629** JURY TRIAL DEMANDED
ALCON LABORATORIES, INC. and ALCON RESEARCH, LLC, Counterclaim Plaintiffs, v. HOYA CORPORATION and HOYA SURGICAL OPTICS, INC. Counterclaim Defendants.	

FIRST AMENDED COMPLAINT

Plaintiffs HOYA Corporation, HOYA Surgical Optics, Inc., HOYA Lamphun Ltd., and HOYA Medical Singapore Pte Ltd. (collectively "HOYA" or "Plaintiffs") file this Original Complaint against Defendants Alcon Inc., Alcon Laboratories, Inc., Alcon Research, LLC, and Alcon Vision, LLC (collectively "Alcon" or "Defendants") and hereby allege as follows:

NATURE OF ACTION

1. HOYA alleges that Alcon has infringed and continues to infringe at least one claim of U.S. Patent Nos. 9,901,442 ("the '442 Patent"); 9,980,811 ("the '811 Patent"); 9,655,718 ("the '718 Patent"); 9,877,826 ("the '826 Patent"); 9,907,647 ("the '647 Patent"); and 10,039,668 ("the '668 Patent") (collectively, "Patents-in-Suit").

2. HOYA has been at the forefront of intraocular lens ("IOL") technology since 1987, when it produced its first IOL. An IOL is a synthetic lens implanted in the eye as part of a treatment for cataracts. A cataract is the clouding of the eye's natural lens and is the leading cause of vision loss for people over the age of 40.

3. Cataract surgery is one of the most commonly conducted surgical procedures in the United States, and in the world, and it is essential to restoring vision and improving the quality of life of patients suffering from cataracts. In cataract surgery, an IOL is implanted inside the anterior segment of the eye once the eye's natural lens has been removed. As the number of cataract patients has increased with time, there has been an increased need for improved technologies that allow surgeons to safely and effectively treat these patients.

4. For several decades, HOYA has been a leading developer of IOL technology. HOYA's IOLs and IOL insertion devices dramatically improved cataract surgery because they allow surgeons greater control and precision when implanting the IOL, eliminate the need for manual folding of the lens, and reduce the risk of infection as a result of the device's sterile packaging. HOYA has secured numerous patents on its revolutionary inventions in this technology space, including the Patents-in-Suit, which cover methods and apparatuses for IOL insertion.

5. Alcon infringes the Patents-in-Suit through the manufacture, use, sale, offer for sale, and/or import of at least Alcon's UltraSert Preloaded Delivery System ("UltraSert"). Alcon's

UltraSert is a disposable IOL injector with a preloaded intraocular lens. Alcon has marketed and sold UltraSert to others in the medical industry, including hospitals, medical centers, clinicians, doctors, nurse practitioners, and care providers, with knowledge of HOYA's intellectual property asserted herein. As a result of such actions, Alcon infringes, contributes to the infringement of, and/or induces the infringement of each of the Patents-in-Suit.

PARTIES

6. Plaintiff HOYA Corporation is a corporation organized under the laws of Japan with its principal place of business at 20F Nittochi Nishishinjuku Building, 6-10-1 Nishi-Shinjuku, Shinjuku-ku, Tokyo 160-8347 Japan.

7. Plaintiff HOYA Surgical Optics, Inc. is a corporation organized under the laws of the state of Delaware with its principal place of business at 15335 Fairfield Ranch Road, Suite 250, Chino Hills, CA 91709. HOYA Surgical Optics, Inc. is a subsidiary of HOYA Corporation.

8. Plaintiff HOYA Lamphun Ltd. is a company organized and existing under the laws of the Kingdom of Thailand with its principal office at Northern Region Industrial Estate, 75/2 Moo 4, Tambol Banklang, Amphur Muang, Lamphun, 51000 Thailand.

9. Plaintiff HOYA Medical Singapore Pte Ltd. is a corporation organized and existing under the laws of Singapore, having its principal office at 455A Jalan Ahmad Ibrahim Singapore 639939.

10. Plaintiff HOYA Corporation owns a number of subsidiaries incorporated and headquartered in the United States, including in the state of Texas. For example, HOYA Corporation, through a subsidiary, owns and operates a large facility at 651 E. Corporate Dr., Lewisville, TX 75057.

11. Plaintiffs HOYA Medical Singapore Pte Ltd. and HOYA Lamphun Ltd. are subsidiaries related to HOYA Corporation.

12. Plaintiff HOYA Medical Singapore Pte Ltd. manufactures HOYA IOL insertion devices and distributes HOYA IOL insertion devices in the United States as an exclusive licensee of the patents in suit.

13. Defendant Alcon Inc. is organized under the laws of Switzerland with its principal place of business at Chemin de Blandonnet 8, 1214 Vernier-Geneva, Switzerland. Alcon Inc.'s principal office for U.S. operations is located in Fort Worth, Texas. Alcon Inc. is the ultimate parent company of Alcon Laboratories, Inc., Alcon Research, LLC, and other Alcon entities.

14. Defendant Alcon Laboratories, Inc. is a corporation organized under the laws of the state of Delaware, with its principal place of business at 6201 South Freeway, Fort Worth, Texas 76134. Alcon Laboratories, Inc. is licensed with the Texas Department of Health to manufacture and/or distribute medical devices in the State of Texas. Alcon Laboratories, Inc. is a wholly-owned subsidiary of Alcon Inc.

15. Defendant Alcon Research, LLC (formerly known as Alcon Research, Ltd.) ("Alcon Research") is a corporation organized under the laws of the state of Delaware, with its principal place of business at 6201 South Freeway, Fort Worth, Texas 76134. Alcon Research is licensed with the Texas Department of Health to manufacture and/or distribute medical devices in the State of Texas. Alcon Research is a wholly-owned subsidiary of Alcon Inc.

16. Defendant Alcon Vision, LLC ("Alcon Vision") is a corporation organized under the laws of the state of Delaware, with its principal place of business at 6201 South Freeway, Fort Worth, Texas, 76134. Alcon Vision is licensed with the Texas Department of Health to

manufacture and/or distribute products in the State of Texas. Alcon Vision, LLC is an affiliate of Alcon Inc.

JURISDICTION AND VENUE

17. This Court has subject matter jurisdiction over the patent infringement claims asserted in this case under 28 U.S.C. §§ 1331 and 1338.

18. Venue is proper in this Court pursuant to 28 U.S.C. §§ 1391 and 1400 because Alcon has committed, and continues to commit, acts of infringement in this District and has a regular and established place of business in this District. Alcon maintains regular and established places of business in the District at: 6201 South Freeway, Fort Worth, Texas 76134; 250 E. Altamesa Boulevard, Fort Worth, Texas 76134; 101 E. Altamesa Boulevard, Fort Worth, Texas 76134; 13155 Noel Rd., Dallas, Texas 75240; 777 Taylor St., Suite 900, Fort Worth, TX 76102; and 6551 South Freeway, Fort Worth, Texas 76134.

19. This Court has personal jurisdiction over each named Alcon entity. Alcon was founded in 1945 within the Northern District of Texas. Alcon Inc.'s global headquarters was located in the Northern District of Texas until 2019. Alcon Inc.'s U.S. headquarters is currently located in the Northern District of Texas. Additionally, Alcon Laboratories, Inc.'s and Alcon Research's principal place of business is currently located in the Northern District of Texas.

20. Alcon's largest production and research and development facility is located in the Northern District of Texas.

21. Alcon Inc., Alcon Laboratories, Inc., Alcon Research, and Alcon Vision employ thousands of individuals within the Northern District of Texas, including sales managers, engineers, scientists, materials specialists, legal counsel, and financial analysts.

22. Alcon conducts business extensively within the Northern District of Texas. For example, Alcon employees within this District solicit orders for Alcon's products; demonstrate Alcon's products; maintain an inventory of Alcon's products; and/or fill orders from their inventory of Alcon's products within this District.

23. Alcon has created a manufacturing, sales, and distribution system comprising substantial resources within the Northern District of Texas. Through this distribution channel, Alcon introduces infringing products into the stream of commerce with the knowledge, expectation, and intent that they will be sold and used in the United States, including in the State of Texas and in this District.

THE HOYA PATENTS

24. On February 27, 2018, the U.S. Patent and Trademark Office duly and legally issued U.S. Patent No. 9,901,442 ("the '442 Patent"), entitled "Intraocular Lens Insertion Device," to inventors Kazunori Kudo and Masahiro Noda. HOYA owns all rights to the '442 Patent necessary to bring this action. A true and correct copy of the '442 Patent is attached hereto as Exhibit 1 and incorporated herein by reference.

25. On May 29, 2018, the U.S. Patent and Trademark Office duly and legally issued U.S. Patent No. 9,980,811 ("the '811 Patent"), entitled "Ocular Implant Insertion Apparatus and Methods," to inventors Kazunori Kudo and Masahiro Noda. HOYA owns all rights to the '811 Patent necessary to bring this action. A true and correct copy of the '811 Patent is attached hereto as Exhibit 2 and incorporated herein by reference.

26. On May 23, 2017, the U.S. Patent and Trademark Office duly and legally issued U.S. Patent No. 9,655,718 ("the '718 Patent"), entitled "Intraocular Lens Insertion Device," to inventors Kazunori Kudo and Masahiro Noda. HOYA owns all rights to the '718 Patent necessary

to bring this action. A true and correct copy of the ’718 Patent is attached hereto as Exhibit 3 and incorporated herein by reference.

27. On January 30, 2018, the U.S. Patent and Trademark Office duly and legally issued U.S. Patent No. 9,877,826 (“the ’826 Patent”), entitled “Intraocular Lens Insertion Device,” to inventors Kazunori Kudo and Masahiro Noda. HOYA owns all rights to the ’826 Patent necessary to bring this action. A true and correct copy of the ’826 Patent is attached hereto as Exhibit 4 and incorporated herein by reference.

28. On March 6, 2018, the U.S. Patent and Trademark Office duly and legally issued U.S. Patent No. 9,907,647 (“the ’647 Patent”), entitled “Intraocular Lens Insertion Device and Method for Controlling Movement of the Intraocular Lens,” to inventor Masanobu Inoue. HOYA owns all rights to the ’647 Patent necessary to bring this action. A true and correct copy of the ’647 Patent is attached hereto as Exhibit 5 and incorporated herein by reference.

29. On August 7, 2018, the U.S. Patent and Trademark Office duly and legally issued U.S. Patent No. 10,039,668 (“the ’668 Patent”), entitled “Ocular Implant Insertion Apparatus and Methods,” to inventors Kazunori Kudo and Masahiro Noda. HOYA owns all rights to the ’668 Patent necessary to bring this action. A true and correct copy of the ’668 Patent is attached hereto as Exhibit 6 and incorporated herein by reference.

FACTUAL BACKGROUND

30. For nearly three decades, HOYA has been a leading innovator in the design and manufacture of IOLs and IOL insertion devices, including HOYA’s iSert® injector system. One of HOYA’s revolutionary innovations is its IOL injector technology, which has increased the safety and effectiveness of cataract surgery as we know it today.

31. Cataracts are a major cause of blindness worldwide, and cataract surgery is one of the most commonly performed eye surgeries in the world. Cataract surgery typically involves removing the cloudy natural lens and replacing it with an IOL, which is implanted in the anterior chamber of the eye after the natural lens has been removed.

32. To perform cataract surgery today, a physician typically makes an incision in the periphery of the cornea (the clear outer covering of the eye) and removes the diseased lens using phacoemulsification. The physician then implants the new lens through the same incision. The new lens that is implanted in the patient's eye is typically an IOL that is made of hydrogel, soft acrylic, silicone, or the like.

33. Prior to the introduction of IOL injectors, a surgeon performing cataract surgery would have to insert a rigid polymethylmethacrylate ("PMMA") lens or manually fold a soft foldable lens and place it in the patient's eye using forceps. *See, e.g.*, '718 Patent at 1:25-2:4; '826 Patent at 1:28-3:18; '647 Patent at 1:25-3:07. Performing cataract surgery in this manner was difficult and potentially problematic for several reasons. First, the physician's use of forceps to place the lens in the patient's eye often caused damage to the IOL. Second, performing cataract surgery in this manner required the physician to make large incisions in the cornea in order to be able to place and position the lens on the eye. These large incisions often had to be closed using sutures, which increased the duration of the procedure. Although the size of the incision could be minimized by using foldable lenses, which unfold after insertion, manually folding an IOL requires a high level of skill and presents additional room for error by the physician and possible infection. For example, an uneven fold could cause the lens to be positioned improperly on the eye, which typically could only be remedied by enlarging the incision or making an additional incision. *See, e.g.*, '718 Patent at 1:25-2:4; '826 Patent at 1:28-3:18; '647 Patent at 1:25-3:07. Assistive devices

were eventually developed to help with the challenges presented as a result of having to manually fold the lens during surgery. Although these assistive devices aided with standardizing the proportions of the fold, none of these devices eliminated the use of forceps or provided a method for more controlled and consistent lens insertion.

34. The 1990s saw the development of reusable IOL injectors for soft deformable lenses, allowing physicians to inject an IOL into smaller incisions in the eye. These injectors generally used a cartridge into which the physician loaded the IOL using forceps, and the cartridge was subsequently attached to the injector body. The physician then slowly manipulated the plunger of the injector to advance the loaded IOL out of the injector cartridge and into the capsular sac of the eye. Because physicians had to manually load the IOLs into these injectors, there was the potential for contamination and damage to the optic (round lens portion) or the haptics (*e.g.*, the arm-like supports attached to the optic) of the IOLs. *See, e.g.*, '718 Patent at 1:60-65; '811 Patent at 1:47-57; '647 Patent at 1:60-64. Use of such injectors in certain circumstances could result in damage to the IOL due to the plunger riding up onto the rear haptic and optic, resulting in deformation of the IOL. *See, e.g.*, '718 Patent at 1:66-2:23; '826 Patent at 1:58-2:6; '647 Patent at 1:65-2:20.

35. In the 2000s, HOYA developed disposable, preloaded IOL injectors, which solved many of the challenges that existed with the prior cataract surgery methods and IOL injectors. *See, e.g.*, '718 Patent at 2:57-3:14; '826 Patent at 3:21-67; '647 Patent at 2:50-4:51. To date, HOYA has sold more than nine million preloaded IOL injector systems.

ALCON'S ACCUSED PRODUCTS

A. Alcon Makes, Imports, Uses, Sells, and/or Offers for Sale Products that Infringe the Patents-in-Suit.

36. Alcon makes, imports, uses, sells, and/or offers for sale IOL insertion devices that infringe at least one claim of each of the Patents-in-Suit ("Accused Products").

37. For example, Alcon manufactures, imports, tests, uses, offers for sale, and sells an IOL delivery system called UltraSert, which is preloaded with an IOL. An image of the UltraSert injector is shown below:

https://2.myalcon.com/professional/cataract-surgery/intraocular-lens/ultrasert-preloaded-delivery-system/features-specifications (last visited 12/10/20).

38. Alcon received FDA approval for the UltraSert.

39. Alcon manufacturers UltraSert in the United States. *See* https://www.accessdata.fda.gov/scripts/cdrh/cfdocs/cfRes/res.cfm?ID=181244 (last visited 12/10/2020); https://www.accessdata.fda.gov/scripts/cdrh/cfdocs/cfres/res.cfm?id=148530 (last visited 12/10/2020).

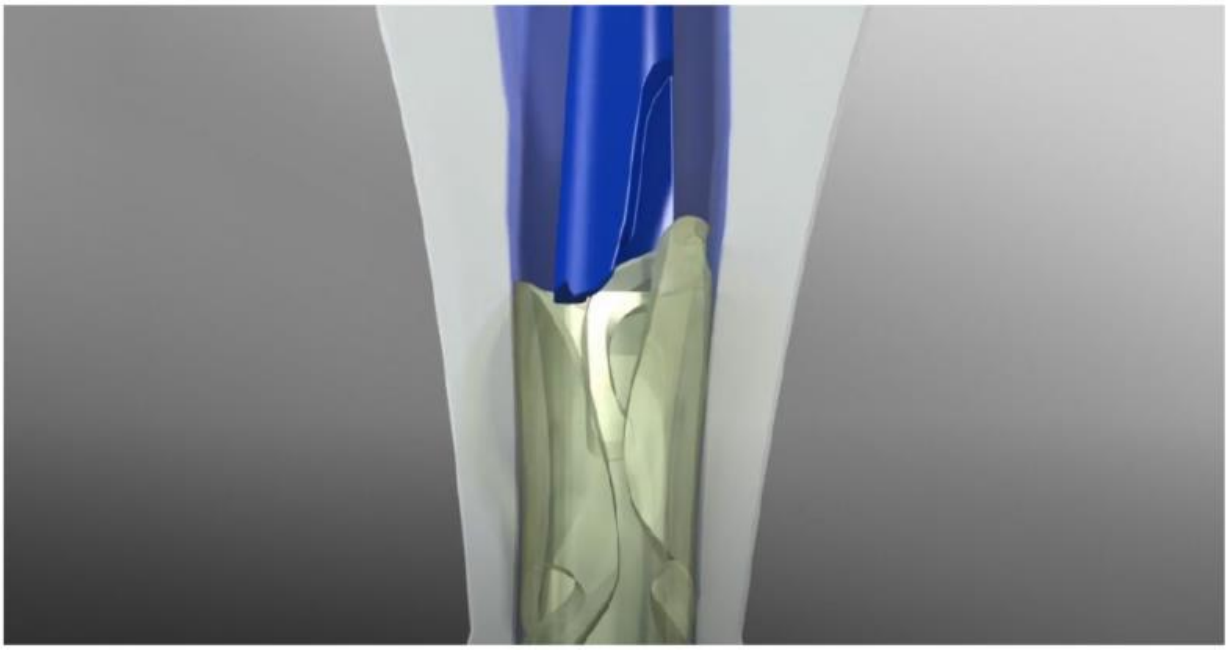
40. Alcon markets, sells, and/or provides UltraSert to hospitals, medical centers, clinics, surgeons, and/or nurses in the United States directly, or through sales representatives or

distributors, and provides instructions on how to use UltraSert. For example, Alcon advertises its UltraSert product on public webpages registered to Alcon Inc. and using public videos branded and/or sponsored by Alcon Inc. *See, e.g.*, https://professional.myalcon.com/cataract-surgery/intraocular-lens/ (last visited 12/10/20); https://www.alcon.com/media-release/alcon-introduces-newly-optimized-ultrasertr-pre-loaded-intraocular-lens-delivery (last visited12/10/20); https://www.ophthalmologytimes.com/view/ultrasert-pre-loaded-delivery-system-surgical-pearls (last visited 12/10/20). Alcon Inc.'s recent SEC filings also include repeated mentions of its UltraSert product. *See* Alcon Inc., Registration Statement (Form 20-F) at 100, 107-108, 110-11, 136 (Mar. 21, 2019).

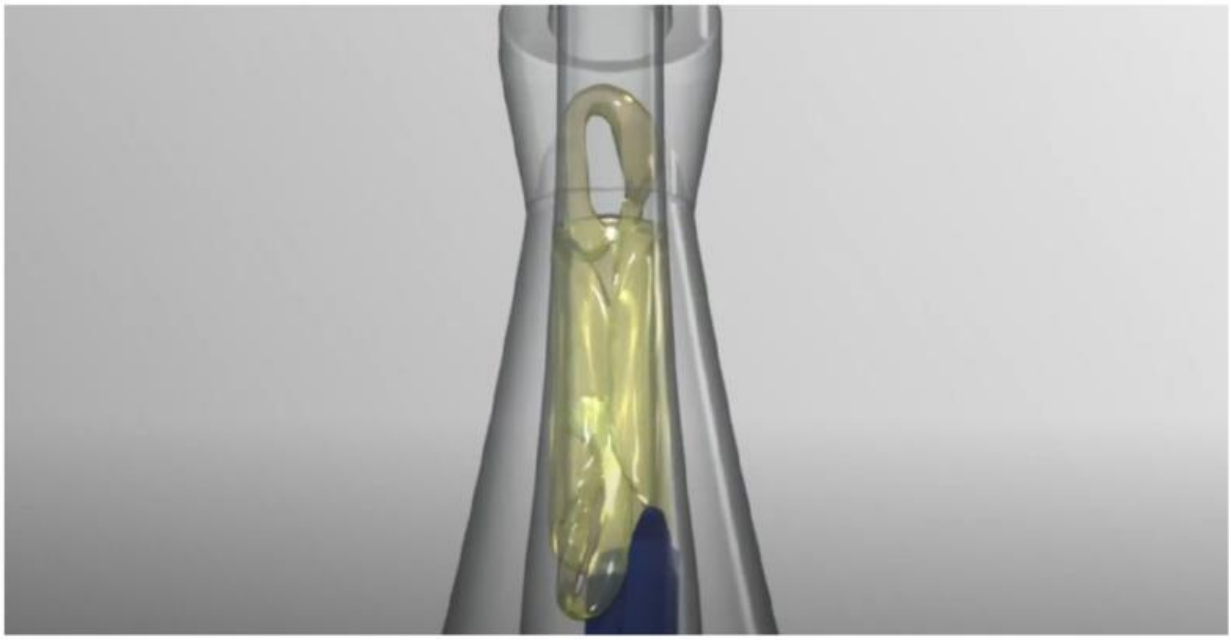
41. Alcon also regularly includes information concerning the production and sale of UltraSert in Alcon Inc.'s SEC filings and presentations to Alcon's investors. *See, e.g.*, https://www.alcon.com/sites/g/files/rbvwei496/files/2019-04/Feb_Roadshow_Presentation_2.12.19.pdf (last visited 12/10/20); https://s1.q4cdn.com/963204942/files/doc_financials/2019/q4/Alcon-Form-20-F-2019.pdf (last visited 12/10/20).

42. Use of UltraSert is depicted in a video titled "Alcon UltraSert preloaded IOL delivery system," available at https://www.youtube.com/watch?v=uXWhS-BVcz4 (last visited 12/10/20). The following images of UltraSert are screenshots captured from this video.

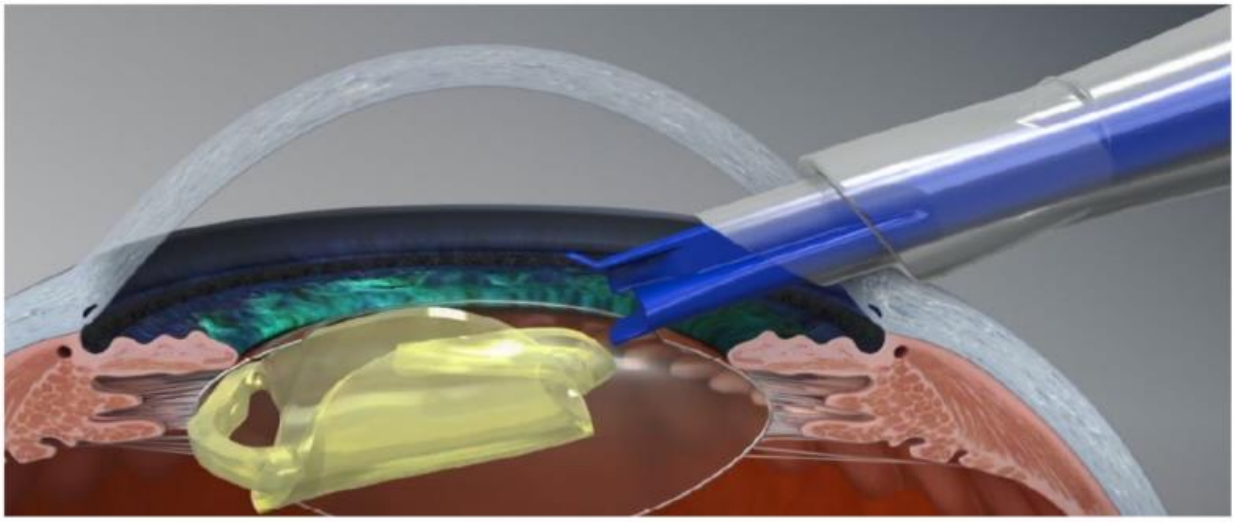
Id. at 0:34.



Id. at 1:08.



Id. at 1:14.



Id. at 6:36.

43. UltraSert is preloaded with an IOL that is comprised of a foldable optic, a bendable distal (*e.g.*, towards the eye) haptic that is attached to the optic at one end and free at another end, and a bendable proximal (*e.g.*, away from the eye) haptic that is attached to the optic at one end and free at another end. The preloaded IOL is positioned within a chamber atop lens supporting

surfaces within the UltraSert injector. The UltraSert also has a main body, a nozzle through which the IOL exits the device, and a tapered transition portion connecting the main body to the nozzle.

44. UltraSert contains a plunger that the user can depress to move the plunger in the distal direction towards the eye. The plunger has top, bottom, and side walls that form a recess, as well as a lens contacting portion. As the plunger moves distally, it first contacts the unfolded proximal haptic and bends it distally in an upward direction such that the free end of the proximal haptic passes over an unfolded portion of the optic. At least a portion of the proximal haptic enters the plunger recess as this occurs. The lens contacting portion of the plunger contacts the optic as the plunger moves distally through the main body. The sides of the optic fold in an upwards direction as the optic approaches the nozzle, and the free end of the upwardly bent proximal haptic enters the space in between the folded portions of the optic. As the IOL is pushed through the nozzle and into the eye by the plunger, the IOL is in a folded configuration with the free end of the proximal haptic pointing in the distal direction and positioned in the space between the folded portions of the optic.

45. When used or tested, UltraSert, and any other Alcon products that operate in substantially the same manner, either alone or in combination, directly infringe at least one claim of each of the Patents-in-Suit.

46. UltraSert is designed and sold to be used only to deliver an intraocular lens in a specific way, as directed by the instructions in the manuals delivered with UltraSert and promotional materials concerning UltraSert. The manuals and promotional materials provide specific instructions for using UltraSert in a way that infringes at least one claim of each of the Patents-in-Suit, and they do not contemplate any non-infringing uses.

GENERAL ALLEGATIONS RELATED TO INFRINGEMENT

47. Alcon has infringed and continues to directly and indirectly infringe at least one claim of each of the Patents-in-Suit by engaging in acts constituting infringement under 35 U.S.C. § 271(a), (b), (c) and/or (f), including but not limited to one or more of making, using, selling, offering for sale, importing, exporting, and inducing and contributing to infringement by others, the Accused Products in this District and elsewhere in the United States.

48. As a result of Alcon's infringement, HOYA has suffered and will continue to suffer harm in the form of reasonable royalties and/or lost profits. HOYA seeks damages for infringing acts beginning as early as six years prior to the filing of this Original Complaint.

49. HOYA also seeks an injunction prohibiting further acts of infringement. Each of Alcon's acts of infringement has caused and will continue to cause HOYA irreparable harm for which there is no adequate remedy at law. Such injunctive relief would not disserve the public interest, and is warranted when considering the balance of equities.

50. Alcon had actual or constructive knowledge and notice of infringement as to each of the Patents-in-Suit. Alcon is a direct competitor of HOYA in the IOL insertion device market. As such, Alcon knew, should have known, or was willfully blind as to the existence of the Patents-in-Suit at the time of Alcon's infringing acts. Additionally, Alcon's patents cite a number of patent applications and publications by the named inventors of the Patents-in-Suit and/or within the same family as the Patents-in-Suit, thereby confirming that Alcon is familiar with HOYA's intellectual property and knew, should have known, or was willfully blind as to the existence of the Patents-in-Suit at the time of Alcon's infringing acts. *See, e.g.*, U.S. Patent Nos. 9,463,089; 9,724,191; 10,010,408; 10,172,706; 10,188,506; 10,568,735; 10,588,780.

51. Alcon's infringement of the Patents-in-Suit has been, and continues to be, willful because Alcon has committed and continues to commit acts of infringement even though Alcon knew or should have known that its actions constituted an unjustifiably high risk of infringement.

52. Alcon's infringement of the Patents-in-Suit has been, and continues to be, without permission, consent, authorization, or license.

COUNT I: PATENT INFRINGEMENT OF THE '442 PATENT

53. HOYA incorporates by reference the preceding paragraphs as though fully set forth herein.

54. Alcon infringes, contributes to the infringement of, and/or induces infringement of the '442 Patent by making, using, selling, offering for sale, and/or importing into the United States the Accused Products that are covered by one or more claims of the '442 Patent.

55. The Accused Products directly infringe, literally and/or by the doctrine of equivalents, one of more claims of the '442 Patent. Alcon makes, uses, sells, offers for sale, and/or imports, in this District and elsewhere in the United States, the Accused Products and thus directly infringes claims of the '442 Patent.

56. For example, Claim 1 of the '442 Patent is reproduced below:

> 1. An intraocular lens insertion apparatus, comprising:
>
> a main body;
>
> an intraocular lens including an optic and haptics, each haptic having a free end, stored in the main body in such a manner that one of the haptics is a proximal haptic and one of the haptics is a distal haptic;
>
> a nozzle associated with the main body and configured to be inserted into an eye; and
>
> a plunger, carried within the main body and movable relative to the main body from a first position to a second position at the nozzle, including a lens contact portion and a recess that is located above

> the lens contact portion, that extends proximally from the lens contact portion, that has a first lateral side that is open, a second lateral side that is closed by a lateral wall, and an open distal end, wherein the plunger is configured to hold a portion of the proximal haptic in the recess when the proximal haptic is bent such that the free end of the proximal haptic is positioned over the optic.

57. As a non-limiting example, UltraSert is an intraocular lens insertion apparatus. This insertion apparatus includes a main body.

58. UltraSert includes an intraocular lens including an optic and haptics, each haptic having a free end, stored in the main body in such a manner that one of the haptics is a proximal haptic and one of the haptics is a distal haptic.

59. UltraSert includes a nozzle associated with the main body and configured to be inserted into an eye.

60. UltraSert includes a plunger that is carried within the main body and movable relative to the main body from a first position to a second position at the nozzle.

61. UltraSert includes a plunger including a lens contact portion and a recess that is located above the lens contact portion.

62. UltraSert includes a plunger including a recess that extends proximally from the lens contact portion, that has a first lateral side that is open, a second lateral side that is closed by a lateral wall, and an open distal end.

63. UltraSert includes a plunger wherein the plunger is configured to hold a portion of the proximal haptic in the recess when the proximal haptic is bent such that the free end of the proximal haptic is positioned over the optic.

64. Alcon also indirectly infringes claims of the ’442 Patent, as provided in 35 U.S.C. § 271(b), by inducing infringement by others, such as Alcon’s distributors, customers, and end users, in this District and elsewhere in the United States. For example, Alcon’s customers and end

users directly infringe through their use of the inventions claimed in the ’442 Patent. Alcon induces this direct infringement through its affirmative acts of manufacturing, selling, distributing, and/or otherwise making available the Accused Products, and providing instructions, documentation, online technical support, marketing, product manuals, advertisements, and other information to customers and end users suggesting they use the Accused Products in an infringing manner. As a result of Alcon’s inducement, Alcon’s customers and end users use the Accused Products in the way Alcon intends and directly infringe the ’442 Patent. Alcon has performed and continues to perform these affirmative acts with knowledge of the ’442 Patent and with the intent, or willful blindness, that the induced acts directly infringe the ’442 Patent.

65. Alcon also indirectly infringes claims of the ’442 Patent, as provided by 35 U.S.C. § 271(c), by contributing to direct infringement committed by others, such as customers and end users, in this District and elsewhere in the United States. Alcon’s affirmative acts of selling and offering to sell, in this District and elsewhere in the United States, the Accused Products and causing the Accused Products to be manufactured, used, sold, and offered for sale, contribute to Alcon’s customers’ and end users’ use of the Accused Products, such that the ’442 Patent is directly infringed. The accused components within the Accused Products are material to the invention of the ’442 Patent, are not staple articles or commodities of commerce, have no substantial non-infringing uses, and are known by Alcon to be especially made or especially adapted for use in infringement of the ’442 Patent. Alcon has performed and continues to perform these affirmative acts with knowledge of the ’442 Patent and with intent, or willful blindness, that they cause the direct infringement of the ’442 Patent.

COUNT II: PATENT INFRINGEMENT OF THE '811 PATENT

66. HOYA incorporates by reference the preceding paragraphs as though fully set forth herein.

67. Alcon infringes, contributes to the infringement of, and/or induces infringement of the '811 Patent by making, using, selling, offering for sale, and/or importing into the United States the Accused Products that are covered by one or more claims of the '811 Patent.

68. The Accused Products directly infringe, literally and/or by the doctrine of equivalents, one or more claims of the '811 Patent. Alcon makes, uses, sells, offers for sale, and/or imports, in this District and elsewhere in the United States, the Accused Products and thus directly infringes claims of the '811 Patent.

69. For example, Claim 1 of the '811 Patent is reproduced below: 1. An intraocular lens insertion apparatus, comprising:

> an outer body including a lens placement section and a nozzle and defining a lens movement direction;
>
> an intraocular lens, having an optic with a diameter and haptics with respective free ends, stored in the lens placement section in such a manner that the optic diameter is perpendicular to the lens movement direction, one of the haptics is a proximal haptic and one of the haptics is a distal haptic; and
>
> a plunger, at least a portion of which is carried within the outer body, that is movable relative to the outer body and which has a distal region that defines a longitudinal axis, the distal region including
>
> a bottom wall having an upper surface and defining a width in a direction transverse to the longitudinal axis of the distal region,
>
> a lens contact surface extending downwardly from the bottom wall upper surface,
>
> a top wall defining a width in a direction transverse to the longitudinal axis of the distal region that is less than the width of the bottom wall, and

> a lateral wall that extends from the bottom wall to the top wall in a direction perpendicular to the optic diameter that is perpendicular to the lens movement direction,
>
> the top wall, bottom wall and lateral wall together defining a recess that is located above the bottom wall, that extends proximally from the lens contact surface, that has a first lateral side that is open, a second lateral side that is closed by the lateral wall, and an open distal end, and that is configured to hold a portion of the proximal haptic when the proximal haptic is bent such that the free end is positioned over the optic.

70. As a non-limiting example, UltraSert is an intraocular lens insertion apparatus. This insertion apparatus includes an outer body including a lens placement section and a nozzle and defining a lens movement direction.

71. UltraSert includes an intraocular lens including an optic with a diameter and haptics with respective free ends, stored in the lens placement section in such a manner that the optic diameter is perpendicular to the lens movement direction, one of the haptics is a proximal haptic and one of the haptics is a distal haptic.

72. UltraSert includes a plunger, at least a portion of which is carried within the outer body, that is movable relative to the outer body and which has a distal region that defines a longitudinal axis.

73. UltraSert includes a plunger with a distal region including a bottom wall having an upper surface and defining a width in a direction transverse to the longitudinal axis of the distal region, a lens contact surface extending downwardly from the bottom wall upper surface, a top wall defining a width in a direction transverse to the longitudinal axis of the distal region that is less than the width of the bottom wall, and a lateral wall that extends from the bottom wall to the top wall in a direction perpendicular to the optic diameter that is perpendicular to the lens movement direction, the top wall, bottom wall and lateral wall together defining a recess that is located above the bottom wall, that extends proximally from the lens contact surface, that has a

first lateral side that is open, a second lateral side that is closed by the lateral wall, and an open distal end, and that is configured to hold a portion of the proximal haptic when the proximal haptic is bent such that the free end is positioned over the optic.

74. Alcon also indirectly infringes claims of the ’811 Patent, as provided in 35 U.S.C. § 271(b), by inducing infringement by others, such as Alcon’s distributors, customers, and end users, in this District and elsewhere in the United States. For example, Alcon’s customers and end users directly infringe through their use of the inventions claimed in the ’811 Patent. Alcon induces this direct infringement through its affirmative acts of manufacturing, selling, distributing, and/or otherwise making available the Accused Products, and providing instructions, documentation, online technical support, marketing, product manuals, advertisements, and other information to customers and end users suggesting they use the Accused Products in an infringing manner. As a result of Alcon’s inducement, Alcon’s customers and end users use the Accused Products in the way Alcon intends and directly infringe the ’811 Patent. Alcon has performed and continues to perform these affirmative acts with knowledge of the ’811 Patent and with the intent, or willful blindness, that the induced acts directly infringe the ’811 Patent.

75. Alcon also indirectly infringes claims of the ’811 Patent, as provided by 35 U.S.C. § 271(c), by contributing to direct infringement committed by others, such as customers and end users, in this District and elsewhere in the United States. Alcon’s affirmative acts of selling and offering to sell, in this District and elsewhere in the United States, the Accused Products and causing the Accused Products to be manufactured, used, sold, and offered for sale, contribute to Alcon’s customers’ and end users’ use of the Accused Products, such that the ’811 Patent is directly infringed. The accused components within the Accused Products are material to the invention of the ’811 Patent, are not staple articles or commodities of commerce, have no

substantial non-infringing uses, and are known by Alcon to be especially made or especially adapted for use in infringement of the ’811 Patent. Alcon has performed and continues to perform these affirmative acts with knowledge of the ’811 Patent and with intent, or willful blindness, that they cause the direct infringement of the ’811 Patent.

COUNT III: PATENT INFRINGEMENT OF THE ’718 PATENT

76. HOYA incorporates by reference the preceding paragraphs as though fully set forth herein.

77. Alcon infringes, contributes to the infringement of, and/or induces infringement of the ’718 Patent by making, using, selling, offering for sale, and/or importing into the United States the Accused Products that are covered by one or more claims of the ’718 Patent.

78. The Accused Products directly infringe, literally and/or by the doctrine of equivalents, one or more claims of the ’718 Patent. Alcon makes, uses, sells, offers for sale, and/or imports, in this District and elsewhere in the United States, the Accused Products and thus directly infringes claims of the ’718 Patent.

79. For example, Claim 1 of the ’718 Patent is reproduced below:

> 1. A method for use with an intraocular lens, including an optic, a forward haptic having an end and a rear haptic having an end, that is located within an insertion device defining a lens travelling axis and including a nozzle, a transition section and a plunger that moves forwardly toward the nozzle and includes a forward region with a side wall and a bottom wall that together define a slot that extends rearwardly and is configured to receive a portion of the rear haptic, the method comprising the steps of:
>
> pushing the end of the rear haptic upwardly and forwardly relative to the optic;
>
> pushing the end of the rear haptic over the optic, while the portion of the optic over which the rear haptic passes remains unfolded, with the forward region of the plunger such that a portion of the rear haptic is bent and received in the slot that extends rearwardly;

folding the optic such that there is a space between folded portions of the optic; and

pushing the intraocular lens through the nozzle with the forward region of the plunger while the end of the rear haptic is in the space between the folded portions of the optic.

80. As a non-limiting example, UltraSert is used according to a method of use with an intraocular lens. UltraSert is used with an intraocular lens including an optic, a forward haptic having an end and a rear haptic having an end.

81. UltraSert is used according to a method in which the intraocular lens is located within an insertion device defining a lens travelling axis and including a nozzle, a transition section, and a plunger that moves forwardly toward the nozzle.

82. UltraSert has a plunger which includes a forward region with a side wall and a bottom wall that together define a slot that extends rearwardly and is configured to receive a portion of the rear haptic.

83. UltraSert is operated by pushing the end of the rear haptic upwardly and forwardly relative to the optic.

84. UltraSert provides for pushing the end of the rear haptic over the optic, while the portion of the optic over which the rear haptic passes remains unfolded, with the forward region of the plunger such that a portion of the rear haptic is bent and received in the slot that extends rearwardly.

85. The implantation method of UltraSert provides for folding the optic such that there is a space between folded portions of the optic.

86. The implantation method of UltraSert provides for pushing the intraocular lens through the nozzle with the forward region of the plunger while the end of the rear haptic is in the space between the folded portions of the optic.

87. Alcon also indirectly infringes claims of the ’718 Patent, as provided in 35 U.S.C. § 271(b), by inducing infringement by others, such as Alcon’s distributors, customers, and end users, in this District and elsewhere in the United States. For example, Alcon’s customers and end users directly infringe through their use of the invention claimed in the ’718 Patent. Alcon induces this direct infringement through its affirmative acts of manufacturing, selling, distributing, and/or otherwise making available the Accused Products, and providing instructions, documentation, online technical support, marketing, product manuals, advertisements, and other information to customers and end users suggesting they use the Accused Products in an infringing manner. As a result of Alcon’s inducement, Alcon’s customers and end users use the Accused Products in the way Alcon intends and directly infringe the ’718 Patent. Alcon has performed and continues to perform these affirmative acts with knowledge of the ’718 Patent and with the intent, or willful blindness, that the induced acts directly infringe the ’718 Patent.

88. Alcon also indirectly infringes claims of the ’718 Patent, as provided by 35 U.S.C. § 271(c), by contributing to direct infringement committed by others, such as customers and end users, in this District and elsewhere in the United States. Alcon’s affirmative acts of selling and offering to sell, in this District and elsewhere in the United States, the Accused Products and causing the Accused Products to be manufactured, used, sold, and offered for sale, contribute to Alcon’s customers’ and end users’ use of the Accused Products, such that the ’718 Patent is directly infringed. The accused components within the Accused Products are material to the invention of the ’718 Patent, are not staple articles or commodities of commerce, have no substantial non-infringing uses, and are known by Alcon to be especially made or especially adapted for use in infringement of the ’718 Patent. Alcon has performed and continues to perform

these affirmative acts with knowledge of the '718 Patent and with intent, or willful blindness, that they cause the direct infringement of the '718 Patent.

COUNT IV: PATENT INFRINGEMENT OF THE '826 PATENT

89. HOYA incorporates by reference the preceding paragraphs as though fully set forth herein.

90. Alcon infringes, contributes to the infringement of, and/or induces infringement of the '826 Patent by making, using, selling, offering for sale, and/or importing into the United States the Accused Products that are covered by one or more claims of the '826 Patent.

91. The Accused Products directly infringe, literally and/or by the doctrine of equivalents, one or more claims of the '826 Patent. Alcon makes, uses, sells, offers for sale, and/or imports, in this District and elsewhere in the United States, the Accused Products and thus directly infringes claims of the '826 Patent.

92. For example, Claim 1 of the '826 Patent is reproduced below:

> 1. A method performed by an intraocular lens insertion device on an intraocular lens, the intraocular lens including an optic, a forward haptic having an end and a rear haptic having an end, the insertion device including a nozzle, a transition section and a plunger having a forward region with a side wall and a bottom wall that together define an indentation and is configured to receive a portion of the rear haptic, the method comprising the steps of:
>
> pushing the rear haptic such that the end of the rear haptic moves upwardly and forwardly relative to the optic;
>
> pushing the rear haptic such that the end of the rear haptic passes over the optic , while the portion of the optic over which the rear haptic passes remains unfolded, with the forward region of the plunger in such a manner that the rear haptic is bent and a portion of the rear haptic is received in the indentation;
>
> folding a portion of the optic such that there is a space between folded portions of the optic; and
>
> pushing the intraocular lens through the nozzle with the forward region of the plunger while the end of the rear haptic is in the space between the folded portions of the optic.

93. As a non-limiting example, UltraSert is used according to a method of using an intraocular lens insertion device on an intraocular lens. UltraSert is used according to a method in which the intraocular lens includes an optic, a forward haptic having an end and a rear haptic having an end, the insertion device including a nozzle, a transition section and a plunger having a forward region with a side wall and a bottom wall that together define an indentation and is configured to receive a portion of the rear haptic.

94. UltraSert is used according to a method which includes pushing the rear haptic such that the end of the rear haptic moves upwardly and forwardly relative to the optic.

95. UltraSert is used according to a method which includes pushing the rear haptic such that the end of the rear haptic passes over the optic, while the portion of the optic over which the rear haptic passes remains unfolded, with the forward region of the plunger in such a manner that the rear haptic is bent and a portion of the rear haptic is received in the indentation.

96. UltraSert is used according to a method which includes folding a portion of the optic such that there is a space between folded portions of the optic.

97. UltraSert is used according to a method which includes pushing the intraocular lens through the nozzle with the forward region of the plunger while the end of the rear haptic is in the space between the folded portions of the optic.

98. UltraSert is operated by moving the free end of the rear haptic, from a position rearward of the optic, over the optic and into a space between folded portions of the optic with the plunger.

99. Alcon also indirectly infringes claims of the ’826 Patent, as provided in 35 U.S.C. § 271(b), by inducing infringement by others, such as Alcon’s customers, and end users,

in this District and elsewhere in the United States. For example, Alcon's customers and end users directly infringe through their use of the inventions claimed in the '826 Patent. Alcon induces this direct infringement through its affirmative acts of manufacturing, selling, distributing, and/or otherwise making available the Accused Products, and providing instructions, documentation, online technical support, marketing, product manuals, advertisements, and other information to customers and end users suggesting they use the Accused Products in an infringing manner. As a result of Alcon's inducement, Alcon's customers and end users use the Accused Products in the way Alcon intends and directly infringe the '826 Patent. Alcon has performed and continues to perform these affirmative acts with knowledge of the '826 Patent and with the intent, or willful blindness, that the induced acts directly infringe the '826 Patent.

100. Alcon also indirectly infringes claims of the '826 Patent, as provided by 35 U.S.C. § 271(c), by contributing to direct infringement committed by others, such as customers and end users, in this District and elsewhere in the United States. Alcon's affirmative acts of selling and offering to sell, in this District and elsewhere in the United States, the Accused Products and causing the Accused Products to be manufactured, used, sold, and offered for sale, contribute to Alcon's customers' and end users' use of the Accused Products, such that the '826 Patent is directly infringed. The accused components within the Accused Products are material to the invention of the '826 Patent, are not staple articles or commodities of commerce, have no substantial non-infringing uses, and are known by Alcon to be especially made or especially adapted for use in infringement of the '826 Patent. Alcon has performed and continues to perform these affirmative acts with knowledge of the '826 Patent and with intent, or willful blindness, that they cause the direct infringement of the '826 Patent.

COUNT V: PATENT INFRINGEMENT OF THE '647 PATENT

101. HOYA incorporates by reference the preceding paragraphs as though fully set forth herein.

102. Alcon infringes, contributes to the infringement of, and/or induces infringement of the '647 Patent by making, using, selling, offering for sale, and/or importing into the United States the Accused Products that are covered by one or more claims of the '647 Patent.

103. The Accused Products directly infringe, literally and/or by the doctrine of equivalents, one or more claims of the '647 Patent. Alcon makes, uses, sells, offers for sale, and/or imports, in this District and elsewhere in the United States, the Accused Products and thus directly infringes claims of the '647 Patent.

104. For example, Claim 1 of the '647 Patent is reproduced below:

> 1. A method of operating an insertion device including a main body, a nozzle, and a tapered transition portion proximal of the nozzle, the method comprising the steps of:
>
> applying force to an intraocular lens, located within the main body and having an optic, a leading loop haptic with a fixed end at the optic and a free end, and a trailing loop haptic with a fixed end at the optic and a free end, with a plunger, including a distal portion with a lens contact surface and a slot that extends proximally from the lens contact surface, in such a manner that a portion of the trailing loop haptic is located within the slot while being bent toward the nozzle by the distal portion and the free end of the trailing loop haptic points toward the nozzle; and
>
> pushing the intraocular lens into the nozzle with the plunger.

105. As a non-limiting example, UltraSert is used according to a method of operating an insertion device. The insertion device includes a main body, a nozzle, and a tapered transition portion proximal of the nozzle.

106. UltraSert is used according to a method in which force is applied to an intraocular lens, located within the main body and having an optic, a leading loop haptic with a fixed end at

the optic and a free end, and a trailing loop haptic with a fixed end at the optic and a free end, with a plunger.

107. UltraSert is used according to a method which includes a plunger, including a distal portion with a lens contact surface and a slot that extends proximally from the lens contact surface.

108. UltraSert is operated by applying a force to the intraocular lens with a plunger in such a manner that a portion of the trailing loop haptic is located within the slot while being bent toward the nozzle by the distal portion and the free end of the trailing loop haptic points toward the nozzle.

109. UltraSert is operated by pushing the intraocular lens into the nozzle with the plunger.

110. Alcon also indirectly infringes claims of the '647 Patent, as provided in 35 U.S.C. § 271(b), by inducing infringement by others, such as Alcon's customers, and end users, in this District and elsewhere in the United States. For example, Alcon's customers and end users directly infringe through their use of the inventions claimed in the '647 Patent. Alcon induces this direct infringement through its affirmative acts of manufacturing, selling, distributing, and/or otherwise making available the Accused Products, and providing instructions, documentation, online technical support, marketing, product manuals, advertisements, and other information to customers and end users suggesting they use the Accused Products in an infringing manner. As a result of Alcon's inducement, Alcon's customers and end users use the Accused Products in the way Alcon intends and directly infringe the '647 Patent. Alcon has performed and continues to perform these affirmative acts with knowledge of the '647 Patent and with the intent, or willful blindness, that the induced acts directly infringe the '647 Patent.

111. Alcon also indirectly infringes claims of the ’647 Patent, as provided by 35 U.S.C. § 271(c), by contributing to direct infringement committed by others, such as customers and end users, in this District and elsewhere in the United States. Alcon’s affirmative acts of selling and offering to sell, in this District and elsewhere in the United States, the Accused Products and causing the Accused Products to be manufactured, used, sold, and offered for sale, contribute to Alcon’s customers’ and end users’ use of the Accused Products, such that the ’647 Patent is directly infringed. The accused components within the Accused Products are material to the invention of the ’647 Patent, are not staple articles or commodities of commerce, have no substantial non-infringing uses, and are known by Alcon to be especially made or especially adapted for use in infringement of the ’647 Patent. Alcon has performed and continues to perform these affirmative acts with knowledge of the ’647 Patent and with intent, or willful blindness, that they cause the direct infringement of the ’647 Patent.

COUNT VI: PATENT INFRINGEMENT OF THE ’668 PATENT

112. HOYA incorporates by reference the preceding paragraphs as though fully set forth herein.

113. Alcon infringes, contributes to the infringement of, and/or induces infringement of the ’668 Patent by making, using, selling, offering for sale, and/or importing into the United States the Accused Products that are covered by one or more claims of the ’668 Patent.

114. The Accused Products directly infringe, literally and/or by the doctrine of equivalents, one or more claims of the ’668 Patent. Alcon makes, uses, sells, offers for sale, and/or imports, in this District and elsewhere in the United States the Accused Products and thus directly infringes claims of the ’668 Patent.

115. For example, Claim 1 of the ’668 Patent is reproduced below:

> 1. An intraocular lens insertion apparatus, comprising:
>
> an outer body that defines a lens movement direction, that includes a nozzle and a lens placement section with lens supporting surfaces having portions that are spaced from one another in a spacing direction that is perpendicular to the lens movement direction, and that is configured to store an intraocular lens, having an optic with a diameter and haptics with respective free ends in such a manner that diametrically opposed portions of the optic are on the lens supporting surface portions that are spaced in the spacing direction that is perpendicular to the lens movement direction, one of the haptics is a proximal haptic, and one of the haptics is a distal haptic; and
>
> a plunger, at least a portion of which is carried within the outer body, that is movable relative to the outer body and which has a distal region that defines a longitudinal axis, the distal region including a bottom wall having an upper surface and defining a width in a direction transverse to the longitudinal axis of the distal region, a lens contact surface extending downwardly from the bottom wall upper surface, a top wall defining a width in a direction transverse to the longitudinal axis of the distal region that is less than the width of the bottom wall, and a lateral wall that extends from the bottom wall to the top wall in a direction perpendicular to the spacing direction that is perpendicular to the lens movement direction, the top wall, bottom wall and lateral wall together defining a recess that is located above the bottom wall, that extends proximally from the lens contact surface , that has a first lateral side that is open, second lateral side that is closed by the lateral wall and an open distal end, and that is configured to hold a portion of the proximal haptic when the proximal haptic is bent such that the free end is positioned over the optic.

116. As a non-limiting example, UltraSert is an intraocular lens insertion apparatus. This insertion apparatus includes an outer body and a plunger.

117. UltraSert includes an outer body that defines a lens movement direction, that includes a nozzle and a lens placement section with lens supporting surfaces having portions that are spaced from one another in a spacing direction that is perpendicular to the lens movement direction, and that is configured to store an intraocular lens, having an optic with a diameter and haptics with respective free ends in such a manner that diametrically opposed portions of the optic are on the lens supporting surface portions that are spaced in the spacing direction that is

perpendicular to the lens movement direction, one of the haptics is a proximal haptic, and one of the haptics is a distal haptic.

118. UltraSert includes a plunger, at least a portion of which is carried within the outer body, that is movable relative to the outer body and which has a distal region that defines a longitudinal axis, the distal region including a bottom wall having an upper surface and defining a width in a direction transverse to the longitudinal axis of the distal region, a lens contact surface extending downwardly from the bottom wall upper surface, a top wall defining a width in a direction transverse to the longitudinal axis of the distal region that is less than the width of the bottom wall, and a lateral wall that extends from the bottom wall to the top wall in a direction perpendicular to the spacing direction that is perpendicular to the lens movement direction, the top wall, bottom wall and lateral wall together defining a recess that is located above the bottom wall, that extends proximally from the lens contact surface, that has a first lateral side that is open, second lateral side that is closed by the lateral wall and an open distal end, and that is configured to hold a portion of the proximal haptic when the proximal haptic is bent such that the free end is positioned over the optic.

119. Alcon also indirectly infringes claims of the ’668 Patent, as provided in 35 U.S.C. § 271(b), by inducing infringement by others, such as Alcon’s customers, and end users, in this District and elsewhere in the United States. For example, Alcon’s customers and end users directly infringe through their use of the inventions claimed in the ’668 Patent. Alcon induces this direct infringement through its affirmative acts of manufacturing, selling, distributing, and/or otherwise making available the Accused Products, and providing instructions, documentation, online technical support, marketing, product manuals, advertisements, and other information to customers and end users suggesting they use the Accused Products in an infringing manner. As a result of

Alcon's inducement, Alcon's customers and end users use the Accused Products in the way Alcon intends and directly infringe the '668 Patent. Alcon has performed and continues to perform these affirmative acts with knowledge of the '668 Patent and with the intent, or willful blindness, that the induced acts directly infringe the '668 Patent.

120. Alcon also indirectly infringes claims of the '668 Patent, as provided by 35 U.S.C. § 271(c), by contributing to direct infringement committed by others, such as customers and end users, in this District and elsewhere in the United States. Alcon's affirmative acts of selling and offering to sell, in this District and elsewhere in the United States, the Accused Products and causing the Accused Products to be manufactured, used, sold, and offered for sale, contribute to Alcon's customers' and end users' use of the Accused Products, such that the '668 Patent is directly infringed. The accused components within the Accused Products are material to the invention of the '668 Patent, are not staple articles or commodities of commerce, have no substantial non-infringing uses, and are known by Alcon to be especially made or especially adapted for use in infringement of the '668 Patent. Alcon has performed and continues to perform these affirmative acts with knowledge of the '668 Patent and with intent, or willful blindness, that they cause the direct infringement of the '668 Patent.

PRAYER FOR RELIEF

WHEREFORE, HOYA respectfully requests that this Court enter judgment in its favor as follows and award HOYA the following relief:

(a) an award of damages adequate to compensate HOYA for infringement of the Patents-in-Suit by Alcon, in an amount to be proven at trial, including supplemental post-verdict damages until such time as Alcon ceases its infringing conduct;

(b) a permanent injunction prohibiting Alcon and its officers, directors, employees, agents, consultants, contractors, suppliers, distributors, all affiliated entities, and

all others acting in privity with Alcon, from committing further acts of infringement;

(c) enhanced damages for willful infringement;

(d) the costs of this action, as well as attorneys' fees as provided by 35 U.S.C. § 285;

(e) pre-judgment and post-judgment interest at the maximum amount permitted by law;

(f) all other relief, in law or equity, to which HOYA is entitled.

DEMAND FOR JURY TRIAL

Plaintiff hereby demands a jury trial for all issues so triable.

Dated: July 30, 2021

Theodore Stevenson, III

Theodore Stevenson, III
Texas State Bar No. 19196650
ted.stevenson@alston.com
ALSTON & BIRD
2200 Ross Avenue, Suite 2300
Dallas, TX 75201
Telephone: (214) 922-3400

Natalie C. Clayton
(admitted *pro hac vice*)
natalie.clayton@alston.com
Madeline E. Byrd
(admitted *pro hac vice*)
maddy.byrd@alston.com
ALSTON & BIRD LLP
90 Park Avenue, 15th Floor
New York, NY 10016-1387
Telephone: (212) 210-9400

Lindsay C. Church
(admitted *pro hac vice*)
lindsay.church@alston.com
ALSTON & BIRD LLP
1201 W Peachtree St NE
Atlanta, GA 30309
Telephone: (404) 881-7777

ATTORNEYS FOR PLAINTIFFS

EXHIBIT 1

US009901442B2

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

(10) **Patent No.: US 9,901,442 B2**
(45) **Date of Patent: *Feb. 27, 2018**

(54) **INTRAOCULAR LENS INSERTION DEVICE**

(71) Applicant: **Hoya Corporation**, Tokyo (JP)

(72) Inventors: **Kazunori Kudo**, Saku (JP); **Masahiro Noda**, Toda (JP)

(73) Assignee: **Hoya Corporation**, Tokyo (JP)

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

This patent is subject to a terminal disclaimer.

(21) Appl. No.: **15/600,684**

(22) Filed: **May 19, 2017**

(65) **Prior Publication Data**

US 2017/0252150 A1 Sep. 7, 2017

Related U.S. Application Data

(63) Continuation of application No. 14/099,989, filed on Dec. 8, 2013, now Pat. No. 9,655,718, which is a (Continued)

(30) **Foreign Application Priority Data**

Jan. 7, 2009 (JP) 2009-001493

(51) **Int. Cl.**
A61F 2/16 (2006.01)

(52) **U.S. Cl.**
CPC ***A61F 2/167*** (2013.01); ***A61F 2/1672*** (2013.01)

(58) **Field of Classification Search**
CPC A61F 2/167; A61F 2/1662; A61F 2/1672; A61F 2/1675; A61F 2/1678; A61F 2/14; A61F 2/16
(Continued)

(56) **References Cited**

U.S. PATENT DOCUMENTS

2,761,446 A 9/1956 Reed
4,205,747 A 6/1980 Gilliam et al.
(Continued)

FOREIGN PATENT DOCUMENTS

DE 3610925 10/1987
DE 4110278 10/1992
(Continued)

OTHER PUBLICATIONS

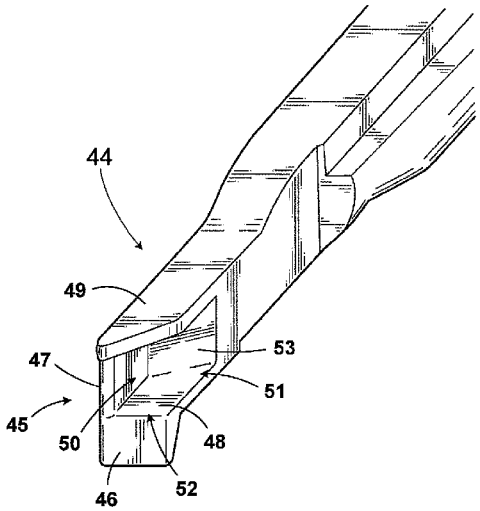
PCT International Search Report dated Feb. 2, 2010 for PCT App. Ser. No. PCT/JP2010/050029.

Primary Examiner — Kathleen Holwerda
Assistant Examiner — Socrates L Boutsikaris
(74) *Attorney, Agent, or Firm* — Henricks, Slavin & Holmes LLP

(57) **ABSTRACT**

There is provided an intraocular lens insertion device capable of appropriately regulating the motion of a rear supporting portion during a process of moving an intraocular lens, and reducing the possibility of reoperation being required after the intraocular lens is inserted into an eye. An intraocular lens insertion device **1** comprises a main body **2**, and a slider **3** and a plunger **4** that are attached to the main body **2**. Further, the intraocular lens insertion device **1** is of a preset type in which an intraocular lens **5** is placed inside the main body **2** in advance. The slider **3** includes a first abutting portion **21** for pushing up a supporting portion **7** (rear supporting portion **7***a*) arranged on a rear side of an optical part **6** with respect to a lens advancement axis A, and second abutting portions **22***a*, **22***b* abutting against an outer edge of a rear portion of the optical part **6**.

27 Claims, 9 Drawing Sheets



Related U.S. Application Data

continuation of application No. 13/143,322, filed as application No. PCT/JP2010/050029 on Jan. 5, 2010, now Pat. No. 8,603,103.

(58) **Field of Classification Search**
USPC 606/107; 623/6.12
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

4,269,307	A	5/1981	LaHaye
4,423,809	A	1/1984	Mazzocco
4,573,998	A	3/1986	Mazzocco
4,608,049	A	8/1986	Kelman
4,634,423	A	1/1987	Bailey
4,681,102	A	7/1987	Bartell
4,697,697	A	10/1987	Graham et al.
4,699,140	A	10/1987	Holmes
4,702,244	A	10/1987	Mazzocco
4,715,373	A	12/1987	Mazzocco et al.
4,747,404	A	5/1988	Jampel et al.
4,750,498	A	6/1988	Graham
4,759,359	A	7/1988	Willis et al.
4,763,650	A	8/1988	Hauser
4,765,329	A	8/1988	Cumming et al.
4,769,034	A	9/1988	Poley
4,781,719	A	11/1988	Kelman
4,787,904	A	11/1988	Severin
4,810,249	A	3/1989	Haber et al.
4,819,631	A	4/1989	Poley
4,834,094	A	5/1989	Patton
4,836,201	A	6/1989	Patton
4,862,885	A	9/1989	Cumming
4,880,000	A	11/1989	Holmes et al.
4,919,130	A	4/1990	Stoy et al.
4,934,363	A	6/1990	Smith et al.
4,955,889	A	9/1990	Van Gent
4,976,716	A	12/1990	Cumming
4,988,352	A	1/1991	Poley
4,994,028	A	2/1991	Leonard et al.
5,066,297	A	11/1991	Cumming
5,098,439	A	3/1992	Hill et al.
5,123,905	A	6/1992	Kelman
5,139,501	A	8/1992	Klaas
5,171,241	A	12/1992	Buboltz et al.
5,176,686	A	1/1993	Poley
5,190,552	A	3/1993	Kelman
5,190,553	A	3/1993	Kanert et al.
5,222,972	A	6/1993	Hill et al.
5,242,450	A	9/1993	McDonald
5,259,395	A	11/1993	Li
5,275,604	A	1/1994	Rheinish et al.
5,281,227	A	1/1994	Sussman
5,304,182	A	4/1994	Rheinish et al.
5,354,333	A	10/1994	Kammann et al.
5,395,378	A	3/1995	McDonald
5,425,734	A	6/1995	Blake
5,454,818	A	10/1995	Hambleton et al.
5,468,246	A	11/1995	Blake
5,474,562	A	12/1995	Orchowski et al.
5,494,484	A	2/1996	Feingold
5,496,328	A	3/1996	Nakajima et al.
5,499,987	A	3/1996	Feingold
5,562,676	A	10/1996	Brady et al.
5,571,113	A	11/1996	McDonald
5,578,042	A	11/1996	Cumming
5,582,613	A	12/1996	Brady
5,582,614	A	12/1996	Feingold
5,584,304	A	12/1996	Brady
5,616,148	A	4/1997	Eagles et al.
5,620,450	A	4/1997	Eagles et al.
5,643,275	A	7/1997	Blake
5,643,276	A	7/1997	Zaleski
5,645,534	A	7/1997	Chanoch
5,653,715	A	8/1997	Reich et al.
5,653,753	A	8/1997	Brady et al.
5,702,402	A	12/1997	Brady
5,702,441	A	12/1997	Zhou
5,716,364	A	2/1998	Makker et al.
5,728,075	A	3/1998	Levander
5,728,102	A	3/1998	Feingold et al.
5,735,858	A	4/1998	Makker et al.
5,766,181	A	6/1998	Chambers et al.
5,772,666	A	6/1998	Feingold et al.
5,772,667	A	6/1998	Blake
5,776,138	A	7/1998	Vidal et al.
5,800,442	A	9/1998	Wolf et al.
5,803,925	A	9/1998	Yang et al.
5,807,400	A	9/1998	Chambers et al.
5,810,833	A	9/1998	Brady et al.
5,810,834	A	9/1998	Heyman
5,860,984	A	1/1999	Chambers et al.
5,860,986	A	1/1999	Reich et al.
5,868,751	A	2/1999	Feingold
5,868,752	A	2/1999	Makker et al.
5,873,879	A	2/1999	Figueroa et al.
5,876,406	A	3/1999	Wolf et al.
5,876,407	A	3/1999	Makker et al.
5,876,440	A	3/1999	Feingold
5,891,152	A	4/1999	Feingold
5,902,307	A	5/1999	Feingold et al.
5,919,197	A	7/1999	McDonald
5,921,989	A	7/1999	Deacon et al.
5,928,245	A	7/1999	Wolf et al.
5,941,886	A	8/1999	Feingold
5,942,277	A	8/1999	Makker et al.
5,944,725	A	8/1999	Cicenas
5,947,974	A	9/1999	Brady et al.
5,947,975	A	9/1999	Kikuchi et al.
5,957,748	A	9/1999	Ichiha
5,957,896	A	9/1999	Bendek et al.
6,001,107	A	12/1999	Feingold
6,010,510	A	1/2000	Brown et al.
6,022,358	A	2/2000	Wolf et al.
6,048,348	A	4/2000	Chambers et al.
6,051,000	A	4/2000	Heyman
6,056,757	A	5/2000	Feingold et al.
6,056,758	A	5/2000	Vidal et al.
6,059,791	A	5/2000	Chambers
6,074,397	A	6/2000	Chambers et al.
6,083,230	A	7/2000	Makker et al.
6,093,193	A	7/2000	Makker et al.
6,129,733	A	10/2000	Brady et al.
6,142,999	A	11/2000	Brady et al.
6,143,000	A	11/2000	Feingold
6,162,229	A	12/2000	Feingold et al.
6,174,315	B1	1/2001	Chambers et al.
6,214,015	B1	4/2001	Reich et al.
6,241,737	B1	6/2001	Feingold
6,248,111	B1	6/2001	Glick et al.
6,251,114	B1	6/2001	Farmer et al.
6,254,607	B1	7/2001	Makker et al.
6,267,768	B1	7/2001	Deacon
6,283,975	B1	9/2001	Glick et al.
6,283,976	B1	9/2001	Portney
6,312,433	B1	11/2001	Butts
6,334,862	B1	1/2002	Vidal et al.
6,336,932	B1	1/2002	Figueroa et al.
6,355,046	B2	3/2002	Kikuchi et al.
6,371,960	B2	4/2002	Heyman et al.
6,386,357	B1	5/2002	Egawa
6,387,101	B1	5/2002	Butts et al.
6,398,788	B1	6/2002	Makker et al.
6,406,481	B2	6/2002	Feingold et al.
6,428,545	B2	8/2002	Portney
6,447,519	B1	9/2002	Brady et al.
6,447,520	B1	9/2002	Ott et al.
6,468,282	B2	10/2002	Kikuchi et al.
6,471,708	B2	10/2002	Green
6,491,697	B1	12/2002	Clark et al.
6,497,708	B1	12/2002	Cumming
6,500,181	B1	12/2002	Portney
6,506,195	B2	1/2003	Chambers et al.
6,537,283	B2	3/2003	Van Noy

(56) **References Cited**

U.S. PATENT DOCUMENTS

6,540,754	B2	4/2003	Brady	
6,554,839	B2	4/2003	Brady	
6,558,395	B2	5/2003	Hjertman et al.	
6,605,093	B1	8/2003	Blake	
6,607,537	B1	8/2003	Binder	
6,629,979	B1	10/2003	Feingold	
6,666,871	B2	12/2003	Kikuchi et al.	
6,679,891	B2	1/2004	Makker et al.	
6,685,740	B2	2/2004	Figueroa et al.	
6,712,848	B1	3/2004	Wolf et al.	
6,723,104	B2	4/2004	Ott	
6,733,507	B2	5/2004	McNicholas et al.	
6,793,674	B2	9/2004	Zapata	
6,858,033	B2	2/2005	Kobayashi	
6,921,405	B2	7/2005	Feingold et al.	
6,923,815	B2	8/2005	Brady et al.	
6,976,989	B1	12/2005	Vincent	
7,014,641	B2	3/2006	Kobayashi et al.	
7,025,782	B2	4/2006	Kobayashi et al.	
7,033,366	B2	4/2006	Brady	
7,037,312	B2	5/2006	Kikuchi et al.	
7,074,227	B2	7/2006	Portney	
7,097,649	B2	8/2006	Meyer	
7,131,976	B2	11/2006	Kobayashi et al.	
7,156,854	B2	1/2007	Brown et al.	
7,348,038	B2	3/2008	Makker et al.	
7,422,604	B2	9/2008	Vaquero et al.	
7,429,263	B2	9/2008	Vaquero et al.	
7,458,976	B2	12/2008	Peterson et al.	
7,476,230	B2	1/2009	Ohno et al.	
7,494,505	B2	2/2009	Kappelhof et al.	
7,645,300	B2	1/2010	Tsai	
8,273,122	B2	9/2012	Anderson	
8,382,769	B2	2/2013	Inoue	
8,460,311	B2	6/2013	Ishii	
8,470,032	B2	6/2013	Inoue et al.	
8,475,528	B2	7/2013	Ichinohe et al.	
8,523,877	B2	9/2013	Ichinohe et al.	
8,523,941	B2	9/2013	Ichinohe et al.	
8,535,375	B2	9/2013	Ichinohe et al.	
8,545,512	B2	10/2013	Ichinohe et al.	
8,574,239	B2	11/2013	Ichinohe et al.	
8,603,103	B2	12/2013	Kudo et al.	
8,647,382	B2	2/2014	Kudo et al.	
8,702,795	B2	4/2014	Shoji et al.	
8,747,465	B2 *	6/2014	Someya	A61F 2/1678 606/107
8,968,328	B2	3/2015	Ichinohe et al.	
9,114,006	B2	8/2015	Inoue	
9,114,007	B2	8/2015	Ichinohe et al.	
9,186,246	B2	11/2015	Inoue	
9,220,593	B2	12/2015	Ichinohe	
9,289,288	B2	3/2016	Someya et al.	
9,314,373	B2	4/2016	Kudo et al.	
9,326,847	B2	5/2016	Sanger	
9,364,320	B2	6/2016	Ichinohe et al.	
9,554,894	B2	1/2017	Inoue	
9,572,710	B1	2/2017	Kudo et al.	
9,655,718	B2	5/2017	Kudo et al.	
2001/0007942	A1	7/2001	Kikuchi et al.	
2002/0103490	A1	8/2002	Brady	
2002/0151904	A1	10/2002	Feingold et al.	
2002/0165610	A1	11/2002	Waldock	
2002/0193805	A1	12/2002	Ott et al.	
2003/0036765	A1	2/2003	Van Noy	
2003/0040755	A1	2/2003	Meyer	
2003/0050647	A1	3/2003	Brady	
2003/0088253	A1	5/2003	Seil	
2003/0139749	A1	7/2003	Kikuchi et al.	
2003/0181921	A1	9/2003	Jeannin	
2003/0195522	A1	10/2003	McNicholas	
2003/0212406	A1	11/2003	Kobayashi et al.	
2003/0212407	A1	11/2003	Kikuchi	
2003/0212409	A1	11/2003	Kobayashi et al.	
2004/0111094	A1	6/2004	Meyer	
2004/0117012	A1	6/2004	Vincent	
2004/0127911	A1	7/2004	Figueroa et al.	
2004/0186428	A1	9/2004	Ray	
2004/0238392	A1	12/2004	Peterson et al.	
2004/0243141	A1	12/2004	Brown et al.	
2005/0033308	A1	2/2005	Callahan et al.	
2005/0049605	A1	3/2005	Vaquero et al.	
2005/0049606	A1	3/2005	Vaquero et al.	
2005/0055011	A1	3/2005	Enggaard	
2005/0125000	A1	6/2005	Tourrette et al.	
2005/0143750	A1	6/2005	Vaquero	
2005/0182419	A1	8/2005	Tsai	
2005/0222578	A1	10/2005	Vaquero	
2005/0261703	A1	11/2005	Feingold et al.	
2006/0085013	A1	4/2006	Dusek	
2006/0142781	A1	6/2006	Pynson et al.	
2006/0167466	A1	7/2006	Dusek	
2006/0200167	A1	9/2006	Peterson et al.	
2006/0229633	A1	10/2006	Shepherd	
2006/0235429	A1	10/2006	Lee et al.	
2006/0293694	A1	12/2006	Futamura	
2007/0005135	A1	1/2007	Makker et al.	
2008/0033449	A1	2/2008	Cole et al.	
2008/0058830	A1	3/2008	Cole et al.	
2008/0086146	A1	4/2008	Ishii et al.	
2008/0097459	A1	4/2008	Kammerlander et al.	
2008/0221584	A1	9/2008	Downer	
2009/0036898	A1	2/2009	Ichinohe	
2009/0043313	A1	2/2009	Ichinohe	
2009/0112223	A1	4/2009	Downer et al.	
2009/0125034	A1	5/2009	Pynson	
2009/0138022	A1	5/2009	Tu et al.	
2009/0204122	A1	8/2009	Ichinohe et al.	
2009/0216244	A1	8/2009	Pynson	
2009/0248031	A1	10/2009	Ichinohe	
2010/0094309	A1	4/2010	Boukhny et al.	
2010/0106160	A1	4/2010	Tsai	
2010/0161049	A1	6/2010	Inoue	
2010/0185206	A1	7/2010	Ichinohe et al.	
2010/0217273	A1	8/2010	Someya et al.	
2010/0286704	A1	11/2010	Ichinohe et al.	
2010/0331808	A1	12/2010	Py et al.	
2011/0082463	A1	4/2011	Inoue	
2011/0098717	A1	4/2011	Inoue	
2011/0264101	A1	10/2011	Inoue et al.	
2011/0270264	A1	11/2011	Shoji et al.	
2011/0288557	A1	11/2011	Kudo et al.	
2012/0022549	A1	1/2012	Someya et al.	
2012/0071887	A1	3/2012	Ichinohe et al.	
2013/0006259	A1	1/2013	Sanger	
2013/0018460	A1	1/2013	Anderson	
2013/0226193	A1	8/2013	Kudo et al.	
2013/0245635	A1	9/2013	Inoue	
2014/0081284	A1	3/2014	Ichinohe et al.	
2014/0107660	A1	4/2014	Ichinohe et al.	
2014/0114323	A1	4/2014	Kudo et al.	
2014/0180299	A1	6/2014	Ichinohe et al.	
2014/0180300	A1	6/2014	Ichinohe et al.	
2014/0194890	A1	7/2014	Kudo et al.	
2016/0113759	A1	4/2016	Inoue	
2016/0193038	A1	7/2016	Kudo et al.	
2016/0346077	A1	12/2016	Someya et al.	
2017/0079772	A1	3/2017	Kudo	
2017/0151056	A1	6/2017	Inoue	
2017/0202662	A1	7/2017	Someya et al.	
2017/0252149	A1	9/2017	Kudo et al.	
2017/0258582	A1	9/2017	Kudo et al.	

FOREIGN PATENT DOCUMENTS

EP	0363213		4/1990
EP	0727966		9/2003
EP	1832247	A1	9/2007
EP	1338254		12/2008
FR	2749752	A	12/1997
JP	63-197453	A	8/1988
JP	4-212350	A	8/1992
JP	5-103808		4/1993
JP	5-103809		4/1993

(56) **References Cited**

FOREIGN PATENT DOCUMENTS

JP	8-024282	A	1/1996
JP	8-505540		6/1996
JP	9-506285	A	6/1997
JP	11-113939	A	4/1999
JP	11-506357	A	6/1999
JP	2000-516487	A	12/2000
JP	2000-516488	A	12/2000
JP	2001-502563		2/2001
JP	2001-104347	A	4/2001
JP	2002-516709	A	6/2002
JP	2002-355268	A	12/2002
JP	2002-541912	A	12/2002
JP	2003-144480	A	5/2003
JP	3412106	B2	6/2003
JP	2003-210498	A	7/2003
JP	2003-325569	A	11/2003
JP	2003-325570	A	11/2003
JP	2003-325572	A	11/2003
JP	2004-024854	A	1/2004
JP	2004-188194	A	7/2004
JP	2004-351196	A	12/2004
JP	2006-181269	A	7/2006
JP	2006-297146	A	11/2006
JP	2006-333924	A	12/2006
JP	2006-333981	A	12/2006
JP	2007-503872	A	3/2007
JP	2007-152010	A	6/2007
JP	2007-181604	A	7/2007
JP	2007-526091	A	9/2007
JP	2008-521535	A	6/2008
JP	2008-212689	A	9/2008
JP	2014-050484	A	3/2014
WO	WO9407436	A1	4/1994
WO	WO9513022	A1	5/1995
WO	WO9628122	A1	9/1996
WO	WO9715253	A1	5/1997
WO	WO9812969	A1	4/1998
WO	WO9958086	A1	11/1999
WO	WO9959668	A1	11/1999
WO	WO0045746	A1	8/2000
WO	WO0062712	A1	10/2000
WO	WO2002071982	A1	9/2002
WO	WO2002096322	A1	12/2002
WO	WO2005023154	A1	3/2005
WO	WO2005070341	A1	8/2005
WO	WO2005084588	A1	9/2005
WO	WO2006070628	A1	7/2006
WO	WO2006080191	A1	8/2006
WO	WO2006090531	A1	8/2006
WO	WO2007037223	A1	4/2007
WO	WO2007097221	A1	4/2007
WO	WO2007080869	A1	7/2007
WO	WO2008149794	A1	12/2008
WO	WO2008149795	A1	12/2008
WO	WO-2008149795	A1 *	12/2008 ..... A61F 2/16
WO	WO2009058929	A1	7/2009
WO	WO2009148091	A1	12/2009
WO	WO2011126144	A1	10/2011
WO	WO2011155636	A1	12/2011

* cited by examiner

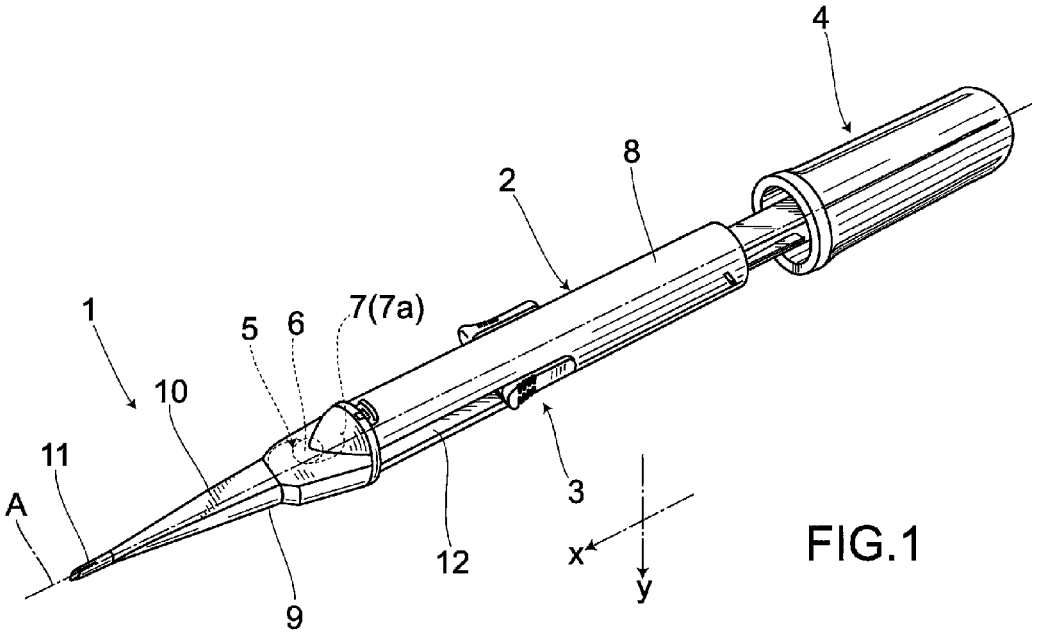


FIG.1

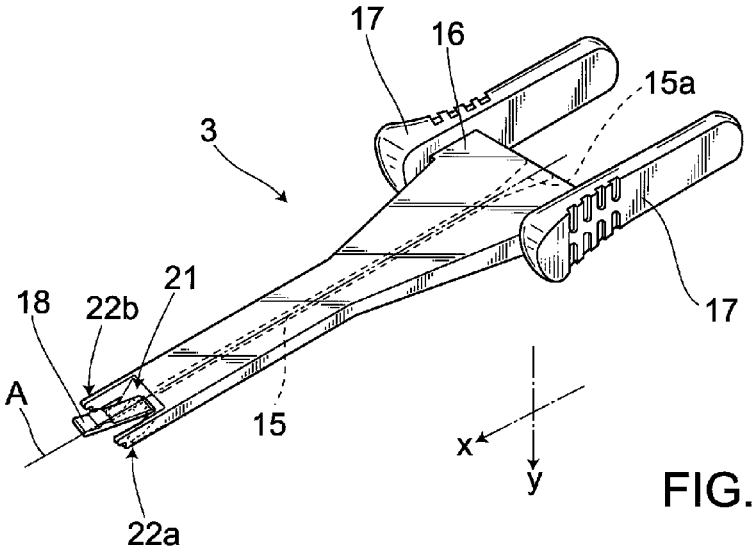


FIG.2

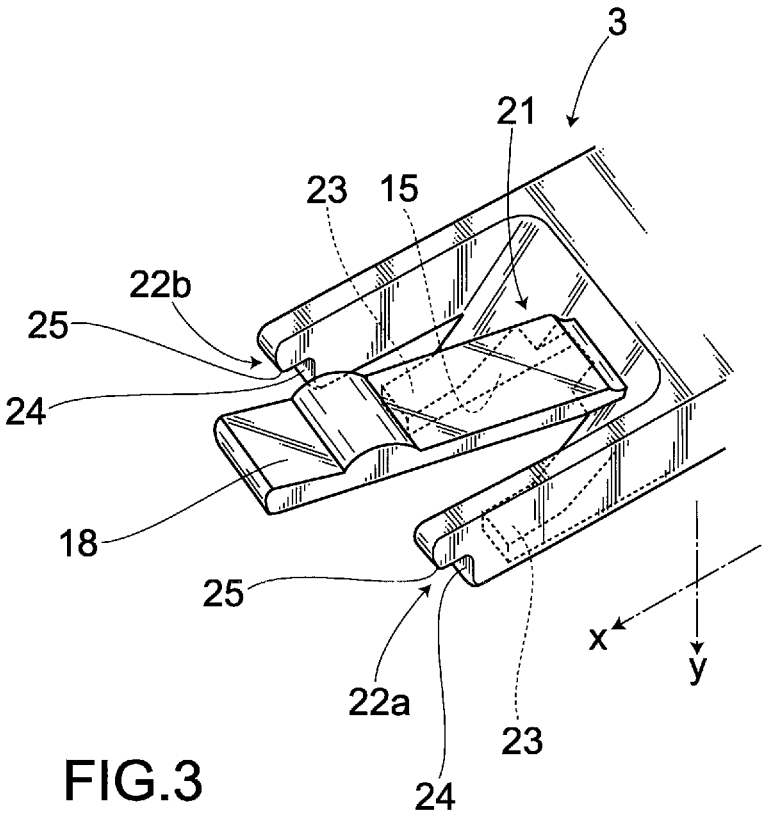


FIG.3

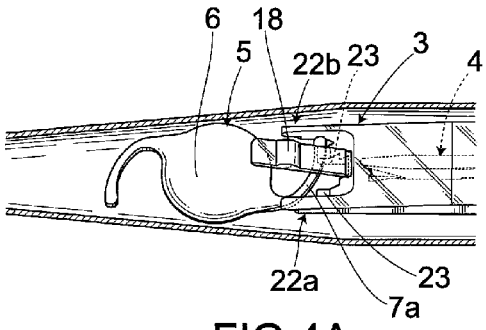


FIG.4A

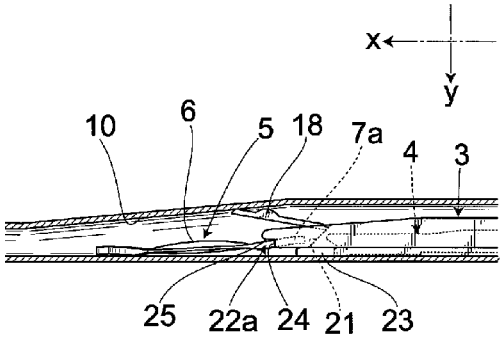


FIG.4B

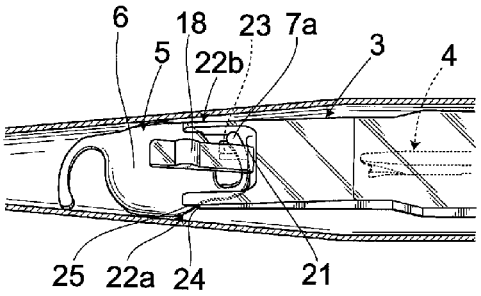


FIG.5A

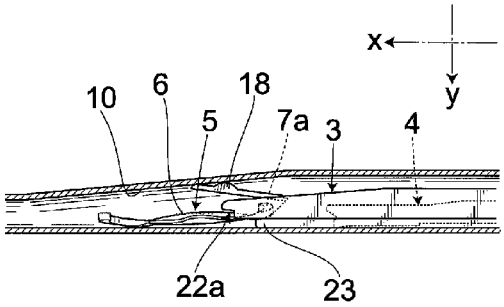


FIG.5B

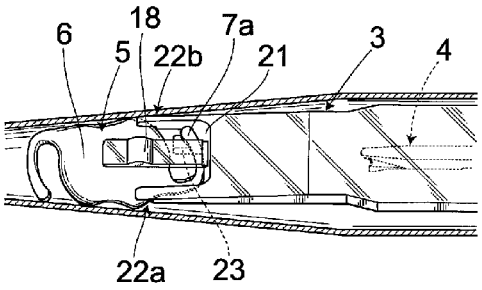


FIG.6A

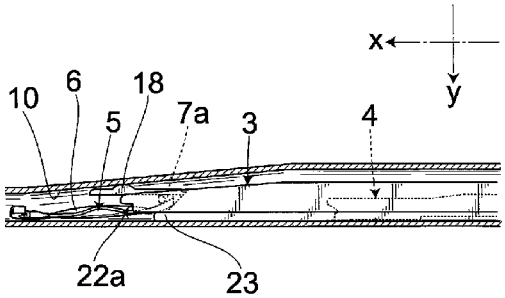


FIG.6B

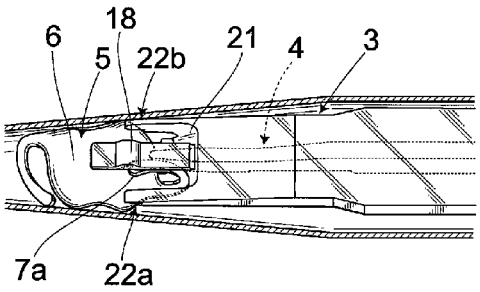


FIG.7A

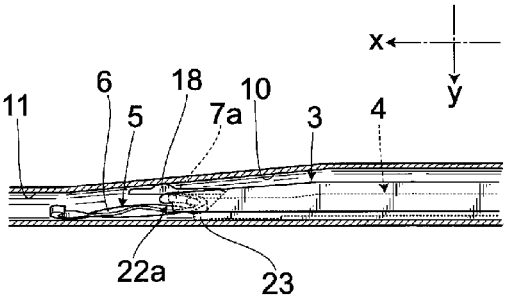


FIG.7B

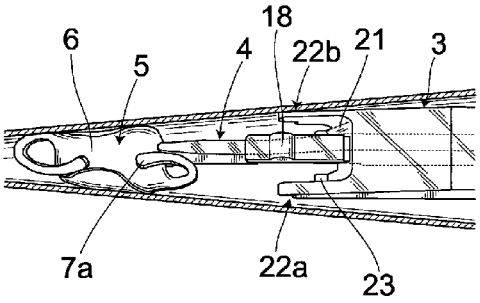


FIG.8A

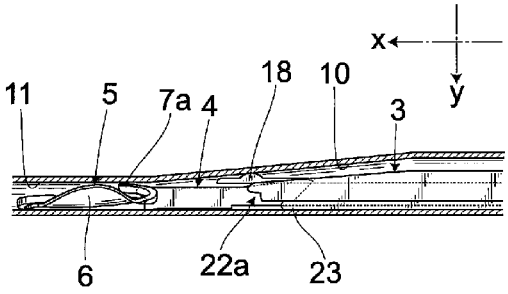


FIG.8B

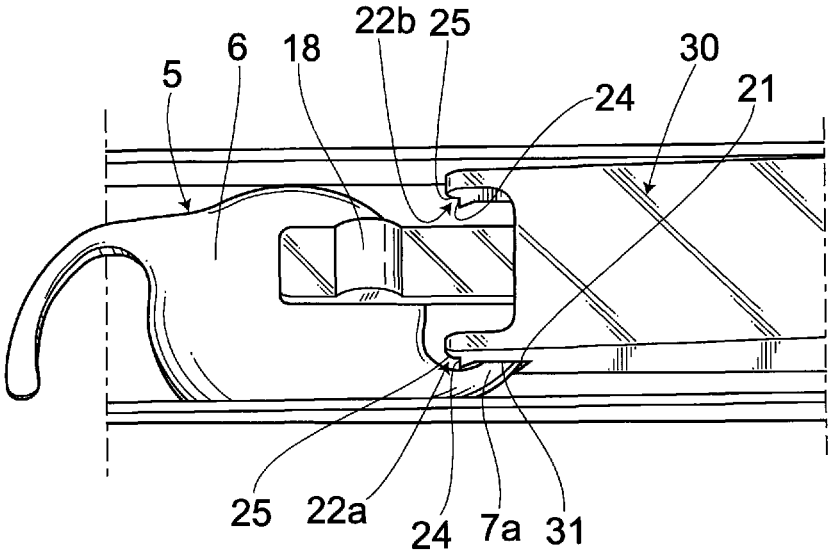


FIG.9

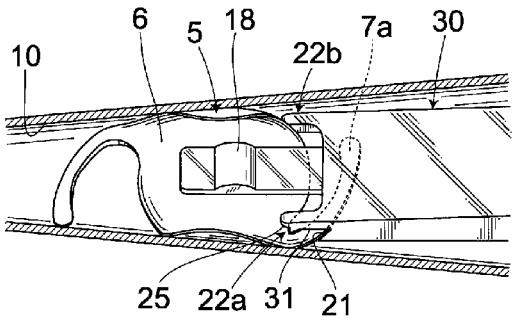


FIG.10A

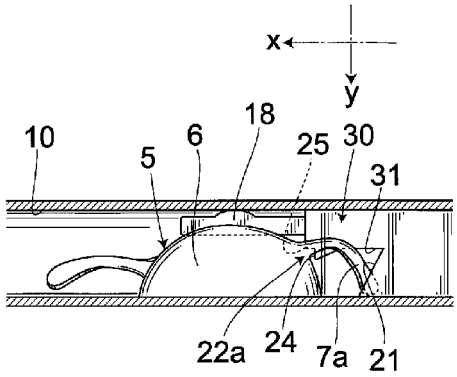


FIG.10B

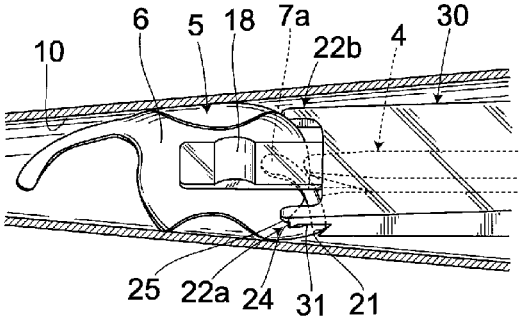


FIG.11A

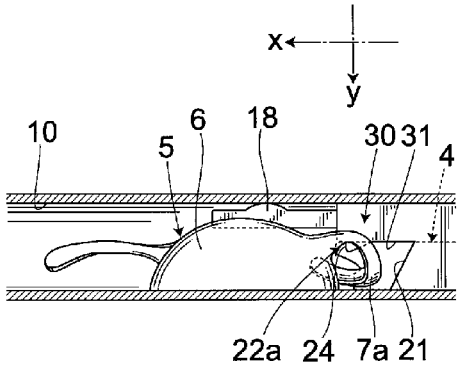


FIG.11B

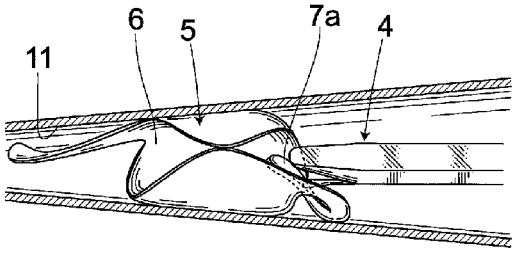


FIG.12A

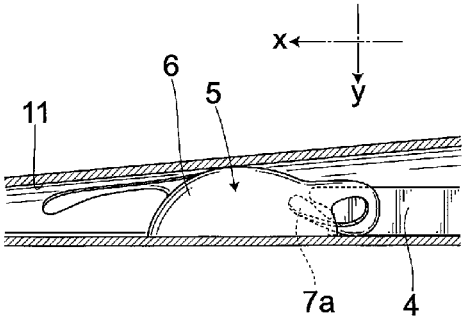


FIG.12B

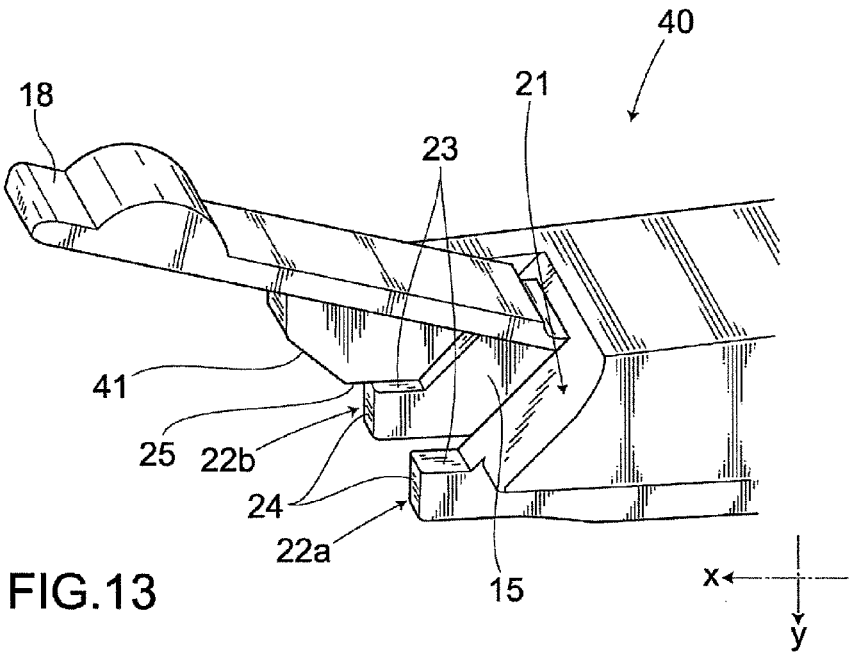


FIG.13

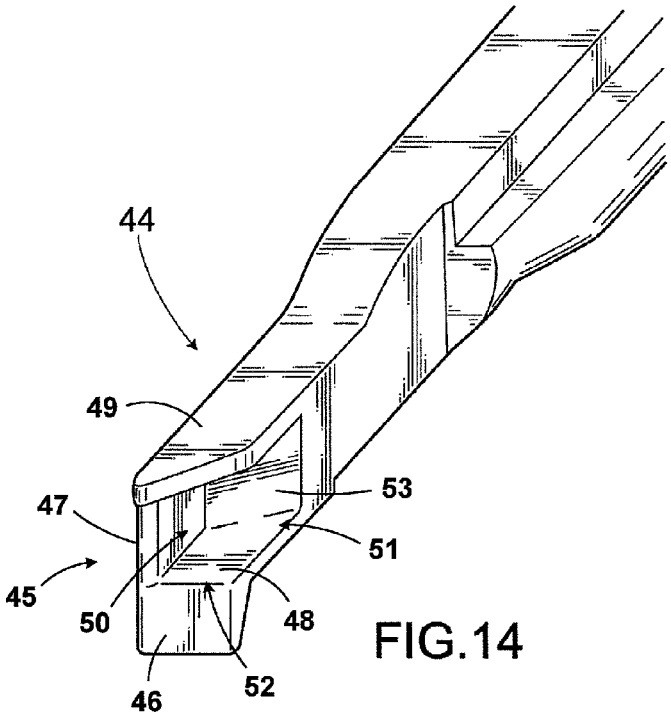


FIG.14

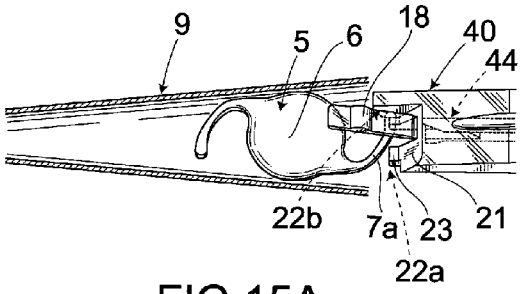


FIG.15A

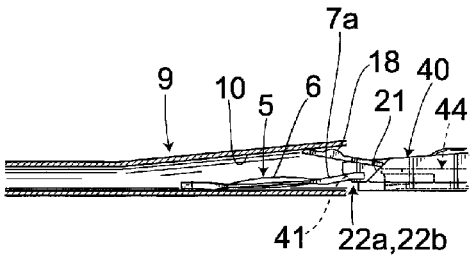


FIG.15B

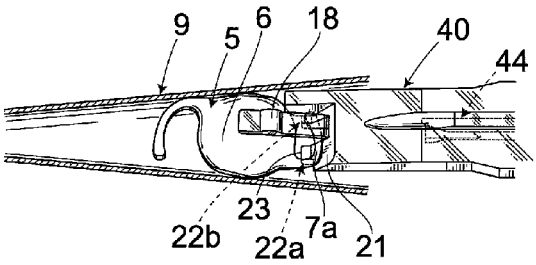


FIG.16A

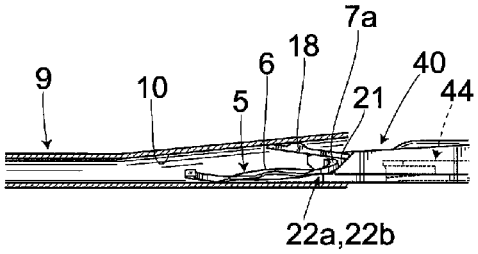


FIG.16B

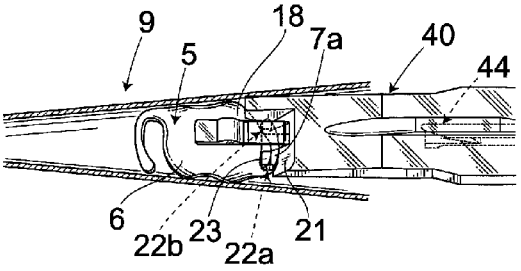


FIG.17A

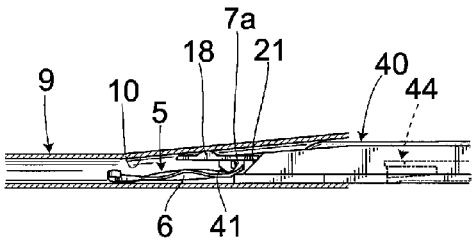


FIG.17B

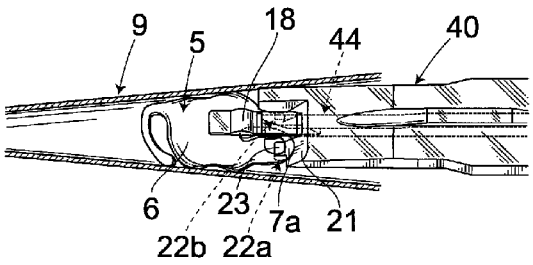


FIG.18A

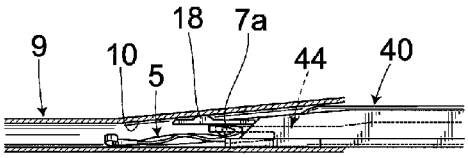


FIG.18B

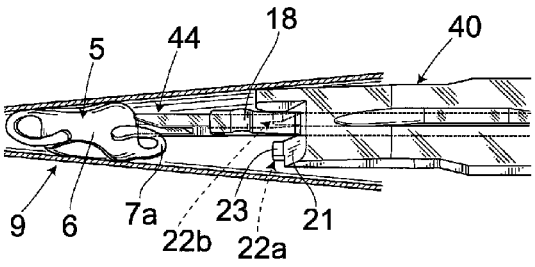


FIG.19A

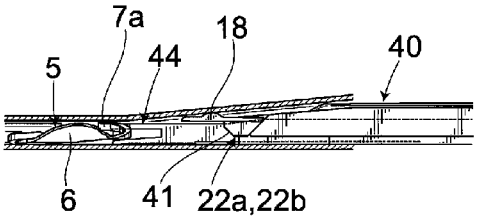


FIG.19B

INTRAOCULAR LENS INSERTION DEVICE

CROSS REFERENCE TO RELATED APPLICATIONS

This application is a continuation of U.S. application Ser. No. 14/099,989, filed Dec. 8, 2013, now U.S. Pat. No. 9,655,718, which is a continuation of U.S. application Ser. No. 13/143,322, filed Jul. 5, 2011, now U.S. Pat. No. 8,603,103, which is a U.S. national phase application under 35 U.S.C. §371 of International Patent Application No. PCT/JP2010/050029 filed Jan. 5, 2010, which claims priority to Japanese patent application No. 2009-001493, filed Jan. 7, 2009. The International Application was published in Japanese on Jul. 15, 2010 as International Publication No. WO 2010/079780A1. The content of each application is incorporated herein in its entirety.

TECHNICAL FIELD

The present invention relates to an intraocular lens insertion device for inserting an intraocular lens into an eyeball as a substitute of a crystalline lens exenterated through cataract surgery.

BACKGROUND ART

Cataract surgery often involves removing an opacified crystalline lens through phacoemulsification (PEA), and implanting an intraocular lens after the crystalline lens has been removed. Intraocular lenses include hard intraocular lenses whose optical parts are made of hard materials such as PMMA or the like, and soft intraocular lenses whose optical parts are made of soft materials such as silicon elastomer, soft acrylic, hydrogel or the like.

When inserting a hard intraocular lens, there has to be formed on the cornea or the sclera an incision substantially as wide as the diameter of the optical part of the corresponding hard intraocular lens. In contrast, a soft intraocular lens can be inserted through an incision smaller than the diameter of the optical part thereof by allowing the corresponding optical part to be folded.

An intraocular lens is preferably inserted through a small incision in order to reduce the possibilities of corneal astigmatism and infection after the surgery. In this sense, soft intraocular lenses tend to be preferred nowadays. Types of soft intraocular lens include: a soft intraocular lens having an optical part made of a soft material and supporting portions made of a hard material such as PMMA or the like (the supporting portions of this type of intraocular lens are usually two thin filamentary members); a soft intraocular lens whose optical part and supporting portions are made of a same soft material (the supporting portions of this type are usually plate members); or a soft intraocular lens employing a plurality of thin strips as supporting portions, and the like.

Further, in order to insert an intraocular lens into an eye, there has also been used a dedicated intraocular lens insertion device having a structure for introducing the intraocular lens into the eye through an elongated tube. This type of intraocular lens insertion device allows an intraocular lens to be inserted through an incision smaller than 3 mm.

Furthermore, in recent years, there has been developed a type of intraocular lens insertion device which has an intraocular lens placed therein in advance and can be packaged and stored, in order to exclude the possibilities of bacteria contamination and errors in operation at the time of handling the intraocular lens (e.g., patent document 1).

However, this type of intraocular lens insertion device may cause a supporting portion (referred to as a rear supporting portion, hereunder) arranged on a rear side with respect to a lens advancement axis to slip in between a plunger for pushing out the intraocular lens and a passage inner wall surface of the insertion device, or be tangled with the corresponding plunger, during a process of moving the intraocular lens. These problems are particularly noticeable with soft intraocular lenses employing thin filamentary members as supporting portions and intraocular lenses employing thin strips as supporting portions.

Further, this type of intraocular lens insertion device may cause the rear supporting portion to be stretched during the process of moving the intraocular lens. Accordingly, the corresponding rear supporting portion may then be left outside an eye ball at the time of performing insertion through a small incision on the eyeball, thereby requiring an additional operation for inserting such rear supporting portion into the eye ball after pushing out the intraocular lens with the plunger, and thus making the surgery troublesome.

In this sense, when using an intraocular lens insertion device to insert an intraocular lens into an eye, the motion of the rear supporting portion of the intraocular lens has to be appropriately regulated during the process of moving the intraocular lens.

In view of the aforementioned problems, there has been disclosed a device in which a clearance is formed on a front end side portion of a plunger, for allowing the rear supporting portion to be kept therein and thus preventing the same from being damaged (e.g., patent document 2). Further, there has been disclosed a device in which a rear supporting portion receiving passage for receiving the rear supporting portion is provided on a lower side portion of a plunger (e.g., patent document 3). Furthermore, there has also been disclosed a device in which the rear supporting portion is pushed up on a lump portion by means of a plunger, thereby allowing the corresponding haptic to be bended upward and eventually positioned higher than an IOL (e.g., patent document 4). Accordingly, all the devices disclosed in the aforementioned patent documents serve to reduce holding pressures applied to the rear supporting portions of intraocular lenses employing thin filaments or strips as supporting portions.

REFERENCE

Patent document 1: WO2007/037223

Patent document 2: Japanese Unexamined Patent Application Publication (Translation of PCT Application) No. 1999-506357

Patent document 3: U.S. Pat. No. 6,733,507

Patent document 4: Japanese Unexamined Patent Application Publication No. 2004-351196

DISCLOSURE OF THE INVENTION

Problem to be Solved by the Invention

However, according to the patent documents 2 and 3, the rear supporting portion received in the clearance formed on the front end side portion of the plunger and in the rear supporting portion receiving passage is stretched, thereby still incurring a problem in which the corresponding rear supporting portion may be left outside a small incision formed on an eye ball when inserting an intraocular lens therethrough. Particularly, with regard to intraocular lenses employing thin strips as supporting portions, reoperation is

often troublesome because the corresponding supporting portions are composed of soft members that are thick in sizes. Further, according to the patent document 4, the supporting portion is pushed by a small plunger front end matched to a nozzle front end with a small aperture diameter, thus causing the rear supporting portion to be compressed into an unexpected shape when bending the supporting portion upward so as to position the same higher than an optical part or when allowing an intraocular lens to pass through a passage.

Here, in view of the aforementioned problems, it is an object of the present invention to provide an intraocular lens insertion device capable of appropriately regulating the motion of a rear supporting portion during a process of moving an intraocular lens, and reducing the possibility of reoperation being required after the intraocular lens has been inserted into an eye.

Means for Solving the Problem

The invention according to a first aspect of the present invention is an intraocular lens insertion device comprising: a lens placement section for placing an intraocular lens having an optical part and one or more supporting portions provided on an outer edge of the optical part; a transition section for deforming the intraocular lens; a nozzle section for releasing the intraocular lens; a slider for pushing out the intraocular lens placed in the lens placement section; and a plunger for releasing the intraocular lens pushed out by the slider from the nozzle section, in which the slider includes: a first abutting portion for pushing up a supporting portion disposed in a rear direction of a lens advancement axis; and one or more second abutting portions abutting against an outer edge of a rear portion of the intraocular lens.

According to the invention described in a second aspect of the present invention, the second abutting portions are provided outside the first abutting portion with respect to the lens advancement axis.

According to the invention described in a third aspect of the present invention, the first abutting portion slants downward in a lens advancement direction.

According to the invention described in a fourth aspect of the present invention, at least one of the second abutting portions includes: an x-direction abutting surface substantially perpendicular to a surface of the optical part; and a y-direction abutting surface substantially parallel with the surface of the optical part.

The invention according to a fifth aspect of the present invention comprises a guiding portion for guiding the outer edge of the optical part to the second abutting portions.

According to the invention described in a sixth aspect of the present invention, the second abutting portions are provided as a left-right pair centered about the lens advancement axis.

Effects of the Invention

According to the present invention, the first abutting portion provided on the slider serves to push up the supporting portion arranged on the rear side with respect to the lens advancement axis, thereby allowing the motion of the rear supporting portion to be appropriately regulated during the process of moving the intraocular lens, and thus reducing the possibility of reoperation being required after the intraocular lens is inserted into the eye.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a perspective view showing an overall structure of an intraocular lens insertion device of a first embodiment of the present invention.

FIG. **2** is a perspective view showing a structure of a slider of the first embodiment of the present invention.

FIG. **3** is a partially enlarged perspective view showing the structure of the slider of the first embodiment of the present invention.

FIGS. **4**A and **4**B are diagrams showing a usage state (1) of the intraocular lens insertion device of the first embodiment of the present invention, in which FIG. **4**A is a cross sectional top view, and FIG. **4**B is a longitudinal sectional view.

FIGS. **5**A and **5**B are diagrams showing a usage state (2) of the intraocular lens insertion device of the first embodiment of the present invention, in which FIG. **5**A is a cross sectional top view, and FIG. **5**B is a longitudinal sectional view.

FIGS. **6**A and **6**B are diagrams showing a usage state (3) of the intraocular lens insertion device of the first embodiment of the present invention, in which FIG. **6**A is a cross sectional top view, and FIG. **6**B is a longitudinal sectional view.

FIGS. **7**A and **7**B are diagrams showing a usage state (4) of the intraocular lens insertion device of the first embodiment of the present invention, in which FIG. **7**A is a cross sectional top view, and FIG. **7**B is a longitudinal sectional view.

FIGS. **8**A and **8**B are diagrams showing a usage state (5) of the intraocular lens insertion device of the first embodiment of the present invention, in which FIG. **8**A is a cross sectional top view, and FIG. **8**B is a longitudinal sectional view.

FIG. **9** is a partially enlarged perspective view showing a structure of a slider of a second embodiment of the present invention.

FIGS. **10**A and **10**B are diagrams showing a usage state (1) of an intraocular lens insertion device of the second embodiment of the present invention, in which FIG. **10**A is a cross sectional top view, and FIG. **10**B is a longitudinal sectional view.

FIGS. **11**A and **11**B are diagrams showing a usage state (2) of the intraocular lens insertion device of the second embodiment of the present invention, in which FIG. **11**A is a cross sectional top view, and FIG. **11**B is a longitudinal sectional view.

FIGS. **12**A and **12**B are diagrams showing a usage state (3) of the intraocular lens insertion device of the second embodiment of the present invention, in which FIG. **12**A is a cross sectional top view, and FIG. **12**B is a longitudinal sectional view.

FIG. **13** is a partially enlarged perspective view showing a structure of a slider of a third embodiment of the present invention.

FIG. **14** is a partially enlarged perspective view showing a structure of a plunger of the third embodiment of the present invention.

FIGS. **15**A and **15**B are diagrams showing a usage state (1) of an intraocular lens insertion device of the third embodiment of the present invention, in which FIG. **15**A is a cross sectional top view, and FIG. **15**B is a longitudinal sectional view.

FIGS. **16**A and **16**B are diagrams showing a usage state (2) of the intraocular lens insertion device of the third

embodiment of the present invention, in which FIG. **16**A is a cross sectional top view, and FIG. **16**B is a longitudinal sectional view.

FIGS. **17**A and **17**B are diagrams showing a usage state (3) of the intraocular lens insertion device of the third embodiment of the present invention, in which FIG. **17**A is a cross sectional top view, and FIG. **17**B is a longitudinal sectional view.

FIGS. **18**A and **18**B are diagrams showing a usage state (4) of the intraocular lens insertion device of the third embodiment of the present invention, in which FIG. **18**A is a cross sectional top view, and FIG. **18**B is a longitudinal sectional view.

FIGS. **19**A and **19**B are diagrams showing a usage state (5) of the intraocular lens insertion device of the third embodiment of the present invention, in which FIG. **19**A is a cross sectional top view, and FIG. **19**B is a longitudinal sectional view.

BEST MODE FOR CARRYING OUT THE INVENTION

1. First Embodiment

(1) Basic Structure

An embodiment of the present invention is described hereunder in detail and with reference to the accompanying drawings.

An intraocular lens insertion device **1** shown in FIG. **1** comprises a main body **2**, and a slider **3** and a plunger **4** that are attached to the main body **2**. The intraocular lens insertion device **1** is of a preset type in which an intraocular lens **5** is placed inside the main body **2** in advance. Here, the intraocular lens **5** includes an optical part **6** and a pair of supporting portions **7** (or "haptics") provided on an outer edge of the optical part **6**. As the supporting portions **7**, there can be employed various types of members including, for example, members of a thin strip type.

In the following descriptions, an axis extending through the center of the intraocular lens **5** moving inside the main body **2** is referred to as a lens advancement axis A. Further, a direction to which the intraocular lens **5** moves is referred to as an "advancement direction x," and a downward direction is referred to as a "direction y."

The main body **2** is composed of a base end portion **8** and an insertion tube **9** connected to a front end of the base end portion **8** in the advancement direction x. Although not shown, a lens placement section made of a plate type member is formed on the front end of the base end portion **8** in the advancement direction x. The intraocular lens **5** is placed in the corresponding lens placement section. On side surfaces of the base end portion **8**, there are provided slits **12** formed in parallel with the lens advancement axis A and extending to the front end of the base end portion **8**. Further, the insertion tube **9** is integrally connected to the front end of the base end portion **8**, thereby allowing the intraocular lens **5** placed in the lens placement section of the base end portion **8** to be disposed internally.

The insertion tube **9** comprises a transition section **10** and a nozzle section **11** that are successively disposed along the lens advancement axis A. The transition section **10** is formed into a tapered shape in which an inner wall of the transition section **10** tapers toward a front end thereof, such front end being further communicated with the nozzle section **11**. The nozzle section **11** is so formed that an outer shape thereof can be inserted into an incision (not shown).

According to this intraocular lens insertion device **1**, the intraocular lens **5** placed in the lens placement section is at first moved to the transition section **10** after being pushed out by the slider **3**, thereby allowing the intraocular lens **5** to be reliably folded into a given shape. Next, the intraocular lens **5** is further moved to the nozzle section **11** after being pushed out by the plunger **4**, thereby causing the intraocular lens **5** to be folded even smaller, and thus allowing the intraocular lens **5** to be inserted into an eye from a front end of the nozzle section **11**. Accordingly, the intraocular lens insertion device **1** allows the intraocular lens **5** to be moved in the advancement direction x in two stages involving successively the slider **3** and the plunger **4**, thus causing the intraocular lens **5** to be folded into a given shape and releasing the same to the outside.

(2) Structure of Slider

Next, the slider **3** attached to the main body **2** is described. As shown in FIG. **2**, the slider **3** servers to push out the intraocular lens **5** placed in the lens placement section to the transition section **10** without imposing a local load thereon, and fold the intraocular lens **5** into the given shape. The slider **3** includes a guiding groove **15**, a wing portion **16**, operation portions **17** and a lens pressing member **18**.

The guiding groove **15** is so configured that the plunger **4** can be supported thereby along the lens advancement axis A. Specifically, the guiding groove **15** allows the plunger **4** to slide, and a front end of the plunger **4** to protrude from a front end of the slider **3**. According to the present embodiment, the guiding groove **15** is longitudinally formed over an entire length of a surface of the slider **3** in a manner such that the guiding groove **15** is substantially located in the center of the surface of the slider **3**. Accordingly, the guiding groove **15** serves as a groove parallel to the lens advancement axis A. A cross-sectional surface of the guiding groove **15** is substantially formed into a same shape as an outer shape of the plunger **4**. A wedge guiding path **15***a* is formed on a base end of the guiding groove **15**. In this way, the plunger **4** is allowed to be inserted into the guiding groove **15** formed on the slider **3**, and slide within the guiding groove **15** in a longitudinal direction of the slider **3**.

The wing portion **16** is inserted into the slits **12** provided on the main body **2**, and serves to support the slider **3** along the lens advancement axis A. By inserting the wing portion **16** into the slits **12**, the slider **3** is allowed to not only be held in a substantial center portion of the main body **2**, but also move along the lens advancement axis A. In this sense, the plunger **4** can also be held in the center portion of the main body **2** and move along the lens advancement axis A, when inserted into the guiding groove **15** formed on the slider **3**. The slider **3** can be easily moved by means of the operation portions **17**.

The operation portions **17** are provided as a left-right pair centered about the lens advancement axis A. Further, the operation portions **17** are connected to side end portions of the wing portion **16**, and protrude from each side of the base end portion **8**.

The lens pressing member **18** serves to fold the intraocular lens **5** in a given direction by pressing a surface of the intraocular lens **5** only when the intraocular lens **5** is being pushed out. According to the present embodiment, the lens pressing member **18** serves to press a surface of the intraocular lens **5** to the direction y, thereby causing the intraocular lens **5** to be folded inside the nozzle section **11** with the foregoing surface being folded inwardly, such surface being a front surface when releasing the intraocular lens **5** into the eye. The lens pressing member **18** is made of a strip type

member provided on the front end of the slider **3**, and is capable of swinging freely to the direction y.

In addition to the structure described so far, the slider **3** of the present embodiment, as shown in FIG. **3**, further includes a first abutting portion **21** for pushing up a supporting portion **7** arranged on a rear side with respect to the lens advancement axis A with respect to the optical part **6** (referred to as a rear supporting portion **7***a*, hereunder), and second abutting portions **22***a*, **22***b* abutting against a rear outer edge of the optical part **6**.

The first abutting portion **21** has a slanting surface formed in the center of the front end of the slider **3** and slanting toward a direction between the advancement direction x and the direction y. The guiding groove **15** is opened in the center of the first abutting portion **21**, and a front end of the plunger **4** is thus allowed to protrude from the guiding groove **15** in the advancement direction x. Further, restriction portions **23** are formed on front ends of the first abutting portion **21**. The restriction portions **23** serve to prevent the rear supporting portion **7***a* from entering in between the slider **3** and the main body **2** and thus being damaged, as the rear supporting portion **7***a* deforms in the direction y. According to the present embodiment, the restriction portions **23** protrude from lower ends of the slanting surface to the advancement direction x.

The second abutting portions **22***a*, **22***b* are respectively provided on both sides of the first abutting portion **21**, and are configured to be able to abut against the outer edge of the optical part **6** of the intraocular lens **5**. According to the present embodiment, the second abutting portions **22***a*, **22***b* protrude from the front end of the slider **3** to the advancement direction x, and at least **22***a* is allowed to abut against, along the lens advancement axis A, an outer edge of a section of the optical part **6**, such section of the optical part **6** being located outward from a connecting portion of the supporting portion **7** and the optical part **6**.

Further, the second abutting portions **22***a*, **22***b* have x-direction abutting surfaces **24** and y-direction abutting surfaces **25**. The x-direction abutting surfaces **24** are perpendicular to a surface of the optical part **6**, and are thus capable of pushing out the outer edge of the optical part **6**. The y-direction abutting surfaces **25** are parallel with the surface of the optical part **6**, and are thus able to restrict a surface of the optical part **6** in the vicinity of the outer edge thereof from being valley folded before the rear supporting portion **7***a* has been sufficiently deformed.

As described above, according to the intraocular lens insertion device **1** of the present embodiment, the first abutting portion **21** and the second abutting portions **22***a*, **22***b* are provided on the slider **3** allowing the intraocular lens **5** to be in contact therewith through a contact area larger than that of the plunger **4**. Accordingly, the motion of the rear supporting portion **7***a* can be appropriately regulated during the process of moving the intraocular lens **5**. Further, there can be reduced the possibility of reoperation being required after the intraocular lens **5** is inserted into the eye.

(3) Operation and Effect

According to the intraocular lens insertion device **1** having the aforementioned structure, the intraocular lens **5** is placed internally in a manner such that the optical part **6** thereof is arranged in parallel with the lens advancement axis A (FIGS. **4**A and **4**B). The slider **3** is at first moved to the advancement direction x in order to release the intraocular lens **5** internally placed in advance to the outside from the front end of the nozzle section **11**. In this way, the first abutting portion **21** formed on the front end of the slider **3** is caused to abut against the rear supporting portion **7***a* (FIGS. **5**A and **5**B).

Since the first abutting portion **21** has the slanting surface, the rear supporting portion **7***a* is pushed up therealong as the slider **3** is further moved to the advancement direction x (FIGS. **6**A and **6**B). At the same time, the x-direction abutting surfaces **24** of the second abutting portions **22***a*, **22***b* are caused to abut against as well as push out the optical part **6**, thereby moving the intraocular lens **5** from the lens placement section to the transition section **10**. At that time, the outer edge of the optical part **6** is pushed by the inner wall of the transition section **10**. Further, the lens pressing member **18** is also pushed by the inner wall of the transition section **10**, and is thus caused to push down the surface of the optical part **6** to the direction y. In this way, the optical part **6** of the intraocular lens **5** is valley folded.

Next, as the plunger **4** is moved to the advancement direction x, the front end of such plunger **4** supported by the guiding groove **15** of the slider **3** is caused to abut against the outer edge of the optical part **6** (FIGS. **7**A and **7**B). The rear supporting portion **7***a* pushed up by the first abutting portion **21** is thus caused to deform along the plunger **4** in a manner such that a front end of the rear supporting portion **7***a* eventually points to the advancement direction x. In this way, the front end of the rear supporting portion **7***a* deformed due to the first abutting portion **21**, is tucked into the surface of the valley-folded optical part **6**.

Here, the y-direction abutting surfaces **25** of the second abutting portions **22***a*, **22***b* are configured to restrict the surface of the optical part **6** in the vicinity of the outer edge thereof from being valley folded, thereby preventing the outer edge of the optical part **6** from interfering with the rear supporting portion **7***a* during a deformation process of the rear supporting portion **7***a*. Accordingly, the intraocular lens insertion device **1** allows the rear supporting portion **7***a* to further reliably enter a space formed by the valley-folded surface of the optical part **6**, thereby making it possible to further reliably deform the intraocular lens **5** into the given shape.

Further, the restriction portions **23** provided on the first abutting portion **21** serve to prevent the rear supporting portion **7***a* from deforming to the direction y. In this sense, the intraocular lens insertion device **1** allows the intraocular lens **5** to be further reliably deformed into the given shape.

Next, by further moving the plunger **4** to the advancement direction x, the intraocular lens **5** is moved from the transition section **10** to the nozzle section **11** (FIGS. **8**A and **8**B), followed by being released to the outside from the front end of the nozzle section **11** with the intraocular lens **5** itself being folded even smaller.

As described earlier, the intraocular lens insertion device **1** allows the rear supporting portion **7***a* to be pushed up by the first abutting portion **21**, thereby making it possible to appropriately regulate the motion of the rear supporting portion **7***a* during the process of moving the intraocular lens **5** and reduce the possibility of reoperation being required after the intraocular lens **5** is inserted into the eye.

Further, since the first abutting portion **21** is provided on the slider **3**, the rear supporting portion **7***a* is allowed to come into contact with the first abutting portion **21** through a large contact area. Accordingly, the intraocular lens insertion device **1** of the present embodiment allows the rear supporting portion **7***a* to be further stably deformed, thereby making it possible to further appropriately regulate the rear supporting portion **7***a*.

2. Second Embodiment

A second embodiment of the present invention is described hereunder with reference to the accompanying drawings. Here, the second embodiment differs from the first embodiment only in the structure of the front end portion of the slider **3**. Therefore, same symbols are used to describe the same members as those in the first embodiment, and the descriptions of the corresponding members are thus omitted for the sake of convenience.

According to a slider **30** shown in FIG. **9**, at least **22***a* of second abutting portions **22***a*, **22***b* is configured to abut against an outer edge of a section of the optical part **6** between the connecting portion of the rear supporting portion **7***a* and the optical part **6**, and the lens advancement axis A. Further, this slider **30** has a cutout hole **31** formed on a side surface thereof, such cutout hole **31** allowing the rear supporting portion **7***a* to be inserted therethrough inwardly from the outside.

According to the present embodiment having the aforementioned structure, the slider **30** is at first moved to the advancement direction x by gripping operation portions **17**. As a result, a first abutting portion **21** formed on a front end of the slider **30** is caused to abut against the rear supporting portion **7***a*.

As the slider **30** is further moved to the advancement direction x, the rear supporting portion **7***a* is pushed up with x-direction abutting surfaces **24** of the second abutting portion **22** abutting against and pushing out the optical part **6**, at the same time, thus allowing the intraocular lens **5** to be moved from a lens placement section to a transition section **10**. In this way, the optical part **6** is pushed by an inner wall of the transition section **10**, and a surface of the optical part **6** is pushed down to the direction y by means of a lens pressing member **18**, thus allowing the optical part **6** to be valley folded (FIGS. **10**A and **10**B).

Next, as a plunger **4** is moved to the advancement direction x, the front end of such plunger **4** supported by a guiding groove **15** of the slider **3** is caused to abut against the outer edge of the optical part **6** (FIGS. **11**A and **11**B). The supporting portion **7** pushed up by the first abutting portion **21** is thus caused to deform along the plunger **4** in a manner such that a front end of the supporting portion **7** eventually points to the advancement direction x. In this way, a front end of the supporting portion **7** deformed due to the first abutting portion **21**, is tucked into the surface of the valley-folded optical part **6**.

Next, by further moving the plunger **4** to the advancement direction x, the intraocular lens **5** is moved from the transition section **10** to a nozzle section **11** (FIGS. **12**A and **12**B), followed by being released to the outside from a front end of the nozzle section **11** with the intraocular lens **5** itself being folded even smaller.

Due to the aforementioned structure of the present embodiment, the present embodiment, as is the case in the first embodiment, allows the motion of the rear supporting portion **7***a* to be appropriately regulated during the process of moving the intraocular lens **5**, and reduces the possibility of reoperation being required after the intraocular lens **5** is inserted into the eye.

3. Third Embodiment

As shown in FIG. **13**, a slider **40** of the present embodiment includes a first abutting portion **21**, second abutting portions **22***a*, **22***b* and a guiding portion **41** for guiding the optical part **6** to the second abutting portion **22***b*. The second abutting portion **22***b* is provided on a location opposite to the connecting portion of the rear supporting portion **7***a* and the optical part **6**, and is configured to be able to abut against the optical part **6** or the outer edge thereof. Further, the second abutting portion **22***b* has an x-direction abutting surface **24** and a y-direction abutting surface **25**. In contrast, the second abutting portion **22***a* only has the x-direction abutting surface **24**.

Here, the y-direction abutting surface **25** of the second abutting portion **22***b* may be arranged substantially on the same plane as restriction portions **23**, or beyond the restriction portions **23** in the direction y. According to the present embodiment, the y-direction abutting surface **25** is arranged on the same plane as the restriction portions **23**.

The guiding portion **41** has a slanting surface slanting toward a direction between the advancement direction x and an opposite direction of the direction y. A lower end of the guiding portion **41** is communicated with the y-direction abutting surface **25**. Here, a plunger having a shape shown in FIG. **14** can be used as a plunger **44**. The plunger **44** includes a distal end **45** with a lens contact portion **46**, a lateral wall **47**, a bottom wall **48**, and a top wall **49**. A recess **50** has a first lateral side **51** that is open, a second lateral side that is closed by the lateral wall **47**, and an open distal end **52**. The recess **50** is located above, and extends proximally from, the lens contact portion **46**. The proximal end of the recess **50** is defined by a slanted wall **53**.

Next, there are described an operation and effect of the slider **40** having the aforementioned structure. The intraocular lens **5** is placed in a lens placement section (not shown) in a manner such that the optical part **6** thereof is arranged in parallel with the lens advancement axis A (FIGS. **15**A and **15**B). The slider **40** is at first moved to the advancement direction x in order to release such intraocular lens **5** to the outside from a front end of a nozzle section **11**. As a result, the first abutting portion **21** formed on a front end of the slider **40** is caused to abut against the rear supporting portion **7***a* (FIGS. **16**A and **16**B).

Since the first abutting portion **21** has a slanting surface, the rear supporting portion **7***a* is pushed up therealong as the slider **40** is further moved to the advancement direction x (FIGS. **17**A and **17**B). At the same time, the guiding portion **41** serves to push down a surface of the optical part **6** to the direction y, thereby guiding the corresponding optical part **6** to the second abutting portion **22***b*. As a result, the x-direction abutting surface **24** of the second abutting portion **22***b* and the x-direction abutting surface **24** of the second abutting portion **22***a* are caused to abut against and then push out the optical part **6**, thus allowing the intraocular lens **5** to be moved from the lens placement section to a transition section **10**.

Here, the slider **40** allows the optical part **6** to be guided to the second abutting portion **22***b* by means of the guiding portion **41**, thereby causing the second abutting portion **22***b* to further reliably abut against the optical part **6**, and thus allowing the intraocular lens **5** to be further reliably pushed out.

In this way, the outer edge of the optical part **6** is pushed by an inner wall of the transition section **10**. Further, at that time, a lens pressing member **18** is also pushed by the inner wall of the transition section **10**, thus pushing down the surface of the optical part **6** to the direction y. As a result, the optical part **6** of the intraocular lens **5** is valley folded.

Next, as the plunger **44** is moved to the advancement direction x, the front end of such plunger **44** supported by a guiding groove **15** of the slider **40** is caused to abut against the outer edge of the optical part **6** (FIGS. **18**A and **18**B).

The rear supporting portion **7***a* pushed up by the first abutting portion **21** is thus caused to deform along the plunger **44** in a manner such that a front end of the rear supporting portion **7***a* eventually points to the advancement direction x and a part of the rear supporting portion **7***a* is in the recess. In this way, the front end of the rear supporting portion **7***a* deformed due to the first abutting portion **21**, is enclosed by the valley-folded surface of the optical part **6**.

Here, the y-direction abutting surface **25** of the second abutting portion **22***b* is configured to restrict the surface of the optical part **6** in the vicinity of the outer edge thereof from being valley folded, thereby preventing the outer edge of the optical part **6** from interfering with the rear supporting portion **7***a* during the deformation process of the rear supporting portion **7***a*.

Particularly, according to the present embodiment, since the y-direction abutting surface **25** is arranged on the same plane as the restriction portions **23**, the outer edge of the optical part **6** is restricted from deforming to the opposite direction of the direction y, particularly, from deforming beyond the restriction portions **23** and the rear supporting portion **7***a* deformed due to the first abutting portion **21**. In this sense, the slider **40** can further reliably prevent the outer edge of the optical part **6** from interfering with the rear supporting portion **7***a*, thereby allowing the intraocular lens **5** to be further reliably deformed into the given shape.

Next, by further moving the plunger **44** to the advancement direction x, the intraocular lens **5** is moved from a transition section **10** to a nozzle section **11** (FIGS. **19**A and **19**B), followed by being released to the outside from a front end of the nozzle section **11** with the intraocular lens **5** itself being folded even smaller.

Since the slider **40** of the present embodiment includes the first abutting portion **21** and the restriction portions **23**, there can be achieved the same effects as those of the first embodiment.

4. Modified Embodiment

The present invention is not limited to the aforementioned embodiments. As a matter of fact, appropriate modifications are possible within the scope of the gist of the present invention. For example, in each one of the aforementioned embodiments, there are provided two second abutting portions in total. However, the present invention is not limited to this configuration. Particularly, the number of the second abutting portions can be one, three or more than three.

Further, in each one of the aforementioned embodiments, the second abutting portions **22** are provided as a symmetrical pair. However, the present invention is not limited to this configuration. The second abutting portions **22** can actually be provided in an asymmetrical manner. For example, one of the second abutting portions **22** may be formed longer than the other second abutting portion **22** in the advancement direction x, thereby making it possible to slightly rotate the intraocular lens **5** about an optical axis, and thus making it easier to regulate a supporting portion disposed forward.

DESCRIPTION OF SYMBOLS

1 intraocular lens insertion device
2 main body
3 slider
4 plunger
5 intraocular lens
6 optical part
7 supporting portion
7*a* rear supporting portion
21 first abutting portion
22 second abutting portion
x advancement direction
y direction (downward direction)
A lens advancement axis

The invention claimed is:

1. An intraocular lens insertion apparatus, comprising:
a main body;
an intraocular lens including an optic and haptics, each haptic having a free end, stored in the main body in such a manner that one of the haptics is a proximal haptic and one of the haptics is a distal haptic;
a nozzle associated with the main body and configured to be inserted into an eye; and
a plunger, carried within the main body and movable relative to the main body from a first position to a second position at the nozzle, including a lens contact portion and a recess that is located above the lens contact portion, that extends proximally from the lens contact portion, that has a first lateral side that is open, a second lateral side that is closed by a lateral wall, and an open distal end, wherein the plunger is configured to hold a portion of the proximal haptic in the recess when the proximal haptic is bent such that the free end of the proximal haptic is positioned over the optic.

2. An intraocular lens insertion apparatus as claimed in claim **1**, wherein
the plunger includes a top wall that extends over at least a portion of the recess.

3. An intraocular lens insertion apparatus as claimed in claim **1**, wherein
the plunger includes a portion with a slanted wall and the slanted wall defines a proximal end of the recess.

4. An intraocular lens insertion apparatus as claimed in claim **3**, wherein
the plunger defines a longitudinal axis; and
the slanted wall is oriented at a non-perpendicular angle with respect to the longitudinal axis.

5. An intraocular lens insertion apparatus as claimed in claim **3**, wherein
the slanted wall extends from the lateral wall to the first lateral side that is open.

6. An intraocular lens insertion system as claimed in claim **1**, further comprising:
a slider movable relative to the plunger from a pre-use slider position to a second slider position.

7. An intraocular lens insertion apparatus as claimed in claim **6**, wherein
movement of the slider from the pre-use slider position to the second slider position moves the free end of the proximal haptic towards the optic.

8. An intraocular lens insertion apparatus as claimed in claim **1**, wherein
the plunger includes a rotatable handle.

9. An intraocular lens insertion apparatus as claimed in claim **1**, wherein
the plunger includes a thumb rest.

10. An intraocular lens insertion apparatus as claimed in claim **1**, wherein
the lens contact portion is planar.

11. An intraocular lens insertion apparatus as claimed in claim **1**, wherein
the main body includes a base portion and an insertion tube.

12. An intraocular lens insertion apparatus as claimed in claim 11, wherein the insertion tube includes a tapered transition section and the nozzle.

13. An intraocular lens insertion apparatus, comprising:

a main body;

an intraocular lens including an optic and haptics, each haptic having a free end, stored in the main body in such a manner that one of the haptics is a proximal haptic and one of the haptics is a distal haptic;

a nozzle associated with the main body and configured to be inserted into an eye; and

a plunger, carried within the main body and movable relative to the main body, including a lens contact portion and a recess that extends proximally from the lens contact portion, that has a first lateral side that is open, a second lateral side that is closed by a lateral wall, and an open distal end, and that is configured to hold a portion of the proximal haptic when the proximal haptic is bent such that the free end of the proximal haptic is positioned over the optic;

wherein the insertion apparatus defines an x-direction and a y-direction that is perpendicular to the x-direction, the plunger moves in the x-direction, the lens contact portion and the recess are offset from one another in the y-direction, and the first and second lateral sides are offset from one another in a lateral direction that is perpendicular to both the x-direction and the y-direction.

14. An intraocular lens insertion apparatus as claimed in claim 13, wherein

the plunger includes a top wall that extends over at least a portion of the recess.

15. An intraocular lens insertion apparatus as claimed in claim 13, wherein

the plunger includes a portion with a slanted wall and the slanted wall defines a proximal end of the recess; and

the plunger defines a longitudinal axis.

16. An intraocular lens insertion apparatus as claimed in claim 15, wherein

the slanted wall is oriented at a non-perpendicular angle with respect to the longitudinal axis.

17. An intraocular lens insertion apparatus as claimed in claim 15, wherein

the slanted wall extends from the lateral wall to the first lateral side that is open.

18. An intraocular lens insertion system as claimed in claim 13, further comprising:

a slider movable relative to the plunger from a pre-use slider position to a second slider position.

19. An intraocular lens insertion apparatus as claimed in claim 18, wherein

movement of the slider from the pre-use slider position to the second slider position moves the free end of the proximal haptic towards the optic.

20. An intraocular lens insertion apparatus as claimed in claim 13, wherein

the plunger includes a rotatable handle.

21. An intraocular lens insertion apparatus as claimed in claim 13, wherein

the plunger includes a thumb rest.

22. An intraocular lens insertion apparatus as claimed in claim 13, wherein

the lens contact portion is planar.

23. An intraocular lens insertion apparatus as claimed in claim 13, wherein

the main body includes a base portion and an insertion tube.

24. An intraocular lens insertion apparatus as claimed in claim 23, wherein the insertion tube includes a tapered transition section and the nozzle.

25. An intraocular lens insertion apparatus, comprising:

a main body;

an intraocular lens including an optic and haptics, each having a free end, stored in the main body in such a manner that one of the haptics is a proximal haptic and one of the haptics is a distal haptic;

a nozzle associated with the main body and configured to be inserted into an eye; and

a plunger, carried within the main body and movable relative to the main body, including a lens contact portion and means for holding a portion of the proximal haptic when the proximal haptic is bent such that the free end of the proximal haptic is positioned over the optic.

26. An intraocular lens insertion system as claimed in claim 25, further comprising:

a slider movable relative to the plunger from a pre-use slider position to a second slider position.

27. An intraocular lens insertion apparatus as claimed in claim 26, wherein

movement of the slider from the pre-use slider position to the second slider position moves the free end of the proximal haptic towards the optic.

* * * * *

EXHIBIT 2

US009980811B2

(12) United States Patent

Kudo et al.

(10) Patent No.: US 9,980,811 B2
(45) Date of Patent: May 29, 2018

(54) **OCULAR IMPLANT INSERTION APPARATUS AND METHODS**

(71) Applicant: **Hoya Corporation**, Tokyo (JP)

(72) Inventors: **Kazunori Kudo**, Saku (JP); **Masahiro Noda**, Toda (JP)

(73) Assignee: **Hoya Corporation**, Tokyo (JP)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 12 days.

(21) Appl. No.: **15/608,895**

(22) Filed: **May 30, 2017**

(65) **Prior Publication Data**

US 2017/0258582 A1 Sep. 14, 2017

Related U.S. Application Data

(63) Continuation of application No. 15/071,880, filed on Mar. 16, 2016, which is a continuation of application (Continued)

(30) **Foreign Application Priority Data**

Jun. 10, 2010 (JP) 2010-132952

(51) **Int. Cl.**
A61F 2/16 (2006.01)
A61F 2/14 (2006.01)

(52) **U.S. Cl.**
CPC ..... ***A61F 2/1672*** (2013.01); ***A61F 2/167*** (2013.01); ***A61F 2/1664*** (2013.01); (Continued)

(58) **Field of Classification Search**
CPC A61F 2/148; A61F 9/0008; A61F 2/167; A61F 2/1662
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

2,761,446 A 9/1956 Reed
4,205,747 A 6/1980 Gilliam et al.
(Continued)

FOREIGN PATENT DOCUMENTS

DE 3610925 10/1987
DE 4110278 10/1992
(Continued)

OTHER PUBLICATIONS

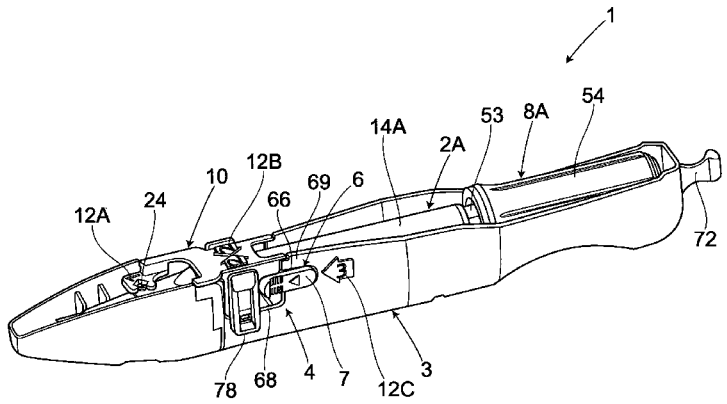
U.S. Appl. No. 13/244,449, filed Sep. 24. 2011, U.S. Pat. No. 9,289,288.
(Continued)

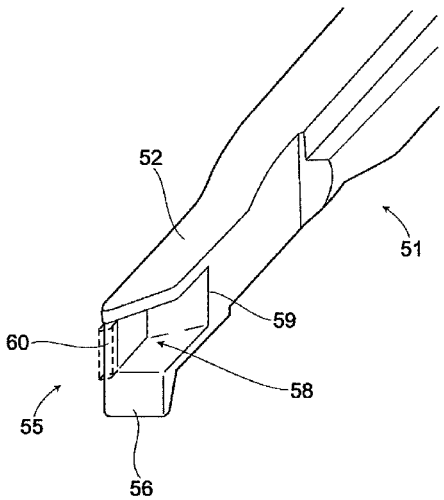
Primary Examiner — Son Dang
(74) *Attorney, Agent, or Firm* — Henricks, Slavin & Holmes LLP

(57) **ABSTRACT**

An exemplary ocular implant insertion system includes a case and a preloaded ocular implant insertion apparatus. The apparatus includes first and second movable structures that move the ocular implant in a predetermined sequence. The respective configurations of the case and the ocular implant insertion apparatus are such that the ocular implant insertion apparatus is not removable from the case when the ocular implant insertion apparatus is in the pre-use state and is removable after the first movable structure has moved at least a portion of the optical implant.

17 Claims, 12 Drawing Sheets





Related U.S. Application Data

No. 14/145,846, filed on Dec. 31, 2013, now Pat. No. 9,314,373, which is a continuation of application No. 13/699,708, filed as application No. PCT/JP2011/063747 on Jun. 8, 2011, now Pat. No. 8,647,382.

(52) **U.S. Cl.**
CPC ***A61F 2/1678*** (2013.01); *A61F 2/148* (2013.01); *A61F 2/1662* (2013.01); *A61F 2002/16903* (2015.04)

(56) **References Cited**

U.S. PATENT DOCUMENTS

4,269,307	A	5/1981	LaHaye
4,423,809	A	1/1984	Mazzocco
4,573,998	A	3/1986	Mazzocco
4,608,049	A	8/1986	Kelman
4,634,423	A	1/1987	Bailey
4,681,102	A	7/1987	Bartell
4,697,697	A	10/1987	Graham et al.
4,699,140	A	10/1987	Holmes
4,702,244	A	10/1987	Mazzocco
4,715,373	A	12/1987	Mazzocco et al.
4,747,404	A	5/1988	Jampel et al.
4,750,498	A	6/1988	Graham
4,759,359	A	7/1988	Willis et al.
4,763,650	A	8/1988	Hauser
4,765,329	A	8/1988	Cumming et al.
4,769,034	A	9/1988	Poley
4,781,719	A	11/1988	Kelman
4,787,904	A	11/1988	Severin
4,810,249	A	3/1989	Haber et al.
4,819,631	A	4/1989	Poley
4,834,094	A	5/1989	Patton
4,836,201	A	6/1989	Patton
4,862,885	A	9/1989	Cumming
4,880,000	A	11/1989	Holmes et al.
4,919,130	A	4/1990	Stoy et al.
4,934,363	A	6/1990	Smith et al.
4,955,889	A	9/1990	Van Gent
4,976,716	A	12/1990	Cumming
4,988,352	A	1/1991	Poley
4,994,028	A	2/1991	Leonard et al.
5,066,297	A	11/1991	Cumming
5,098,439	A	3/1992	Hill et al.
5,123,905	A	6/1992	Kelman
5,139,501	A	8/1992	Klaas
5,171,241	A	12/1992	Buboltz et al.
5,176,686	A	1/1993	Poley
5,190,552	A	3/1993	Kelman
5,190,553	A	3/1993	Kanert et al.
5,222,972	A	6/1993	Hill et al.
5,242,450	A	9/1993	McDonald
5,259,395	A	11/1993	Li
5,275,604	A	1/1994	Rheinish et al.
5,281,227	A	1/1994	Sussman
5,304,182	A	4/1994	Rheinish et al.
5,354,333	A	10/1994	Kammann et al.
5,395,378	A	3/1995	McDonald
5,425,734	A	6/1995	Blake
5,454,818	A	10/1995	Hambleton et al.
5,468,246	A	11/1995	Blake
5,474,562	A	12/1995	Orchowski et al.
5,494,484	A	2/1996	Feingold
5,496,328	A	3/1996	Nakajima et al.
5,499,987	A	3/1996	Feingold
5,562,676	A	10/1996	Brady et al.
5,571,113	A	11/1996	McDonald
5,578,042	A	11/1996	Cumming
5,582,613	A	12/1996	Brady
5,582,614	A	12/1996	Feingold
5,584,304	A	12/1996	Brady
5,616,148	A	4/1997	Eagles et al.
5,620,450	A	4/1997	Eagles et al.
5,643,275	A	7/1997	Blake
5,643,276	A	7/1997	Zaleski
5,645,534	A	7/1997	Chanoch
5,653,715	A	8/1997	Reich et al.
5,653,753	A	8/1997	Brady et al.
5,702,402	A	12/1997	Brady
5,702,441	A	12/1997	Zhou
5,716,364	A	2/1998	Makker et al.
5,728,075	A	3/1998	Levander
5,728,102	A	3/1998	Feingold et al.
5,735,858	A	4/1998	Makker et al.
5,766,181	A	6/1998	Chambers et al.
5,772,666	A	6/1998	Feingold et al.
5,772,667	A	6/1998	Blake
5,776,138	A	7/1998	Vidal et al.
5,800,442	A	9/1998	Wolf et al.
5,803,925	A	9/1998	Yang et al.
5,807,400	A	9/1998	Chambers et al.
5,810,833	A	9/1998	Brady et al.
5,810,834	A	9/1998	Heyman
5,860,984	A	1/1999	Chambers et al.
5,860,986	A	1/1999	Reich et al.
5,868,751	A	2/1999	Feingold
5,868,752	A	2/1999	Makker et al.
5,873,879	A	2/1999	Figueroa et al.
5,876,406	A	3/1999	Wolf et al.
5,876,407	A	3/1999	Makker et al.
5,876,440	A	3/1999	Feingold
5,891,152	A	4/1999	Feingold
5,902,307	A	5/1999	Feingold et al.
5,919,197	A	7/1999	McDonald
5,921,989	A	7/1999	Deacon et al.
5,928,245	A	7/1999	Wolf et al.
5,941,886	A	8/1999	Feingold
5,942,277	A	8/1999	Makker et al.
5,944,725	A	8/1999	Cicenas
5,947,974	A	9/1999	Brady et al.
5,947,975	A	9/1999	Kikuchi et al.
5,957,748	A	9/1999	Ichiha
5,957,896	A	9/1999	Bendek et al.
6,001,107	A	12/1999	Feingold
6,010,510	A	1/2000	Brown et al.
6,022,358	A	2/2000	Wolf et al.
6,048,348	A	4/2000	Chambers et al.
6,051,000	A	4/2000	Heyman
6,056,757	A	5/2000	Feingold et al.
6,056,758	A	5/2000	Vidal et al.
6,059,791	A	5/2000	Chambers
6,074,397	A	6/2000	Chambers et al.
6,083,230	A	7/2000	Makker et al.
6,093,193	A	7/2000	Makker et al.
6,129,733	A	10/2000	Brady et al.
6,142,999	A	11/2000	Brady et al.
6,143,000	A	11/2000	Feingold
6,162,229	A	12/2000	Feingold et al.
6,174,315	B1	1/2001	Chambers et al.
6,214,015	B1	4/2001	Reich et al.
6,241,737	B1	6/2001	Feingold
6,248,111	B1	6/2001	Glick et al.
6,251,114	B1	6/2001	Farmer et al.
6,254,607	B1	7/2001	Makker et al.
6,267,768	B1	7/2001	Deacon
6,283,975	B1	9/2001	Glick et al.
6,283,976	B1	9/2001	Portney
6,312,433	B1	11/2001	Butts
6,334,862	B1	1/2002	Vidal et al.
6,336,932	B1	1/2002	Figueroa et al.
6,355,046	B2	3/2002	Kikuchi et al.
6,371,960	B2	4/2002	Heyman et al.
6,386,357	B1	5/2002	Egawa
6,387,101	B1	5/2002	Butts et al.
6,398,788	B1	6/2002	Makker et al.
6,406,481	B2	6/2002	Feingold et al.
6,428,545	B2	8/2002	Portney
6,447,519	B1	9/2002	Brady et al.
6,447,520	B1	9/2002	Ott et al.
6,468,282	B2	10/2002	Kikuchi et al.
6,471,708	B2	10/2002	Green
6,491,697	B1	12/2002	Clark et al.

(56) **References Cited**

U.S. PATENT DOCUMENTS

6,497,708 B1 12/2002 Cumming
6,500,181 B1 12/2002 Portney
6,506,195 B2 1/2003 Chambers et al.
6,537,283 B2 3/2003 Van Noy
6,540,754 B2 4/2003 Brady
6,554,839 B2 4/2003 Brady
6,558,395 B2 5/2003 Hjertman et al.
6,605,093 B1 8/2003 Blake
6,607,537 B1 8/2003 Binder
6,629,979 B1 10/2003 Feingold
6,666,871 B2 12/2003 Kikuchi et al.
6,679,891 B2 1/2004 Makker et al.
6,685,740 B2 2/2004 Figueroa et al.
6,712,848 B1 3/2004 Wolf et al.
6,723,104 B2 4/2004 Ott
6,733,507 B2 5/2004 McNicholas et al.
6,793,674 B2 9/2004 Zapata
6,858,033 B2 2/2005 Kobayashi
6,921,405 B2 7/2005 Feingold et al.
6,923,815 B2 8/2005 Brady et al.
6,976,989 B1 12/2005 Vincent
7,014,641 B2 3/2006 Kobayashi et al.
7,025,782 B2 4/2006 Kobayashi et al.
7,033,366 B2 4/2006 Brady
7,037,312 B2 5/2006 Kikuchi et al.
7,074,227 B2 7/2006 Portney
7,097,649 B2 8/2006 Meyer
7,131,976 B2 11/2006 Kobayashi et al.
7,156,854 B2 1/2007 Brown et al.
7,348,038 B2 3/2008 Makker et al.
7,422,604 B2 9/2008 Vaquero et al.
7,429,263 B2 9/2008 Vaquero et al.
7,458,976 B2 12/2008 Peterson et al.
7,476,230 B2 1/2009 Ohno et al.
7,494,505 B2 2/2009 Kappelhof et al.
7,645,300 B2 1/2010 Tsai
8,273,122 B2 9/2012 Anderson
8,382,769 B2 2/2013 Inoue
8,460,311 B2 * 6/2013 Ishii A61F 2/1678 606/107
8,470,032 B2 6/2013 Inoue et al.
8,475,528 B2 7/2013 Ichinohe et al.
8,523,877 B2 * 9/2013 Ichinohe A61F 2/1662 606/107
8,523,941 B2 * 9/2013 Ichinohe A61F 9/0017 606/107
8,535,375 B2 9/2013 Ichinohe et al.
8,545,512 B2 10/2013 Ichinohe et al.
8,574,239 B2 11/2013 Ichinohe et al.
8,603,103 B2 12/2013 Kudo et al.
8,647,382 B2 2/2014 Kudo et al.
8,702,795 B2 4/2014 Shoji et al.
8,747,465 B2 * 6/2014 Someya A61F 2/1678 606/107
8,968,328 B2 3/2015 Ichinohe et al.
9,114,006 B2 8/2015 Inoue
9,114,007 B2 8/2015 Ichinohe et al.
9,186,246 B2 11/2015 Inoue
9,220,593 B2 12/2015 Ichinohe
9,289,288 B2 3/2016 Someya et al.
9,314,373 B2 4/2016 Kudo et al.
9,326,847 B2 5/2016 Sanger
9,364,320 B2 6/2016 Ichinohe et al.
9,554,894 B2 1/2017 Inoue
9,572,710 B1 2/2017 Kudo et al.
9,655,718 B2 5/2017 Kudo et al.
2001/0007942 A1 * 7/2001 Kikuchi A61F 2/1672 606/107
2002/0103490 A1 8/2002 Brady
2002/0151904 A1 10/2002 Feingold et al.
2002/0165610 A1 11/2002 Waldock
2002/0193805 A1 12/2002 Ott et al.
2003/0036765 A1 2/2003 Van Noy
2003/0040755 A1 2/2003 Meyer
2003/0050647 A1 3/2003 Brady
2003/0088253 A1 5/2003 Seil
2003/0139749 A1 7/2003 Kikuchi et al.
2003/0181921 A1 9/2003 Jeannin
2003/0195522 A1 10/2003 McNicholas
2003/0212406 A1 11/2003 Kobayashi et al.
2003/0212407 A1 11/2003 Kikuchi
2003/0212409 A1 11/2003 Kobayashi et al.
2004/0111094 A1 6/2004 Meyer
2004/0117012 A1 6/2004 Vincent
2004/0127911 A1 7/2004 Figueroa
2004/0186428 A1 9/2004 Ray
2004/0238392 A1 12/2004 Peterson et al.
2004/0243141 A1 12/2004 Brown et al.
2005/0033308 A1 2/2005 Callahan et al.
2005/0049605 A1 3/2005 Vaquero et al.
2005/0049606 A1 3/2005 Vaquero et al.
2005/0055011 A1 3/2005 Enggaard
2005/0125000 A1 6/2005 Tourrette et al.
2005/0143750 A1 * 6/2005 Vaquero A61F 2/1664 606/107
2005/0182419 A1 8/2005 Tsai
2005/0222578 A1 10/2005 Vaquero
2005/0261703 A1 11/2005 Feingold et al.
2006/0085013 A1 4/2006 Dusek
2006/0142781 A1 6/2006 Pynson et al.
2006/0167466 A1 7/2006 Dusek
2006/0200167 A1 9/2006 Peterson et al.
2006/0229633 A1 10/2006 Shepherd
2006/0235429 A1 10/2006 Lee et al.
2006/0235437 A1 * 10/2006 Vitali A61B 17/10 606/142
2006/0293694 A1 12/2006 Futamura
2007/0005135 A1 1/2007 Makker et al.
2008/0033449 A1 2/2008 Cole et al.
2008/0058830 A1 3/2008 Cole et al.
2008/0086146 A1 4/2008 Ishii et al.
2008/0097459 A1 4/2008 Kammerlander et al.
2008/0221584 A1 9/2008 Downer
2009/0036898 A1 2/2009 Ichinohe
2009/0043313 A1 2/2009 Ichinohe
2009/0112223 A1 4/2009 Downer et al.
2009/0125034 A1 5/2009 Pynson
2009/0138022 A1 5/2009 Tu et al.
2009/0204122 A1 8/2009 Ichinohe et al.
2009/0216244 A1 8/2009 Pynson
2009/0248031 A1 10/2009 Ichinohe
2010/0094309 A1 4/2010 Hboukhny et al.
2010/0106160 A1 4/2010 Tsai
2010/0161049 A1 * 6/2010 Inoue A61F 2/167 623/6.12
2010/0185206 A1 * 7/2010 Ichinohe A61F 2/1672 606/107
2010/0217273 A1 8/2010 Someya et al.
2010/0286704 A1 11/2010 Ichinohe et al.
2010/0331808 A1 12/2010 Py et al.
2011/0082463 A1 4/2011 Inoue
2011/0098717 A1 4/2011 Inoue
2011/0264101 A1 10/2011 Inoue et al.
2011/0270264 A1 11/2011 Shoji et al.
2011/0288557 A1 * 11/2011 Kudo A61F 2/1672 606/107
2012/0022549 A1 1/2012 Someya et al.
2012/0071887 A1 3/2012 Ichinohe et al.
2013/0006259 A1 1/2013 Sanger
2013/0018460 A1 1/2013 Anderson
2013/0226193 A1 * 8/2013 Kudo A61F 2/148 606/107
2013/0245635 A1 9/2013 Inoue
2014/0081284 A1 3/2014 Ichinohe et al.
2014/0107660 A1 4/2014 Ichinohe et al.
2014/0114323 A1 4/2014 Kudo et al.
2014/0180299 A1 6/2014 Ichinohe et al.
2014/0180300 A1 6/2014 Ichinohe et al.
2014/0194890 A1 7/2014 Kudo et al.
2015/0342726 A1 * 12/2015 Deacon A61F 2/148 623/6.12
2016/0113759 A1 4/2016 Inoue
2016/0193038 A1 7/2016 Kudo et al.

(56) **References Cited**

U.S. PATENT DOCUMENTS

2016/0346077	A1	12/2016	Someya et al.
2017/0079772	A1	3/2017	Kudo
2017/0151056	A1	6/2017	Inoue
2017/0202662	A1	7/2017	Someya et al.
2017/0252149	A1	9/2017	Kudo et al.
2017/0252150	A1	9/2017	Kudo et al.

FOREIGN PATENT DOCUMENTS

EP	0363213		4/1990
EP	0727966		9/2003
EP	1832247	A1	9/2007
EP	1338254		12/2008
FR	2749752	A	12/1997
JP	63-197453	A	8/1988
JP	4-212350	A	8/1992
JP	5-103808		4/1993
JP	5-103809		4/1993
JP	8-024282	A	1/1996
JP	8-505540		6/1996
JP	9-506285	A	6/1997
JP	11-113939	A	4/1999
JP	11-506357	A	6/1999
JP	2000-516487	A	12/2000
JP	2000-516488	A	12/2000
JP	2001-502563		2/2001
JP	2001-104347	A	4/2001
JP	2002-516709	A	6/2002
JP	2002-355268	A	12/2002
JP	2002-541912	A	12/2002
JP	2003-144480	A	5/2003
JP	3412106	B2	6/2003
JP	2003-210498	A	7/2003
JP	2003-325569	A	11/2003
JP	2003-325570	A	11/2003
JP	2003-325572	A	11/2003
JP	2004-024854	A	1/2004
JP	2004-188194	A	7/2004
JP	2004-351196	A	12/2004
JP	2006-181269	A	7/2006
JP	2006-297146	A	11/2006
JP	2006-333924	A	12/2006
JP	2006-333981	A	12/2006
JP	2007-503872	A	3/2007
JP	2007-152010	A	6/2007
JP	2007-181604	A	7/2007
JP	2007-526091	A	9/2007
JP	2008-521535	A	6/2008
JP	2008-212689	A	9/2008
JP	2014-050484	A	3/2014
WO	WO9407436	A1	4/1994
WO	WO9513022	A1	5/1995
WO	WO9628122	A1	9/1996
WO	WO9715253	A1	5/1997
WO	WO9812969	A1	4/1998
WO	WO9958086	A1	11/1999
WO	WO9959668	A1	11/1999
WO	WO0045746	A1	8/2000
WO	WO0062712	A1	10/2000
WO	WO2002071982	A1	9/2002
WO	WO2002096322	A1	12/2002
WO	WO2005023154	A1	3/2005
WO	WO2005070341	A1	8/2005
WO	WO2005084588	A1	9/2005
WO	WO2006070628	A1	7/2006
WO	WO2006080191	A1	8/2006
WO	WO2006090531	A1	8/2006
WO	WO2007037223	A1	4/2007
WO	WO2007097221	A1	4/2007
WO	WO2007080869	A1	7/2007
WO	WO2008149794	A1	12/2008
WO	WO2008149795	A1	12/2008
WO	WO2009058929	A1	7/2009
WO	WO2009148091	A1	12/2009
WO	WO2011126144	A1	10/2011
WO	WO2011155636	A1	12/2011

OTHER PUBLICATIONS

U.S. Appl. No. 15/476,717, filed Mar. 31, 2017.
U.S. Appl. No. 12/667,510, filed Dec. 31, 2009, U.S. Pat. No. 9,114,006.
U.S. Appl. No. 15/382,377, filed Dec. 16, 2016.
U.S. Appl. No. 15/600,679, filed May 19, 2017.
U.S. Appl. No. 15/600,684, filed May 19, 2017.
U.S. Appl. No. 15/126,277, filed Sep. 14, 2016, US 20170079772.
U.S. Appl. No. 12/602,442, filed Dec. 15, 2009, U.S. Pat. No. 8,747,465.
U.S. Appl. No. 13/244,449, filed Sep. 24, 2011, U.S. Pat. No. 9,289,288.
U.S. Appl. No. 15/063,395, filed Mar. 7, 2016, US 20160346077A1.
U.S. Appl. No. 15/476,717, filed Mar. 31, 2017, US 20170202662A1.
U.S. Appl. No. 12/602,454, filed Dec. 15, 2009, U.S. Pat. No. 8,475,528.
U.S. Appl. No. 13/244,452, filed Sep. 24, 2011, U.S. Pat. No. 8,535,375.
U.S. Appl. No. 12/667,510, filed Dec. 31, 2009, U.S. Pat. No. Pat. 9,114,006.
U.S. Appl. No. 14/812,104, filed Jul. 29, 2015, US 20160113759A1.
U.S. Appl. No. 12/995,263, filed Dec. 15, 2010, U.S. Pat. No. 9,554,894.
U.S. Appl. No. 15/382,377, filed Dec. 16, 2016, US 20170151056A1.
U.S. Appl. No. 12/997,651, filed Dec. 13, 2010, U.S. Pat. No. 8,382,769.
U.S. Appl. No. 13/757,790, filed Feb. 2, 2012, U.S. Pat. No. 9,186,246.
U.S. Appl. No. 13/583,216, filed Apr. 6, 2011, U.S. Pat. No. 9,326,847.
U.S. Appl. No. 13/699,708, filed Jun. 8, 2011, U.S. Pat. No. 8,647,382.
U.S. Appl. No. 14/145,846, filed Dec. 31, 2013, U.S. Pat. No. 9,314,373.
U.S. Appl. No. 15/071,880, filed Mar. 16, 2016, US 20160193038A1.
U.S. Appl. No. 15/336,678, filed Oct. 27, 2016, U.S. Pat. No. 9,572,710.
U.S. Appl. No. 15/608,895, filed May 30, 2017, US 20170258582A1.
U.S. Appl. No. 13/059,401, filed Feb. 16, 2011, U.S. Pat. No. 8,702,795.
U.S. Appl. No. 13/061,143, filed Feb. 26, 2011, U.S. Pat. No. 8,470,032.
U.S. Appl. No. 13/143,322, filed Jul. 5, 2011, U.S. Pat. No. 8,603,103.
U.S. Appl. No. 14/099,989, filed Dec. 8, 2013, U.S. Pat. No. 9,655,718.
U.S. Appl. No. 15/600,679, filed May 19, 2017, US 20170252149A1.
U.S. Appl. No. 15/600,684, filed May 19, 2017, US 20170252150A1.
U.S. Appl. No. 11/814,508, filed Jul. 23, 2007, U.S. Pat. No. 8,545,512.
U.S. Appl. No. 14/033,888, filed Sep. 23, 2013, U.S. Pat. No. 9,220,593.
U.S. Appl. No. 11/816,676, filed Aug. 20, 2007, U.S. Pat. No. 8,523,877.
U.S. Appl. No. 13/966,209, filed Aug. 13, 2013, U.S. Pat. No. 9,364,320.
U.S. Appl. No. 12/095,172, filed May 28, 2008, U.S. Pat. No. 8,523,941.
U.S. Appl. No. 14/011,018, filed Aug. 27, 2013, U.S. Pat. No. 8,968,328.

(56) **References Cited**

OTHER PUBLICATIONS

U.S. Appl. No. 12/088,328, filed Mar. 27, 2008, U.S. Pat. No. 8,574,239.
U.S. Appl. No. 14/065,365, filed Oct. 28, 2013, U.S. Pat. No. 9,114,007.
U.S. Appl. No. 11/722,601, filed Apr. 10, 2008, U.S. Pat. No. 8,460,311.
U.S. Appl. No. 15/126,277, filed Sep. 14, 2016, US 20170079772A1.

* cited by examiner

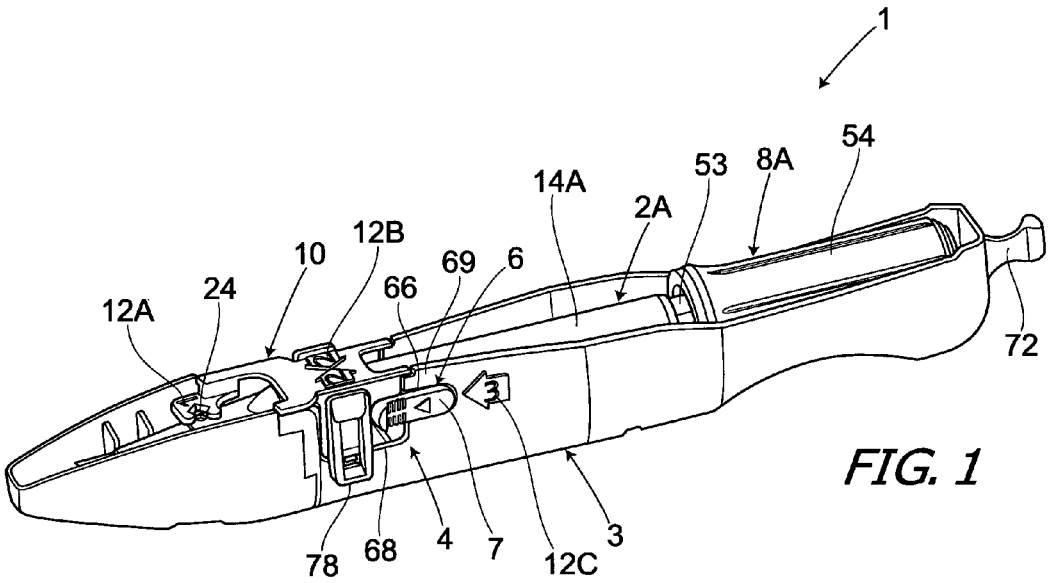


FIG. 1

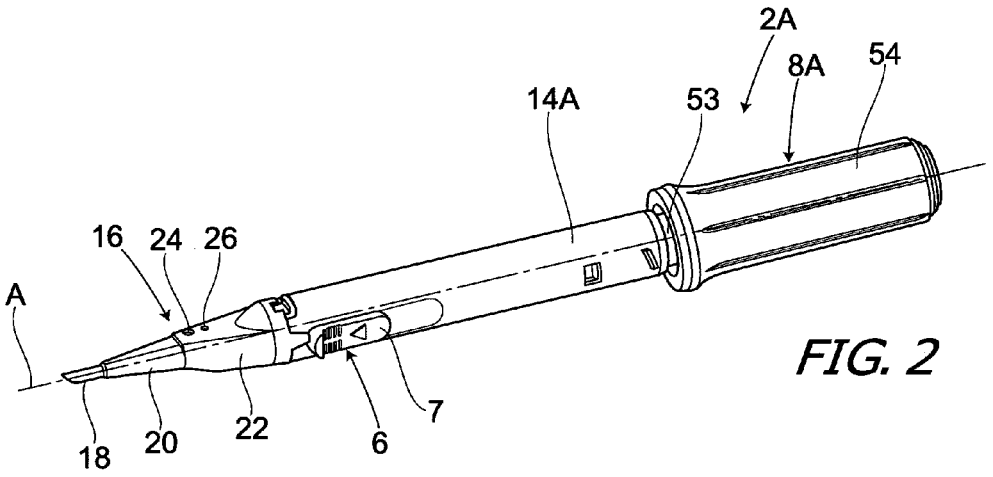


FIG. 2

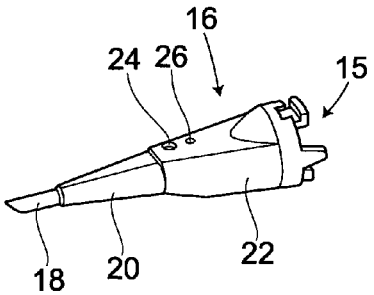


FIG. 3

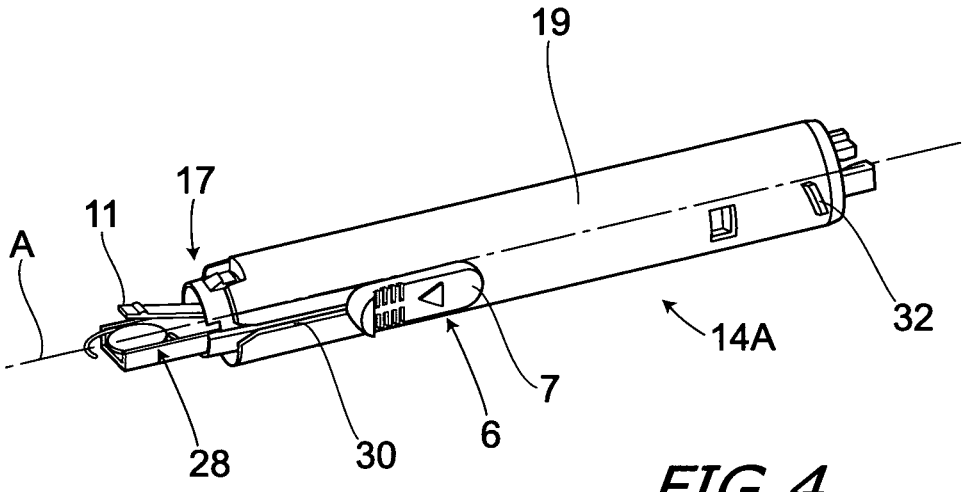

19
17
11
A
14A
32
7
6
28
30

FIG. 4

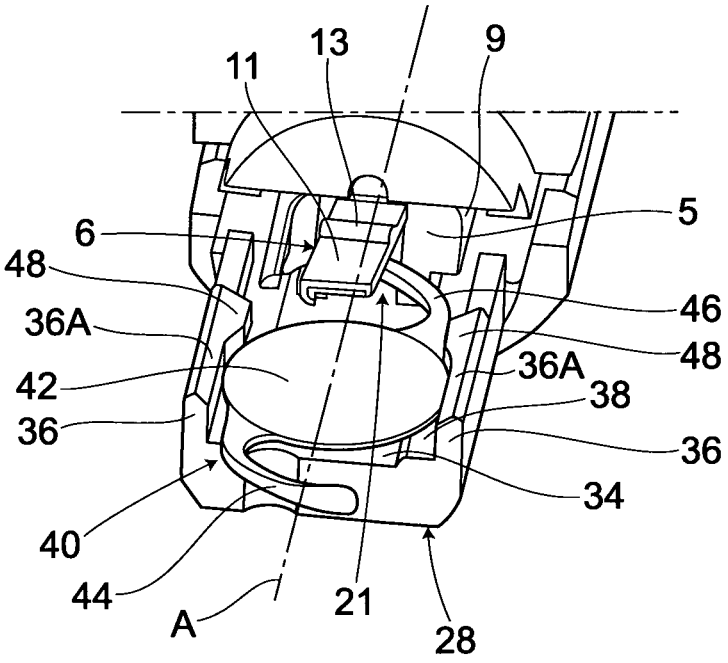

11
13
9
5
6
48
46
36A
48
36A
38
42
36
36
34
40
44
A
21
28

FIG. 5

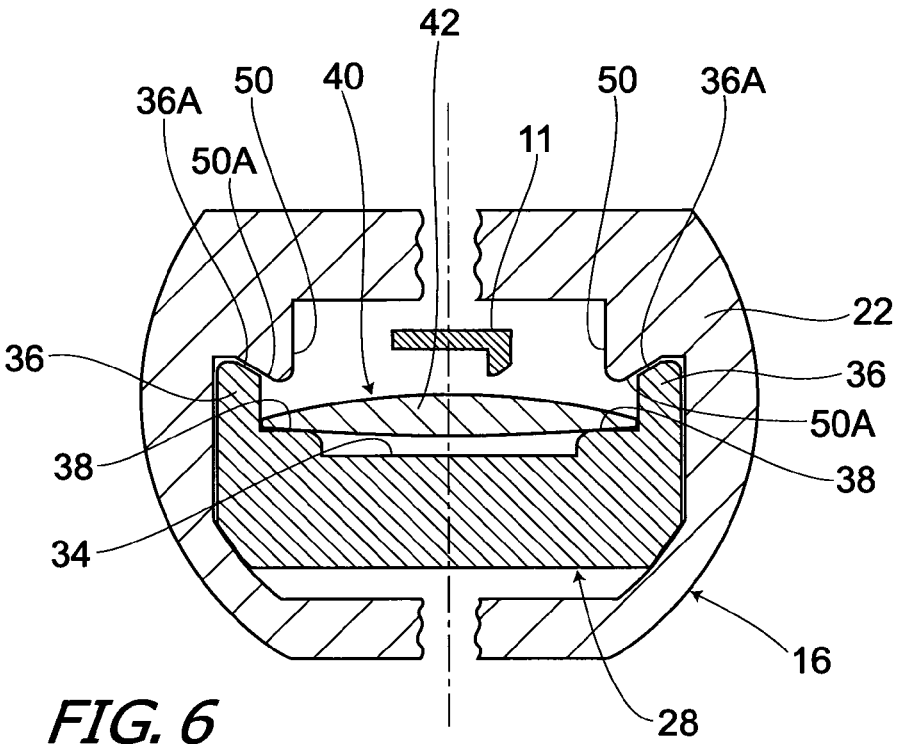

42
36A
50
40
50
36A
50A
11
22
36
36
50A
38
38
34
16
28

FIG. 6

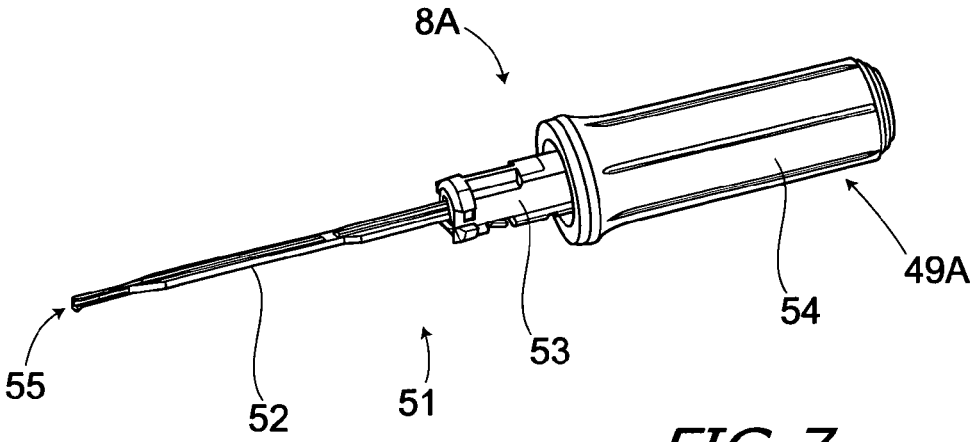

8A
49A
54
53
55
52
51

FIG. 7

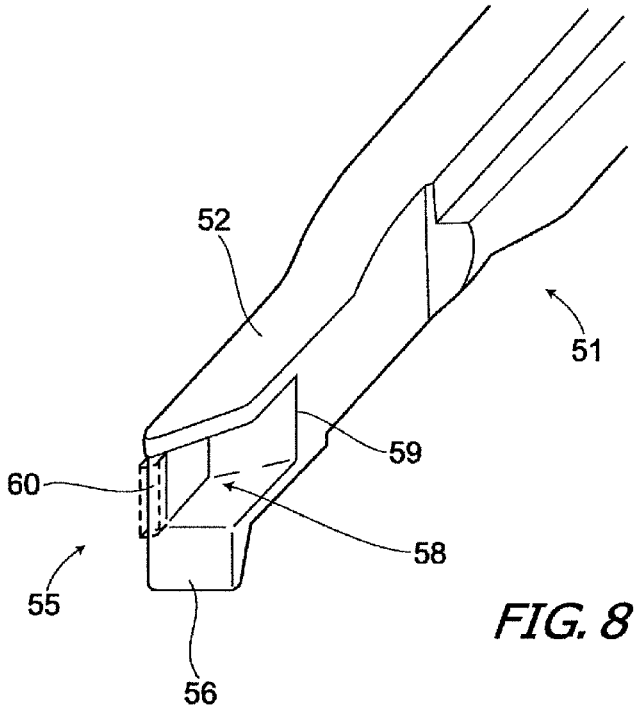


FIG. 8

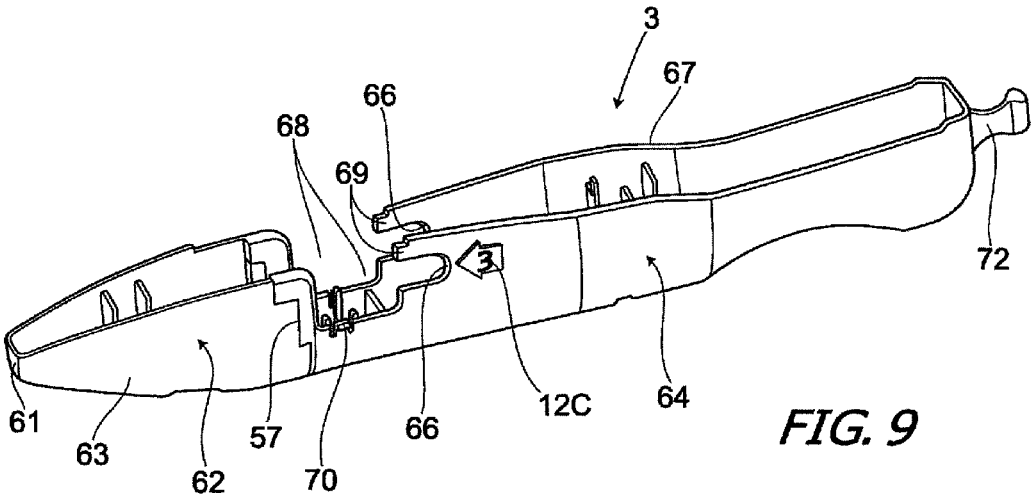


FIG. 9

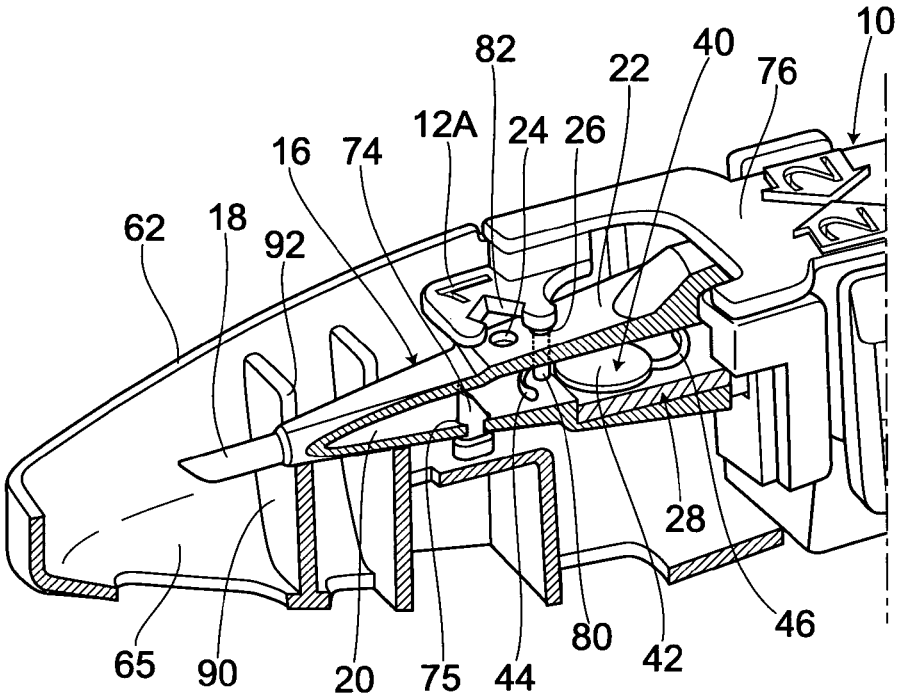

82
22
40
10
76
12A
24
26
16
74
62
18
92
28
46
80
42
65
90
20
75
44

FIG. 10

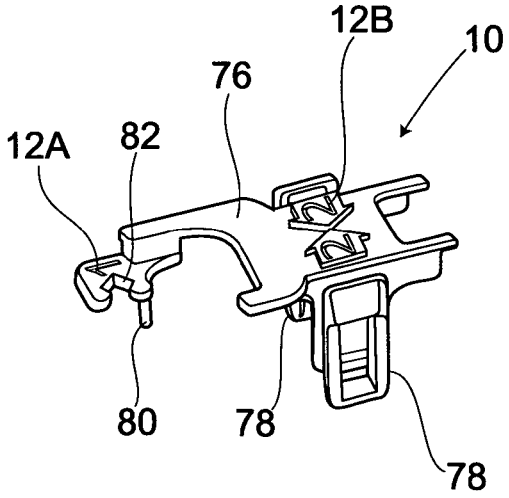

12B
10
76
12A
82
80
78
78

FIG. 11

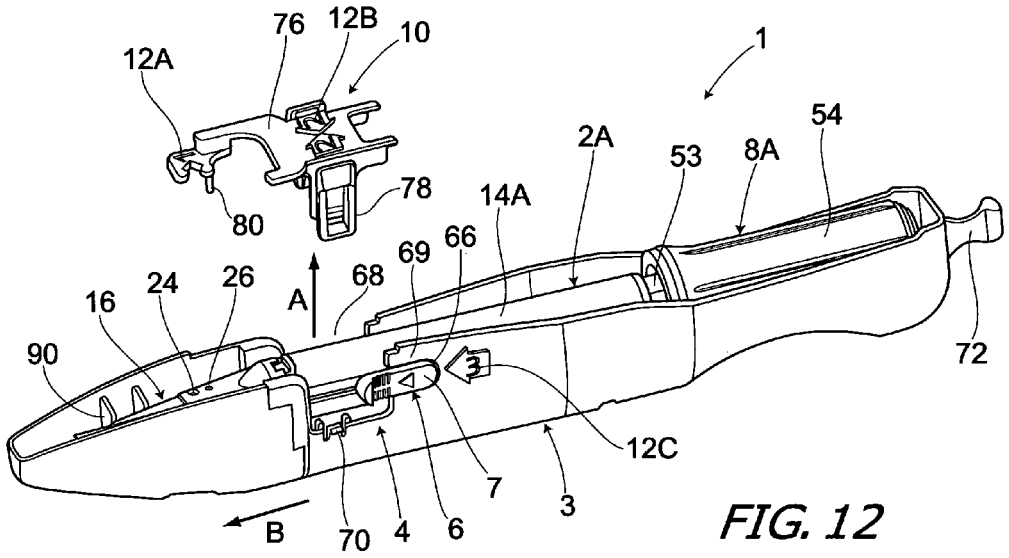

76
12B
10
12A
1
54
2A
53
8A
78
14A
80
69
66
24
26
A
68
16
90
72
12C
7
3
B
70
4
6

FIG. 12

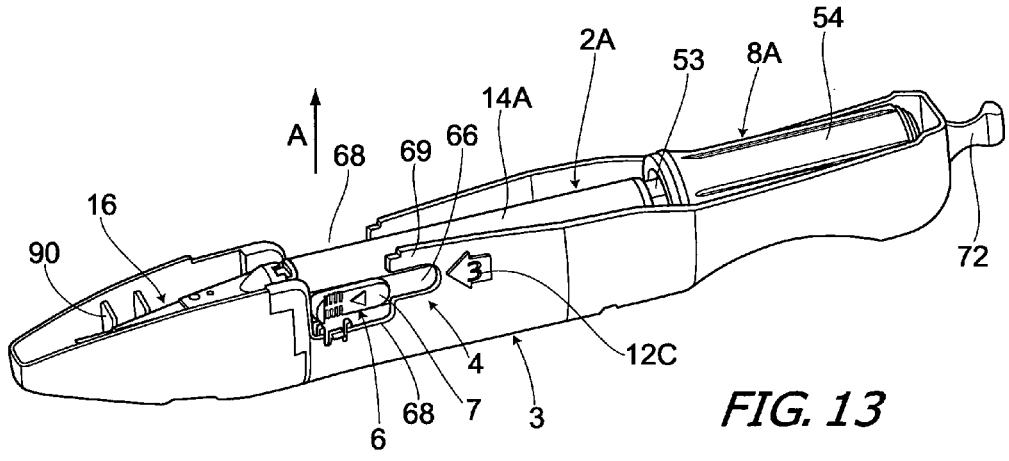

54
2A
53
8A
14A
A
68
69
66
16
90
72
12C
4
68
7
3
6

FIG. 13

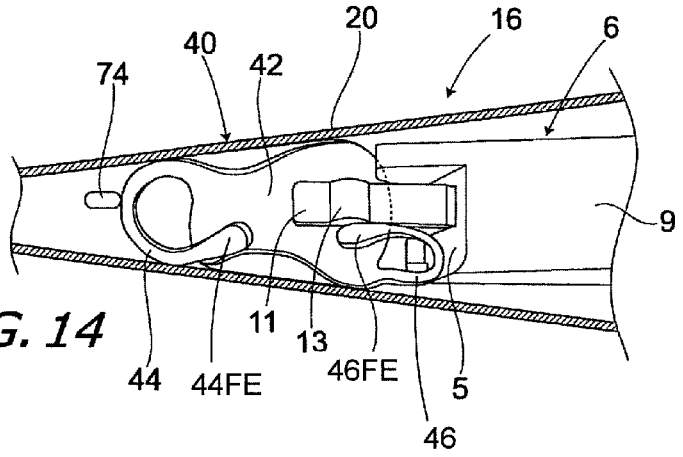

74
40
42
20
16
6
9
11
13
46FE
5
44
44FE
46

FIG. 14

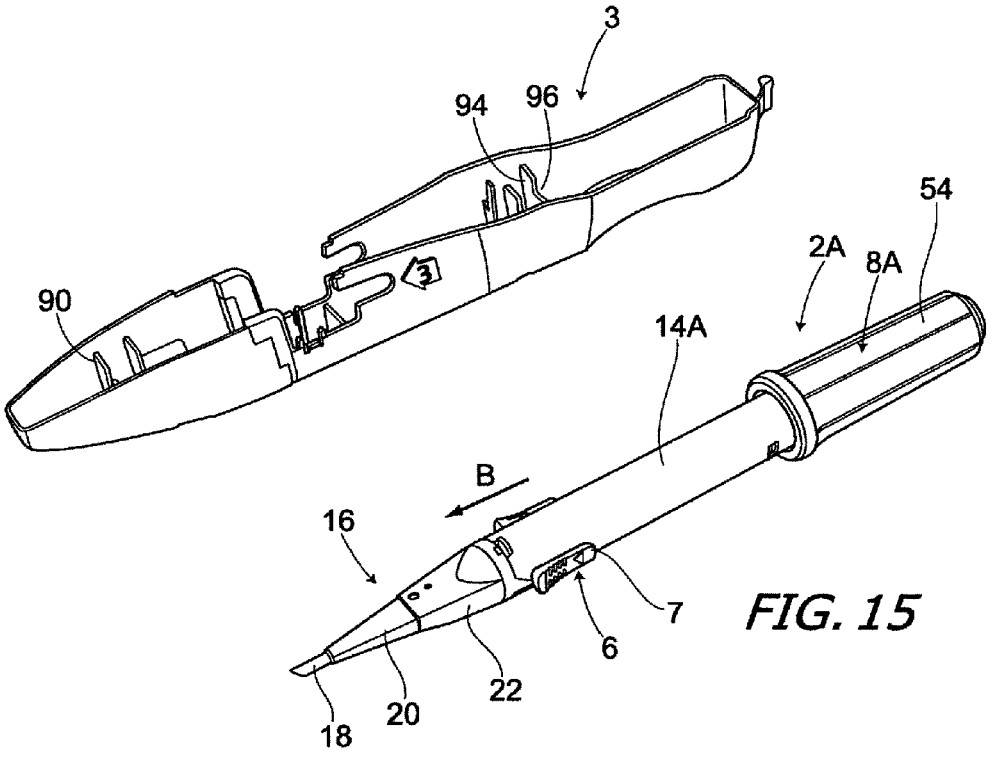

3
94
96
90
54
2A
8A
14A
B
16
7
6
22
20
18

FIG. 15

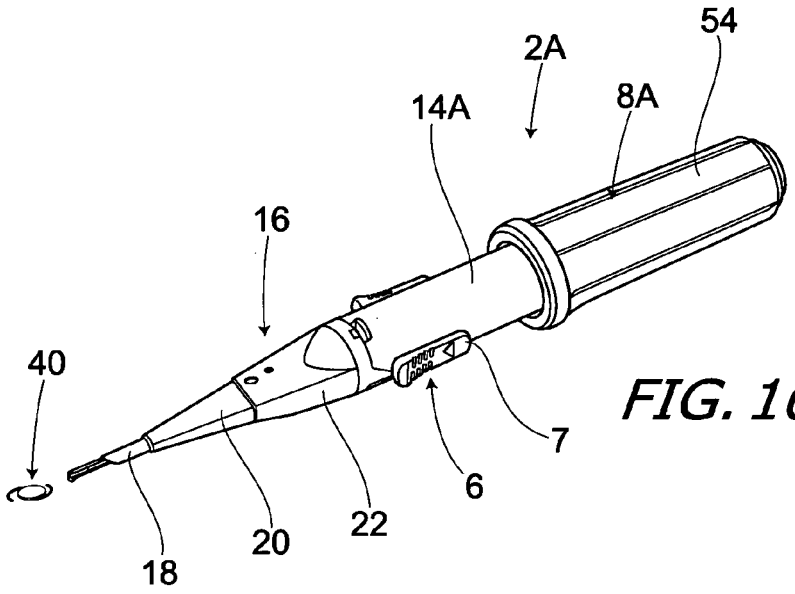

54
2A
8A
14A
16
40
7
6
22
20
18

FIG. 16

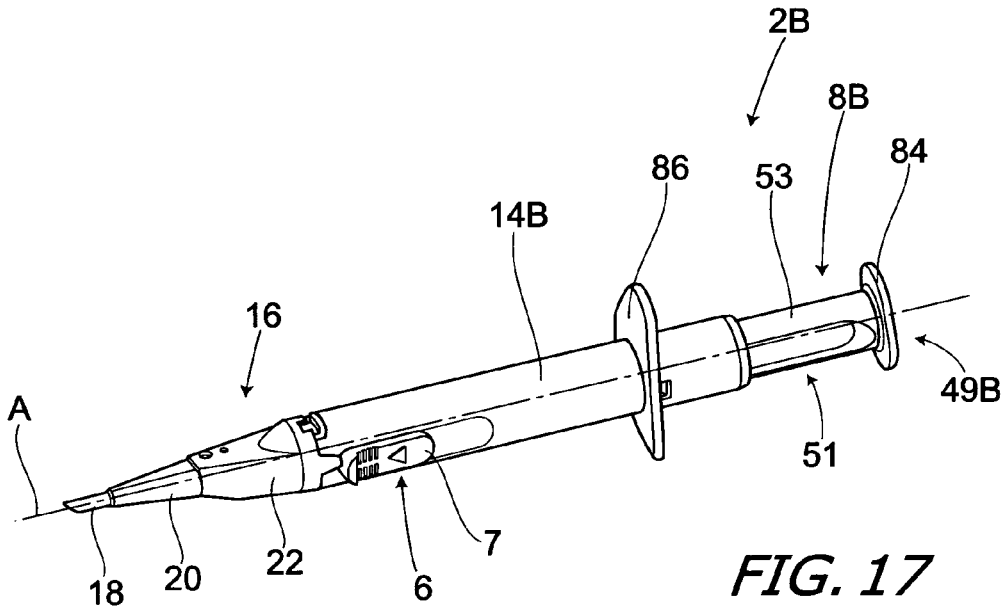

2B
8B
84
86
53
14B
16
A
49B
51
7
6
22
20
18

FIG. 17

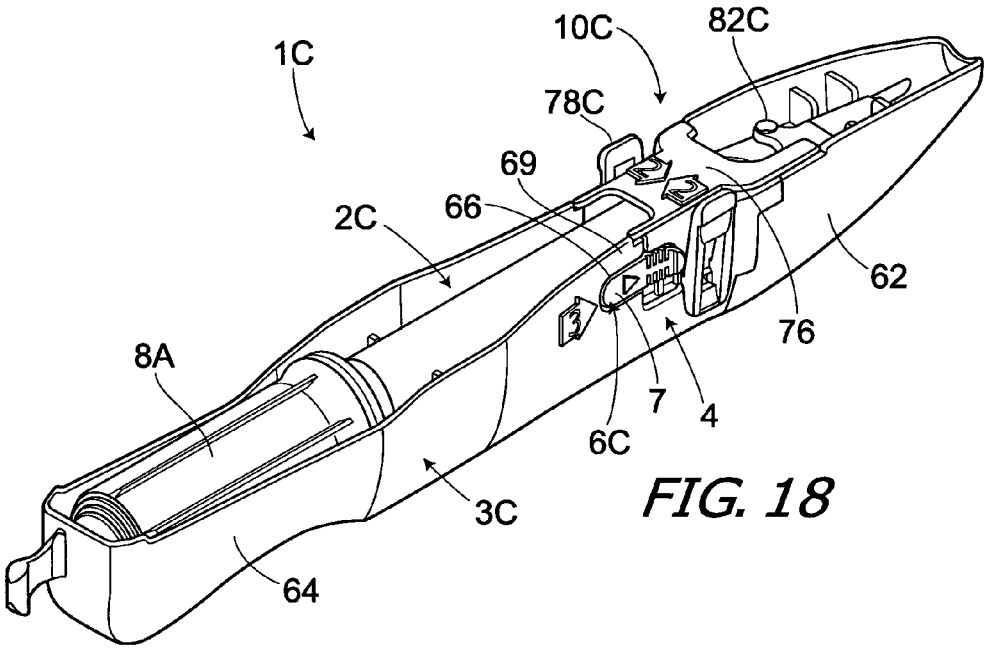


FIG. 18

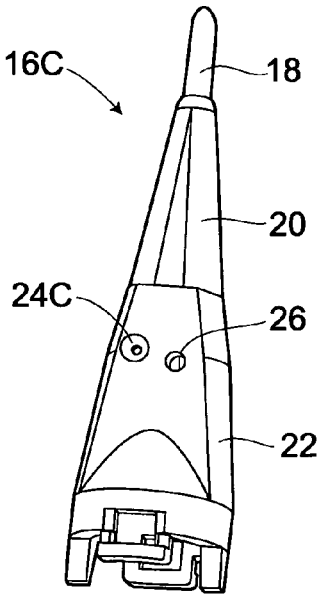


FIG. 19

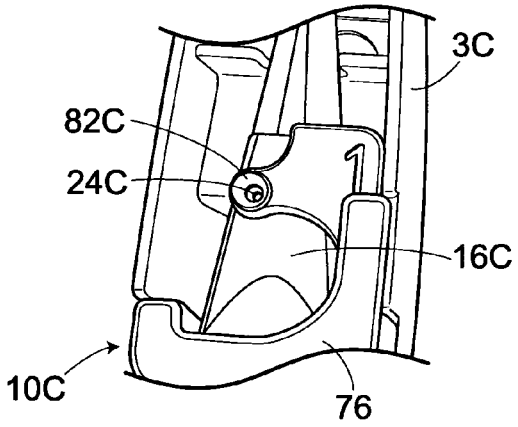


FIG. 20

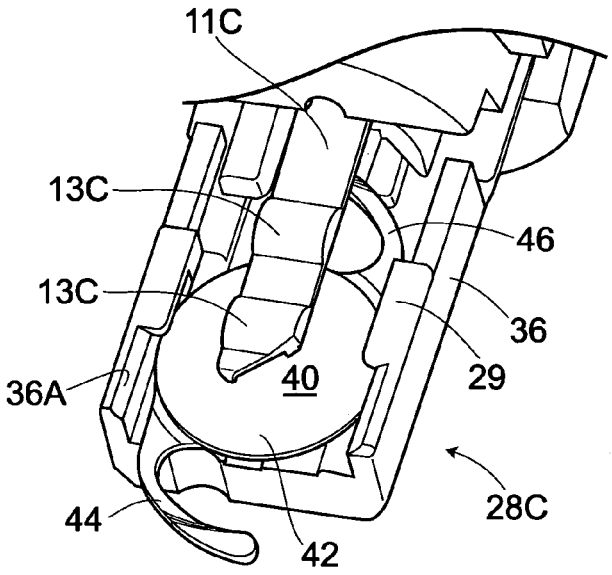


FIG. 21

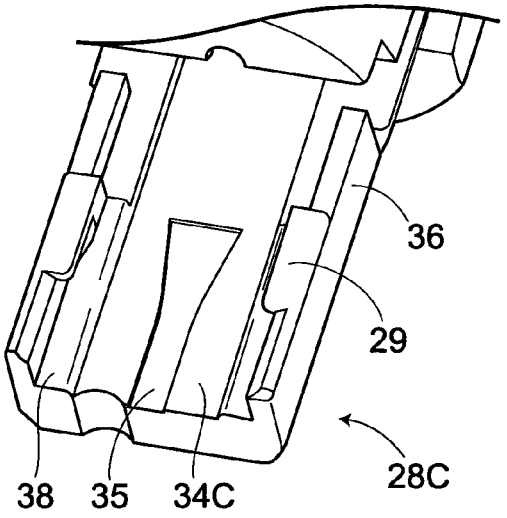


FIG. 22

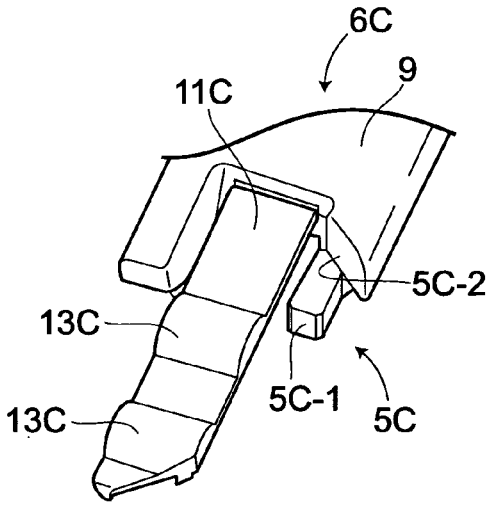
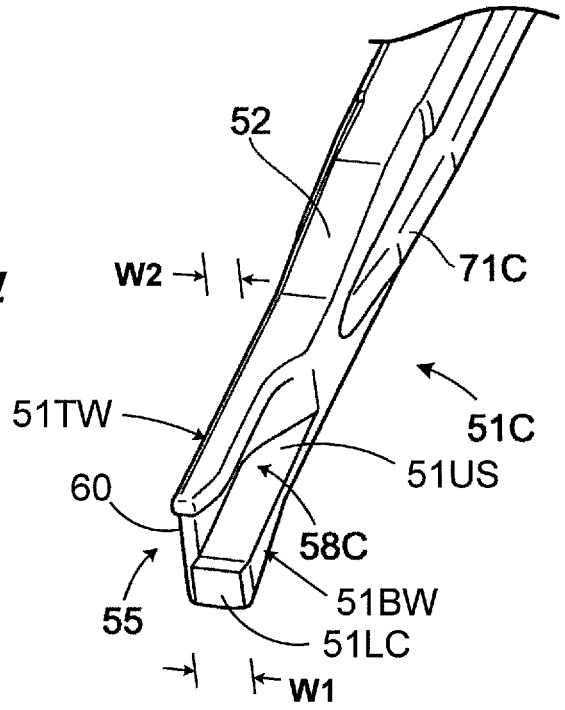


FIG. 23

FIG. 24


52
W2
71C
51C
51TW
51US
60
58C
51BW
55
51LC
W1

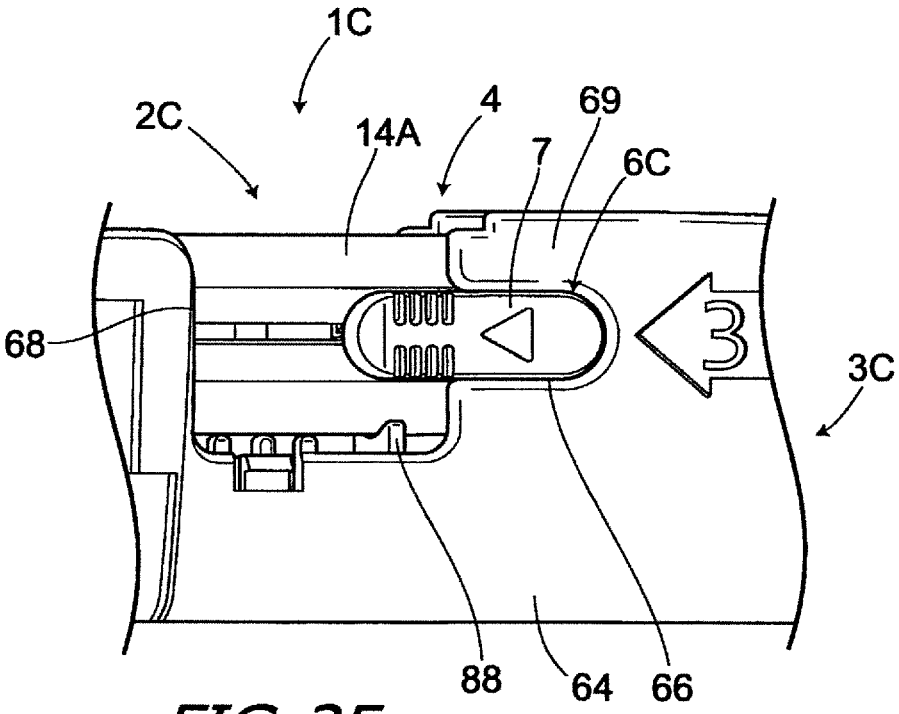

1C
2C
14A
4
69
7
6C
68
3
3C
88
64
66

FIG. 25

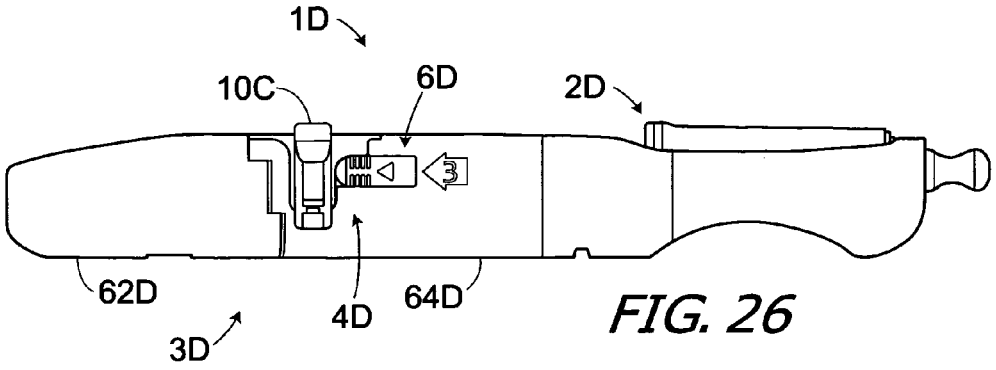


FIG. 26

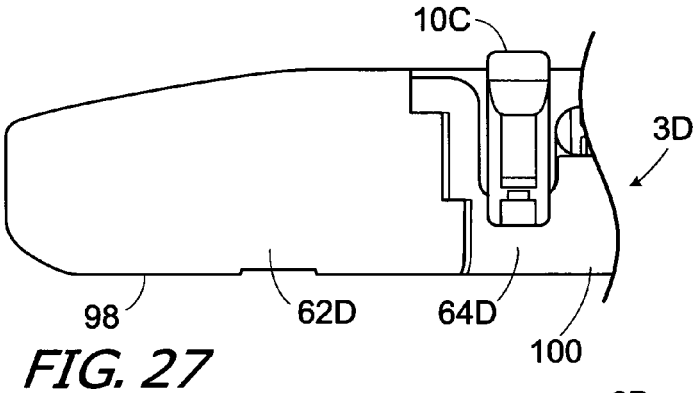


FIG. 27

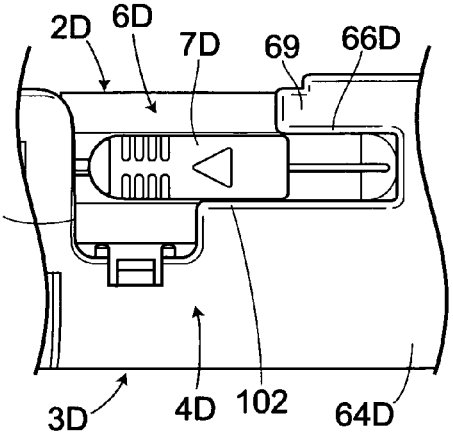


FIG. 28

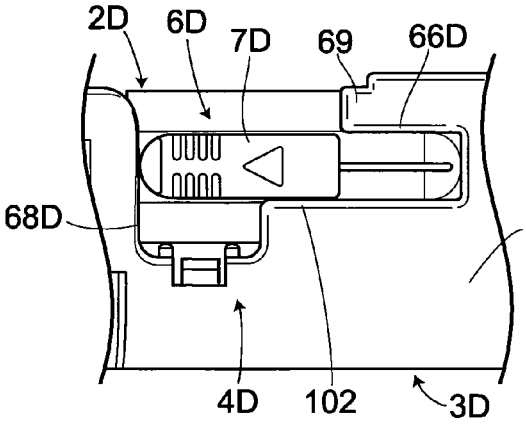


FIG. 29

OCULAR IMPLANT INSERTION APPARATUS AND METHODS

CROSS-REFERENCE TO RELATED APPLICATIONS

This application is a continuation of U.S. application Ser. No. 15/071,880, filed Mar. 16, 2016, which is a continuation of U.S. application Ser. No. 14/145,846, filed Dec. 31, 2013, now U.S. Pat. No. 9,314,373, which is a continuation of U.S. application Ser. No. 13/699,708, now U.S. Pat. No. 8,647,382, which has a 35 U.S.C. § 371(c) date of May 11, 2013 and is a U.S. national phase application under 35 U.S.C. § 371 of International Patent Application No. PCT/JP2011/063747, filed Jun. 8, 2011, which claims priority to Japanese patent application No. 2010-132952, filed Jun. 10, 2010. The International Application was published in English on Dec. 15, 2011 as International Publication No. WO 2011/155636 A1. The content of each application is incorporated herein in its entirety.

BACKGROUND OF THE INVENTIONS

1. Field of the Inventions

The present inventions relate generally to apparatus and methods for inserting an ocular implant into an eye.

2. Description of the Related Art

There are a variety of instances where an ocular implant is inserted into the anterior chamber, posterior chamber, cornea, vitreous space and/or other portion of an eye. Exemplary ocular implants include, but are not limited to, lenses, capsular tension rings, ocular prosthesis and lamellar transplants. An intraocular lens (IOL), for example, may be inserted into an aphakic eye that has undergone a cataract surgery or may be inserted into a phakic eye during a refractive surgery. One type of lens is a foldable lens. Foldable lenses are formed from soft material such as a silicone elastomer, soft acrylic, or hydrogel and may be inserted into the eye through a small incision. Lens insertion apparatus, which may be used to push a foldable lens into an eye through a nozzle, generally include screw-type insertion apparatus and push-type insertion apparatus. In both cases, the lens insertion apparatus may include a plunger that is used to push a folded lens through the nozzle into the eye by way of an incision that is relatively small, e.g., an incision that is smaller than the diameter of an IOL optic.

Loading an ocular implant into an inserter can be a troublesome portion of the insertion procedure. The implant may be contaminated, damaged or improperly placed into the inserter by operator, e.g., a surgeon or assistant. Accordingly, in some instances, the insertion apparatus is pre-loaded, i.e., the insertion apparatus is shipped from the factory with the ocular implant (e.g., an IOL) stored therein. An operator using a preloaded inserter does not place the implant into the insertion apparatus, thereby eliminating the possibility of the aforementioned operator error associated with loading.

In addition to the basic functions of storing and inserting an IOL or other ocular implant, it may also be desirable for the insertion apparatus to minimize the physical load on the ocular implant during storage in order to ensure that the ocular implant returns to its unstressed state after being inserted into the eye. It may also be desirable to fold the IOL or other ocular implant into as small a state as possible in order to reduce the size of the incision and the likelihood of corneal astigmatism caused by the surgery or infection. Thus, the desired insertion apparatus must be able to fold the unstressed ocular implant into a small state in a predetermined direction, and into a predetermined shape, in order to insure that the plunger can move the folded ocular implant through the nozzle without the insertion apparatus becoming clogged at or near the nozzle or the ocular implant being damaged. To that end, instead of using only a plunger to move the lens through the folding and insertion processes, some insertion apparatus have been configured to fold and move an IOL in stepwise fashion through the use of multiple IOL moving structures. Examples of such insertion apparatus are illustrated and described in PCT Pub. No. WO 2009/148091 (also published as US 2011/0082463) and Laid-open JP Pat. Pub. No. 2001-104347 (also published as US 2001/0007942).

The present inventor has, however, determined that insertion apparatus with multiple ocular implant moving structures are susceptible to improvement. For example, the present inventor has determined that such insertion apparatus are susceptible to erroneous operation, such as use of the moving structures in an incorrect sequence.

SUMMARY

An exemplary ocular implant insertion system includes a case and an ocular implant insertion apparatus including an ocular implant, a first movable structure that moves at least a portion of the ocular implant during movement thereof, and a second movable structure that moves the ocular implant through the nozzle. The ocular implant insertion apparatus is located at least partially within the case in pre-use state wherein the first and second movable structures have not folded and moved the ocular implant. The respective configurations of the case and the ocular implant insertion apparatus are such that the ocular implant insertion apparatus is not removable from the case when the ocular implant insertion apparatus is in the pre-use state and is removable after the first movable structure has moved at least a portion of the optical implant.

An exemplary method of using a system including a case and a preloaded ocular implant insertion apparatus locked to the case includes the steps of unlocking the insertion apparatus from the case by moving a first movable structure a distance sufficient to at least partial fold a stored ocular implant, removing the insertion apparatus from the case, and pushing the ocular implant from the insertion apparatus with a second movable structure.

There are a number of advantages associated with such systems and methods. For example, such systems and methods prevent the use of the first and second movable structures in an incorrect sequence.

BRIEF DESCRIPTION OF THE DRAWINGS

Detailed description of exemplary embodiments of the inventions will be made with reference to the accompanying drawings.

FIG. **1** is a perspective view of an IOL insertion system, including an IOL insertion apparatus and an insertion apparatus case, in accordance with one embodiment of a present invention.

FIG. **2** is a perspective view of the exemplary IOL insertion apparatus illustrated in FIG. **1**.

FIG. **3** is a perspective view of the insertion tube of the exemplary IOL insertion apparatus illustrated in FIG. **2**.

FIG. **4** is a perspective view of the main body of the exemplary IOL insertion apparatus illustrated in FIG. **2**.

FIG. **5** is a perspective view of the lens placement section of the exemplary IOL insertion apparatus illustrated in FIG. **2**.

FIG. **6** is a section view of the insertion tube and lens placement section of the exemplary IOL insertion apparatus illustrated in FIG. **2**.

FIG. **7** is a perspective view of the plunger of the exemplary IOL insertion apparatus illustrated in FIG. **2**.

FIG. **8** is a perspective view of the distal portion of the plunger rod of the exemplary IOL insertion apparatus illustrated in FIG. **2**.

FIG. **9** is a perspective view of the exemplary insertion apparatus case illustrated in FIG. **1**.

FIG. **10** is a partial section view of a portion of the exemplary IOL insertion system illustrated in FIG. **1**.

FIG. **11** is a perspective view of the exemplary cover illustrated in FIG. **1**.

FIG. **12** is a perspective view showing one aspect of the operation of the exemplary IOL insertion system illustrated in FIG. **1**.

FIG. **13** is a perspective view showing another aspect of the operation of the exemplary IOL insertion system illustrated in FIG. **1**.

FIG. **14** is a partial section view showing another aspect of the operation of the exemplary IOL insertion system illustrated in FIG. **1**.

FIG. **15** is a perspective view showing another aspect of the operation of the exemplary IOL insertion system illustrated in FIG. **1**.

FIG. **16** is a perspective view showing another aspect of the operation of the exemplary IOL insertion system illustrated in FIG. **1**.

FIG. **17** is a perspective view of another exemplary IOL insertion apparatus that may be combined with a case in the manner illustrated in FIG. **1** to form an IOL insertion system.

FIG. **18** is a perspective view of an IOL insertion system, including an IOL insertion apparatus and an insertion apparatus case, in accordance with one embodiment of a present invention.

FIG. **19** is a perspective view of the insertion tube of the exemplary IOL insertion apparatus illustrated in FIG. **18**.

FIG. **20** is a perspective view of a portion of the exemplary IOL insertion system illustrated in FIG. **18**.

FIG. **21** is a perspective view of a portion of the slider and the lens placement section of the exemplary IOL insertion apparatus illustrated in FIG. **18**.

FIG. **22** is a perspective view of the lens placement section of the exemplary IOL insertion apparatus illustrated in FIG. **18**.

FIG. **23** is a perspective view of a portion of the slider of the exemplary IOL insertion apparatus illustrated in FIG. **18**.

FIG. **24** is a perspective view of a portion of the plunger rod of the exemplary IOL insertion apparatus illustrated in FIG. **18**.

FIG. **25** is a side view of a portion of the exemplary IOL insertion apparatus illustrated in FIG. **18**.

FIG. **26** is a perspective view of an IOL insertion system, including an IOL insertion apparatus and an insertion apparatus case, in accordance with one embodiment of a present invention.

FIG. **27** is a side view of a portion of the exemplary IOL insertion system illustrated in FIG. **26**.

FIG. **28** is a side view of a portion of the exemplary IOL insertion system illustrated in FIG. **26**.

FIG. **29** is a side view of a portion of the exemplary IOL insertion system illustrated in FIG. **26**.

DETAILED DESCRIPTION OF EXEMPLARY EMBODIMENTS

The following is a detailed description of the best presently known modes of carrying out the inventions. This description is not to be taken in a limiting sense, but is made merely for the purpose of illustrating the general principles of the inventions. The present inventions are also applicable to a wide variety of ocular implants which, as used herein, refers to any structure, instrumentality or device that is placed into any ocular structure or region. Ophthalmic lenses, capsular tension rings, ocular prosthesis and lamellar transplants are examples of ocular implants. Although the exemplary implementations are described below in the context of an intraocular lens (IOL), the present inventions are also applicable other types of ocular implants, including those yet to be developed. For example, the present inventions are applicable to other types of ophthalmic lenses. Such lenses include, but are not limited to, intraocular contact lenses, phakic IOLs, and other lenses that may be inserted into the eye.

I. Overview

As illustrated in FIG. **1**, the exemplary IOL insertion system **1** includes an IOL insertion apparatus **2**A and a case **3** in which the IOL insertion apparatus **2**A is stored during shipping and at other times prior to an insertion procedure. The IOL insertion apparatus **2**A is a preloaded insertion apparatus and, to that end, an IOL **40** (FIG. **5**) is placed within the insertion apparatus during the assembly process and the insertion apparatus is shipped and stored with the IOL located therein. The IOL insertion system **1** includes a lock mechanism **4** that prevents the IOL insertion apparatus **2**A from being removed from the case **3** when in a locked state, and allows the IOL insertion apparatus to be removed from the case when in an unlocked state. As is discussed in greater detail below, the operation of the IOL insertion apparatus **2**A itself is, generally speaking, a two-step process where the steps must be performed in the proper sequence. The first step involves folding a previously unstressed IOL into a particular configuration with a first device and the second step pushing the folded IOL though a tapered passage, where it is further folded, and then into the eye. The IOL insertion system **1** is configured such that the lock mechanism **4** will transition from the locked state to the unlocked state, thereby allowing the IOL insertion apparatus **2**A to be removed from the case **3**, when the first step is performed. In other words, the IOL insertion system **1** is configured such that the operator will not be able to remove the IOL insertion apparatus **2**A from the case **3** unless the first step in the process has been performed. By requiring the first step to be performed prior to removal of the IOL insertion apparatus **2**A from the case **3**, the IOL insertion system **1** forces the operator to perform the steps in the correct order.

II. Exemplary IOL Insertion Apparatus

Turning to FIG. **2**, the exemplary IOL insertion apparatus **2**A includes a slider **6**, a plunger **8**A, a main body **14**A and an insertion tube **16** that is mounted on the forward end of the main body. The main body **14**A and insertion tube **16** together define the external housing of the insertion appa-

ratus **2**A. The slider **6** and plunger **8**A are movable relative to the external housing and relative to each other.

Operation of the IOL insertion apparatus **2**A, where the IOL is pushed out of the apparatus and into the eye, is referred to herein as a "push-out" or "insertion" process. The slider **6**, which has a pair of finger grips **7**, performs the first step in the insertion process, i.e., folding a previously unstressed IOL into a particular configuration, and may therefore be referred to as one example of a first lens push-out mechanism. The exemplary slider **6** pushes the IOL **40** distally as it folds the IOL. In other implementations, the first "push-out" mechanism may perform the first step of the "push-out" process by simply folding an IOL without moving it distally. The exemplary plunger **8**A performs the second step in the insertion process, i.e., pushing the folded IOL through a tapered lumen and then into the eye, and may therefore be referred to as one example of a second lens push-out mechanism. The IOL moves along a lens advancement axis A during the insertion process. Movement of the movable components of the insertion apparatus **2**A and the IOL **40** towards the eye is referred to herein as movement in the forward (or "distal") direction and movement away from the eye is referred to herein as movement in the rearward (or "proximal") direction. Similarly, the end of a structure that faces the eye during use is referred to as the forward (or "distal") end and the other end the structure is referred to as the rearward (or "proximal") end. The slider **6** and plunger **8**A are both movable in the forward and rearward directions relative to the main body **14**A.

The exemplary insertion tube **16** includes a nozzle **18**, a transition section **20** and a protector **22**, with interior regions that are in communication with one another so that an IOL can pass therethrough. The insertion tube **16** is connected to the main body **14**A by a connector arrangement **15** (FIG. **3**) on the insertion tube and a corresponding connector arrangement **17** (FIG. **4**) on the main body. The inner diameter of the transition section **20** tapers downwardly from the end adjacent to the protector **22** to the end adjacent the nozzle **18**. The protector **22** has an injection port **24** for viscoelastic material and a first insertion hole **26** (discussed below).

Turning to FIG. **4**, the exemplary main body **14**A includes a tubular member **19**, a lens placement section **28**, a slider guide section **30** and a protrusion **32**. The lens placement section **28** (described below with reference to FIG. **5**) protrudes distally from the front end of the tubular member **19**. The slider guide section **30** is configured to allow the slider **6** to move forwardly and rearwardly. The slider guide section **30** may be a pair of slits, formed in the tubular member **19**, that are parallel to the lens advancement axis A. The slider guide section **30** also extends rearwardly from the distal end of the tubular member **19** to the central portion of the tubular member. The plunger **8**A is threadedly connected to the main body **14**A in the illustrated implementation. To that end, the exemplary main body **14**A includes a male screw. The protrusion **32**, which is transverse to the lens advancement axis A, defines a portion of the screw thread of the male screw and a portion of the outer surface of the tubular member **19** defines the root of the thread. Another protrusion (not shown) may be located on the tubular member **19** 180 degrees offset from the tubular member **32**.

As shown in FIG. **5**, the IOL insertion apparatus **2**A may be used to store an IOL **40** that has an optic **42** and a pair of supports **44** and **46** such as, for example, the illustrated pair of haptics. The exemplary lens placement section **28** includes a bottom surface **34**, a pair of side walls **36** respectively located on opposite sides of the bottom surface and extending upwardly from the bottom surface, and a pair of rails **38**. The bottom surface **34** and the side walls **36** are parallel to the lens advancement axis A and the lens advancement axis A is located between the side walls. The side walls **36** each include, near the upper end, an inclined surface **36**A. The rear portions of the side walls **36** include inward protrusions **48** that prevent the IOL **40** from moving in the rearward direction. The lens supporting surfaces of the rails **38** are oriented in a direction that is transverse to the lens advancement axis A and slope away from the axis A in the rearward to forward direction. As such, the stored IOL **40** is tilted relative to the lens advancement axis A, with the forward end of the IOL optic **42** closer to the bottom surface **34** than the rearward end. The lens supporting surfaces of the rails **38** are also located a sufficient distance above the bottom surface **34** to prevent the IOL optic **42** from coming into contact with the bottom surface (note FIG. **6**).

It should be noted that references herein to "top," "bottom," "upward," "downward" and the like are merely references to the illustrated orientation and/or the relationship of the components relative to one another in the illustrated orientation. For example, the side of the IOL **40** facing the bottom surface **34** is referred to "the downward side" and movement toward the bottom surface is referred to as movement in the "downward direction," while the opposite side of the IOL **40** is referred to as the "the upward side" and movement away from the bottom surface **34** is referred to as movement in the "the upward direction."

In addition to the grips **7**, and referring to FIGS. **5** and **14**, the exemplary slider **6** includes an elongate member **9**, with a lens contact surface **5**, that is carried within the main body **14**A and is slidable relative thereto. The grips **7** are connected to elongate member **9**. The lens contact surface **5**, which is larger than the plunger distal end **55** (discussed below), is used to scoop up the proximal IOL support **46** during the initial folding of the IOL **40**. A lens holder **11** is pivotably mounted on the distal end of elongate member **9** and includes a protrusion **13**. The lens holder **11** controls the initial folding of the IOL **40** during the first step of the lens insertion process. More specifically, as the slider **6** moves distally, the protrusion **13** rides along the tapered inner surface of the transition section **20**, which causes the lens holder **11** to pivot downwardly into contact with the IOL optic **42** to fold the IOL **40**. The slider elongate member **9** also includes a slot **21** through which the plunger rod **51** (discussed below) passes during the second step of the insertion process. Additional discussion concerning the use of a lens holder to fold an IOL may be found in, for example, U.S. Pat. Pub. No. 2010/0185206.

Referring to FIG. **6**, the protector **22** of exemplary insertion tube **16** includes protrusions **50**, with inclined surfaces **50**A, that extend downwardly and inwardly from both sides of the protector inner surface. The projections **50**, which guide the insertion tube **16** onto the upper ends of the side walls **36** during assembly, are sized such that the inclined surfaces **50**A extend beyond the side wall inclined surface **36**A. This prevents the outer edge of the IOL optic **42** located in the lens placement section **28** from becoming wedged between the protrusions **50** and the side walls **36**.

Turning to FIG. **7**, the exemplary plunger **8**A includes an operational member **49**A and a rod **51** with a distal rod portion **52**, a proximal rod portion **53**, and a rod distal end **55**. The distal rod portion **52**, which is sized such that it can be inserted through the nozzle **18**, may be connected to, or may be integral with, the proximal rod portion **53**. The operational portion **49**A includes a handle **54** that is generally cylindrical in shape. The proximal (or "rearward") end of the handle **54** is rotatably journaled, or is otherwise

rotatably secured, to the proximal (or "rearward") end of the proximal rod portion **53**. The handle **54** is also hollow and configured to receive the proximal portion of the main body **14**A. The inner surface of the handle **54** includes a female screw (not shown) with threads that operationally correspond to the threads on the male screw associated with the main body **14**A (note protrusion **32** in FIG. **4**). As such, after the plunger **8**A has been moved distally from the position illustrated in FIG. **2** until the male thread defined in part by the protrusion **32** engages the female thread within the handle **54**, further distal movement is accomplished by rotating the handle.

As illustrated for example in FIG. **8**, the rod distal end **55** may have a lens contact portion **56** and a recess **58** in which the free end of the proximal IOL support **46** is located during the second step of the two-step process. The exemplary lens contact portion **56** is a planar surface that is perpendicular to the lens advancement axis A, and is provided on a lower portion of the rod distal end **55**. The exemplary recess **58**, which has an opening **59** on one lateral side and a wall **60** on the other lateral side, is located above the lens contact portion **56**. The recess **58** may be formed by cutting (or otherwise removing) material from the rod distal portion **52**, starting at the distal end **55**, or by molding the rod in the illustrated configuration. The wall **60** engages the outer edge of the IOL optic **42** and prevents optic of the folded IOL **40** from entering the recess **58**. The wall **60** also keeps the IOL support **46** within the recess **58**. The distal end of the wall **60** may be in the same plane as the lens contact portion **56** (as shown) or may be located distally beyond the lens contact portion **56** (as shown in dashed lines).

With respect to operation of the exemplary IOL insertion apparatus **2**A, and as alluded to above, the IOL **40** is initially pushed forwardly (or distally) and folded into a predetermined shape with the slider **6**. The slider **6** also forms part of the lock mechanism **4** that locks the IOL insertion apparatus **2**A to the case **3** and, as is discussed below, the initial forward movement of the slider, unlocks the lock mechanism. The folded IOL **40** is subsequently pushed by the plunger **8**A forwardly (or distally) through the transition section **20** where it is further folded, then thorough the nozzle **18**, and then into the eye. In other words, the exemplary IOL insertion apparatus **2**A deforms an IOL that has been preloaded within the main body **14**A and insertion tube **16** into a predetermined shape while moving the IOL in the forward direction, first by using the slider **6** and second by using the plunger **8**A, and then discharges the folded IOL into the eye. The IOL **40** may be folded by operation of the slider **6** into the predetermined shape in which the optic **42** is curled up and around the lens advancement axis A, with an upper surface of the optic dented downwardly, and in which the free ends **44**FE and **46**FE of the supports **44** and **46** are tucked into the upper surface of the curled optic **42** (note FIG. **14**).

III. Exemplary Case

The case **3**, which protects the IOL insertion apparatus **2**A during shipping and storage, may be an elongated container with an open upper end. To that end, and referring to FIG. **9**, the exemplary case **3** includes a pair of end walls **61**, a pair of side walls **63** that each extend from one end wall to the other, and a bottom wall **65** (FIG. **10**) at the bottom ends of the end and side walls. The top ends of the end walls **61** and side walls **63** define the open upper end **67** of the case **3**. The front portion of the case **3** is identified by reference numeral **62** and the rear portion of the case is identified by referent numeral **64**. The front and rear portions **62** and **64** may be separable structures that are secured to one another during the assembly process (note joint **57**) as is discussed below.

The case **3** also includes a portion of the lock mechanism **4** that locks the IOL insertion apparatus **2**A to the case. In the illustrated embodiment, each of the side walls **63** includes a storage slot **66** and removal slot **68**. The storage slots **66** are separated, in the upward direction, from the open upper end **67** of the case by projections **69**. The removal slots **68** extend to and through the upper end **67** of the case **3**, and each storage slot **66** extends to the adjacent removal slot. Engagement members **70**, which are located at the lower end of each removal slot **68**, may be detachably engaged with a cover **10** (FIG. **1**) to secure the cover to the case **3**. A handle **72** may be located on the rear end wall **61** and used to remove the IOL insertion system **1** from the sterile package in which it is stored. The slider grips **7** are respectively located within the storage slots **66** when the lock mechanism **4** is in a locked state (FIG. **1**) and are located within the removal slots when the lock mechanism is in an unlocked state (FIG. **13**). The width of the slider grips **7** (in the direction of axis A) is less than or equal to the width of the removal slots **68**. The respective configurations of the IOL insertion apparatus **2**A and case **3** are also such that the slider grips **7** can be located within the storage slots **66** when the slider **6** is in its retracted, storage location (FIG. **12**) and can also be pushed distally beyond the storage slots **66** to the point at which the slider **6** has completed the initial folding of the IOL **40** (FIG. **13**).

With respect to the locked state, the projections **69** prevent the slider grips **7** and, therefore, the IOL insertion apparatus **2**A, from moving in the upward direction identified by arrow A in FIGS. **12** and **13**. The projections **69** do not, on the other hand, prevent the slider grips **7** from moving upwardly when the slider grips are located within the removal slots **68**.

The exemplary case **3** also includes structure that helps control the initial folding of the lens during the movement of the slider **6** moves from the position illustrated in FIG. **12** to the position illustrated in FIG. **13**. To that end, and referring to FIG. **10**, the front portion **62** of the exemplary case **3** includes a protrusion **74** that extends through a correspondingly sized and located insertion hole **75** on the bottom surface of the insertion tube **16**. The exemplary protrusion **74** has an overall ellipsoidal shape that is elongate in a direction parallel to the lens advancement axis A, and has a rearward facing surface that is slanted upwardly in the lens advancement (i.e., proximal to distal) direction. The protrusion **74** is located within the path of the IOL **40** and used to deflect the distal IOL support **44**, as is discussed below with reference to FIG. **14**. The protrusion **74** is removed from the IOL path, by way of the insertion hole **75**, when the IOL insertion apparatus **2**A is removed from the case **3**.

It should also be noted here that the front portion **62** of the exemplary case **3** may include one or more support walls **90** (two in the exemplary embodiment) with slots **92** in which the insertion tube **16** is supported (FIG. **10**). The width of each slot **92** (in a direction perpendicular to the lens advancement axis A) is equal to the width of the portion of the insertion tube **16** that is located therein. Similarly, the rear portion **64** includes a wall **94** (FIG. **15**) with a slot **96** that is smaller in width than, and located distally of, the distal end of the handle **54**. As a result, the IOL insertion apparatus main body **14**A, insertion tube **16** and handle **54** may not be moved forward (i.e., in the direction of arrow B in FIG. **12**) when the insertion apparatus **2**A is located within the case **3**. Also, as discussed above, the insertion apparatus

2A may not be pulled out of the case **3** (i.e., in the direction of arrow A in FIGS. **12** and **13**) when the slider grips **7** are within the storage slots **66**.

The exemplary cover **10**, which is shown in detail in FIG. **11**, includes a flat main body **76** and a pair of clips (or other attachment devices) **78**. The clips **78** are size and positioned such that they can be located in the removal slots **68**, and are configured to interlock with the engagement members **70** on the case **3**. The clips **78**, which extend downwardly from and are perpendicular to the main body **76**, are resiliently deflectable about the main body at the point at which the clips are attached to the main body. As a result, the cover **10** can be easily secured to and removed from the case **3** by pressing the top ends of the clips **78** toward one another.

A protrusion **80** (FIG. **10**), which extends downwardly from the bottom surface of the main body **76**, is located such that it will extend into the first insertion hole **26** on the insertion tube **16** when the IOL insertion apparatus **2**A is located within the case **3** and the cover **10** is secured to the case. The protrusion **80** is located within the path of the IOL adjacent to the distal end of the IOL optic **42** and, therefore, prevents distal movement of the IOL **40** within the lens placement section **28** during shipping and other times prior to use. The protrusion **80** is removed from the IOL path when the cover **10** is removed from the case **3**. The cover **10** also includes an injection port opening **82** that will be aligned with insertion tube injection port **24** when the IOL insertion apparatus **2**A is located within the case **3** and the cover **10** is secured to the case.

The cover **10** may be attached to the case **3**, with each of the clips **78** located with a portion of a removal slot **68** and secured to an engagement member **70**, when the lock mechanism **4** is in the locked state illustrated in FIG. **1**. The clips **78** are also positioned forward of the slider grips **7**, thereby preventing the slider **6** from being moved forwardly to unlock the lock mechanism **4** and move the IOL **40**, when the cover **10** is secured to the case **3**.

IV. Assembly

The exemplary IOL insertion system **1** may be assembled from an IOL insertion apparatus **2**A and case **3** in a variety of ways. One exemplary assembly methods begins with an IOL insertion apparatus **2**A that is complete, but for the loading of the IOL **40** and the attachment of the insertion tube **16** to the main body **14**A, and the front and rear portions **62** and **64** of the case **3** separated from one another. In the initial step of the exemplary assembly method, the slider **6** and plunger **8** are attached to the main body **14**A and the slider **6** is moved to its forward position so that the grip will be located within the removal slots **68**. The main body **14**A is then attached to the rear portion **64** of the case **3**, which is still separated from the front portion **62**, and the slider **6** is moved to the rearward position with the grips **7** within the storage slots **66**. The IOL **40** is then placed in the lens placement section **28**, with the outer edge of the optic **42** on the rails **38**, and the supports **44** and **46** located distally and proximally of the optic. The inward protrusions **48** (FIG. **5**) prevent the IOL **40** from moving in the rearward direction. The insertion tube **16** may then be attached to the front end of the main body **14**A such that the lens placement section **28** is covered by the protector **22**.

Next, the cover **10** is inserted onto the case **3**. The clips **78** move through the removal slots **68** until they clip onto the engagement members **70**, thereby securing the cover **10** to the case **3**. The cover protrusion **80** will now extend through the first insertion hole **26** and be positioned between the forward support **44** and the optic **42** of the IOL **40**. As a result, movement of the IOL **40** is held between the lens placement section inward protrusions **48** and the cover protrusion **80** with no physical load is applied thereto (FIG. **10**). The proximal end of the case front portion **62** is then attached to the distal end of the rear portion **64** from underneath, thereby completing assembly of the exemplary IOL insertion system **1** (FIG. **1**).

V. Operation and Instructive Indicia

Operation of the exemplary IOL insertion system **1** is discussed below with reference to FIGS. **1** and **12-16**. The operational method may includes a number of step that are intended to be performed in a particular order. Some of the steps are associated with unlocking the lock mechanism **4** and removing the IOL insertion apparatus **2**A from the case **3**, some of the steps are associated with the operation of the IOL insertion apparatus itself, and at least one step is associated with both.

The exemplary IOL insertion system **1** may be provided with indicia that guides the operator through the initial steps in the proper sequence. More specifically, the exemplary IOL insertion system **1** includes markers **12**A-**12**C. Each marker includes a number and, where appropriate, a directional indicator. Marker **12**A is a "1" and is located on the cover **10** adjacent to the opening **82** for the injection port **24**. Marker **12**B, which is located on the cover **10** near the clips **78**, includes a pair of inwardly facing arrows and each arrow has a "2" associated therewith. Marker **12**C may be located on one or both sides of the case **3** adjacent to one or both of the storage slots **66**. In the illustrated implementation, marker **12**C consists of a forwardly facing arrow and a "3" adjacent to each of the storage slots **66** and, accordingly, each of the slider grips **7** when the IOL insertion system **1** is in its initial, pre-use state. As will be apparent from the discussion below, the markers **12**A-**12**C reduce the likelihood of operator error by guiding the operator through the associated steps in the correct sequence.

The exemplary IOL insertion system **1** may be operated as follows. The IOL insertion system may be provided to the operator in a sterile bag and removed therefrom while holding the handle **72** (FIG. **1**). A volume of viscoelastic material sufficient to fill the region around the IOL **40** may then be injected into the insertion tube **16** by way of injection port **24** (note marker **12**A). The ends of the cover clips **78** adjacent to the main body **76** may then be pressed together (note marker **12**B) to pivot the clips away from the engagement members **70**, thereby disconnecting the cover **10** from the case **3**. The cover **10** may then be removed from the case **3**, as shown in FIG. **12**. After the cover **10** has been removed from the case **3**, the clips **78** will no longer prevent the slider grips **7** from being moved forwardly and the protrusion **80** will no longer prevent the IOL **40** from being moved forwardly. The lock mechanism **4** will, however, still be in the locked state.

As illustrated in FIG. **13**, the next step is to move the slider **6** in the forward direction (note marker **12**C) until the slider grips **7** have moved out of the storage slots **66** and, in the illustrated embodiment, have come into contact with a front ends of the removal slots **68**. Such movement of the slider **6** causes the IOL **40** to move from the lens placement section **28** to the transition section **20**, thereby causing the lateral sides of IOL optic **42** to fold upwardly as the lens holder **11** pushes the central portion of the IOL optic downwardly (FIG. **14**). As the IOL **40** moves forwardly into the transition section **20**, the protrusion **74** bends the distal

IOL support **44** such that the free end of the support is positioned on the upper surface of the folded IOL optic **42** (FIG. **14**). In particular, the slanted rearwardly facing surface of the protrusion **74** (FIG. **10**) scoops up the distal IOL support **44** as it is bent, thereby facilitating reliable positioning of the distal IOL support on the upper surface of the folded IOL optic **42**. The lens contact surface **5** of the slider **6** also scoops up the proximal IOL support **46** and pushes it forwardly such that the proximal IOL support **46** will also be positioned on the upper surface of the folded IOL optic **42**. With respect to the folding of the IOL optic **42**, the distal portion is folded to a greater extent than the proximal portion, with the lateral edges folded up and the center pushed down, due to the tapered shape of the interior of the transition section **20**. This completes the initial folding of the IOL **40**.

Movement of the slider **6** from the position illustrated in FIG. **12** to the position illustrated in FIGS. **13** and **14** also unlocks the lock mechanism **4** because the slider grips **7** are no longer within the storage slots **66** and, instead, are within the removal slots **68**. The IOL insertion apparatus **2**A may now be removed from the case **3** by simply lifting the apparatus in the direction identified by arrow A in FIG. **13**. In addition to freeing up the IOL insertion apparatus **2**A for use by the operator, removal of the IOL insertion apparatus from the case **3** also removes the protrusion **74**, which is part of the case and which facilitated reliable folding of the IOL **40** during movement of the slider **6**, from the path of the IOL. Thus, the protrusion **74** is located within the path of the IOL **40** when needed (i.e. during the initial folding of the IOL) and is automatically removed from the path when appropriate (i.e. prior to operation of the plunder **8**A).

Next, the operator pushes the plunger handle **54** forward in the direction of arrow B (FIG. **15**) until the threads associated with the inner surface of the handle engage the thread (note protrusion **32** in FIG. **5**) on the main body **14**A. The handle **54** may then be rotated to drive the plunger **8**A. Forward movement of the plunger rod **51** drives the IOL **40** into, and then through, the nozzle **18** and then into the eye (FIG. **16**). The IOL **40** is further folded from the state illustrated in FIGS. **14** and **15** as it moves into the nozzle **18**. The above-described initial state of the folded IOL **40**, i.e. the IOL optic **42** folded with the supports **44** and **46** resting on the upper surface thereof, facilitates the subsequent folding associated with movement of the plunger rod **51**.

It should be again emphasized here that the IOL insertion apparatus **2**A is secured to the case **3** by the lock mechanism **4** until the slider **6** has been moved forward, thereby unlocking the lock mechanism so that the IOL insertion apparatus can be removed from the case. By incorporating such movement of the slider **6** into the unlocking process, the present IOL insertion system **1** prevents the operator from erroneously pushing the IOL **40** with the plunger **8**A until after the IOL has undergone the initial folding associated with the slider **6**.

VI. Other Exemplary Embodiments

The present inventions are not limited to the exemplary embodiments described above.

For example, in addition to screw-type IOL insertion apparatus such as that described above, the present inventions are applicable to push-type IOL insertion apparatus. One example of such a push-type IOL insertion apparatus is generally represented by reference numeral **2**B in FIG. **17**. The push-type IOL insertion apparatus **2**B is essentially identical to apparatus **2**A and similar elements are represented by similar reference numerals. Here, however, instead of a screw-type operational member, the plunger **8**B includes a push-type operational member **49**B that operates in a manner similar to a syringe. Operational member **49**B includes a disk-shaped member **84** on the proximal end of the proximal rod portion **53**, and a flange **86** on the outer surface of the main body **14**B. The plunger rod **51** is driven by resting one or more fingers on the flange **86** and pushing the disk-shaped member **84** with the thumb. The IOL insertion apparatus **2**B may be combined, for example, with the case **3** and cover **10** described above to form an IOL insertion system that requires operation of the slider **6** prior to removal of the IOL insertion apparatus from the case.

Another exemplary IOL insertion system, which is generally represented by reference numeral **1**C in FIG. **18**, includes an IOL insertion apparatus **2**C and a case **3**C. IOL insertion system **1**C is essentially identical to system **1** and similar elements are represented by similar reference numbers. For example, IOL insertion system **1**C includes a screw-type IOL insertion apparatus **2**C, a case **3**C, a lock mechanism **4** and a cover **10**C. In the interest of brevity, the discussion below focuses on the differences between the two systems.

As illustrated in FIG. **18**, the exemplary cover **10**C includes clips **78**C that extend above the main body **76** to a greater extent than do the clips **78** of the cover **10**. The additional length makes the clips **78**C easier to grip and the cover **10**C easier to remove.

Turning to FIGS. **19** and **20**, in the exemplary IOL insertion apparatus **2**C, the location of the injection port **24**C on the insertion tube **16**C decreases the likelihood that the cannula (not shown) delivering the viscoelastic material will come into contact with the IOL **40**. Additionally, the cover **10**C is provided with a frustoconical injection port opening **82**C that will be aligned with insertion tube injection port **24**C when the IOL insertion apparatus **2**C is located within the case **3**C and the cover is secured to the case. The frustoconical injection port opening **82**C guides the cannula into the injection port **24**C.

Referring to FIG. **21**, the exemplary IOL insertion apparatus **2**C includes a lens placement section **28**C with a pair of lens covers **29** that extend over the inward protrusions **48** (FIG. **5**) and portions of the IOL optic **42** and proximal support **46**. The lens covers **29** prevent upward movement of the IOL **40** prior to operation of the slider **6**C (e.g., during shipping or handling by the operator). As such, the lens covers **29** increase the likelihood that the IOL **40** will be properly positioned when the operator pushes the slider **6**C forward. Additionally, as shown in FIG. **22**, the lens placement section **28**C has a bottom surface **34**C with a groove **35** that guides the plunger rod **51**C (FIG. **24**) as it passes through the lens placement section, thereby increasing the likelihood that the plunder rod **51** will remain properly oriented.

With respect to the exemplary slider **6**C, and turning to FIG. **23**, the slider has a pivotable lens holder **11**C with a pair of protrusions **13**C. The dual protrusion arrangement causes the cause the lens holder **11**C to engage the inner surface of the insertion tube **16**C, and begin the pivoting and associated IOL folding, at an earlier point in the movement of the slider **6**C than would be the case with the single protrusion embodiment illustrate in FIG. **14**. Such earlier folding of the IOL **40** helps insure that the edge of the IOL is positioned in the manner illustrated in FIG. **14** so that the proximal IOL support **46** can slide over the IOL optic **42**. With respect to deflection of the proximal IOL support **46**, the exemplary slider **6**C includes a lens contact assembly **5**C that has a

support post **5**C-**1** and a vertical guide surface **5**C-**2** that tapers outwardly in the proximal to distal direction. The lens contact assembly **5**C insures that the proximal IOL support **46** will deflect in the manner described above with reference to FIG. **14**.

As illustrated example in FIG. **24**, the exemplary plunger rod **51**C has a rib **71**C that extends distally to a point adjacent to the recess **58**C. The rib **71**C increases the rigidity of plunger rod **51**C which, in turn, helps to maintain the alignment of the plunger rod **51**C. The shape of the recess **58**C, which is larger than recess **58**, helps insure that the proximal support **46** will move out of the recess once in the eye. The plunger rod **51**C also has a bottom wall **51**BW with an upper surface **51**US and a width W**1**, a lens contact surface **51**LC that extends downwardly from the bottom wall upper surface, a top wall **51**TW with a width W**2** that is less than the bottom wall width, and a lateral wall **60**.

Referring to FIG. **25**, the exemplary case **3**C includes a support member **88** that engages the bottom of the main body **14**A when the IOL insertion apparatus **2**C is stored within the case and the lock mechanism **4** is in the locked state (as shown). The support member **88**, which may be a thin wall with a curved upper surface, prevents the main body **14**A from bending in the downward direction as the user is pushing the slider **6**C forwardly. Such bending could result in an undesirable level of friction between the case **3**C and the slider grip **7**.

Another exemplary IOL insertion system, which is generally represented by reference numeral **1**D in FIG. **26**, includes an IOL insertion apparatus **2**D and a case **3**D. IOL insertion system **1**D is essentially identical to system **1**C and similar elements are represented by similar reference numbers. For example, IOL insertion system **1**D includes a screw-type IOL insertion apparatus **2**D, a lock mechanism **4**D, and a cover **10**C. In the interest of brevity, the discussion below focuses on the differences between the two systems.

The present inventor has determined that there may be some instances where, during the first step of the two-step process, the operator will place the case on a table or other flat support surface, hold the front portion of the case with one hand and the push the slider forward the other hand. Referring first to the embodiment illustrated in FIG. **18**, the front portion **62** of the case **6**C includes a bottom surface that tapers upwardly. If the operator pushes the front portion **62** of the case **3**C downwardly with too much force while firmly holding the slider grips **7**, the front portion of the case may deflect, the case protrusion **74** may be completely or partially pulled out of the IOL path, and the IOL distal support **44** may not deflect properly. The front portion **62**D of the exemplary case **3**D illustrated in FIGS. **26** and **27** includes a flat bottom surface **98**, which is aligned with the flat bottom surface **100** of the rear portion **64**D, that prevents such bending.

The present inventor has also determined that there may be some instances where the operator attempts to pull the insertion apparatus out of the case, in a direction that is slightly angled from vertical, before the slider movement has been completed and the slider has engaged the distal wall of the removal slot. The curvature of the proximal ends of the slider grips may create a gap, between the curved proximal ends and the distal end of the storage slot protrusion (note grip **7** and protrusion **69** in FIG. **25**) that invites these attempts. Turning to FIG. **28**, the respective shapes of the slider grip **7**D (not the flat proximal end), storage slot **66**D and removal slot **68**D (note extension **102**) prevent the insertion apparatus **2**D from being pulled out of the case **3**D when the slider **6**D is only in the almost fully forward position illustrated in FIG. **28**. The top corner of the slider grip **7**D is in contact with the bottom corner of the protrusion **69**. Only after the slider **6**D is moved to the fully forward position illustrated in FIG. **29** will removal of the insertion apparatus **2**D from the case **3**D be possible.

Numerous other modifications and/or additions to the above-described preferred embodiments would be readily apparent to one skilled in the art. It is intended that the scope of the present inventions extends to all such modifications and/or additions.

We claim:

1. An intraocular lens insertion apparatus, comprising:
- an outer body including a lens placement section and a nozzle and defining a lens movement direction;
- an intraocular lens, having an optic with a diameter and haptics with respective free ends, stored in the lens placement section in such a manner that the optic diameter is perpendicular to the lens movement direction, one of the haptics is a proximal haptic and one of the haptics is a distal haptic; and
- a plunger, at least a portion of which is carried within the outer body, that is movable relative to the outer body and which has a distal region that defines a longitudinal axis, the distal region including
  - a bottom wall having an upper surface and defining a width in a direction transverse to the longitudinal axis of the distal region,
  - a lens contact surface extending downwardly from the bottom wall upper surface,
  - a top wall defining a width in a direction transverse to the longitudinal axis of the distal region that is less than the width of the bottom wall, and
  - a lateral wall that extends from the bottom wall to the top wall in a direction perpendicular to the optic diameter that is perpendicular to the lens movement direction,
  - the top wall, bottom wall and lateral wall together defining a recess that is located above the bottom wall, that extends proximally from the lens contact surface, that has a first lateral side that is open, a second lateral side that is closed by the lateral wall, and an open distal end, and that is configured to hold a portion of the proximal haptic when the proximal haptic is bent such that the free end is positioned over the optic.

2. An ocular implant insertion apparatus as claimed in claim **1**, wherein
- the plunger includes a slanted wall that defines the proximal end of the recess.

3. An ocular implant insertion apparatus as claimed in claim **2**, wherein
- the slanted wall is oriented at a non-perpendicular angle with respect to the longitudinal axis of the distal region.

4. An ocular implant insertion apparatus as claimed in claim **2**, wherein
- the slanted wall extends from the lateral wall to the first lateral side that is open.

5. An ocular implant insertion apparatus as claimed in claim **2**, wherein
- the width of the top wall at the open distal end of the recess is less than the width of the top wall at the proximal end of the recess.

6. An ocular implant insertion system as claimed in claim **1**, further comprising:
- a slider movable relative to the plunger from a pre-use slider position to a second slider position.

7. An ocular implant insertion apparatus as claimed in claim **6**, wherein

the proximal haptic includes a free end; and

movement of the slider from the pre-use slider position to the second slider position moves the free end of the proximal haptic over the optic.

8. An ocular implant insertion apparatus as claimed in claim **6**, wherein

the proximal haptic includes a free end; and

movement of the slider from the pre-use slider position to the second slider position moves the free end of the distal haptic over the optic.

9. An ocular implant insertion apparatus as claimed in claim **1**, wherein

the plunger includes a rotatable handle.

10. An ocular implant insertion apparatus as claimed in claim **1**, wherein

the plunger includes a thumb rest.

11. An ocular implant insertion apparatus as claimed in claim **1**, wherein

the lens contact surface is planar.

12. An ocular implant insertion apparatus as claimed in claim **1**, wherein

the lateral wall defines a lateral side of the distal region of the plunger.

13. An ocular implant insertion apparatus as claimed in claim **1**, wherein

the lateral wall defines a distal end; and

the top wall defines a distal end that extends distally beyond the distal end of the lateral wall.

14. An ocular implant insertion apparatus as claimed in claim **1**, further comprising:

a tapered transition proximal of the nozzle.

15. An ocular implant insertion apparatus as claimed in claim **1**, wherein

the outer body comprises main body and an insertion tube mounted on the main body.

16. An ocular implant insertion apparatus as claimed in claim **15**, wherein

the insertion tube includes the nozzle.

17. An ocular implant insertion apparatus as claimed in claim **1**, wherein

the lateral wall extends distally beyond the lens contact surface.

* * * * *

EXHIBIT 3

US009655718B2

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

(10) **Patent No.: US 9,655,718 B2**
(45) **Date of Patent: May 23, 2017**

(54) **INTRAOCULAR LENS INSERTION DEVICE**

(71) Applicant: **Hoya Corporation**, Tokyo (JP)

(72) Inventors: **Kazunori Kudo**, Saku (JP); **Masahiro Noda**, Toda (JP)

(73) Assignee: **Hoya Corporation**, Tokyo (JP)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 488 days.

(21) Appl. No.: **14/099,989**

(22) Filed: **Dec. 8, 2013**

(65) **Prior Publication Data**

US 2014/0194890 A1 Jul. 10, 2014

Related U.S. Application Data

(63) Continuation of application No. 13/143,322, filed as application No. PCT/JP2010/050029 on Jan. 5, 2010, now Pat. No. 8,603,103.

(30) **Foreign Application Priority Data**

Jan. 7, 2009 (JP) 2009-001493

(51) **Int. Cl.**
A61F 2/16 (2006.01)

(52) **U.S. Cl.**
CPC ***A61F 2/167*** (2013.01); ***A61F 2/1672*** (2013.01)

(58) **Field of Classification Search**
CPC A61F 2/167; A61F 2/1662; A61F 2/1672; A61F 2/1675; A61F 2/1678; A61F 2/14; A61F 2/16
USPC 606/107; 623/6.12
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

2,761,446	A	9/1956	Reed
4,205,747	A	6/1980	Gilliam et al.
4,269,307	A	5/1981	LaHaye
4,423,809	A	1/1984	Mazzocco
4,573,998	A	3/1986	Mazzocco

(Continued)

FOREIGN PATENT DOCUMENTS

DE	3610925	10/1987
DE	4110278	10/1992

(Continued)

OTHER PUBLICATIONS

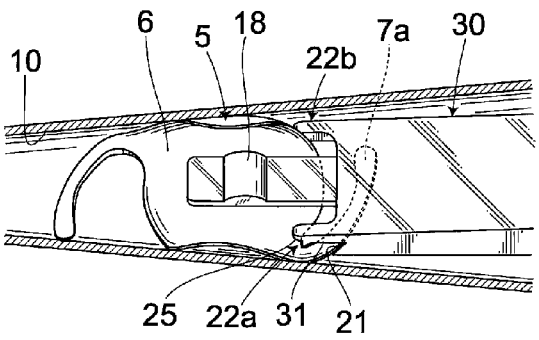
U.S. Appl. No. 15/336,678, filed Oct. 27, 2016.
U.S. Appl. No. 15/382,377, filed Dec. 16, 2016.
U.S. Appl. No. 15/126,277, filed Sep. 14, 2016.

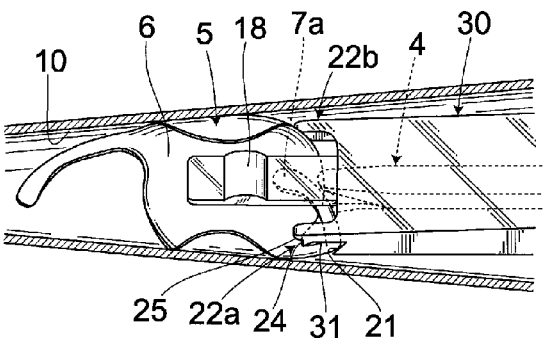
Primary Examiner — Kathleen Holwerda
Assistant Examiner — Socrates L Boutsikaris
(74) *Attorney, Agent, or Firm* — Henricks, Slavin & Holmes LLP

(57) **ABSTRACT**

There is provided an intraocular lens insertion device capable of appropriately regulating the motion of a rear supporting portion during a process of moving an intraocular lens, and reducing the possibility of reoperation being required after the intraocular lens is inserted into an eye. An intraocular lens insertion device **1** comprises a main body **2**, and a slider **3** and a plunger **4** that are attached to the main body **2**. Further, the intraocular lens insertion device **1** is of a preset type in which an intraocular lens **5** is placed inside the main body **2** in advance. The slider **3** includes a first abutting portion **21** for pushing up a supporting portion **7** (rear supporting portion **7***a*) arranged on a rear side of an optical part **6** with respect to a lens advancement axis A, and second abutting portions **22***a*, **22***b* abutting against an outer edge of a rear portion of the optical part **6**.

16 Claims, 9 Drawing Sheets





(56) **References Cited**

U.S. PATENT DOCUMENTS

4,608,049	A	8/1986	Kelman
4,634,423	A	1/1987	Bailey
4,681,102	A	7/1987	Bartell
4,697,697	A	10/1987	Graham et al.
4,699,140	A	10/1987	Holmes
4,702,244	A	10/1987	Mazzocco
4,715,373	A	12/1987	Mazzocco et al.
4,747,404	A	5/1988	Jampel et al.
4,750,498	A	6/1988	Graham
4,759,359	A	7/1988	Willis et al.
4,763,650	A	8/1988	Hauser
4,765,329	A	8/1988	Cumming et al.
4,769,034	A	9/1988	Poley
4,781,719	A	11/1988	Kelman
4,787,904	A	11/1988	Severin
4,810,249	A	3/1989	Haber et al.
4,819,631	A	4/1989	Poley
4,834,094	A	5/1989	Patton
4,836,201	A	6/1989	Patton
4,862,885	A	9/1989	Cumming
4,880,000	A	11/1989	Holmes et al.
4,919,130	A	4/1990	Stoy et al.
4,934,363	A	6/1990	Smith et al.
4,955,889	A	9/1990	Van Gent
4,976,716	A	12/1990	Cumming
4,988,352	A	1/1991	Poley
4,994,028	A	2/1991	Leonard et al.
5,066,297	A	11/1991	Cumming
5,098,439	A	3/1992	Hill et al.
5,123,905	A	6/1992	Kelman
5,139,501	A	8/1992	Klaas
5,171,241	A	12/1992	Buboltz et al.
5,176,686	A	1/1993	Poley
5,190,552	A	3/1993	Kelman
5,190,553	A	3/1993	Kanert et al.
5,222,972	A	6/1993	Hill et al.
5,242,450	A	9/1993	McDonald
5,259,395	A	11/1993	Li
5,275,604	A	1/1994	Rheinish et al.
5,281,227	A	1/1994	Sussman
5,304,182	A	4/1994	Rheinish et al.
5,354,333	A	10/1994	Kammann et al.
5,395,378	A	3/1995	McDonald
5,425,734	A	6/1995	Blake
5,454,818	A	10/1995	Hambleton et al.
5,468,246	A	11/1995	Blake
5,474,562	A	12/1995	Orchowski et al.
5,494,484	A	2/1996	Feingold
5,496,328	A	3/1996	Nakajima et al.
5,499,987	A	3/1996	Feingold
5,562,676	A	10/1996	Brady et al.
5,571,113	A	11/1996	McDonald
5,578,042	A	11/1996	Cumming
5,582,613	A	12/1996	Brady
5,582,614	A	12/1996	Feingold
5,584,304	A	12/1996	Brady
5,616,148	A	4/1997	Eagles et al.
5,620,450	A	4/1997	Eagles et al.
5,643,275	A	7/1997	Blake
5,643,276	A	7/1997	Zaleski
5,645,534	A	7/1997	Chanoch
5,653,715	A	8/1997	Reich et al.
5,653,753	A	8/1997	Brady et al.
5,702,402	A	12/1997	Brady
5,702,441	A	12/1997	Zhou
5,716,364	A	2/1998	Makker et al.
5,728,075	A	3/1998	Levander
5,728,102	A	3/1998	Feingold et al.
5,735,858	A	4/1998	Makker et al.
5,766,181	A	6/1998	Chambers et al.
5,772,666	A	6/1998	Feingold et al.
5,772,667	A	6/1998	Blake
5,776,138	A	7/1998	Vidal et al.
5,800,442	A	9/1998	Wolf et al.
5,803,925	A	9/1998	Yang et al.
5,807,400	A	9/1998	Chambers et al.
5,810,833	A	9/1998	Brady et al.
5,810,834	A	9/1998	Heyman
5,860,984	A	1/1999	Chambers et al.
5,860,986	A	1/1999	Reich et al.
5,868,751	A	2/1999	Feingold
5,868,752	A	2/1999	Makker et al.
5,873,879	A	2/1999	Figueroa et al.
5,876,406	A	3/1999	Wolf et al.
5,876,407	A	3/1999	Makker et al.
5,876,440	A	3/1999	Feingold
5,891,152	A	4/1999	Feingold
5,902,307	A	5/1999	Feingold et al.
5,919,197	A	7/1999	McDonald
5,921,989	A	7/1999	Deacon et al.
5,928,245	A	7/1999	Wolf et al.
5,941,886	A	8/1999	Feingold
5,942,277	A	8/1999	Makker et al.
5,944,725	A	8/1999	Cicenas
5,947,974	A	9/1999	Brady et al.
5,947,975	A	9/1999	Kikuchi et al.
5,957,748	A	9/1999	Ichiha
5,957,896	A	9/1999	Bendek et al.
6,001,107	A	12/1999	Feingold
6,010,510	A	1/2000	Brown et al.
6,022,358	A	2/2000	Wolf et al.
6,048,348	A	4/2000	Chambers et al.
6,051,000	A	4/2000	Heyman
6,056,757	A	5/2000	Feingold et al.
6,056,758	A	5/2000	Vidal et al.
6,059,791	A	5/2000	Chambers
6,074,397	A	6/2000	Chambers et al.
6,083,230	A	7/2000	Makker et al.
6,093,193	A	7/2000	Makker et al.
6,129,733	A	10/2000	Brady et al.
6,142,999	A	11/2000	Brady et al.
6,143,000	A	11/2000	Feingold
6,162,229	A	12/2000	Feingold et al.
6,174,315	B1	1/2001	Chambers et al.
6,214,015	B1	4/2001	Reich et al.
6,241,737	B1	6/2001	Feingold
6,248,111	B1	6/2001	Glick et al.
6,251,114	B1	6/2001	Farmer et al.
6,254,607	B1	7/2001	Makker et al.
6,267,768	B1	7/2001	Deacon
6,283,975	B1	9/2001	Glick et al.
6,283,976	B1	9/2001	Portney
6,312,433	B1	11/2001	Butts
6,334,862	B1	1/2002	Vidal et al.
6,336,932	B1	1/2002	Figueroa et al.
6,355,046	B2	3/2002	Kikuchi et al.
6,371,960	B2	4/2002	Heyman et al.
6,386,357	B1	5/2002	Egawa
6,387,101	B1	5/2002	Butts et al.
6,398,788	B1	6/2002	Makker et al.
6,406,481	B2	6/2002	Feingold et al.
6,428,545	B2	8/2002	Portney
6,447,519	B1	9/2002	Brady et al.
6,447,520	B1	9/2002	Ott et al.
6,468,282	B2	10/2002	Kikuchi et al.
6,471,708	B2	10/2002	Green
6,491,697	B1	12/2002	Clark et al.
6,497,708	B1	12/2002	Cumming
6,500,181	B1	12/2002	Portney
6,506,195	B2	1/2003	Chambers et al.
6,537,283	B2	3/2003	Van Noy
6,540,754	B2	4/2003	Brady
6,554,839	B2	4/2003	Brady
6,558,395	B2	5/2003	Hjertman et al.
6,605,093	B1	8/2003	Blake
6,607,537	B1	8/2003	Binder
6,629,979	B1	10/2003	Feingold
6,666,871	B2	12/2003	Kikuchi et al.
6,679,891	B2	1/2004	Makker et al.
6,685,740	B2	2/2004	Figueroa et al.
6,712,848	B1	3/2004	Wolf et al.
6,723,104	B2	4/2004	Ott
6,733,507	B2	5/2004	McNicholas et al.
6,793,674	B2	9/2004	Zapata

(56) **References Cited**

U.S. PATENT DOCUMENTS

6,858,033	B2	2/2005	Kobayashi
6,921,405	B2	7/2005	Feingold et al.
6,923,815	B2	8/2005	Brady et al.
6,976,989	B1	12/2005	Vincent
7,014,641	B2	3/2006	Kobayashi et al.
7,025,782	B2	4/2006	Kobayashi et al.
7,033,366	B2	4/2006	Brady
7,037,312	B2	5/2006	Kikuchi et al.
7,074,227	B2	7/2006	Portney
7,097,649	B2	8/2006	Meyer
7,131,976	B2	11/2006	Kobayashi et al.
7,156,854	B2	1/2007	Brown et al.
7,348,038	B2	3/2008	Makker et al.
7,422,604	B2	9/2008	Vaquero et al.
7,429,263	B2	9/2008	Vaquero et al.
7,458,976	B2	12/2008	Peterson et al.
7,476,230	B2	1/2009	Ohno et al.
7,494,505	B2	2/2009	Kappelhof et al.
7,645,300	B2	1/2010	Tsai
8,273,122	B2	9/2012	Anderson
8,382,769	B2	2/2013	Inoue
8,460,311	B2	6/2013	Ishii et al.
8,470,032	B2	6/2013	Inoue et al.
8,475,528	B2	7/2013	Ichinohe et al.
8,523,877	B2	9/2013	Ichinohe et al.
8,523,941	B2	9/2013	Ichinohe et al.
8,535,375	B2	9/2013	Ichinohe et al.
8,545,512	B2	10/2013	Ichinohe et al.
8,574,239	B2	11/2013	Ichinohe et al.
8,603,103	B2	12/2013	Kudo et al.
8,647,382	B2	2/2014	Kudo et al.
8,702,795	B2	4/2014	Shoji et al.
8,747,465	B2	6/2014	Someya et al.
8,968,328	B2	3/2015	Ichinohe et al.
9,114,006	B2	8/2015	Inoue
9,114,007	B2	8/2015	Ichinohe et al.
9,186,246	B2	11/2015	Inoue
9,220,593	B2	12/2015	Ichinohe et al.
9,289,288	B2	3/2016	Someya et al.
9,314,373	B2	4/2016	Kudo et al.
9,326,847	B2	5/2016	Sanger
9,364,320	B2	6/2016	Ichinohe et al.
9,554,894	B2	1/2017	Inoue
9,572,710	B1	2/2017	Kudo et al.
2001/0007942	A1	7/2001	Kikuchi et al.
2002/0103490	A1	8/2002	Brady
2002/0151904	A1	10/2002	Feingold et al.
2002/0165610	A1	11/2002	Wadlaock
2002/0193805	A1	12/2002	Ott et al.
2003/0036765	A1	2/2003	Van Noy
2003/0040755	A1	2/2003	Meyer
2003/0050647	A1	3/2003	Brady
2003/0088253	A1	5/2003	Seil
2003/0139749	A1	7/2003	Kikuchi et al.
2003/0181921	A1	9/2003	Jeannin
2003/0195522	A1	10/2003	McNicholas
2003/0212406	A1	11/2003	Kobayashi et al.
2003/0212407	A1	11/2003	Kikuchi
2003/0212409	A1	11/2003	Kobayashi et al.
2004/0111094	A1	6/2004	Meyer
2004/0117012	A1	6/2004	Vincent
2004/0186428	A1	9/2004	Ray
2004/0238392	A1	12/2004	Peterson et al.
2004/0243141	A1	12/2004	Brown et al.
2005/0033308	A1	2/2005	Callahan et al.
2005/0049605	A1	3/2005	Vaquero et al.
2005/0049606	A1	3/2005	Vaquero et al.
2005/0055011	A1	3/2005	Enggaard
2005/0125000	A1	6/2005	Tourrette et al.
2005/0143750	A1	6/2005	Vaquero
2005/0182419	A1	8/2005	Tsai
2005/0222578	A1	10/2005	Vaquero
2005/0261703	A1	11/2005	Feingold et al.
2006/0085013	A1	4/2006	Dusek
2006/0142781	A1	6/2006	Pynson et al.
2006/0167466	A1	7/2006	Dusek
2006/0200167	A1	9/2006	Peterson et al.
2006/0229633	A1	10/2006	Shepherd
2006/0235429	A1	10/2006	Lee et al.
2006/0293694	A1	12/2006	Futamura
2007/0005135	A1	1/2007	Makker et al.
2008/0033449	A1	2/2008	Cole et al.
2008/0058830	A1	3/2008	Cole et al.
2008/0086146	A1	4/2008	Ishii et al.
2008/0097459	A1	4/2008	Kammerlander et al.
2008/0221584	A1	9/2008	Downer
2009/0036898	A1	2/2009	Ichinohe
2009/0043313	A1	2/2009	Ichinohe
2009/0112223	A1	4/2009	Downer et al.
2009/0125034	A1	5/2009	Pynson
2009/0138022	A1	5/2009	Tu et al.
2009/0204122	A1	8/2009	Ichinohe et al.
2009/0216244	A1	8/2009	Pynson
2009/0248031	A1	10/2009	Ichinohe
2010/0094309	A1	4/2010	Hboukhny et al.
2010/0106160	A1	4/2010	Tsai
2010/0161049	A1	6/2010	Inoue
2010/0185206	A1	7/2010	Ichinohe et al.
2010/0217273	A1	8/2010	Someya et al.
2010/0286704	A1	11/2010	Ichinohe et al.
2010/0331808	A1	12/2010	Py et al.
2011/0082463	A1	4/2011	Inoue
2011/0098717	A1	4/2011	Inoue
2011/0264101	A1	10/2011	Inoue et al.
2011/0270264	A1	11/2011	Shoji et al.
2011/0288557	A1	11/2011	Kudo et al.
2012/0022549	A1	1/2012	Someya et al.
2012/0071887	A1	3/2012	Ichinohe et al.
2013/0006259	A1	1/2013	Sanger
2013/0018460	A1	1/2013	Anderson
2013/0226193	A1	8/2013	Kudo et al.
2013/0245635	A1	9/2013	Inoue
2014/0081284	A1	3/2014	Ichinohe et al.
2014/0107660	A1	4/2014	Ichinohe et al.
2014/0114323	A1	4/2014	Kudo et al.
2014/0180299	A1	6/2014	Ichinohe et al.
2014/0180300	A1	6/2014	Ichinohe et al.
2014/0194890	A1	7/2014	Kudo et al.
2016/0113759	A1	4/2016	Inoue
2016/0193038	A1	7/2016	Kudo et al.
2016/0346077	A1	12/2016	Someya et al.

FOREIGN PATENT DOCUMENTS

EP	0363213		4/1990
EP	0727966		9/2003
EP	1832247	A1	9/2007
EP	1338254		12/2008
FR	2749752	A	12/1997
JP	63-197453	A	8/1988
JP	4-212350	A	8/1992
JP	5-103808		4/1993
JP	5-103809		4/1993
JP	8-024282	A	1/1996
JP	8-505540		6/1996
JP	9-506285	A	6/1997
JP	11-113939	A	4/1999
JP	11-506357	A	6/1999
JP	2000-516487	A	12/2000
JP	2000-516488	A	12/2000
JP	2001-502563		2/2001
JP	2001-104347	A	4/2001
JP	2002-516709	A	6/2002
JP	2002-355268	A	12/2002
JP	2002-541912	A	12/2002
JP	2003-144480	A	5/2003
JP	3412106	B2	6/2003
JP	2003-210498	A	7/2003
JP	2003-325569	A	11/2003
JP	2003-325570	A	11/2003
JP	2003-325572	A	11/2003
JP	2004-024854	A	1/2004
JP	2004-188194	A	7/2004
JP	2004-351196	A	12/2004

(56) **References Cited**

FOREIGN PATENT DOCUMENTS

JP	2006-181269	A	7/2006
JP	2006-297146	A	11/2006
JP	2006-333924	A	12/2006
JP	2006-333981	A	12/2006
JP	2007-503872	A	3/2007
JP	2007-152010	A	6/2007
JP	2007-181604	A	7/2007
JP	2007-526091	A	9/2007
JP	2008-521535	A	6/2008
JP	2008-212689	A	9/2008
JP	2014-050484	A	3/2014
WO	WO9407436	A1	4/1994
WO	WO9513022	A1	5/1995
WO	WO9628122	A1	9/1996
WO	WO9715253	A1	5/1997
WO	WO9812969	A1	4/1998
WO	WO9958086	A1	11/1999
WO	WO9959668	A1	11/1999
WO	WO0045746	A1	8/2000
WO	WO0062712	A1	10/2000
WO	WO02071982	A1	9/2002
WO	WO02096322	A1	12/2002
WO	WO2005023154	A1	3/2005
WO	WO2005070341	A1	8/2005
WO	WO2005084588	A1	9/2005
WO	WO2006070628	A1	7/2006
WO	WO2006080191	A1	8/2006
WO	WO2006090531	A1	8/2006
WO	WO2007037223	A1	4/2007
WO	WO2007097221	A1	4/2007
WO	WO2007080869	A1	7/2007
WO	WO2008149794	A1	12/2008
WO	WO2008149795	A1	12/2008
WO	WO2009058929	A1	7/2009
WO	WO2009148091	A1	12/2009
WO	WO2011126144	A1	10/2011
WO	WO2011155636	A1	12/2011

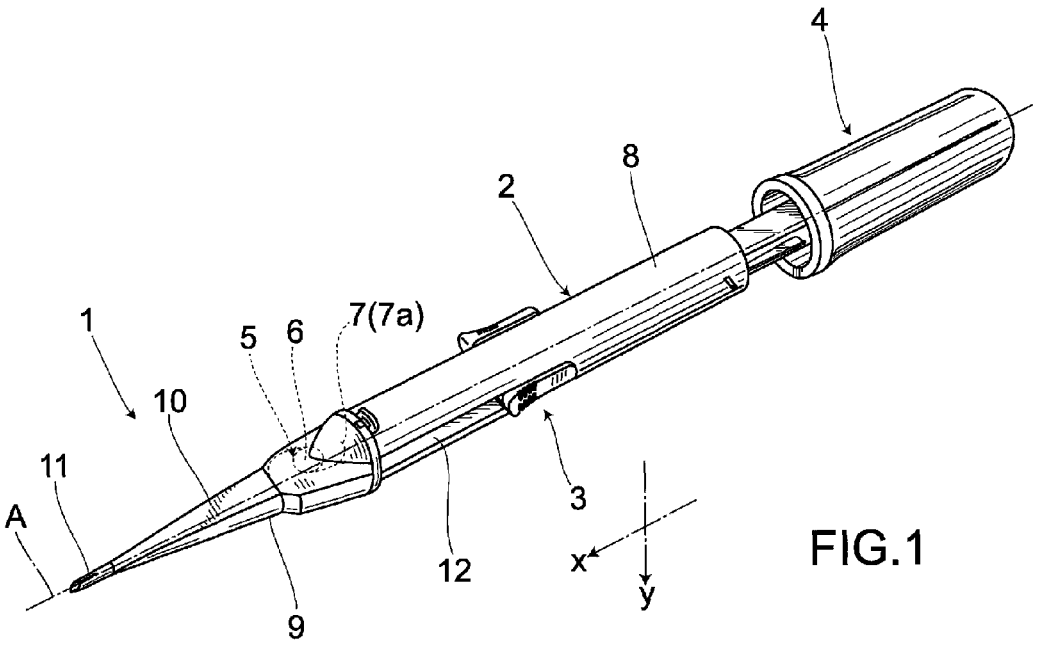


FIG.1

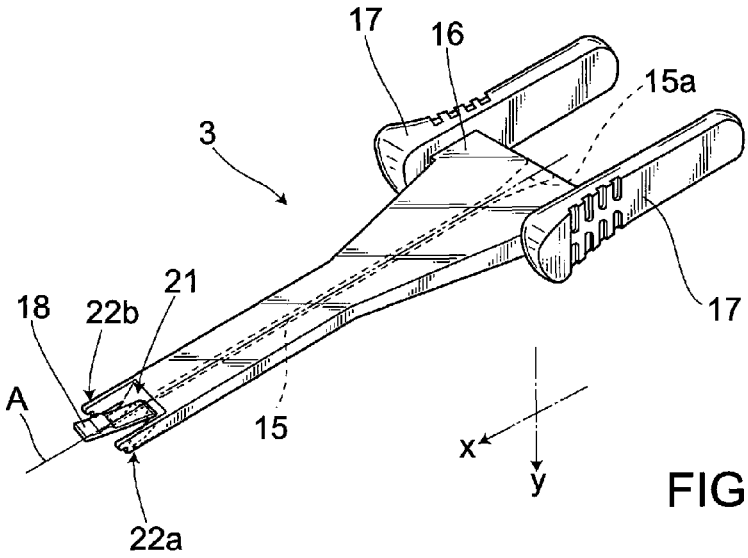


FIG.2

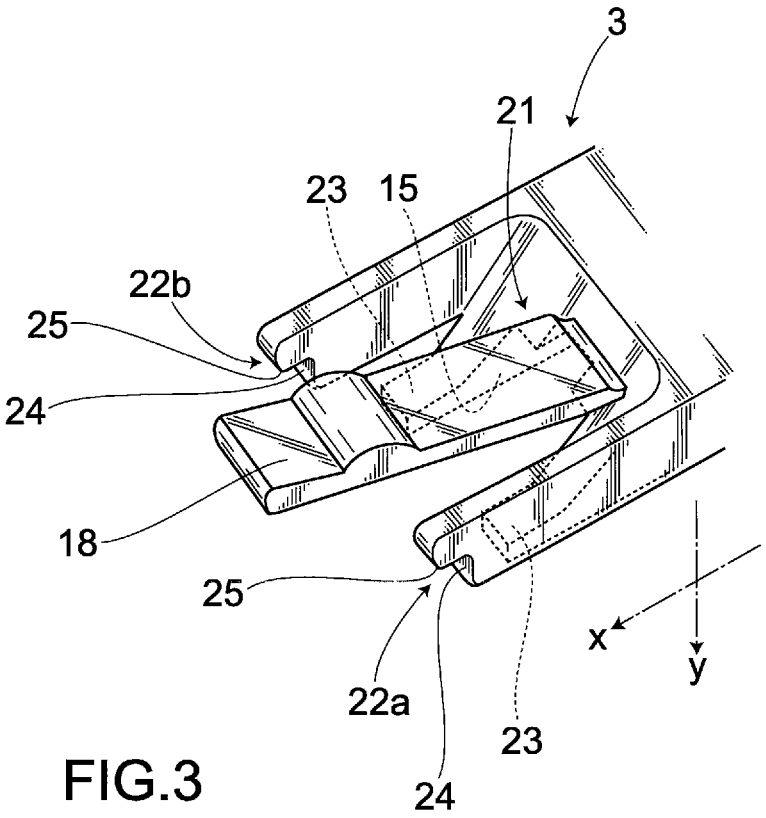


FIG.3

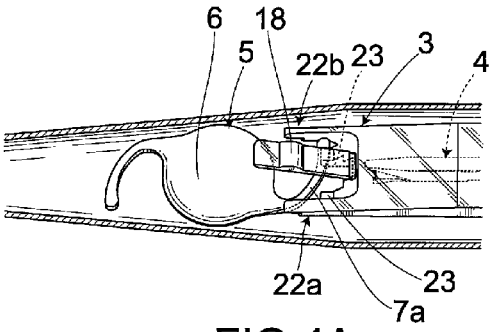


FIG.4A

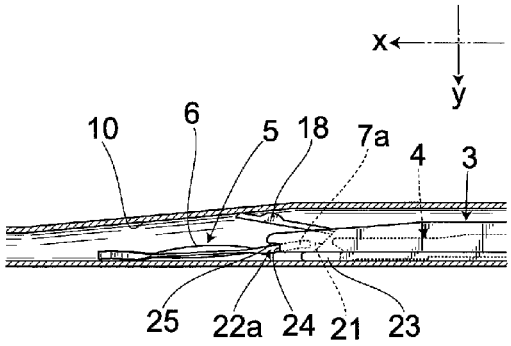


FIG.4B

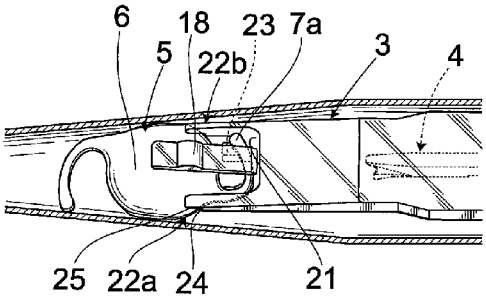


FIG.5A

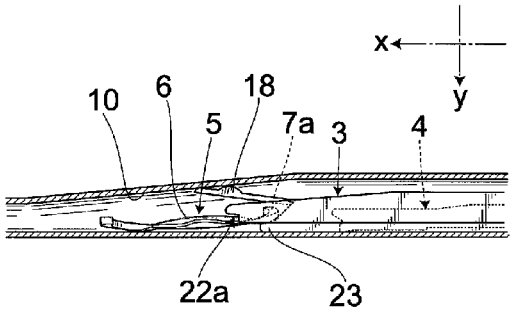


FIG.5B

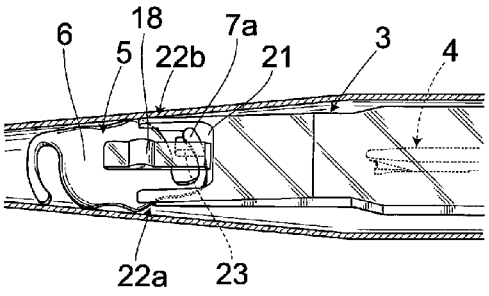


FIG.6A

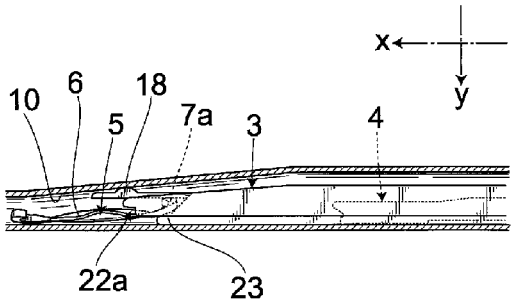


FIG.6B

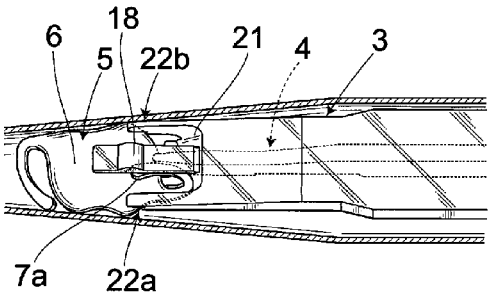


FIG.7A

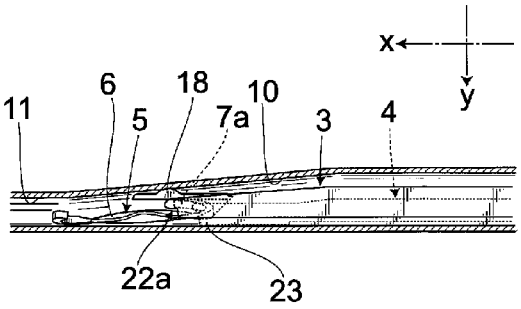


FIG.7B

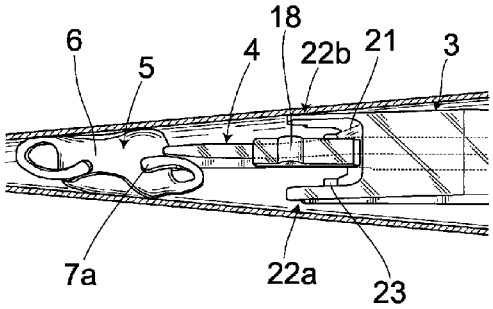


FIG.8A

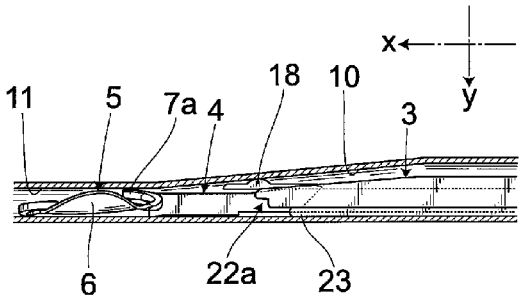


FIG.8B

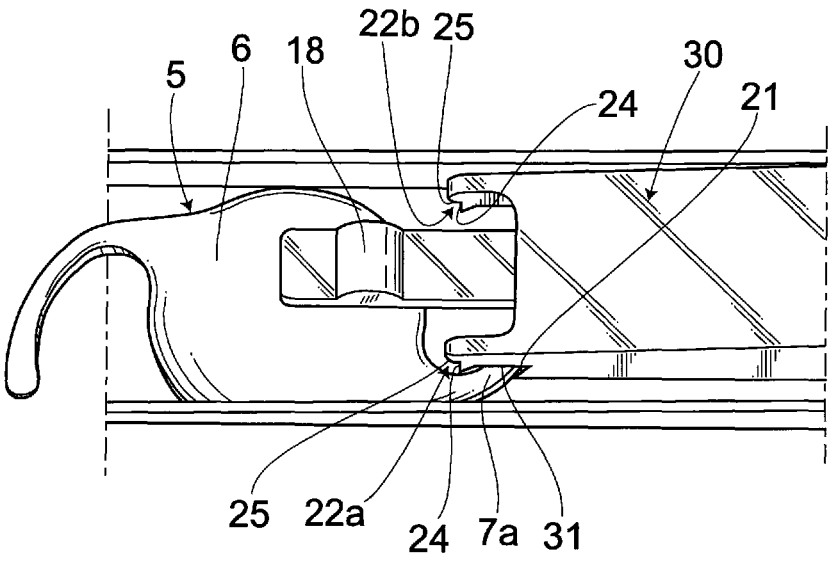


FIG.9

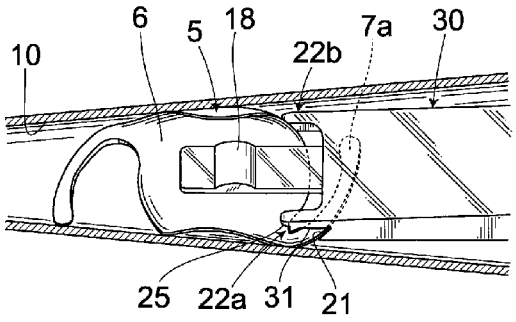


FIG.10A

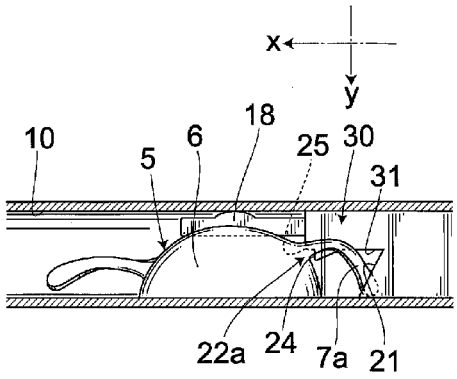


FIG.10B

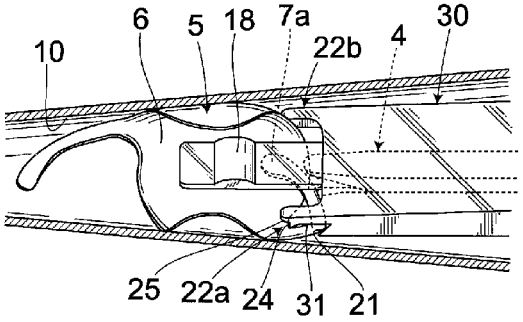


FIG.11A

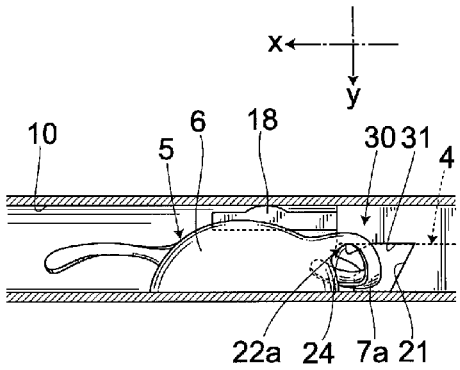


FIG.11B

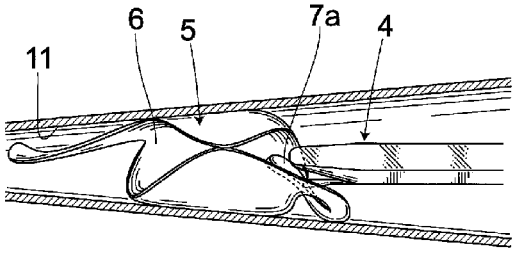


FIG.12A

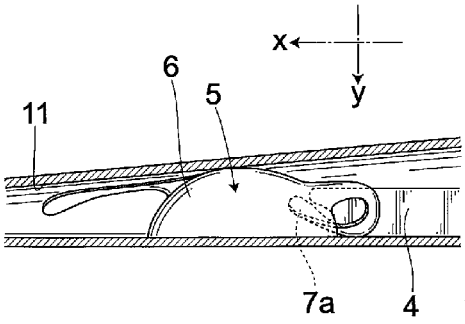


FIG.12B

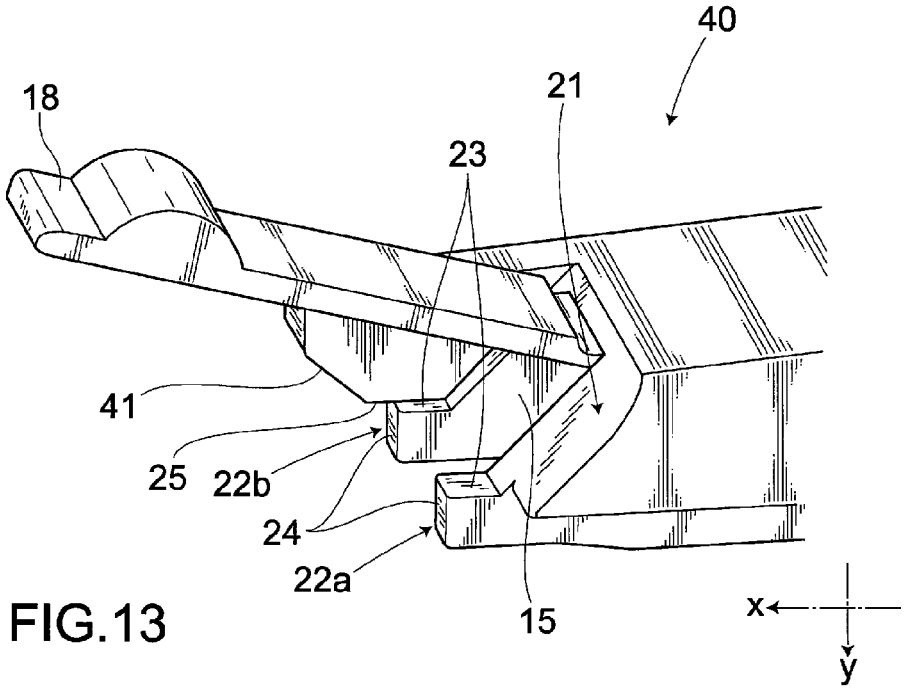


FIG.13

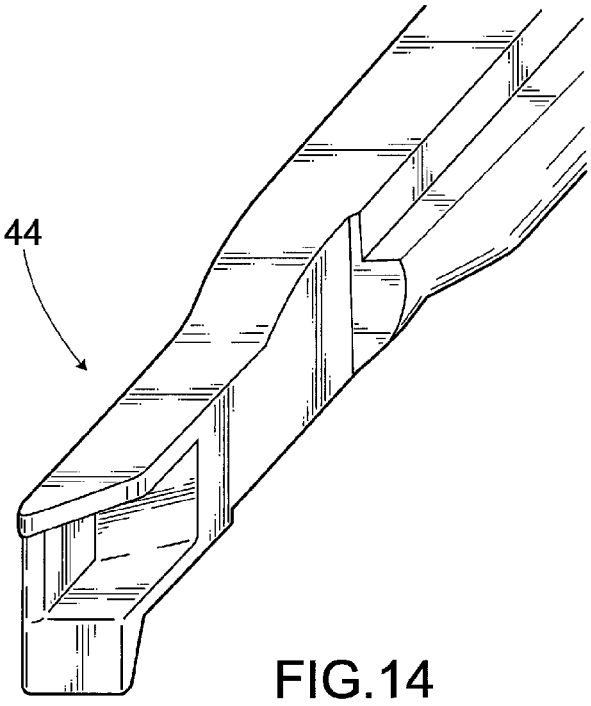


FIG.14

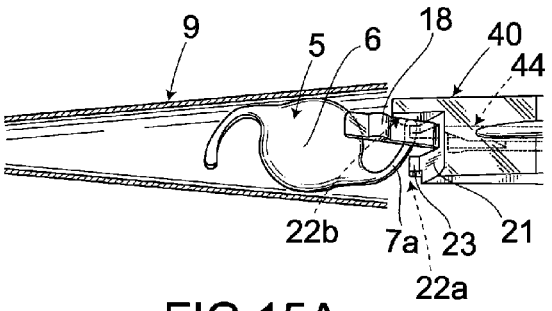


FIG.15A

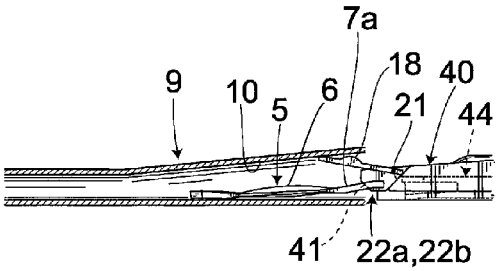


FIG.15B

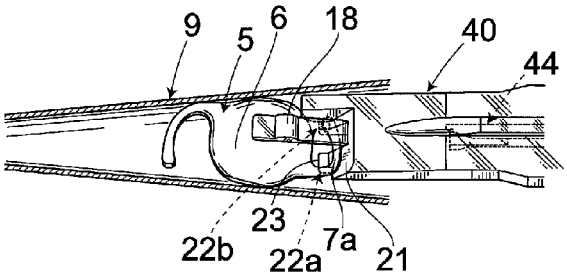


FIG.16A

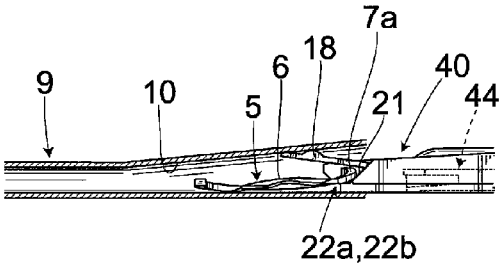


FIG.16B

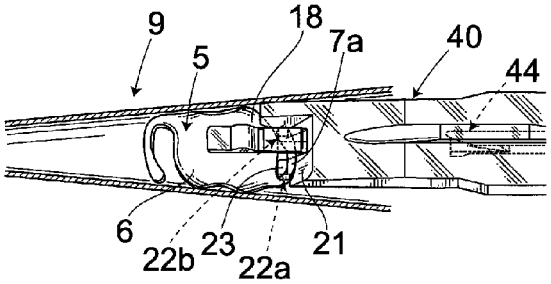


FIG.17A

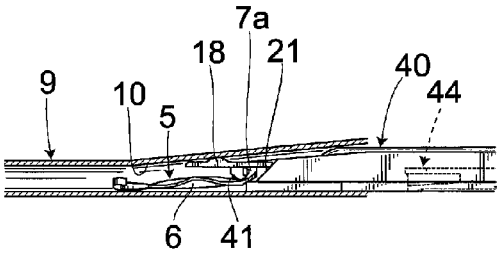


FIG.17B

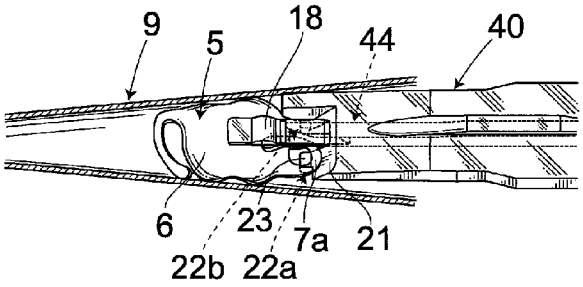


FIG.18A

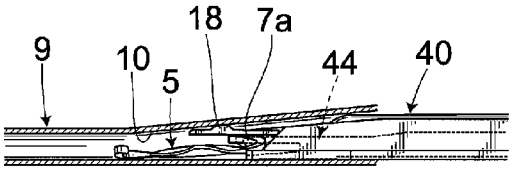


FIG.18B

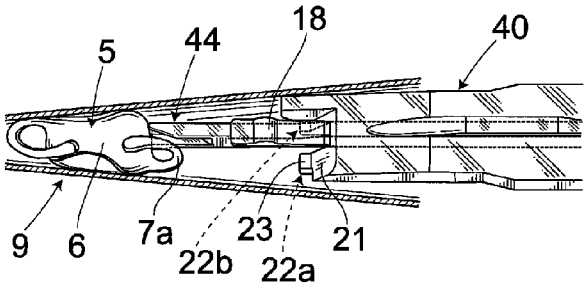


FIG.19A

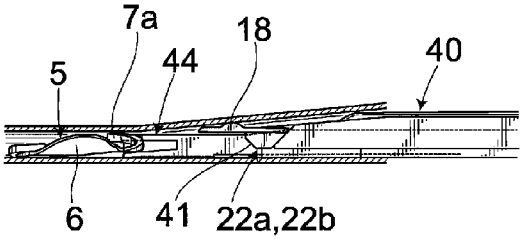


FIG.19B

INTRAOCULAR LENS INSERTION DEVICE

CROSS REFERENCE TO RELATED APPLICATIONS

This application is a continuation of U.S. application Ser. No. 13/143,322, filed Jul. 5, 2011, now U.S. Pat. No. 8,603,103, which is a U.S. national phase application under 35 U.S.C. §371 of International Patent Application No. PCT/JP2010/050029 filed Jan. 5, 2010, which claims priority to Japanese patent application No. 2009-001493, filed Jan. 7, 2009. The International Application was published in Japanese on Jul. 15, 2010 as International Publication No. WO 2010/079780A1. The content of each application is incorporated herein in its entirety.

TECHNICAL FIELD

The present invention relates to an intraocular lens insertion device for inserting an intraocular lens into an eyeball as a substitute of a crystalline lens exenterated through cataract surgery.

BACKGROUND ART

Cataract surgery often involves removing an opacified crystalline lens through phacoemulsification (PEA), and implanting an intraocular lens after the crystalline lens has been removed. Intraocular lenses include hard intraocular lenses whose optical parts are made of hard materials such as PMMA or the like, and soft intraocular lenses whose optical parts are made of soft materials such as silicon elastomer, soft acrylic, hydrogel or the like.

When inserting a hard intraocular lens, there has to be formed on the cornea or the sclera an incision substantially as wide as the diameter of the optical part of the corresponding hard intraocular lens. In contrast, a soft intraocular lens can be inserted through an incision smaller than the diameter of the optical part thereof by allowing the corresponding optical part to be folded.

An intraocular lens is preferably inserted through a small incision in order to reduce the possibilities of corneal astigmatism and infection after the surgery. In this sense, soft intraocular lenses tend to be preferred nowadays. Types of soft intraocular lens include: a soft intraocular lens having an optical part made of a soft material and supporting portions made of a hard material such as PMMA or the like (the supporting portions of this type of intraocular lens are usually two thin filamentary members); a soft intraocular lens whose optical part and supporting portions are made of a same soft material (the supporting portions of this type are usually plate members); or a soft intraocular lens employing a plurality of thin strips as supporting portions, and the like.

Further, in order to insert an intraocular lens into an eye, there has also been used a dedicated intraocular lens insertion device having a structure for introducing the intraocular lens into the eye through an elongated tube. This type of intraocular lens insertion device allows an intraocular lens to be inserted through an incision smaller than 3 mm.

Furthermore, in recent years, there has been developed a type of intraocular lens insertion device which has an intraocular lens placed therein in advance and can be packaged and stored, in order to exclude the possibilities of bacteria contamination and errors in operation at the time of handling the intraocular lens (e.g., patent document 1).

However, this type of intraocular lens insertion device may cause a supporting portion (referred to as a rear supporting portion, hereunder) arranged on a rear side with respect to a lens advancement axis to slip in between a plunger for pushing out the intraocular lens and a passage inner wall surface of the insertion device, or be tangled with the corresponding plunger, during a process of moving the intraocular lens. These problems are particularly noticeable with soft intraocular lenses employing thin filamentary members as supporting portions and intraocular lenses employing thin strips as supporting portions.

Further, this type of intraocular lens insertion device may cause the rear supporting portion to be stretched during the process of moving the intraocular lens. Accordingly, the corresponding rear supporting portion may then be left outside an eye ball at the time of performing insertion through a small incision on the eyeball, thereby requiring an additional operation for inserting such rear supporting portion into the eye ball after pushing out the intraocular lens with the plunger, and thus making the surgery troublesome.

In this sense, when using an intraocular lens insertion device to insert an intraocular lens into an eye, the motion of the rear supporting portion of the intraocular lens has to be appropriately regulated during the process of moving the intraocular lens.

In view of the aforementioned problems, there has been disclosed a device in which a clearance is formed on a front end side portion of a plunger, for allowing the rear supporting portion to be kept therein and thus preventing the same from being damaged (e.g., patent document 2). Further, there has been disclosed a device in which a rear supporting portion receiving passage for receiving the rear supporting portion is provided on a lower side portion of a plunger (e.g., patent document 3). Furthermore, there has also been disclosed a device in which the rear supporting portion is pushed up on a lump portion by means of a plunger, thereby allowing the corresponding haptic to be bended upward and eventually positioned higher than an IOL (e.g., patent document 4). Accordingly, all the devices disclosed in the aforementioned patent documents serve to reduce holding pressures applied to the rear supporting portions of intraocular lenses employing thin filaments or strips as supporting portions.

REFERENCE

Patent document 1: WO2007/037223

Patent document 2: Japanese Unexamined Patent Application Publication (Translation of PCT Application) No. 1999-506357

Patent document 3: U.S. Pat. No. 6,733,507

Patent document 4: Japanese Unexamined Patent Application Publication No. 2004-351196

DISCLOSURE OF THE INVENTION

Problem to be Solved by the Invention

However, according to the patent documents 2 and 3, the rear supporting portion received in the clearance formed on the front end side portion of the plunger and in the rear supporting portion receiving passage is stretched, thereby still incurring a problem in which the corresponding rear supporting portion may be left outside a small incision formed on an eye ball when inserting an intraocular lens therethrough. Particularly, with regard to intraocular lenses employing thin strips as supporting portions, reoperation is often troublesome because the corresponding supporting portions are composed of soft members that are thick in

sizes. Further, according to the patent document 4, the supporting portion is pushed by a small plunger front end matched to a nozzle front end with a small aperture diameter, thus causing the rear supporting portion to be compressed into an unexpected shape when bending the supporting portion upward so as to position the same higher than an optical part or when allowing an intraocular lens to pass through a passage.

Here, in view of the aforementioned problems, it is an object of the present invention to provide an intraocular lens insertion device capable of appropriately regulating the motion of a rear supporting portion during a process of moving an intraocular lens, and reducing the possibility of reoperation being required after the intraocular lens has been inserted into an eye.

Means for Solving the Problem

The invention according to a first aspect of the present invention is an intraocular lens insertion device comprising: a lens placement section for placing an intraocular lens having an optical part and one or more supporting portions provided on an outer edge of the optical part; a transition section for deforming the intraocular lens; a nozzle section for releasing the intraocular lens; a slider for pushing out the intraocular lens placed in the lens placement section; and a plunger for releasing the intraocular lens pushed out by the slider from the nozzle section, in which the slider includes: a first abutting portion for pushing up a supporting portion disposed in a rear direction of a lens advancement axis; and one or more second abutting portions abutting against an outer edge of a rear portion of the intraocular lens.

According to the invention described in a second aspect of the present invention, the second abutting portions are provided outside the first abutting portion with respect to the lens advancement axis.

According to the invention described in a third aspect of the present invention, the first abutting portion slants downward in a lens advancement direction.

According to the invention described in a fourth aspect of the present invention, at least one of the second abutting portions includes: an x-direction abutting surface substantially perpendicular to a surface of the optical part; and a y-direction abutting surface substantially parallel with the surface of the optical part.

The invention according to a fifth aspect of the present invention comprises a guiding portion for guiding the outer edge of the optical part to the second abutting portions.

According to the invention described in a sixth aspect of the present invention, the second abutting portions are provided as a left-right pair centered about the lens advancement axis.

Effects of the Invention

According to the present invention, the first abutting portion provided on the slider serves to push up the supporting portion arranged on the rear side with respect to the lens advancement axis, thereby allowing the motion of the rear supporting portion to be appropriately regulated during the process of moving the intraocular lens, and thus reducing the possibility of reoperation being required after the intraocular lens is inserted into the eye.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a perspective view showing an overall structure of an intraocular lens insertion device of a first embodiment of the present invention.

FIG. **2** is a perspective view showing a structure of a slider of the first embodiment of the present invention.

FIG. **3** is a partially enlarged perspective view showing the structure of the slider of the first embodiment of the present invention.

FIGS. **4**A and **4**B are diagrams showing a usage state (1) of the intraocular lens insertion device of the first embodiment of the present invention, in which FIG. **4**A is a cross sectional top view, and FIG. **4**B is a longitudinal sectional view.

FIGS. **5**A and **5**B are diagrams showing a usage state (2) of the intraocular lens insertion device of the first embodiment of the present invention, in which FIG. **5**A is a cross sectional top view, and FIG. **5**B is a longitudinal sectional view.

FIGS. **6**A and **6**B are diagrams showing a usage state (3) of the intraocular lens insertion device of the first embodiment of the present invention, in which FIG. **6**A is a cross sectional top view, and FIG. **6**B is a longitudinal sectional view.

FIGS. **7**A and **7**B are diagrams showing a usage state (4) of the intraocular lens insertion device of the first embodiment of the present invention, in which FIG. **7**A is a cross sectional top view, and FIG. **7**B is a longitudinal sectional view.

FIGS. **8**A and **8**B are diagrams showing a usage state (5) of the intraocular lens insertion device of the first embodiment of the present invention, in which FIG. **8**A is a cross sectional top view, and FIG. **8**B is a longitudinal sectional view.

FIG. **9** is a partially enlarged perspective view showing a structure of a slider of a second embodiment of the present invention.

FIGS. **10**A and **10**B are diagrams showing a usage state (1) of an intraocular lens insertion device of the second embodiment of the present invention, in which FIG. **10**A is a cross sectional top view, and FIG. **10**B is a longitudinal sectional view.

FIGS. **11**A and **11**B are diagrams showing a usage state (2) of the intraocular lens insertion device of the second embodiment of the present invention, in which FIG. **11**A is a cross sectional top view, and FIG. **11**B is a longitudinal sectional view.

FIGS. **12**A and **12**B are diagrams showing a usage state (3) of the intraocular lens insertion device of the second embodiment of the present invention, in which FIG. **12**A is a cross sectional top view, and FIG. **12**B is a longitudinal sectional view.

FIG. **13** is a partially enlarged perspective view showing a structure of a slider of a third embodiment of the present invention.

FIG. **14** is a partially enlarged perspective view showing a structure of a plunger of the third embodiment of the present invention.

FIGS. **15**A and **15**B are diagrams showing a usage state (1) of an intraocular lens insertion device of the third embodiment of the present invention, in which FIG. **15**A is a cross sectional top view, and FIG. **15**B is a longitudinal sectional view.

FIGS. **16**A and **16**B are diagrams showing a usage state (2) of the intraocular lens insertion device of the third embodiment of the present invention, in which FIG. **16**A is a cross sectional top view, and FIG. **16**B is a longitudinal sectional view.

FIGS. **17**A and **17**B are diagrams showing a usage state (3) of the intraocular lens insertion device of the third

embodiment of the present invention, in which FIG. **17**A is a cross sectional top view, and FIG. **17**B is a longitudinal sectional view.

FIGS. **18**A and **18**B are diagrams showing a usage state (4) of the intraocular lens insertion device of the third embodiment of the present invention, in which FIG. **18**A is a cross sectional top view, and FIG. **18**B is a longitudinal sectional view.

FIGS. **19**A and **19**B are diagrams showing a usage state (5) of the intraocular lens insertion device of the third embodiment of the present invention, in which FIG. **19**A is a cross sectional top view, and FIG. **19**B is a longitudinal sectional view.

BEST MODE FOR CARRYING OUT THE INVENTION

1. First Embodiment

(1) Basic Structure

An embodiment of the present invention is described hereunder in detail and with reference to the accompanying drawings.

An intraocular lens insertion device **1** shown in FIG. **1** comprises a main body **2**, and a slider **3** and a plunger **4** that are attached to the main body **2**. The intraocular lens insertion device **1** is of a preset type in which an intraocular lens **5** is placed inside the main body **2** in advance. Here, the intraocular lens **5** includes an optical part **6** and a pair of supporting portions **7** (or "haptics") provided on an outer edge of the optical part **6**. As the supporting portions **7**, there can be employed various types of members including, for example, members of a thin strip type.

In the following descriptions, an axis extending through the center of the intraocular lens **5** moving inside the main body **2** is referred to as a lens advancement axis A. Further, a direction to which the intraocular lens **5** moves is referred to as an "advancement direction x," and a downward direction is referred to as a "direction y."

The main body **2** is composed of a base end portion **8** and an insertion tube **9** connected to a front end of the base end portion **8** in the advancement direction x. Although not shown, a lens placement section made of a plate type member is formed on the front end of the base end portion **8** in the advancement direction x. The intraocular lens **5** is placed in the corresponding lens placement section. On side surfaces of the base end portion **8**, there are provided slits **12** formed in parallel with the lens advancement axis A and extending to the front end of the base end portion **8**. Further, the insertion tube **9** is integrally connected to the front end of the base end portion **8**, thereby allowing the intraocular lens **5** placed in the lens placement section of the base end portion **8** to be disposed internally.

The insertion tube **9** comprises a transition section **10** and a nozzle section **11** that are successively disposed along the lens advancement axis A. The transition section **10** is formed into a tapered shape in which an inner wall of the transition section **10** tapers toward a front end thereof, such front end being further communicated with the nozzle section **11**. The nozzle section **11** is so formed that an outer shape thereof can be inserted into an incision (not shown).

According to this intraocular lens insertion device **1**, the intraocular lens **5** placed in the lens placement section is at first moved to the transition section **10** after being pushed out by the slider **3**, thereby allowing the intraocular lens **5** to be reliably folded into a given shape. Next, the intraocular lens **5** is further moved to the nozzle section **11** after being pushed out by the plunger **4**, thereby causing the intraocular lens **5** to be folded even smaller, and thus allowing the intraocular lens **5** to be inserted into an eye from a front end of the nozzle section **11**. Accordingly, the intraocular lens insertion device **1** allows the intraocular lens **5** to be moved in the advancement direction x in two stages involving successively the slider **3** and the plunger **4**, thus causing the intraocular lens **5** to be folded into a given shape and releasing the same to the outside.

(2) Structure of Slider

Next, the slider **3** attached to the main body **2** is described. As shown in FIG. **2**, the slider **3** servers to push out the intraocular lens **5** placed in the lens placement section to the transition section **10** without imposing a local load thereon, and fold the intraocular lens **5** into the given shape. The slider **3** includes a guiding groove **15**, a wing portion **16**, operation portions **17** and a lens pressing member **18**.

The guiding groove **15** is so configured that the plunger **4** can be supported thereby along the lens advancement axis A. Specifically, the guiding groove **15** allows the plunger **4** to slide, and a front end of the plunger **4** to protrude from a front end of the slider **3**. According to the present embodiment, the guiding groove **15** is longitudinally formed over an entire length of a surface of the slider **3** in a manner such that the guiding groove **15** is substantially located in the center of the surface of the slider **3**. Accordingly, the guiding groove **15** serves as a groove parallel to the lens advancement axis A. A cross-sectional surface of the guiding groove **15** is substantially formed into a same shape as an outer shape of the plunger **4**. A wedge guiding path **15***a* is formed on a base end of the guiding groove **15**. In this way, the plunger **4** is allowed to be inserted into the guiding groove **15** formed on the slider **3**, and slide within the guiding groove **15** in a longitudinal direction of the slider **3**.

The wing portion **16** is inserted into the slits **12** provided on the main body **2**, and serves to support the slider **3** along the lens advancement axis A. By inserting the wing portion **16** into the slits **12**, the slider **3** is allowed to not only be held in a substantial center portion of the main body **2**, but also move along the lens advancement axis A. In this sense, the plunger **4** can also be held in the center portion of the main body **2** and move along the lens advancement axis A, when inserted into the guiding groove **15** formed on the slider **3**. The slider **3** can be easily moved by means of the operation portions **17**.

The operation portions **17** are provided as a left-right pair centered about the lens advancement axis A. Further, the operation portions **17** are connected to side end portions of the wing portion **16**, and protrude from each side of the base end portion **8**.

The lens pressing member **18** serves to fold the intraocular lens **5** in a given direction by pressing a surface of the intraocular lens **5** only when the intraocular lens **5** is being pushed out. According to the present embodiment, the lens pressing member **18** serves to press a surface of the intraocular lens **5** to the direction y, thereby causing the intraocular lens **5** to be folded inside the nozzle section **11** with the foregoing surface being folded inwardly, such surface being a front surface when releasing the intraocular lens **5** into the eye. The lens pressing member **18** is made of a strip type member provided on the front end of the slider **3**, and is capable of swinging freely to the direction y.

In addition to the structure described so far, the slider **3** of the present embodiment, as shown in FIG. **3**, further includes a first abutting portion **21** for pushing up a supporting portion **7** arranged on a rear side with respect to the lens advancement axis A with respect to the optical part **6**

(referred to as a rear supporting portion **7***a*, hereunder), and second abutting portions **22***a*, **22***b* abutting against a rear outer edge of the optical part **6**.

The first abutting portion **21** has a slanting surface formed in the center of the front end of the slider **3** and slanting toward a direction between the advancement direction x and the direction y. The guiding groove **15** is opened in the center of the first abutting portion **21**, and a front end of the plunger **4** is thus allowed to protrude from the guiding groove **15** in the advancement direction x. Further, restriction portions **23** are formed on front ends of the first abutting portion **21**. The restriction portions **23** serve to prevent the rear supporting portion **7***a* from entering in between the slider **3** and the main body **2** and thus being damaged, as the rear supporting portion **7***a* deforms in the direction y. According to the present embodiment, the restriction portions **23** protrude from lower ends of the slanting surface to the advancement direction x.

The second abutting portions **22***a*, **22***b* are respectively provided on both sides of the first abutting portion **21**, and are configured to be able to abut against the outer edge of the optical part **6** of the intraocular lens **5**. According to the present embodiment, the second abutting portions **22***a*, **22***b* protrude from the front end of the slider **3** to the advancement direction x, and at least **22***a* is allowed to abut against, along the lens advancement axis A, an outer edge of a section of the optical part **6**, such section of the optical part **6** being located outward from a connecting portion of the supporting portion **7** and the optical part **6**.

Further, the second abutting portions **22***a*, **22***b* have x-direction abutting surfaces **24** and y-direction abutting surfaces **25**. The x-direction abutting surfaces **24** are perpendicular to a surface of the optical part **6**, and are thus capable of pushing out the outer edge of the optical part **6**. The y-direction abutting surfaces **25** are parallel with the surface of the optical part **6**, and are thus able to restrict a surface of the optical part **6** in the vicinity of the outer edge thereof from being valley folded before the rear supporting portion **7***a* has been sufficiently deformed.

As described above, according to the intraocular lens insertion device **1** of the present embodiment, the first abutting portion **21** and the second abutting portions **22***a*, **22***b* are provided on the slider **3** allowing the intraocular lens **5** to be in contact therewith through a contact area larger than that of the plunger **4**. Accordingly, the motion of the rear supporting portion **7***a* can be appropriately regulated during the process of moving the intraocular lens **5**. Further, there can be reduced the possibility of reoperation being required after the intraocular lens **5** is inserted into the eye.

(3) Operation and Effect

According to the intraocular lens insertion device **1** having the aforementioned structure, the intraocular lens **5** is placed internally in a manner such that the optical part **6** thereof is arranged in parallel with the lens advancement axis A (FIGS. **4**A and **4**B). The slider **3** is at first moved to the advancement direction x in order to release the intraocular lens **5** internally placed in advance to the outside from the front end of the nozzle section **11**. In this way, the first abutting portion **21** formed on the front end of the slider **3** is caused to abut against the rear supporting portion **7***a* (FIGS. **5**A and **5**B).

Since the first abutting portion **21** has the slanting surface, the rear supporting portion **7***a* is pushed up therealong as the slider **3** is further moved to the advancement direction x (FIGS. **6**A and **6**B). At the same time, the x-direction abutting surfaces **24** of the second abutting portions **22***a*, **22***b* are caused to abut against as well as push out the optical part **6**, thereby moving the intraocular lens **5** from the lens placement section to the transition section **10**. At that time, the outer edge of the optical part **6** is pushed by the inner wall of the transition section **10**. Further, the lens pressing member **18** is also pushed by the inner wall of the transition section **10**, and is thus caused to push down the surface of the optical part **6** to the direction y. In this way, the optical part **6** of the intraocular lens **5** is valley folded.

Next, as the plunger **4** is moved to the advancement direction x, the front end of such plunger **4** supported by the guiding groove **15** of the slider **3** is caused to abut against the outer edge of the optical part **6** (FIGS. **7**A and **7**B). The rear supporting portion **7***a* pushed up by the first abutting portion **21** is thus caused to deform along the plunger **4** in a manner such that a front end of the rear supporting portion **7***a* eventually points to the advancement direction x. In this way, the front end of the rear supporting portion **7***a* deformed due to the first abutting portion **21**, is tucked into the surface of the valley-folded optical part **6**.

Here, the y-direction abutting surfaces **25** of the second abutting portions **22***a*, **22***b* are configured to restrict the surface of the optical part **6** in the vicinity of the outer edge thereof from being valley folded, thereby preventing the outer edge of the optical part **6** from interfering with the rear supporting portion **7***a* during a deformation process of the rear supporting portion **7***a*. Accordingly, the intraocular lens insertion device **1** allows the rear supporting portion **7***a* to further reliably enter a space formed by the valley-folded surface of the optical part **6**, thereby making it possible to further reliably deform the intraocular lens **5** into the given shape.

Further, the restriction portions **23** provided on the first abutting portion **21** serve to prevent the rear supporting portion **7***a* from deforming to the direction y. In this sense, the intraocular lens insertion device **1** allows the intraocular lens **5** to be further reliably deformed into the given shape.

Next, by further moving the plunger **4** to the advancement direction x, the intraocular lens **5** is moved from the transition section **10** to the nozzle section **11** (FIGS. **8**A and **8**B), followed by being released to the outside from the front end of the nozzle section **11** with the intraocular lens **5** itself being folded even smaller.

As described earlier, the intraocular lens insertion device **1** allows the rear supporting portion **7***a* to be pushed up by the first abutting portion **21**, thereby making it possible to appropriately regulate the motion of the rear supporting portion **7***a* during the process of moving the intraocular lens **5** and reduce the possibility of reoperation being required after the intraocular lens **5** is inserted into the eye.

Further, since the first abutting portion **21** is provided on the slider **3**, the rear supporting portion **7***a* is allowed to come into contact with the first abutting portion **21** through a large contact area. Accordingly, the intraocular lens insertion device **1** of the present embodiment allows the rear supporting portion **7***a* to be further stably deformed, thereby making it possible to further appropriately regulate the rear supporting portion **7***a*.

2. Second Embodiment

A second embodiment of the present invention is described hereunder with reference to the accompanying drawings. Here, the second embodiment differs from the first embodiment only in the structure of the front end portion of the slider **3**. Therefore, same symbols are used to describe

the same members as those in the first embodiment, and the descriptions of the corresponding members are thus omitted for the sake of convenience.

According to a slider **30** shown in FIG. **9**, at least **22***a* of second abutting portions **22***a*, **22***b* is configured to abut against an outer edge of a section of the optical part **6** between the connecting portion of the rear supporting portion **7***a* and the optical part **6**, and the lens advancement axis A. Further, this slider **30** has a cutout hole **31** formed on a side surface thereof, such cutout hole **31** allowing the rear supporting portion **7***a* to be inserted therethrough inwardly from the outside.

According to the present embodiment having the aforementioned structure, the slider **30** is at first moved to the advancement direction x by gripping operation portions **17**. As a result, a first abutting portion **21** formed on a front end of the slider **30** is caused to abut against the rear supporting portion **7***a*.

As the slider **30** is further moved to the advancement direction x, the rear supporting portion **7***a* is pushed up with x-direction abutting surfaces **24** of the second abutting portion **22** abutting against and pushing out the optical part **6**, at the same time, thus allowing the intraocular lens **5** to be moved from a lens placement section to a transition section **10**. In this way, the optical part **6** is pushed by an inner wall of the transition section **10**, and a surface of the optical part **6** is pushed down to the direction y by means of a lens pressing member **18**, thus allowing the optical part **6** to be valley folded (FIGS. **10**A and **10**B).

Next, as a plunger **4** is moved to the advancement direction x, the front end of such plunger **4** supported by a guiding groove **15** of the slider **3** is caused to abut against the outer edge of the optical part **6** (FIGS. **11**A and **11**B). The supporting portion **7** pushed up by the first abutting portion **21** is thus caused to deform along the plunger **4** in a manner such that a front end of the supporting portion **7** eventually points to the advancement direction x. In this way, a front end of the supporting portion **7** deformed due to the first abutting portion **21**, is tucked into the surface of the valley-folded optical part **6**.

Next, by further moving the plunger **4** to the advancement direction x, the intraocular lens **5** is moved from the transition section **10** to a nozzle section **11** (FIGS. **12**A and **12**B), followed by being released to the outside from a front end of the nozzle section **11** with the intraocular lens **5** itself being folded even smaller.

Due to the aforementioned structure of the present embodiment, the present embodiment, as is the case in the first embodiment, allows the motion of the rear supporting portion **7***a* to be appropriately regulated during the process of moving the intraocular lens **5**, and reduces the possibility of reoperation being required after the intraocular lens **5** is inserted into the eye.

3. Third Embodiment

As shown in FIG. **13**, a slider **40** of the present embodiment includes a first abutting portion **21**, second abutting portions **22***a*, **22***b* and a guiding portion **41** for guiding the optical part **6** to the second abutting portion **22***b*. The second abutting portion **22***b* is provided on a location opposite to the connecting portion of the rear supporting portion **7***a* and the optical part **6**, and is configured to be able to abut against the optical part **6** or the outer edge thereof. Further, the second abutting portion **22***b* has an x-direction abutting surface **24** and a y-direction abutting surface **25**. In contrast, the second abutting portion **22***a* only has the x-direction abutting surface **24**.

Here, the y-direction abutting surface **25** of the second abutting portion **22***b* may be arranged substantially on the same plane as restriction portions **23**, or beyond the restriction portions **23** in the direction y. According to the present embodiment, the y-direction abutting surface **25** is arranged on the same plane as the restriction portions **23**.

The guiding portion **41** has a slanting surface slanting toward a direction between the advancement direction x and an opposite direction of the direction y. A lower end of the guiding portion **41** is communicated with the y-direction abutting surface **25**. Here, a plunger having a shape shown in FIG. **14** can be used as a plunger **44**.

Next, there are described an operation and effect of the slider **40** having the aforementioned structure. The intraocular lens **5** is placed in a lens placement section (not shown) in a manner such that the optical part **6** thereof is arranged in parallel with the lens advancement axis A (FIGS. **15**A and **15**B). The slider **40** is at first moved to the advancement direction x in order to release such intraocular lens **5** to the outside from a front end of a nozzle section **11**. As a result, the first abutting portion **21** formed on a front end of the slider **40** is caused to abut against the rear supporting portion **7***a* (FIGS. **16**A and **16**B).

Since the first abutting portion **21** has a slanting surface, the rear supporting portion **7***a* is pushed up therealong as the slider **40** is further moved to the advancement direction x (FIGS. **17**A and **17**B). At the same time, the guiding portion **41** serves to push down a surface of the optical part **6** to the direction y, thereby guiding the corresponding optical part **6** to the second abutting portion **22***b*. As a result, the x-direction abutting surface **24** of the second abutting portion **22***b* and the x-direction abutting surface **24** of the second abutting portion **22***a* are caused to abut against and then push out the optical part **6**, thus allowing the intraocular lens **5** to be moved from the lens placement section to a transition section **10**.

Here, the slider **40** allows the optical part **6** to be guided to the second abutting portion **22***b* by means of the guiding portion **41**, thereby causing the second abutting portion **22***b* to further reliably abut against the optical part **6**, and thus allowing the intraocular lens **5** to be further reliably pushed out.

In this way, the outer edge of the optical part **6** is pushed by an inner wall of the transition section **10**. Further, at that time, a lens pressing member **18** is also pushed by the inner wall of the transition section **10**, thus pushing down the surface of the optical part **6** to the direction y. As a result, the optical part **6** of the intraocular lens **5** is valley folded.

Next, as the plunger **44** is moved to the advancement direction x, the front end of such plunger **44** supported by a guiding groove **15** of the slider **40** is caused to abut against the outer edge of the optical part **6** (FIGS. **18**A and **18**B). The rear supporting portion **7***a* pushed up by the first abutting portion **21** is thus caused to deform along the plunger **44** in a manner such that a front end of the rear supporting portion **7***a* eventually points to the advancement direction x. In this way, the front end of the rear supporting portion **7***a* deformed due to the first abutting portion **21**, is enclosed by the valley-folded surface of the optical part **6**.

Here, the y-direction abutting surface **25** of the second abutting portion **22***b* is configured to restrict the surface of the optical part **6** in the vicinity of the outer edge thereof from being valley folded, thereby preventing the outer edge

of the optical part **6** from interfering with the rear supporting portion **7***a* during the deformation process of the rear supporting portion **7***a*.

Particularly, according to the present embodiment, since the y-direction abutting surface **25** is arranged on the same plane as the restriction portions **23**, the outer edge of the optical part **6** is restricted from deforming to the opposite direction of the direction y, particularly, from deforming beyond the restriction portions **23** and the rear supporting portion **7***a* deformed due to the first abutting portion **21**. In this sense, the slider **40** can further reliably prevent the outer edge of the optical part **6** from interfering with the rear supporting portion **7***a*, thereby allowing the intraocular lens **5** to be further reliably deformed into the given shape.

Next, by further moving the plunger **44** to the advancement direction x, the intraocular lens **5** is moved from a transition section **10** to a nozzle section **11** (FIGS. **19**A and **19**B), followed by being released to the outside from a front end of the nozzle section **11** with the intraocular lens **5** itself being folded even smaller.

Since the slider **40** of the present embodiment includes the first abutting portion **21** and the restriction portions **23**, there can be achieved the same effects as those of the first embodiment.

4. Modified Embodiment

The present invention is not limited to the aforementioned embodiments. As a matter of fact, appropriate modifications are possible within the scope of the gist of the present invention. For example, in each one of the aforementioned embodiments, there are provided two second abutting portions in total. However, the present invention is not limited to this configuration. Particularly, the number of the second abutting portions can be one, three or more than three.

Further, in each one of the aforementioned embodiments, the second abutting portions **22** are provided as a symmetrical pair. However, the present invention is not limited to this configuration. The second abutting portions **22** can actually be provided in an asymmetrical manner. For example, one of the second abutting portions **22** may be formed longer than the other second abutting portion **22** in the advancement direction x, thereby making it possible to slightly rotate the intraocular lens **5** about an optical axis, and thus making it easier to regulate a supporting portion disposed forward.

DESCRIPTION OF SYMBOLS

1 intraocular lens insertion device q
2 main body
3 slider
4 plunger
5 intraocular lens
6 optical part
7 supporting portion
7*a* rear supporting portion
21 first abutting portion
22 second abutting portion
x advancement direction
y direction (downward direction)
A lens advancement axis

The invention claimed is:

1. A method for use with an intraocular lens, including an optic, a forward haptic having an end and a rear haptic having an end, that is located within an insertion device defining a lens travelling axis and including a nozzle, a transition section and a plunger that moves forwardly toward the nozzle and includes a forward region with a side wall and a bottom wall that together define a slot that extends rearwardly and is configured to receive a portion of the rear haptic, the method comprising the steps of:

pushing the end of the rear haptic upwardly and forwardly relative to the optic;

pushing the end of the rear haptic over the optic, while the portion of the optic over which the rear haptic passes remains unfolded, with the forward region of the plunger such that a portion of the rear haptic is bent and received in the slot that extends rearwardly;

folding the optic such that there is a space between folded portions of the optic; and

pushing the intraocular lens through the nozzle with the forward region of the plunger while the end of the rear haptic is in the space between the folded portions of the optic.

2. A method as claimed in claim **1**, wherein

the insertion device includes a slider that is movable relative to the plunger; and

pushing the end of the rear haptic upwardly and forwardly comprises pushing the end of the rear haptic upwardly and forwardly relative to the optic with the slider.

3. A method as claimed in claim **1**, wherein

the insertion device includes a slider with an abutting portion that is slanted relative to the lens travelling axis and that is movable relative to the plunger; and

pushing the end of the rear haptic upwardly and forwardly comprises pushing the end of the rear haptic upwardly and forwardly relative to the optic with the abutting portion of the slider.

4. A method as claimed in claim **1**, wherein

folding the optic comprises folding the optic with the transition section.

5. A method as claimed in claim **1**, wherein

the insertion device includes a slider that is movable relative to the plunger; and

folding the optic comprises pushing the optic into the transition section with the slider to fold the optic.

6. A method as claimed in claim **5**, wherein

the slider includes a pivotable lens pressing member; and

folding the optic comprises pushing the optic into the transition section while the pivotable lens pressing member engages a portion of the optic to fold the optic.

7. A method as claimed in claim **1**, wherein

the insertion device includes a slider that is movable relative to the plunger, the slider having a first abutting portion that is slanted relative to the lens travelling axis and a pair of second abutting portions located on opposite sides of the lens travelling axis;

pushing the end of the rear haptic upwardly and forwardly comprises pushing the end of the rear haptic upwardly and forwardly relative to the optic with the first abutting portion of the slider before the second abutting portions contact the optic; and

folding the optic comprises pushing the optic into the transition section with the second abutting portions to fold the optic.

8. A method as claimed in claim **1**, wherein

pushing the intraocular lens through the nozzle comprises pushing the intraocular lens through the nozzle with the forward region of the plunger while the end of the rear haptic is in the space between the folded portions of the optic and the end of the rear haptic faces in a lens travelling direction.

9. A method as claimed in claim **1**, further comprising the step of:

pushing the end of the forward haptic into the space between the folded portions of the optic.

10. A method as claimed in claim **1**, further comprising the step of:

prior to pushing the end of the rear haptic upwardly and forwardly relative to the optic, storing the lens in the insertion device with the optic parallel to the lens travelling axis and the rear haptic positioned at a different angle than the forward haptic relative to the lens travelling axis.

11. A method as claimed in claim **1**, wherein:

pushing the end of the rear haptic upwardly and forwardly comprises pushing the end of the rear haptic upwardly and forwardly relative to the optic while the end of the rear haptic is on a surface that is not parallel to the lens travelling axis.

12. A method performed by an insertion device, including a nozzle, a plunger that moves forwardly toward the nozzle and a transition section and defining a lens travelling axis, on an intraocular lens including an optic, a forward haptic having an end and a rear haptic having an end, the method comprising the steps of:

folding the optic with the insertion device such that there is a space between folded portions of the optic;

moving the end of the rear haptic over the optic and into the space between the folded portions of the optic with the plunger;

moving the end of the forward haptic into the space between the folded portions of the optic with the insertion device; and

pushing the intraocular lens with the plunger through the nozzle with the ends of the forward and rear haptics in the space between the folded portions of the optic.

13. A method as claimed in claim **12**, wherein

folding the optic comprises folding the optic with the transition section of the insertion device.

14. A method as claimed in claim **12**, wherein

the insertion device includes a slider and the plunger is movable relative to the slider; and

moving the end of the rear haptic further includes pushing the end of the rear haptic upwardly and forwardly relative to the optic with the slider.

15. A method as claimed in claim **12**, wherein

moving the end of the forward haptic comprises bending the end of the forward haptic into the space between the folded portions of the optic with an inner surface of the transition section as the intraocular lens moves toward the nozzle.

16. A method as claimed in claim **12**, further comprising the step of:

prior to folding the optic such that there is a space is between folded portions of the optic, pushing the end of the rear haptic with the insertion device upwardly and forwardly relative to the optic.

* * * * *

EXHIBIT 4

US009877826B2

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

(10) **Patent No.: US 9,877,826 B2**
(45) **Date of Patent: *Jan. 30, 2018**

(54) **INTRAOCULAR LENS INSERTION DEVICE**

(71) Applicant: **Hoya Corporation**, Tokyo (JP)

(72) Inventors: **Kazunori Kudo**, Saku (JP); **Masahiro Noda**, Toda (JP)

(73) Assignee: **Hoya Corporation**, Tokyo (JP)

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

This patent is subject to a terminal disclaimer.

(21) Appl. No.: **15/600,679**

(22) Filed: **May 19, 2017**

(65) **Prior Publication Data**

US 2017/0252149 A1 Sep. 7, 2017

Related U.S. Application Data

(63) Continuation of application No. 14/099,989, filed on Dec. 8, 2013, now Pat. No. 9,655,718, which is a (Continued)

(30) **Foreign Application Priority Data**

Jan. 7, 2009 (JP) 2009-001493

(51) **Int. Cl.**
A61F 2/16 (2006.01)

(52) **U.S. Cl.**
CPC ***A61F 2/167*** (2013.01); ***A61F 2/1672*** (2013.01)

(58) **Field of Classification Search**
CPC A61F 2/167; A61F 2/1662; A61F 2/1672; A61F 2/1675; A61F 2/1678; A61F 2/14; A61F 2/16
(Continued)

(56) **References Cited**

U.S. PATENT DOCUMENTS

2,761,446 A 9/1956 Reed
4,205,747 A 6/1980 Gilliam et al.
(Continued)

FOREIGN PATENT DOCUMENTS

DE 3610925 10/1987
DE 4110278 10/1992
(Continued)

OTHER PUBLICATIONS

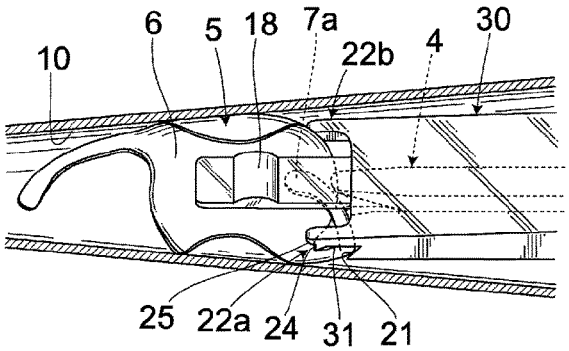
PCT International Search Report dated Feb. 2, 2010 for PCT App. Ser. No. PCT/JP2010/050029.
(Continued)

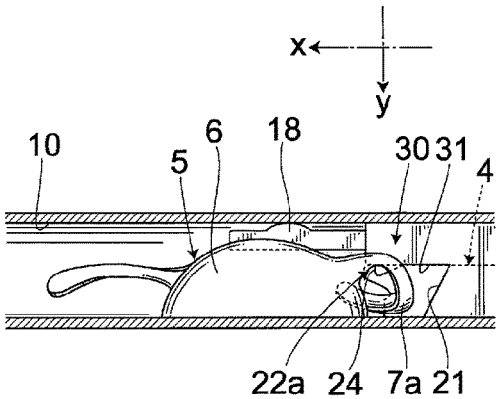
Primary Examiner — Kathleen Holwerda
Assistant Examiner — Socrates L Boutsikaris
(74) *Attorney, Agent, or Firm* — Henricks, Slavin & Holmes LLP

(57) **ABSTRACT**

There is provided an intraocular lens insertion device capable of appropriately regulating the motion of a rear supporting portion during a process of moving an intraocular lens, and reducing the possibility of reoperation being required after the intraocular lens is inserted into an eye. An intraocular lens insertion device **1** comprises a main body **2**, and a slider **3** and a plunger **4** that are attached to the main body **2**. Further, the intraocular lens insertion device **1** is of a preset type in which an intraocular lens **5** is placed inside the main body **2** in advance. The slider **3** includes a first abutting portion **21** for pushing up a supporting portion **7** (rear supporting portion **7***a*) arranged on a rear side of an optical part **6** with respect to a lens advancement axis A, and second abutting portions **22***a*, **22***b* abutting against an outer edge of a rear portion of the optical part **6**.

16 Claims, 9 Drawing Sheets





Related U.S. Application Data

continuation of application No. 13/143,322, filed as application No. PCT/JP2010/050029 on Jan. 5, 2010, now Pat. No. 8,603,103.

(58) **Field of Classification Search**
USPC 606/107; 623/6.12
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

4,269,307	A	5/1981	LaHaye
4,423,809	A	1/1984	Mazzocco
4,573,998	A	3/1986	Mazzocco
4,608,049	A	8/1986	Kelman
4,634,423	A	1/1987	Bailey
4,681,102	A	7/1987	Bartell
4,697,697	A	10/1987	Graham et al.
4,699,140	A	10/1987	Holmes
4,702,244	A	10/1987	Mazzocco
4,715,373	A	12/1987	Mazzocco et al.
4,747,404	A	5/1988	Jampel et al.
4,750,498	A	6/1988	Graham
4,759,359	A	7/1988	Willis et al.
4,763,650	A	8/1988	Hauser
4,765,329	A	8/1988	Cumming et al.
4,769,034	A	9/1988	Poley
4,781,719	A	11/1988	Kelman
4,787,904	A	11/1988	Severin
4,810,249	A	3/1989	Haber et al.
4,819,631	A	4/1989	Poley
4,834,094	A	5/1989	Patton
4,836,201	A	6/1989	Patton
4,862,885	A	9/1989	Cumming
4,880,000	A	11/1989	Holmes et al.
4,919,130	A	4/1990	Stoy et al.
4,934,363	A	6/1990	Smith et al.
4,955,889	A	9/1990	Van Gent
4,976,716	A	12/1990	Cumming
4,988,352	A	1/1991	Poley
4,994,028	A	2/1991	Leonard et al.
5,066,297	A	11/1991	Cumming
5,098,439	A	3/1992	Hill et al.
5,123,905	A	6/1992	Kelman
5,139,501	A	8/1992	Klaas
5,171,241	A	12/1992	Buboltz et al.
5,176,686	A	1/1993	Poley
5,190,552	A	3/1993	Kelman
5,190,553	A	3/1993	Kanert et al.
5,222,972	A	6/1993	Hill et al.
5,242,450	A	9/1993	McDonald
5,259,395	A	11/1993	Li
5,275,604	A	1/1994	Rheinish et al.
5,281,227	A	1/1994	Sussman
5,304,182	A	4/1994	Rheinish et al.
5,354,333	A	10/1994	Kammann et al.
5,395,378	A	3/1995	McDonald
5,425,734	A	6/1995	Blake
5,454,818	A	10/1995	Hambleton et al.
5,468,246	A	11/1995	Blake
5,474,562	A	12/1995	Orchowski et al.
5,494,484	A	2/1996	Feingold
5,496,328	A	3/1996	Nakajima et al.
5,499,987	A	3/1996	Feingold
5,562,676	A	10/1996	Brady et al.
5,571,113	A	11/1996	McDonald
5,578,042	A	11/1996	Cumming
5,582,613	A	12/1996	Brady
5,582,614	A	12/1996	Feingold
5,584,304	A	12/1996	Brady
5,616,148	A	4/1997	Eagles et al.
5,620,450	A	4/1997	Eagles et al.
5,643,275	A	7/1997	Blake
5,643,276	A	7/1997	Zaleski
5,645,534	A	7/1997	Chanoch
5,653,715	A	8/1997	Reich et al.
5,653,753	A	8/1997	Brady et al.
5,702,402	A	12/1997	Brady
5,702,441	A	12/1997	Zhou
5,716,364	A	2/1998	Makker et al.
5,728,075	A	3/1998	Levander
5,728,102	A	3/1998	Feingold et al.
5,735,858	A	4/1998	Makker et al.
5,766,181	A	6/1998	Chambers et al.
5,772,666	A	6/1998	Feingold et al.
5,772,667	A	6/1998	Blake
5,776,138	A	7/1998	Vidal et al.
5,800,442	A	9/1998	Wolf et al.
5,803,925	A	9/1998	Yang et al.
5,807,400	A	9/1998	Chambers et al.
5,810,833	A	9/1998	Brady et al.
5,810,834	A	9/1998	Heyman
5,860,984	A	1/1999	Chambers et al.
5,860,986	A	1/1999	Reich et al.
5,868,751	A	2/1999	Feingold
5,868,752	A	2/1999	Makker et al.
5,873,879	A	2/1999	Figueroa et al.
5,876,406	A	3/1999	Wolf et al.
5,876,407	A	3/1999	Makker et al.
5,876,440	A	3/1999	Feingold
5,891,152	A	4/1999	Feingold
5,902,307	A	5/1999	Feingold et al.
5,919,197	A	7/1999	McDonald
5,921,989	A	7/1999	Deacon et al.
5,928,245	A	7/1999	Wolf et al.
5,941,886	A	8/1999	Feingold
5,942,277	A	8/1999	Makker et al.
5,944,725	A	8/1999	Cicenas
5,947,974	A	9/1999	Brady et al.
5,947,975	A	9/1999	Kikuchi et al.
5,957,748	A	9/1999	Ichiha
5,957,896	A	9/1999	Bendek et al.
6,001,107	A	12/1999	Feingold
6,010,510	A	1/2000	Brown et al.
6,022,358	A	2/2000	Wolf et al.
6,048,348	A	4/2000	Chambers et al.
6,051,000	A	4/2000	Heyman
6,056,757	A	5/2000	Feingold et al.
6,056,758	A	5/2000	Vidal et al.
6,059,791	A	5/2000	Chambers
6,074,397	A	6/2000	Chambers et al.
6,083,230	A	7/2000	Makker et al.
6,093,193	A	7/2000	Makker et al.
6,129,733	A	10/2000	Brady et al.
6,142,999	A	11/2000	Brady et al.
6,143,000	A	11/2000	Feingold
6,162,229	A	12/2000	Feingold et al.
6,174,315	B1	1/2001	Chambers et al.
6,214,015	B1	4/2001	Reich et al.
6,241,737	B1	6/2001	Feingold
6,248,111	B1	6/2001	Glick et al.
6,251,114	B1	6/2001	Farmer et al.
6,254,607	B1	7/2001	Makker et al.
6,267,768	B1	7/2001	Deacon
6,283,975	B1	9/2001	Glick et al.
6,283,976	B1	9/2001	Portney
6,312,433	B1	11/2001	Butts
6,334,862	B1	1/2002	Vidal et al.
6,336,932	B1	1/2002	Figueroa et al.
6,355,046	B2	3/2002	Kikuchi et al.
6,371,960	B2	4/2002	Heyman et al.
6,386,357	B1	5/2002	Egawa
6,387,101	B1	5/2002	Butts et al.
6,398,788	B1	6/2002	Makker et al.
6,406,481	B2	6/2002	Feingold et al.
6,428,545	B2	8/2002	Portney
6,447,519	B1	9/2002	Brady et al.
6,447,520	B1	9/2002	Ott et al.
6,468,282	B2	10/2002	Kikuchi et al.
6,471,708	B2	10/2002	Green
6,491,697	B1	12/2002	Clark et al.
6,497,708	B1	12/2002	Cumming
6,500,181	B1	12/2002	Portney
6,506,195	B2	1/2003	Chambers et al.
6,537,283	B2	3/2003	Van Noy

(56) **References Cited**

U.S. PATENT DOCUMENTS

6,540,754	B2	4/2003	Brady
6,554,839	B2	4/2003	Brady
6,558,395	B2	5/2003	Hjertman et al.
6,605,093	B1	8/2003	Blake
6,607,537	B1	8/2003	Binder
6,629,979	B1	10/2003	Feingold
6,666,871	B2	12/2003	Kikuchi et al.
6,679,891	B2	1/2004	Makker et al.
6,685,740	B2	2/2004	Figueroa et al.
6,712,848	B1	3/2004	Wolf et al.
6,723,104	B2	4/2004	Ott
6,733,507	B2	5/2004	McNicholas et al.
6,793,674	B2	9/2004	Zapata
6,858,033	B2	2/2005	Kobayashi
6,921,405	B2	7/2005	Feingold et al.
6,923,815	B2	8/2005	Brady et al.
6,976,989	B1	12/2005	Vincent
7,014,641	B2	3/2006	Kobayashi et al.
7,025,782	B2	4/2006	Kobayashi et al.
7,033,366	B2	4/2006	Brady
7,037,312	B2	5/2006	Kikuchi et al.
7,074,227	B2	7/2006	Portney
7,097,649	B2	8/2006	Meyer
7,131,976	B2	11/2006	Kobayashi et al.
7,156,854	B2	1/2007	Brown et al.
7,348,038	B2	3/2008	Makker et al.
7,422,604	B2	9/2008	Vaquero et al.
7,429,263	B2	9/2008	Vaquero et al.
7,458,976	B2	12/2008	Peterson et al.
7,476,230	B2	1/2009	Ohno et al.
7,494,505	B2	2/2009	Kappelhof et al.
7,645,300	B2	1/2010	Tsai
8,273,122	B2	9/2012	Anderson
8,382,769	B2	2/2013	Inoue
8,460,311	B2	6/2013	Ishii
8,470,032	B2	6/2013	Inoue et al.
8,475,528	B2	7/2013	Ichinohe et al.
8,523,877	B2	9/2013	Ichinohe et al.
8,523,941	B2	9/2013	Ichinohe et al.
8,535,375	B2	9/2013	Ichinohe et al.
8,545,512	B2	10/2013	Ichinohe et al.
8,574,239	B2	11/2013	Ichinohe et al.
8,603,103	B2	12/2013	Kudo et al.
8,647,382	B2	2/2014	Kudo et al.
8,702,795	B2	4/2014	Shoji et al.
8,747,465	B2	6/2014	Someya et al.
8,968,328	B2	3/2015	Ichinohe et al.
9,114,006	B2	8/2015	Inoue
9,114,007	B2	8/2015	Ichinohe et al.
9,186,246	B2	11/2015	Inoue
9,220,593	B2	12/2015	Ichinohe
9,289,288	B2	3/2016	Someya et al.
9,314,373	B2	4/2016	Kudo et al.
9,326,847	B2	5/2016	Sanger
9,364,320	B2	6/2016	Ichinohe et al.
9,554,894	B2	1/2017	Inoue
9,572,710	B1	2/2017	Kudo et al.
9,655,718	B2	5/2017	Kudo et al.
2001/0007942	A1	7/2001	Kikuchi et al.
2002/0103490	A1	8/2002	Brady
2002/0151904	A1	10/2002	Feingold et al.
2002/0165610	A1	11/2002	Wadlaock
2002/0193805	A1	12/2002	Ott et al.
2003/0036765	A1	2/2003	Van Noy
2003/0040755	A1	2/2003	Meyer
2003/0050647	A1	3/2003	Brady
2003/0088253	A1	5/2003	Seil
2003/0139749	A1	7/2003	Kikuchi et al.
2003/0181921	A1	9/2003	Jeannin
2003/0195522	A1	10/2003	McNicholas
2003/0212406	A1	11/2003	Kobayashi et al.
2003/0212407	A1	11/2003	Kikuchi
2003/0212409	A1	11/2003	Kobayashi et al.
2004/0111094	A1	6/2004	Meyer
2004/0117012	A1	6/2004	Vincent
2004/0127911	A1	7/2004	Figueroa
2004/0186428	A1	9/2004	Ray
2004/0238392	A1	12/2004	Peterson et al.
2004/0243141	A1	12/2004	Brown et al.
2005/0033308	A1	2/2005	Callahan et al.
2005/0049605	A1	3/2005	Vaquero et al.
2005/0049606	A1	3/2005	Vaquero et al.
2005/0055011	A1	3/2005	Enggaard
2005/0125000	A1	6/2005	Tourrette et al.
2005/0143750	A1	6/2005	Vaquero
2005/0182419	A1	8/2005	Tsai
2005/0222578	A1	10/2005	Vaquero
2005/0261703	A1	11/2005	Feingold et al.
2006/0085013	A1	4/2006	Dusek
2006/0142781	A1	6/2006	Pynson et al.
2006/0167466	A1	7/2006	Dusek
2006/0200167	A1	9/2006	Peterson et al.
2006/0229633	A1	10/2006	Shepherd
2006/0235429	A1	10/2006	Lee et al.
2006/0293694	A1	12/2006	Futamura
2007/0005135	A1	1/2007	Makker et al.
2008/0033449	A1	2/2008	Cole et al.
2008/0058830	A1*	3/2008	Cole A61F 2/1664 606/107
2008/0086146	A1	4/2008	Ishii et al.
2008/0097459	A1	4/2008	Kammerlander et al.
2008/0221584	A1	9/2008	Downer
2009/0036898	A1	2/2009	Ichinohe
2009/0043313	A1	2/2009	Ichinohe
2009/0112223	A1	4/2009	Downer et al.
2009/0125034	A1	5/2009	Pynson
2009/0138022	A1	5/2009	Tu et al.
2009/0204122	A1	8/2009	Ichinohe et al.
2009/0216244	A1	8/2009	Pynson
2009/0248031	A1	10/2009	Ichinohe
2010/0094309	A1	4/2010	Hboukhny et al.
2010/0106160	A1	4/2010	Tsai
2010/0161049	A1	6/2010	Inoue
2010/0185206	A1	7/2010	Ichinohe et al.
2010/0217273	A1	8/2010	Someya et al.
2010/0286704	A1	11/2010	Ichinohe et al.
2010/0331808	A1	12/2010	Py et al.
2011/0082463	A1	4/2011	Inoue
2011/0098717	A1	4/2011	Inoue
2011/0264101	A1	10/2011	Inoue et al.
2011/0270264	A1	11/2011	Shoji et al.
2011/0288557	A1	11/2011	Kudo et al.
2012/0022549	A1	1/2012	Someya et al.
2012/0071887	A1	3/2012	Ichinohe et al.
2013/0006259	A1	1/2013	Sanger
2013/0018460	A1	1/2013	Anderson
2013/0226193	A1	8/2013	Kudo et al.
2013/0245635	A1	9/2013	Inoue
2014/0081284	A1	3/2014	Ichinohe et al.
2014/0107660	A1	4/2014	Ichinohe et al.
2014/0114323	A1	4/2014	Kudo et al.
2014/0180299	A1	6/2014	Ichinohe et al.
2014/0180300	A1	6/2014	Ichinohe et al.
2014/0194890	A1	7/2014	Kudo et al.
2016/0113759	A1	4/2016	Inoue
2016/0193038	A1	7/2016	Kudo et al.
2016/0346077	A1	12/2016	Someya et al.
2017/0079772	A1	3/2017	Kudo
2017/0151056	A1	6/2017	Inoue
2017/0202662	A1	7/2017	Someya et al.
2017/0252150	A1	9/2017	Kudo et al.
2017/0258582	A1	9/2017	Kudo et al.

FOREIGN PATENT DOCUMENTS

EP	0363213		4/1990
EP	0727966		9/2003
EP	1832247	A1	9/2007
EP	1338254		12/2008
FR	2749752	A	12/1997
JP	63-197453	A	8/1988
JP	4-212350	A	8/1992
JP	5-103808		4/1993
JP	5-103809		4/1993

(56) **References Cited**

FOREIGN PATENT DOCUMENTS

JP	8-024282	A	1/1996
JP	8-505540		6/1996
JP	9-506285	A	6/1997
JP	11-113939	A	4/1999
JP	11-506357	A	6/1999
JP	2000-516487	A	12/2000
JP	2000-516488	A	12/2000
JP	2001-502563		2/2001
JP	2001-104347	A	4/2001
JP	2002-516709	A	6/2002
JP	2002-355268	A	12/2002
JP	2002-541912	A	12/2002
JP	2003-144480	A	5/2003
JP	3412106	B2	6/2003
JP	2003-210498	A	7/2003
JP	2003-325569	A	11/2003
JP	2003-325570	A	11/2003
JP	2003-325572	A	11/2003
JP	2004-024854	A	1/2004
JP	2004-188194	A	7/2004
JP	2004-351196	A	12/2004
JP	2006-181269	A	7/2006
JP	2006-297146	A	11/2006
JP	2006-333924	A	12/2006
JP	2006-333981	A	12/2006
JP	2007-503872	A	3/2007
JP	2007-152010	A	6/2007
JP	2007-181604	A	7/2007
JP	2007-526091	A	9/2007
JP	2008-521535	A	6/2008
JP	2008-212689	A	9/2008
JP	2014-050484	A	3/2014
WO	WO9407436	A1	4/1994
WO	WO9513022	A1	5/1995
WO	WO9628122	A1	9/1996
WO	WO9715253	A1	5/1997
WO	WO9812969	A1	4/1998
WO	WO9958086	A1	11/1999
WO	WO9959668	A1	11/1999
WO	WO0045746	A1	8/2000
WO	WO0062712	A1	10/2000
WO	WO2002071982	A1	9/2002
WO	WO2002096322	A1	12/2002
WO	WO2005023154	A1	3/2005
WO	WO2005070341	A1	8/2005
WO	WO2005084588	A1	9/2005
WO	WO2006070628	A1	7/2006
WO	WO2006080191	A1	8/2006
WO	WO2006090531	A1	8/2006
WO	WO2007037223	A1	4/2007
WO	WO2007097221	A1	4/2007
WO	WO2007080869	A1	7/2007
WO	WO2008149794	A1	12/2008
WO	WO2008149795	A1	12/2008
WO	WO2009058929	A1	7/2009
WO	WO2009148091	A1	12/2009
WO	WO2011126144	A1	10/2011
WO	WO2011155636	A1	12/2011

OTHER PUBLICATIONS

U.S. Appl. No. 15/608,895, filed May 30, 2017.
U.S. Appl. No. 15/600,679, filed May 19, 2017.
U.S. Appl. No. 15/600,684, filed May 19, 2017.

* cited by examiner

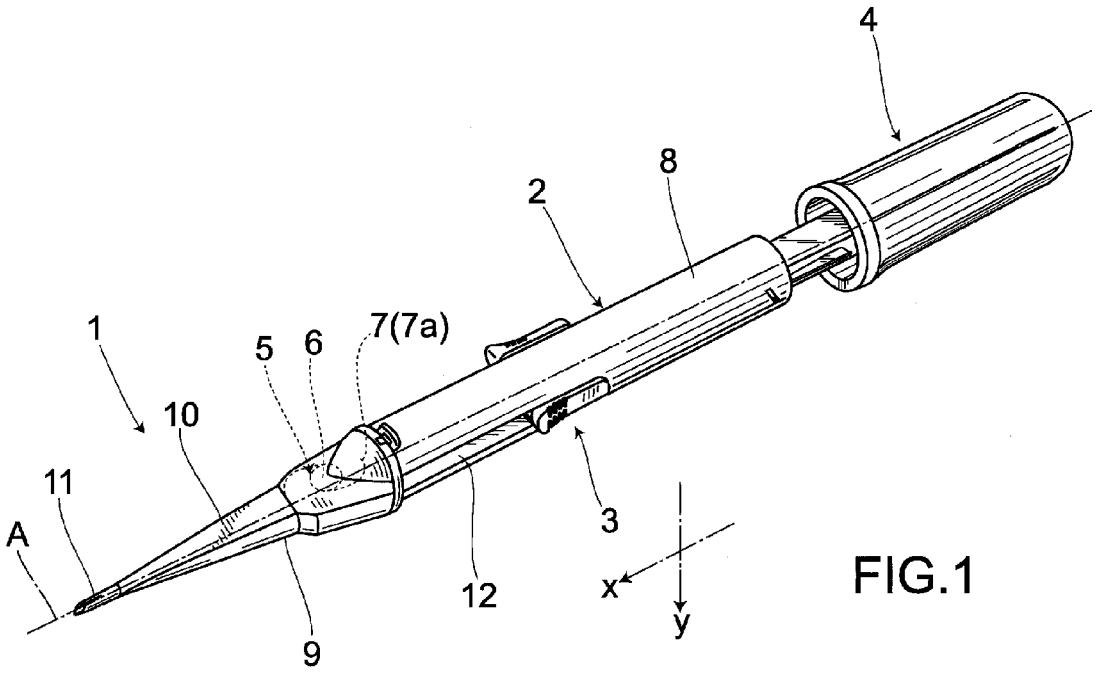


FIG.1

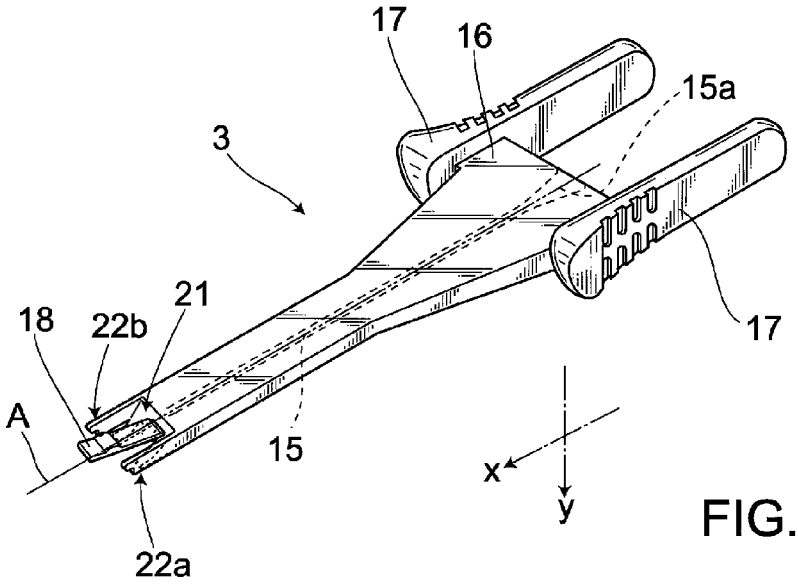


FIG.2

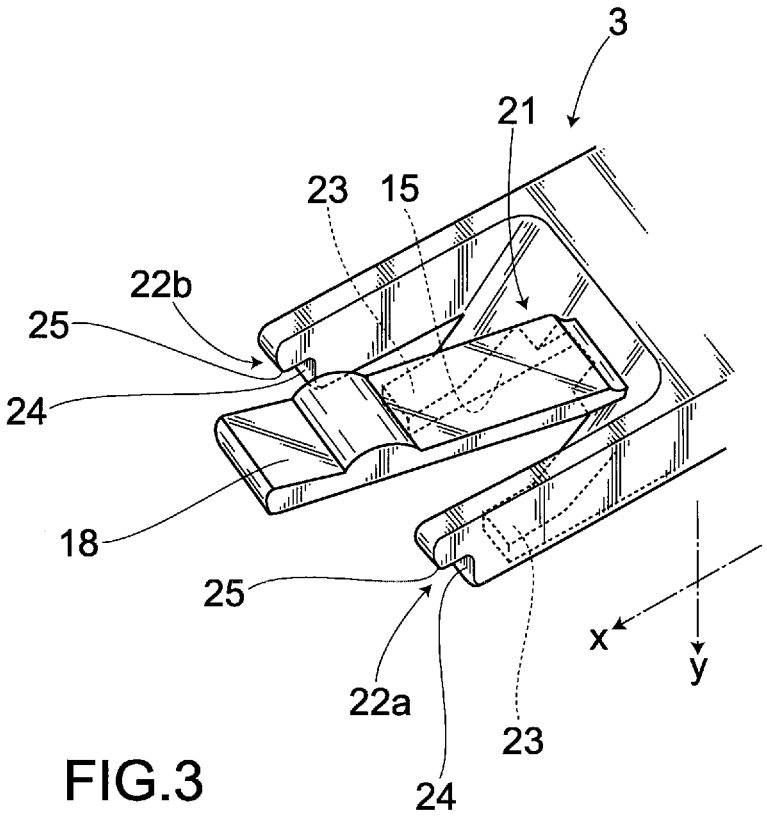


FIG.3

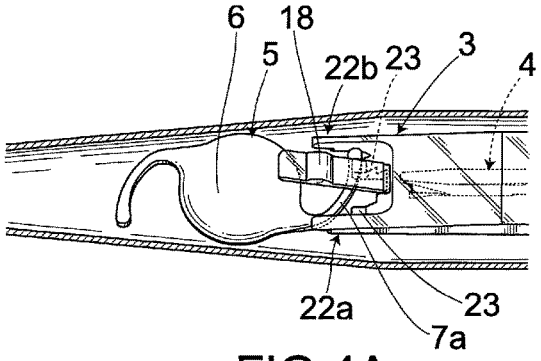


FIG.4A

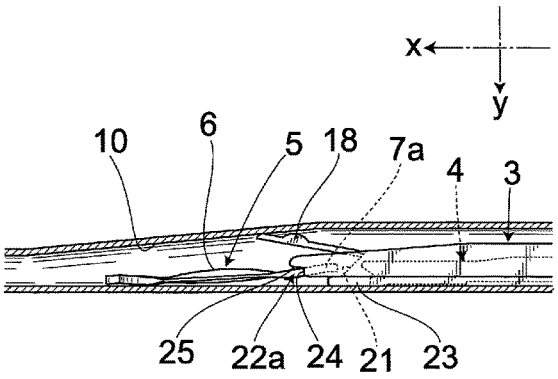


FIG.4B

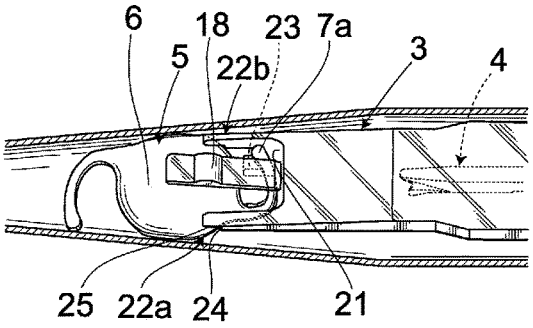


FIG.5A

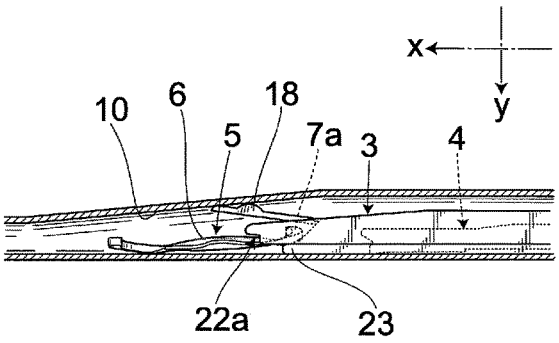


FIG.5B

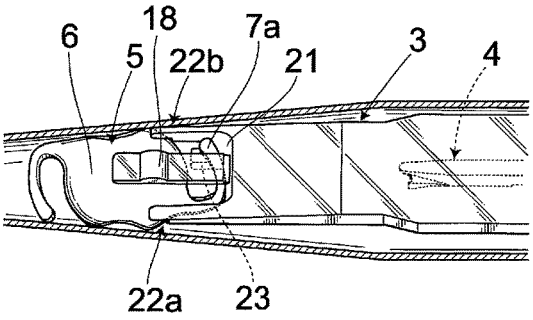


FIG.6A

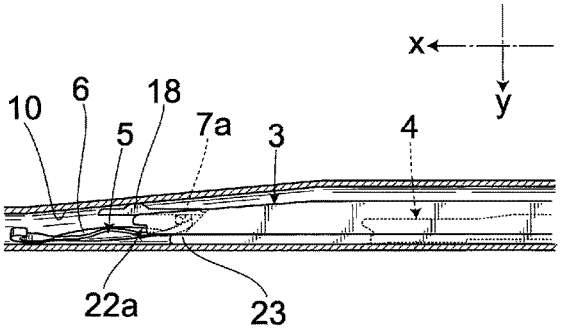


FIG.6B

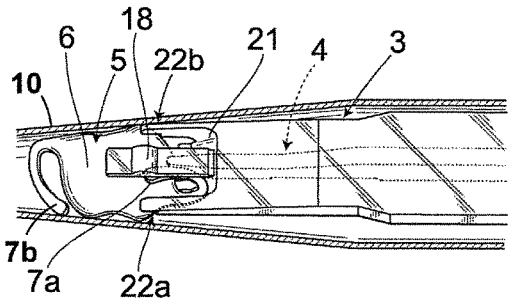


FIG.7A

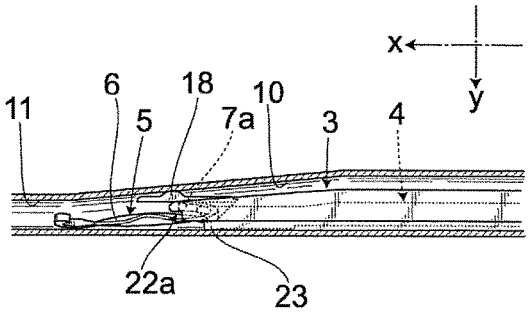


FIG.7B

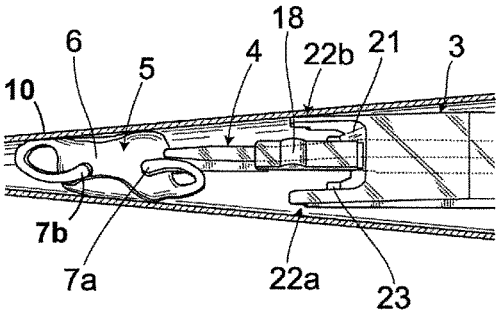


FIG.8A

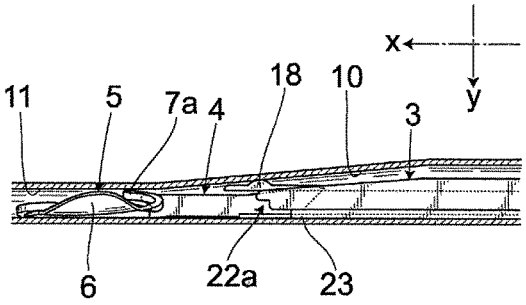


FIG.8B

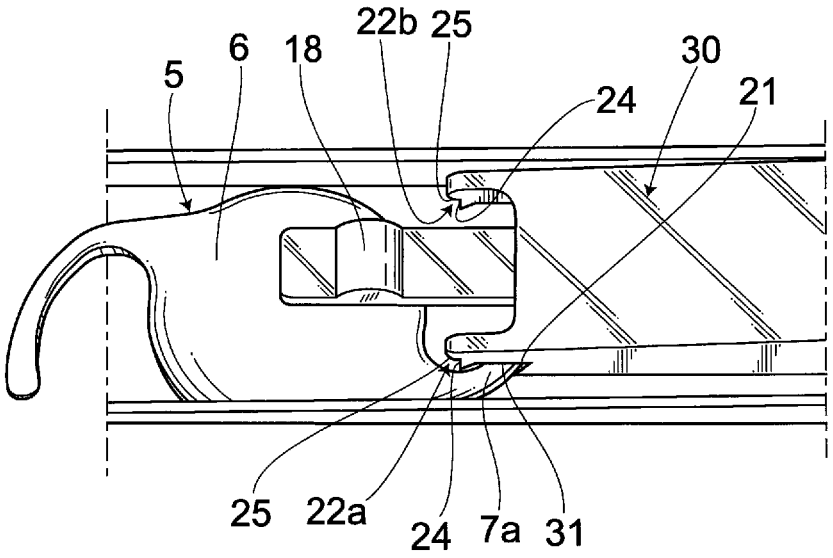


FIG.9

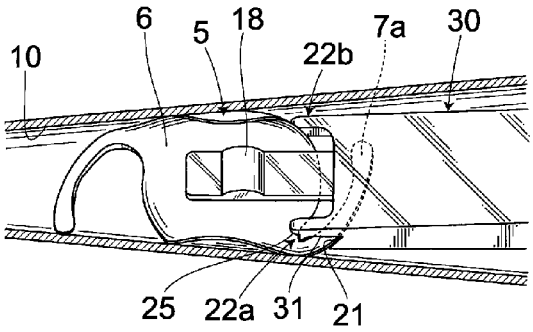


FIG.10A

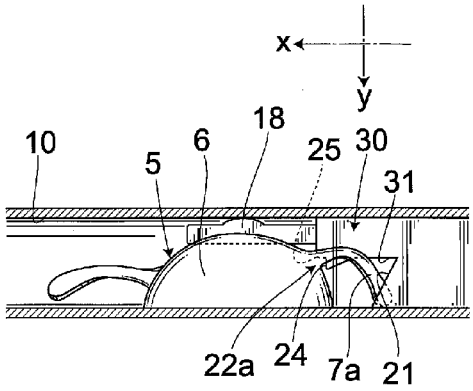


FIG.10B

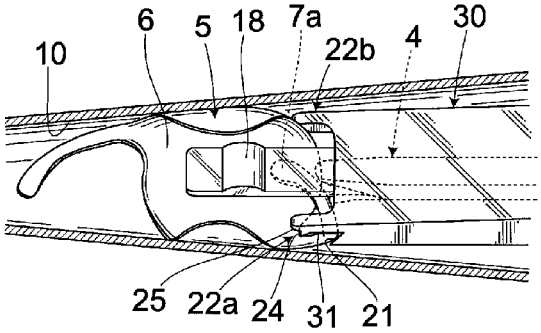


FIG.11A

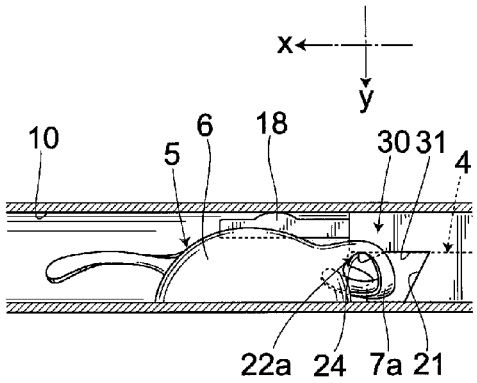


FIG.11B

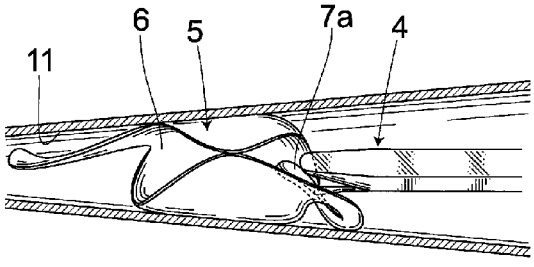


FIG.12A

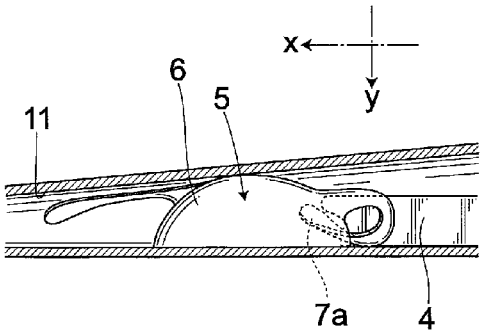


FIG.12B

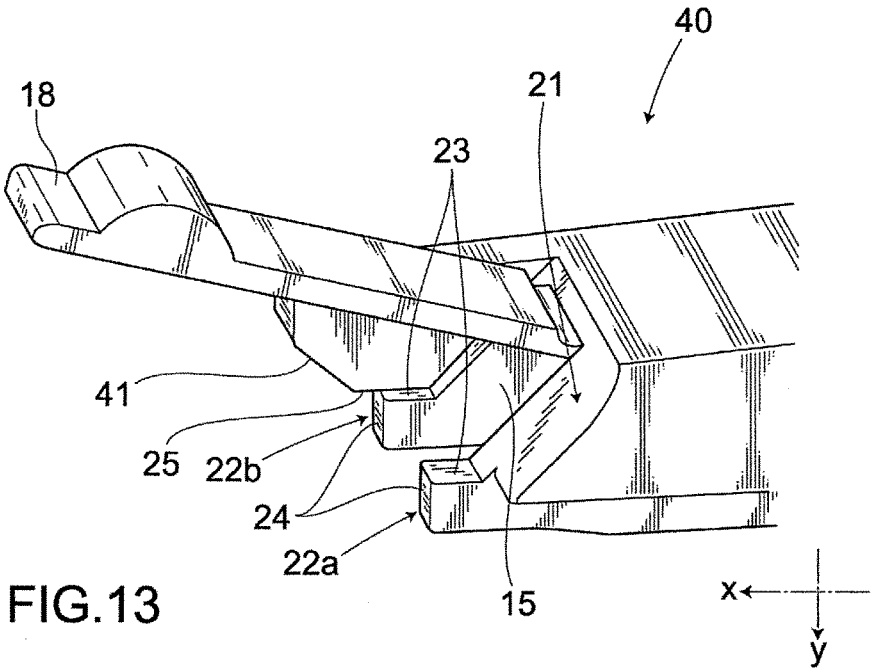


FIG.13

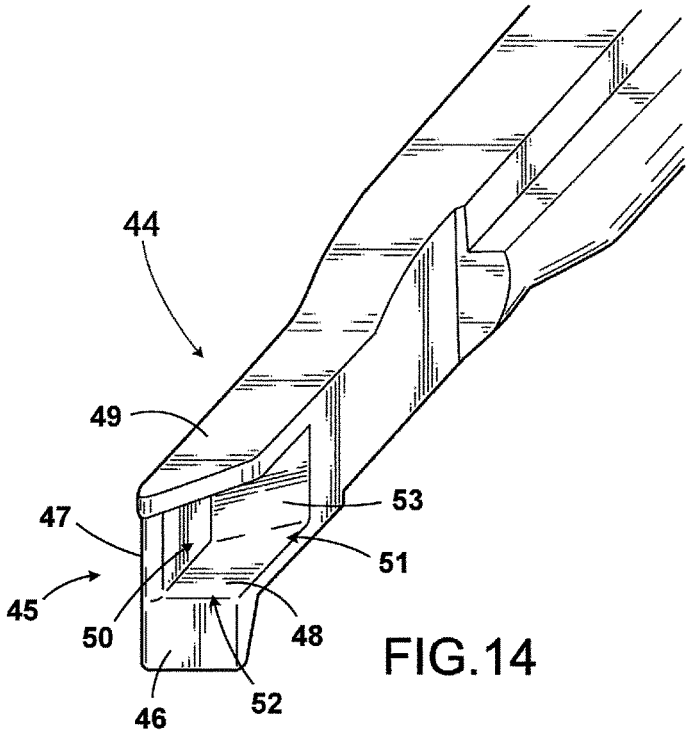


FIG.14

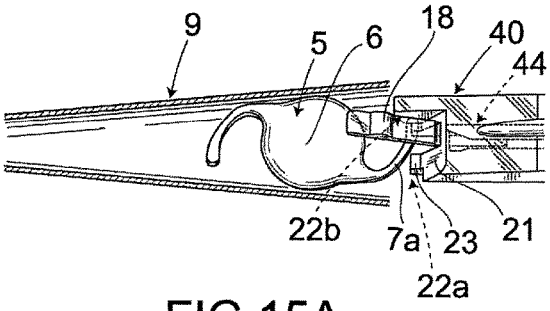


FIG.15A

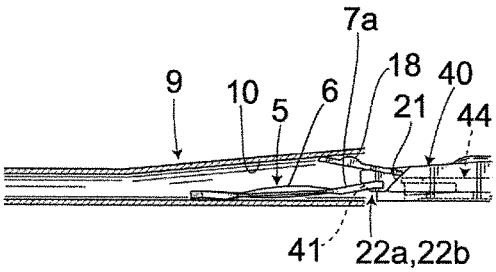


FIG.15B

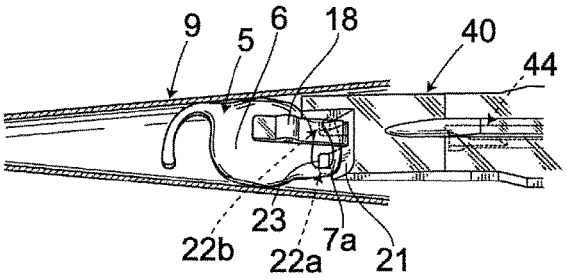


FIG.16A

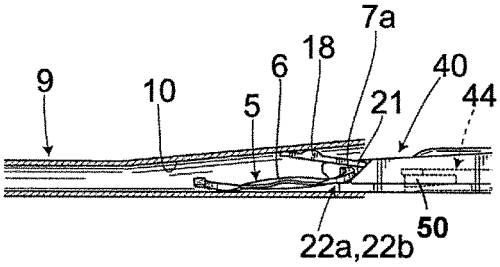


FIG.16B

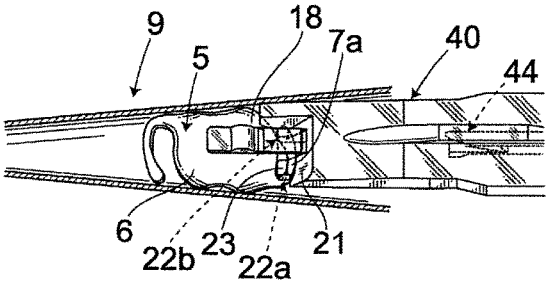


FIG.17A

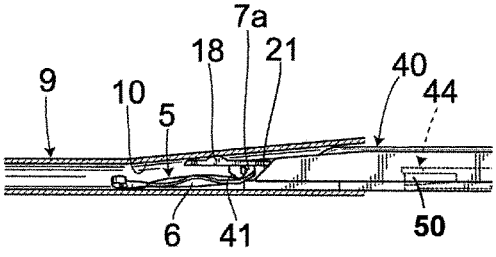


FIG.17B

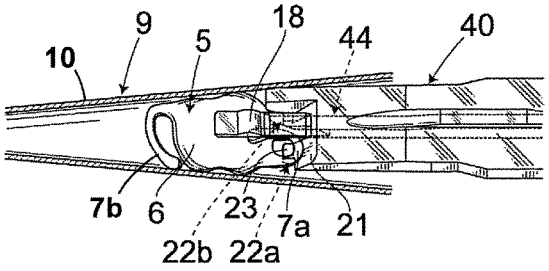


FIG.18A

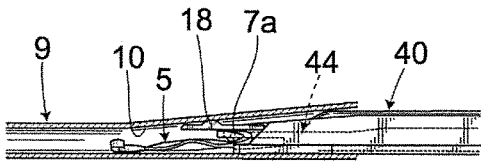


FIG.18B

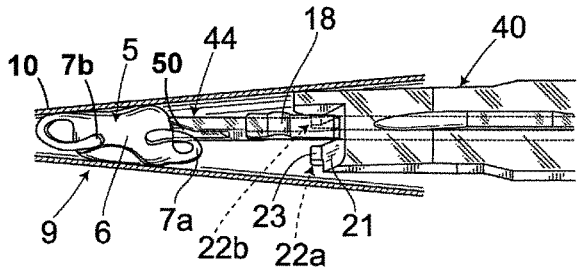


FIG.19A

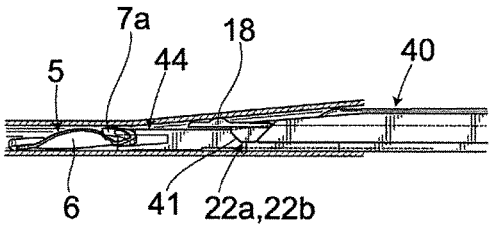


FIG.19B

INTRAOCULAR LENS INSERTION DEVICE

CROSS REFERENCE TO RELATED APPLICATIONS

This application is a continuation of U.S. application Ser. No. 14/099,989, filed Dec. 8, 2013, now U.S. Pat. No. 9,655,718, which is a continuation of U.S. application Ser. No. 13/143,322, filed Jul. 5, 2011, now U.S. Pat. No. 8,603,103, which is a U.S. national phase application under 35 U.S.C. §371 of International Patent Application No. PCT/JP2010/050029 filed Jan. 5, 2010, which claims priority to Japanese patent application No. 2009-001493, filed Jan. 7, 2009. The International Application was published in Japanese on Jul. 15, 2010 as International Publication No. WO 2010/079780A1. The content of each application is incorporated herein in its entirety.

TECHNICAL FIELD

The present invention relates to an intraocular lens insertion device for inserting an intraocular lens into an eyeball as a substitute of a crystalline lens exenterated through cataract surgery.

BACKGROUND ART

Cataract surgery often involves removing an opacified crystalline lens through phacoemulsification (PEA), and implanting an intraocular lens after the crystalline lens has been removed. Intraocular lenses include hard intraocular lenses whose optical parts are made of hard materials such as PMMA or the like, and soft intraocular lenses whose optical parts are made of soft materials such as silicon elastomer, soft acrylic, hydrogel or the like.

When inserting a hard intraocular lens, there has to be formed on the cornea or the sclera an incision substantially as wide as the diameter of the optical part of the corresponding hard intraocular lens. In contrast, a soft intraocular lens can be inserted through an incision smaller than the diameter of the optical part thereof by allowing the corresponding optical part to be folded.

An intraocular lens is preferably inserted through a small incision in order to reduce the possibilities of corneal astigmatism and infection after the surgery. In this sense, soft intraocular lenses tend to be preferred nowadays. Types of soft intraocular lens include: a soft intraocular lens having an optical part made of a soft material and supporting portions made of a hard material such as PMMA or the like (the supporting portions of this type of intraocular lens are usually two thin filamentary members); a soft intraocular lens whose optical part and supporting portions are made of a same soft material (the supporting portions of this type are usually plate members); or a soft intraocular lens employing a plurality of thin strips as supporting portions, and the like.

Further, in order to insert an intraocular lens into an eye, there has also been used a dedicated intraocular lens insertion device having a structure for introducing the intraocular lens into the eye through an elongated tube. This type of intraocular lens insertion device allows an intraocular lens to be inserted through an incision smaller than 3 mm.

Furthermore, in recent years, there has been developed a type of intraocular lens insertion device which has an intraocular lens placed therein in advance and can be packaged and stored, in order to exclude the possibilities of bacteria contamination and errors in operation at the time of handling the intraocular lens (e.g., patent document 1).

However, this type of intraocular lens insertion device may cause a supporting portion (referred to as a rear supporting portion, hereunder) arranged on a rear side with respect to a lens advancement axis to slip in between a plunger for pushing out the intraocular lens and a passage inner wall surface of the insertion device, or be tangled with the corresponding plunger, during a process of moving the intraocular lens. These problems are particularly noticeable with soft intraocular lenses employing thin filamentary members as supporting portions and intraocular lenses employing thin strips as supporting portions.

Further, this type of intraocular lens insertion device may cause the rear supporting portion to be stretched during the process of moving the intraocular lens. Accordingly, the corresponding rear supporting portion may then be left outside an eye ball at the time of performing insertion through a small incision on the eyeball, thereby requiring an additional operation for inserting such rear supporting portion into the eye ball after pushing out the intraocular lens with the plunger, and thus making the surgery troublesome.

In this sense, when using an intraocular lens insertion device to insert an intraocular lens into an eye, the motion of the rear supporting portion of the intraocular lens has to be appropriately regulated during the process of moving the intraocular lens.

In view of the aforementioned problems, there has been disclosed a device in which a clearance is formed on a front end side portion of a plunger, for allowing the rear supporting portion to be kept therein and thus preventing the same from being damaged (e.g., patent document 2). Further, there has been disclosed a device in which a rear supporting portion receiving passage for receiving the rear supporting portion is provided on a lower side portion of a plunger (e.g., patent document 3). Furthermore, there has also been disclosed a device in which the rear supporting portion is pushed up on a lump portion by means of a plunger, thereby allowing the corresponding haptic to be bended upward and eventually positioned higher than an IOL (e.g., patent document 4). Accordingly, all the devices disclosed in the aforementioned patent documents serve to reduce holding pressures applied to the rear supporting portions of intraocular lenses employing thin filaments or strips as supporting portions.

REFERENCE

Patent document 1: WO2007/037223
Patent document 2: Japanese Unexamined Patent Application Publication (Translation of PCT Application) No. 1999-506357
Patent document 3: U.S. Pat. No. 6,733,507
Patent document 4: Japanese Unexamined Patent Application Publication No. 2004-351196

DISCLOSURE OF THE INVENTION

Problem to be Solved by the Invention

However, according to the patent documents 2 and 3, the rear supporting portion received in the clearance formed on the front end side portion of the plunger and in the rear supporting portion receiving passage is stretched, thereby still incurring a problem in which the corresponding rear supporting portion may be left outside a small incision formed on an eye ball when inserting an intraocular lens therethrough. Particularly, with regard to intraocular lenses employing thin strips as supporting portions, reoperation is

often troublesome because the corresponding supporting portions are composed of soft members that are thick in sizes. Further, according to the patent document 4, the supporting portion is pushed by a small plunger front end matched to a nozzle front end with a small aperture diameter, thus causing the rear supporting portion to be compressed into an unexpected shape when bending the supporting portion upward so as to position the same higher than an optical part or when allowing an intraocular lens to pass through a passage.

Here, in view of the aforementioned problems, it is an object of the present invention to provide an intraocular lens insertion device capable of appropriately regulating the motion of a rear supporting portion during a process of moving an intraocular lens, and reducing the possibility of reoperation being required after the intraocular lens has been inserted into an eye.

Means for Solving the Problem

The invention according to a first aspect of the present invention is an intraocular lens insertion device comprising: a lens placement section for placing an intraocular lens having an optical part and one or more supporting portions provided on an outer edge of the optical part; a transition section for deforming the intraocular lens; a nozzle section for releasing the intraocular lens; a slider for pushing out the intraocular lens placed in the lens placement section; and a plunger for releasing the intraocular lens pushed out by the slider from the nozzle section, in which the slider includes: a first abutting portion for pushing up a supporting portion disposed in a rear direction of a lens advancement axis; and one or more second abutting portions abutting against an outer edge of a rear portion of the intraocular lens.

According to the invention described in a second aspect of the present invention, the second abutting portions are provided outside the first abutting portion with respect to the lens advancement axis.

According to the invention described in a third aspect of the present invention, the first abutting portion slants downward in a lens advancement direction.

According to the invention described in a fourth aspect of the present invention, at least one of the second abutting portions includes: an x-direction abutting surface substantially perpendicular to a surface of the optical part; and a y-direction abutting surface substantially parallel with the surface of the optical part.

The invention according to a fifth aspect of the present invention comprises a guiding portion for guiding the outer edge of the optical part to the second abutting portions.

According to the invention described in a sixth aspect of the present invention, the second abutting portions are provided as a left-right pair centered about the lens advancement axis.

Effects of the Invention

According to the present invention, the first abutting portion provided on the slider serves to push up the supporting portion arranged on the rear side with respect to the lens advancement axis, thereby allowing the motion of the rear supporting portion to be appropriately regulated during the process of moving the intraocular lens, and thus reducing the possibility of reoperation being required after the intraocular lens is inserted into the eye.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a perspective view showing an overall structure of an intraocular lens insertion device of a first embodiment of the present invention.

FIG. **2** is a perspective view showing a structure of a slider of the first embodiment of the present invention.

FIG. **3** is a partially enlarged perspective view showing the structure of the slider of the first embodiment of the present invention.

FIGS. **4**A and **4**B are diagrams showing a usage state (**1**) of the intraocular lens insertion device of the first embodiment of the present invention, in which FIG. **4**A is a cross sectional top view, and FIG. **4**B is a longitudinal sectional view.

FIGS. **5**A and **5**B are diagrams showing a usage state (**2**) of the intraocular lens insertion device of the first embodiment of the present invention, in which FIG. **5**A is a cross sectional top view, and FIG. **5**B is a longitudinal sectional view.

FIGS. **6**A and **6**B are diagrams showing a usage state (**3**) of the intraocular lens insertion device of the first embodiment of the present invention, in which FIG. **6**A is a cross sectional top view, and FIG. **6**B is a longitudinal sectional view.

FIGS. **7**A and **7**B are diagrams showing a usage state (**4**) of the intraocular lens insertion device of the first embodiment of the present invention, in which FIG. **7**A is a cross sectional top view, and FIG. **7**B is a longitudinal sectional view.

FIGS. **8**A and **8**B are diagrams showing a usage state (**5**) of the intraocular lens insertion device of the first embodiment of the present invention, in which FIG. **8**A is a cross sectional top view, and FIG. **8**B is a longitudinal sectional view.

FIG. **9** is a partially enlarged perspective view showing a structure of a slider of a second embodiment of the present invention.

FIGS. **10**A and **10**B are diagrams showing a usage state (**1**) of an intraocular lens insertion device of the second embodiment of the present invention, in which FIG. **10**A is a cross sectional top view, and FIG. **10**B is a longitudinal sectional view.

FIGS. **11**A and **11**B are diagrams showing a usage state (**2**) of the intraocular lens insertion device of the second embodiment of the present invention, in which FIG. **11**A is a cross sectional top view, and FIG. **11**B is a longitudinal sectional view.

FIGS. **12**A and **12**B are diagrams showing a usage state (**3**) of the intraocular lens insertion device of the second embodiment of the present invention, in which FIG. **12**A is a cross sectional top view, and FIG. **12**B is a longitudinal sectional view.

FIG. **13** is a partially enlarged perspective view showing a structure of a slider of a third embodiment of the present invention.

FIG. **14** is a partially enlarged perspective view showing a structure of a plunger of the third embodiment of the present invention.

FIGS. **15**A and **15**B are diagrams showing a usage state (**1**) of an intraocular lens insertion device of the third embodiment of the present invention, in which FIG. **15**A is a cross sectional top view, and FIG. **15**B is a longitudinal sectional view.

FIGS. **16**A and **16**B are diagrams showing a usage state (**2**) of the intraocular lens insertion device of the third

embodiment of the present invention, in which FIG. **16**A is a cross sectional top view, and FIG. **16**B is a longitudinal sectional view.

FIGS. **17**A and **17**B are diagrams showing a usage state (**3**) of the intraocular lens insertion device of the third embodiment of the present invention, in which FIG. **17**A is a cross sectional top view, and FIG. **17**B is a longitudinal sectional view.

FIGS. **18**A and **18**B are diagrams showing a usage state (**4**) of the intraocular lens insertion device of the third embodiment of the present invention, in which FIG. **18**A is a cross sectional top view, and FIG. **18**B is a longitudinal sectional view.

FIGS. **19**A and **19**B are diagrams showing a usage state (**5**) of the intraocular lens insertion device of the third embodiment of the present invention, in which FIG. **19**A is a cross sectional top view, and FIG. **19**B is a longitudinal sectional view.

BEST MODE FOR CARRYING OUT THE INVENTION

1. First Embodiment

(1) Basic Structure

An embodiment of the present invention is described hereunder in detail and with reference to the accompanying drawings.

An intraocular lens insertion device **1** shown in FIG. **1** comprises a main body **2**, and a slider **3** and a plunger **4** that are attached to the main body **2**. The intraocular lens insertion device **1** is of a preset type in which an intraocular lens **5** is placed inside the main body **2** in advance. Here, the intraocular lens **5** includes an optical part **6** and a pair of supporting portions **7** (or "haptics") provided on an outer edge of the optical part **6**. As the supporting portions **7**, there can be employed various types of members including, for example, members of a thin strip type.

In the following descriptions, an axis extending through the center of the intraocular lens **5** moving inside the main body **2** is referred to as a lens advancement axis A. Further, a direction to which the intraocular lens **5** moves is referred to as an "advancement direction x," and a downward direction is referred to as a "direction y."

The main body **2** is composed of a base end portion **8** and an insertion tube **9** connected to a front end of the base end portion **8** in the advancement direction x. Although not shown, a lens placement section made of a plate type member is formed on the front end of the base end portion **8** in the advancement direction x. The intraocular lens **5** is placed in the corresponding lens placement section. On side surfaces of the base end portion **8**, there are provided slits **12** formed in parallel with the lens advancement axis A and extending to the front end of the base end portion **8**. Further, the insertion tube **9** is integrally connected to the front end of the base end portion **8**, thereby allowing the intraocular lens **5** placed in the lens placement section of the base end portion **8** to be disposed internally.

The insertion tube **9** comprises a transition section **10** and a nozzle section **11** that are successively disposed along the lens advancement axis A. The transition section **10** is formed into a tapered shape in which an inner wall of the transition section **10** tapers toward a front end thereof, such front end being further communicated with the nozzle section **11**. The nozzle section **11** is so formed that an outer shape thereof can be inserted into an incision (not shown).

According to this intraocular lens insertion device **1**, the intraocular lens **5** placed in the lens placement section is at first moved to the transition section **10** after being pushed out by the slider **3**, thereby allowing the intraocular lens **5** to be reliably folded into a given shape. Next, the intraocular lens **5** is further moved to the nozzle section **11** after being pushed out by the plunger **4**, thereby causing the intraocular lens **5** to be folded even smaller, and thus allowing the intraocular lens **5** to be inserted into an eye from a front end of the nozzle section **11**. Accordingly, the intraocular lens insertion device **1** allows the intraocular lens **5** to be moved in the advancement direction x in two stages involving successively the slider **3** and the plunger **4**, thus causing the intraocular lens **5** to be folded into a given shape and releasing the same to the outside.

(2) Structure of Slider

Next, the slider **3** attached to the main body **2** is described. As shown in FIG. **2**, the slider **3** servers to push out the intraocular lens **5** placed in the lens placement section to the transition section **10** without imposing a local load thereon, and fold the intraocular lens **5** into the given shape. The slider **3** includes a guiding groove **15**, a wing portion **16**, operation portions **17** and a lens pressing member **18**.

The guiding groove **15** is so configured that the plunger **4** can be supported thereby along the lens advancement axis A. Specifically, the guiding groove **15** allows the plunger **4** to slide, and a front end of the plunger **4** to protrude from a front end of the slider **3**. According to the present embodiment, the guiding groove **15** is longitudinally formed over an entire length of a surface of the slider **3** in a manner such that the guiding groove **15** is substantially located in the center of the surface of the slider **3**. Accordingly, the guiding groove **15** serves as a groove parallel to the lens advancement axis A. A cross-sectional surface of the guiding groove **15** is substantially formed into a same shape as an outer shape of the plunger **4**. A wedge guiding path **15***a* is formed on a base end of the guiding groove **15**. In this way, the plunger **4** is allowed to be inserted into the guiding groove **15** formed on the slider **3**, and slide within the guiding groove **15** in a longitudinal direction of the slider **3**.

The wing portion **16** is inserted into the slits **12** provided on the main body **2**, and serves to support the slider **3** along the lens advancement axis A. By inserting the wing portion **16** into the slits **12**, the slider **3** is allowed to not only be held in a substantial center portion of the main body **2**, but also move along the lens advancement axis A. In this sense, the plunger **4** can also be held in the center portion of the main body **2** and move along the lens advancement axis A, when inserted into the guiding groove **15** formed on the slider **3**. The slider **3** can be easily moved by means of the operation portions **17**.

The operation portions **17** are provided as a left-right pair centered about the lens advancement axis A. Further, the operation portions **17** are connected to side end portions of the wing portion **16**, and protrude from each side of the base end portion **8**.

The lens pressing member **18** serves to fold the intraocular lens **5** in a given direction by pressing a surface of the intraocular lens **5** only when the intraocular lens **5** is being pushed out. According to the present embodiment, the lens pressing member **18** serves to press a surface of the intraocular lens **5** to the direction y, thereby causing the intraocular lens **5** to be folded inside the nozzle section **11** with the foregoing surface being folded inwardly, such surface being a front surface when releasing the intraocular lens **5** into the eye. The lens pressing member **18** is made of a strip type

member provided on the front end of the slider **3**, and is capable of swinging freely to the direction y.

In addition to the structure described so far, the slider **3** of the present embodiment, as shown in FIG. **3**, further includes a first abutting portion **21** for pushing up a supporting portion **7** arranged on a rear side with respect to the lens advancement axis A with respect to the optical part **6** (referred to as a rear supporting portion **7***a*, hereunder), and second abutting portions **22***a*, **22***b* abutting against a rear outer edge of the optical part **6**.

The first abutting portion **21** has a slanting surface formed in the center of the front end of the slider **3** and slanting toward a direction between the advancement direction x and the direction y. The guiding groove **15** is opened in the center of the first abutting portion **21**, and a front end of the plunger **4** is thus allowed to protrude from the guiding groove **15** in the advancement direction x. Further, restriction portions **23** are formed on front ends of the first abutting portion **21**. The restriction portions **23** serve to prevent the rear supporting portion **7***a* from entering in between the slider **3** and the main body **2** and thus being damaged, as the rear supporting portion **7***a* deforms in the direction y. According to the present embodiment, the restriction portions **23** protrude from lower ends of the slanting surface to the advancement direction x.

The second abutting portions **22***a*, **22***b* are respectively provided on both sides of the first abutting portion **21**, and are configured to be able to abut against the outer edge of the optical part **6** of the intraocular lens **5**. According to the present embodiment, the second abutting portions **22***a*, **22***b* protrude from the front end of the slider **3** to the advancement direction x, and at least **22***a* is allowed to abut against, along the lens advancement axis A, an outer edge of a section of the optical part **6**, such section of the optical part **6** being located outward from a connecting portion of the supporting portion **7** and the optical part **6**.

Further, the second abutting portions **22***a*, **22***b* have x-direction abutting surfaces **24** and y-direction abutting surfaces **25**. The x-direction abutting surfaces **24** are perpendicular to a surface of the optical part **6**, and are thus capable of pushing out the outer edge of the optical part **6**. The y-direction abutting surfaces **25** are parallel with the surface of the optical part **6**, and are thus able to restrict a surface of the optical part **6** in the vicinity of the outer edge thereof from being valley folded before the rear supporting portion **7***a* has been sufficiently deformed.

As described above, according to the intraocular lens insertion device **1** of the present embodiment, the first abutting portion **21** and the second abutting portions **22***a*, **22***b* are provided on the slider **3** allowing the intraocular lens **5** to be in contact therewith through a contact area larger than that of the plunger **4**. Accordingly, the motion of the rear supporting portion **7***a* can be appropriately regulated during the process of moving the intraocular lens **5**. Further, there can be reduced the possibility of reoperation being required after the intraocular lens **5** is inserted into the eye.

(3) Operation and Effect

According to the intraocular lens insertion device **1** having the aforementioned structure, the intraocular lens **5** is placed internally in a manner such that the optical part **6** thereof is arranged in parallel with the lens advancement axis A (FIGS. **4**A and **4**B). The slider **3** is at first moved to the advancement direction x in order to release the intraocular lens **5** internally placed in advance to the outside from the front end of the nozzle section **11**. In this way, the first abutting portion **21** formed on the front end of the slider **3** is caused to abut against the rear supporting portion **7***a* (FIGS. **5**A and **5**B).

Since the first abutting portion **21** has the slanting surface, the rear supporting portion **7***a* is pushed up therealong as the slider **3** is further moved to the advancement direction x (FIGS. **6**A and **6**B). At the same time, the x-direction abutting surfaces **24** of the second abutting portions **22***a*, **22***b* are caused to abut against as well as push out the optical part **6**, thereby moving the intraocular lens **5** from the lens placement section to the transition section **10**. At that time, the outer edge of the optical part **6** is pushed by the inner wall of the transition section **10**. Further, the lens pressing member **18** is also pushed by the inner wall of the transition section **10**, and is thus caused to push down the surface of the optical part **6** to the direction y. In this way, the optical part **6** of the intraocular lens **5** is valley folded.

Next, as the plunger **4** is moved to the advancement direction x, the front end of such plunger **4** supported by the guiding groove **15** of the slider **3** is caused to abut against the outer edge of the optical part **6** (FIGS. **7**A and **7**B). The rear supporting portion **7***a* pushed up by the first abutting portion **21** is thus caused to deform along the plunger **4** in a manner such that a front end of the rear supporting portion **7***a* eventually points to the advancement direction x. In other words, the plunger **4** moves the front end (or "free end") of the rear supporting portion **7***a* over the optical part **6**. In this way, the front end of the rear supporting portion **7***a* deformed due to the first abutting portion **21**, is tucked into the surface of the valley-folded optical part **6** by the plunger **4**.

Here, the y-direction abutting surfaces **25** of the second abutting portions **22***a*, **22***b* are configured to restrict the surface of the optical part **6** in the vicinity of the outer edge thereof from being valley folded, thereby preventing the outer edge of the optical part **6** from interfering with the rear supporting portion **7***a* during a deformation process of the rear supporting portion **7***a*. Accordingly, the intraocular lens insertion device **1** allows the rear supporting portion **7***a* to further reliably enter a space formed by the valley-folded surface of the optical part **6**, thereby making it possible to further reliably deform the intraocular lens **5** into the given shape. The inner surface of the transition section **10** deforms the free end of the forward supporting portion **7***b* toward (and then over) the optical part **6** as the plunger is moved in the advancement direction x.

Further, the restriction portions **23** provided on the first abutting portion **21** serve to prevent the rear supporting portion **7***a* from deforming to the direction y. In this sense, the intraocular lens insertion device **1** allows the intraocular lens **5** to be further reliably deformed into the given shape.

Next, by further moving the plunger **4** to the advancement direction x, the intraocular lens **5** is moved from the transition section **10** to the nozzle section **11** (FIGS. **8**A and **8**B) with the rear supporting portion **7***a* and the forward supporting portion **7***b* both over the optical part **6** and within the space between the folded portions of the optical part, followed by being released to the outside from the front end of the nozzle section **11** with the intraocular lens **5** itself being folded even smaller.

As described earlier, the intraocular lens insertion device **1** allows the rear supporting portion **7***a* to be pushed up by the first abutting portion **21**, thereby making it possible to appropriately regulate the motion of the rear supporting portion **7***a* during the process of moving the intraocular lens **5** and reduce the possibility of reoperation being required after the intraocular lens **5** is inserted into the eye.

Further, since the first abutting portion **21** is provided on the slider **3**, the rear supporting portion **7***a* is allowed to come into contact with the first abutting portion **21** through a large contact area. Accordingly, the intraocular lens insertion device **1** of the present embodiment allows the rear supporting portion **7***a* to be further stably deformed, thereby making it possible to further appropriately regulate the rear supporting portion **7***a*.

2. Second Embodiment

A second embodiment of the present invention is described hereunder with reference to the accompanying drawings. Here, the second embodiment differs from the first embodiment only in the structure of the front end portion of the slider **3**. Therefore, same symbols are used to describe the same members as those in the first embodiment, and the descriptions of the corresponding members are thus omitted for the sake of convenience.

According to a slider **30** shown in FIG. **9**, at least **22***a* of second abutting portions **22***a*, **22***b* is configured to abut against an outer edge of a section of the optical part **6** between the connecting portion of the rear supporting portion **7***a* and the optical part **6**, and the lens advancement axis A. Further, this slider **30** has a cutout hole **31** formed on a side surface thereof, such cutout hole **31** allowing the rear supporting portion **7***a* to be inserted therethrough inwardly from the outside.

According to the present embodiment having the aforementioned structure, the slider **30** is at first moved to the advancement direction x by gripping operation portions **17**. As a result, a first abutting portion **21** formed on a front end of the slider **30** is caused to abut against the rear supporting portion **7***a*.

As the slider **30** is further moved to the advancement direction x, the rear supporting portion **7***a* is pushed up with x-direction abutting surfaces **24** of the second abutting portion **22** abutting against and pushing out the optical part **6**, at the same time, thus allowing the intraocular lens **5** to be moved from a lens placement section to a transition section **10**. In this way, the optical part **6** is pushed by an inner wall of the transition section **10**, and a surface of the optical part **6** is pushed down to the direction y by means of a lens pressing member **18**, thus allowing the optical part **6** to be valley folded (FIGS. **10**A and **10**B).

Next, as a plunger **4** is moved to the advancement direction x, the front end of such plunger **4** supported by a guiding groove **15** of the slider **3** is caused to abut against the outer edge of the optical part **6** (FIGS. **11**A and **11**B). The supporting portion **7** pushed up by the first abutting portion **21** is thus caused to deform along the plunger **4** in a manner such that a front end of the supporting portion **7** eventually points to the advancement direction x. In this way, a front end of the supporting portion **7** deformed due to the first abutting portion **21**, is tucked into the surface of the valley-folded optical part **6**.

Next, by further moving the plunger **4** to the advancement direction x, the intraocular lens **5** is moved from the transition section **10** to a nozzle section **11** (FIGS. **12**A and **12**B), followed by being released to the outside from a front end of the nozzle section **11** with the intraocular lens **5** itself being folded even smaller.

Due to the aforementioned structure of the present embodiment, the present embodiment, as is the case in the first embodiment, allows the motion of the rear supporting portion **7***a* to be appropriately regulated during the process of moving the intraocular lens **5**, and reduces the possibility of reoperation being required after the intraocular lens **5** is inserted into the eye.

3. Third Embodiment

As shown in FIG. **13**, a slider **40** of the present embodiment includes a first abutting portion **21**, second abutting portions **22***a*, **22***b* and a guiding portion **41** for guiding the optical part **6** to the second abutting portion **22***b*. The second abutting portion **22***b* is provided on a location opposite to the connecting portion of the rear supporting portion **7***a* and the optical part **6**, and is configured to be able to abut against the optical part **6** or the outer edge thereof. Further, the second abutting portion **22***b* has an x-direction abutting surface **24** and a y-direction abutting surface **25**. In contrast, the second abutting portion **22***a* only has the x-direction abutting surface **24**.

Here, the y-direction abutting surface **25** of the second abutting portion **22***b* may be arranged substantially on the same plane as restriction portions **23**, or beyond the restriction portions **23** in the direction y. According to the present embodiment, the y-direction abutting surface **25** is arranged on the same plane as the restriction portions **23**.

The guiding portion **41** has a slanting surface slanting toward a direction between the advancement direction x and an opposite direction of the direction y. A lower end of the guiding portion **41** is communicated with the y-direction abutting surface **25**. Here, a plunger having a shape shown in FIG. **14** can be used as a plunger **44**. The plunger **44** includes a forward region **45** with a lens contact portion **46**, a side wall **47**, a bottom wall **48**, and a top wall **49**. An indentation **50** has a first lateral side **51** that is open, a second lateral side that is closed by the side wall **47**, and an open distal end **52**. The indentation **50** is located above, and extends proximally from, the lens contact portion **46**. The proximal end of the indentation **50** is defined by a slanted wall **53**.

Next, there are described an operation and effect of the slider **40** having the aforementioned structure. The intraocular lens **5** is placed in a lens placement section (not shown) in a manner such that the optical part **6** thereof is arranged in parallel with the lens advancement axis A (FIGS. **15**A and **15**B). The slider **40** is at first moved to the advancement direction x in order to release such intraocular lens **5** to the outside from a front end of a nozzle section **11**. As a result, the first abutting portion **21** formed on a front end of the slider **40** is caused to abut against the rear supporting portion **7***a* (FIGS. **16**A and **16**B).

Since the first abutting portion **21** has a slanting surface, the rear supporting portion **7***a* is pushed up therealong as the slider **40** is further moved to the advancement direction x (FIGS. **17**A and **17**B). At the same time, the guiding portion **41** serves to push down a surface of the optical part **6** to the direction y, thereby guiding the corresponding optical part **6** to the second abutting portion **22***b*. As a result, the x-direction abutting surface **24** of the second abutting portion **22***b* and the x-direction abutting surface **24** of the second abutting portion **22***a* are caused to abut against and then push out the optical part **6**, thus allowing the intraocular lens **5** to be moved from the lens placement section to a transition section **10**.

Here, the slider **40** allows the optical part **6** to be guided to the second abutting portion **22***b* by means of the guiding portion **41**, thereby causing the second abutting portion **22***b*

to further reliably abut against the optical part **6**, and thus allowing the intraocular lens **5** to be further reliably pushed out.

In this way, the outer edge of the optical part **6** is pushed by an inner wall of the transition section **10**. Further, at that time, a lens pressing member **18** is also pushed by the inner wall of the transition section **10**, thus pushing down the surface of the optical part **6** to the direction y. As a result, the optical part **6** of the intraocular lens **5** is valley folded.

Next, as the plunger **44** is moved to the advancement direction x, the front end of such plunger **44** supported by a guiding groove **15** of the slider **40** is caused to abut against the outer edge of the optical part **6** (FIGS. **18**A and **18**B). The rear supporting portion **7***a* pushed up by the first abutting portion **21** is thus caused to deform along the plunger **44** in a manner such that a front end of the rear supporting portion **7***a* eventually points to the advancement direction x and a part of the rear supporting portion **7***a* is in the indentation **50**. In this way, the front end of the rear supporting portion **7***a* deformed due to the first abutting portion **21**, is enclosed by the valley-folded surface of the optical part **6**.

Here, the y-direction abutting surface **25** of the second abutting portion **22***b* is configured to restrict the surface of the optical part **6** in the vicinity of the outer edge thereof from being valley folded, thereby preventing the outer edge of the optical part **6** from interfering with the rear supporting portion **7***a* during the deformation process of the rear supporting portion **7***a*.

Particularly, according to the present embodiment, since the y-direction abutting surface **25** is arranged on the same plane as the restriction portions **23**, the outer edge of the optical part **6** is restricted from deforming to the opposite direction of the direction y, particularly, from deforming beyond the restriction portions **23** and the rear supporting portion **7***a* deformed due to the first abutting portion **21**. In this sense, the slider **40** can further reliably prevent the outer edge of the optical part **6** from interfering with the rear supporting portion **7***a*, thereby allowing the intraocular lens **5** to be further reliably deformed into the given shape. The inner surface of the transition section **10** deforms the end of the forward supporting portion **7***b* toward (and then over) the optical part **6** as the plunger is moved in the advancement direction x.

Next, by further moving the plunger **44** to the advancement direction x, the intraocular lens **5** is moved from a transition section **10** to a nozzle section **11** (FIGS. **19**A and **19**B) with the rear supporting portion **7***a* and the forward supporting portion **7***b* both over the optical part **6** and within the space between the folded portions of the optical part, followed by being released to the outside from a front end of the nozzle section **11** with the intraocular lens **5** itself being folded even smaller.

Since the slider **40** of the present embodiment includes the first abutting portion **21** and the restriction portions **23**, there can be achieved the same effects as those of the first embodiment.

4. Modified Embodiment

The present invention is not limited to the aforementioned embodiments. As a matter of fact, appropriate modifications are possible within the scope of the gist of the present invention. For example, in each one of the aforementioned embodiments, there are provided two second abutting portions in total. However, the present invention is not limited to this configuration. Particularly, the number of the second abutting portions can be one, three or more than three.

Further, in each one of the aforementioned embodiments, the second abutting portions **22** are provided as a symmetrical pair. However, the present invention is not limited to this configuration. The second abutting portions **22** can actually be provided in an asymmetrical manner. For example, one of the second abutting portions **22** may be formed longer than the other second abutting portion **22** in the advancement direction x, thereby making it possible to slightly rotate the intraocular lens **5** about an optical axis, and thus making it easier to regulate a supporting portion disposed forward.

DESCRIPTION OF SYMBOLS

1 intraocular lens insertion device
2 main body
3 slider
4 plunger
5 intraocular lens
6 optical part
7 supporting portion
7*a* rear supporting portion
21 first abutting portion
22 second abutting portion
x advancement direction
y direction (downward direction)
A lens advancement axis

The invention claimed is:

1. A method performed by an intraocular lens insertion device on an intraocular lens, the intraocular lens including an optic, a forward haptic having an end and a rear haptic having an end, the insertion device including a nozzle, a transition section and a plunger having a forward region with a side wall and a bottom wall that together define an indentation and is configured to receive a portion of the rear haptic, the method comprising the steps of:

pushing the rear haptic such that the end of the rear haptic moves upwardly and forwardly relative to the optic;

pushing the rear haptic such that the end of the rear haptic passes over the optic, while the portion of the optic over which the rear haptic passes remains unfolded, with the forward region of the plunger in such a manner that the rear haptic is bent and a portion of the rear haptic is received in the indentation;

folding a portion of the optic such that there is a space between folded portions of the optic; and

pushing the intraocular lens through the nozzle with the forward region of the plunger while the end of the rear haptic is in the space between the folded portions of the optic.

2. A method as claimed in claim **1**, wherein

folding a portion of the optic comprises folding a portion of the optic with the transition section such that there is a space between folded portions of the optic.

3. A method as claimed in claim **1**, wherein

pushing the intraocular lens through the nozzle comprises pushing the intraocular lens through the nozzle with the forward region of the plunger while the end of the rear haptic is in the space between the folded portions of the optic and the end of the rear haptic faces in a lens travelling direction.

4. A method as claimed in claim **1**, further comprising the step of:

bending the forward haptic such that the end of the forward haptic moves into the space between the folded portions of the optic.

5. A method as claimed in claim 1, wherein
the intraocular lens insertion device defines a lens travelling axis; and
the method further comprises the step of storing the lens in the insertion device with the optic parallel to the lens travelling axis and the rear haptic positioned at a different angle than the forward haptic relative to the lens travelling axis.

6. A method as claimed in claim 1, wherein
the intraocular lens insertion device defines a lens travelling axis; and
pushing the rear haptic such that the end of the rear haptic moves upwardly and forwardly relative to the optic comprises pushing the rear haptic such that the end of the rear haptic moves upwardly and forwardly relative to the optic while the end of the rear haptic is on a surface that is not parallel to the lens travelling axis.

7. A method as claimed in claim 1, wherein
the insertion device includes a slider that is movable relative to the plunger; and
pushing the rear haptic such that the end of the rear haptic moves upwardly and forwardly relative to the optic comprises pushing the rear haptic such that the end of the rear haptic moves upwardly and forwardly relative to the optic with the slider.

8. A method as claimed in claim 1, wherein
the intraocular lens insertion device defines a lens travelling axis;
the insertion device includes a slider with an abutting portion that is slanted relative to the lens travelling axis and that is movable relative to the plunger; and
pushing the rear haptic such that the end of the rear haptic moves upwardly and forwardly relative to the optic comprises pushing the rear haptic such that the end of the rear haptic moves upwardly and forwardly relative to the optic with the abutting portion of the slider.

9. A method as claimed in claim 1, wherein
the insertion device includes a slider that is movable relative to the plunger; and
folding a portion of the optic comprises pushing a portion of the optic into the transition section with the slider.

10. A method as claimed in claim 9, wherein
the slider includes a pivotable lens pressing member; and
folding a portion of the optic comprises pushing a portion of the optic into the transition section while the pivotable lens pressing member engages the portion of the optic.

11. A method as claimed in claim 1, wherein
the intraocular lens insertion device defines a lens travelling axis;
the insertion device includes a slider that is movable relative to the plunger, the slider having a first abutting portion that is slanted relative to the lens travelling axis and a pair of second abutting portions located on opposite sides of the lens travelling axis;
pushing the rear haptic such that the end of the rear haptic moves upwardly and forwardly relative to the optic comprises pushing the rear haptic such that the end of the rear haptic moves upwardly and forwardly relative to the optic with the first abutting portion of the slider before the second abutting portions contact the optic; and
folding a portion of the optic comprises pushing a portion of the optic into the transition section with the second abutting portions.

12. A method performed by an intraocular lens insertion device on an intraocular lens, the intraocular lens including an optic, a forward haptic having a free end and a rear haptic having a free end, the insertion device including a nozzle, a transition section and a plunger, the method comprising the steps of:
moving the free end of the rear haptic, from a position rearward of the optic, over the optic and into a space between folded portions of the optic with the plunger;
moving the free end of the forward haptic into the space between the folded portions of the optic with the transition section; and
pushing the intraocular lens with the plunger through the nozzle with the free ends of the forward and rear haptics in the space between the folded portions of the optic.

13. A method as claimed in claim 12, wherein
the optic is folded with the transition section of the insertion device.

14. A method as claimed in claim 13, further comprising the step of:
prior to folding the optic, pushing the rear haptic such that the free end of the rear haptic moves upwardly and forwardly relative to the optic.

15. A method as claimed in claim 14, wherein
the insertion device includes a slider, and the plunger is movable relative to the slider; and
pushing the rear haptic such that the free end of the rear haptic moves upwardly and forwardly relative to the optic comprises pushing the rear haptic such that the free end of the rear haptic moves upwardly and forwardly relative to the optic with the slider.

16. A method as claimed in claim 13, wherein
moving the free end of the forward haptic comprises bending the forward haptic into the space between the folded portions of the optic with an inner surface of the transition section as the intraocular lens moves toward the nozzle.

* * * * *

EXHIBIT 5

US009907647B2

(12) **United States Patent**
Inoue

(10) **Patent No.: US 9,907,647 B2**
(45) **Date of Patent: Mar. 6, 2018**

(54) **INTRAOCULAR LENS INSERTION DEVICE AND METHOD FOR CONTROLLING MOVEMENT OF THE INTRAOCULAR LENS**

(71) Applicant: **Hoya Corporation**, Tokyo (JP)

(72) Inventor: **Masanobu Inoue**, Honjo (JP)

(73) Assignee: **Hoya Corporation**, Tokyo (JP)

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

(21) Appl. No.: **14/812,104**

(22) Filed: **Jul. 29, 2015**

(65) **Prior Publication Data**

US 2016/0113759 A1 Apr. 28, 2016

Related U.S. Application Data

(63) Continuation of application No. 12/667,510, filed as application No. PCT/JP2008/062382 on Jul. 9, 2008, now Pat. No. 9,114,006.

(30) **Foreign Application Priority Data**

Jul. 11, 2007 (JP) 2007-182535

(51) **Int. Cl.**
A61F 2/16 (2006.01)

(52) **U.S. Cl.**
CPC ***A61F 2/167*** (2013.01)

(58) **Field of Classification Search**
CPC A61F 2/167; A61F 2/1662; A61F 2002/1681; A61F 2002/1682
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

2,761,446 A 9/1956 Reed
4,205,747 A 6/1980 Gilliam et al.
4,269,307 A 5/1981 LaHaye
(Continued)

FOREIGN PATENT DOCUMENTS

DE 3610925 10/1987
DE 4110278 10/1992
(Continued)

OTHER PUBLICATIONS

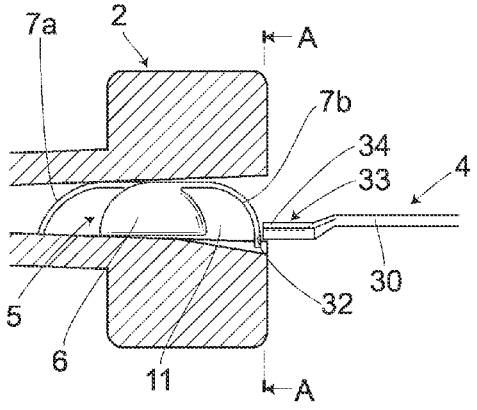
U.S. Appl. No. 14/145,846, filed Dec. 31, 2013, U.S. 20140114323A1.
(Continued)

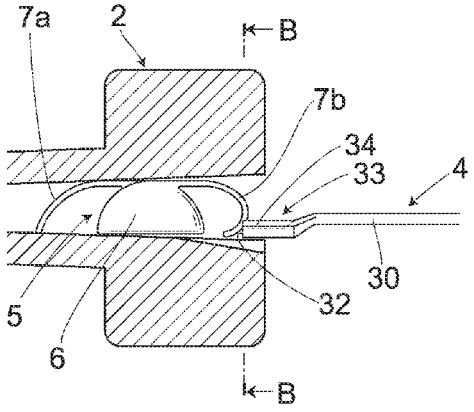
Primary Examiner — Gregory Anderson
Assistant Examiner — Sarah Simpson
(74) *Attorney, Agent, or Firm* — Henricks, Slavin & Holmes LLP

(57) **ABSTRACT**

Provided is an intraocular lens insertion device capable of omitting a repeated operation after the intraocular lens is inserted into the eye. The intraocular lens insertion device (**1**) comprises a lens setting part (**11**) for mounting an intraocular lens (**5**) having an optic (**6**) and one or two or more supporting portions (**7***a* and **7***b*) disposed at the outer edge of the optic (**6**), a plunger (**4**) for pushing out the intraocular lens (**5**) mounted in the lens setting part (**11**), and a nozzle (**13**) for releasing the intraocular lens (**5**) pushed out by the plunger (**4**). This plunger (**4**) includes a lens contact portion (**32**) for abutting against the outer edge of the optic (**6**), and a pushing portion (**33**) for pushing out the supporting portion (**7***b*) arranged in the backward direction of a lens advancing axis (A).

13 Claims, 6 Drawing Sheets





(56) **References Cited**

U.S. PATENT DOCUMENTS

4,423,809	A	1/1984	Mazzocco	
4,573,998	A	3/1986	Mazzocco	
4,608,049	A	8/1986	Kelman	
4,634,423	A	1/1987	Bailey	
4,681,102	A	7/1987	Bartell	
4,697,697	A	10/1987	Graham et al.	
4,699,140	A	10/1987	Holmes	
4,702,244	A	10/1987	Mazzocco	
4,715,373	A	12/1987	Mazzocco et al.	
4,747,404	A	5/1988	Jampel et al.	
4,750,498	A	6/1988	Graham	
4,759,359	A	7/1988	Willis et al.	
4,763,650	A	8/1988	Hauser	
4,765,329	A	8/1988	Cumming et al.	
4,769,034	A	9/1988	Poley	
4,781,719	A	11/1988	Kelman	
4,787,904	A	11/1988	Severin	
4,810,249	A	3/1989	Haber et al.	
4,819,631	A	4/1989	Poley	
4,834,094	A	5/1989	Patton	
4,836,201	A	6/1989	Patton	
4,862,885	A	9/1989	Cumming	
4,880,000	A	11/1989	Holmes et al.	
4,919,130	A	4/1990	Stoy et al.	
4,934,363	A	6/1990	Smith et al.	
4,955,889	A	9/1990	Van Gent	
4,976,716	A	12/1990	Cumming	
4,988,352	A	1/1991	Poley	
4,994,028	A	2/1991	Leonard et al.	
5,066,297	A	11/1991	Cumming	
5,098,439	A	3/1992	Hill et al.	
5,123,905	A	6/1992	Kelman	
5,139,501	A	8/1992	Klaas	
5,171,241	A	12/1992	Buboltz et al.	
5,176,686	A	1/1993	Poley	
5,190,552	A	3/1993	Kelman	
5,190,553	A	3/1993	Kanert et al.	
5,222,972	A	6/1993	Hill et al.	
5,242,450	A	9/1993	McDonald	
5,259,395	A	11/1993	Li	
5,275,604	A	1/1994	Rheinish et al.	
5,281,227	A	1/1994	Sussman	
5,304,182	A	4/1994	Rheinish et al.	
5,354,333	A	10/1994	Kammann et al.	
5,395,378	A	3/1995	McDonald	
5,425,734	A	6/1995	Blake	
5,454,818	A	10/1995	Hambleton et al.	
5,468,246	A	11/1995	Blake	
5,474,562	A	12/1995	Orchowski et al.	
5,494,484	A	2/1996	Feingold	
5,496,328	A	3/1996	Nakajima et al.	
5,499,987	A	3/1996	Feingold	
5,562,676	A	10/1996	Brady et al.	
5,571,113	A	11/1996	McDonald	
5,578,042	A	11/1996	Cumming	
5,582,613	A	12/1996	Brady	
5,582,614	A	12/1996	Feingold	
5,584,304	A	12/1996	Brady	
5,616,148	A	4/1997	Eagles et al.	
5,620,450	A	4/1997	Eagles et al.	
5,643,275	A	7/1997	Blake	
5,643,276	A	7/1997	Zaleski	
5,645,534	A	7/1997	Chanoch	
5,653,715	A	8/1997	Reich et al.	
5,653,753	A	8/1997	Brady et al.	
5,702,402	A	12/1997	Brady	
5,702,441	A	12/1997	Zhou	
5,716,364	A	2/1998	Makker et al.	
5,728,075	A	3/1998	Levander	
5,728,102	A	3/1998	Feingold et al.	
5,735,858	A	4/1998	Makker et al.	
5,766,181	A	6/1998	Chambers et al.	
5,772,666	A	6/1998	Feingold et al.	
5,772,667	A	6/1998	Blake	
5,776,138	A	7/1998	Vidal et al.	
5,800,442	A *	9/1998	Wolf	A61F 2/167 606/107
5,803,925	A	9/1998	Yang et al.	
5,807,400	A	9/1998	Chambers et al.	
5,810,833	A	9/1998	Brady et al.	
5,810,834	A	9/1998	Heyman	
5,860,984	A	1/1999	Chambers et al.	
5,860,986	A	1/1999	Reich et al.	
5,868,751	A	2/1999	Feingold	
5,868,752	A	2/1999	Makker et al.	
5,873,879	A	2/1999	Figueroa et al.	
5,876,406	A	3/1999	Wolf et al.	
5,876,407	A	3/1999	Makker et al.	
5,876,440	A	3/1999	Feingold	
5,891,152	A	4/1999	Feingold	
5,902,307	A	5/1999	Feingold et al.	
5,919,197	A	7/1999	McDonald	
5,921,989	A	7/1999	Deacon et al.	
5,928,245	A	7/1999	Wolf et al.	
5,941,886	A	8/1999	Feingold	
5,942,277	A	8/1999	Makker et al.	
5,944,725	A	8/1999	Cicenas	
5,947,974	A	9/1999	Brady et al.	
5,947,975	A	9/1999	Kikuchi et al.	
5,957,748	A	9/1999	Ichiha	
5,957,896	A	9/1999	Bendek et al.	
6,001,107	A	12/1999	Feingold	
6,010,510	A	1/2000	Brown et al.	
6,022,358	A	2/2000	Wolf et al.	
6,048,348	A	4/2000	Chambers et al.	
6,051,000	A	4/2000	Heyman	
6,056,757	A	5/2000	Feingold et al.	
6,056,758	A	5/2000	Vidal et al.	
6,059,791	A	5/2000	Chambers	
6,074,397	A	6/2000	Chambers et al.	
6,083,230	A	7/2000	Makker et al.	
6,093,193	A	7/2000	Makker et al.	
6,129,733	A	10/2000	Brady et al.	
6,142,999	A	11/2000	Brady et al.	
6,143,000	A	11/2000	Feingold	
6,162,229	A	12/2000	Feingold et al.	
6,174,315	B1	1/2001	Chambers et al.	
6,214,015	B1	4/2001	Reich et al.	
6,241,737	B1 *	6/2001	Feingold	A61F 2/1664 606/107
6,248,111	B1	6/2001	Glick et al.	
6,251,114	B1	6/2001	Farmer et al.	
6,254,607	B1	7/2001	Makker et al.	
6,267,768	B1	7/2001	Deacon	
6,283,975	B1	9/2001	Glick et al.	
6,283,976	B1	9/2001	Portney	
6,312,433	B1	11/2001	Butts	
6,334,862	B1	1/2002	Vidal et al.	
6,336,932	B1	1/2002	Figueroa et al.	
6,355,046	B2	3/2002	Kikuchi et al.	
6,371,960	B2	4/2002	Heyman et al.	
6,386,357	B1	5/2002	Egawa	
6,387,101	B1	5/2002	Butts et al.	
6,398,788	B1	6/2002	Makker et al.	
6,406,481	B2	6/2002	Feingold et al.	
6,428,545	B2	8/2002	Portney	
6,447,519	B1	9/2002	Brady et al.	
6,447,520	B1	9/2002	Ott et al.	
6,468,282	B2	10/2002	Kikuchi et al.	
6,471,708	B2	10/2002	Green	
6,491,697	B1	12/2002	Clark et al.	
6,497,708	B1	12/2002	Cumming	
6,500,181	B1	12/2002	Portney	
6,506,195	B2	1/2003	Chambers et al.	
6,537,283	B2	3/2003	Van Noy	
6,540,754	B2	4/2003	Brady	
6,554,839	B2	4/2003	Brady	
6,558,395	B2	5/2003	Hjertman et al.	
6,605,093	B1	8/2003	Blake	
6,607,537	B1	8/2003	Binder	
6,629,979	B1	10/2003	Feingold	
6,666,871	B2	12/2003	Kikuchi et al.	
6,679,891	B2	1/2004	Makker et al.	
6,685,740	B2	2/2004	Figueroa et al.	

(56) **References Cited**

U.S. PATENT DOCUMENTS

6,712,848	B1	3/2004	Wolf et al.
6,723,104	B2	4/2004	Ott
6,733,507	B2	5/2004	McNicholas et al.
6,793,674	B2	9/2004	Zapata
6,858,033	B2	2/2005	Kobayashi
6,921,405	B2	7/2005	Feingold et al.
6,923,815	B2	8/2005	Brady et al.
6,976,989	B1	12/2005	Vincent
7,014,641	B2	3/2006	Kobayashi et al.
7,025,782	B2	4/2006	Kobayashi et al.
7,033,366	B2	4/2006	Brady
7,037,312	B2	5/2006	Kikuchi et al.
7,074,227	B2	7/2006	Portney
7,097,649	B2	8/2006	Meyer
7,131,976	B2	11/2006	Kobayashi et al.
7,156,854	B2	1/2007	Brown et al.
7,348,038	B2	3/2008	Makker et al.
7,422,604	B2	9/2008	Vaquero et al.
7,429,263	B2	9/2008	Vaquero et al.
7,458,976	B2	12/2008	Peterson et al.
7,476,230	B2	1/2009	Ohno et al.
7,494,505	B2	2/2009	Kappelhof et al.
7,645,300	B2	1/2010	Tsai
8,273,122	B2	9/2012	Anderson
8,382,769	B2	2/2013	Inoue
8,460,311	B2	6/2013	Ishii
8,470,032	B2	6/2013	Inoue et al.
8,475,528	B2	7/2013	Ichinohe et al.
8,523,877	B2	9/2013	Ichinohe et al.
8,523,941	B2	9/2013	Ichinohe et al.
8,535,375	B2	9/2013	Ichinohe et al.
8,545,512	B2	10/2013	Ichinohe et al.
8,574,239	B2	11/2013	Ichinohe et al.
8,603,103	B2	12/2013	Kudo et al.
8,647,382	B2	2/2014	Kudo et al.
8,702,795	B2	4/2014	Shoji et al.
8,747,465	B2	6/2014	Someya et al.
8,968,328	B2	3/2015	Ichinohe et al.
9,114,006	B2	8/2015	Inoue
9,114,007	B2	8/2015	Ichinohe et al.
9,186,246	B2	11/2015	Inoue
9,220,593	B2	12/2015	Ichinohe
9,289,288	B2	3/2016	Someya et al.
9,314,373	B2	4/2016	Kudo et al.
9,326,847	B2	5/2016	Demas
9,364,320	B2	6/2016	Ichinohe et al.
9,554,894	B2	1/2017	Inoue
9,572,710	B1	2/2017	Kudo et al.
9,655,718	B2	5/2017	Kudo
2001/0007942	A1	7/2001	Kikuchi et al.
2002/0103490	A1	8/2002	Brady
2002/0151904	A1	10/2002	Feingold et al.
2002/0165610	A1	11/2002	Waldock
2002/0193805	A1	12/2002	Ott et al.
2003/0036765	A1	2/2003	Van Noy
2003/0040755	A1	2/2003	Meyer
2003/0050647	A1	3/2003	Brady
2003/0088253	A1	5/2003	Seil
2003/0139749	A1	7/2003	Kikuchi et al.
2003/0181921	A1	9/2003	Jeannin et al.
2003/0195522	A1	10/2003	McNicholas
2003/0212406	A1	11/2003	Kobayashi et al.
2003/0212407	A1	11/2003	Kikuchi
2003/0212409	A1	11/2003	Kobayashi et al.
2004/0111094	A1	6/2004	Meyer
2004/0117012	A1	6/2004	Vincent
2004/0186428	A1	9/2004	Ray
2004/0238392	A1	12/2004	Peterson et al.
2004/0243141	A1	12/2004	Brown et al.
2005/0033308	A1	2/2005	Callahan et al.
2005/0049605	A1	3/2005	Vaquero et al.
2005/0049606	A1	3/2005	Vaquero et al.
2005/0055011	A1	3/2005	Enggaard
2005/0125000	A1	6/2005	Tourrette et al.
2005/0143750	A1	6/2005	Vaquero
2005/0182419	A1	8/2005	Tsai
2005/0222578	A1	10/2005	Vaquero
2005/0261703	A1	11/2005	Feingold et al.
2006/0085013	A1	4/2006	Dusek et al.
2006/0142781	A1	6/2006	Pynson et al.
2006/0167466	A1	7/2006	Dusek
2006/0200167	A1	9/2006	Peterson et al.
2006/0229633	A1	10/2006	Shepherd
2006/0235429	A1	10/2006	Lee et al.
2006/0293694	A1	12/2006	Futamura
2007/0005135	A1	1/2007	Makker et al.
2008/0033449	A1*	2/2008	Cole A61F 2/1691 606/107
2008/0058830	A1	3/2008	Cole et al.
2008/0086146	A1	4/2008	Ishii et al.
2008/0097459	A1	4/2008	Kammerlander et al.
2008/0221584	A1	9/2008	Downer
2009/0036898	A1	2/2009	Ichinohe
2009/0043313	A1	2/2009	Ichinohe
2009/0112223	A1	4/2009	Downer et al.
2009/0125034	A1	5/2009	Pynson
2009/0138022	A1	5/2009	Tu et al.
2009/0204122	A1	8/2009	Ichinohe et al.
2009/0216244	A1	8/2009	Pynson
2009/0248031	A1	10/2009	Ichinohe
2010/0094309	A1	4/2010	Hboukhny et al.
2010/0106160	A1	4/2010	Tsai
2010/0161049	A1	6/2010	Inoue
2010/0185206	A1	7/2010	Ichinohe et al.
2010/0217273	A1	8/2010	Someya et al.
2010/0286704	A1	11/2010	Ichinohe et al.
2010/0331808	A1	12/2010	Py et al.
2011/0082463	A1	4/2011	Inoue
2011/0098717	A1	4/2011	Inoue
2011/0264101	A1	10/2011	Inoue et al.
2011/0270264	A1	11/2011	Shoji et al.
2011/0288557	A1	11/2011	Kudo et al.
2012/0022549	A1	1/2012	Someya et al.
2012/0071887	A1	3/2012	Ichinohe et al.
2013/0006259	A1	1/2013	Sanger
2013/0018460	A1	1/2013	Anderson
2013/0226193	A1	8/2013	Kudo et al.
2013/0245635	A1	9/2013	Inoue
2014/0081284	A1	3/2014	Ichinohe et al.
2014/0107660	A1	4/2014	Ichinohe et al.
2014/0180299	A1	6/2014	Ichinohe et al.
2014/0180300	A1	6/2014	Ichinohe et al.
2014/0194890	A1	7/2014	Kudo et al.
2016/0193038	A1	7/2016	Kudo et al.
2016/0346077	A1	12/2016	Someya et al.
2017/0079772	A1	3/2017	Kudo
2017/0151056	A1	6/2017	Inoue
2017/0202662	A1	7/2017	Someya et al.
2017/0252149	A1	9/2017	Kudo et al.
2017/0252150	A1	9/2017	Kudo et al.
2017/0258582	A1	9/2017	Kudo et al.

FOREIGN PATENT DOCUMENTS

EP	0363213		4/1990
EP	0727966		9/2003
EP	1832247	A1	9/2007
EP	1338254		12/2008
FR	2749752	A	12/1997
JP	63-197453	A	8/1988
JP	4-212350	A	8/1992
JP	5-103808		4/1993
JP	5-103809		4/1993
JP	8-024282	A	1/1996
JP	8-505540		6/1996
JP	9-506285	A	6/1997
JP	11-113939	A	4/1999
JP	11-506357	A	6/1999
JP	2000-516487	A	12/2000
JP	2000-516488	A	12/2000
JP	2001-502563		2/2001
JP	2001-104347	A	4/2001
JP	2002-516709	A	6/2002
JP	2002-355268	A	12/2002

(56) **References Cited**

FOREIGN PATENT DOCUMENTS

JP	2002-541912	A	12/2002
JP	2003-144480	A	5/2003
JP	3412106	B2	6/2003
JP	2003-210498	A	7/2003
JP	2003-325569	A	11/2003
JP	2003-325570	A	11/2003
JP	2003-325572	A	11/2003
JP	2004-024854	A	1/2004
JP	2004-188194	A	7/2004
JP	2004-351196	A	12/2004
JP	2006-181269	A	7/2006
JP	2006-297146	A	11/2006
JP	2006-333924	A	12/2006
JP	2006-333981	A	12/2006
JP	2007-503872	A	3/2007
JP	2007-152010	A	6/2007
JP	2007-181604	A	7/2007
JP	2007-526091	A	9/2007
JP	2008-521535	A	6/2008
JP	2008-212689	A	9/2008
JP	2014-050484	A	3/2014
WO	WO9407436	A1	4/1994
WO	WO9513022	A1	5/1995
WO	WO9628122	A1	9/1996
WO	WO9715253	A1	5/1997
WO	WO9812969	A1	4/1998
WO	WO9958086	A1	11/1999
WO	WO9959668	A1	11/1999
WO	WO0045746	A1	8/2000
WO	WO0062712	A1	10/2000
WO	WO2002071982	A1	9/2002
WO	WO2002096322	A1	12/2002
WO	WO2005023154	A1	3/2005
WO	WO2005070341	A1	8/2005
WO	WO2005084588	A1	9/2005
WO	WO2006070628	A1	7/2006
WO	WO2006080191	A1	8/2006
WO	WO2006090531	A1	8/2006
WO	WO2007037223	A1	4/2007
WO	WO2007097221	A1	4/2007
WO	WO2007080869	A1	7/2007
WO	WO2008149794	A1	12/2008
WO	WO2008149795	A1	12/2008
WO	WO2009058929	A1	7/2009
WO	WO2009148091	A1	12/2009
WO	WO2011126144	A1	10/2011
WO	WO2011155636	A1	12/2011

OTHER PUBLICATIONS

U.S. Appl. No. 14/812,104, filed Jul. 29, 2015, U.S. 20160113759A1.

* cited by examiner

FIG.1

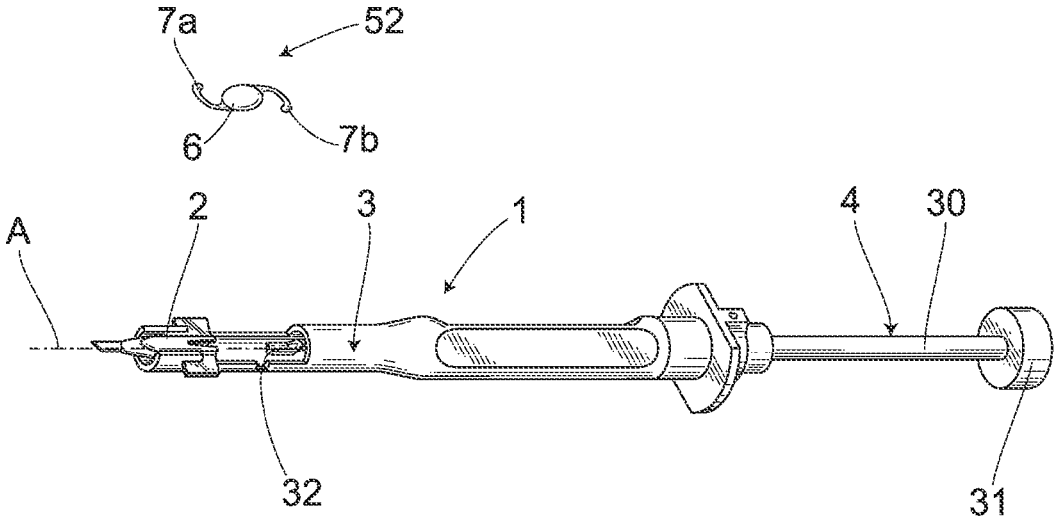


FIG.2

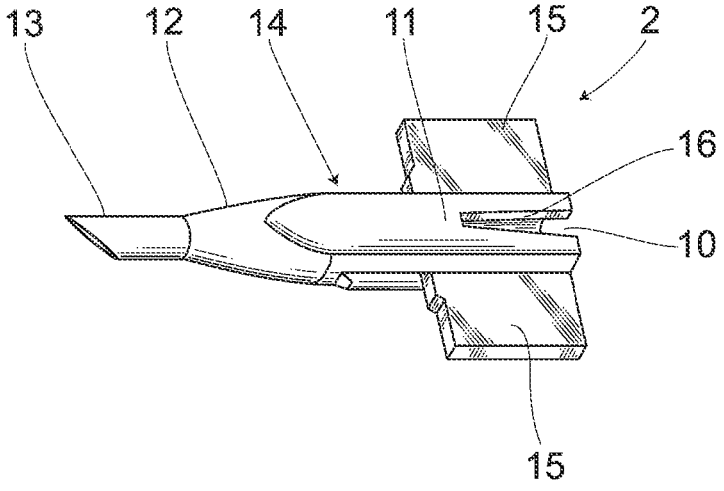


FIG.3

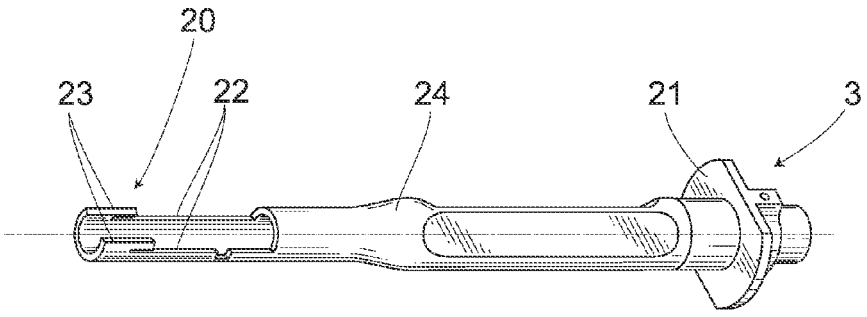


FIG.4

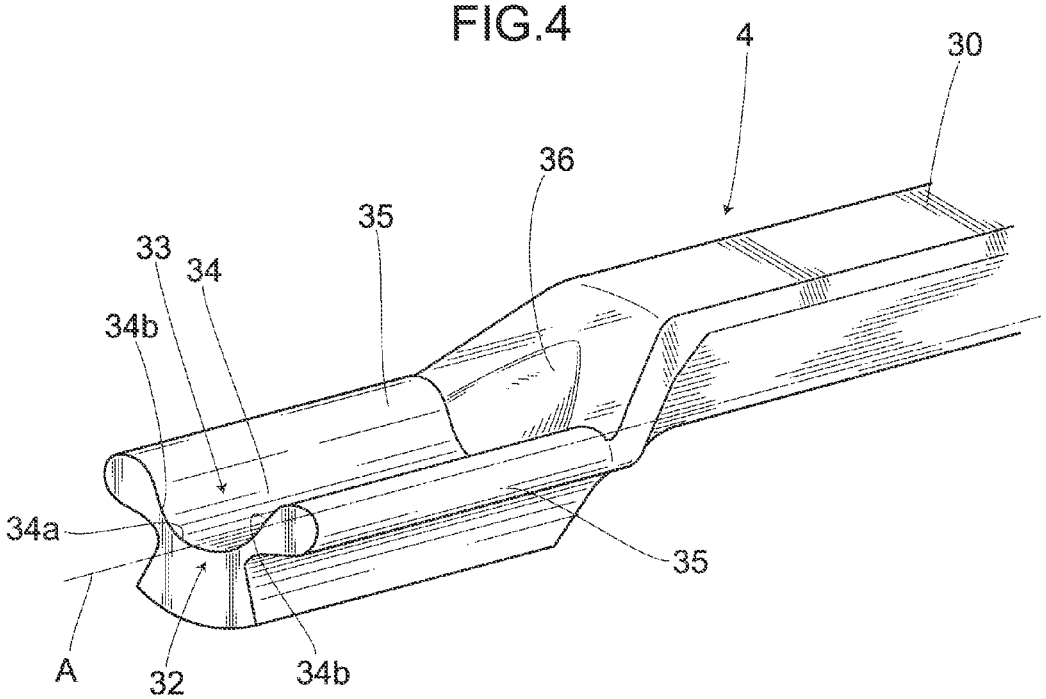


FIG.5A

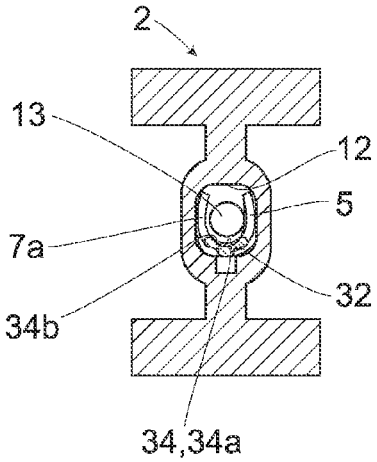


FIG.5A'

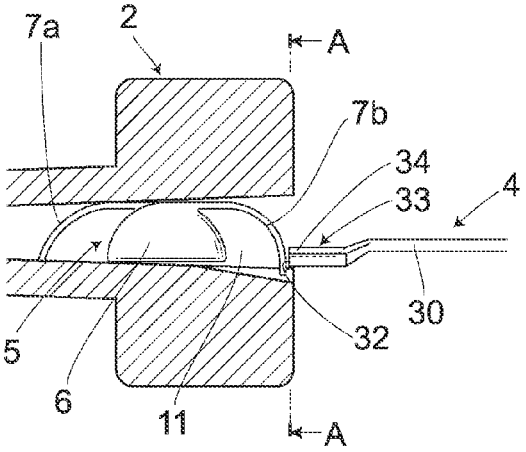


FIG.5B

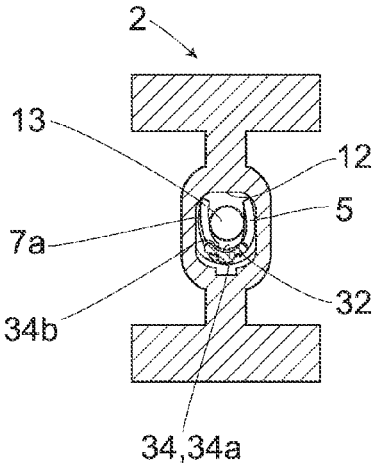


FIG.5B'

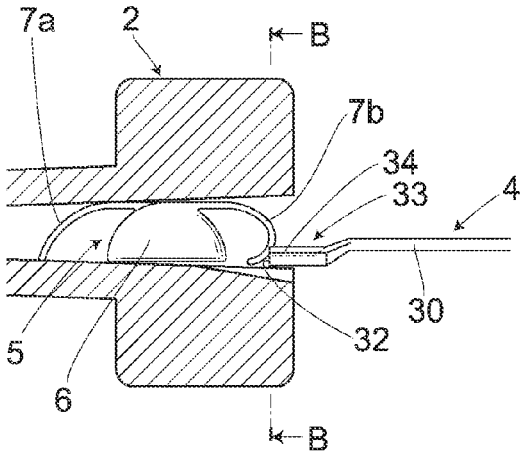


FIG.5C

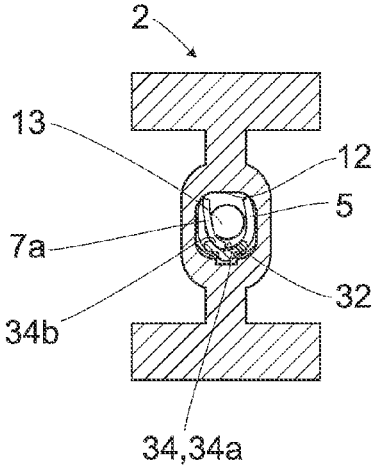


FIG.5C'

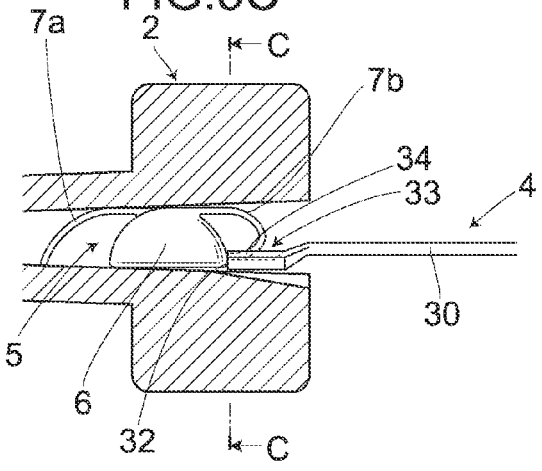


FIG.6A

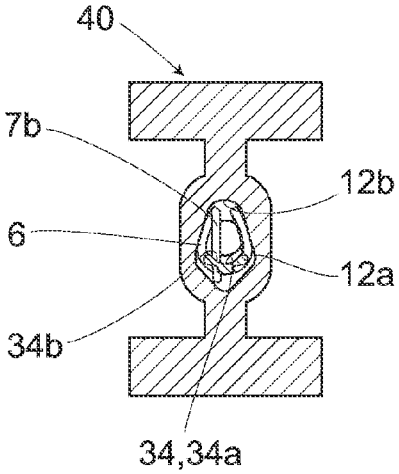


FIG.6A'

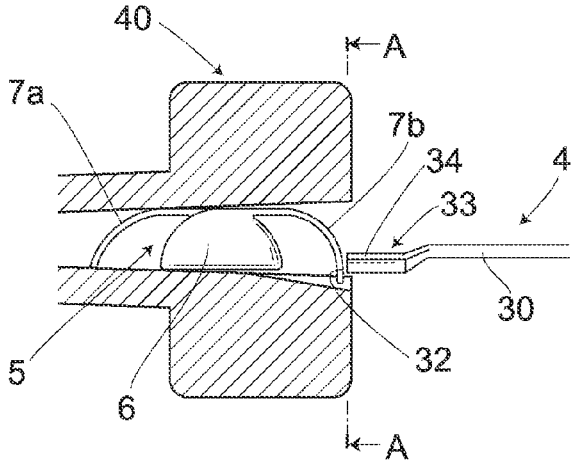


FIG.6B

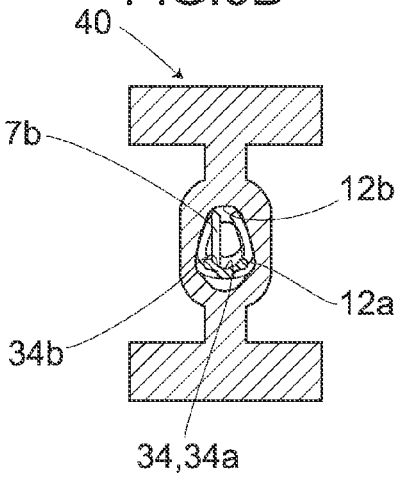


FIG.6B'

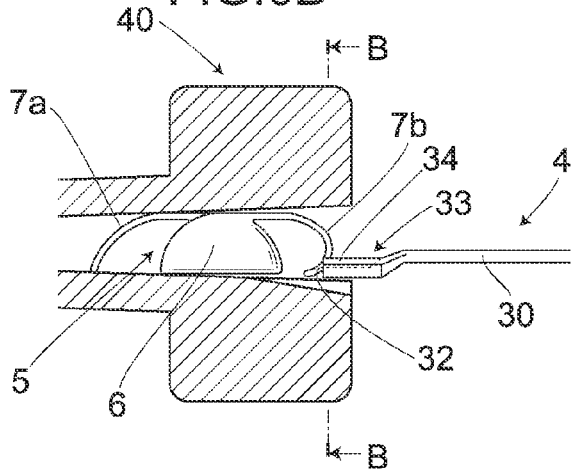


FIG.6C

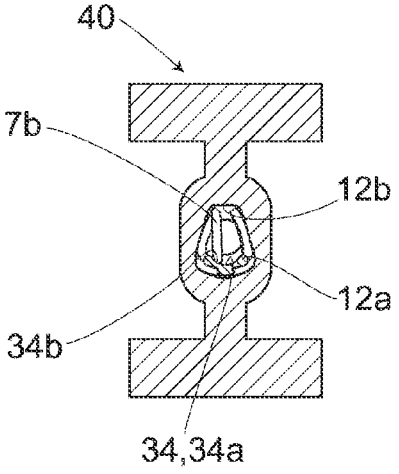


FIG.6C'

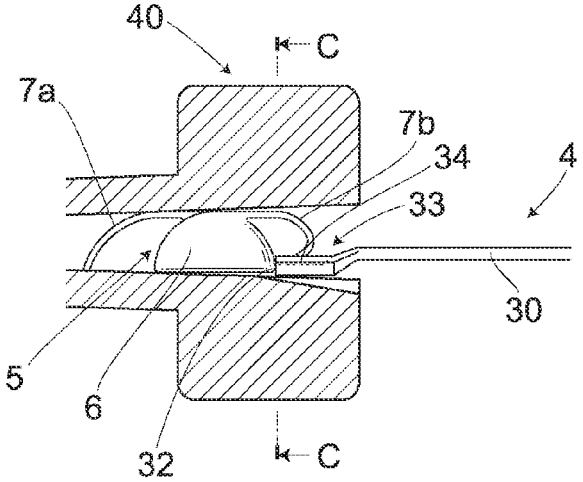


FIG.7

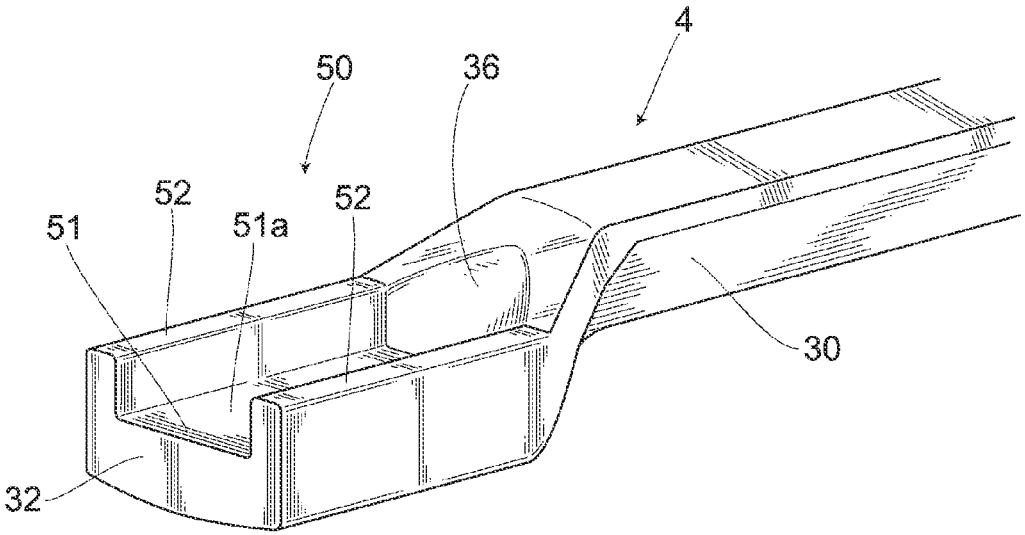


FIG.8

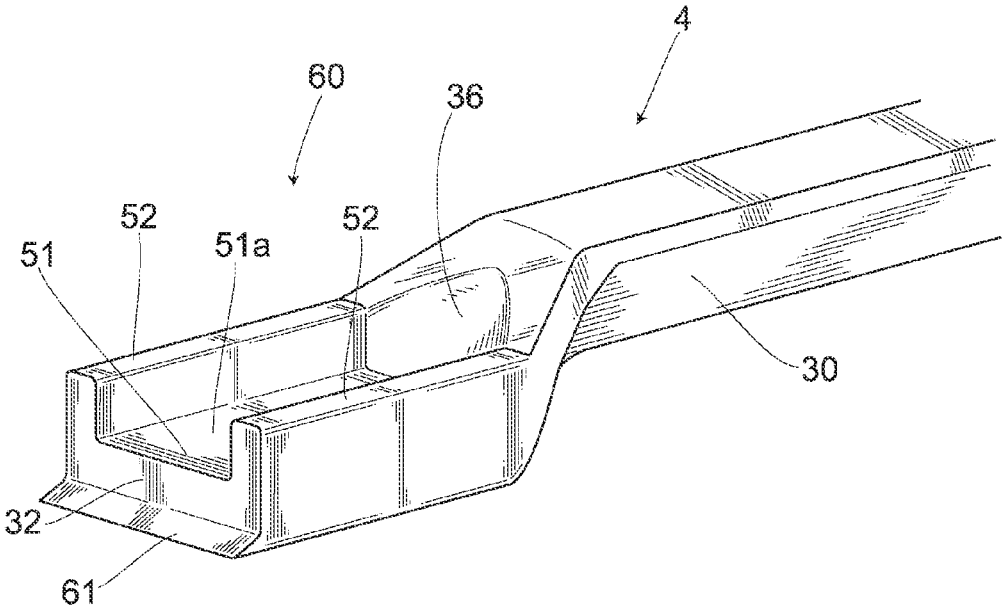


FIG.9A

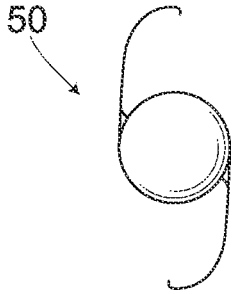


FIG.9B

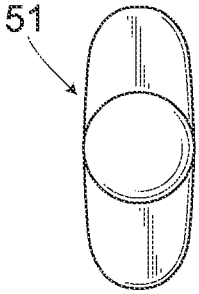
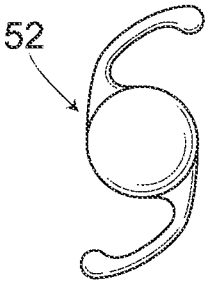


FIG.9C



INTRAOCULAR LENS INSERTION DEVICE AND METHOD FOR CONTROLLING MOVEMENT OF THE INTRAOCULAR LENS

CROSS-REFERENCE TO RELATED APPLICATIONS

This application is a continuation of U.S. application Ser. No. 12/667,510, filed Dec. 31, 2009, now U.S. Pat. No. 9,114,006, which was the U.S. national phase under 35 U.S.C. § 371 of PCT International Application No. PCT/JP2008/062382, which has an International filing date of Jul. 9, 2008, and claims the benefit of Japanese Application No. 2007-182535, filed Jul. 11, 2007, each of which are incorporated by reference herein.

TECHNICAL FIELD

The present invention relates to an intraocular lens insertion device and a method for controlling movement of the intraocular lens used to implant an intraocular lens into an eye in place of a crystalline lens removed in cataract surgery.

BACKGROUND ART

In cataract surgery, there has been widely performed removal of opacified crystalline lenses by phacoemulsification and aspiration (PEA) followed by implantation of intraocular lenses into aphakic eyes. There are two types of intraocular lens: a hard intraocular lens whose optic is made of a hard material such as PMMA and a soft intraocular lens whose optic is made of a flexible material such as silicone elastomer, soft acrylic or hydrogel.

Upon use of a hard intraocular lens, the lens needs to be inserted through an incision having been cut in a cornea or sclera in a width approximately the same as the diameter of the optic of the lens. On the other hand, upon use of a soft intraocular lens, the lens can be inserted through an incision smaller than the diameter of the optic of the lens by folding the optic.

In order to reduce the risk of post-surgery corneal astigmatism or infection, insertion of a lens through a small incision is preferable. Consequently, soft intraocular lenses tend to be preferred now. There are three types of soft intraocular lens: Type **50** whose optic is made of a soft material and supporting portions are made of a hard material such as PMMA (generally, this type of intraocular lens has two thin filament-shaped supporting portions (FIG. **9**A); Type **51** whose optic and supporting portions are made of the same soft material (generally, this type of intraocular lens has plate-like supporting portions (FIG. **9**B); and Type **52** which has two or more thin plate-like supporting portions (FIG. **9**C).

In addition, a dedicated intraocular lens insertion device having a mechanism to lead an intraocular lens to an eye through a slender tube is used in some cases in order to insert intraocular lenses into eyes. By using such an intraocular lens insertion device, an intraocular lens can be inserted through an incision opening smaller than 3 mm.

In recent years, in order to eliminate the possibility of bacterial contamination or operational error in handling intraocular lenses, an intraocular lens insertion device where an intraocular lens is set beforehand and which can be packaged and stored has been developed.

With such an intraocular lens insertion device, however, there was a problem that a supporting portion arranged in the backward direction of a lens advancing axis (hereinafter, referred to as a trailing supporting portion) got caught in the gap between a plunger for pushing out the intraocular lens and an inner wall of a passage of the insertion device or entangled in the plunger in a process of movement of the intraocular lens. Such a problem is brought to the fore especially with a soft intraocular lens having thin filament-shaped supporting portions or a soft intraocular lens having thin plate-like supporting portions.

In such an intraocular lens insertion device, if the trailing supporting portion stretches in a process of movement of the intraocular lens, the trailing supporting portion is left outside of the eye when the lens is inserted through a small incision in the eye. Therefore, after the lens is pushed by the plunger, a repeated operation for inserting the trailing supporting portion into the eye is required, and it takes time and labor in surgery. In some cases, while the intraocular lens is moving inside the intraocular lens insertion device, the optic and the trailing supporting portion interfere with each other, resulting in damage or breakage of the optic or the trailing supporting portion.

Therefore, when an intraocular lens is inserted into an eye using the intraocular lens insertion device, the behavior of the trailing supporting portion of intraocular lens needs to be controlled appropriately in a process of movement of the intraocular lens.

In view of the foregoing problems, a lens insertion tool which has a side clearance provided at the distal end of a plunger for accommodating a trailing supporting portion to prevent damage to the trailing supporting portion has been disclosed (Patent Document 1, for example). A lens insertion tool provided with a relief channel for a trailing supporting portion at the lower side of a plunger has been also disclosed (Patent Document 2, for example). Furthermore, a lens insertion tool wherein a plunger pushes a trailing supporting portion up a ramp and bends haptics up and over IOL has been disclosed (Patent Document 3, for example). Thus, the above-mentioned Patent Documents can reduce getting caught of a trailing supporting portion of intraocular lens having thin filament-shaped or plate-like supporting portions. Patent Document 1: Japanese Translation of PCT International Application No. 11-506357

Patent Document 2: U.S. Pat. No. 6,733,507

Patent Document 3: Japanese Unexamined Patent Publication No. 2004-351196

DISCLOSURE OF THE INVENTION

Problems to be Solved by the Invention

The above-mentioned Patent Documents 1 and 2, however, still have a problem that the trailing supporting portion relieved into a clearance at the distal end of plunger or a relief channel for a trailing supporting portion stretches and the trailing supporting portion is left outside of the incision when the intraocular lens is inserted through a small incision of the eye. Especially, an intraocular lens having thin plate-like supporting portions which are made of thick soft members has a problem that it takes time and labor to conduct a repeated operation. In the foregoing Patent Document 3, too, there are concerns that while an intraocular lens is moved further through the nozzle after the haptics are bent up and over IOL, the trailing supporting portion may be compressed into an unexpected shape, causing a breakage of the trailing supporting portion, a trouble during insertion, or a state of the folded trailing supporting portion accommodated in the intraocular lens not returning to a desired shape after insertion into an eye.

In view of the foregoing problems, an object of the present invention is to provide an intraocular lens insertion device and an intraocular lens movement control method which can appropriately control the behavior of a trailing supporting portion in a process of movement of the intraocular lens and can reduce the possibility of a repeated operation after insertion of the intraocular lens into an eye.

Means for Solving the Problems

The inventor of the present application conducted studies over and over again and found that the above-mentioned object could be achieved by folding an optic and supporting portions individually while minimizing the interference of the optic and the supporting portions during movement of the intraocular lens.

To achieve the above object, the invention according to claim **1** features an intraocular lens insertion device comprising: a lens setting part for setting an intraocular lens having an optic and one or two or more supporting portions disposed at the outer edge of the optic; a plunger for pushing out the intraocular lens set on the lens setting part; and a nozzle for releasing the intraocular lens pushed out by the plunger, the intraocular lens being set on the lens setting part with at least one of the supporting portions being arranged in the backward direction of a lens advancing axis, wherein the plunger includes a lens contact portion for abutting against the outer edge of the optic and a pushing portion for pushing out the supporting portion arranged in the backward direction of the lens advancing axis.

The invention according to claim **2** is characterized in that the pushing portion bends the supporting portion in the forward direction of the lens advancing axis.

The invention according to claim **3** is characterized in that the pushing portion bends the supporting portion in the forward direction of the lens advancing axis without interference of the optic and the supporting portion.

The invention according to claim **4** is characterized in that the pushing portion includes a guide extending in the direction of the lens advancing axis.

The invention according to claim **5** is characterized in that the pushing portion is a groove extending in the direction of the lens advancing axis.

The invention according to claim **6** is characterized in that the pushing portion includes a supporting portion abutting face for abutting against the deformed supporting portion.

The invention according to claim **7** features a method for controlling movement of an intraocular lens, comprising the steps of: setting an intraocular lens having an optic and one or two or more supporting portions disposed at the outer edge of the optic on a lens setting part with at least one of the supporting portions being arranged in the backward direction of a lens advancing axis; and moving the intraocular lens in the forward direction of the lens advancing axis, wherein the moving step includes the steps of: pushing out the supporting portion arranged in the backward direction of the lens advancing axis in the lens moving direction; and pushing out the outer edge of the optic in the forward direction of the lens advancing axis.

The invention according to claim **8** is characterized in that the step of pushing out of the supporting portion comprises a step of bending a tip of the supporting portion in the forward direction of the lens advancing axis.

Effect of the Invention

According to the intraocular lens insertion device set forth in claim **1** of the present invention, the pushing portion provided on the plunger moves an intraocular lens forward with the supporting portion being caught, thereby preventing the supporting portion from stretching backward as the intraocular lens is moving forward. Therefore, with this intraocular lens insertion device, the supporting portions can be inserted together with the optic into an eye through an incision at one operation, thereby omitting a repeated operation after the intraocular lens was inserted into the eye.

According to the intraocular lens insertion device set forth in claim **2** of the present invention, the optic and the supporting portion arranged in the backward direction of the lens advancing axis are prevented from being damaged or broken while the intraocular lens is moving.

According to the intraocular lens insertion device set forth in claim **3** of the present invention, the intraocular lens is moved forward with a minimum of interference of the optic and the supporting portion arranged in the backward direction of the lens advancing axis, thereby preventing the optic and the trailing supporting portion from being damaged or broken while the intraocular lens is moving.

According to the intraocular lens insertion device set forth in claim **4** of the present invention, the supporting portion arranged in the backward direction of the lens advancing axis is prevented from dropping off in a process of movement of the intraocular lens, resulting in a more reliable control of the supporting portion.

According to the intraocular lens insertion device set forth in claim **5** of the present invention, the supporting portion arranged in the backward direction of the lens advancing axis is pushed out by the supporting portion abutting face and can be inserted into the eye, thereby ensuring that a repeated operation after insertion of the lens into the eye can be omitted.

According to the intraocular lens insertion device set forth in claim **6** of the present invention, the supporting portion can be caught with a simple configuration.

According to the intraocular lens movement control method set forth in claim **7** of the present invention, the pushing portion provided on the plunger moves the intraocular lens forward with the supporting portion being caught, thereby preventing the supporting portion from stretching as the intraocular lens moves forward. Therefore, the intraocular lens insertion device enables the supporting portions to be inserted together with the optic into an eye through an incision at one operation. Thus, the intraocular lens insertion device can omit a repeated operation after insertion of the intraocular lens into the eye.

According to the intraocular lens movement control method set forth in claim **8** of the present invention, the supporting portion can be more surely prevented from stretching backward as the intraocular lens moves forward.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** shows the overall configuration of an intraocular lens insertion device of the present invention.

FIG. **2** is a perspective view showing the configuration of a cartridge of the same as above.

FIG. **3** is a perspective view showing the configuration of a main body of the same as above.

FIG. **4** is a partial perspective view showing the configuration of a plunger of the same as above.

FIG. **5**A' is a section view showing the intraocular lens insertion device illustrated in FIG. **1** with the plunger abutting against a supporting portion.

FIG. **5**A is a section view taken along line A-A in FIG. **5**A'.

FIG. **5**B' is a section view showing the intraocular lens insertion device illustrated in FIG. **1** with the plunger catching a supporting portion.

FIG. **5**B is a section view taken along line B-B in FIG. **5**B'.

FIG. **5**C' is a section view showing the intraocular lens insertion device illustrated in FIG. **1** with the plunger abutting against an optic.

FIG. **5**C is a section view taken along line C-C in FIG. **5**C'.

FIG. **6**A' is a section view showing another exemplary intraocular lens insertion device with the plunger abutting against a supporting portion.

FIG. **6**A is a section view taken along line A-A in FIG. **6**A'.

FIG. **6**B' is a section view showing the intraocular lens insertion device illustrated in FIG. **6**A' with the plunger catching a supporting portion.

FIG. **6**B is a section view taken along line B-B in FIG. **6**B'.

FIG. **6**C' is a section view showing the intraocular lens insertion device illustrated in FIG. **6**A' with the plunger abutting against an optic.

FIG. **6**C is a section view taken along line C-C in FIG. **6**C'.

FIG. **7** is a view showing a modified example of a plunger of the same as above.

FIG. **8** is a view showing another modified example of a plunger of the same as above.

FIG. **9**A is a plan view of an intraocular lens having filament-shaped supporting portions.

FIG. **9**B is a plan view of an intraocular lens having a plate-like supporting portion.

FIG. **9**C is a plan view of an intraocular lens having thin plate-like supporting portions.

BEST MODE FOR CARRYING OUT THE INVENTION

Hereinafter, a preferred embodiment of the present invention will be described with reference to the accompanying drawings.

1. Embodiment

(1) General Structure

An intraocular lens insertion device **1** shown in FIG. **1** has a cartridge **2**, a main body **3** and a plunger **4**. The cartridge **2** is installed to the main body **3** after an intraocular lens **5** is set on the cartridge. On the other hand, the plunger **4** is provided so that it can move in the forward and backward directions of the lens advancing axis A inside the main body **3**. The intraocular lens insertion device **1** having such a configuration is generally configured to push out the intraocular lens **5** set in the cartridge **2** by using the plunger **4** and to release the intraocular lens **5** from the end of the cartridge **2** into an eye.

For reference's sake, an intraocular lens insertion device **1** may be made of various materials. For example, synthetic resin may be used for all portions of the tool, thereby allowing easy mass production; or metal such as titanium may be used. The intraocular lens **5** also has an optic **6** and a pair of thin plate-like supporting portions (sometimes referred to as "loop haptics") **7***a*,**7***b* disposed at the outer edge of the optic **6**.

Hereinafter, each configuration will be described in detail. In the description below, the forward direction of the lens advancing axis A is simply referred to as "forward" and the backward direction of the lens advancing axis A is simply referred to as "backward".

As shown in FIG. **2**, the cartridge **2** comprises: a cartridge main body **14** having an insertion opening **10**, a lens setting part **11**, a transition part **12** and a nozzle **13** in the order along the lens advancing axis A; and wing portions **15**,**15** extending from both sides of the cartridge main body **14**. At the insertion opening **10**, an insertion groove **16** which was formed by notching in the direction of the lens advancing axis A is provided. In the forward direction of the lens advancing axis A of the insertion opening **10**, a lens setting part **11** is provided. In the forward direction of the lens advancing axis A of the lens setting part **11**, the transition part **12** is provided. The inner wall of the transition part **12** has a mortar shape tapering toward the distal end and communicates with a nozzle **13** at the distal end. With this configuration, the cartridge main body **14** is formed so that it can move from the lens setting part **11** to the transition part **12**, and then, from the transition part **12** to the nozzle **13** when the intraocular lens **5** mounted on the lens setting part **11** through the insertion opening **10** is pushed by the plunger **4**. The nozzle **13** is formed so that it has an outside diameter sized to be inserted into the incision opening (not shown). The bore of the cartridge **2** is formed so that it has an oval shape at the insertion opening **10**, converging into a perfect circle toward the proximal end of the nozzle **13**.

As shown in FIG. **3**, the main body **3** comprises an attachment portion **20** for removably attaching the cartridge **2**, a flange **21** for locking the fingers of the operator, and a tubular body **24** connecting the attachment portion **20** and the flange **21**. The attachment portion **20** is provided at the distal end of the main body **3** formed into a semicircle shape and comprises guide passages **22**,**22** for guiding the wing portions **15**,**15** of the cartridge **2** and locking pieces **23**,**23** provided forward of the lens advancing axis A of the guide passages **22**,**22**. The locking pieces **23**,**23** are configured so that it can lock the front ends of the wing portions **15**,**15** of the cartridge **2**. The flange **21** is provided on the outer surface of the proximal end of the main body **3**.

Next, a plunger **4** which is a characteristic component of the present invention will be described in detail. As shown in FIG. **1**, the plunger **4** comprises a pushing rod **30** for pushing out the intraocular lens **5**, a pressing portion **31** provided at the proximal end of the pushing rod **30** and a lens contact portion **32** provided at the distal end of the pushing rod **30**. This plunger **4** is installed into the main body **3** in such a manner as to move forward or backward along the lens advancing axis A inside the main body **3**. The plunger **4** installed into the main body **3** is configured so that the operator can push out the intraocular lens **5** by pushing the pressing portion **31** and bringing the lens contact portion **32** into contact with the intraocular lens **5** mounted on the lens setting part **11**.

As shown in FIG. **4**, the plunger has a lens contact portion **32** and a pushing portion **33** connected to the lens contact portion **32** at the distal end of the pushing rod **30**.

The lens contact portion **32** is formed by a vertical plane relative to the lens advancing axis A. The pushing portion **33** catches the supporting portion (hereinafter referred to as the trailing supporting portion) **7***b* arranged in the backward direction of the lens advancing axis A and moves the trailing supporting portion **7***b* together with the optic **6** without separating from the optic **6**. The pushing portion **33** is provided on one side of the lens contact portion **32** and

comprises a groove **34** extending in the backward direction from the distal end of the pushing rod **30**, guides **35**,**35** provided on both sides of the groove **34** in parallel with the lens advancing axis A, and a supporting portion abutting face **36**. In this embodiment, the groove **34** has a concave bottom face and connects to the guides **35**,**35** at the opening end of the side face **34***b* converging from the opening toward the bottom face **34***a*. These guides **35**,**35** are provided at both sides of the groove **34** and formed into a columnar shape, and their ends form part of the lens contact portion **32**. The supporting portion abutting face **36** is provided so that a deformed trailing supporting portion **7***b* can abut against it. This supporting portion abutting face **36** is formed with a plane which slants backward as it goes upward from the surface of the groove **34**, and blocks the backward end of the groove **34**.

The plunger **4** having such a configuration is attached to the main body **3**, as shown in FIG. **1**, by inserting the lens contact portion **32**, first, in the proximal end of the main body **3** and by positioning the lens contact portion **32** at the distal end of the main body **3** and the pressing portion **31** at the proximal end of the main body **3**.

(2) Operation and Effect

Next, the operation and effect of the above-mentioned intraocular lens insertion device **1** will be described with reference to the accompanying drawings. FIGS. **5**A'-**5**C' are sectional views of the vicinity of the lens setting part **11** of the cartridge **2**, and FIGS. **5**A-**5**C are cross-sections of FIGS. **5**A'-**5**C'.

First, the intraocular lens **5** folded into two by use of tweezers (not shown) is inserted through the insertion opening **10**, and then the intraocular lens **5** is set on the lens setting part **11** of the cartridge **2** pre-filled with ophthalmic viscoelastic material. At this time, the intraocular lens **5** is set with a pair of supporting portions **7***a*,**7***b* arranged in the forward and backward directions, respectively, relative to the optic **6** (FIGS. **5**A and **5**A'). The intraocular lens **5** is positioned with the folded optic **6** arranged on one side and the proximal ends of the supporting portions **7***a*,**7***b* arranged on the other side, respectively. The tips of the supporting portions **7***a*,**7***b* hang down on one side as they move in the forward and backward directions across the optic **6**, respectively. Furthermore, the intraocular lens **5** which is folded into two comes into contact with the bore of the cartridge **2** formed into an oval shape, and accordingly, the supporting portions **7***a*,**7***b* are arranged along the side wall of the bore.

Next, the cartridge **2** having the intraocular lens **5** mounted on the lens setting part **11** is attached to the attachment portion **20** of the main body **3** by sliding forward of the lens advancing axis A with the wing portions **15**,**15** mounted on the guide passages **22**,**22** and locking the front ends of the wing portions **15**,**15** with the locking pieces **23**,**23**.

After the cartridge **2** is attached to the main body **3**, the nozzle portion **13** is first inserted into an eye through the incision opening (not shown) by the operator.

On the other hand, the plunger **4** moves forward when the operator pushes the pressing portion **31**. When the plunger **4** moves forward, the lens contact portion **32** provided at the distal end of the pushing rod **30** comes in contact with the tip of the trailing supporting portion **7***b* (FIGS. **5**A and **5**A'). At this time, the trailing supporting portion **7***b* is positioned along the bore of the cartridge **2** and comes in contact with the trailing supporting portion **7***b* at the distal end of the guides **35**,**35**.

Furthermore, when the plunger **4** is pushed and the lens contact portion **32** moves forward, the trailing supporting portion **7***b* which is hanging down to one side is bent at its tip in the forward direction (FIGS. **5**B and **5**B'). At the same time, the trailing supporting portion **7***b* is guided into the central groove **34** by the side face **34***b* converging from the opening toward the bottom face **34***a*. In this way, the pushing portion **33** catches the trailing supporting portion **7***b* by supporting the tip of the trailing supporting portion **7***b* from one side by the groove **34**.

The plunger **4**, by which the trailing supporting portion **7***b* was caught at the pushing portion **33**, is pushed further, and the lens contact portion **32** abuts against the outer edge of the intraocular lens **5** and moves the intraocular lens **5** forward (FIGS. **5**C and **5**C'). The intraocular lens **5** moving in the cartridge **2** is pushed inward by the inner wall of the transition part **12** and folded to a smaller size. In this way, the intraocular lens insertion device **1** releases the compactly folded intraocular lens **5** from the tip of the nozzle **13**.

In the conventional intraocular lens insertion device **1**, as the intraocular lens **5** moves forward, the trailing supporting portion **7***b* stretches backward. Therefore, by using the conventional intraocular lens insertion device **1**, the trailing supporting portion **7***b* is left outside of the incision when the intraocular lens **5** is inserted through a small incision of an eye, and a repeated operation was needed to insert the trailing supporting portion **7***b* left outside of the incision into the incision.

In contrast, in the intraocular lens insertion device **1** according to this embodiment, the pushing portion **33** provided on the plunger **4** moves the intraocular lens **5** forward with the trailing supporting portion **7***b* being caught, thereby preventing the trailing supporting portion **7***b* from stretching backward as the intraocular lens **5** moves forward. Thus, the intraocular lens insertion device **1** allows the pushing portion **33** to move the intraocular lens **5** without separating the trailing supporting portion **7***b* from the optic **6** and enables the trailing supporting portion **7***b* and the optic **6** to be inserted into the eye through the incision at one operation. Therefore, the intraocular lens insertion device **1** can omit a repeated operation after the intraocular lens **5** was inserted into the eye.

In addition, the supporting portion abutting face **36** abuts against the trailing supporting portion **7***b*. By pushing out the trailing supporting portion **7***b* by the supporting portion abutting face **36**, the trailing supporting portion **7***b* can be inserted into the eye. Thus, the intraocular lens insertion device **1** can omit a repeated operation more surely after the intraocular lens **5** was inserted into the eye.

As mentioned above, the plunger **4** is provided with a pushing portion **33** for pushing out the trailing supporting portion **7***b*, besides a lens contact portion **32**, thereby folding the trailing supporting portion **7***b* and the optic **6**, separately. Therefore, the intraocular lens insertion device **1** can move the intraocular lens **5** forward, keeping interference of the trailing supporting portion **7***b* and the optic **6** at a minimum level. Thus, the intraocular lens insertion device **1** can reduce interference of the optic **6** and the trailing supporting portion **7***b* during movement of the intraocular lens **5**, thereby preventing the optic **6** and the trailing supporting portion **7***b* from being damaged or broken.

As mentioned above, in this embodiment, the guides **35**,**35** are formed into a columnar shape, and they can guide the trailing supporting portion **7***b* in contact with the distal ends of the guides **35**,**35** to the groove **34** without causing damage.

This pushing portion **33** is formed by the groove **34**, thereby catching the trailing supporting portion **7***b* with such a simple structure. Also, the groove **34** has a concave bottom face and can guide the trailing supporting portion **7***b* in contact with the guides **35**,**35** smoothly in the groove **34** in the center.

In addition, the bottom face of the groove **34** on the pushing portion **33** is formed by a concave face, thereby catching the trailing supporting portion **7***b* guided to the groove **34** without causing damage.

Furthermore, as the pushing portion **33** is provided with the guides **35**,**35**, it can prevent the caught trailing supporting portion **7***b* from falling off in the process of movement of the intraocular lens **5** and control the trailing supporting portion **7***b* with more reliability.

2. Modified Example of Cartridge

The difference between the cartridge **40** shown in FIGS. **6**A-**6**C' and the above embodiment lies in only the bore shape. With regard to this cartridge **40**, when the side of the bore where the optic **6** of the intraocular lens **5** folded into two is placed is regarded as one side **12***a*, the other side **12***b* has a smaller width compared to the one side **12***a*. FIGS. **6**A'-**6**C' are sectional views of the vicinity of the lens setting part **11** on the cartridge **40** and FIGS. **6**A-**6**C are cross-sections of FIGS. **6**A'-**6**C'.

In this modified example, when the operator pushes the pressing portion **31**, the plunger **4** moves forward and the lens contact portion **32** provided at the distal end of the pushing rod **30** abuts against the tip of the trailing supporting portion **7***b* (FIGS. **6**A and **6**A'). The trailing supporting portion **7***b* is pushed by the inner wall of the other side **12***b* in the bore of the cartridge **40** having a smaller width compared with the one side **12***a* which is the side of the optic **6** of the intraocular lens **5** placed on the cartridge and is placed in the vicinity of the center of the bore. As a result, the trailing supporting portion **7***b* comes in contact with the center of the pushing portion **33**, that is, the groove **34**.

When the plunger **4** is pushed further and the lens contact portion **32** moves forward, the trailing supporting portion **7***b* hanging down to the one side **12***a* is bent in the forward direction at its tip (FIGS. **6**B and **6**B'). At the same time, the trailing supporting portion **7***b* is guided into the groove **34** in the center by the side face **34***b* converging from the opening toward the bottom face **34***a*. In this way, the pushing portion **33** catches the trailing supporting portion **7***b* by supporting the tip of the trailing supporting portion **7***b* from the one side **12***a* by the groove **34**.

When the plunger **4** which caught the trailing supporting portion **7***b* at the pushing portion **33** is further pushed, the lens contact portion **32** abuts against the outer edge of the intraocular lens **5** and the intraocular lens **5** is moved forward (FIGS. **6**C and **6**C'). In this way, the cartridge **40** according to this modified example has a bore whose width of the other side **2***b* is smaller than that of the one side **12***a*, allowing the trailing supporting portion **7***b* to be guided to the groove **34** in the center more easily than the above embodiment.

3. Modified Example of Plunger

The plunger **4** shown in FIG. **7** is different from the above embodiment in the structure of a pushing portion. More specifically, the pushing portion **50** according to this modified example is formed into a rectangular parallelepiped shape defined by a groove **51** and guides **52**,**52** integrally set up on both sides of the groove **34**. The distal ends of the guides **52**,**52** form part of the lens contact portion **32**. The bottom face **51***a* of the groove **51** is formed by a flat plane, and a pair of guides **52**,**52** formed on both sides of the groove **51** have a rectangular parallelepiped shape. The corners of these guides **52**,**52** are processed into round shape. Though this modified example has a simple shape compared to the above embodiment, it has an effect of omitting a repeated operation after the intraocular lens **5** was inserted into an eye.

In addition, the plunger **60** shown in FIG. **8** is provided with a scooping face **61** at the lens contact portion **32** on the pushing portion **50** shown in FIG. **7**. Providing such a scooping face **61** at the lens contact portion **32** can prevent the distal end of the plunger **4** from running on the optic **6** in the process of movement of the intraocular lens **5**. In this modified example, the same effect as the above embodiment can be obtained by providing the pushing portion **50**.

The present invention is not limited to the embodiment described above, and various modifications can be made thereto within the scope of the present invention. For example, in the above-mentioned embodiment, the transition part of the main body has a mortar shape tapering toward the distal end, and the intraocular lens **5** is folded into a small size by passing through the transition part. The present invention, however, is not limited to this embodiment, but applies to the main body having a simple cylindrical transition part.

According to the above-mentioned embodiment, the supporting portions are thin plates. The present invention, however, is not limited to this embodiment, but applies to an intraocular lens having thin filament-shaped supporting portions.

The invention claimed is:

1. A method of operating an insertion device including a main body, a nozzle, and a tapered transition portion proximal of the nozzle, the method comprising the steps of:

applying force to an intraocular lens, located within the main body and having an optic, a leading loop haptic with a fixed end at the optic and a free end, and a trailing loop haptic with a fixed end at the optic and a free end, with a plunger, including a distal portion with a lens contact surface and a slot that extends proximally from the lens contact surface, in such a manner that a portion of the trailing loop haptic is located within the slot while being bent toward the nozzle by the distal portion and the free end of the trailing loop haptic points toward the nozzle; and

pushing the intraocular lens into the nozzle with the plunger.

2. A method as claimed in claim **1**, wherein

the trailing loop haptic is in an unbent state prior to force being applied with the plunger.

3. A method as claimed in claim **1**, wherein

the main body and nozzle of the insertion device define a lens advancing axis; and

the free end of the trailing loop haptic is located on the lens advancing axis when pointing toward the nozzle.

4. A method as claimed in claim **1**, wherein

the main body and nozzle of the insertion device define a lens advancing axis; and

the distal portion with the lens contact surface and the slot has an outer surface that defines a non-circular shape in a cross-section that is perpendicular to the lens advancing axis.

5. A method as claimed in claim **1**, wherein

the trailing and leading loop haptics comprise filament shaped loop haptics.

6. A method as claimed in claim **1**, wherein

the trailing and leading loop haptics comprise thin plate loop haptics.

7. A method as claimed in claim **1**, wherein

the distal portion of the plunger includes a scoop projecting from the lens contact surface.

8. A method as claimed in claim **1**, further comprising the step of:

folding the optic prior to applying force to the intraocular lens with a plunger.

9. A method as claimed in claim **8**, wherein

the main body and nozzle of the insertion device are part of a cartridge;

the method further comprises the step of placing the intraocular lens with the folded optic into the cartridge prior to applying force to the intraocular lens with a plunger.

10. A method as claimed in claim **1**, wherein

the main body and nozzle of the insertion device define a lens advancing axis; and

the slot comprises an elongate slot that is located on the lens advancing axis.

11. A method as claimed in claim **1**, wherein

at least a portion of the trailing haptic is bent into a U-shape when the trailing loop haptic is located within the slot and the free end of the trailing loop haptic points toward the nozzle.

12. A method of operating an insertion device including a main body and a nozzle, the method comprising the step of:

applying force to an intraocular lens, located within the main body and having an optic, a leading loop haptic with a fixed end at the optic and a free end, and a trailing loop haptic with a fixed end at the optic and a free end, with a plunger, including a distal portion with a lens contact surface and an elongate slot that extends proximally from the lens contact surface, in such a manner that a portion of the trailing loop haptic is located within the elongate slot while being bent toward the nozzle by the distal portion and the free end of the trailing loop haptic points toward the nozzle prior to the lens contact surface contacting the optic.

13. A method as claimed in claim **12**, further comprising the step of:

engaging the optic with the lens contact surface after the trailing loop haptic is located within the elongate slot and the free end of the trailing loop haptic points toward the nozzle.

* * * * *

EXHIBIT 6

US010039668B2

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

(10) **Patent No.: US 10,039,668 B2**
(45) **Date of Patent: Aug. 7, 2018**

(54) **OCULAR IMPLANT INSERTION APPARATUS AND METHODS**

(71) Applicant: **Hoya Corporation**, Tokyo (JP)

(72) Inventors: **Kazunori Kudo**, Saku (JP); **Masahiro Noda**, Toda (JP)

(73) Assignee: **Hoya Corporation**, Tokyo (JP)

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

(21) Appl. No.: **15/071,880**

(22) Filed: **Mar. 16, 2016**

(65) **Prior Publication Data**

US 2016/0193038 A1 Jul. 7, 2016

Related U.S. Application Data

(63) Continuation of application No. 14/145,846, filed on Dec. 31, 2013, now Pat. No. 9,314,373, which is a (Continued)

(30) **Foreign Application Priority Data**

Jun. 10, 2010 (JP) 2010-132952

(51) **Int. Cl.**
A61F 2/16 (2006.01)
A61F 9/00 (2006.01)
(Continued)

(52) **U.S. Cl.**
CPC ***A61F 9/0017*** (2013.01); ***A61F 2/148*** (2013.01); ***A61F 2/167*** (2013.01); ***A61F 2/1667*** (2013.01); ***A61F 9/0008*** (2013.01); *A61F 2/0095* (2013.01); *A61F 2/1678* (2013.01); *A61F 2/1691* (2013.01); *A61F 2002/1681* (2013.01)

(58) **Field of Classification Search**
CPC A61F 2/148; A61F 9/0008; A61F 2/167; A61F 2/1662
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

2,761,446 A 9/1956 Reed
4,205,747 A 6/1980 Gilliam et al.
(Continued)

FOREIGN PATENT DOCUMENTS

DE 3610925 10/1987
DE 4110278 10/1992
(Continued)

OTHER PUBLICATIONS

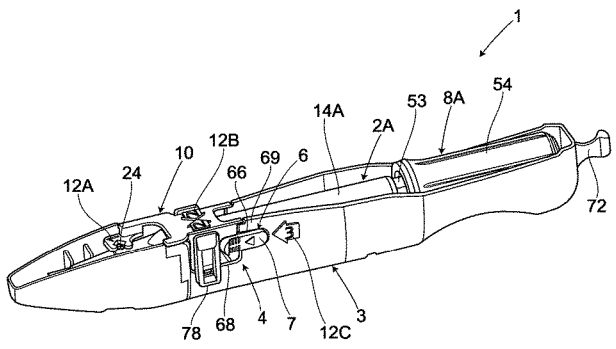
U.S. Appl. No. 15/870,979, filed Jan. 14, 2018.

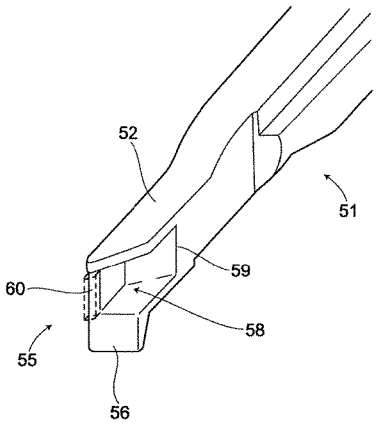
Primary Examiner — Son Dang
(74) *Attorney, Agent, or Firm* — Henricks, Slavin & Holmes LLP

(57) **ABSTRACT**

An exemplary ocular implant insertion system includes a case and a preloaded ocular implant insertion apparatus. The apparatus includes first and second movable structures that move the ocular implant in a predetermined sequence. The respective configurations of the case and the ocular implant insertion apparatus are such that the ocular implant insertion apparatus is not removable from the case when the ocular implant insertion apparatus is in the pre-use state and is removable after the first movable structure has moved at least a portion of the optical implant.

17 Claims, 12 Drawing Sheets





Related U.S. Application Data

continuation of application No. 13/699,708, filed as application No. PCT/JP2011/063747 on Jun. 8, 2011, now Pat. No. 8,647,382.

(51) **Int. Cl.**
A61F 2/14 (2006.01)
A61F 2/00 (2006.01)

(56) **References Cited**

U.S. PATENT DOCUMENTS

4,269,307 A 5/1981 LaHaye
4,423,809 A 1/1984 Mazzocco
4,573,998 A 3/1986 Mazzocco
4,608,049 A 8/1986 Kelman
4,634,423 A 1/1987 Bailey
4,681,102 A 7/1987 Bartell
4,697,697 A 10/1987 Graham et al.
4,699,140 A 10/1987 Holmes
4,702,244 A 10/1987 Mazzocco
4,715,373 A 12/1987 Mazzocco et al.
4,747,404 A 5/1988 Jampel et al.
4,750,498 A 6/1988 Graham
4,759,359 A 7/1988 Willis et al.
4,763,650 A 8/1988 Hauser
4,765,329 A 8/1988 Cumming et al.
4,769,034 A 9/1988 Poley
4,781,719 A 11/1988 Kelman
4,787,904 A 11/1988 Severin
4,810,249 A 3/1989 Haber et al.
4,819,631 A 4/1989 Poley
4,834,094 A 5/1989 Patton
4,836,201 A 6/1989 Patton
4,862,885 A 9/1989 Cumming
4,880,000 A 11/1989 Holmes et al.
4,919,130 A 4/1990 Stoy et al.
4,934,363 A 6/1990 Smith et al.
4,955,889 A 9/1990 Van Gent
4,976,716 A 12/1990 Cumming
4,988,352 A 1/1991 Poley
4,994,028 A 2/1991 Leonard et al.
5,066,297 A 11/1991 Cumming
5,098,439 A 3/1992 Hill et al.
5,123,905 A 6/1992 Kelman
5,139,501 A 8/1992 Klaas
5,171,241 A 12/1992 Buboltz et al.
5,176,686 A 1/1993 Poley
5,190,552 A 3/1993 Kelman
5,190,553 A 3/1993 Kanert et al.
5,222,972 A 6/1993 Hill et al.
5,242,450 A 9/1993 McDonald
5,259,395 A 11/1993 Li
5,275,604 A 1/1994 Rheinish et al.
5,281,227 A 1/1994 Sussman
5,304,182 A 4/1994 Rheinish et al.
5,354,333 A 10/1994 Kammann et al.
5,395,378 A 3/1995 McDonald
5,425,734 A 6/1995 Blake
5,454,818 A 10/1995 Hambleton et al.
5,468,246 A 11/1995 Blake
5,474,562 A 12/1995 Orchowski et al.
5,494,484 A 2/1996 Feingold
5,496,328 A 3/1996 Nakajima et al.
5,499,987 A 3/1996 Feingold
5,562,676 A 10/1996 Brady et al.
5,571,113 A 11/1996 McDonald
5,578,042 A 11/1996 Cumming
5,582,613 A 12/1996 Brady
5,582,614 A 12/1996 Feingold
5,584,304 A 12/1996 Brady
5,616,148 A 4/1997 Eagles et al.
5,620,450 A 4/1997 Eagles et al.
5,643,275 A 7/1997 Blake
5,643,276 A 7/1997 Zaleski
5,645,534 A 7/1997 Chanoch
5,653,715 A 8/1997 Reich et al.
5,653,753 A 8/1997 Brady et al.
5,702,402 A 12/1997 Brady
5,702,441 A 12/1997 Zhou
5,716,364 A 2/1998 Makker et al.
5,728,075 A 3/1998 Levander
5,728,102 A 3/1998 Feingold et al.
5,735,858 A 4/1998 Makker et al.
5,766,181 A 6/1998 Chambers et al.
5,772,666 A 6/1998 Feingold et al.
5,772,667 A 6/1998 Blake
5,776,138 A 7/1998 Vidal et al.
5,800,442 A 9/1998 Wolf et al.
5,803,925 A 9/1998 Yang et al.
5,807,400 A 9/1998 Chambers et al.
5,810,833 A 9/1998 Brady et al.
5,810,834 A 9/1998 Heyman
5,860,984 A 1/1999 Chambers et al.
5,860,986 A 1/1999 Reich et al.
5,868,751 A 2/1999 Feingold
5,868,752 A 2/1999 Makker et al.
5,873,879 A 2/1999 Figueroa et al.
5,876,406 A 3/1999 Wolf et al.
5,876,407 A 3/1999 Makker et al.
5,876,440 A 3/1999 Feingold
5,891,152 A 4/1999 Feingold
5,902,307 A 5/1999 Feingold et al.
5,919,197 A 7/1999 McDonald
5,921,989 A 7/1999 Deacon et al.
5,928,245 A 7/1999 Wolf et al.
5,941,886 A 8/1999 Feingold
5,942,277 A 8/1999 Makker et al.
5,944,725 A 8/1999 Cicenas
5,947,974 A 9/1999 Brady et al.
5,947,975 A 9/1999 Kikuchi et al.
5,957,748 A 9/1999 Ichiha
5,957,896 A 9/1999 Bendek et al.
6,001,107 A 12/1999 Feingold
6,010,510 A 1/2000 Brown et al.
6,022,358 A 2/2000 Wolf et al.
6,048,348 A 4/2000 Chambers et al.
6,051,000 A 4/2000 Heyman
6,056,757 A 5/2000 Feingold et al.
6,056,758 A 5/2000 Vidal et al.
6,059,791 A 5/2000 Chambers
6,074,397 A 6/2000 Chambers et al.
6,083,230 A 7/2000 Makker et al.
6,093,193 A 7/2000 Makker et al.
6,129,733 A 10/2000 Brady et al.
6,142,999 A 11/2000 Brady et al.
6,143,000 A 11/2000 Feingold
6,162,229 A 12/2000 Feingold et al.
6,174,315 B1 1/2001 Chambers et al.
6,214,015 B1 4/2001 Reich et al.
6,241,737 B1 6/2001 Feingold
6,248,111 B1 6/2001 Glick et al.
6,251,114 B1 6/2001 Farmer et al.
6,254,607 B1 7/2001 Makker et al.
6,267,768 B1 7/2001 Deacon
6,283,975 B1 9/2001 Glick et al.
6,283,976 B1 9/2001 Portney
6,312,433 B1 11/2001 Butts
6,334,862 B1 1/2002 Vidal et al.
6,336,932 B1 1/2002 Figueroa et al.
6,355,046 B2 3/2002 Kikuchi et al.
6,371,960 B2 4/2002 Heyman et al.
6,386,357 B1 5/2002 Egawa
6,387,101 B1 5/2002 Butts et al.
6,398,788 B1 6/2002 Makker et al.
6,406,481 B2 6/2002 Feingold et al.
6,428,545 B2 8/2002 Portney
6,447,519 B1 9/2002 Brady et al.
6,447,520 B1 9/2002 Ott et al.
6,468,282 B2 10/2002 Kikuchi et al.
6,471,708 B2 10/2002 Green
6,491,697 B1 12/2002 Clark et al.
6,497,708 B1 12/2002 Cumming
6,500,181 B1 12/2002 Portney
6,506,195 B2 1/2003 Chambers et al.

(56) **References Cited**

U.S. PATENT DOCUMENTS

6,537,283 B2 3/2003 Van Noy
6,540,754 B2 4/2003 Brady
6,554,839 B2 4/2003 Brady
6,558,395 B2 5/2003 Hjertman et al.
6,605,093 B1 8/2003 Blake
6,607,537 B1 8/2003 Binder
6,629,979 B1 10/2003 Feingold
6,666,871 B2 12/2003 Kikuchi et al.
6,679,891 B2 1/2004 Makker et al.
6,685,740 B2 2/2004 Figueroa et al.
6,712,848 B1 3/2004 Wolf et al.
6,723,104 B2 4/2004 Ott
6,733,507 B2 5/2004 McNicholas et al.
6,793,674 B2 9/2004 Zapata
6,858,033 B2 2/2005 Kobayashi
6,921,405 B2 7/2005 Feingold et al.
6,923,815 B2 8/2005 Brady et al.
6,976,989 B1 12/2005 Vincent
7,014,641 B2 3/2006 Kobayashi et al.
7,025,782 B2 4/2006 Kobayashi et al.
7,033,366 B2 4/2006 Brady
7,037,312 B2 5/2006 Kikuchi et al.
7,074,227 B2 7/2006 Portney
7,097,649 B2 8/2006 Meyer
7,131,976 B2 11/2006 Kobayashi et al.
7,156,854 B2 1/2007 Brown et al.
7,348,038 B2 3/2008 Makker et al.
7,422,604 B2 9/2008 Vaquero et al.
7,429,263 B2 9/2008 Vaquero et al.
7,458,976 B2 12/2008 Peterson et al.
7,476,230 B2 1/2009 Ohno et al.
7,494,505 B2 2/2009 Kappelhof et al.
7,645,300 B2 1/2010 Tsai
8,273,122 B2 9/2012 Anderson
8,382,769 B2 2/2013 Inoue
8,460,311 B2 * 6/2013 Ishii A61F 2/1678 606/107
8,470,032 B2 6/2013 Inoue et al.
8,475,528 B2 7/2013 Ichinohe et al.
8,523,877 B2 * 9/2013 Ichinohe A61F 2/1662 606/107
8,523,941 B2 * 9/2013 Ichinohe A61F 9/0017 606/107
8,535,375 B2 9/2013 Ichinohe et al.
8,545,512 B2 10/2013 Ichinohe et al.
8,574,239 B2 11/2013 Ichinohe et al.
8,603,103 B2 12/2013 Kudo et al.
8,647,382 B2 2/2014 Kudo et al.
8,702,795 B2 4/2014 Shoji et al.
8,747,465 B2 * 6/2014 Someya A61F 2/1678 606/107
8,968,328 B2 3/2015 Ichinohe et al.
9,114,006 B2 8/2015 Inoue
9,114,007 B2 8/2015 Ichinohe et al.
9,186,246 B2 11/2015 Inoue
9,220,593 B2 12/2015 Ichinohe
9,289,288 B2 3/2016 Someya et al.
9,314,373 B2 4/2016 Kudo et al.
9,326,847 B2 5/2016 Sanger
9,364,320 B2 6/2016 Ichinohe et al.
9,554,894 B2 1/2017 Inoue
9,572,710 B1 2/2017 Kudo et al.
9,655,718 B2 5/2017 Kudo et al.
9,877,826 B2 1/2018 Kudo et al.
2001/0007942 A1 * 7/2001 Kikuchi A61F 2/1672 606/107
2002/0103490 A1 8/2002 Brady
2002/0151904 A1 10/2002 Feingold et al.
2002/0165610 A1 11/2002 Waldock
2002/0193805 A1 12/2002 Ott et al.
2003/0036765 A1 2/2003 Van Noy
2003/0040755 A1 2/2003 Meyer
2003/0050647 A1 3/2003 Brady
2003/0088253 A1 5/2003 Seil
2003/0139749 A1 7/2003 Kikuchi et al.
2003/0181921 A1 9/2003 Jeannin
2003/0195522 A1 10/2003 McNicholas
2003/0212406 A1 11/2003 Kobayashi et al.
2003/0212407 A1 11/2003 Kikuchi
2003/0212409 A1 11/2003 Kobayashi et al.
2004/0111094 A1 6/2004 Meyer
2004/0117012 A1 6/2004 Vincent
2004/0127911 A1 7/2004 Figueroa et al.
2004/0186428 A1 9/2004 Ray
2004/0238392 A1 12/2004 Peterson et al.
2004/0243141 A1 12/2004 Brown et al.
2005/0033308 A1 2/2005 Callahan et al.
2005/0049605 A1 3/2005 Vaquero et al.
2005/0049606 A1 3/2005 Vaquero et al.
2005/0055011 A1 3/2005 Enggaard
2005/0125000 A1 6/2005 Tourrette et al.
2005/0143750 A1 * 6/2005 Vaquero A61F 2/1664 606/107
2005/0182419 A1 8/2005 Tsai
2005/0222578 A1 10/2005 Vaquero
2005/0261703 A1 11/2005 Feingold et al.
2006/0085013 A1 4/2006 Dusek et al.
2006/0142781 A1 6/2006 Pynson et al.
2006/0167466 A1 7/2006 Dusek
2006/0200167 A1 9/2006 Peterson et al.
2006/0229633 A1 10/2006 Shepherd
2006/0235429 A1 10/2006 Lee et al.
2006/0235437 A1 * 10/2006 Vitali A61B 17/10 606/142
2006/0293694 A1 12/2006 Futamura
2007/0005135 A1 1/2007 Makker et al.
2008/0033449 A1 2/2008 Cole et al.
2008/0058830 A1 3/2008 Cole et al.
2008/0086146 A1 4/2008 Ishii et al.
2008/0097459 A1 4/2008 Kammerlander et al.
2008/0221584 A1 9/2008 Downer
2009/0036898 A1 2/2009 Ichinohe
2009/0043313 A1 2/2009 Ichinohe
2009/0112223 A1 4/2009 Downer et al.
2009/0125034 A1 5/2009 Pynson
2009/0138022 A1 5/2009 Tu et al.
2009/0204122 A1 8/2009 Ichinohe et al.
2009/0216244 A1 8/2009 Pynson
2009/0248031 A1 10/2009 Ichinohe
2010/0094309 A1 4/2010 Hboukhny et al.
2010/0106160 A1 4/2010 Tsai
2010/0161049 A1 * 6/2010 Inoue A61F 2/167 623/6.12
2010/0185206 A1 * 7/2010 Ichinohe A61F 2/1672 606/107
2010/0217273 A1 8/2010 Someya et al.
2010/0286704 A1 11/2010 Ichinohe et al.
2010/0331808 A1 12/2010 Py et al.
2011/0082463 A1 4/2011 Inoue
2011/0098717 A1 4/2011 Inoue
2011/0264101 A1 10/2011 Inoue et al.
2011/0270264 A1 11/2011 Shoji et al.
2011/0288557 A1 * 11/2011 Kudo A61F 2/167 606/107
2012/0022549 A1 1/2012 Someya et al.
2012/0071887 A1 3/2012 Ichinohe et al.
2013/0006259 A1 1/2013 Sanger
2013/0018460 A1 1/2013 Anderson
2013/0226193 A1 * 8/2013 Kudo A61F 2/148 606/107
2013/0245635 A1 9/2013 Inoue
2014/0081284 A1 3/2014 Ichinohe et al.
2014/0107660 A1 4/2014 Ichinohe et al.
2014/0114323 A1 4/2014 Kudo et al.
2014/0180299 A1 6/2014 Ichinohe et al.
2014/0180300 A1 6/2014 Ichinohe et al.
2014/0194890 A1 7/2014 Kudo et al.
2015/0342726 A1 * 12/2015 Deacon A61F 2/148 623/6.12
2016/0113759 A1 4/2016 Inoue
2016/0346077 A1 12/2016 Someya et al.
2017/0079772 A1 3/2017 Kudo
2017/0151056 A1 6/2017 Inoue

(56) **References Cited**

U.S. PATENT DOCUMENTS

2017/0202662	A1	7/2017	Someya et al.
2017/0252149	A1	9/2017	Kudo et al.
2017/0252150	A1	9/2017	Kudo et al.
2017/0258582	A1	9/2017	Kudo et al.

FOREIGN PATENT DOCUMENTS

EP	0363213		4/1990
EP	0727966		9/2003
EP	1832247	A1	9/2007
EP	1338254		12/2008
FR	2749752	A	12/1997
JP	63-197453	A	8/1988
JP	4-212350	A	8/1992
JP	5-103808		4/1993
JP	5-103809		4/1993
JP	8-024282	A	1/1996
JP	8-505540		6/1996
JP	9-506285	A	6/1997
JP	11-113939	A	4/1999
JP	11-506357	A	6/1999
JP	2000-516487	A	12/2000
JP	2000-516488	A	12/2000
JP	2001-502563		2/2001
JP	2001-104347	A	4/2001
JP	2002-516709	A	6/2002
JP	2002-355268	A	12/2002
JP	2002-541912	A	12/2002
JP	2003-144480	A	5/2003
JP	3412106	B2	6/2003
JP	2003-210498	A	7/2003
JP	2003-325569	A	11/2003
JP	2003-325570	A	11/2003
JP	2003-325572	A	11/2003
JP	2004-024854	A	1/2004
JP	2004-188194	A	7/2004
JP	2004-351196	A	12/2004
JP	2006-181269	A	7/2006
JP	2006-297146	A	11/2006
JP	2006-333924	A	12/2006
JP	2006-333981	A	12/2006
JP	2007-503872	A	3/2007
JP	2007-152010	A	6/2007
JP	2007-181604	A	7/2007
JP	2007-526091	A	9/2007
JP	2008-521535	A	6/2008
JP	2008-212689	A	9/2008
JP	2014-050484	A	3/2014
WO	WO9407436	A1	4/1994
WO	WO9513022	A1	5/1995
WO	WO9628122	A1	9/1996
WO	WO9715253	A1	5/1997
WO	WO9812969	A1	4/1998
WO	WO9958086	A1	11/1999
WO	WO9959668	A1	11/1999
WO	WO0045746	A1	8/2000
WO	WO0062712	A1	10/2000
WO	WO2002071982	A1	9/2002
WO	WO2002096322	A1	12/2002
WO	WO2005023154	A1	3/2005
WO	WO2005070341	A1	8/2005
WO	WO2005084588	A1	9/2005
WO	WO2006070628	A1	7/2006
WO	WO2006080191	A1	8/2006
WO	WO2006090531	A1	8/2006
WO	WO2007037223	A1	4/2007
WO	WO2007097221	A1	4/2007
WO	WO2007080869	A1	7/2007
WO	WO2008149794	A1	12/2008
WO	WO2008149795	A1	12/2008
WO	WO2009058929	A1	7/2009
WO	WO2009148091	A1	12/2009
WO	WO2011126144	A1	10/2011
WO	WO2011155636	A1	12/2011

* cited by examiner

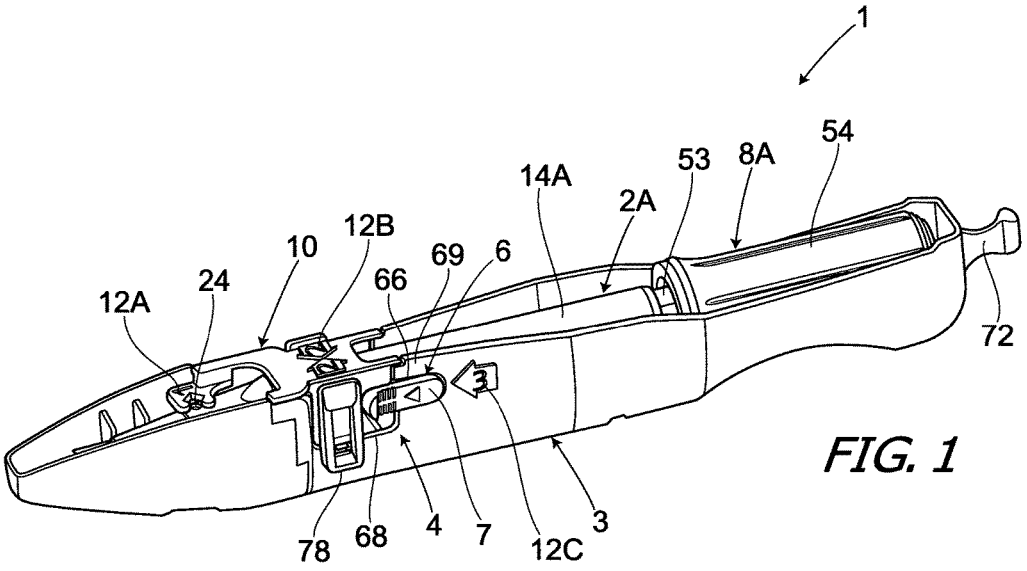


FIG. 1

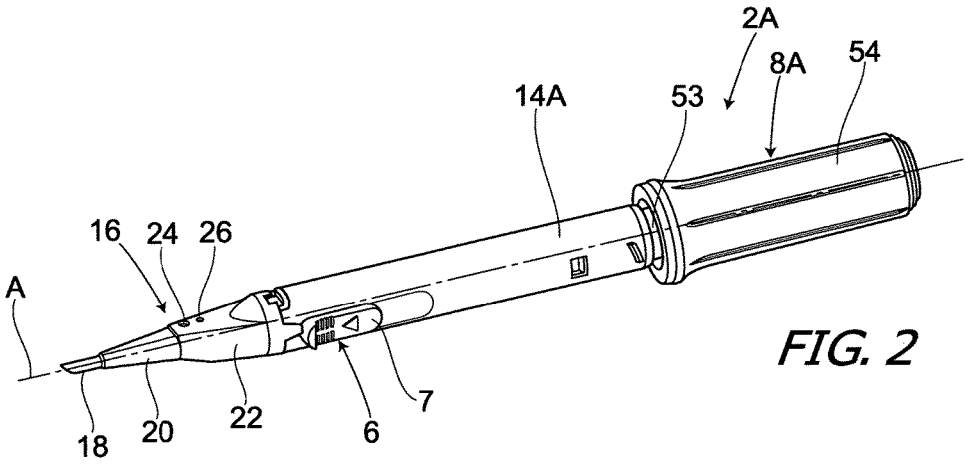


FIG. 2

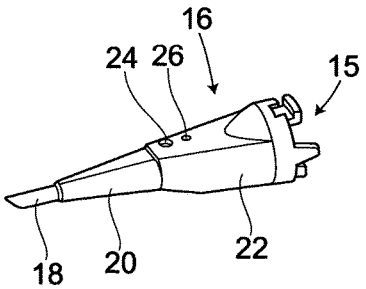


FIG. 3

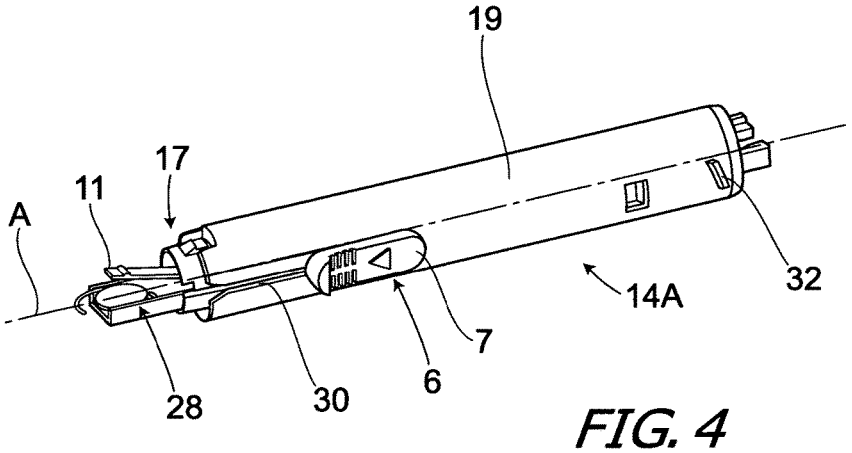

19
17
11
A
14A
32
7
6
30
28

FIG. 4

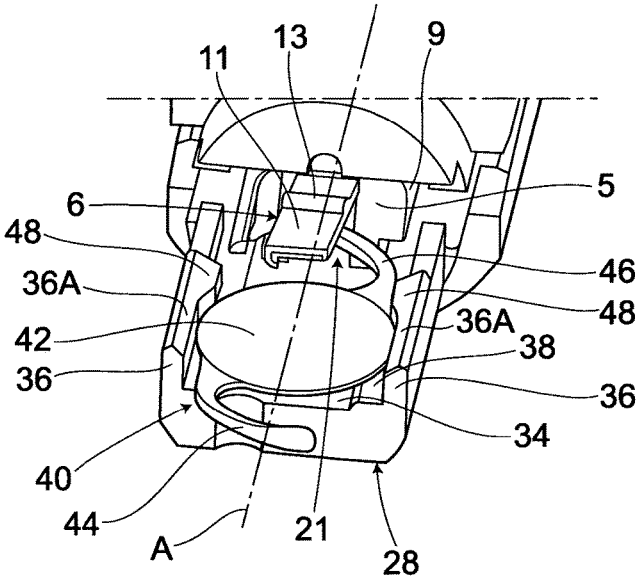

11
13
9
5
6
48
46
36A
48
36A
38
42
36
36
34
40
44
A
21
28

FIG. 5

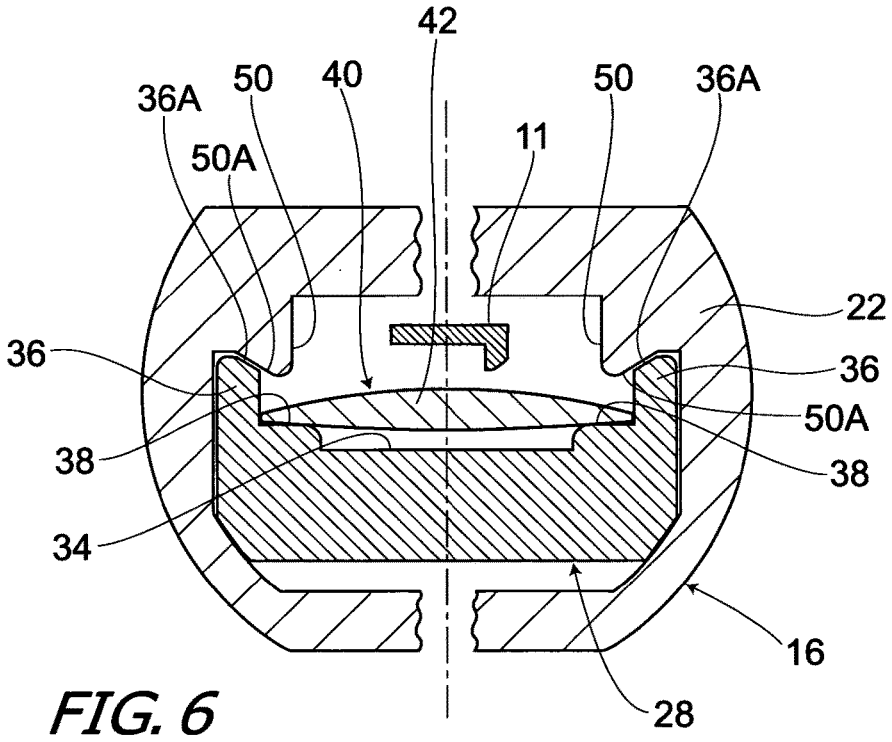

42
36A
50
40
50
36A
50A
11
22
36
36
50A
38
38
34
16
28

FIG. 6

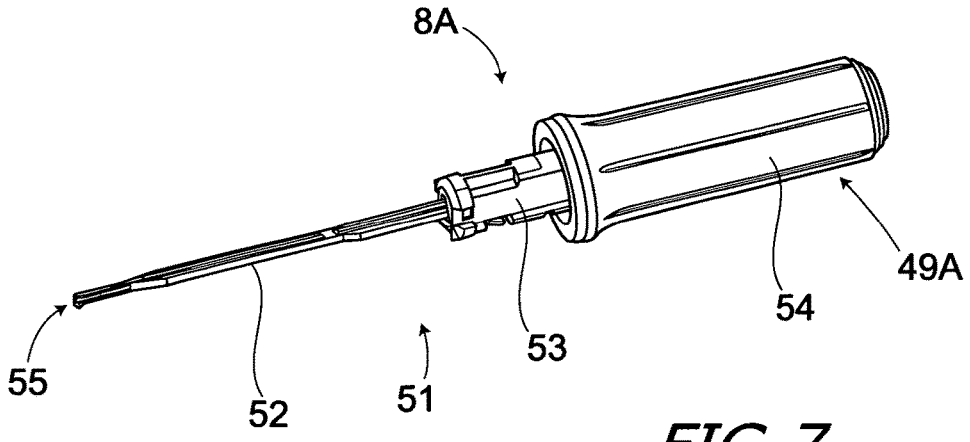

8A
49A
54
53
55
52
51

FIG. 7

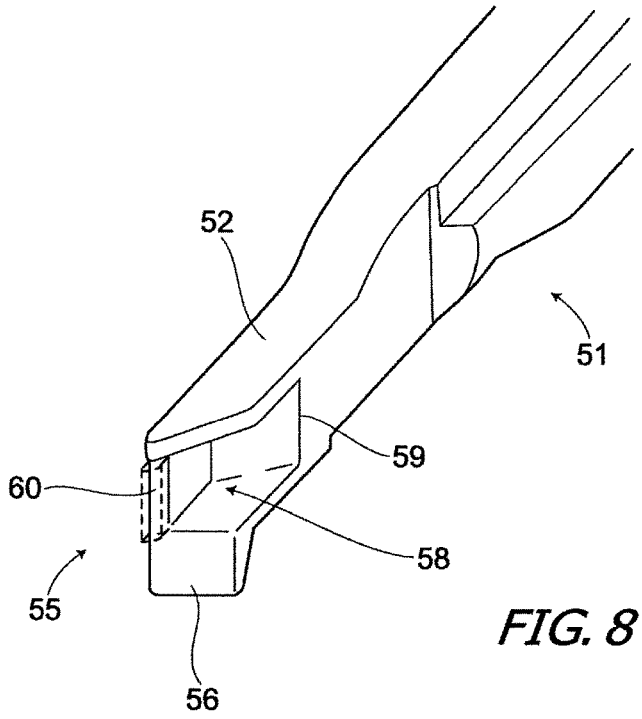


FIG. 8

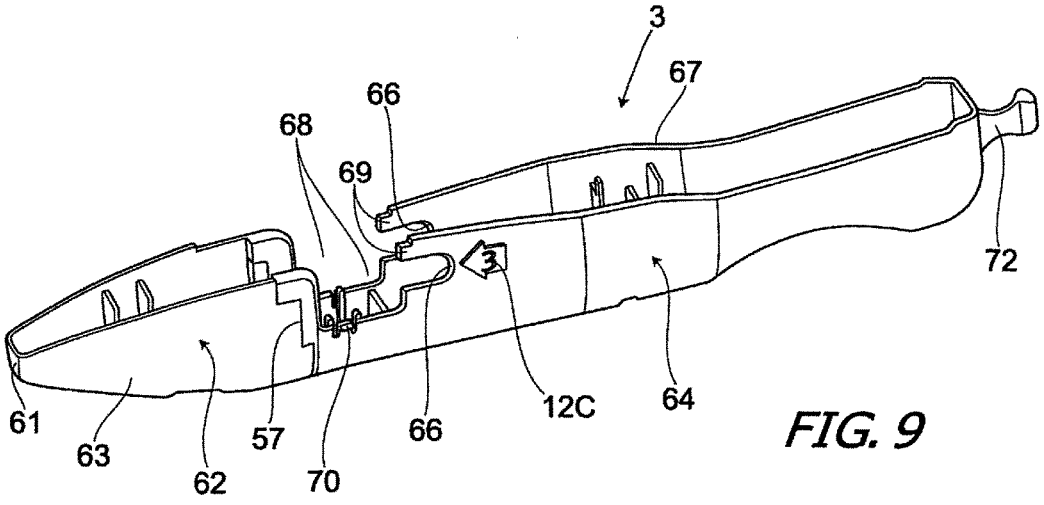


FIG. 9

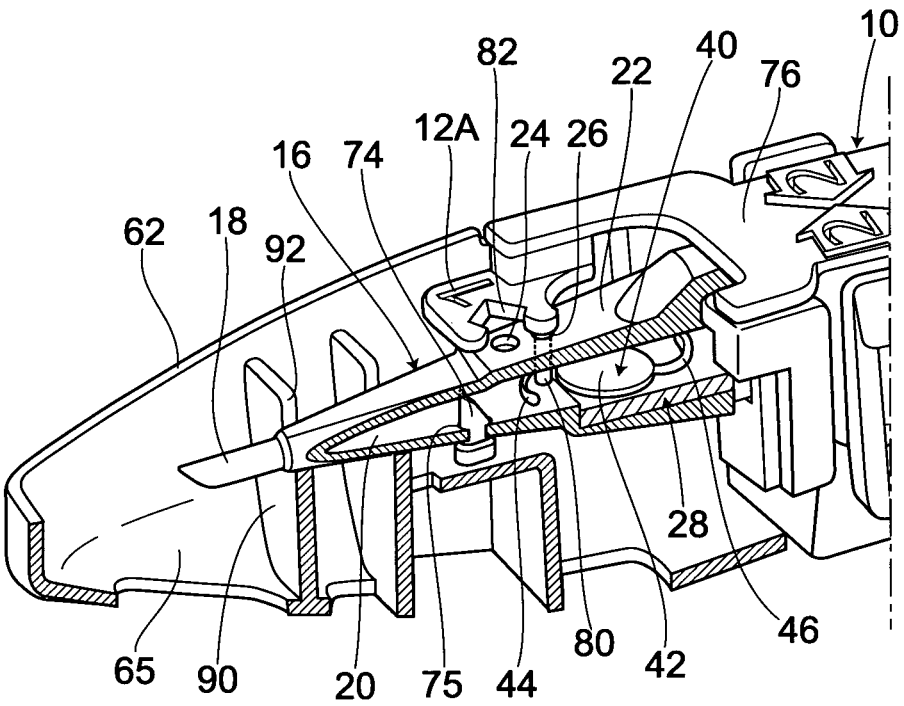

10
82
40
22
76
12A
24
26
16
74
62
18
92
28
46
80
42
65
90
20
75
44

FIG. 10

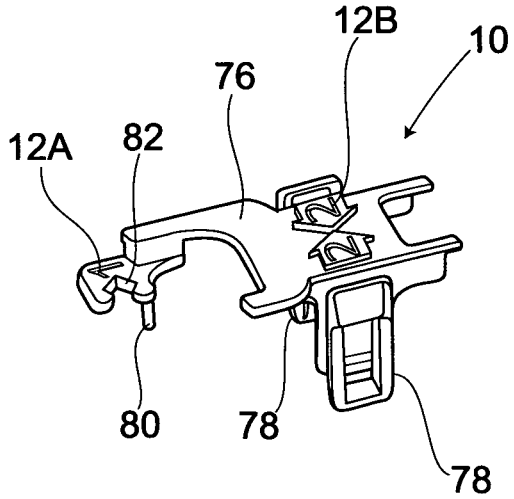

12B
10
76
12A
82
80
78
78

FIG. 11

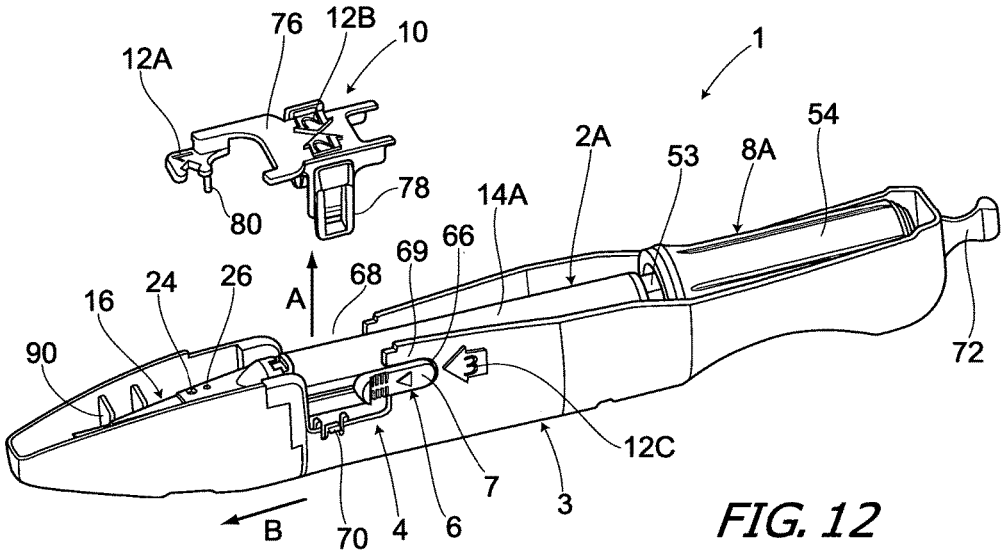

76
12B
10
12A
1
54
2A
53
8A
78
14A
80
69
66
16
24
26
A
68
90
72
12C
7
3
B
70
4
6

FIG. 12

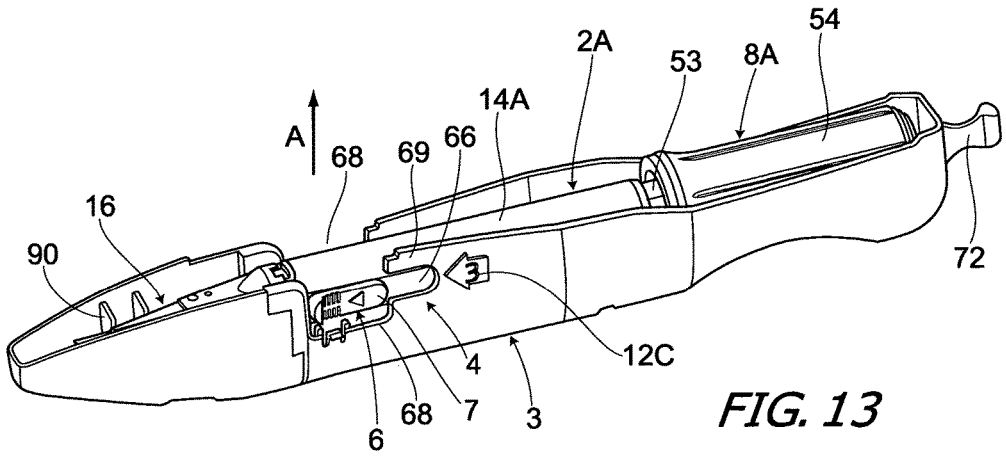

54
2A
53
8A
14A
A
68
69
66
16
90
72
12C
4
68
7
3
6

FIG. 13

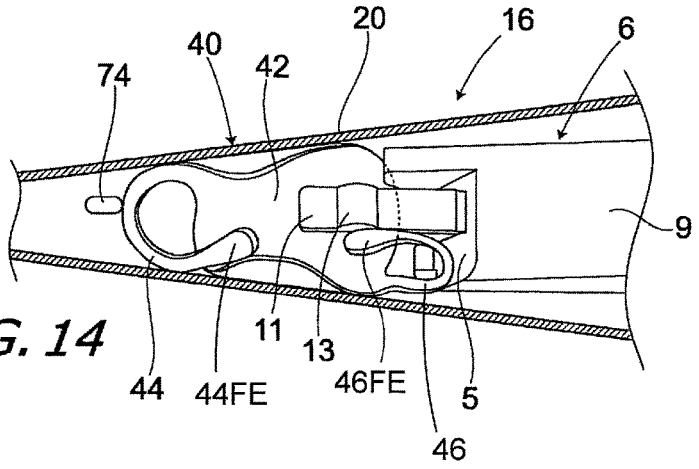

74
40
42
20
16
6
9
11
13
46FE
5
44
44FE
46

FIG. 14

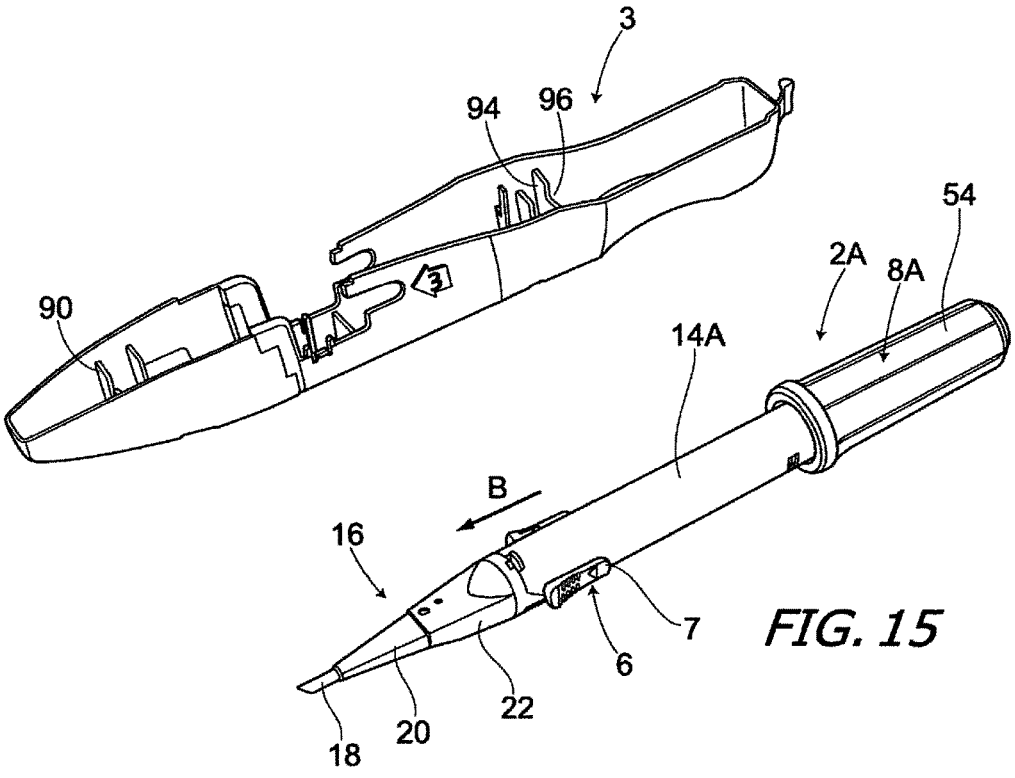

3
94
96
54
2A
8A
90
14A
B
16
7
6
22
20
18

FIG. 15

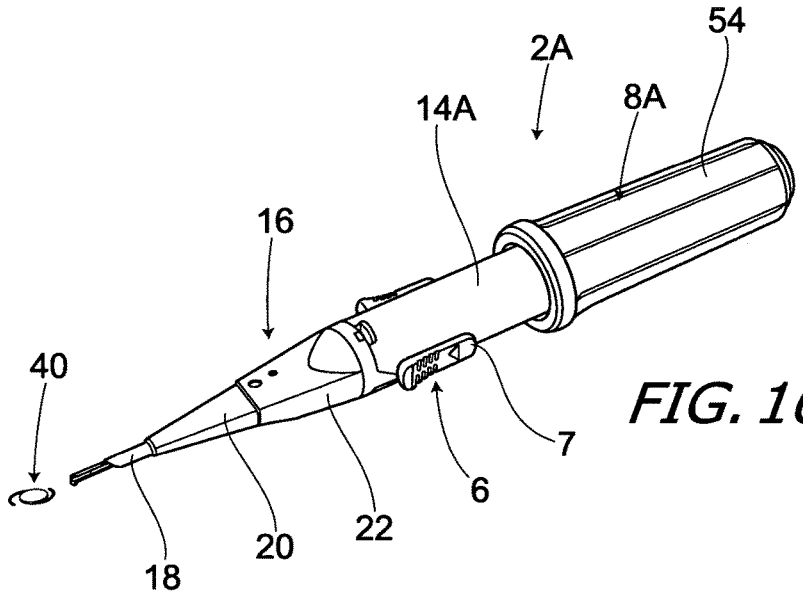

54
2A
14A
8A
16
40
7
6
22
20
18

FIG. 16

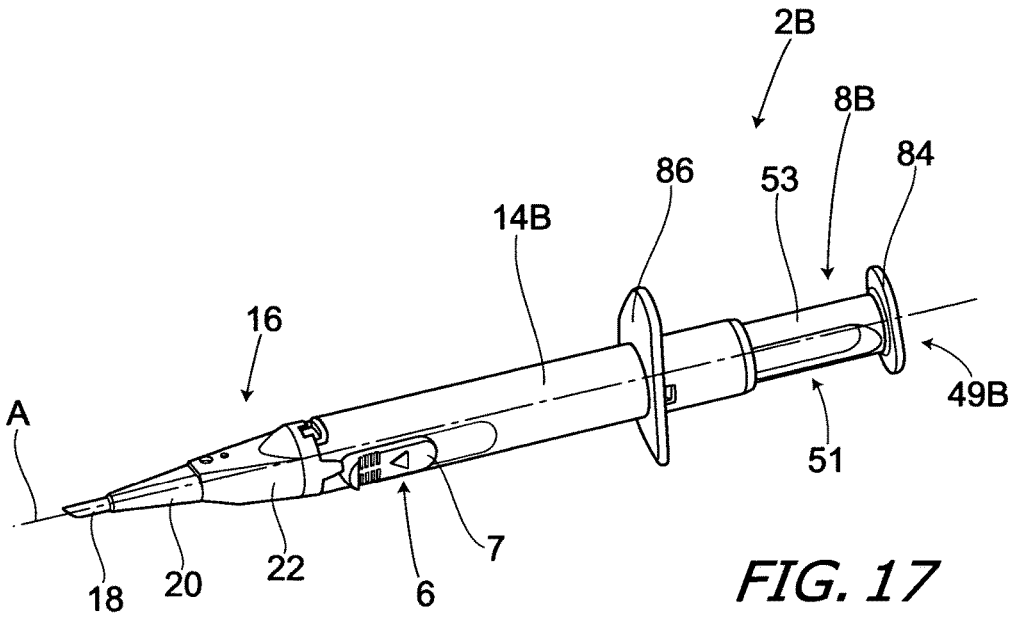

2B
8B
84
86
53
14B
16
49B
A
51
7
18
20
22
6

FIG. 17

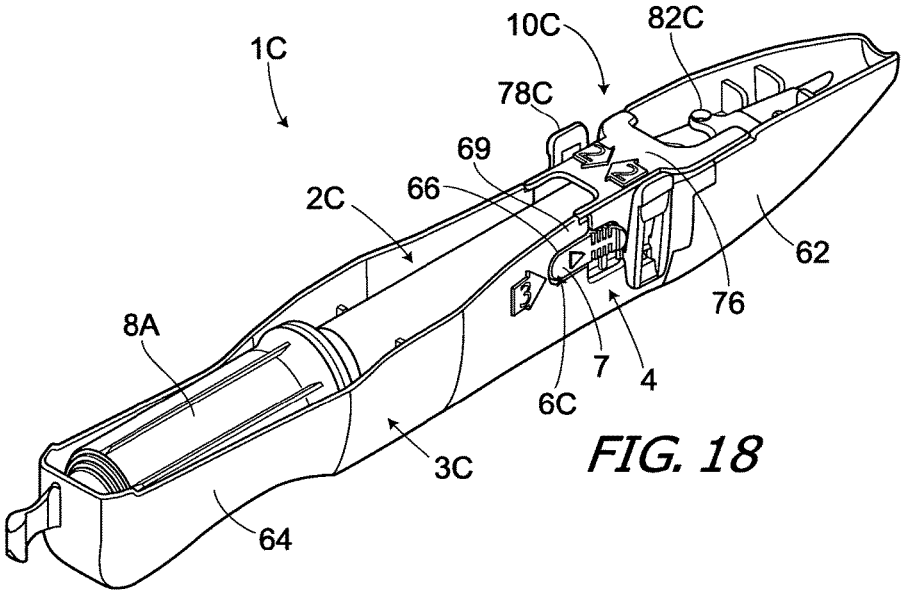


FIG. 18

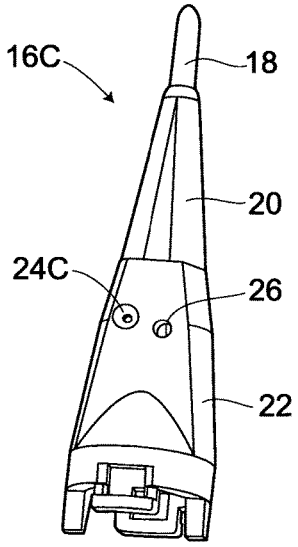


FIG. 19

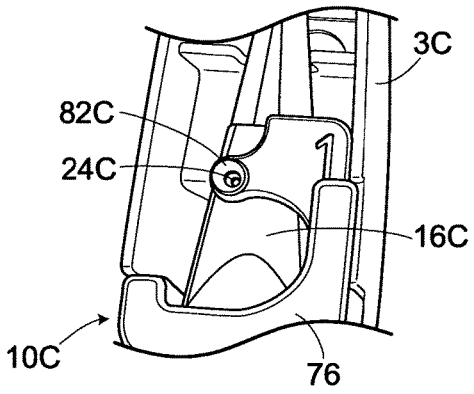


FIG. 20

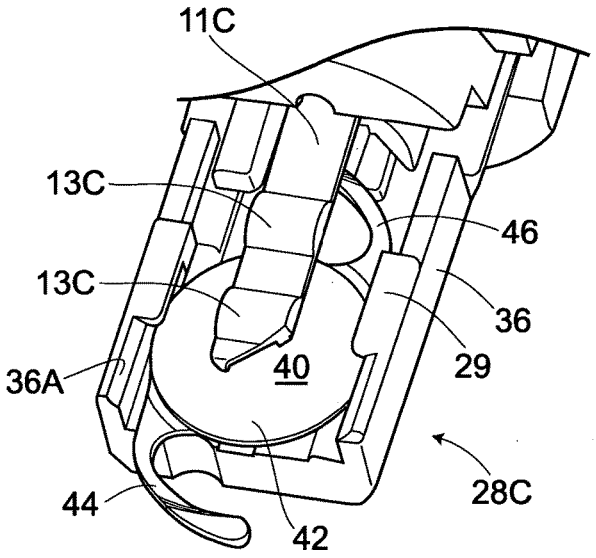


FIG. 21

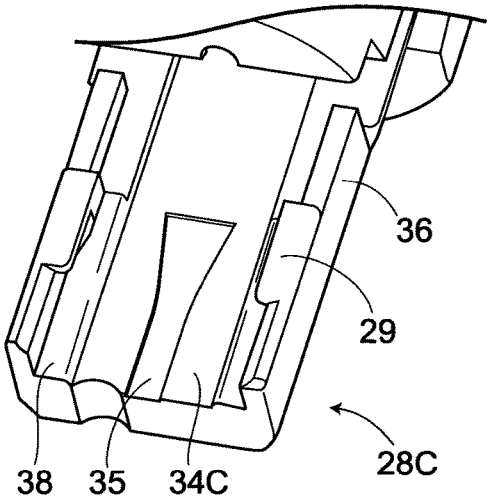


FIG. 22

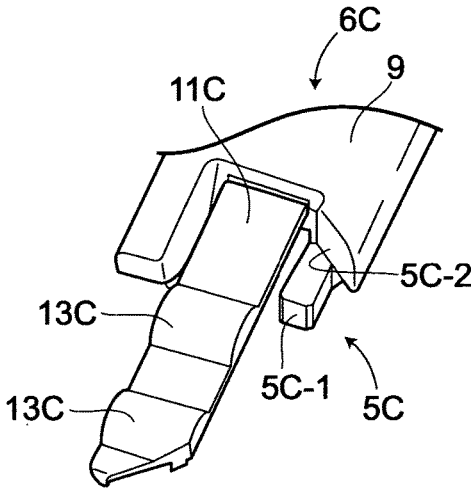
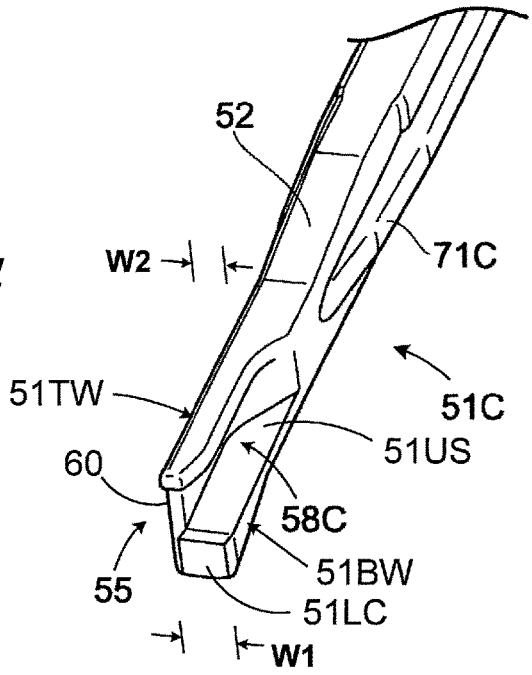


FIG. 23

FIG. 24


52
W2
71C
51C
51TW
51US
60
58C
51BW
55
51LC
W1

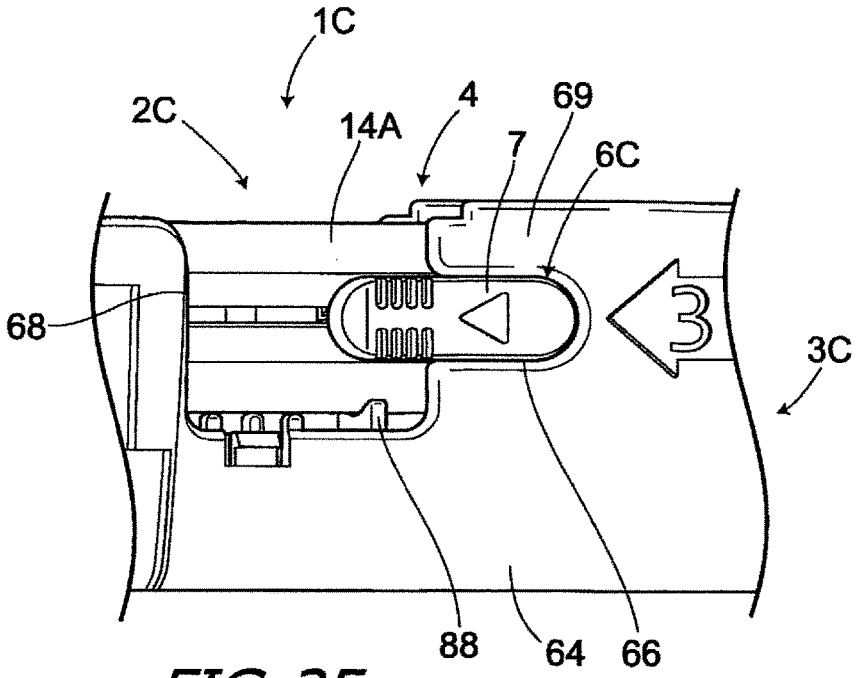

1C
2C
14A
4
69
7
6C
68
3C
88
64
66

FIG. 25

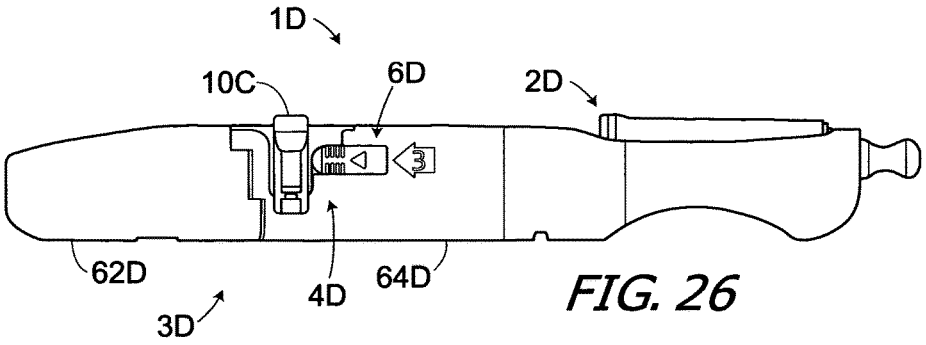


FIG. 26

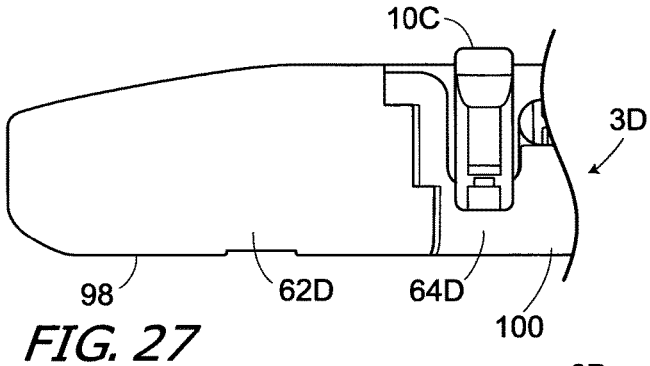


FIG. 27

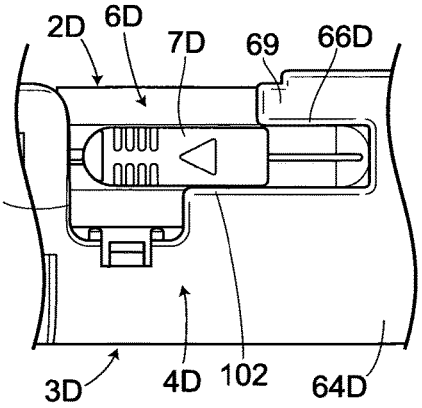


FIG. 28

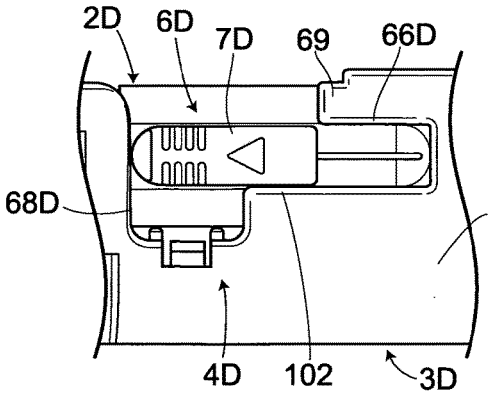


FIG. 29

OCULAR IMPLANT INSERTION APPARATUS AND METHODS

CROSS-REFERENCE TO RELATED APPLICATIONS

This application is a continuation of U.S. application Ser. No. 14/145,846, filed Dec. 31, 2013, which is a continuation of U.S. application Ser. No. 13/699,708, now U.S. Pat. No. 8,647,382, which has a 35 U.S.C. § 371(c) date of May 11, 2013 and is a U.S. national phase application under 35 U.S.C. § 371 of International Patent Application No. PCT/JP2011/063747, filed Jun. 8, 2011, which claims priority to Japanese patent application No. 2010-132952, filed Jun. 10, 2010. The International Application was published in English on Dec. 15, 2011 as International Publication No. WO 2011/155636 A1. The content of each application is incorporated herein in its entirety.

BACKGROUND OF THE INVENTIONS

1. Field of the Inventions

The present inventions relate generally to apparatus and methods for inserting an ocular implant into an eye.

2. Description of the Related Art

There are a variety of instances where an ocular implant is inserted into the anterior chamber, posterior chamber, cornea, vitreous space and/or other portion of an eye. Exemplary ocular implants include, but are not limited to, lenses, capsular tension rings, ocular prosthesis and lamellar transplants. An intraocular lens (IOL), for example, may be inserted into an a phakic eye that has undergone a cataract surgery or may be inserted into a phakic eye during a refractive surgery. One type of lens is a foldable lens. Foldable lenses are formed from soft material such as a silicone elastomer, soft acrylic, or hydrogel and may be inserted into the eye through a small incision. Lens insertion apparatus, which may be used to push a foldable lens into an eye through a nozzle, generally include screw-type insertion apparatus and push-type insertion apparatus. In both cases, the lens insertion apparatus may include a plunger that is used to push a folded lens through the nozzle into the eye by way of an incision that is relatively small, e.g., an incision that is smaller than the diameter of an IOL optic.

Loading an ocular implant into an inserter can be a troublesome portion of the insertion procedure. The implant may be contaminated, damaged or improperly placed into the inserter by operator, e.g., a surgeon or assistant. Accordingly, in some instances, the insertion apparatus is preloaded, i.e., the insertion apparatus is shipped from the factory with the ocular implant (e.g., an IOL) stored therein. An operator using a preloaded inserter does not place the implant into the insertion apparatus, thereby eliminating the possibility of the aforementioned operator error associated with loading.

In addition to the basic functions of storing and inserting an IOL or other ocular implant, it may also be desirable for the insertion apparatus to minimize the physical load on the ocular implant during storage in order to ensure that the ocular implant returns to its unstressed state after being inserted into the eye. It may also be desirable to fold the IOL or other ocular implant into as small a state as possible in order to reduce the size of the incision and the likelihood of corneal astigmatism caused by the surgery or infection.

Thus, the desired insertion apparatus must be able to fold the unstressed ocular implant into a small state in a predetermined direction, and into a predetermined shape, in order to insure that the plunger can move the folded ocular implant through the nozzle without the insertion apparatus becoming clogged at or near the nozzle or the ocular implant being damaged. To that end, instead of using only a plunger to move the lens through the folding and insertion processes, some insertion apparatus have been configured to fold and move an IOL in stepwise fashion through the use of multiple IOL moving structures. Examples of such insertion apparatus are illustrated and described in PCT Pub. No. WO 2009/148091 (also published as US 2011/0082463) and Laid-open JP Pat. Pub. No. 2001-104347 (also published as US 2001/0007942).

The present inventor has, however, determined that insertion apparatus with multiple ocular implant moving structures are susceptible to improvement. For example, the present inventor has determined that such insertion apparatus are susceptible to erroneous operation, such as use of the moving structures in an incorrect sequence.

SUMMARY

An exemplary ocular implant insertion system includes a case and an ocular implant insertion apparatus including an ocular implant, a first movable structure that moves at least a portion of the ocular implant during movement thereof, and a second movable structure that moves the ocular implant through the nozzle. The ocular implant insertion apparatus is located at least partially within the case in pre-use state wherein the first and second movable structures have not folded and moved the ocular implant. The respective configurations of the case and the ocular implant insertion apparatus are such that the ocular implant insertion apparatus is not removable from the case when the ocular implant insertion apparatus is in the pre-use state and is removable after the first movable structure has moved at least a portion of the optical implant.

An exemplary method of using a system including a case and a preloaded ocular implant insertion apparatus locked to the case includes the steps of unlocking the insertion apparatus from the case by moving a first movable structure a distance sufficient to at least partial fold a stored ocular implant, removing the insertion apparatus from the case, and pushing the ocular implant from the insertion apparatus with a second movable structure.

There are a number of advantages associated with such systems and methods. For example, such systems and methods prevent the use of the first and second movable structures in an incorrect sequence.

BRIEF DESCRIPTION OF THE DRAWINGS

Detailed description of exemplary embodiments of the inventions will be made with reference to the accompanying drawings.

FIG. **1** is a perspective view of an IOL insertion system, including an IOL insertion apparatus and an insertion apparatus case, in accordance with one embodiment of a present invention.

FIG. **2** is a perspective view of the exemplary IOL insertion apparatus illustrated in FIG. **1**.

FIG. **3** is a perspective view of the insertion tube of the exemplary IOL insertion apparatus illustrated in FIG. **2**.

FIG. **4** is a perspective view of the main body of the exemplary IOL insertion apparatus illustrated in FIG. **2**.

FIG. **5** is a perspective view of the lens placement section of the exemplary IOL insertion apparatus illustrated in FIG. **2**.

FIG. **6** is a section view of the insertion tube and lens placement section of the exemplary IOL insertion apparatus illustrated in FIG. **2**.

FIG. **7** is a perspective view of the plunger of the exemplary IOL insertion apparatus illustrated in FIG. **2**.

FIG. **8** is a perspective view of the distal portion of the plunger rod of the exemplary IOL insertion apparatus illustrated in FIG. **2**.

FIG. **9** is a perspective view of the exemplary insertion apparatus case illustrated in FIG. **1**.

FIG. **10** is a partial section view of a portion of the exemplary IOL insertion system illustrated in FIG. **1**.

FIG. **11** is a perspective view of the exemplary cover illustrated in FIG. **1**.

FIG. **12** is a perspective view showing one aspect of the operation of the exemplary IOL insertion system illustrated in FIG. **1**.

FIG. **13** is a perspective view showing another aspect of the operation of the exemplary IOL insertion system illustrated in FIG. **1**.

FIG. **14** is a partial section view showing another aspect of the operation of the exemplary IOL insertion system illustrated in FIG. **1**.

FIG. **15** is a perspective view showing another aspect of the operation of the exemplary IOL insertion system illustrated in FIG. **1**.

FIG. **16** is a perspective view showing another aspect of the operation of the exemplary IOL insertion system illustrated in FIG. **1**.

FIG. **17** is a perspective view of another exemplary IOL insertion apparatus that may be combined with a case in the manner illustrated in FIG. **1** to form an IOL insertion system.

FIG. **18** is a perspective view of an IOL insertion system, including an IOL insertion apparatus and an insertion apparatus case, in accordance with one embodiment of a present invention.

FIG. **19** is a perspective view of the insertion tube of the exemplary IOL insertion apparatus illustrated in FIG. **18**.

FIG. **20** is a perspective view of a portion of the exemplary IOL insertion system illustrated in FIG. **18**.

FIG. **21** is a perspective view of a portion of the slider and the lens placement section of the exemplary IOL insertion apparatus illustrated in FIG. **18**.

FIG. **22** is a perspective view of the lens placement section of the exemplary IOL insertion apparatus illustrated in FIG. **18**.

FIG. **23** is a perspective view of a portion of the slider of the exemplary IOL insertion apparatus illustrated in FIG. **18**.

FIG. **24** is a perspective view of a portion of the plunger rod of the exemplary IOL insertion apparatus illustrated in FIG. **18**.

FIG. **25** is a side view of a portion of the exemplary IOL insertion apparatus illustrated in FIG. **18**.

FIG. **26** is a perspective view of an IOL insertion system, including an IOL insertion apparatus and an insertion apparatus case, in accordance with one embodiment of a present invention.

FIG. **27** is a side view of a portion of the exemplary IOL insertion system illustrated in FIG. **26**.

FIG. **28** is a side view of a portion of the exemplary IOL insertion system illustrated in FIG. **26**.

FIG. **29** is a side view of a portion of the exemplary IOL insertion system illustrated in FIG. **26**.

DETAILED DESCRIPTION OF EXEMPLARY EMBODIMENTS

The following is a detailed description of the best presently known modes of carrying out the inventions. This description is not to be taken in a limiting sense, but is made merely for the purpose of illustrating the general principles of the inventions. The present inventions are also applicable to a wide variety of ocular implants which, as used herein, refers to any structure, instrumentality or device that is placed into any ocular structure or region. Ophthalmic lenses, capsular tension rings, ocular prosthesis and lamellar transplants are examples of ocular implants. Although the exemplary implementations are described below in the context of an intraocular lens (IOL), the present inventions are also applicable other types of ocular implants, including those yet to be developed. For example, the present inventions are applicable to other types of ophthalmic lenses. Such lenses include, but are not limited to, intraocular contact lenses, phakic IOLs, and other lenses that may be inserted into the eye.

I. Overview

As illustrated in FIG. **1**, the exemplary IOL insertion system **1** includes an IOL insertion apparatus **2**A and a case **3** in which the IOL insertion apparatus **2**A is stored during shipping and at other times prior to an insertion procedure. The IOL insertion apparatus **2**A is a preloaded insertion apparatus and, to that end, an IOL **40** (FIG. **5**) is placed within the insertion apparatus during the assembly process and the insertion apparatus is shipped and stored with the IOL located therein. The IOL insertion system **1** includes a lock mechanism **4** that prevents the IOL insertion apparatus **2**A from being removed from the case **3** when in a locked state, and allows the IOL insertion apparatus to be removed from the case when in an unlocked state. As is discussed in greater detail below, the operation of the IOL insertion apparatus **2**A itself is, generally speaking, a two-step process where the steps must be performed in the proper sequence. The first step involves folding a previously unstressed IOL into a particular configuration with a first device and the second step pushing the folded IOL though a tapered passage, where it is further folded, and then into the eye. The IOL insertion system **1** is configured such that the lock mechanism **4** will transition from the locked state to the unlocked state, thereby allowing the IOL insertion apparatus **2**A to be removed from the case **3**, when the first step is performed. In other words, the IOL insertion system **1** is configured such that the operator will not be able to remove the IOL insertion apparatus **2**A from the case **3** unless the first step in the process has been performed. By requiring the first step to be performed prior to removal of the IOL insertion apparatus **2**A from the case **3**, the IOL insertion system **1** forces the operator to perform the steps in the correct order.

II. Exemplary IOL Insertion Apparatus

Turning to FIG. **2**, the exemplary IOL insertion apparatus **2**A includes a slider **6**, a plunger **8**A, a main body **14**A and an insertion tube **16** that is mounted on the forward end of the main body. The main body **14**A and insertion tube **16** together define the external housing of the insertion appa-

ratus **2**A. The slider **6** and plunger **8**A are movable relative to the external housing and relative to each other.

Operation of the IOL insertion apparatus **2**A, where the IOL is pushed out of the apparatus and into the eye, is referred to herein as a "push-out" or "insertion" process. The slider **6**, which has a pair of finger grips **7**, performs the first step in the insertion process, i.e., folding a previously unstressed IOL into a particular configuration, and may therefore be referred to as one example of a first lens push-out mechanism. The exemplary slider **6** pushes the IOL **40** distally as it folds the IOL. In other implementations, the first "push-out" mechanism may perform the first step of the "push-out" process by simply folding an IOL without moving it distally. The exemplary plunger **8**A performs the second step in the insertion process, i.e., pushing the folded IOL through a tapered lumen and then into the eye, and may therefore be referred to as one example of a second lens push-out mechanism. The IOL moves along a lens advancement axis A during the insertion process. Movement of the movable components of the insertion apparatus **2**A and the IOL **40** towards the eye is referred to herein as movement in the forward (or "distal") direction and movement away from the eye is referred to herein as movement in the rearward (or "proximal") direction. Similarly, the end of a structure that faces the eye during use is referred to as the forward (or "distal") end and the other end the structure is referred to as the rearward (or "proximal") end. The slider **6** and plunger **8**A are both movable in the forward and rearward directions relative to the main body **14**A.

The exemplary insertion tube **16** includes a nozzle **18**, a transition section **20** and a protector **22**, with interior regions that are in communication with one another so that an IOL can pass therethrough. The insertion tube **16** is connected to the main body **14**A by a connector arrangement **15** (FIG. **3**) on the insertion tube and a corresponding connector arrangement **17** (FIG. **4**) on the main body. The inner diameter of the transition section **20** tapers downwardly from the end adjacent to the protector **22** to the end adjacent the nozzle **18**. The protector **22** has an injection port **24** for viscoelastic material and a first insertion hole **26** (discussed below).

Turning to FIG. **4**, the exemplary main body **14**A includes a tubular member **19**, a lens placement section **28**, a slider guide section **30** and a protrusion **32**. The lens placement section **28** (described below with reference to FIG. **5**) protrudes distally from the front end of the tubular member **19**. The slider guide section **30** is configured to allow the slider **6** to move forwardly and rearwardly. The slider guide section **30** may be a pair of slits, formed in the tubular member **19**, that are parallel to the lens advancement axis A. The slider guide section **30** also extends rearwardly from the distal end of the tubular member **19** to the central portion of the tubular member. The plunger **8**A is threadedly connected to the main body **14**A in the illustrated implementation. To that end, the exemplary main body **14**A includes a male screw. The protrusion **32**, which is transverse to the lens advancement axis A, defines a portion of the screw thread of the male screw and a portion of the outer surface of the tubular member **19** defines the root of the thread. Another protrusion (not shown) may be located on the tubular member **19** 180 degrees offset from the tubular member **32**.

As shown in FIG. **5**, the IOL insertion apparatus **2**A may be used to store an IOL **40** that has an optic **42** and a pair of supports **44** and **46** such as, for example, the illustrated pair of haptics. The exemplary lens placement section **28** includes a bottom surface **34**, a pair of side walls **36** respectively located on opposite sides of the bottom surface and extending upwardly from the bottom surface, and a pair of rails **38**. The bottom surface **34** and the side walls **36** are parallel to the lens advancement axis A and the lens advancement axis A is located between the side walls. The side walls **36** each include, near the upper end, an inclined surface **36**A. The rear portions of the side walls **36** include inward protrusions **48** that prevent the IOL **40** from moving in the rearward direction. The lens supporting surfaces of the rails **38** are oriented in a direction that is transverse to the lens advancement axis A and slope away from the axis A in the rearward to forward direction. As such, the stored IOL **40** is tilted relative to the lens advancement axis A, with the forward end of the IOL optic **42** closer to the bottom surface **34** than the rearward end. The lens supporting surfaces of the rails **38** are also located a sufficient distance above the bottom surface **34** to prevent the IOL optic **42** from coming into contact with the bottom surface (note FIG. **6**).

It should be noted that references herein to "top," "bottom," "upward," "downward" and the like are merely references to the illustrated orientation and/or the relationship of the components relative to one another in the illustrated orientation. For example, the side of the IOL **40** facing the bottom surface **34** is referred to "the downward side" and movement toward the bottom surface is referred to as movement in the "downward direction," while the opposite side of the IOL **40** is referred to as the "the upward side" and movement away from the bottom surface **34** is referred to as movement in the "the upward direction."

In addition to the grips **7**, and referring to FIGS. **5** and **14**, the exemplary slider **6** includes an elongate member **9**, with a lens contact surface **5**, that is carried within the main body **14**A and is slidable relative thereto. The grips **7** are connected to elongate member **9**. The lens contact surface **5**, which is larger than the plunger distal end **55** (discussed below), is used to scoop up the proximal IOL support **46** during the initial folding of the IOL **40**. A lens holder **11** is pivotably mounted on the distal end of elongate member **9** and includes a protrusion **13**. The lens holder **11** controls the initial folding of the IOL **40** during the first step of the lens insertion process. More specifically, as the slider **6** moves distally, the protrusion **13** rides along the tapered inner surface of the transition section **20**, which causes the lens holder **11** to pivot downwardly into contact with the IOL optic **42** to fold the IOL **40**. The slider elongate member **9** also includes a slot **21** through which the plunger rod **51** (discussed below) passes during the second step of the insertion process. Additional discussion concerning the use of a lens holder to fold an IOL may be found in, for example, U.S. Pat. Pub. No. 2010/0185206.

Referring to FIG. **6**, the protector **22** of exemplary insertion tube **16** includes protrusions **50**, with inclined surfaces **50**A, that extend downwardly and inwardly from both sides of the protector inner surface. The projections **50**, which guide the insertion tube **16** onto the upper ends of the side walls **36** during assembly, are sized such that the inclined surfaces **50**A extend beyond the side wall inclined surface **36**A. This prevents the outer edge of the IOL optic **42** located in the lens placement section **28** from becoming wedged between the protrusions **50** and the side walls **36**.

Turning to FIG. **7**, the exemplary plunger **8**A includes an operational member **49**A and a rod **51** with a distal rod portion **52**, a proximal rod portion **53**, and a rod distal end **55**. The distal rod portion **52**, which is sized such that it can be inserted through the nozzle **18**, may be connected to, or may be integral with, the proximal rod portion **53**. The operational portion **49**A includes a handle **54** that is generally cylindrical in shape. The proximal (or "rearward") end of the handle **54** is rotatably journaled, or is otherwise

rotatably secured, to the proximal (or "rearward") end of the proximal rod portion **53**. The handle **54** is also hollow and configured to receive the proximal portion of the main body **14**A. The inner surface of the handle **54** includes a female screw (not shown) with threads that operationally correspond to the threads on the male screw associated with the main body **14**A (note protrusion **32** in FIG. **4**). As such, after the plunger **8**A has been moved distally from the position illustrated in FIG. **2** until the male thread defined in part by the protrusion **32** engages the female thread within the handle **54**, further distal movement is accomplished by rotating the handle.

As illustrated for example in FIG. **8**, the rod distal end **55** may have a lens contact portion **56** and a recess **58** in which the free end of the proximal IOL support **46** is located during the second step of the two-step process. The exemplary lens contact portion **56** is a planar surface that is perpendicular to the lens advancement axis A, and is provided on a lower portion of the rod distal end **55**. The exemplary recess **58**, which has an opening **59** on one lateral side and a wall **60** on the other lateral side, is located above the lens contact portion **56**. The recess **58** may be formed by cutting (or otherwise removing) material from the rod distal portion **52**, starting at the distal end **55**, or by molding the rod in the illustrated configuration. The wall **60** engages the outer edge of the IOL optic **42** and prevents optic of the folded IOL **40** from entering the recess **58**. The wall **60** also keeps the IOL support **46** within the recess **58**. The distal end of the wall **60** may be in the same plane as the lens contact portion **56** (as shown) or may be located distally beyond the lens contact portion **56** (as shown in dashed lines).

With respect to operation of the exemplary IOL insertion apparatus **2**A, and as alluded to above, the IOL **40** is initially pushed forwardly (or distally) and folded into a predetermined shape with the slider **6**. The slider **6** also forms part of the lock mechanism **4** that locks the IOL insertion apparatus **2**A to the case **3** and, as is discussed below, the initial forward movement of the slider, unlocks the lock mechanism. The folded IOL **40** is subsequently pushed by the plunger **8**A forwardly (or distally) through the transition section **20** where it is further folded, then thorough the nozzle **18**, and then into the eye. In other words, the exemplary IOL insertion apparatus **2**A deforms an IOL that has been preloaded within the main body **14**A and insertion tube **16** into a predetermined shape while moving the IOL in the forward direction, first by using the slider **6** and second by using the plunger **8**A, and then discharges the folded IOL into the eye. The IOL **40** may be folded by operation of the slider **6** into the predetermined shape in which the optic **42** is curled up and around the lens advancement axis A, with an upper surface of the optic dented downwardly, and in which the free ends **44**FE and **46**FE of the supports **44** and **46** are tucked into the upper surface of the curled optic **42** (note FIG. **14**).

III. Exemplary Case

The case **3**, which protects the IOL insertion apparatus **2**A during shipping and storage, may be an elongated container with an open upper end. To that end, and referring to FIG. **9**, the exemplary case **3** includes a pair of end walls **61**, a pair of side walls **63** that each extend from one end wall to the other, and a bottom wall **65** (FIG. **10**) at the bottom ends of the end and side walls. The top ends of the end walls **61** and side walls **63** define the open upper end **67** of the case **3**. The front portion of the case **3** is identified by reference numeral **62** and the rear portion of the case is identified by referent numeral **64**. The front and rear portions **62** and **64** may be separable structures that are secured to one another during the assembly process (note joint **57**) as is discussed below.

The case **3** also includes a portion of the lock mechanism **4** that locks the IOL insertion apparatus **2**A to the case. In the illustrated embodiment, each of the side walls **63** includes a storage slot **66** and removal slot **68**. The storage slots **66** are separated, in the upward direction, from the open upper end **67** of the case by projections **69**. The removal slots **68** extend to and through the upper end **67** of the case **3**, and each storage slot **66** extends to the adjacent removal slot. Engagement members **70**, which are located at the lower end of each removal slot **68**, may be detachably engaged with a cover **10** (FIG. **1**) to secure the cover to the case **3**. A handle **72** may be located on the rear end wall **61** and used to remove the IOL insertion system **1** from the sterile package in which it is stored. The slider grips **7** are respectively located within the storage slots **66** when the lock mechanism **4** is in a locked state (FIG. **1**) and are located within the removal slots when the lock mechanism is in an unlocked state (FIG. **13**). The width of the slider grips **7** (in the direction of axis A) is less than or equal to the width of the removal slots **68**. The respective configurations of the IOL insertion apparatus **2**A and case **3** are also such that the slider grips **7** can be located within the storage slots **66** when the slider **6** is in its retracted, storage location (FIG. **12**) and can also be pushed distally beyond the storage slots **66** to the point at which the slider **6** has completed the initial folding of the IOL **40** (FIG. **13**).

With respect to the locked state, the projections **69** prevent the slider grips **7** and, therefore, the IOL insertion apparatus **2**A, from moving in the upward direction identified by arrow A in FIGS. **12** and **13**. The projections **69** do not, on the other hand, prevent the slider grips **7** from moving upwardly when the slider grips are located within the removal slots **68**.

The exemplary case **3** also includes structure that helps control the initial folding of the lens during the movement of the slider **6** moves from the position illustrated in FIG. **12** to the position illustrated in FIG. **13**. To that end, and referring to FIG. **10**, the front portion **62** of the exemplary case **3** includes a protrusion **74** that extends through a correspondingly sized and located insertion hole **75** on the bottom surface of the insertion tube **16**. The exemplary protrusion **74** has an overall ellipsoidal shape that is elongate in a direction parallel to the lens advancement axis A, and has a rearward facing surface that is slanted upwardly in the lens advancement (i.e., proximal to distal) direction. The protrusion **74** is located within the path of the IOL **40** and used to deflect the distal IOL support **44**, as is discussed below with reference to FIG. **14**. The protrusion **74** is removed from the IOL path, by way of the insertion hole **75**, when the IOL insertion apparatus **2**A is removed from the case **3**.

It should also be noted here that the front portion **62** of the exemplary case **3** may include one or more support walls **90** (two in the exemplary embodiment) with slots **92** in which the insertion tube **16** is supported (FIG. **10**). The width of each slot **92** (in a direction perpendicular to the lens advancement axis A) is equal to the width of the portion of the insertion tube **16** that is located therein. Similarly, the rear portion **64** includes a wall **94** (FIG. **15**) with a slot **96** that is smaller in width than, and located distally of, the distal end of the handle **54**. As a result, the IOL insertion apparatus main body **14**A, insertion tube **16** and handle **54** may not be moved forward (i.e., in the direction of arrow B in FIG. **12**) when the insertion apparatus **2**A is located within the case **3**. Also, as discussed above, the insertion apparatus

2A may not be pulled out of the case **3** (i.e., in the direction of arrow A in FIGS. **12** and **13**) when the slider grips **7** are within the storage slots **66**.

The exemplary cover **10**, which is shown in detail in FIG. **11**, includes a flat main body **76** and a pair of clips (or other attachment devices) **78**. The clips **78** are size and positioned such that they can be located in the removal slots **68**, and are configured to interlock with the engagement members **70** on the case **3**. The clips **78**, which extend downwardly from and are perpendicular to the main body **76**, are resiliently deflectable about the main body at the point at which the clips are attached to the main body. As a result, the cover **10** can be easily secured to and removed from the case **3** by pressing the top ends of the clips **78** toward one another.

A protrusion **80** (FIG. **10**), which extends downwardly from the bottom surface of the main body **76**, is located such that it will extend into the first insertion hole **26** on the insertion tube **16** when the IOL insertion apparatus **2**A is located within the case **3** and the cover **10** is secured to the case. The protrusion **80** is located within the path of the IOL adjacent to the distal end of the IOL optic **42** and, therefore, prevents distal movement of the IOL **40** within the lens placement section **28** during shipping and other times prior to use. The protrusion **80** is removed from the IOL path when the cover **10** is removed from the case **3**. The cover **10** also includes an injection port opening **82** that will be aligned with insertion tube injection port **24** when the IOL insertion apparatus **2**A is located within the case **3** and the cover **10** is secured to the case.

The cover **10** may be attached to the case **3**, with each of the clips **78** located with a portion of a removal slot **68** and secured to an engagement member **70**, when the lock mechanism **4** is in the locked state illustrated in FIG. **1**. The clips **78** are also positioned forward of the slider grips **7**, thereby preventing the slider **6** from being moved forwardly to unlock the lock mechanism **4** and move the IOL **40**, when the cover **10** is secured to the case **3**.

IV. Assembly

The exemplary IOL insertion system **1** may be assembled from an IOL insertion apparatus **2**A and case **3** in a variety of ways. One exemplary assembly methods begins with an IOL insertion apparatus **2**A that is complete, but for the loading of the IOL **40** and the attachment of the insertion tube **16** to the main body **14**A, and the front and rear portions **62** and **64** of the case **3** separated from one another. In the initial step of the exemplary assembly method, the slider **6** and plunger **8** are attached to the main body **14**A and the slider **6** is moved to its forward position so that the grip will be located within the removal slots **68**. The main body **14**A is then attached to the rear portion **64** of the case **3**, which is still separated from the front portion **62**, and the slider **6** is moved to the rearward position with the grips **7** within the storage slots **66**. The IOL **40** is then placed in the lens placement section **28**, with the outer edge of the optic **42** on the rails **38**, and the supports **44** and **46** located distally and proximally of the optic. The inward protrusions **48** (FIG. **5**) prevent the IOL **40** from moving in the rearward direction. The insertion tube **16** may then be attached to the front end of the main body **14**A such that the lens placement section **28** is covered by the protector **22**.

Next, the cover **10** is inserted onto the case **3**. The clips **78** move through the removal slots **68** until they clip onto the engagement members **70**, thereby securing the cover **10** to the case **3**. The cover protrusion **80** will now extend through the first insertion hole **26** and be positioned between the forward support **44** and the optic **42** of the IOL **40**. As a result, movement of the IOL **40** is held between the lens placement section inward protrusions **48** and the cover protrusion **80** with no physical load is applied thereto (FIG. **10**). The proximal end of the case front portion **62** is then attached to the distal end of the rear portion **64** from underneath, thereby completing assembly of the exemplary IOL insertion system **1** (FIG. **1**).

V. Operation and Instructive Indicia

Operation of the exemplary IOL insertion system **1** is discussed below with reference to FIGS. **1** and **12-16**. The operational method may includes a number of step that are intended to be performed in a particular order. Some of the steps are associated with unlocking the lock mechanism **4** and removing the IOL insertion apparatus **2**A from the case **3**, some of the steps are associated with the operation of the IOL insertion apparatus itself, and at least one step is associated with both.

The exemplary IOL insertion system **1** may be provided with indicia that guides the operator through the initial steps in the proper sequence. More specifically, the exemplary IOL insertion system **1** includes markers **12**A-**12**C. Each marker includes a number and, where appropriate, a directional indicator. Marker **12**A is a "1" and is located on the cover **10** adjacent to the opening **82** for the injection port **24**. Marker **12**B, which is located on the cover **10** near the clips **78**, includes a pair of inwardly facing arrows and each arrow has a "2" associated therewith. Marker **12**C may be located on one or both sides of the case **3** adjacent to one or both of the storage slots **66**. In the illustrated implementation, marker **12**C consists of a forwardly facing arrow and a "3" adjacent to each of the storage slots **66** and, accordingly, each of the slider grips **7** when the IOL insertion system **1** is in its initial, pre-use state. As will be apparent from the discussion below, the markers **12**A-**12**C reduce the likelihood of operator error by guiding the operator through the associated steps in the correct sequence.

The exemplary IOL insertion system **1** may be operated as follows. The IOL insertion system may be provided to the operator in a sterile bag and removed therefrom while holding the handle **72** (FIG. **1**). A volume of viscoelastic material sufficient to fill the region around the IOL **40** may then be injected into the insertion tube **16** by way of injection port **24** (note marker **12**A). The ends of the cover clips **78** adjacent to the main body **76** may then be pressed together (note marker **12**B) to pivot the clips away from the engagement members **70**, thereby disconnecting the cover **10** from the case **3**. The cover **10** may then be removed from the case **3**, as shown in FIG. **12**. After the cover **10** has been removed from the case **3**, the clips **78** will no longer prevent the slider grips **7** from being moved forwardly and the protrusion **80** will no longer prevent the IOL **40** from being moved forwardly. The lock mechanism **4** will, however, still be in the locked state.

As illustrated in FIG. **13**, the next step is to move the slider **6** in the forward direction (note marker **12**C) until the slider grips **7** have moved out of the storage slots **66** and, in the illustrated embodiment, have come into contact with a front ends of the removal slots **68**. Such movement of the slider **6** causes the IOL **40** to move from the lens placement section **28** to the transition section **20**, thereby causing the lateral sides of IOL optic **42** to fold upwardly as the lens holder **11** pushes the central portion of the IOL optic downwardly (FIG. **14**). As the IOL **40** moves forwardly into the transition section **20**, the protrusion **74** bends the distal

IOL support **44** such that the free end of the support is positioned on the upper surface of the folded IOL optic **42** (FIG. **14**). In particular, the slanted rearwardly facing surface of the protrusion **74** (FIG. **10**) scoops up the distal IOL support **44** as it is bent, thereby facilitating reliable positioning of the distal IOL support on the upper surface of the folded IOL optic **42**. The lens contact surface **5** of the slider **6** also scoops up the proximal IOL support **46** and pushes it forwardly such that the proximal IOL support **46** will also be positioned on the upper surface of the folded IOL optic **42**. With respect to the folding of the IOL optic **42**, the distal portion is folded to a greater extent than the proximal portion, with the lateral edges folded up and the center pushed down, due to the tapered shape of the interior of the transition section **20**. This completes the initial folding of the IOL **40**.

Movement of the slider **6** from the position illustrated in FIG. **12** to the position illustrated in FIGS. **13** and **14** also unlocks the lock mechanism **4** because the slider grips **7** are no longer within the storage slots **66** and, instead, are within the removal slots **68**. The IOL insertion apparatus **2**A may now be removed from the case **3** by simply lifting the apparatus in the direction identified by arrow A in FIG. **13**. In addition to freeing up the IOL insertion apparatus **2**A for use by the operator, removal of the IOL insertion apparatus from the case **3** also removes the protrusion **74**, which is part of the case and which facilitated reliable folding of the IOL **40** during movement of the slider **6**, from the path of the IOL. Thus, the protrusion **74** is located within the path of the IOL **40** when needed (i.e. during the initial folding of the IOL) and is automatically removed from the path when appropriate (i.e. prior to operation of the plunder **8**A).

Next, the operator pushes the plunger handle **54** forward in the direction of arrow B (FIG. **15**) until the threads associated with the inner surface of the handle engage the thread (note protrusion **32** in FIG. **5**) on the main body **14**A. The handle **54** may then be rotated to drive the plunger **8**A. Forward movement of the plunger rod **51** drives the IOL **40** into, and then through, the nozzle **18** and then into the eye (FIG. **16**). The IOL **40** is further folded from the state illustrated in FIGS. **14** and **15** as it moves into the nozzle **18**. The above-described initial state of the folded IOL **40**, i.e. the IOL optic **42** folded with the supports **44** and **46** resting on the upper surface thereof, facilitates the subsequent folding associated with movement of the plunger rod **51**.

It should be again emphasized here that the IOL insertion apparatus **2**A is secured to the case **3** by the lock mechanism **4** until the slider **6** has been moved forward, thereby unlocking the lock mechanism so that the IOL insertion apparatus can be removed from the case. By incorporating such movement of the slider **6** into the unlocking process, the present IOL insertion system **1** prevents the operator from erroneously pushing the IOL **40** with the plunger **8**A until after the IOL has undergone the initial folding associated with the slider **6**.

VI. Other Exemplary Embodiments

The present inventions are not limited to the exemplary embodiments described above.

For example, in addition to screw-type IOL insertion apparatus such as that described above, the present inventions are applicable to push-type IOL insertion apparatus. One example of such a push-type IOL insertion apparatus is generally represented by reference numeral **2**B in FIG. **17**. The push-type IOL insertion apparatus **2**B is essentially identical to apparatus **2**A and similar elements are represented by similar reference numerals. Here, however, instead of a screw-type operational member, the plunger **8**B includes a push-type operational member **49**B that operates in a manner similar to a syringe. Operational member **49**B includes a disk-shaped member **84** on the proximal end of the proximal rod portion **53**, and a flange **86** on the outer surface of the main body **14**B. The plunger rod **51** is driven by resting one or more fingers on the flange **86** and pushing the disk-shaped member **84** with the thumb. The IOL insertion apparatus **2**B may be combined, for example, with the case **3** and cover **10** described above to form an IOL insertion system that requires operation of the slider **6** prior to removal of the IOL insertion apparatus from the case.

Another exemplary IOL insertion system, which is generally represented by reference numeral **1**C in FIG. **18**, includes an IOL insertion apparatus **2**C and a case **3**C. IOL insertion system **1**C is essentially identical to system **1** and similar elements are represented by similar reference numbers. For example, IOL insertion system **1**C includes a screw-type IOL insertion apparatus **2**C, a case **3**C, a lock mechanism **4** and a cover **10**C. In the interest of brevity, the discussion below focuses on the differences between the two systems.

As illustrated in FIG. **18**, the exemplary cover **10**C includes clips **78**C that extend above the main body **76** to a greater extent than do the clips **78** of the cover **10**. The additional length makes the clips **78**C easier to grip and the cover **10**C easier to remove.

Turning to FIGS. **19** and **20**, in the exemplary IOL insertion apparatus **2**C, the location of the injection port **24**C on the insertion tube **16**C decreases the likelihood that the cannula (not shown) delivering the viscoelastic material will come into contact with the IOL **40**. Additionally, the cover **10**C is provided with a frustoconical injection port opening **82**C that will be aligned with insertion tube injection port **24**C when the IOL insertion apparatus **2**C is located within the case **3**C and the cover is secured to the case. The frustoconical injection port opening **82**C guides the cannula into the injection port **24**C.

Referring to FIG. **21**, the exemplary IOL insertion apparatus **2**C includes a lens placement section **28**C with a pair of lens covers **29** that extend over the inward protrusions **48** (FIG. **5**) and portions of the IOL optic **42** and proximal support **46**. The lens covers **29** prevent upward movement of the IOL **40** prior to operation of the slider **6**C (e.g., during shipping or handling by the operator). As such, the lens covers **29** increase the likelihood that the IOL **40** will be properly positioned when the operator pushes the slider **6**C forward. Additionally, as shown in FIG. **22**, the lens placement section **28**C has a bottom surface **34**C with a groove **35** that guides the plunger rod **51**C (FIG. **24**) as it passes through the lens placement section, thereby increasing the likelihood that the plunder rod **51** will remain properly oriented.

With respect to the exemplary slider **6**C, and turning to FIG. **23**, the slider has a pivotable lens holder **11**C with a pair of protrusions **13**C. The dual protrusion arrangement causes the cause the lens holder **11**C to engage the inner surface of the insertion tube **16**C, and begin the pivoting and associated IOL folding, at an earlier point in the movement of the slider **6**C than would be the case with the single protrusion embodiment illustrate in FIG. **14**. Such earlier folding of the IOL **40** helps insure that the edge of the IOL is positioned in the manner illustrated in FIG. **14** so that the proximal IOL support **46** can slide over the IOL optic **42**. With respect to deflection of the proximal IOL support **46**, the exemplary slider **6**C includes a lens contact assembly **5**C that has a

support post **5**C-**1** and a vertical guide surface **5**C-**2** that tapers outwardly in the proximal to distal direction. The lens contact assembly **5**C insures that the proximal IOL support **46** will deflect in the manner described above with reference to FIG. **14**.

As illustrated example in FIG. **24**, the exemplary plunger rod **51**C has a rib **71**C that extends distally to a point adjacent to the recess **58**C. The rib **71**C increases the rigidity of plunger rod **51**C which, in turn, helps to maintain the alignment of the plunger rod **51**C. The shape of the recess **58**C, which is larger than recess **58**, helps insure that the proximal support **46** will move out of the recess once in the eye. The plunger rod **51**C also has a bottom wall **51**BW with an upper surface **51**US and a width W**1**, a lens contact surface **51**LC that extends downwardly from the bottom wall upper surface, a top wall **51**TW with a width W**2** that is less than the bottom wall width, and a lateral wall **60**.

Referring to FIG. **25**, the exemplary case **3**C includes a support member **88** that engages the bottom of the main body **14**A when the IOL insertion apparatus **2**C is stored within the case and the lock mechanism **4** is in the locked state (as shown). The support member **88**, which may be a thin wall with a curved upper surface, prevents the main body **14**A from bending in the downward direction as the user is pushing the slider **6**C forwardly. Such bending could result in an undesirable level of friction between the case **3**C and the slider grip **7**.

Another exemplary IOL insertion system, which is generally represented by reference numeral **1**D in FIG. **26**, includes an IOL insertion apparatus **2**D and a case **3**D. IOL insertion system **1**D is essentially identical to system **1**C and similar elements are represented by similar reference numbers. For example, IOL insertion system **1**D includes a screw-type IOL insertion apparatus **2**D, a lock mechanism **4**D, and a cover **10**C. In the interest of brevity, the discussion below focuses on the differences between the two systems.

The present inventor has determined that there may be some instances where, during the first step of the two-step process, the operator will place the case on a table or other flat support surface, hold the front portion of the case with one hand and the push the slider forward the other hand. Referring first to the embodiment illustrated in FIG. **18**, the front portion **62** of the case **6**C includes a bottom surface that tapers upwardly. If the operator pushes the front portion **62** of the case **3**C downwardly with too much force while firmly holding the slider grips **7**, the front portion of the case may deflect, the case protrusion **74** may be completely or partially pulled out of the IOL path, and the IOL distal support **44** may not deflect properly. The front portion **62**D of the exemplary case **3**D illustrated in FIGS. **26** and **27** includes a flat bottom surface **98**, which is aligned with the flat bottom surface **100** of the rear portion **64**D, that prevents such bending.

The present inventor has also determined that there may be some instances where the operator attempts to pull the insertion apparatus out of the case, in a direction that is slightly angled from vertical, before the slider movement has been completed and the slider has engaged the distal wall of the removal slot. The curvature of the proximal ends of the slider grips may create a gap, between the curved proximal ends and the distal end of the storage slot protrusion (note grip **7** and protrusion **69** in FIG. **25**) that invites these attempts. Turning to FIG. **28**, the respective shapes of the slider grip **7**D (not the flat proximal end), storage slot **66**D and removal slot **68**D (note extension **102**) prevent the insertion apparatus **2**D from being pulled out of the case **3**D when the slider **6**D is only in the almost fully forward position illustrated in FIG. **28**. The top corner of the slider grip **7**D is in contact with the bottom corner of the protrusion **69**. Only after the slider **6**D is moved to the fully forward position illustrated in FIG. **29** will removal of the insertion apparatus **2**D from the case **3**D be possible.

Numerous other modifications and/or additions to the above-described preferred embodiments would be readily apparent to one skilled in the art. It is intended that the scope of the present inventions extends to all such modifications and/or additions.

We claim:

1. An intraocular lens insertion apparatus, comprising:

an outer body that defines a lens movement direction, that includes a nozzle and a lens placement section with lens supporting surfaces having portions that are spaced from one another in a spacing direction that is perpendicular to the lens movement direction, and that is configured to store an intraocular lens, having an optic with a diameter and haptics with respective free ends, in such a manner that diametrically opposed portions of the optic are on the lens supporting surface portions that are spaced in the spacing direction that is perpendicular to the lens movement direction, one of the haptics is a proximal haptic, and one of the haptics is a distal haptic; and

a plunger, at least a portion of which is carried within the outer body, that is movable relative to the outer body and which has a distal region that defines a longitudinal axis, the distal region including

a bottom wall having an upper surface and defining a width in a direction transverse to the longitudinal axis of the distal region,

a lens contact surface extending downwardly from the bottom wall upper surface,

a top wall defining a width in a direction transverse to the longitudinal axis of the distal region that is less than the width of the bottom wall, and

a lateral wall that extends from the bottom wall to the top wall in a direction perpendicular to the spacing direction that is perpendicular to the lens movement direction,

the top wall, bottom wall and lateral wall together defining a recess that is located above the bottom wall, that extends proximally from the lens contact surface, that has a first lateral side that is open, a second lateral side that is closed by the lateral wall, and an open distal end, and that is configured to hold a portion of the proximal haptic when the proximal haptic is bent such that the free end is positioned over the optic.

2. An ocular implant insertion apparatus as claimed in claim **1**, wherein

the plunger includes a slanted wall that defines the proximal end of the recess.

3. An ocular implant insertion apparatus as claimed in claim **2**, wherein

the slanted wall is oriented at a non-perpendicular angle with respect to the longitudinal axis of the distal region.

4. An ocular implant insertion apparatus as claimed in claim **2**, wherein

the slanted wall extends from the lateral wall to the first lateral side that is open.

5. An ocular implant insertion apparatus as claimed in claim **2**, wherein

the width of the top wall at the open distal end of the recess is less than the width of the top wall at the proximal end of the recess.

6. An ocular implant insertion system as claimed in claim **1**, further comprising:

a slider movable relative to the plunger from a pre-use slider position to a second slider position.

7. An ocular implant insertion apparatus as claimed in claim **6**, wherein

the proximal haptic includes a free end; and

movement of the slider from the pre-use slider position to the second slider position moves the free end of the proximal haptic over the optic.

8. An ocular implant insertion apparatus as claimed in claim **6**, wherein

the proximal haptic includes a free end; and

movement of the slider from the pre-use slider position to the second slider position moves the free end of the distal haptic over the optic.

9. An ocular implant insertion apparatus as claimed in claim **1**, wherein

the plunger includes a rotatable handle.

10. An ocular implant insertion apparatus as claimed in claim **1**, wherein

the plunger includes a thumb rest.

11. An ocular implant insertion apparatus as claimed in claim **1**, wherein

the lens contact surface is planar.

12. An ocular implant insertion apparatus as claimed in claim **1**, wherein

the lateral wall defines a lateral side of the distal region of the plunger.

13. An ocular implant insertion apparatus as claimed in claim **1**, wherein

the lateral wall defines a distal end; and

the top wall defines a distal end that extends distally beyond the distal end of the lateral wall.

14. An ocular implant insertion apparatus as claimed in claim **1**, further comprising:

a tapered transition proximal of the nozzle.

15. An ocular implant insertion apparatus as claimed in claim **1**, wherein

the outer body comprises main body and an insertion tube mounted on the main body.

16. An ocular implant insertion apparatus as claimed in claim **15**, wherein

the insertion tube includes the nozzle.

17. An ocular implant insertion apparatus as claimed in claim **1**, wherein

the lateral wall extends distally beyond the lens contact surface.

* * * * *