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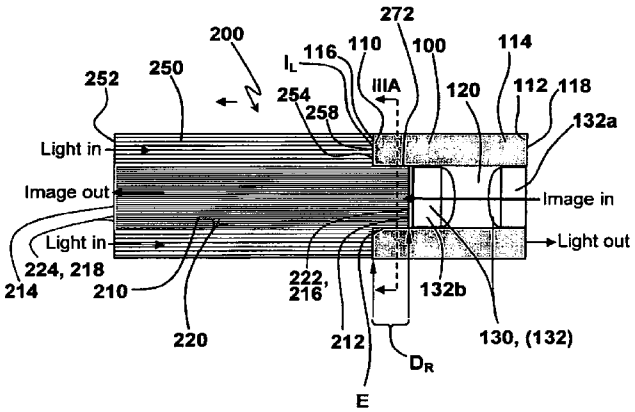
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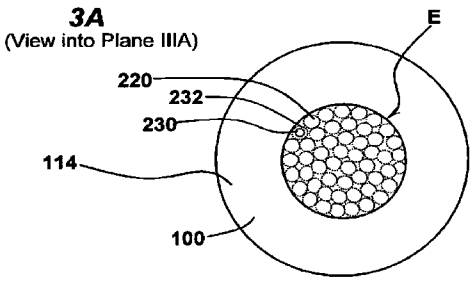
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[Continued on next page]

(54) Title: IMAGE-CONDUCTING OPTICAL ASSEMBLY INCLUDING LIGHT-CONDUCTIVE OPTICS HOUSING





(57) Abstract: An illuminable image-conducting optical assembly includes an illuminable image-transporting optical fiber bundle having (i) an inner image-conducting bundle with opposed image-input and image- output faces and (ii) a plurality of illumination conduits disposed peripherally about the image-conducting bundle. The illumination conduits include light-emission ends that combine to define a light-output face. A translucent optics housing includes light-entrance and light-exit ends and an inside surface defining an optics channel for housing at least one optical element. The optical fiber bundle and the optics housing cooperatively couple such that (a) at least one housed optical element is in optical communication with the image-input face in order to facilitate the projection of an image of an object of interest onto the image-input face and (b) the light-output face of the fiber bundle is in optical communication with the light- entrance end of the optics housing such that light introduced into the light-collection end of an illumination conduit enters the light-entrance end, and emits from the light-exit end, of the optics housing so as to facilitate illumination of the object to be imaged onto the image-input face.

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IMAGE-CONDUCTING OPTICAL ASSEMBLY INCLUDING LIGHT-CONDUCTIVE OPTICS HOUSING

BACKGROUND

Known in the optical-fiber component fabrication field is an optical fiber bundle that includes a first set of imaging fibers bundled with a second set of illuminating fibers arranged, for example, circumferentially or, more generally, peripherally, about the imaging fibers as viewed into a plane orthogonal to a longitudinal axis of the imaging and illuminating fibers. Also known to those in the optical fiber industry is that the purpose of such bundles is to form an illuminating "halo" in the vicinity of an object for which an image is to be acquired by, and transported through, the bundled imaging fibers to a remote sensing location. An example of such a "halo" fiber bundle is schematically represented in FIG. 1A. Typically, a device such as that shown in FIG. 1A is assembled from inner and outward fiber bundles, wherein the outward bundle is comprised of illuminating fibers that transport light from a remote source or sources to the light-output end of the outer bundle and the inner bundle is comprised of imaging fibers having an image-input end arranged proximate to focusing optics (e.g., a lens doublet). In order to accommodate and house focusing optics, arrangements such as that of FIG. 1B are fabricated. In the bundle of FIG. 1B, the light-output end of the outer, illuminating bundle extends beyond the image-input end of the inner, imaging bundle in order to define a void or channel for the mounting of the focusing optics. Where, for instance, the inner and outer bundles are cylindrical, a cylindrical void is defined, and analogously for various cross-sectional bundle geometries.

Difficulties abound in the fabrication of illuminable image-transporting fiber bundles of the general configuration shown in FIG. 1B. A first, typical method fabrication involves the separate fabrication of the inner and outer bundles and then the introduction of the inner bundle into the outer bundle. A second method involves the fabrication of the inner bundle and then the assembly and securement of outer-bundle fibers about the inner bundle. In either event, the frequently small and fragile structures require handling by very skilled operators and/or very sophisticated automation equipment, either of which adds to the expense of fabrication. Moreover, the tolerances that are necessary for assembly, particularly those associated with the first method, are difficult to maintain and often reduce the usable surface(s) of the component. Still further, at least the end face of the inner bundle must be finished (e.g., ground and polished) before the outer bundle is arranged about the inner bundle, which increases the exposure of the finished inner face to the potential for damage during subsequent steps in the fabrication process. In still additional, alternative aspects, end portions of mutually fused imaging fibers are machined away to form an image-input face that is recessed with respect to a peripheral light-emission face in order to form

a void or channel into which, for example, one or more optical elements (e.g., a lens) is mounted for focusing an image onto the image-input face. In a typical version consistent with the current state of the art, the optics mounted into the void or channel adjacent the image-input face are permanently mounted and, therefore, non changeable. It will be appreciated that machining for the purposes creating a channel to house optics subjects the fused image bundle to damage such as the shattering or splintering of constituent fibers that, as one will readily appreciate, results in the degradation of image input and transport through the image bundle. Moreover, polishing the recessed image-input face is difficult and may result in damage to surrounding illumination fibers.

Accordingly, there exists a need for a simplified assembly including an illuminable image-transporting optical fiber bundle and optics for focusing images into the image-input face thereof. Moreover, there is a need for versions of such an assembly capable of retaining in optical communication with the image-input face, alternative sets of optics.

SUMMARY

In accordance with a first illustrative set of embodiments, an illuminable image-conducting optical assembly includes an illuminable image-transporting optical fiber bundle (also referred to as "illuminable image bundle") and optics housing configured for cooperative coupling with the illuminable image bundle. The illuminable image bundle has an inner image-conducting bundle including first and second image-bundle ends and a plurality of light-conductive imaging conduits extending between the first and second ends. Each imaging conduit includes first and second ends and has the capacity to conduct light between its first and second ends by total internal reflection. The first ends of the imaging conduits terminate at and define an image-input face at the first image-bundle end and the second ends of the imaging conduits terminate at and define an image-output face at the second image-bundle end.

Peripherally disposed about the image-conducting bundle is a plurality of illumination conduits. Each illumination conduit includes a light-collection end and a light-emission end opposite the light-collection end. As with the imaging conduits, the illumination conduits are capable of transmitting light between the light-collection and light-emission ends by total internal reflection. In a typical embodiment, plural light-emission ends combine to define a light-output face. Moreover, the light-output face is typically more proximate the image-input face than the image-output face of the image-conducting bundle.

The optics housing extends between first and second housing ends and includes a housing wall that is fabricated, at least partially, from a translucent material. For purposes of the current specification, and the appended claims, "translucent" means "not entirely or completely opaque." Accordingly, "translucent" as defined herein covers the range from totally transparent to nearly, but not totally, opaque. The housing wall includes opposed light-entrance and light-exit ends and inside and outside surfaces extending between the light-entrance and light-exit ends. Moreover, the inside surface of the housing wall defines an interior optics channel. The optics channel is configured for housing an optical element set that includes at least one optical element such as, by way of non-limiting example, a focusing element such as a lens or graded-refractive-index element, an optical filter, an optical isolating element such as baffle, and a reflective element such as mirror or mirrored surface.

In an operative mode, the optics housing is cooperatively coupled with the illuminable image-transporting optical fiber bundle such that (i) at least one of the at least one optical elements housed by the optics housing is in optical communication with the image-input face of the image-conducting bundle in order to facilitate the projection of an image of an object of interest that is external to the optics channel onto the image-input face; and (ii) the light-output face defined by the plural light-emission ends is in

optical communication with the light-entrance end of the optics housing such that light introduced into the light-collection end of an illumination conduit enters the light-entrance end of the housing wall for transmission to, and emission from, the light-exit end of the housing wall so as to facilitate illumination of the object to be imaged onto the image-input face.

Envisioned within the scope and contemplation of various versions as defined in the appended claims are kits wherein at least one of (i) the illuminable image-transporting optical fiber bundle and the optics housing are configured for selective cooperative coupling such that the optics housing is capable of alternative removal from and attachment to the illuminable image-transporting optical fiber bundle and (ii) the optics housing and optical element set are configured such that the optical element set is selectively retainable within and removable from the optics channel. Various such kits include at least one of (i) a set of optics housings including at least two optics housings and (ii) set of at least two optical element sets. In the first instance, optics housings may be alternatively attached to the illuminable image-transporting optical fiber bundle, while, in the second instance, plural optical elements sets may be alternatively retained within the optics channel. While either option increases the versatility of the assembly kit, versions in which both the optics housing and the optical element sets can be changed render possible the selective assembly of a greater number of cooperatively-coupled component combinations than is possible with either option alone.

Among the advantages of various versions providing for the coupling of an optics housing, such as that described above, with an illuminable image bundle are (i) obviation of difficult and expensive techniques such as cutting away portions of imaging fibers to create a void for the mounting of optics; (ii) facilitation of the "mixing" of illuminating light entering the housing from discrete illumination fibers; and (iii) interchangeability of housings and associated optics or of optical element sets within the housing, although the first two advantages are realizable in versions in which both or either of the optics housing and the optical element set are permanently affixed.

Representative, non-limiting embodiments are more completely described and depicted in the following detailed description and the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1A shows a traditional illuminable image-transporting fiber bundle in which an inner bundle of adjacently-fused image-conducting optical fibers, or imaging fibers, is peripherally surrounded by a plurality of illuminating fiber;

FIG. 1B depicts a an illuminable image-transporting fiber bundle in which an image-input face defined at one end of the inner image-conducting bundle is recessed with respect to a peripheral light-emission face defined collectively by the light-emission ends of plural illuminating fibers in order to form a void or channel into which one or more optical elements (e.g., a lens) is mounted for focusing an image onto the image-input face;

FIG. 2 depicts an illuminable image-conducting optical assembly embodying aspects of the present invention and including a light-conductive optics housing having a translucent housing wall defining an optics channel that houses an optical element set and an illuminable image bundle that is cooperatively coupled with the optics housing;

FIG. 2A is a cross-sectional view into the plane IIA of FIG. 2;

FIG. 2B is a cross-sectional view into the plane IIB of FIG. 2;

FIG. 3 shows an optical assembly, alternative to that of FIG. 2, in which the image-input face of the inner image-conducting bundle extends beyond the light-output face defined by the light-emission ends of the illumination conduits so as to define a stepped shoulder about which a portion of the optics housing is peripherally disposed and mounted;

FIG. 3A is a cross-sectional view into the plane IIIA of FIG. 3;

FIG. 4A depicts an illustrative embodiment in which the optics housing and the illuminable image bundle are configured for selective threadable coupling;

FIG. 4B depicts an embodiment, alternative to that of FIG. 4A, in which the optics housing and the illuminable image bundle are configured for selective threadable coupling;

FIG. 5A shows an embodiment in which, irrespective of whether the optics housing is selectively separable from the illuminable image bundle, the optical element set is selectively retainable within the optics channel of the optics housing; and

FIG. 5B illustrates another alternative version in which the optical element set is selectively retainable within the optics channel of the optics housing.

DETAILED DESCRIPTION

The following description of various embodiments of a light-conductive optics housing optically coupled with an illuminable image-transporting optical fiber bundle is illustrative in nature and is therefore not intended to limit the scope of the invention or its application of uses. Accordingly, the various implementations, aspects, versions and embodiments described in the summary and detailed description are in the nature of non-limiting examples falling within the scope of the appended claims and do not serve to define the maximum scope of the claims.

In a first illustrative configuration shown in FIGS. 2, 2A and 2B, a cylindrical light-conductive optics housing **100** extends between open first and second housing ends **110** and **112**. A housing wall **114** extends between the first and second housing ends **110** and **112** and includes a light-entrance end **116** and a light-exit end **118** that coincide with, respectively, the first and second housing ends **110** and **112**. Moreover, the housing wall **114** includes inside and outside surfaces **115a** and **115b** extending between the light-entrance and light-exit ends **116** and **118**. The housing wall **114** defines an optics channel **120** that is bounded by the inside surface **115a** and configured to house an optical element set **130** including at least one optical element. In the illustrative embodiment of FIG. 2, the optical element set **130** comprises a lens doublet **132** including first and second lenses **132a** and **132b**. However, it is to be understood that the optical element set **130** in various versions may include in addition to, or instead of, either or both of first and second lenses **132a** and **132b**, at least one of (i) an additional lens, (ii) a graded-refractive index focusing element, (iii) a dispersive element such as a prism, grating or grism, and (iii) an optical filter, by way of non-limiting example. At least a portion of the housing wall **114** is translucent such that light introduced into the housing wall **114** through the light-entrance end **116** is transmitted through the housing wall **114** for emission from the light-exit end **118**.

Referring still to FIG. 2, the optics housing **100**, and the optical element set **130** housed thereby, are in optical communication (i.e., optically coupled) with an illuminable image-transporting optical fiber bundle **200** which, for convenience and brevity, is alternatively referred to as illuminable image bundle **200** or by some similar designation. The illuminable image bundle **200** includes an inner image-conducting bundle **210** having first and second image-bundle ends **212** and **214** and a plurality of light-conductive imaging conduits **220** (e.g., optical fibers) extending between the first and second image-bundle ends **212** and **214**. Referring to FIGS. 2 and 2B, each imaging conduit **220** includes first and second ends **222** and **224** and comprises an optically transmissive core **230** having an imaging-core refractive index. Each core **230** is surrounded by a cladding material **232** having an imaging-cladding refractive index lower than the imaging-core refractive index such that light propagates through the

imaging conduit **220** by total internal reflection in accordance with principles well-known to those of ordinary skill in the related art. The first ends **222** of the imaging conduits **220** terminate at, and combine to define, an image-input face **216** at the first image-bundle end **212**. Analogously, the second ends **224** of the imaging conduits **220** terminate at, and define, an image-output face **218** at the second image-bundle end **214**.

Disposed circumferentially about the image-conducting bundle **210** is a plurality of bundled illumination conduits **250** (e.g., optical fibers). Each illumination conduit **250** includes a first, light-collection end **252** and a second, light-emission end **254** opposite the light-collection end **252**. In alternative versions, the light-collection ends **252** of the illumination conduits **250** collect light from a single remote light source (not shown) or from multiple remote light sources (not shown). Plural light-emission ends **254** combine to define a light-output face **258**. In the particular illuminable image bundle **200** of FIG. 2, the light-output face **258** is annularly disposed about the first ends **222** of the imaging conduits **220** such that the light-output face **258** and the image-input face **216** form a first common face **270**. Moreover, in the particular version of FIG. 2, the first common face **270** is planar, but, in various versions within the scope and contemplation of the invention, is alternatively configured. Furthermore, in alternative versions, the optical coupling is retained permanently, such as by the application of an adhesive (e.g., optical epoxy E_O) to and between the light-output face **258** of the illuminable image bundle **200** and the light-entrance end **116** of the optics housing **100**.

Depicted in FIGS. 3 and 3A is an embodiment alternative to that of FIGS. 2, 2A and 2B. In most of its aspects, the version of FIGS. 3 and 3A includes elements analogous to those of the version of FIGS. 2-2B and, therefore, the same reference characters are used to identify like elements associated with the two alternative versions. In the version of FIGS. 3 and 3A, the image-input face **216** of the image-conducting bundle **210** does not define with the light-output face **258** a common face, such as common face **270** shown in FIG. 2. More specifically, while in the version of FIGS. 3 and 3A the light-emission ends **254** of the illumination conduits **250** define a light-output face **258** that is annularly disposed about the image-conducting bundle **210**, the light-output face **258** is recessed by a distance D_R relative to the image-input face **216** such that a stepped shoulder **272** separates the image-input face **216** and the light-output face **258**. As shown in FIG. 3, a configuration in which the image-input face **216** extends beyond the light-output face **258** facilitates the protrusion of a portion of the length of the image-conducting bundle **210** into the optics channel **120** of a compatibly dimensioned optics housing **100**. Shown in FIG. 3A is a view into cross-sectional plane **IIIA** of FIG. 3, which is taken along a portion of the image-conducting bundle **210** that protrudes into the optic channel **120** and shows that, along this protruding portion, the image-conducting bundle **210** is surrounded by the optics housing **100**. In a

version such as that of FIG. 3, an adhesive such as epoxy **E**, for example, may be applied to a portion of the stepped shoulder **272** extending along overlapping portions of the lengths of the image-conducting bundle **210** and the optics housing **100** to retain the optics housing **100** in a fixed position relative to the illuminable image bundle **200**. In addition to contributing to overall structural integrity of the joint between the optics housing **100** and the illuminable image bundle **200**, stepped shoulder **272**, by providing a length-wise extending portion along which to apply an adhesive, obviates the need to apply adhesive to the light-entrance end **116** of the housing wall **114** and the light-output face **258**, thereby preserving the integrity of light transmission at the light interface I_L defined between the light-entrance end **116** and the light-output face **258**.

Referring to FIGS. 4A and 4B, alternative versions are shown in which the optics housing **100** is threadably coupled to the illuminable image bundle **200**. One advantage envisioned in association with such embodiments is the ability to selectively remove and attach different optics housings **100** retaining optical element sets **130** with different optical elements to the illuminable image bundle **200**. The illustrative version of FIG. 4A is in most major respects similar to that of FIG. 2 and, therefore, like reference characters are used to refer to analogous elements. In the version of FIG. 4A, however, a portion of the length of the illuminable image bundle **200**, beginning at the light output face **258**, is provided with a first external-thread set **282**. In the particular version depicted, the external-thread set **282** is formed on a first threaded collar **280** that is annularly affixed about a portion of the length of the illuminable image bundle **200**. However, it will be appreciated that the illuminable image bundle **200** may be otherwise provided with an external-thread set **282**. Similarly, a portion of the length of the optics housing **100**, beginning at the light-entrance end **116**, and extending toward the light-exit end **118**, has affixed thereabout a second threaded collar **180** that carries a second external-thread set **182**. The optics housing **100** and illuminable image bundle **200** are selectively coupled by an internally-threaded coupler **300** that has defined therein a first internal-thread set **302a** into which threads of the first external-thread set **282** are threaded and a second internal-thread set **302b** into which threads of the second external-thread set **182** are threaded. It is to be understood that alternative versions may include an internally-threaded coupler **300** that is permanently affixed (e.g. and not threaded) about one of the illuminable image bundle **200** and the optics housing **100**, while the other of the optics housing **100** and the image bundle **200** is threaded into the threaded coupler **300**.

Referring to FIG. 4B, a version including a stepped shoulder **272** such as that exhibited by the version of FIG. 3 is shown. To the extent that elements of the versions of FIGS. 4B and 3 are analogous, they are identified by like reference characters. Referring now to FIG. 4B, at least a portion of the stepped shoulder **272** extending along a portion of the length of the inner image-conducting bundle **210**

carries inner-bundle external threads **292**. In the particular version shown, the inner-bundle external threads **292** are defined about the exterior surface of an inner-bundle threaded collar **290** that is affixed about that portion of the inner bundle **210** protruding beyond the light-output face **258**. However, it will be appreciated that the portion of the inner bundle **210** protruding beyond the light-output face **258** may be otherwise provided with inner-bundle external threads **292**. Beginning adjacent the light-entrance end **116**, a portion along the length of the optics housing **100** includes housing internal threads **192** configured for selective threading engagement with the inner-bundle external threads **292**. In the particular version shown, the housing internal threads **192** are formed (e.g., cut or molded) in the material (e.g., glass or plastic) from which the optics housing **100** is fabricated, although the optics housing **100** may be otherwise provided with internal threads **192**. For instance, a portion of the interior of the optics housing **100** may have affixed therein an internally threaded collar (not shown) along an interior surface of which the housing internal threads **192** are defined.

In still further illustrative embodiments in which the optics housing **100** is either permanently attached or selectively attachable to the illuminable image bundle **200**, an optical element set **130** is selectively insertable into and out of the optics housing **100**. Accordingly, for instance, in an embodiment in which the optics housing **100** is permanently attached to the illuminable image bundle **200**, one set of optics can still be substituted for another in order to increase the overall versatility of the illuminable image bundle **200**. An illustrative, non-limiting example of such an embodiment is shown in FIG. 5.

In the example of FIG. 5, an optical element set **130** comprising a lens doublet **132** including first and second lenses **132a** and **132b** is affixed within an optics casing **140**. The optics casing **140** has interior and exterior surfaces **142** and **144** and exhibits external dimensions that render it configured for the selective introduction into, and retention within, the optics channel **120**. In the version of FIG. 5, the exterior surface **144** of the optics casing **140** carries a set of external casing threads **146** configured for selective threading engagement with internal housing threads **119** depending from the inside surface **115a** of the housing wall **114**.

Depicted in FIG. 5A is another illustrative version in which an optical element set **130** is threadably retainable within the optics channel **120** of an optics housing **100**. In the illustrative version of FIG. 5A, an optics casing **140** carrying a lens doublet **132** is slidably insertable into, and removable from, the optics channel **120** of the optics housing **100**. An optical-set retainer **150** depending from the housing wall **114** is configured for selective retention of the optics casing **140**. More specifically, in the case of FIG. 5A, a threaded bore **117** extending through the housing wall **114** threadably retains a set screw **152**. With the optics casing **140** positioned as desired within the optics channel **120**, the set screw **152** may be threaded into the threaded bore **117** so as to selectively exert a retaining force against the exterior

surface **144** of the optics casing **140**. Although the set screw **152** is not shown in a casing-retentive mode, the mode is readily comprehensible from the depiction of the FIG. 5A and associated description hereinabove.

Various alternative embodiments provide for the selective coupling of an optical element set **130** to the illuminable image bundle **200** by means of threads. It will be appreciated that threaded surfaces must be at least arcuate, and are typically entirely cylindrical. However, alternative embodiments within the scope and contemplation of the invention include at least one of (i) an illuminable image bundle **200**, (ii) an optics housing, and (iii) an optics casing **140** that is other-than-cylindrical in cross-sectional geometry. In various such versions, at least one of the optics housing **100** and the optical element set **130** within the optics housing **100** may be selectively retained by set screws such as set screw **152** in FIG. 5A or devices other than threaded fasteners such, by way of non-limiting example, at least one of a (i) clip, (ii) snap and (iii) magnet.

In still additional versions, it may be desirable to at least partially optically isolate at least one optical element of the optical element set **130** from the translucent material from with the housing wall **114** of the optics housing **110** is fabricated. It will be appreciated that the aforesaid optical isolation may be achieved by the inclusion of one or more opaque layers. Referring to FIG. 5A, in one version, an opaque coating C_O is applied to the inside surface **115a** of the housing wall **114**. Alternatively or in addition, an opaque coating is applied to at least one of the interior and exterior surfaces **142** and **144** of the optics casing **140** in those embodiments including and optics casing **140** such as, by way of example, the embodiment of FIG. 5A. In yet other alternative versions including an optics casing **140**, the optics casing **140** is fabricated from an opaque material.

The foregoing is considered to be illustrative of the principles of the invention. Furthermore, since modifications and changes to various aspects and implementations will occur to those skilled in the art without departing from the scope and spirit of the invention, it is to be understood that the foregoing does not limit the invention as expressed in the appended claims to the exact constructions, implementations and versions shown and described.

What is claimed is:

1. An illuminable image-conducting optical assembly comprising:

(a) an illuminable image-transporting optical fiber bundle having

(i) an inner image-conducting bundle including first and second image-bundle ends and a plurality of light-conductive imaging conduits extending between the first and second ends, each imaging conduit including first and second ends and having the capacity to conduct light between the first and second ends by total internal reflection, the first ends of the imaging conduits terminating at and defining an image-input face at the first image-bundle end and the second ends of the imaging conduits terminating at and defining an image-output face at the second image-bundle end; and

(ii) a plurality of illumination conduits disposed peripherally about the image-conducting bundle, each illumination conduit including a light-collection end and a light-emission end opposite the light-collection end, the plural light-emission ends combining to define a light-output face more proximate the image-input face than the image-output face of the image-conducting bundle;

(b) an optics housing including a housing wall fabricated from a translucent material and having an outside surface and inside surface defining an interior optics channel configured for housing an optical element set, the optics housing extending between first and second housing ends and the housing wall including light-entrance and light-exit ends coinciding with, respectively, the first and second housing ends; and

(c) an optical element set including at least one optical element housed within the optics channel of the optics housing; wherein

the optics housing is cooperatively coupled with the illuminable image-transporting optical fiber bundle such that

(i) at least one of the at least one optical elements housed by the optics housing is in optical communication with the image-input face of the image-conducting bundle in order to facilitate the projection of an image of an object of interest that is external to the optics channel onto the image-input face of the image-conducting bundle; and

(ii) the light-output face defined by the plural light-emission ends is in optical communication with the light-entrance end of the optics housing such that light introduced into the light-collection end of an illumination conduit enters the light-entrance

end of the housing wall for transmission to, and emission from, the light-exit end of the housing wall so as to facilitate illumination of the object to be imaged onto the image-input face.

2. The assembly of claim 1 further comprising an opaque layer that optically isolates at least one of the at least one optical elements housed within the optics channel from the translucent material from which the housing wall is fabricated.

3. The assembly of claim 2 wherein the opaque layer comprises a coating applied to the inside surface of the housing wall.

4. The assembly of claim 1 wherein each optical element of the optical element set is affixed within an optics casing having interior and exterior surfaces and external dimensions that render the optics casing configured for selective introduction into, and retention within, the optics channel of the of optics housing, such that one optical element set can be substituted for another in order to increase the versatility of the assembly.

5. The assembly of claim 4 further comprising an opaque layer that optically isolates at least one of the at least one optical elements housed within the optics channel from the translucent material from which the housing wall is fabricated, wherein the opaque layer comprises at least one of:

(a) a coating applied to the inside surface of the housing wall;

(b) a coating applied to the interior surface of the optics casing;

(c) a coating applied to the exterior surface of the optics casing; and

(d) an optics casing fabricated from an opaque material.

6. The assembly of claim 5 wherein the illuminable image-transporting optical fiber bundle and the optics housing are configured for selective cooperative coupling such that the optics housing is capable of alternative removal from and attachment to the illuminable image-transporting optical fiber bundle.

7. The assembly of claim 4 wherein the illuminable image-transporting optical fiber bundle and the optics housing are configured for selective cooperative coupling such that the optics housing

is capable of alternative removal from and attachment to the illuminable image-transporting optical fiber bundle.

8. The assembly of claim 2 wherein the illuminable image-transporting optical fiber bundle and the optics housing are configured for selective cooperative coupling such that the optics housing is capable of alternative removal from and attachment to the illuminable image-transporting optical fiber bundle.

9. The assembly of claim 1 wherein the illuminable image-transporting optical fiber bundle and the optics housing are configured for selective cooperative coupling such that the optics housing is capable of alternative removal from and attachment to the illuminable image-transporting optical fiber bundle.

10. The assembly of claim 9 wherein

(i) a portion of the length of the illuminable image-transporting optical fiber bundle is provided with a first external-thread set;

(ii) a portion of the length of the optics housing carries a second external-thread set; and

(iii) the optics housing and the illuminable image-transporting optical fiber bundle are selectively coupleable by an internally-threaded coupler that has defined therein a first internal-thread set into which threads of the first external-thread set are threadable and a second internal-thread set into which threads of the second external-thread set are threadable.

11. The assembly of claim 9 wherein the light-output face is peripherally disposed about the image-conducting bundle and recessed relative to the image-input face such that (a) a stepped shoulder extending along a portion of the length of the image-conducting bundle separates the image-input face and the light-output face and (b) when the optics housing and the illuminable image-transporting optical fiber bundle are cooperatively coupled, a portion of the length of the image-conducting bundle protrudes into the optics channel of the optics housing.

12. The assembly of claim 11 wherein

(i) at least a portion of the stepped shoulder carries inner-bundle external threads; and

(i) a portion along the length of the optics housing includes housing internal threads configured for selective threading engagement with the inner-bundle external threads.

13. An illuminable image-transporting optical fiber bundle and optics housing kit comprising:

(a) an illuminable image-transporting optical fiber bundle having

(i) an inner image-conducting bundle including first and second image-bundle ends and a plurality of light-conductive imaging conduits extending between the first and second ends, each imaging conduit including first and second ends and having the capacity to conduct light between the first and second ends by total internal reflection, the first ends of the imaging conduits terminating at and defining an image-input face at the first image-bundle end and the second ends of the imaging conduits terminating at and defining an image-output face at the second image-bundle end; and

(ii) a plurality of illumination conduits disposed peripherally about the image-conducting bundle, each illumination conduit including a light-collection end and a light-emission end opposite the light-collection end, the plural light-emission ends combining to define a light-output face more proximate the image-input face than the image-output face of the image-conducting bundle; and

(b) an optics housing including a housing wall fabricated from a translucent material and having an outside surface and inside surface defining an interior optics channel configured for housing an optical element set, the optics housing extending between first and second housing ends and the housing wall including light-entrance and light-exit ends coinciding with, respectively, the first and second housing ends; wherein

(i) the optics housing one of (a) permanently retains within the optics channel an optical element set including at least one optical element and (b) is configured such that an optical element set including at least one optical element can be alternatively retained within, and removed from, the optics channel; and

(ii) the optics housing is selectively cooperatively coupleable with the illuminable image-transporting optical fiber bundle such that, when the optics housing and the illuminable image-transporting optical fiber bundle are cooperatively coupled

(a) at least one optical element housed by the optics housing is in optical communication with the image-input face of the image-conducting bundle in order to facilitate the projection of an image of an object of interest that is external to the optics

channel onto the image-input face of the image-conducting bundle; and

(b) the light-output face defined by the plural light-emission ends is in optical communication with the light-entrance end of the optics housing such that light introduced into the light-collection end of an illumination conduit enters the light-entrance end of the housing wall for transmission to, and emission from, the light-exit end of the housing wall so as to facilitate illumination of the object to be imaged onto the image-input face.

14. The kit of claim 13 wherein the light-output face is peripherally disposed about the image-conducting bundle and recessed relative to the image-input face such that (a) a stepped shoulder extending along a portion of the length of the image-conducting bundle separates the image-input face and the light-output face and (b) when the optics housing and the illuminable image-transporting optical fiber bundle are cooperatively coupled, a portion of the length of the image-conducting bundle protrudes into the optics channel of the optics housing.

15. The kit of claim 14 wherein

(i) at least a portion of the stepped shoulder carries inner-bundle external threads; and

(i) a portion along the length of the optics housing includes housing internal threads configured for selective threading engagement with the inner-bundle external threads.

16. The kit of claim 15 wherein the optics housing is configured such that an optical element set including at least one optical element can be alternatively retained within, and removed from, the optics channel.

17. The kit of claim 16 further comprising an opaque layer that optically isolates at least one optical element housed within the optics channel from the translucent material from which the housing wall is fabricated, wherein the opaque layer comprises at least one of:

(a) a coating applied to the inside surface of the housing wall;

(b) a coating applied to the interior surface of the optics casing;

(c) a coating applied to the exterior surface of the optics casing; and

(d) an optics casing fabricated from an opaque material.

18. The kit of claim 13 further comprising an opaque layer that optically isolates at least one optical element housed within the optics channel from the translucent material from which the housing wall is fabricated, wherein the opaque layer comprises at least one of:

(a) a coating applied to the inside surface of the housing wall;

(b) a coating applied to the interior surface of the optics casing;

(c) a coating applied to the exterior surface of the optics casing; and

(d) an optics casing fabricated from an opaque material.

19. The kit of claim 13 wherein the optics housing is configured such that an optical element set including at least one optical element can be alternatively retained within, and removed from, the optics channel.

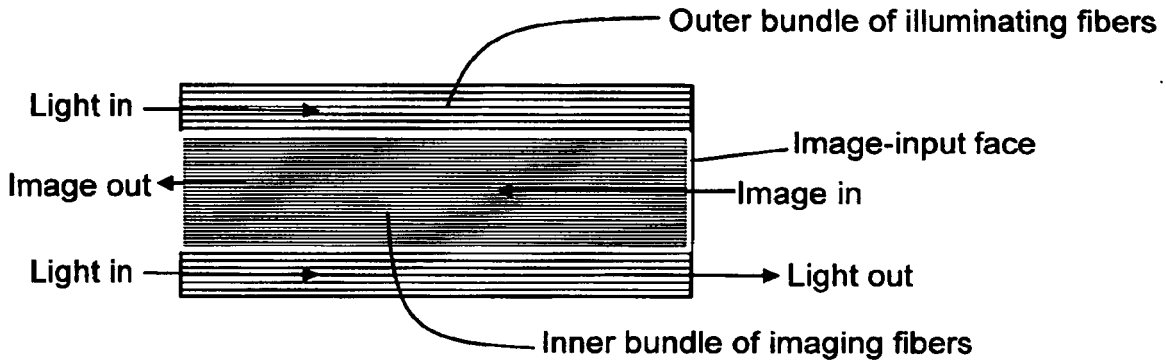
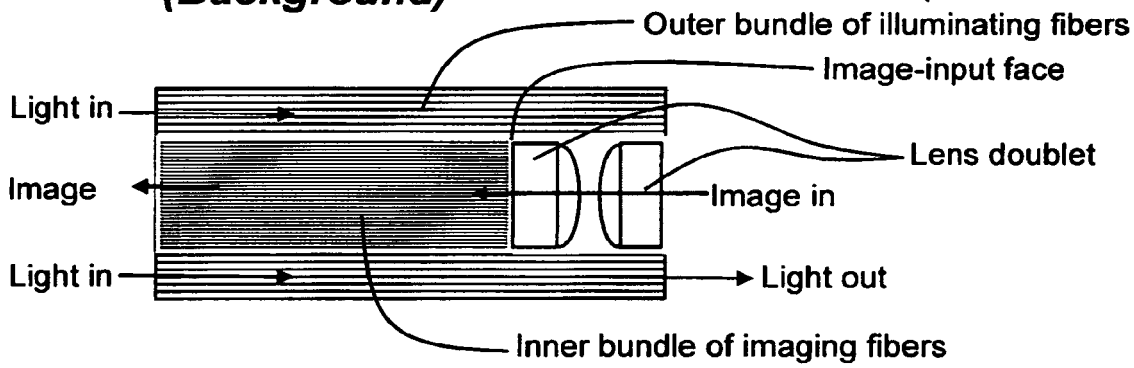


FIG. 1A
(Background)

FIG. 1B
(Background)



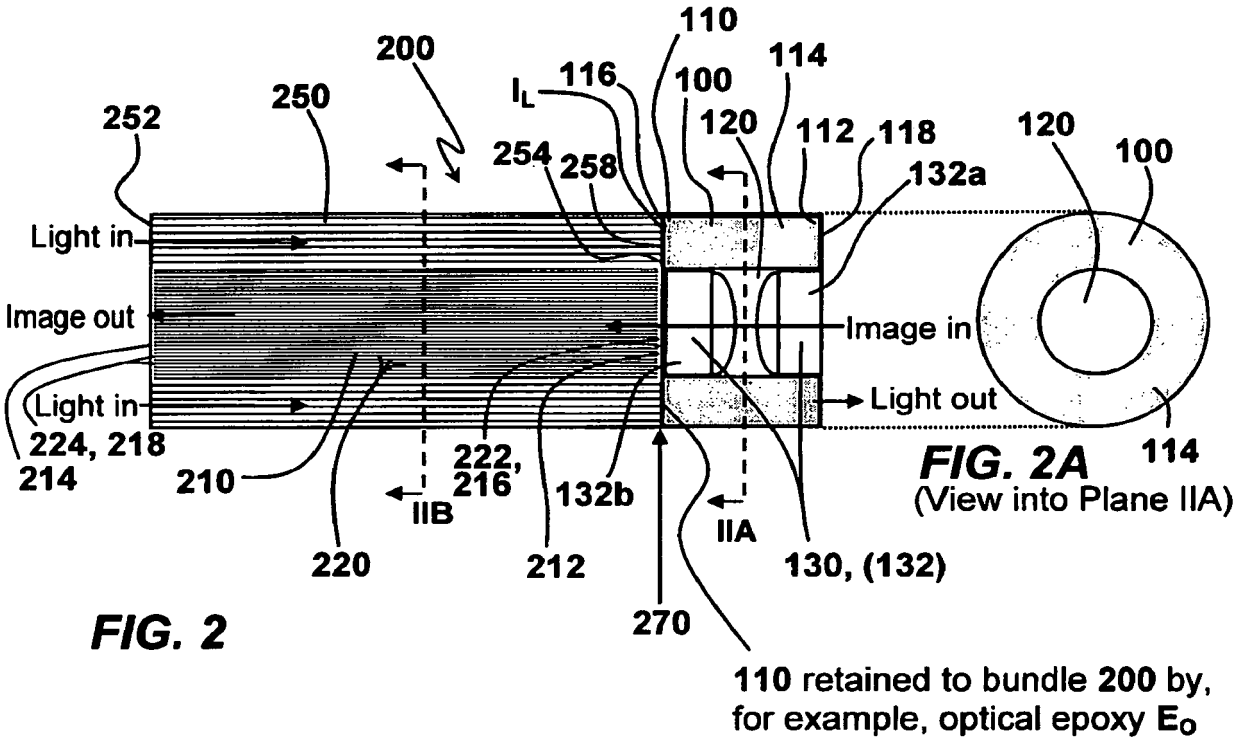


FIG. 2

FIG. 2A
(View into Plane IIA)

FIG. 2B
(View into Plane IIB)

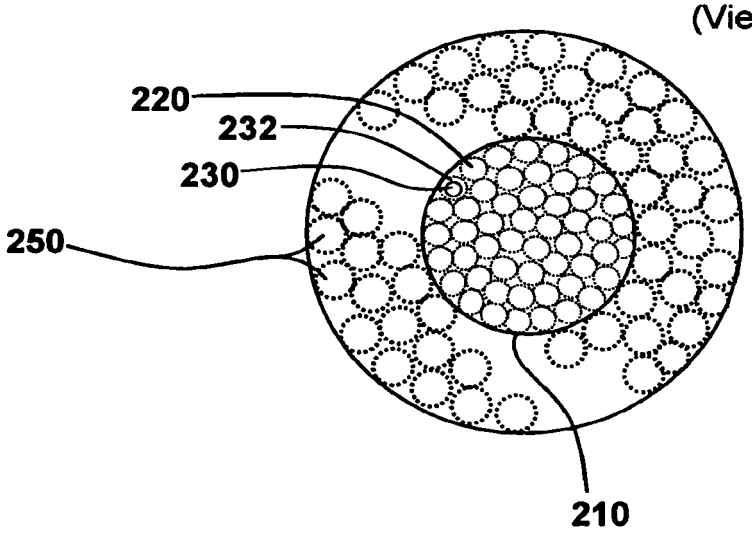


FIG. 3

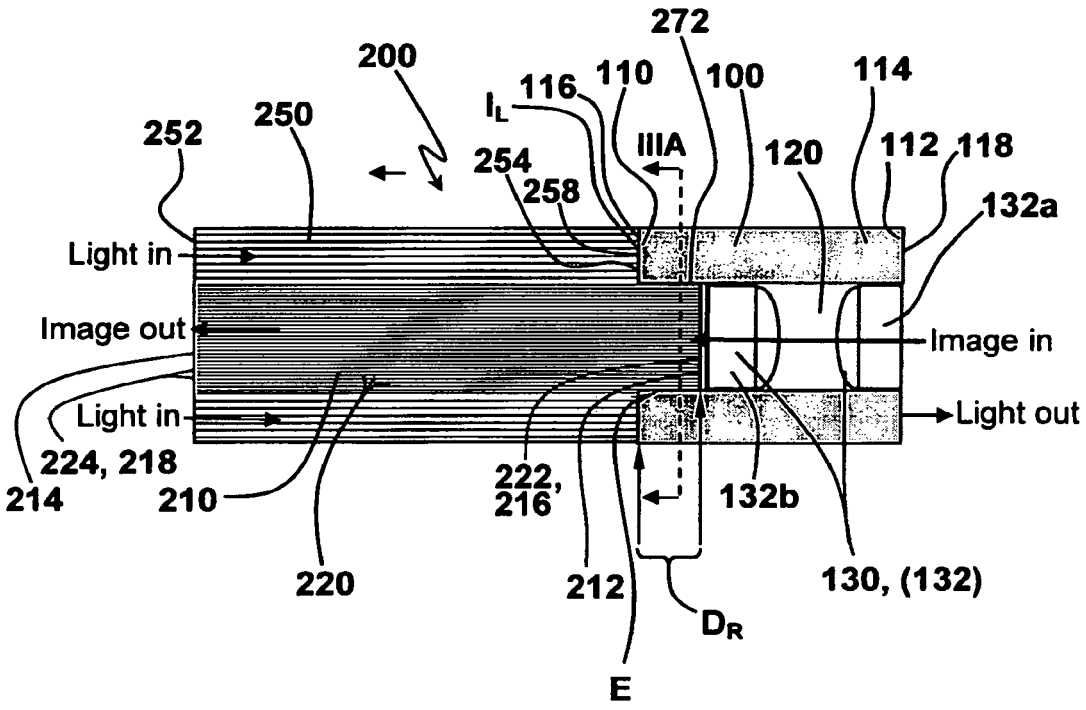
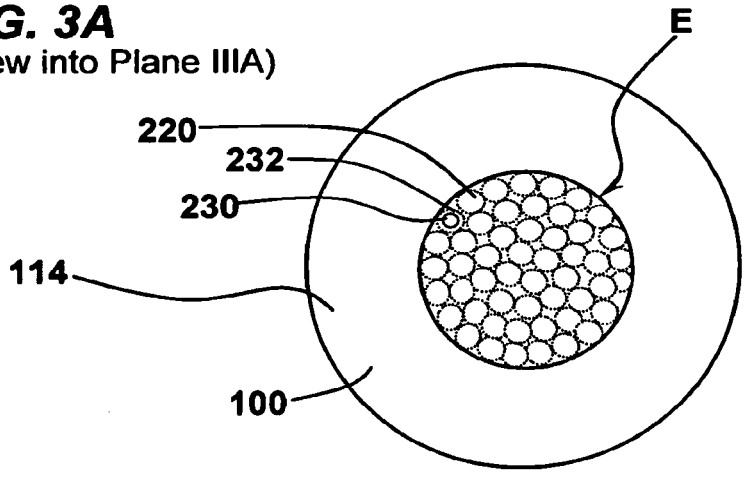


FIG. 3A
(View into Plane IIIA)



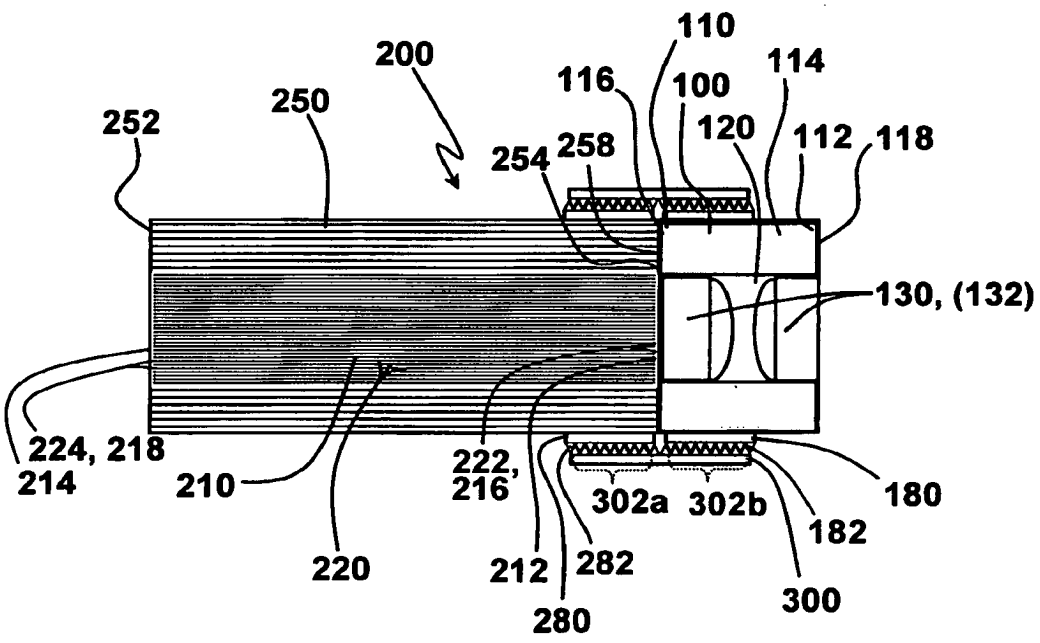

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FIG. 4A

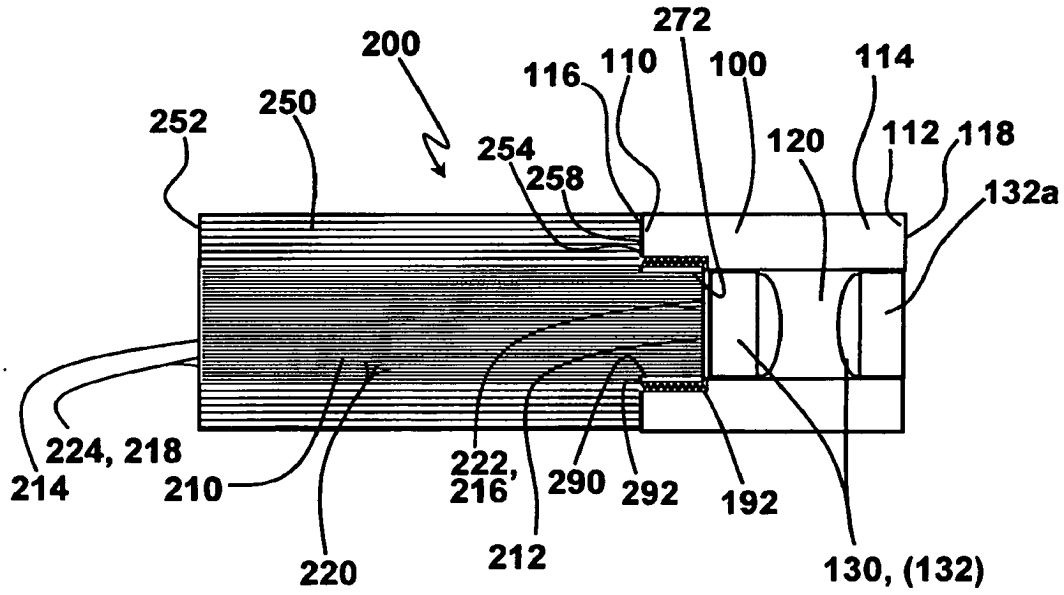

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FIG. 4B

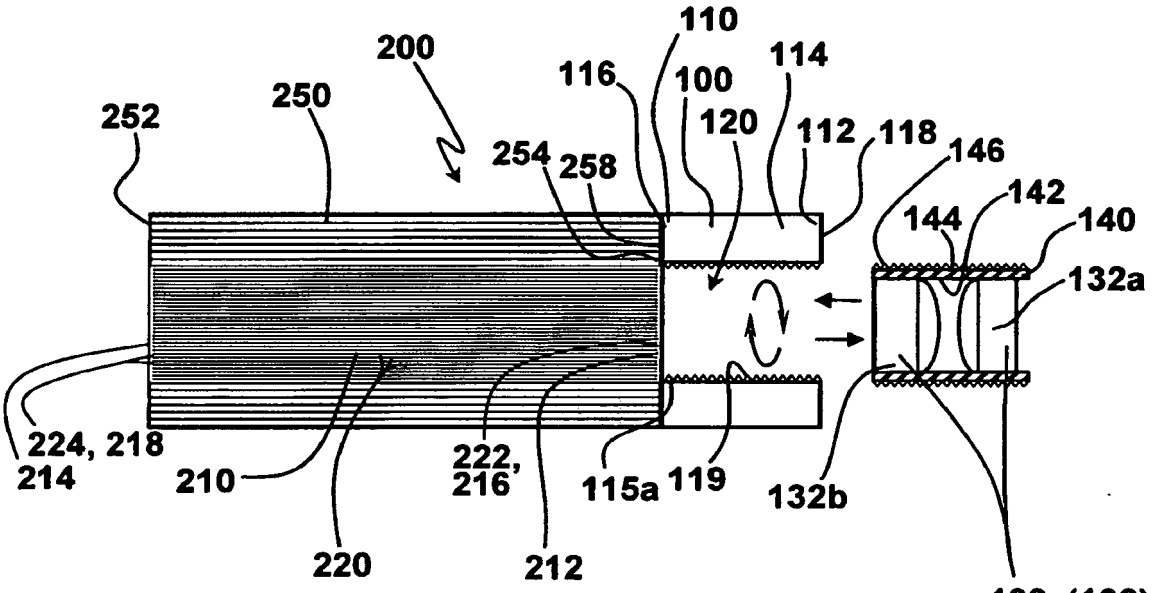
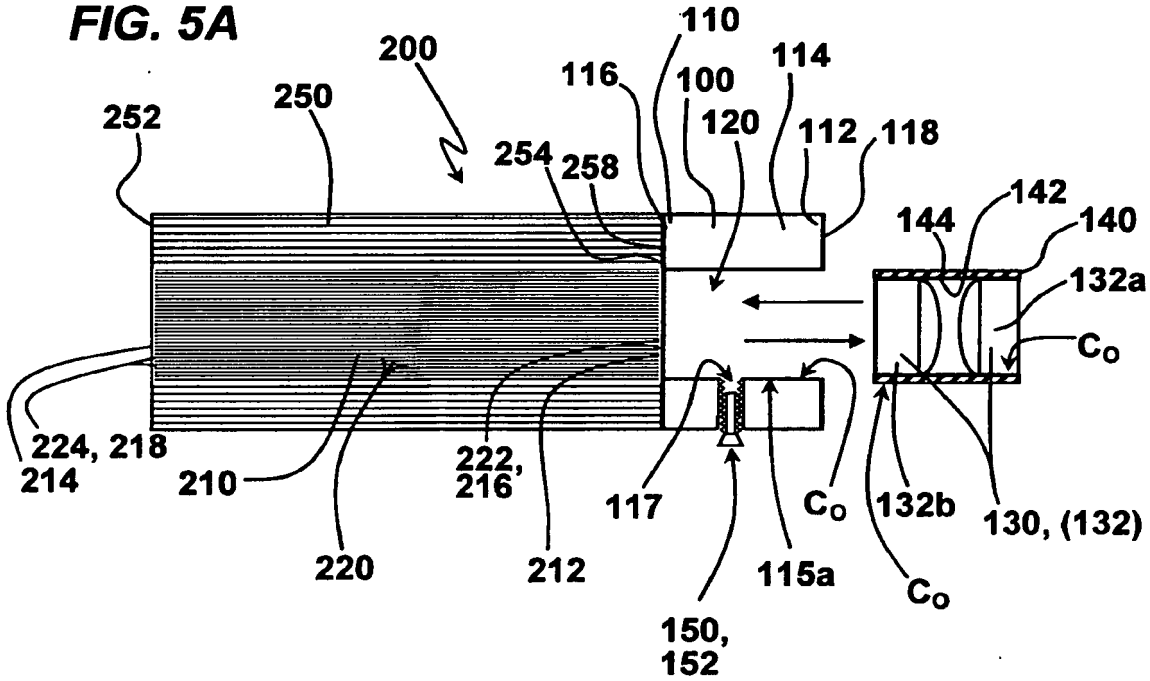

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FIG. 5

FIG. 5A


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