



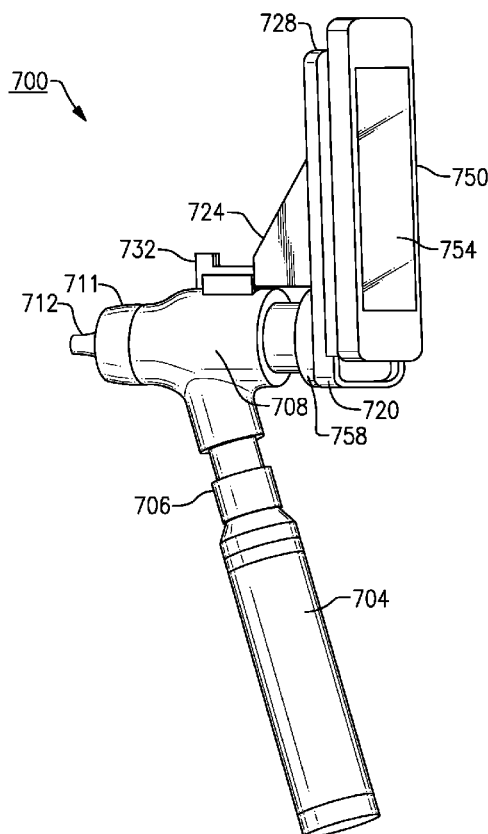
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(19) **United States**(12) **Patent Application Publication**
Perkins et al.(10) **Pub. No.: US 2021/0361241 A1**(43) **Pub. Date: Nov. 25, 2021**(54) **MEDICAL EXAMINATION SYSTEM
ENABLING INTERCHANGEABLE
OPERATING MODES***A61B 1/04* (2006.01)*A61B 1/227* (2006.01)*A61B 1/233* (2006.01)*A61B 1/303* (2006.01)(71) Applicant: **Welch Allyn, Inc.**, Skaneateles Falls,
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(US); **Michael T. McMahon**, Syracuse,
NY (US)(52) **U.S. Cl.**CPC *A61B 5/6898* (2013.01); *A61B 1/00105*
(2013.01); *A61B 1/042* (2013.01); *A61B 1/227*
(2013.01); *A61B 1/233* (2013.01); *A61B 3/14*
(2013.01); *A61B 3/12* (2013.01); *A61B 5/0077*
(2013.01); *F16B 1/00* (2013.01); *H04N 7/185*
(2013.01); *A61B 1/303* (2013.01)(21) Appl. No.: **17/392,643**

(57)

ABSTRACT(22) Filed: **Aug. 3, 2021****Related U.S. Application Data**(63) Continuation of application No. 15/495,065, filed on
Apr. 24, 2017, now Pat. No. 11,096,627.(60) Provisional application No. 62/327,154, filed on Apr.
25, 2016.**Publication Classification**(51) **Int. Cl.***A61B 5/00* (2006.01)*A61B 1/00* (2006.01)

An examination system having separate enabled interchangeable operating modes includes at least one medical device having a housing retaining an optical system. The examination system further includes an adapter that is configured for aligning a plurality of disparate smart devices with the optical system of the medical device when the adapter is attached to the medical device, thereby enabling multiple operating modes without modification to the device. In at least one version, common engagement features are provided on a plurality of medical devices to permit the adapter and an attached smart device to be used therewith interchangeably.



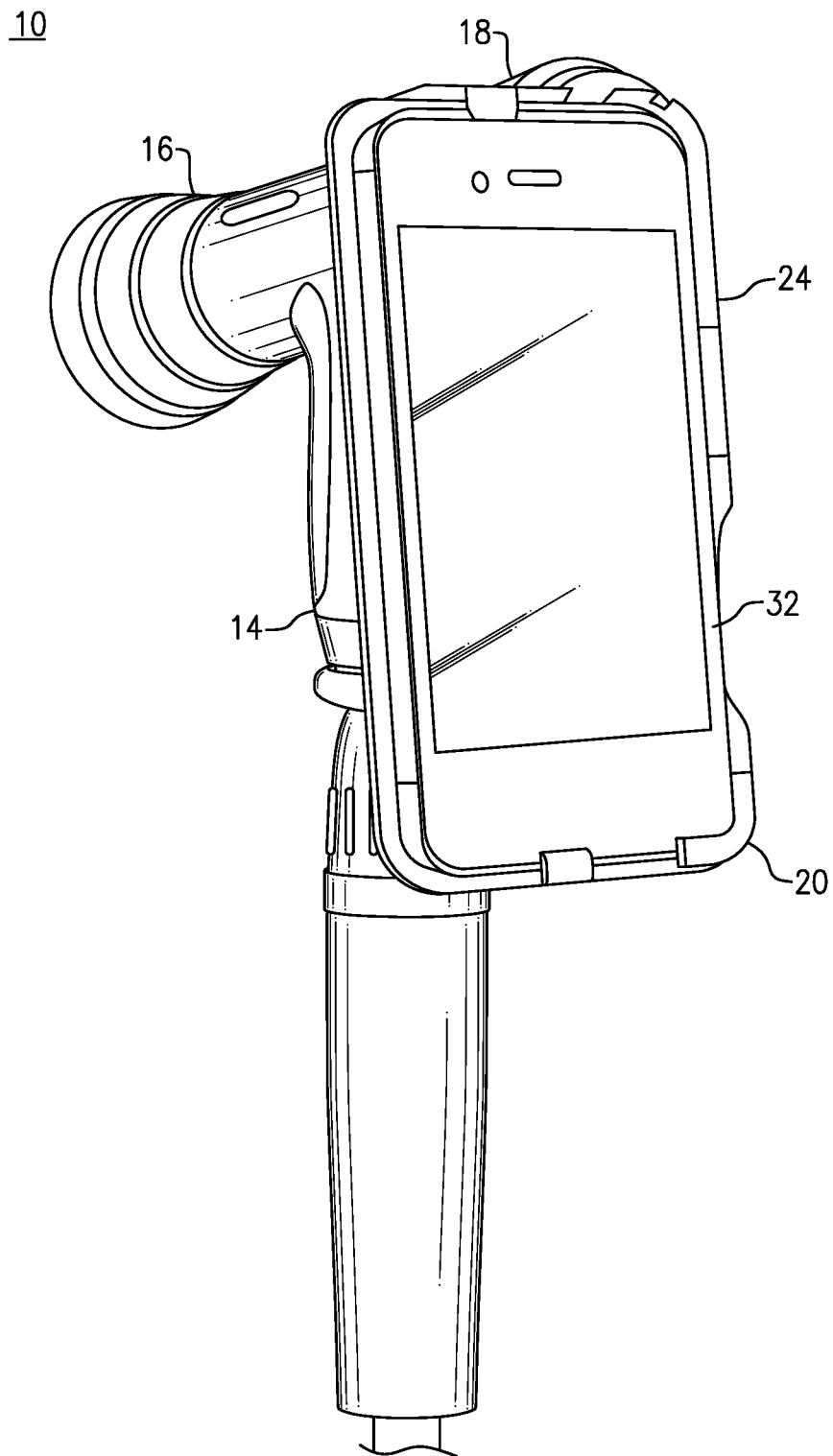
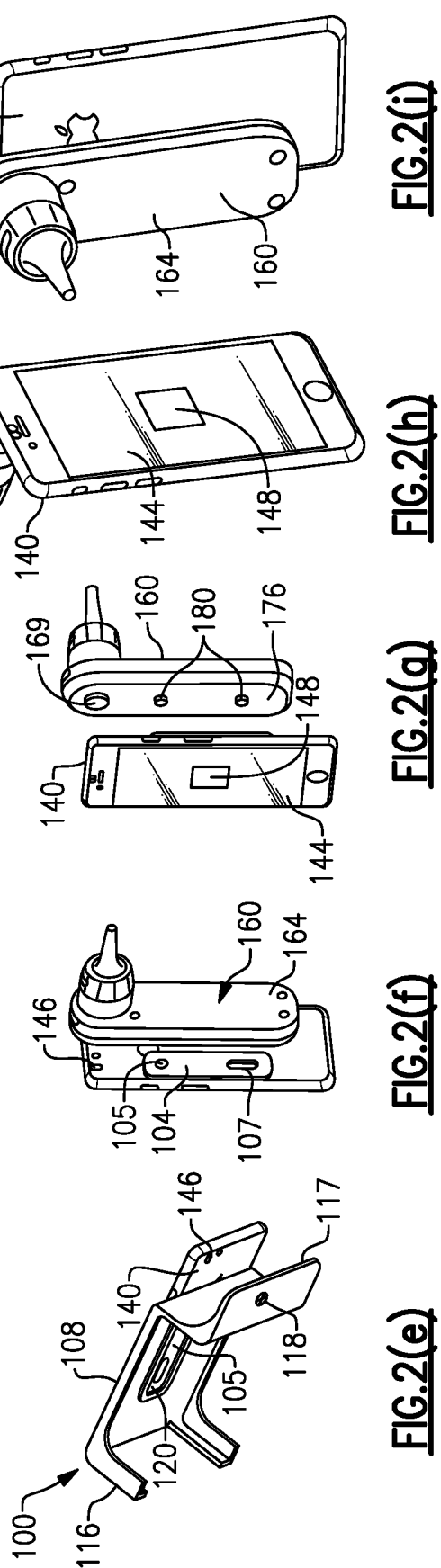
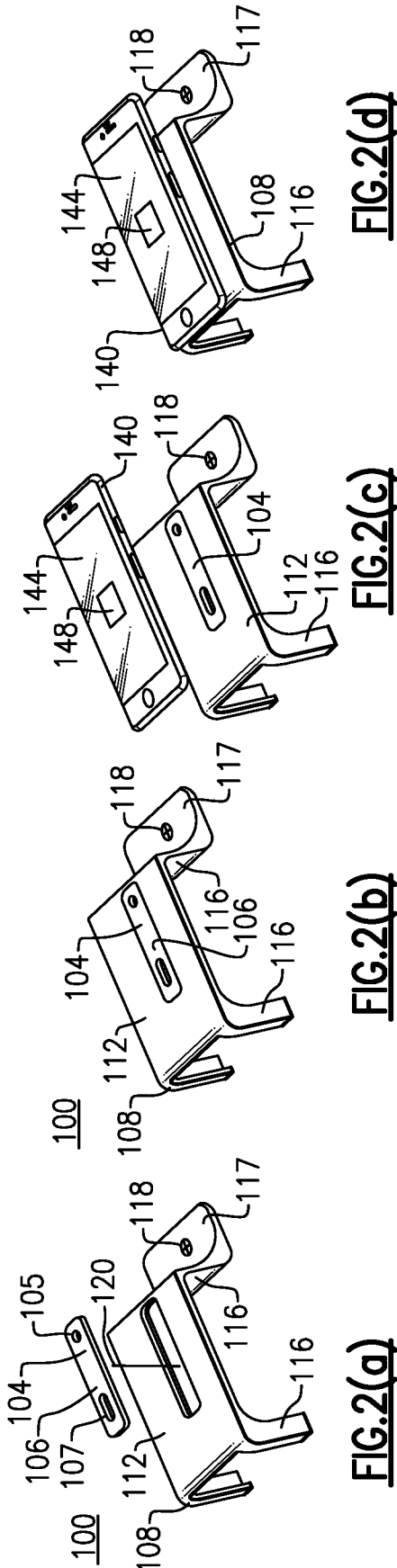


FIG.1
Prior Art



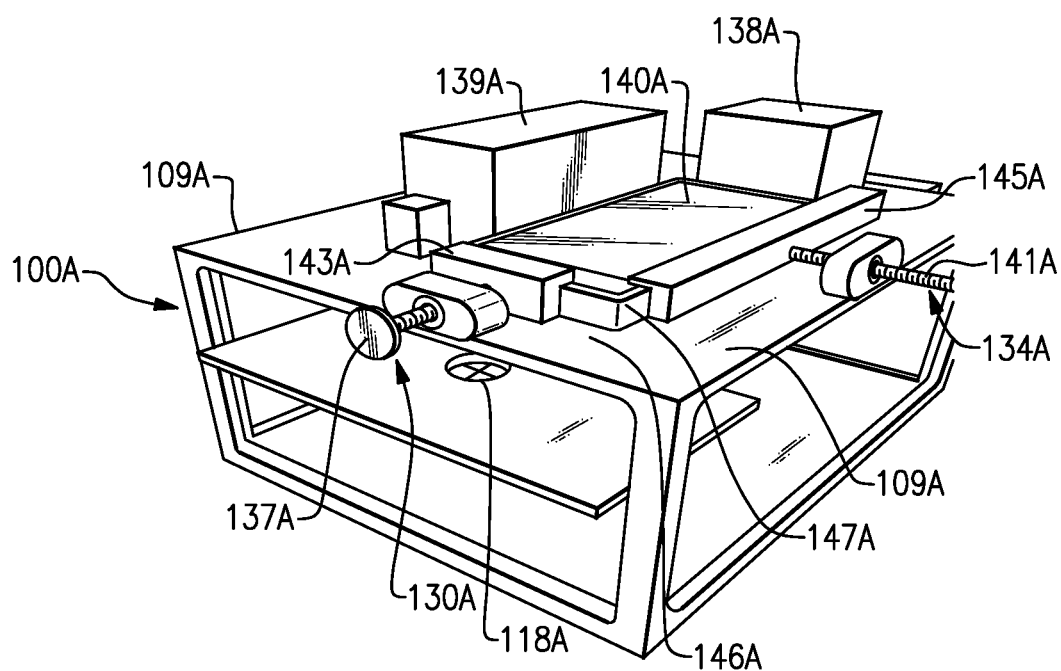


FIG. 2(j)

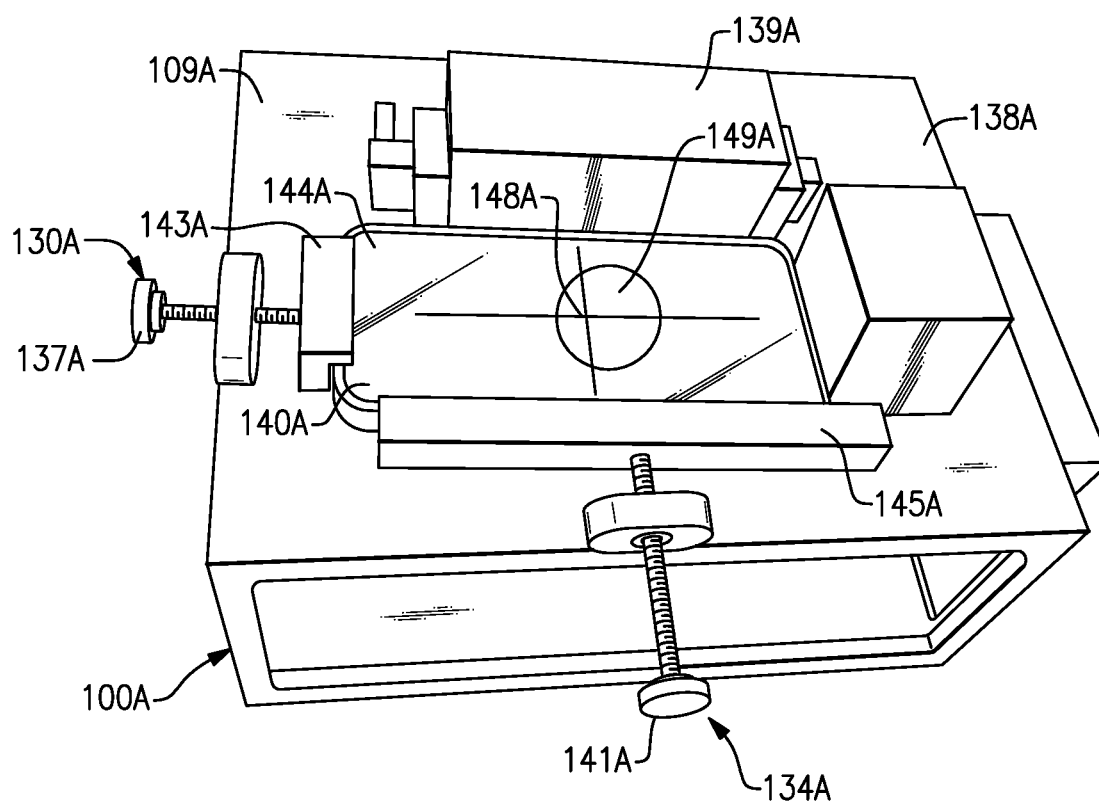


FIG. 2(k)

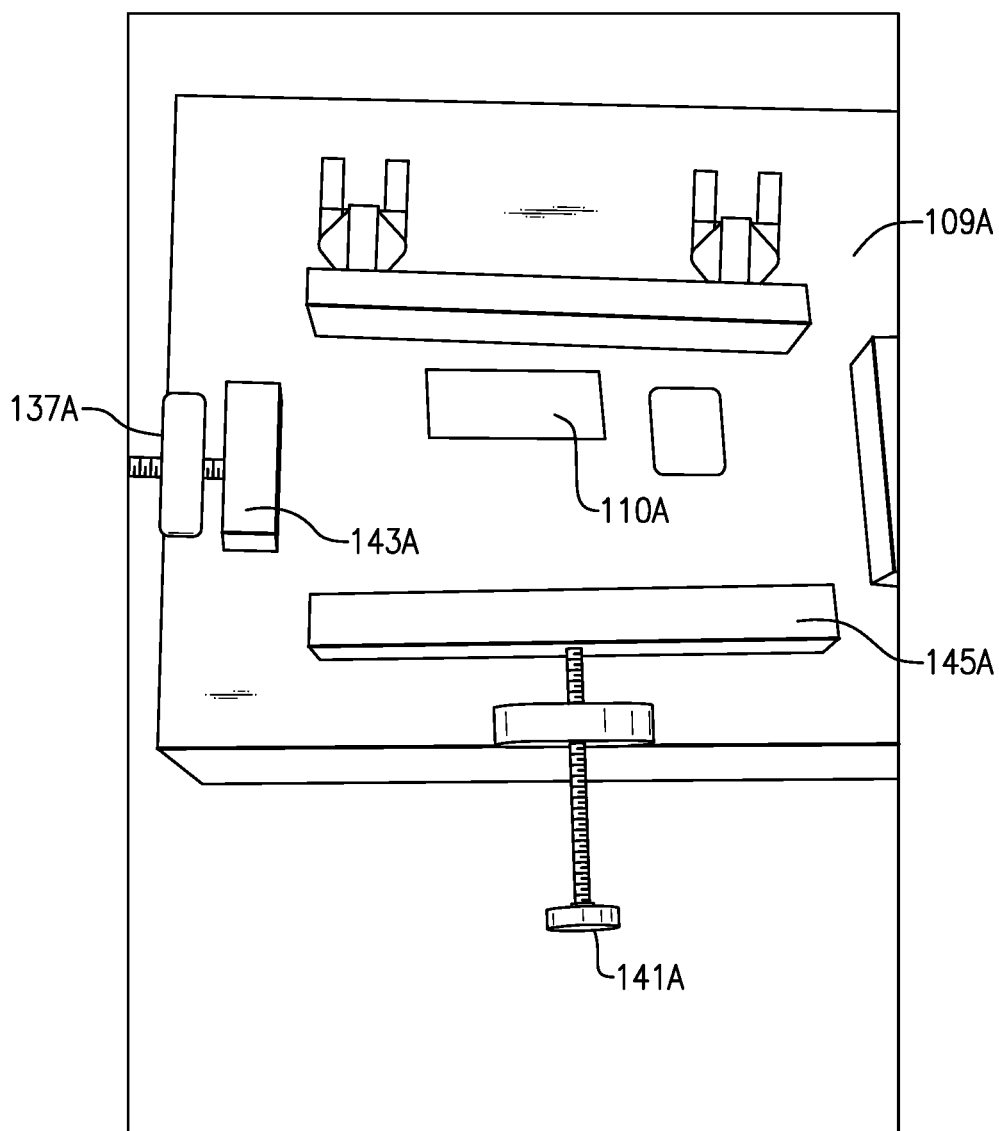


FIG. 2(I)

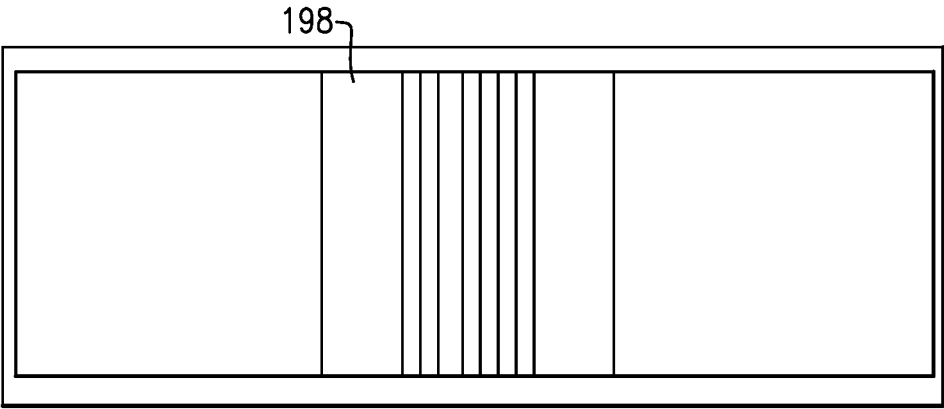


FIG.3

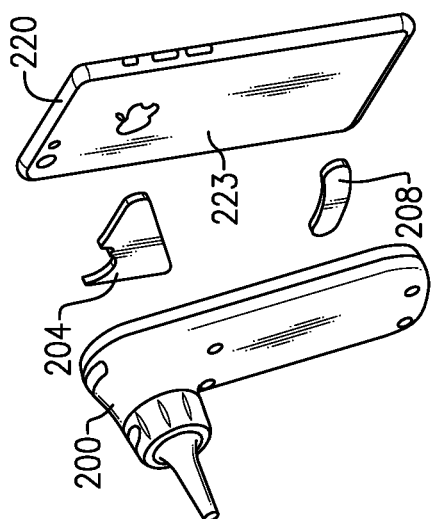


FIG. 4(a)

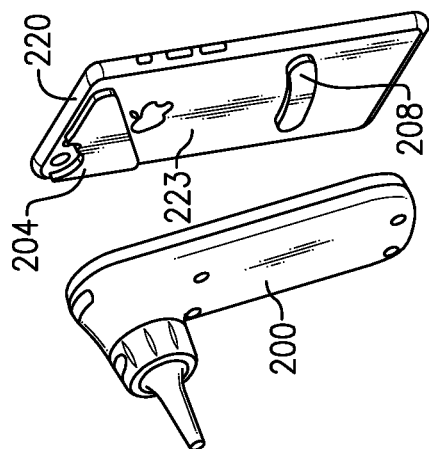


FIG. 4(b)

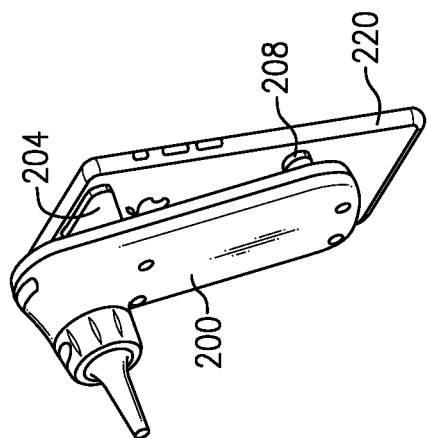


FIG. 4(c)

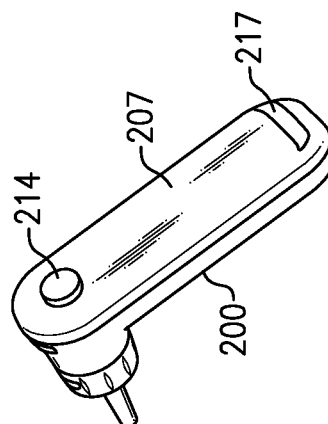


FIG. 4(d)

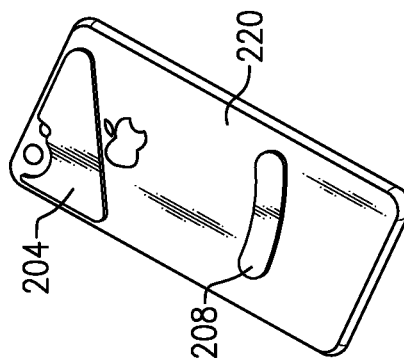


FIG. 4(e)

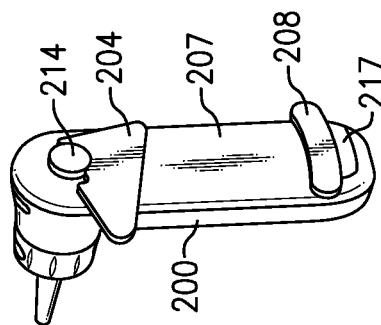


FIG. 4(f)

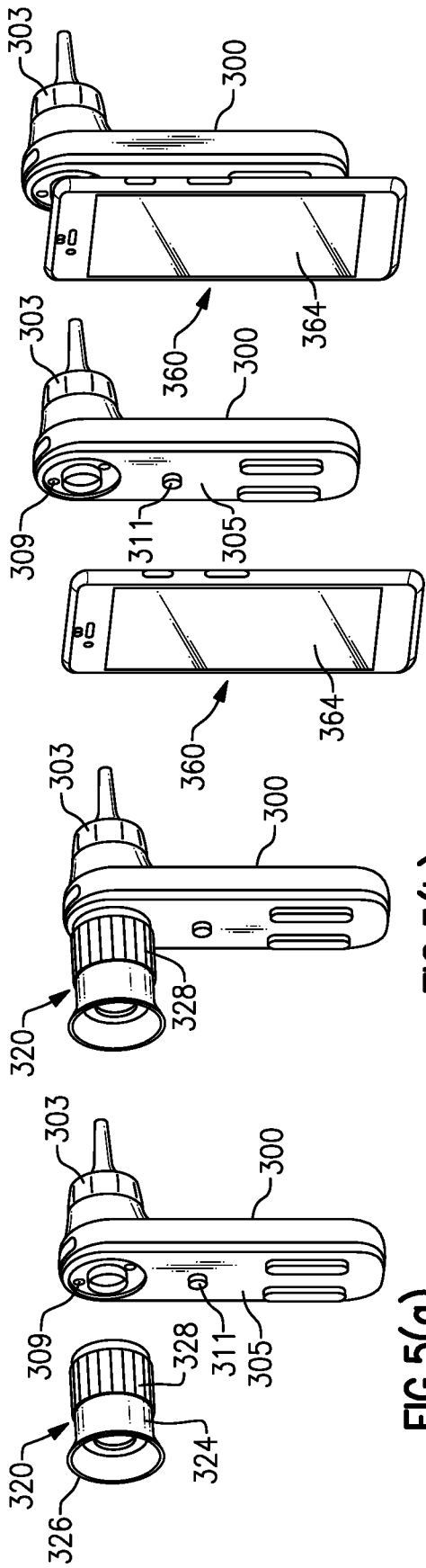


FIG. 5(a) FIG. 5(b) FIG. 5(c) FIG. 5(d)

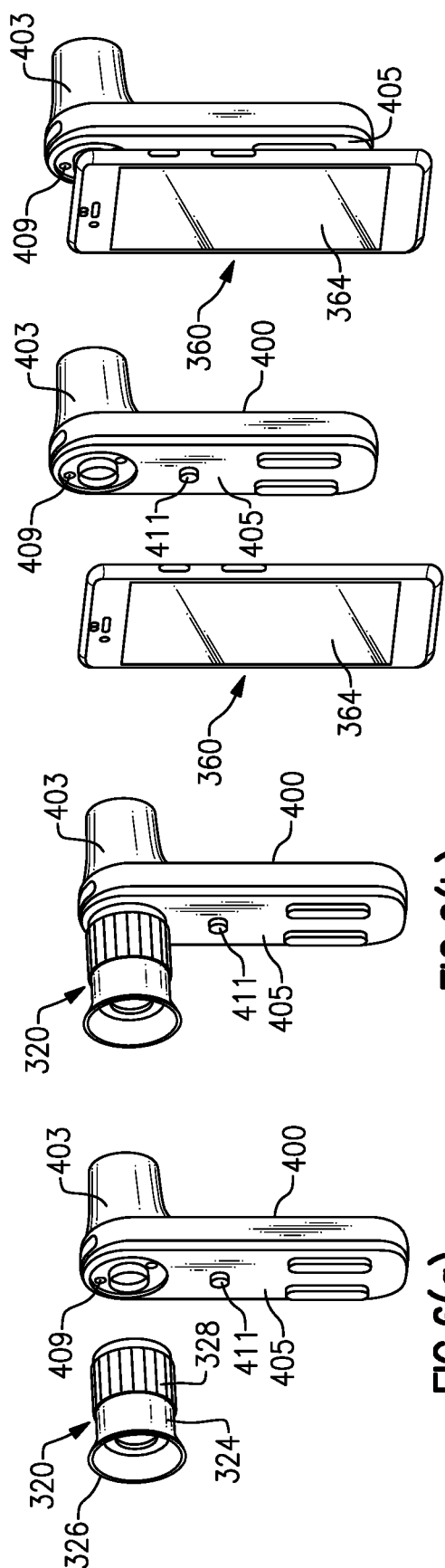


FIG. 6(a) FIG. 6(b) FIG. 6(c) FIG. 6(d)

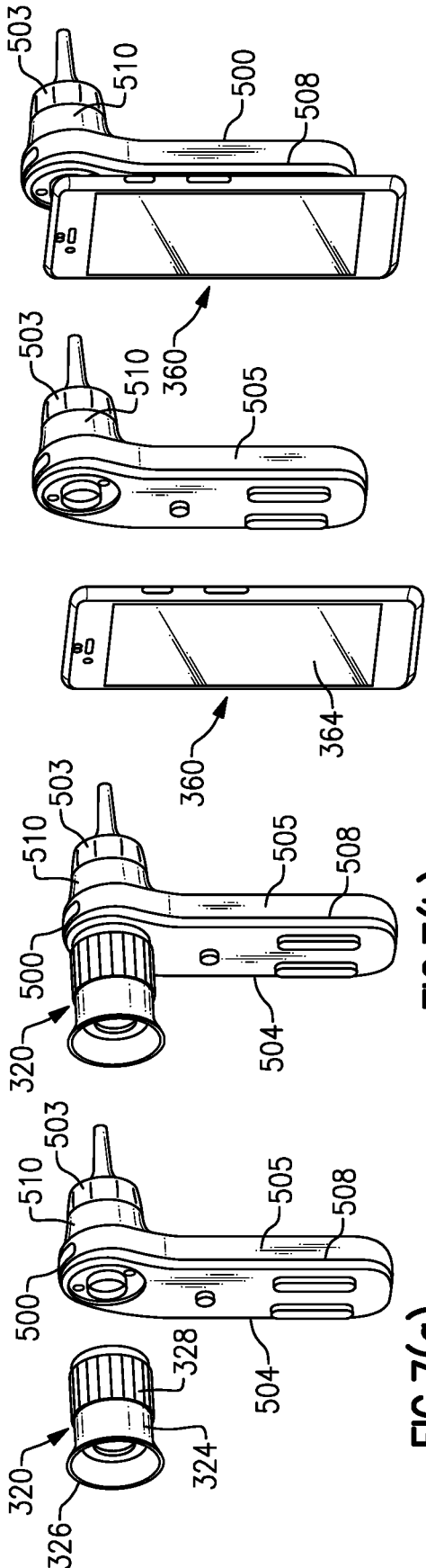


FIG. 7(a)

FIG. 7(b)

FIG. 7(c)

FIG. 7(d)

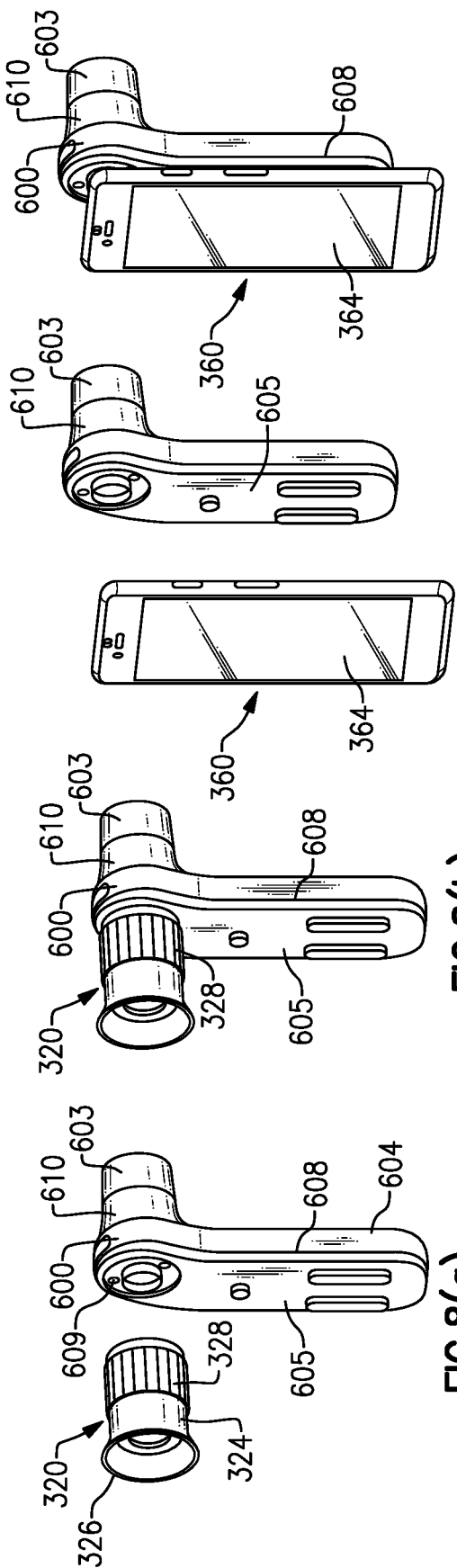


FIG. 8(a)

FIG. 8(b)

FIG. 8(c)

FIG. 8(d)

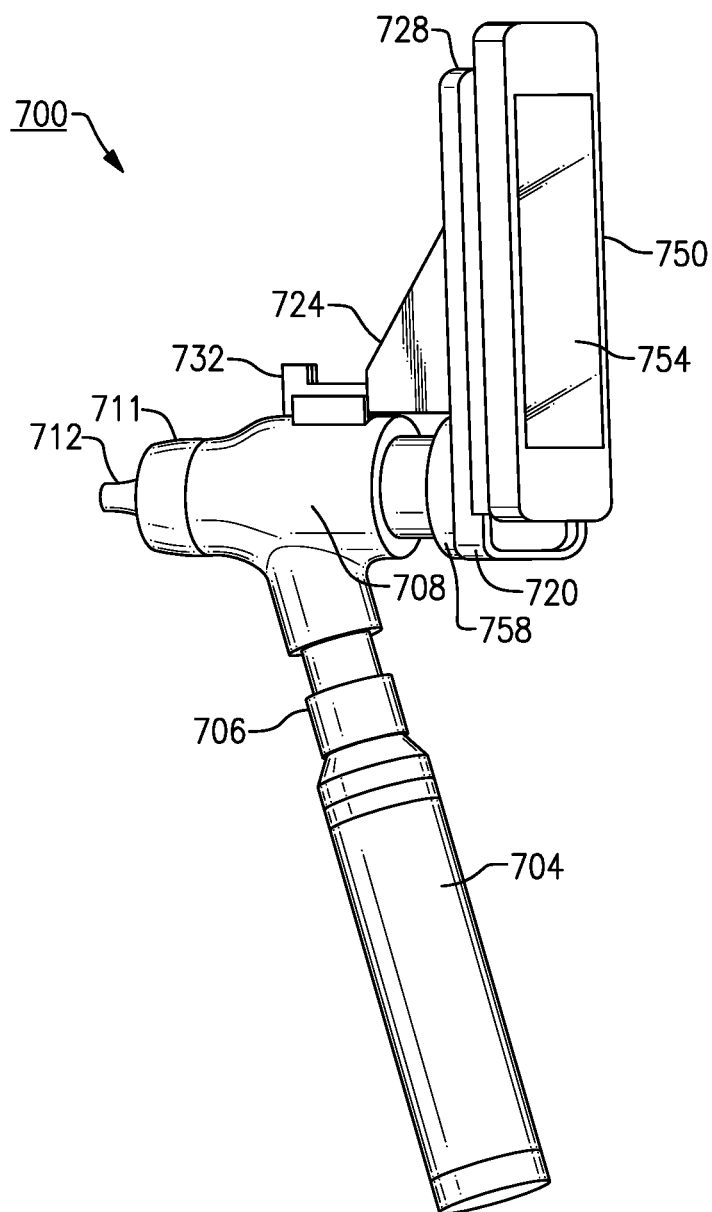


FIG. 9(a)

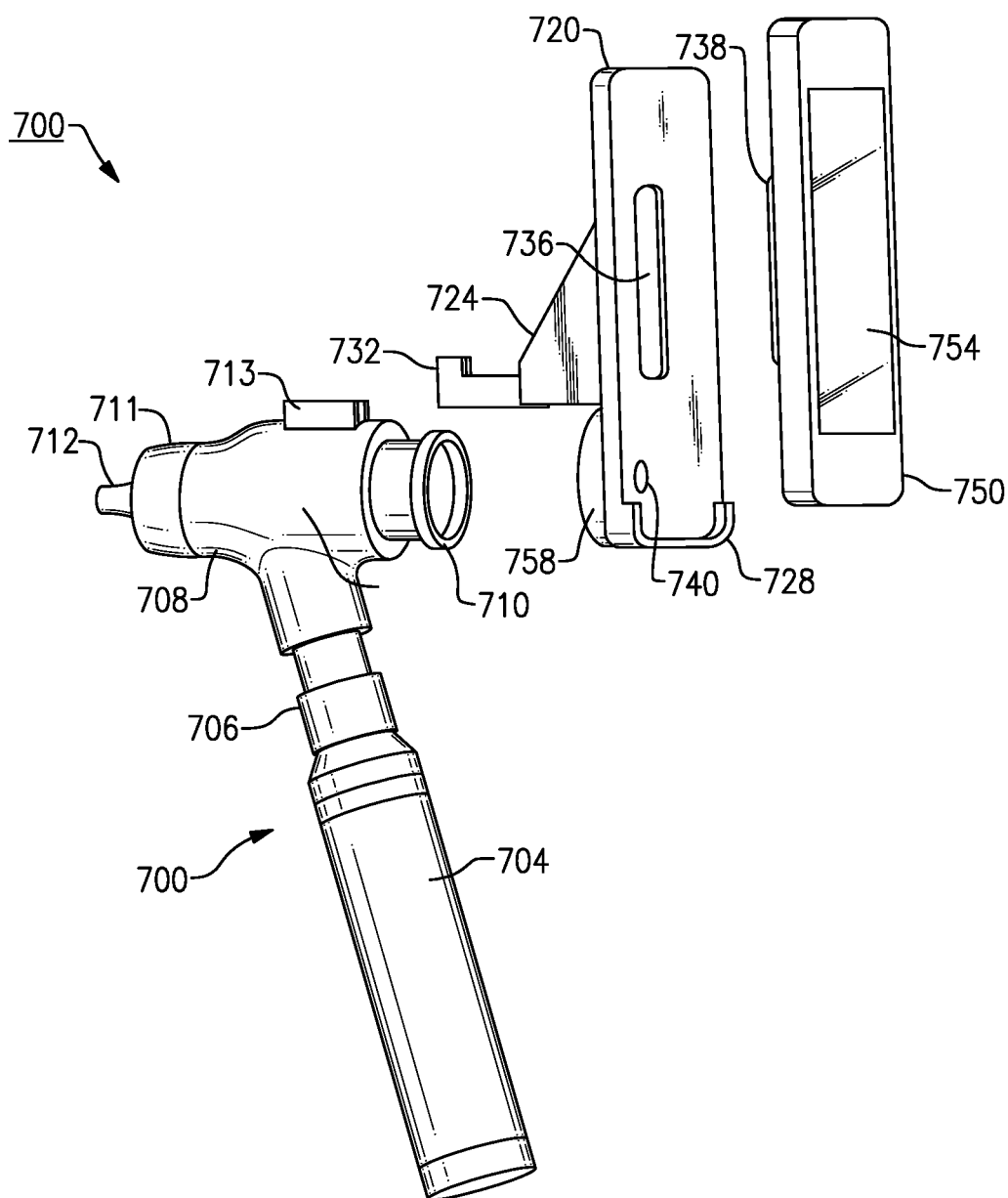


FIG. 9(b)

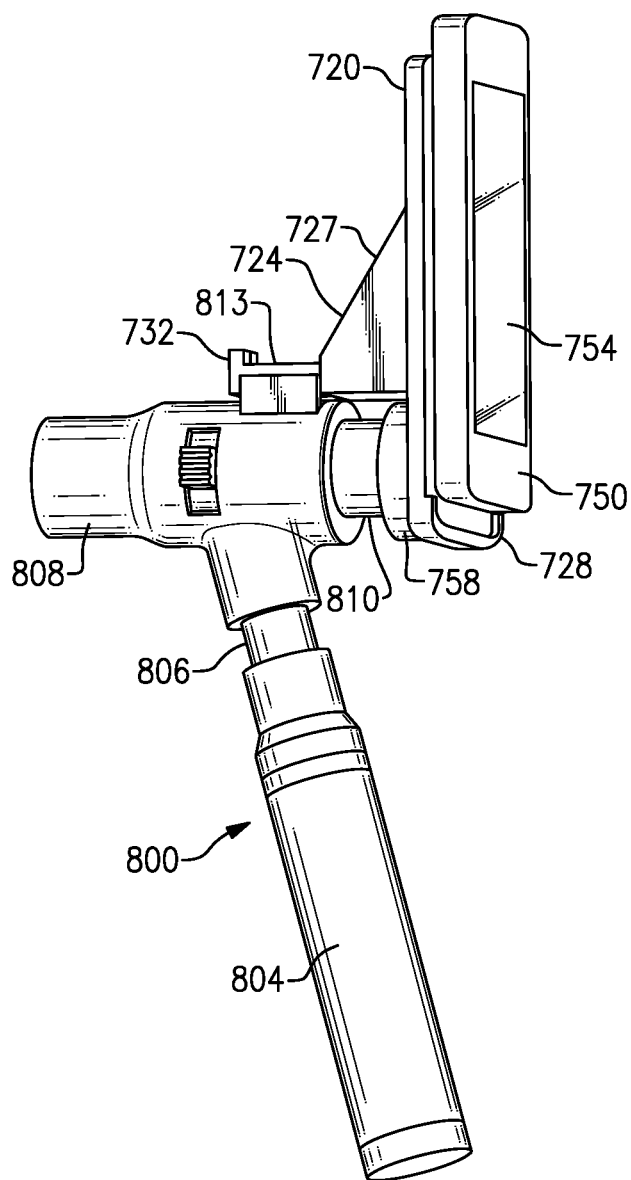


FIG. 9(c)

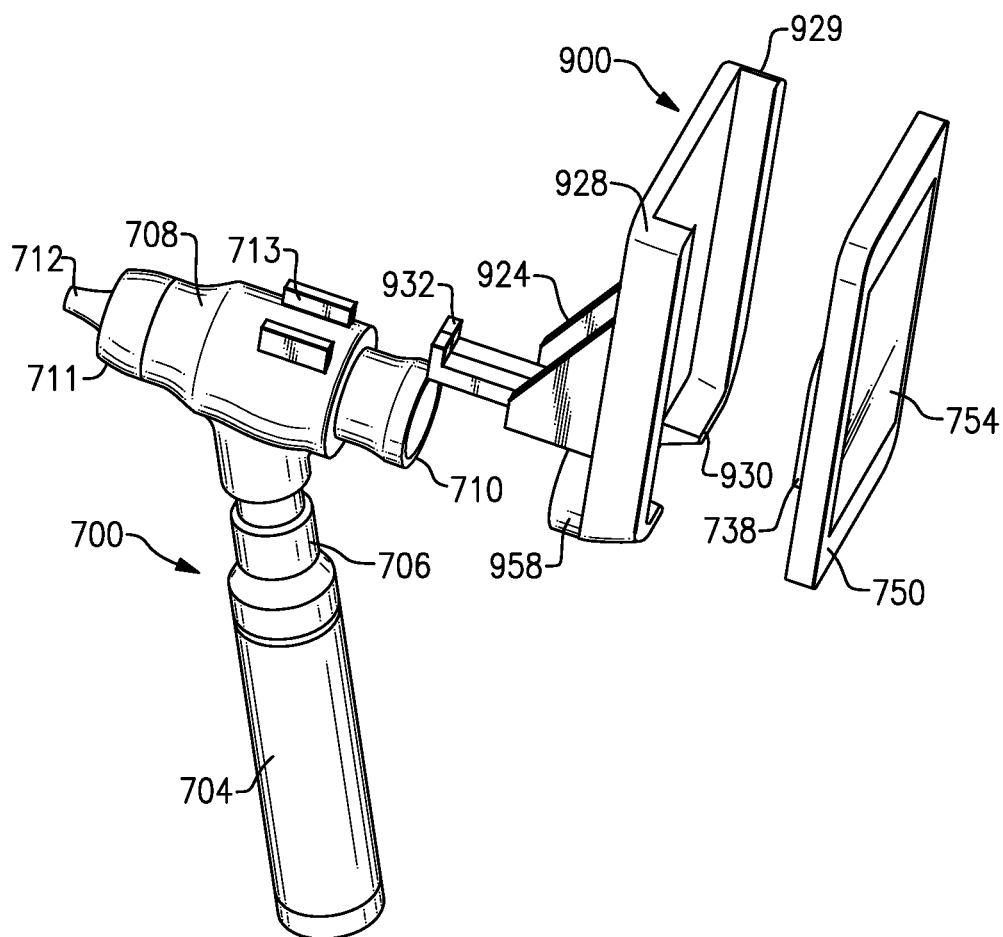
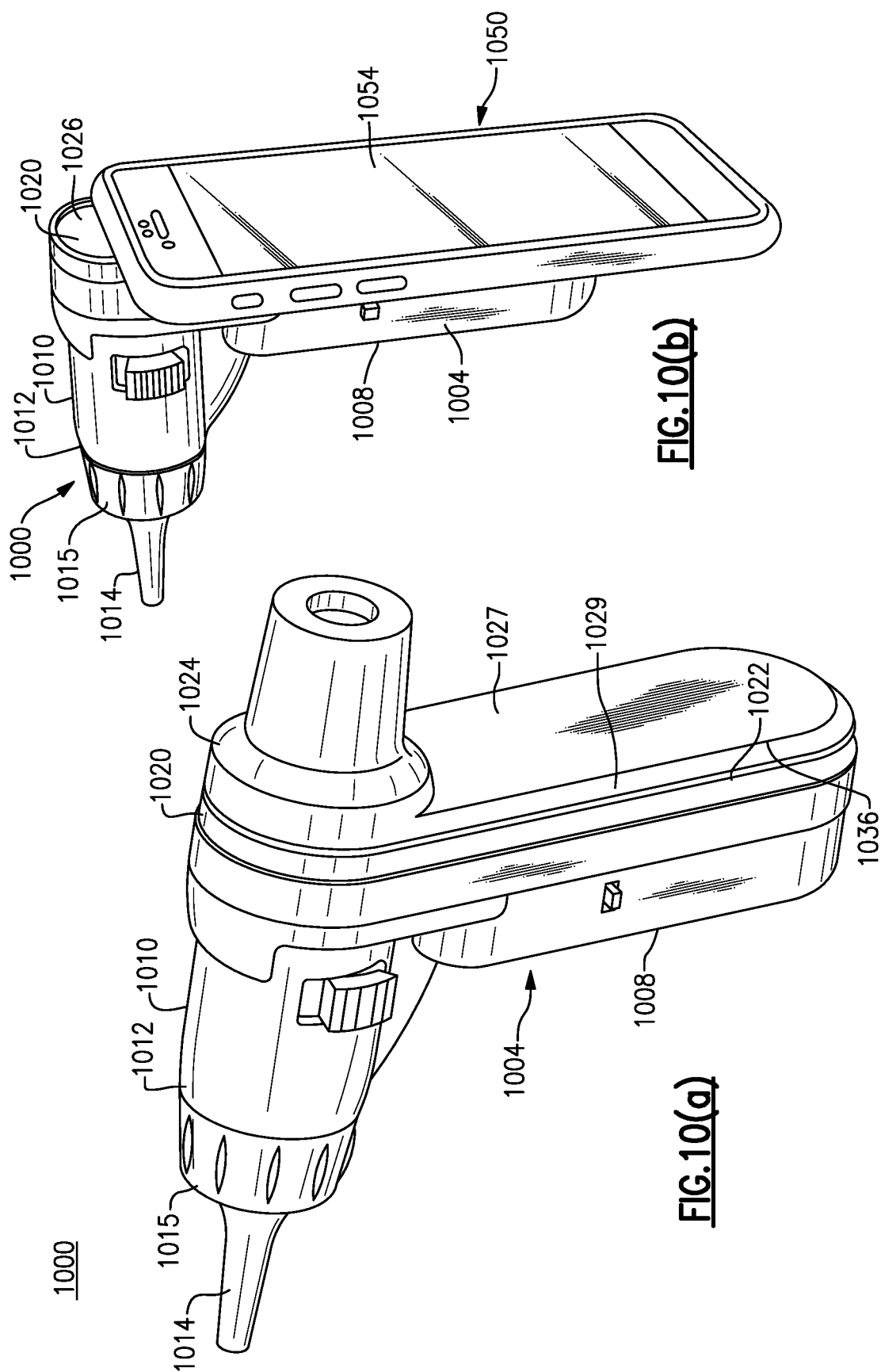
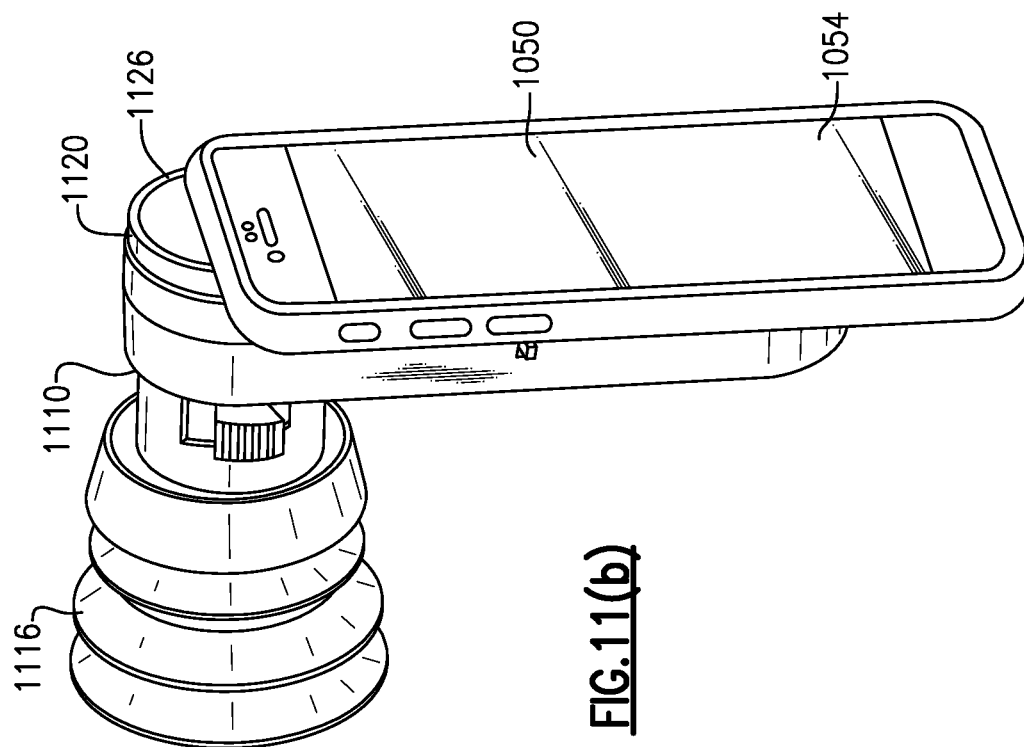
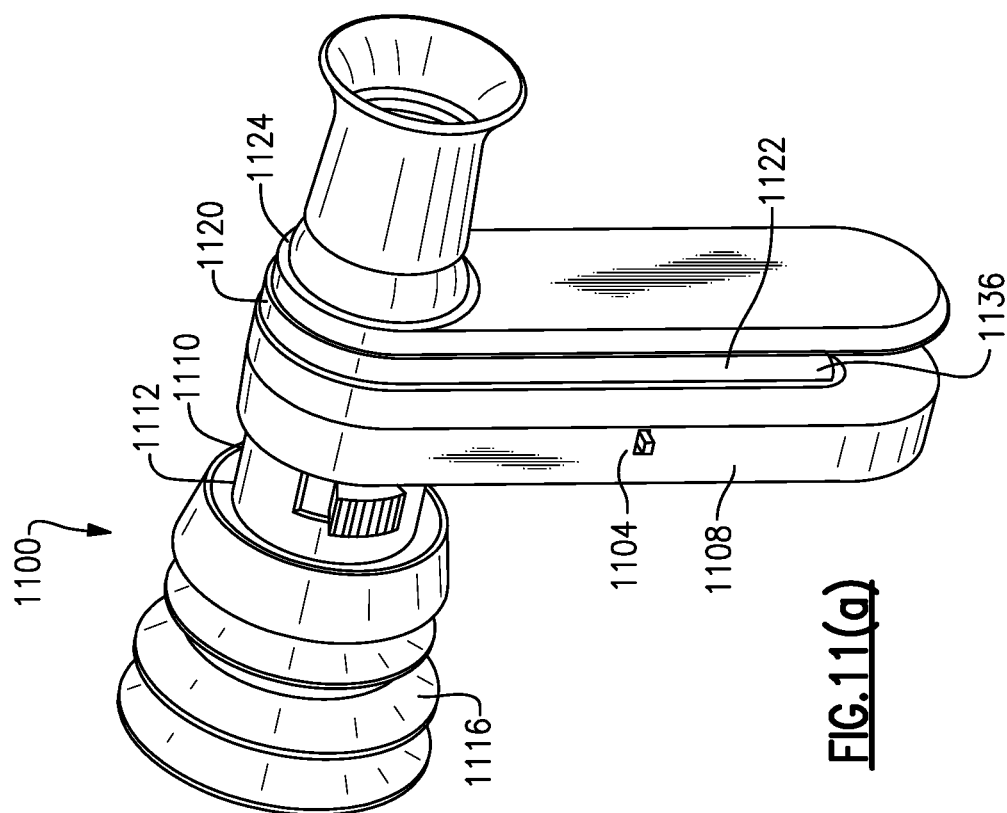
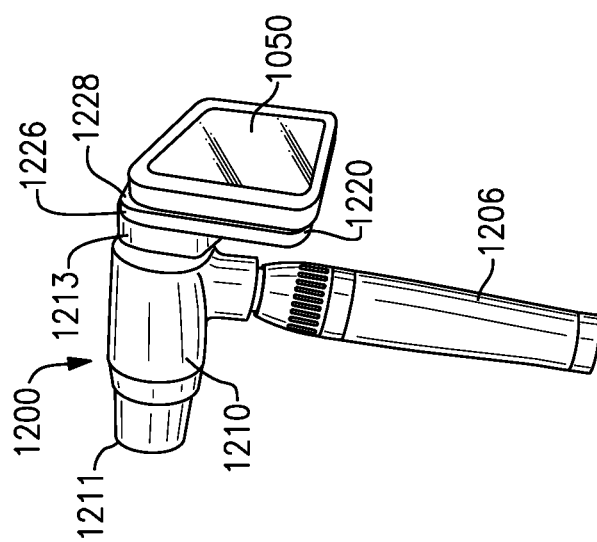
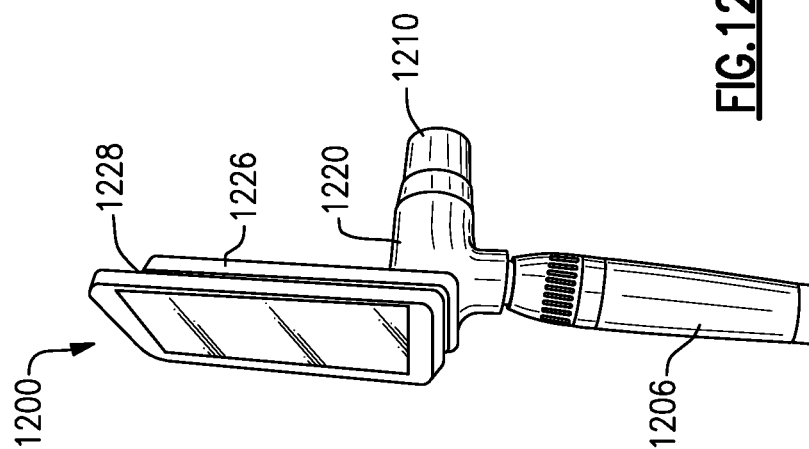


FIG. 9(d)







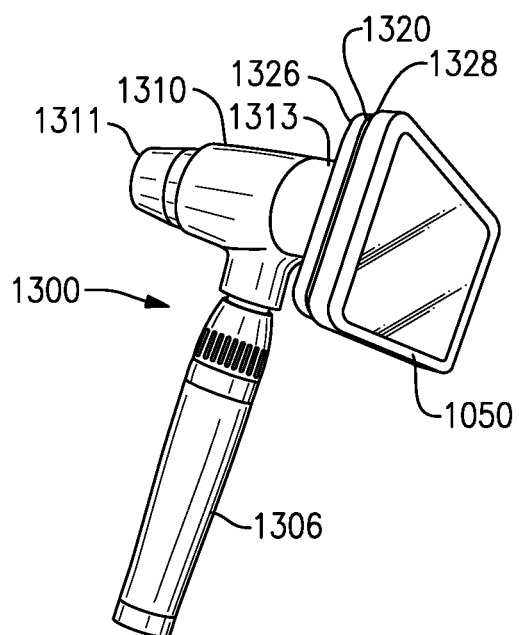


FIG. 13(a)

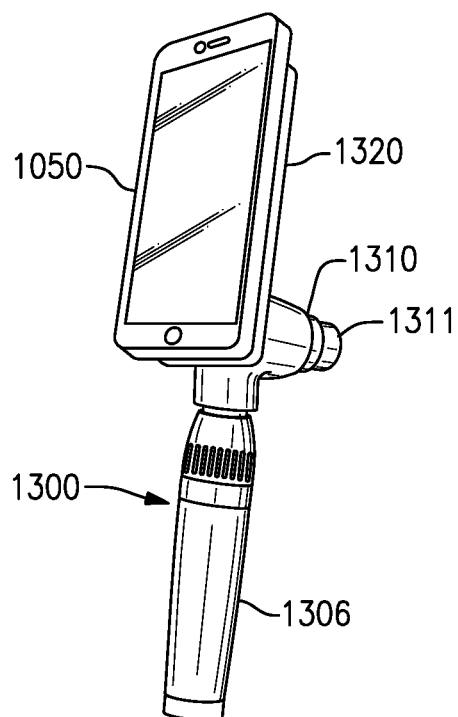
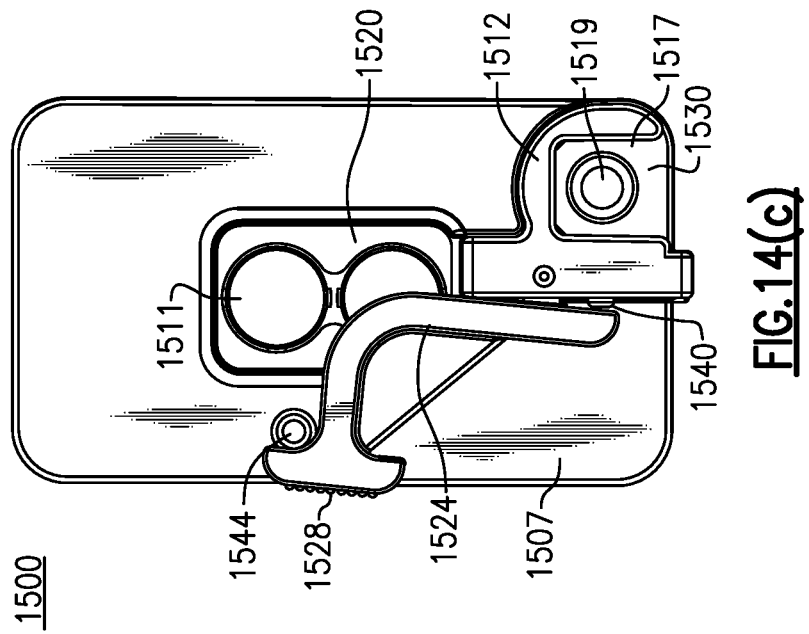
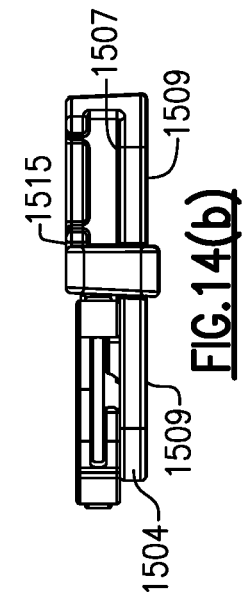
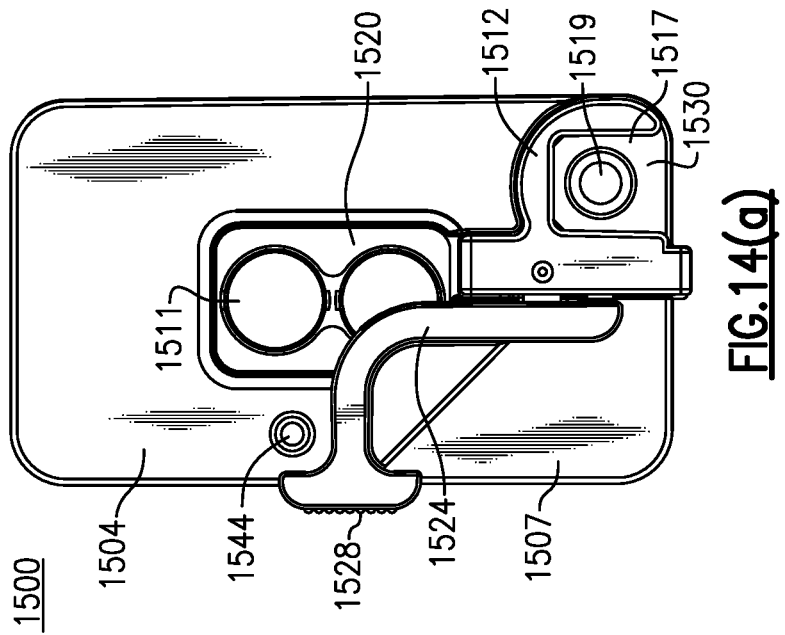
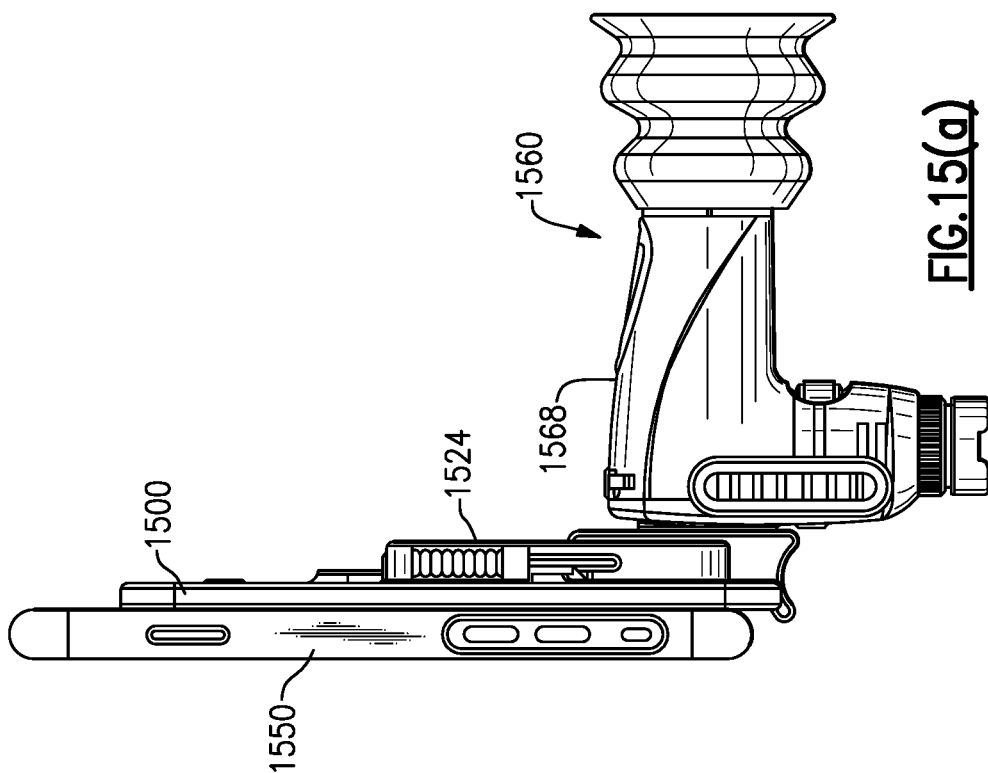
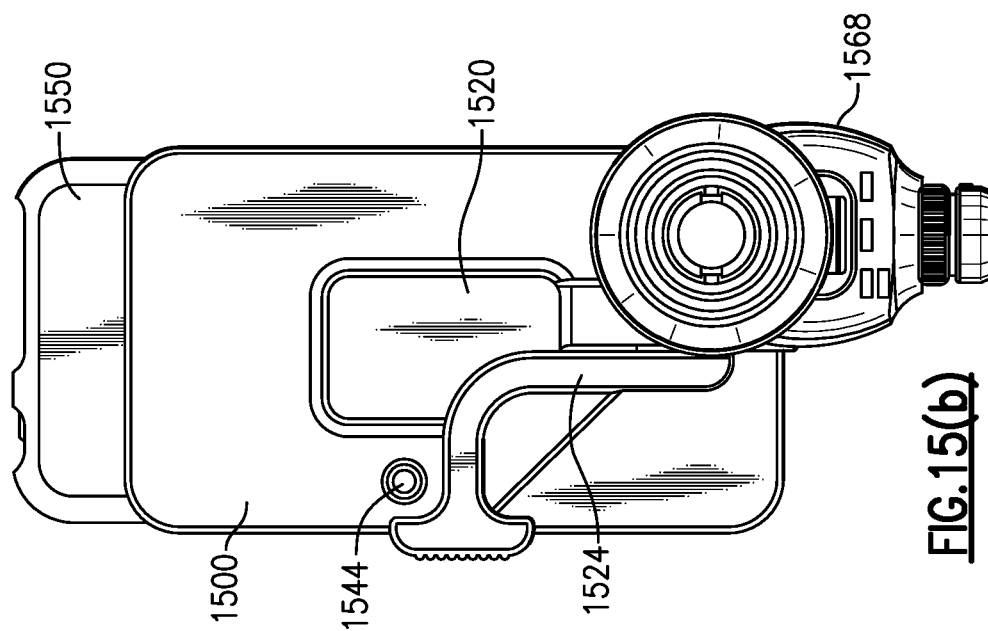


FIG. 13(b)





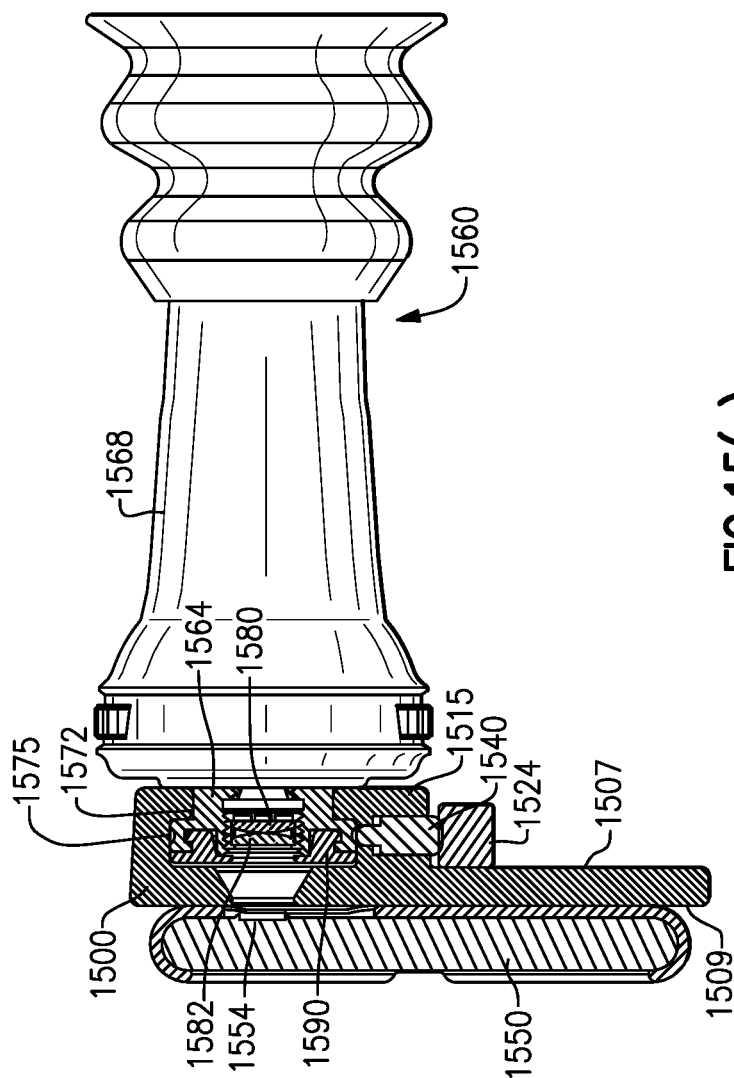


FIG. 15(c)

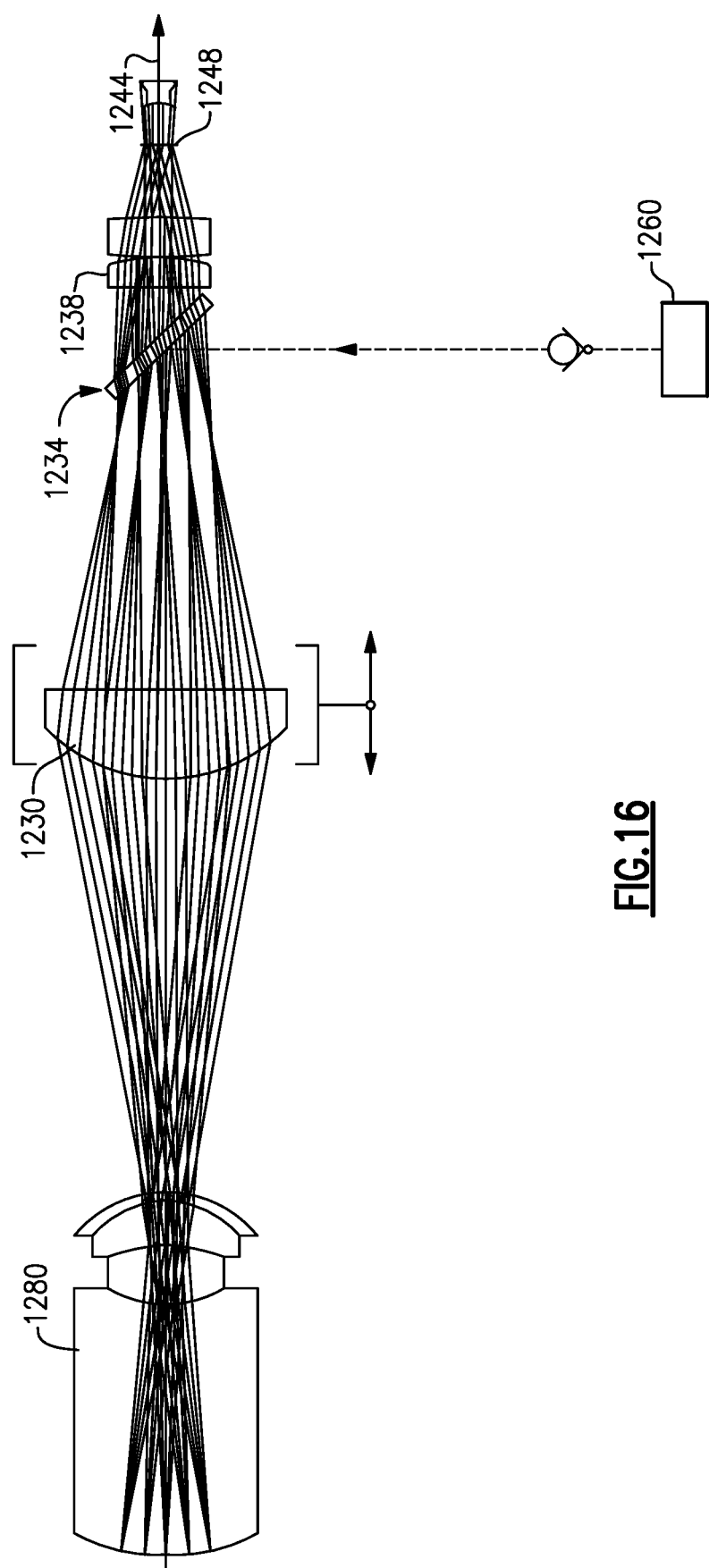


FIG.16

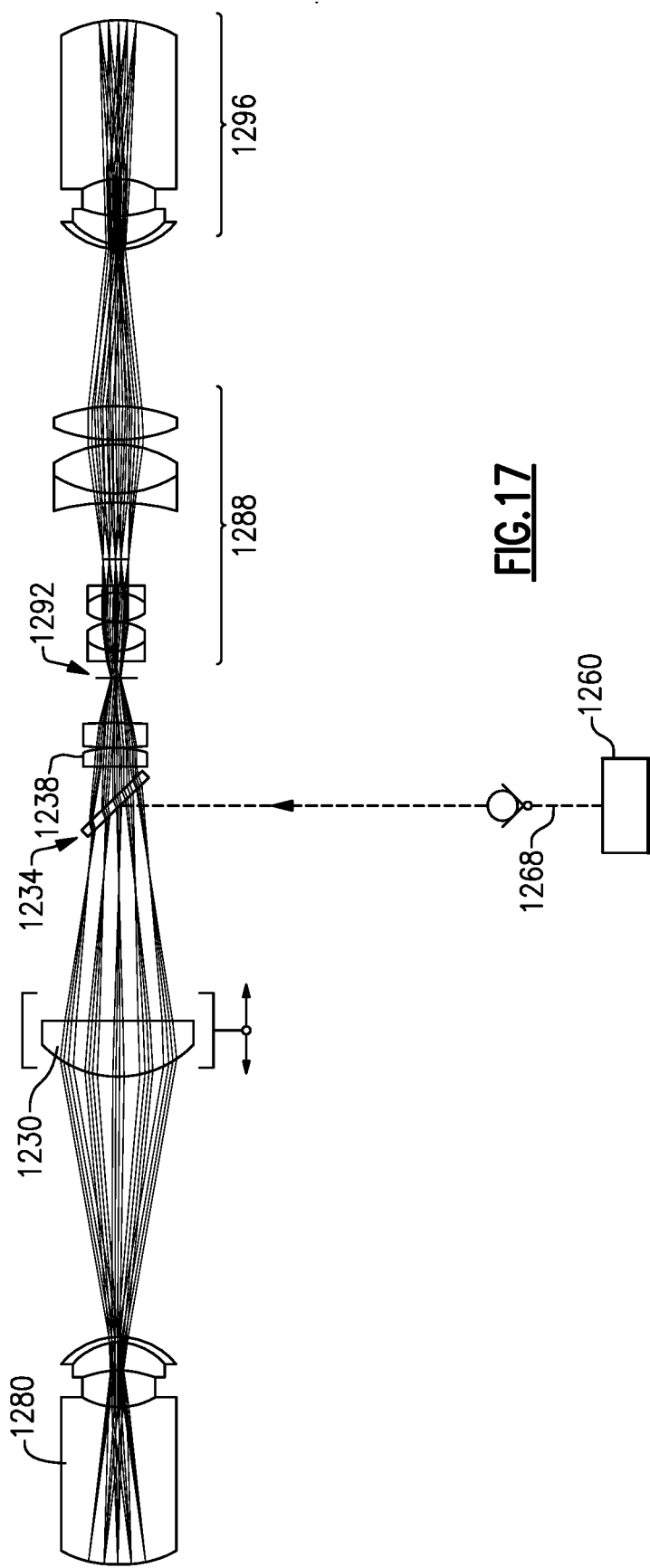


FIG. 17

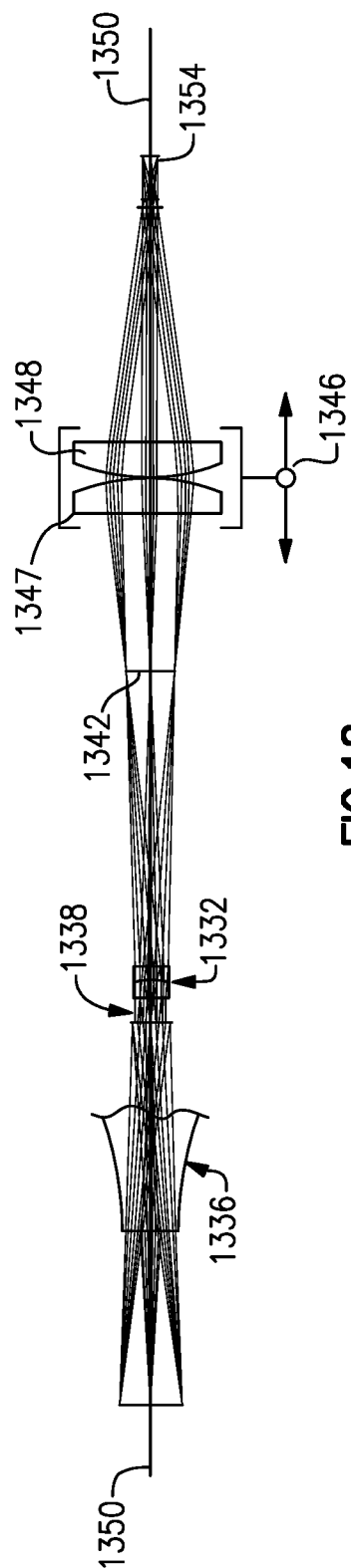


FIG. 18

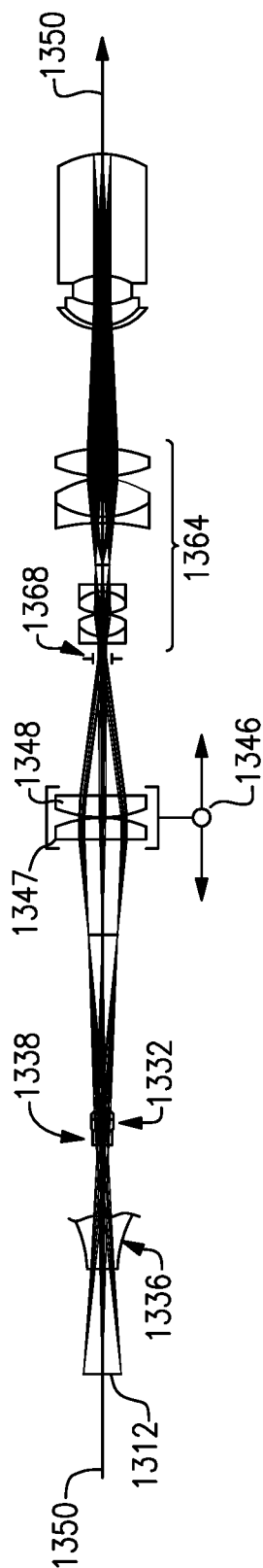


FIG. 19

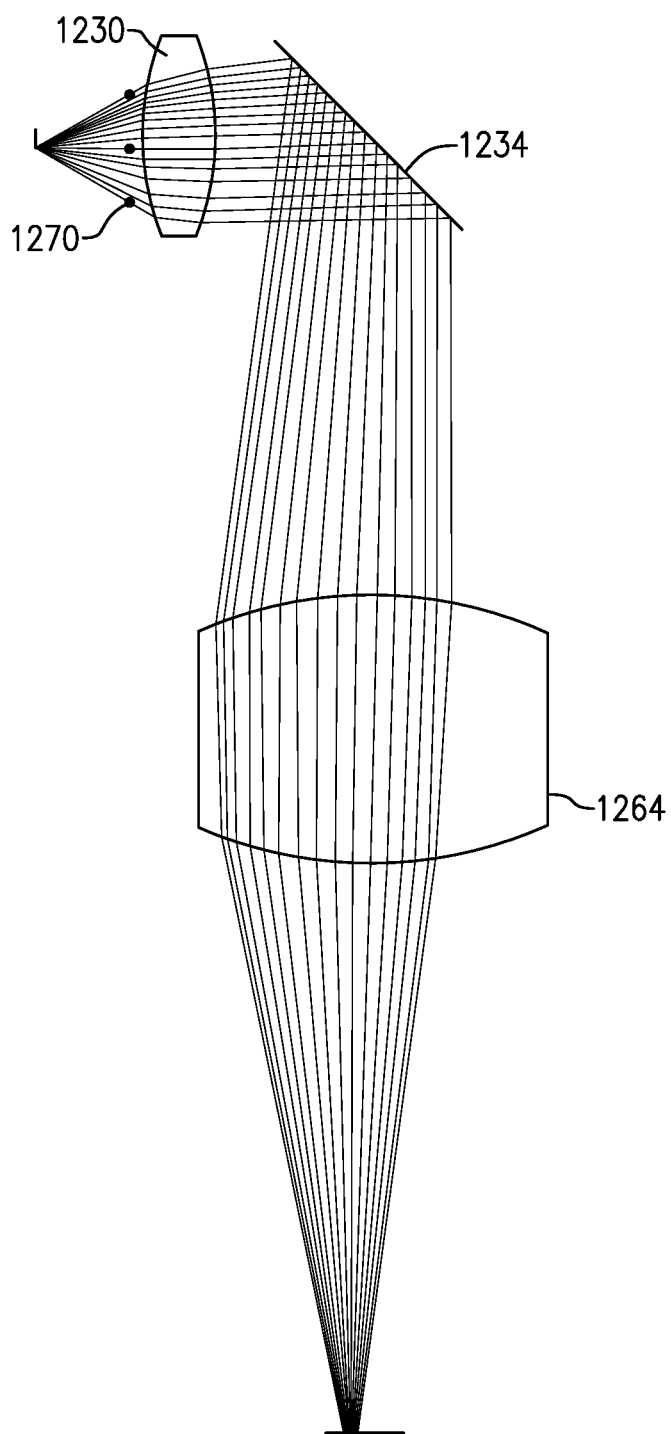


FIG.20

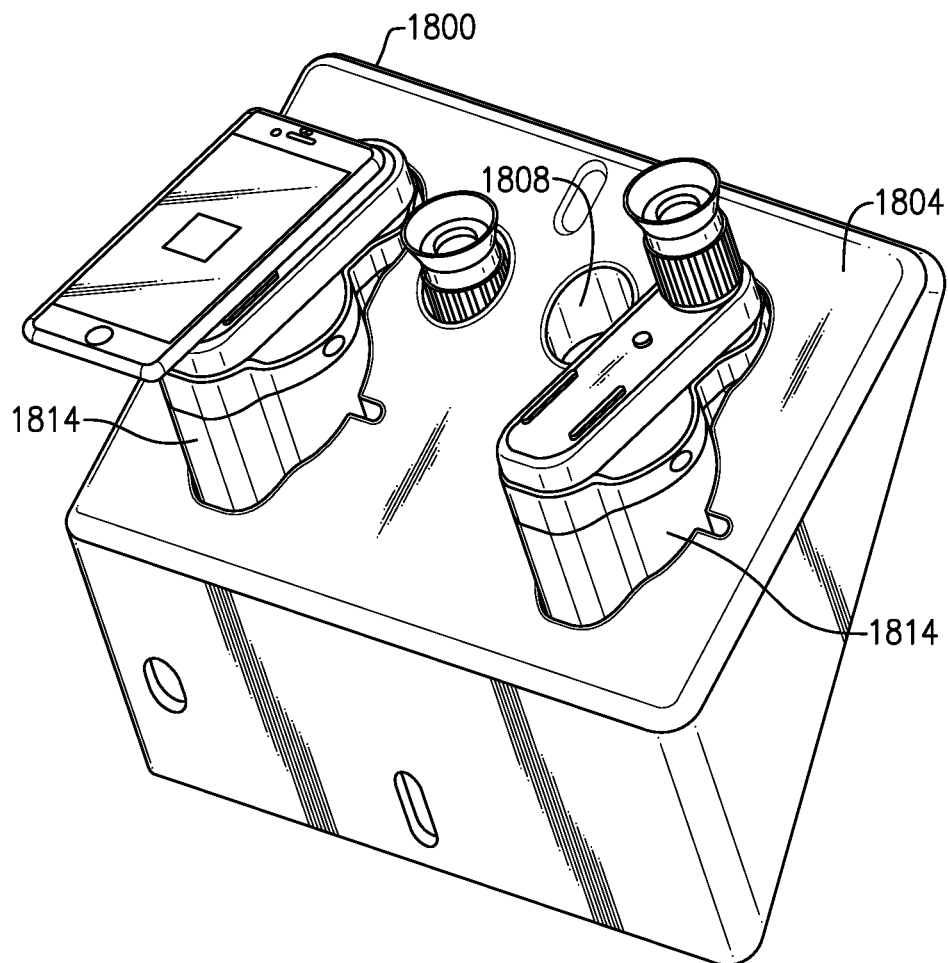
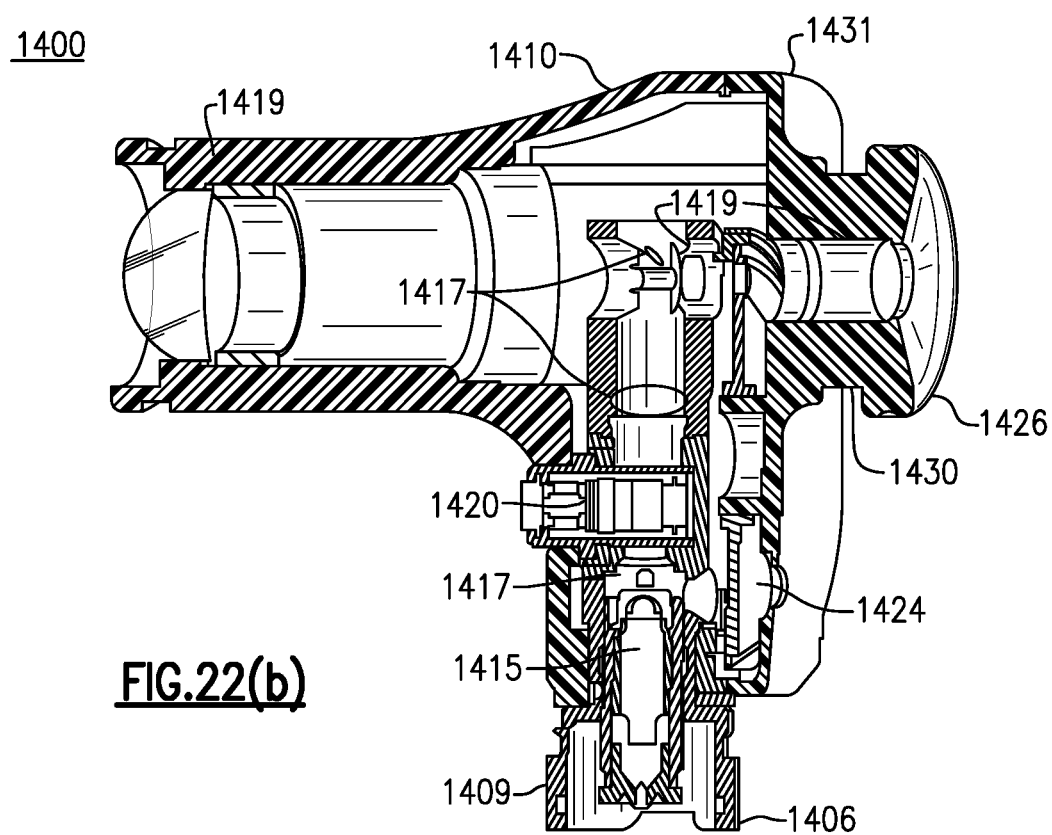
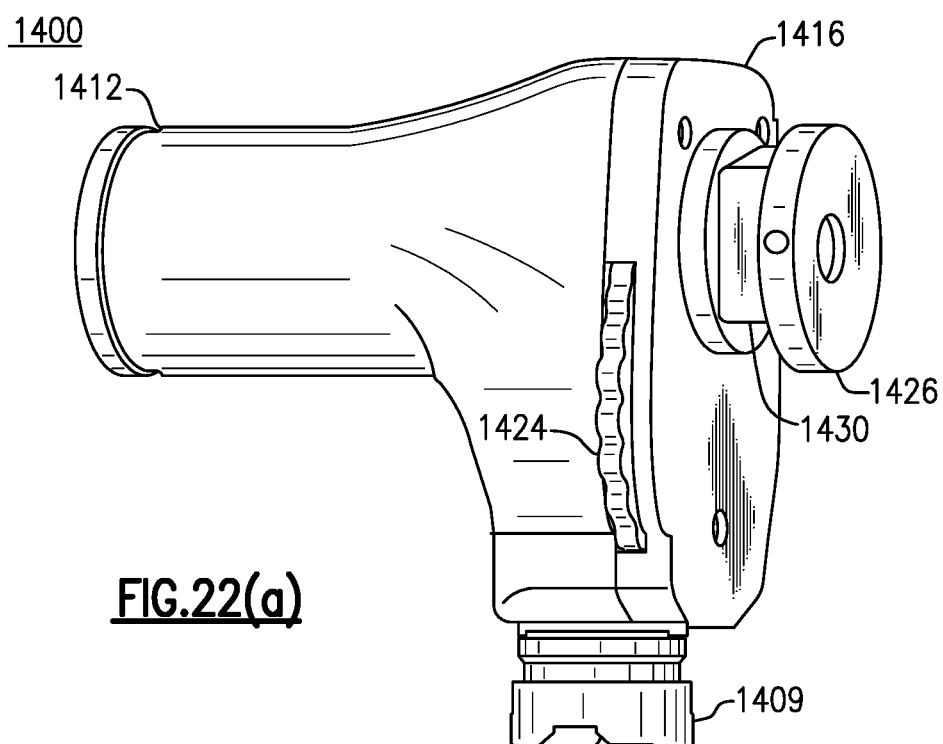


FIG.21



MEDICAL EXAMINATION SYSTEM ENABLING INTERCHANGEABLE OPERATING MODES

CROSS REFERENCE TO RELATED APPLICATION

[0001] This application is a continuation of U.S. Ser. No. 15/495,065, filed Apr. 24, 2017, and entitled: Medical Examination System Enabling Interchangeable Operating Modes, which claims priority under relevant portions of 35 U.S.C. § 119 to U.S. Ser. No. 62/327,154, filed Apr. 25, 2016, and entitled: Medical Examination System Enabling Interchangeable Operating Modes. The entire contents of each application are herein incorporated by reference.

TECHNICAL FIELD

[0002] This application is generally directed to the field of diagnostic medicine and more specifically to a system having at least one stand-alone medical examination or diagnostic device, in which the device can assume or be configured to assume separate interchangeable operating modes. These modes can include a visual mode as well as an electronic viewing mode using an attached smart device. An adapter attached to the at least one medical examination or diagnostic device is configured to support and align one or one of a plurality of disparate smart devices relative to the optical axis of the medical device(s).

BACKGROUND

[0003] Hand-held diagnostic devices are well known in the medical field for purposes of conducting a patient examination, e.g., a wellness examination that would be typically conducted by a primary physician, physician's assistant (PA) or other health care provider, clinician, or caregiver. To that end, a number of disparate devices are routinely used for examining specific medical targets of interest, such as the eyes (ophthalmoscope), ears (otoscope), nose (rhinoscope), skin (dermatoscope), vagina (vagiscope and colposcope), anus (anoscope) and the like.

[0004] Some or all of these medical diagnostic instruments may include optical versions having an eyepiece disposed at one end of an instrument housing. Alternatively, electronic versions are also known having an electronic imager that captures a digital image of the intended medical target. More recently, so-called "smart devices", (e.g., smart phones, tablets and the like), have been incorporated for use with a medical examination or diagnostic device. One such example is the iExaminer® ophthalmoscope, which is manufactured and sold by Welch Allyn, Inc. of Skaneateles Falls, N.Y. Features relating to use of a smart device with a medical examination or diagnostic device herein are more completely described in greater detail in U.S. Pat. No. 8,944,596 B2 and U.S. Patent Application Publication No. 2015/0103317A1, the entire contents of each being herein incorporated by reference.

[0005] Reference is herein made to FIG. 1, which illustrates a known medical diagnostic device (i.e., an ophthalmoscope 10), which is configured to retain a smart device (more specifically, a smart phone). The ophthalmoscope 10 is defined by an instrument housing 14 that includes a distal end 16 and an opposing proximal end 18 and an interior sized and configured to retain a plurality of components. An optical system and an illumination system (not shown) are

each retained within the interior of the instrument housing 14 and configured to enable viewing the eye of a patient (not shown). Features relating to a typical ophthalmoscope for use herein is more completely described in greater detail in U.S. Pat. No. 6,065,837, the entire contents of which is herein incorporated by reference.

[0006] A supporting fixture 20 fixedly secured to the proximal end 18 of the instrument housing 14 is configured to support an attached smart device 32. More specifically, the supporting fixture 20 is defined by a frame-like structure having an open top or upper end as well as a pair of parallel channels or slots 24 that are disposed along opposing lateral sides, enabling a specific smart device 32 (e.g., an iPhone 4.0) to be releasably attached. The supporting fixture 20 further includes a cylindrically shaped nose section (not shown) made from a flexible material that is configured to fully cover the eyepiece of the ophthalmoscope 10. When the smart phone 32 is attached, the supporting fixture 20 retains the smart device 32 in a single defined position that provides the necessary alignment for the optics of the smart device 32 relative to the contained optical system (not shown) of the ophthalmoscope 10.

[0007] In use, the display of the attached smart device 32 is used to provide digital images of an intended medical target and in which a phone application stored into the memory of the smart phone 32 enables the instrument to be operated by a user. The supporting fixture 20 enables the optics of the smart phone 32 to be specifically aligned with the optical system of the ophthalmoscope 10, when the smart device 32 is attached thereto. A shortcoming of this system is that the supporting fixture 20 is only configured to adequately retain the specific smart device 32. Other smart devices cannot be similarly supported.

[0008] The foregoing is significant because alignment between the optics of an attached smart device and the optical system of a stand-alone medical diagnostic or examination device is critical to performance. Additionally, there is a general and pervasive need in the field of medical diagnostics to enable or provide medical examination or diagnostic devices with the capability of assuming a plurality of operating modes, as needed, so as to provide greater versatility.

BRIEF DESCRIPTION

[0009] Therefore and according to one aspect, there is provided a medical examination system comprising a medical device including a housing having an optical system within an interior of the housing. The optical system is defined by an optical axis and configured to operate in an optical viewing mode using an eyepiece. The system further comprises an adapter for aligning a digital camera of a smart device with the optical system of the medical device to enable a separate electronic operating mode, each of the adapter and the medical device having complementary features to permit attachment of the adapter to the medical device, the adapter having at least one feature configured to permit each of a plurality of different sized smart devices to be attached to the adapter and in alignment with the optical system of the medical device when the adapter is attached thereto.

[0010] According to at least one version, an aligning mechanism includes at least one interface plate interconnecting the smart device and the medical examination device. In an embodiment, the at least one interface plate can

be secured, such as adhesively, to the housing of the smart device and in which the medical examination device is releasably attached to the secured at least one interface plate. A mount or alignment assembly or fixture can be provided in order to initially position the at least one interface plate relative to the smart device and in a predetermined location, the adapter having a portion configured to engage the at least one interface plate. Preferably, the interface plate is metal and the portion of the adapter includes at least one magnet for releasably securing the interface plate specifically thereon.

[0011] The medical device can include a proximal end having a device receiving portion that is configured to releasably engage a device connection portion of the adapter wherein the adapter includes an opening that is aligned with the camera aperture of the digital camera of the smart device when the smart device is attached via the at least one interface plate. The opening of the adapter is aligned with the viewing axis of the medical device when the adapter is attached to the medical device.

[0012] According to at least one version, the adapter includes a lever configured for releasing the adapter from the medical device. Additionally, the device connection portion of the adapter can include a spring-loaded pin that is movable into and out of a defined recess sized to engage the proximal receiving portion of the medical device, wherein the lever is movable to a position to release the pin and assist in releasing the adapter from the medical device.

[0013] When attached, the adapter can be moved to a plurality of mounting positions relative to the viewing or optical axis of the medical device. Moreover, the adapter positions the smart device at the convergence point of the eyepiece, thereby placing the smart device in the same position as the viewer's eye in the viewing mode.

[0014] A plurality of different medical examination or diagnostic devices can be provided, each of the medical devices having a proximal receiving portion that is configured for engaging the device connection portion of the adapter.

[0015] According to another aspect, there is provided an adapter configured for attachment to at least one medical device, the adapter comprising a support surface configured to retain one of a plurality of different sized smart devices. The support surface includes a portion that receives an alignment feature of each smart device to align the camera aperture of an attached smart device with a formed opening. Each of the plurality of smart devices includes a digital camera wherein the adapter, when attached, is configured to align the digital camera with the optical system of a medical examination device. The adapter further comprises a device connection portion configured for engaging a proximal receiving portion of a medical device such that, when attached, the opening of the adapter is aligned with the optical axis of the medical device.

[0016] The adapter can include at least one feature for enabling release of the adapter from the medical device such as a lever. In one version, the lever is configured to cooperate with a spring loaded pin of the proximal receiving portion of the medical device.

[0017] According to one version, the portion of the support surface includes at least one magnet for engaging the alignment feature of the smart device.

[0018] According to yet another aspect, there is provided a medical device comprising a housing, an optical system

disposed within the housing including an eyepiece enabling an optical viewing mode; and a proximal receiving portion configured for engaging an adapter retaining a smart device to enable the medical device to assume an electronic imaging mode.

[0019] According to one version, the proximal receiving portion retains a set of eyepiece optics. The proximal receiving portion can be defined in at least one embodiment as a cylindrical section having a channel and a lipped portion configured for releasably engaging a device connection portion of the adapter supporting the smart device.

[0020] The medical device can be at least one of a plurality of disparate medical diagnostic instruments including at least one from the group consisting essentially of dermatoscopes, otoscopes, ophthalmoscopes, colposcopes, rhinoscopes, each of the instruments being configured to engage the adapter.

[0021] According to yet another aspect, a medical instrument examining system comprises a first medical examination device having a distal end, a proximal end and an optical system aligned along an optical axis and a second medical examination device having a distal end, a proximal end and an optical system aligned along an optical axis. Each of the first and second medical examination devices has a proximal receiving portion configured for releasably engaging a device connection portion of the adapter and in which the adapter includes an opening that is aligned with the optical axis of the first and second medical examination device when the adapter.

[0022] The adapter includes a supporting member configured to retain a smart device having a camera, the adapter being configured for retaining the smart device such that the camera of the smart device is automatically aligned with the opening of the adapter and the optical axis of the first and second medical examination devices.

[0023] One advantage realized by the herein described medical examination system is greater versatility by permitting interchangeable attachment of an eyepiece and an electronic device, such as a smart device, with at least one stand-alone medical examination device. In the inventive system, for example, a number of smart devices can be separably attached and aligned with the optics contained within at least one or more discrete stand-alone medical devices using a generic adapter and an interface that permits the adapter to be connected without modification to a number of medical devices.

[0024] Another advantage provided by the herein described system is that either minor or no modifications are required to enable the interchangeable operating modes and in which the adapter used enables repeatable alignment between the optical elements of the stand-alone medical device and the eyepiece or smart device.

[0025] These and other features and advantages will be readily apparent from the following Detailed Description, which should be read in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0026] Various features and advantages of the present invention will become more apparent when taken in conjunction with the following description and drawings wherein identical reference numerals have been used, where possible, to designate identical features that are common to the figures, and wherein:

[0027] FIG. 1 is a perspective view of a stand-alone medical diagnostic or examination device having a smart device attached thereto in accordance with a previously known attachment fixture or frame;

[0028] FIG. 2(a) is a top perspective view of an alignment assembly in accordance with an embodiment, the alignment assembly including an alignment fixture and an interface plate;

[0029] FIG. 2(b) is the top perspective view showing the alignment fixture of FIG. 2A with a retained interface plate;

[0030] FIG. 2(c) is a perspective view of a smart device disposed in relation to the alignment fixture of FIGS. 2(a) and 2(b);

[0031] FIG. 2(d) is a top perspective view of the smart device on the alignment fixture of FIGS. 2(a)-2(c) for purposes of attaching the interface plate thereto;

[0032] FIG. 2(e) is a bottom perspective view of the alignment assembly of FIG. 2(d);

[0033] FIG. 2(f) is a front perspective view showing the attachment of a stand-alone medical diagnostic or examination device to a smart device using the attached interface plate of FIGS. 2(a)-2(e);

[0034] FIG. 2(g) is a rear perspective view showing the attachment of the smart device of FIG. 2(f) to the stand-alone medical diagnostic or examination device;

[0035] FIG. 2(h) is a rear perspective view of the stand-alone medical diagnostic or examination device and attached smart device of FIGS. 2(f) and 2(g), including a display relating to optical alignment;

[0036] FIG. 2(i) is a front perspective view of the stand-alone medical diagnostic or examination device and attached smart device of FIGS. 2(f)-2(h);

[0037] FIG. 2(j) is a top perspective view of an alignment fixture made in accordance with another embodiment;

[0038] FIG. 2(k) is a side perspective view of the alignment fixture of FIG. 2(j);

[0039] FIG. 2(l) is another top perspective view of the alignment fixture of FIGS. 2(j) and 2(k);

[0040] FIG. 3 depicts an embodiment of a calibration target that can be configured for use with the assemblies of FIGS. 2(h)-2(k);

[0041] FIG. 4(a) depicts an exploded perspective view of a medical instrument assembly in accordance with another embodiment including a stand-alone medical diagnostic or examination device and various interface plates for use in enabling the aligned attachment of a smart device;

[0042] FIG. 4(b) depicts a side perspective view of the medical instrument assembly of FIG. 4(a), with the interface plates as attached to the smart device;

[0043] FIG. 4(c) depicts the side perspective view of the medical instrument assembly of FIGS. 4(a) and 4(b) in a nearly assembled condition;

[0044] FIG. 4(d) illustrates a rear perspective view of the stand-alone medical diagnostic or examination device of FIGS. 4(a)-4(c), including magnetic areas configured for alignment with a smart device;

[0045] FIG. 4(e) illustrates a front perspective view of the smart device of FIG. 4(d) having the interface plates attached thereto;

[0046] FIG. 4(f) illustrates a rear perspective view of the stand-alone medical diagnostic or examination device of FIGS. 4(a)-4(d) having interface plates attached thereto;

[0047] FIGS. 5(a)-5(d) depict rear perspective views of a medical instrument assembly showing various assembled

and unassembled operating modes between a first stand-alone medical device, an eyepiece, and a smart device in which the eyepiece and smart device can be interchangeably attached to the first stand-alone medical device to enable the various operating modes;

[0048] FIGS. 6(a)-6(d) depict rear perspective views of another medical instrument assembly showing various assembled and unassembled operating modes between a second stand-alone medical device, an eyepiece and a smart device in which the eyepiece and smart device are interchangeably attached to the second stand-alone medical device to enable the various operating modes;

[0049] FIGS. 7(a)-7(d) depict rear perspective views of yet another medical instrument assembly showing various assembled and unassembled operating modes between another stand-alone medical device, an eyepiece and a smart device in which the eyepiece and smart device are interchangeably attached to the stand-alone medical device to enable the various operating modes;

[0050] FIGS. 8(a)-8(d) depict rear perspective views of still another medical instrument assembly showing various assembled and unassembled operating modes between another stand-alone medical device, an eyepiece and a smart device in which the eyepiece and smart device are interchangeably attached to the depicted stand-alone medical device in order to enable the various operating modes;

[0051] FIG. 9(a) is a side perspective view of a stand-alone medical diagnostic or examination device configured to support an aligned smart device using an adapter in accordance with an embodiment;

[0052] FIG. 9(b) is an exploded assembly view of the medical diagnostic or examination device, adapter and smart device of FIG. 9(a);

[0053] FIG. 9(c) is a side perspective view of another stand-alone medical diagnostic or examination device as configured to support an aligned smart device using an adapter;

[0054] FIG. 9(d) is an exploded assembly view of the stand-alone medical diagnostic or examination device and smart device of FIGS. 9(a) and 9(b) and an adapter made in accordance with another embodiment;

[0055] FIG. 10(a) is a perspective view of a medical examination device made in accordance with another embodiment and configured to provide an optical viewing mode;

[0056] FIG. 10(b) is a perspective view of the medical examination device of FIG. 10(a) having an attached smart device, the medical examination device being configured in an electronic viewing mode;

[0057] FIG. 11(a) is a perspective view of a medical examination device made in accordance with another embodiment in which the device is configured in an optical viewing mode;

[0058] FIG. 11(b) is a perspective view of the medical examination device of FIG. 11(a), including an attached smart device, the medical examination device being configured in an electronic viewing mode;

[0059] FIG. 12(a) is a perspective view of another medical diagnostic or examination device having a smart device attached thereto in accordance with another embodiment, the smart device being disposed in a specific adjustable mounting orientation;

[0060] FIG. 12(b) is another perspective view of the medical diagnostic or examination instrument of FIG. 12(a), with the attached smart device in another adjustable mounting orientation;

[0061] FIG. 13(a) is a perspective view of another medical diagnostic or examination device having a smart device attached thereto in accordance with yet another embodiment, the smart device being disposed in a specific adjustable mounting orientation;

[0062] FIG. 13(b) is the perspective view of the medical diagnostic or examination instrument of FIG. 13(a), the attached smart device being disposed in another adjustable mounting orientation;

[0063] FIG. 14(a) is a front facing view of an adapter made in accordance with another embodiment;

[0064] FIG. 14(b) is an end view of the adapter of FIG. 14(a);

[0065] FIG. 14(c) is the front facing view of the adapter of FIGS. 14(a) and 14(b), with a lever moved to a depressed position;

[0066] FIG. 15(a) is a side elevational view of a medical examination device supporting a smart device using the adapter of FIGS. 14(a)-14(c);

[0067] FIG. 15(b) is a front facing view of the medical examination device of FIG. 15(a); and

[0068] FIG. 15(c) is the side elevational view of medical examination device of FIGS. 15(a) and 15(b), showing the interface between a proximal receiving portion and the adapter shown in section.

[0069] FIG. 16 is a schematic diagram of an optical layout for a stand-alone medical diagnostic or examination device in accordance with an embodiment, the device including an attached smart device and including movable optics provided within the stand-alone medical device;

[0070] FIG. 17 is a schematic diagram of an optical layout of the stand-alone medical device of FIG. 16, including a coupled eyepiece defining an optical viewing mode;

[0071] FIG. 18 is a schematic diagram of an optical layout for a stand-alone medical diagnostic or examination device in accordance with another embodiment, the device including movable optics contained in the device and an attached smart device defining an electronic imaging mode;

[0072] FIG. 19 is a schematic diagram of an optical layout of the stand-alone medical device of FIG. 18, including a coupled eyepiece;

[0073] FIG. 20 is a schematic diagram of an optical layout for an illumination system of a stand-alone medical diagnostic or examination device in accordance with another embodiment;

[0074] FIG. 21 is a perspective view of a mounting fixture in accordance with an embodiment for various components of the herein described medical examination system;

[0075] FIG. 22(a) is a side elevational view of another medical diagnostic or examination device in accordance with another embodiment; and

[0076] FIG. 22(b) depicts the medical device of FIG. 22(a) in section.

DETAILED DESCRIPTION

[0077] The following description relates to certain embodiments of a medical examination system that includes at least one stand-alone medical diagnostic or examination device that is configured for operation in a number (at least two (2)) of interchangeable operating modes. In at least one

version, an adapter is configured to generically support one of a plurality of smart devices, such as smart phones, in which the generic adapter is further configured to be attached to one of a plurality of disparate medical examination devices. In another version, a plurality of medical devices are configured with a common or generic interface enabling a smart device to be used interchangeably with the medical devices.

[0078] For purposes of explanation, the specific medical examination or diagnostic devices described in the following embodiments include otoscopes for examining the ears of a patient and ophthalmoscopes for examining aspects of the eyes of a patient. However, it will be readily apparent that the concepts discussed herein are further applicable to a varied number of other stand-alone medical diagnostic or examination instruments or devices, such as but not limited to dermatoscopes, vagiscopes, colposcopes, and anoscopes, among other devices capable of viewing of a medical target of interest.

[0079] In addition, the following description utilizes a number of terms for the purpose of providing an adequate or suitable frame of reference in relation to the accompanying drawings. These terms, which may include “inner”, “outer”, “external”, “internal”, “distal”, “proximal”, “above”, “below”, “top”, “bottom” and the like should not be interpreted as necessarily limiting the intended scope of the invention, including the claims, unless so specifically indicated.

[0080] As used herein, the term “smart device” refers to any apparatus or device that is mobile and connected to other devices via wireless protocols or networks under IEEE 802.11 including but not limited to WiFi, Bluetooth, 3G and the like. The smart device as defined herein includes at least one electronic imaging device (e.g., a digital camera) and related optics, memory and a microprocessor capable of running application software, which may include but is not limited to smart phones and tablets.

[0081] As used herein, the term “stand-alone medical diagnostic or examination device” refers to an instrument used to view a medical target of interest of a patient which includes an optical system and optionally includes an illumination system. Examples of these devices may include but are not limited to otoscopes, ophthalmoscopes, dermatoscopes, vagiscopes and anoscopes for viewing a medical target of interest.

[0082] A system according to several embodiments is described herein and defined by at least one stand-alone medical diagnostic or examination device that can be used interchangeably using an interface that enables an optical mode as well as an electronic imaging mode. As discussed herein, each of the optical system of the medical device(s) and the camera of the smart device can be repeatably and reliably aligned to enable dual functionalities without significant modification to the stand alone diagnostic or examination device.

[0083] With reference to FIGS. 2(a) and 2(b) and according to a first embodiment, an alignment fixture 100 is provided that is used for indexing a smart device prior to attachment to a medical diagnostic or examination device. As discussed herein, the purpose of the fixture 100 is to provide placement of an interface or alignment plate(s) on a smart device. The positioning of the interface plate(s) enables proper alignment between the camera of the smart device and the optical system of a medical device to which

the smart device is attached. The alignment fixture 100 according to the depicted version is defined by a raised platform 108 having a planar upper or top surface 112, as well as a plurality of legs 116 that extend downwardly from the upper surface 112. One of the legs 116 according to this embodiment includes a support flange 117 that further includes an optical target 118, such as a reticle. An elongate slot 120 formed in the top surface 112 of the alignment fixture 100 is sized and configured to receive an interface plate 104.

[0084] The interface plate 104 according to this specific embodiment is a substantially planar section made preferably from metal and including a through hole 105 and a slot 107, each aligned and spaced from one another. According to this embodiment, an upper side 106 of the interface plate 104 includes an adhesive layer to enable securement to the front facing surface 144 of a smart device 140 as shown in FIGS. 2(c)-2(e) using the alignment fixture 100. More specifically, the interface plate 104 is positioned within the elongate slot 120 of the alignment fixture 100, with the upper side 106 of the interface plate 105 facing upwardly. The smart device 140, which according to this embodiment is a smart phone, is then brought to the alignment fixture 100 with the front facing surface 144 of the smart device 140 facing the top surface 112 of the alignment fixture 100 and the contained camera 146 of the smart device 140 being aimed at the optical target 118.

[0085] As shown in these figures, the smart device 140 is activated by the user and an application stored into memory on the smart device 140 is configured to provide a target on the display 144, including a cross hair or other aiming means (e.g., a target 148) in order to verify that the optical target 118 is centered on the display 144. Once the target 148 is centered on the display 144 of the smart device 140, and as shown in FIGS. 2(d) and 2(e), the smart device 140 can be brought into contact with the adhesive layer 106 of the interface plate 104. The smart device 140 and attached interface plate 104 can be subsequently removed from the alignment fixture 100 by releasing the interface plate 104 from the retaining slot 120.

[0086] With reference to FIGS. 2(f)-2(i), the smart device 140 having the attached interface plate 104 can then be attached to a stand-alone medical diagnostic or examination device. According to this depicted embodiment, the stand-alone medical or examination device is an otoscope 160 that is used for viewing the outer and middle ear of a patient. The otoscope 160 is defined by a housing 164 that includes an instrument head attached to the upper end of a downwardly extending handle, the instrument head having a distal end and an opposing proximal end as well as an interior that is sized and configured to retain a number of optical elements. The distal end of the instrument head of the otoscope 160 includes a conical insertion portion that is configured to releasably receive a hollow speculum tip element, also having a conical configuration that is designed to be fitted only to a predetermined distance into the outer ear of a patient (not shown).

[0087] According to this version, the rear or proximal facing side surface 176 of the instrument housing 164 includes a pair of spaced magnets 180. When assembled and as shown in FIGS. 2(h) and 2(i), the hole 105 and slot 107 of the fixedly secured interface plate 104 provides a specific and repeatable datum with regard to the smart device 140 to enable optical alignment when the smart device 140 is

attached to the otoscope 160. When attached, the camera 146 of the attached smart device 140 is specifically aligned with the optical system of the otoscope 160 and more specifically a rear or proximal opening 169 of the instrument housing 164.

[0088] It will be understood that variations of the alignment fixture are also contemplated given the need determined by Applicants to precisely and very accurately align the interface plate properly onto a smart device for the herein described examination system. For example and as shown in FIGS. 2(j)-2(l), another alignment fixture 100A is depicted for purposes of aligning a smart device for positioning of at least one interface plate (not shown). The alignment fixture 100A, according to this version, is defined by a structure having a planar support surface 109A. Respective x-axis and y-axis adjustment assemblies 130A, 134A are engageable with lateral sides of a smart device, and more specifically a smart phone 140A that is positioned onto the top of the planar support surface 109A. According to this version, the interface plate (not shown) can be placed within a shelf (not shown) located directly beneath the planar support surface 109A. More specifically, the interface plate(s) is positioned within a defined recess(es) or slot(s) (not shown) in the shelf with an exposed adhesive side of the interface plate(s) facing a slot 110A, FIG. 2(l), of the alignment fixture 100A.

[0089] According to this embodiment, the alignment fixture 100A includes respective x-axis and y-axis adjustment assemblies 130A and 134A that include respective spring-loaded adjustment or support blocks 138A and 139A, each set orthogonally to one another on the top of the planar support surface 109A. Respective x-axis and y-axis screw adjustment members 137A and 141A, according to this embodiment, are fixedly and threadingly disposed within the center of a corresponding beam-like member 143A and 145A in spaced parallel relation to the spring-loaded adjustment blocks 138A and 139A. Each of the beam-like members 143A, 145A further include a recessed interior portion 146A and 147A, respectively, that is sized to be placed onto and cover a lateral edge of a smart device (e.g., smart phone 140A) that is introduced onto the fixture 100A. When mounted, the relative position of the smart phone 140A can be laterally shifted wherein vertical movement is restricted by the beam-like members 143A, 145A, as well as the lateral support surface 109A of the alignment fixture 100A.

[0090] When the camera of the smart phone 140A is activated, an alignment application stored by the phone memory is programmed to display a set of cross hairs or other suitable target 148A. The smart phone 140A is then placed on the planar support surface 109A with the display side facing upwardly and the camera of the smart phone 140A aligned with a pinhole 111A, FIG. 2(j) formed on the planar support surface 109A that is aligned with an optical target 118A disposed beneath the planar support surface 109A. A back light (not shown) can be disposed beneath the optical target 118A to enhance illumination and visualization by the smart device 140A.

[0091] The smart phone 140A is initially set with lateral edges of the smart phone 140A being placed against the spring-loaded support blocks 138A and 139A. The screw adjustment members 137A, 141A and the beam-like members 143A, 145A are retracted sufficiently to allow the smart phone 140A to be initially positioned onto the planar support surface 109A. Once crudely positioned and aligned, the x-axis and y-axis adjustment members 130A, 134A are then

moved into position using the screw adjustment members 137A, 141A with the beam-like members 143A, 145A, and more specifically the interior recessed portions 146A and 147A covering and engaging the lateral edges of the smart phone 140A. Fine adjustments can then be made against the bias of the spring loaded support blocks 138A, 139A to accurately center the image 149A of the optical target 118A on the display 144A and more specifically the cross hairs (target 148A) as needed, until the image 149A of an optical target 119A disposed beneath the planar support surface 109A is centered on the display 144A, and more specifically within the defined cross hairs 148A.

[0092] The above procedure can also detect misalignment and tolerancing issues of the smart device 140A and permit the image 149A of the optical target 118A to be as effectively and accurately centered relative to the cross hairs 148A on the display 144A as possible. Such tolerancing and misalignment issues are minor for typical use of the smart device, but are magnified when used for purposes of optically aligning to a medical diagnostic or examination device. Once centered, the shelf retaining the at least one interface plate can be pressed upwardly into contact with the front facing side of the smart device 140A, adhesively and reliably securing the at least one interface plate.

[0093] It will be understood that the alignment fixture 100A can be easily modified to accept smart devices having different configurations and footprints to permit optical alignment and placement of an interface plate(s) as herein described.

[0094] When attached in the manner shown herein, the optical parameters of the entire assembly can be calibrated using a calibration target 198, such as shown in FIG. 3 using the display 144 of the mounted smart phone 140. Optical parameters such as white balance, gray scale and color can be optimized using an application stored within the smart device or other suitable means.

[0095] It should be understood that the number and location of interface plates used for alignment to a stand-alone medical device can be suitably varied provided that the interface plate(s) accurately align a mounted smart device and more specifically the contained optics of the attached smart device with the optical system of the medical diagnostic or examination device. One alternative embodiment is shown in FIGS. 4(a)-4(f) in which a pair of interface plates 204, 208, are provided for disposition between the rear facing surface 207 of a stand-alone medical diagnostic or examination device 200, in this instance an otoscope, and the front facing surface 223 of a smart device 220, for example, a smart phone. Initially, a pair of interface plates 204, 208 are attached to the front facing surface 223 of the smart device 220 using an alignment fixture (not shown) that is similar to that previously shown and depicted in FIGS. 2(a)-2(f). Though not shown, the process of assembly is similar in that the alignment fixture includes a raised platform or an upper or top planar surface that further includes a pair of slots that are spaced from one another and configured for retaining each of the interface plates in a spaced relation. According to this embodiment, the pair of interface plates include a first interface plate 204 and a second interface plate 208. Also and as in the proceeding, an optical target can be provided on the alignment fixture.

[0096] To assemble, each of the first and second interface plates 204, 208 are placed within the retaining slots on the top surface of the alignment fixture with the camera of the

smart device 220 being aimed at the optical target and viewed using a cross hair or similar aiming means provided on the display of the smart device 220 using an application stored within the smart device 220. When the camera of the smart device 220 is properly aimed such that the optical target is centered on the cross hairs provided on the display, the smart device 220 can then be brought into contact with the top surface of the alignment fixture in which each of the facing sides of the interface plates 204 and 208 include an exposed adhesive layer in order to secure same to the smart device 220.

[0097] The smart device 220 can then be removed from the alignment fixture and secured to the rear facing side or surface 207 of the medical examination device 200, which according to this embodiment is an otoscope. In at least one version, the rear facing side 207 of the medical examination device 200 includes a pair of magnets 214, 217 spaced from one another that receive the smart device 220 and more specifically the interface plates 204, 208, the latter being positioned to ensure the attached smart device 220, and more specifically the camera of the smart device 220, is aligned properly with the optical system of the examination device 200.

[0098] With reference to FIGS. 5(a)-5(d), there are depicted a number of varied arrangements between a stand-alone medical diagnostic or examination device 300, an eyepiece 320 and a smart device 360, each of the latter being interchangeably attached to the proximal end of the medical diagnostic device 300.

[0099] First and as shown in FIGS. 5(a) and 5(b), the eyepiece 320 can be releasably engaged with the stand-alone medical examination device 300 (i.e., an otoscope). The eyepiece 320 according to this depicted embodiment is defined by a substantially cylindrical housing 324 having an interior that is configured to retain at least one optical element, such as an objective lens (not shown). The eyepiece 320 can be releasably attached to the stand-alone medical examination device 300 by means of a magnetic interface 309 formed at the proximal end of the medical device 300. According to this embodiment, the magnetic interface 309 includes a plurality of retained magnets which are disposed in a circumferential configuration about a proximal opening of the medical device 300. The distal end of the eyepiece 320 is configured to engage the magnetic interface 309 in a manner in which the contained optics of the eyepiece 320 are optically aligned with the contained optics of the medical examination device 300.

[0100] The eyepiece 320, according to this specific embodiment, further includes an external focusing knob 328 disposed on the housing 324, that when rotated, is configured to axially shift the position of the contained optical element, as needed. When coupled to the stand-alone medical device 300, the external focusing knob 328 can be accessed by the user and rotated to permit adjustments to be made optically while the magnetic interface 309 continues to maintain support and optical alignment of the eyepiece 320 with the optics of the stand-alone medical device 300.

[0101] As shown in FIGS. 6(a) and 6(b), a similar arrangement can be provided for another stand-alone medical diagnostic or examination device 400 (e.g., an ophthalmoscope) in which the eyepiece 320 can also be releasably and interchangeably attached to the proximal end 405 of the device 400. As in the prior embodiment, the device 400 includes a magnetic interface 409 in which a plurality of

retained magnets are disposed in a circumferential pattern to enable optical alignment with the stand-alone medical examination device, when the eyepiece 320 is attached. This attachment further enables a user to view the intended target through the proximal end of the eyepiece 320. In use, the eyepiece 320 can be interchangeably attached to either medical diagnostic or examination device 300, 400 without modifications being required to either the devices 300, 400 or the eyepiece 320.

[0102] Still further and with reference to FIGS. 5(c) and 5(d), and FIGS. 6(c) and 6(d), a smart device 360 can also be separably and interchangeably attachable to the proximal surface 305, 405 of either medical examination or diagnostic device (otoscope 300 or ophthalmoscope 400) in lieu of the eyepiece 320 to provide a separate electronic imaging or viewing mode. According to each of these depicted embodiments, at least one interface plate is first provided and attached to the front or distal facing side of the smart device 360 such as using an alignment fixture (not shown) in a manner previously described—see FIGS. 2(a)-2(i). Once the interface plate(s) are attached, the smart device 360 can be interchangeably attached to the rear facing or proximal surface 305, 405 of either medical examination device 300, 400 using at least a portion of the magnetic interface 309, 409 as well as at least one other suitably spaced magnet 311, 411, the latter being separately provided on the rear facing surface 305, 405 of the otoscope 300 or ophthalmoscope 400 in spaced relation to the interface 309, 409 to properly locate the smart device 360 in alignment with the contained optics of the medical examination device 300, 400. It should be understood that other configurations are possible.

[0103] It should be noted that the design of the medical examination device can be suitably altered to better accommodate an attached and optically aligned smart device for purposes of operation. For example and according to FIGS. 7(a)-7(d) and FIGS. 8(a)-8(d), another embodiment of a medical examination assembly is depicted in which stand-alone medical examination devices (otoscope 500 or ophthalmoscope 600) are commonly defined by a body or housing 504, 604 in which the upper portion of the handle 508, 608 is curved so as to create an offset of the instrument head 510, 610 relative to the handle 508, 608 of the device 500, 600 to enable an attached smart device 360 to be more efficiently centered and balanced due to the off-center nature of an attached smart device 360. Other suitable variations and configurations will be readily evident, for example, depending on the smart device to be supported in the herein described assembly.

[0104] In each of the latter examples, an eyepiece 320 and a smart device 360 can be interchangeably used in connection with either medical examination device 500, 600. The eyepiece 320 is releasably attached by engagement of the distal end of the eyepiece housing 324 with a magnetic interface 509, 609 formed about the periphery of the proximal optics opening of the device 500, 600. The smart device 360 is interchangeably mounted using at least one interface plate (not shown in these views) using a technique that is similar to that described in FIGS. 2(a)-2(i), including a suitable alignment fixture having retention slots that permit specific placement or positioning of the smart device 360 to further provide suitable optical alignment relative to an optical target on the alignment fixture that is configured to represent the optical system of the otoscope 500 or ophthal-

moscope 600 and attached to magnets 511, 611 of the medical devices 500, 600 respectively.

[0105] In accordance with another embodiment and with reference to FIGS. 9(a) and 9(b) there is shown another stand-alone medical diagnostic or examination device that can be configured to support a smart device to provide versatility through an enhanced electronic viewing mode. According to this version, the medical examination or examination device is an otoscope 700, such as the Macroview otoscope manufactured and sold by Welch Allyn, Inc. of Skaneateles Falls, N.Y. This device is described more completely in U.S. Pat. No. 7,399,275, the entire contents of which are herein incorporated by reference. The otoscope 700 according to this embodiment includes a cylindrical handle portion 704 having an upper necked portion 706 that supports an instrument head 708. The handle portion 704 includes a battery compartment (not shown) that retains a set of stacked batteries (not shown) that are coupled to a light source (not shown) retained in the necked portion 706. Light is transmitted from the contained light source through a distal end 711 of the instrument head 708, using a fiberoptic bundle or other suitable means. The fiberoptic bundle (not shown) is configured as a ringlet of fibers that surround a distal optical element (not shown) contained within the instrument head 708. The interior of the instrument head 708 is essentially hollow and includes a conical insertion portion 712 at the distal end 711, as well as a proximal opening including a proximally extending eyepiece 710. In use, an otoscopic tip element (a speculum tip) is releasably attached to a conical insertion portion 712 of the instrument head 708 in which the target of interest (e.g., the tympanic membrane) can be viewed through contained optics via the proximal opening along a defined optical axis. As noted, further details relating to the construction and features of the otoscopic device 700, including the speculum tip, are discussed in greater detail in U.S. Pat. No. 7,399,275, herein previously incorporated by reference.

[0106] As further shown in FIGS. 9(a) and 9(b), an adapter 720 is provided that is attached to the proximal end of the otoscopic device 600. According to this embodiment, the adapter 720 is defined by a distal engaging portion 724 that is configured for engaging the instrument head 708 of the otoscope 700 and a proximal supporting portion 728 that is configured to receive a smart device 750, such as a smart phone, as shown. The distal engaging portion 724, according to this specific embodiment, is defined by a pair of resilient fingers 732 that are configured to engage a slot or slotted portion 713 formed on an upper or top surface of the instrument head 708. The proximal supporting portion 728 of the adapter 720 includes a recessed slot 736 sized for receiving an interface plate 738 (partially shown in the exploded view of FIG. 9(b)) that is first attached to the distal facing side or surface of the smart device 750, using an alignment and indexing fixture in a manner similar to that previously described with regard to FIGS. 2(a)-2(i). In this specific version, the slot 736 (or other part of the adapter 720) is further defined by at least one magnet, the adapter 720 further having a through opening 740 that aligns the optics of the device 700 and those of the optics of the smart device 750 opposite a connector 758 at the lower portion of the adapter 720. The connector 758 is configured to engage with and cover the eyepiece 710 of the otoscope 700.

[0107] When attached, the smart device 750, including the display 754, is situated substantially above the instrument

700 as is depicted in FIG. 9(a) with the optics of the smart device 750 being disposed in proper alignment with the optical system of the otoscope 700.

[0108] The above described adapter 720 can be utilized with other stand-alone medical diagnostic or examination devices. For the sake of clarity, similar parts are herein labeled with the same reference numbers. With reference to FIG. 9(c), an ophthalmoscope 800 includes a handle portion 804 that further includes a necked portion 806 for supporting an instrument head 808. The instrument head 808 retains a plurality of components to enable viewing of a patient's eye (not shown) and more specifically the retina (not shown). According to this embodiment, the device 800 is configured to with an eyepiece 810 at the proximal end of the instrument head 808 in which the interior of the instrument head 808 includes a plurality of optical elements as well as an illumination system, the latter having a contained light source for viewing portions of the eye of the patient. Details relating to the salient features of the ophthalmoscope 800 are provided in U.S. Pat. No. 6,065,837, the entire contents of which are herein incorporated by reference.

[0109] The adapter 720 is attached to the instrument 800 to permit interchangeability between instruments and operating modes (between an optical viewing mode using the eyepiece 810 and an electronic viewing mode using an attached smart device 750). As previously discussed, the adapter 720 includes a distal engaging portion 724 and a proximal supporting portion 728. The distal engaging portion 724 includes a pair of resilient fingers 732 that are configured to engage a recessed slot or slotted portion 813 provided in an upper surface of the instrument head 808. The proximal supporting portion 728 is defined by a vertical support surface including a recessed slot (not shown) that receives an interface plate attached, adhesively or otherwise, to the distal or front facing side of the smart device 750 preferably in the manner previously described. The adapter 720 further includes a cylindrically shaped connector portion 758 in a lower portion of the adapter 720 that is sized to engage the eyepiece 810 of the ophthalmoscope 800 or other medical stand-alone device and in which a gusset 727 engages a top portion of the instrument head 808 to optionally provide additional support and stability.

[0110] With reference to FIG. 9(d), an alternative adapter is depicted for use with a stand-alone medical diagnostic or examination device (e.g., the otoscope 700 previously discussed). According to this version, the adapter 920 includes a proximal supporting portion 928 that includes an open end 929 and a pair of laterally disposed guide rails 930, the latter being sized to receive a smart device 750. According to this specific embodiment, the adapter 920 includes a distal engaging portion 924 having a set of resilient fingers 932 that are configured to engage the slotted portion 713 formed on the upper or top surface of the instrument head 708. The adapter 920 also includes a lower connector portion 758 that is sized to engage the eyepiece 710 of the diagnostic or examination device 700. Each of the herein described adapters 720, 920 enable a smart device, such as device 750, to be attached to at least one stand-alone medical instrument and permit interchangeable operating modes (optical and electronic).

[0111] Yet another embodiment of a medical instrument assembly or system is illustrated in FIGS. 10(a)-10(b). According to this version, a stand-alone medical examination or diagnostic device (e.g., an otoscope 1000) is provided

that is defined by a housing 1004 further defined by a handle 1008 that downwardly extends from an instrument head 1010. The instrument head 1010 is defined by a distal end 1012 including a conically shaped insertion portion (not shown). The insertion portion is configured to releasably support a conically shaped and hollow speculum tip element 1014, the tip element 1014 being releasably attached by means of a rotatable actuator knob 1015. Alternatively, the tip element 1014 can be secured by manually twisting the element in place onto the conical insertion portion using bayonet or other suitable engagement features. Details relating to the speculum tip element and an exemplary attaching and releasing mechanism are described in greater detail in U.S. Pat. Nos. 7,354,399 and 8,197,403, each of which are herein incorporated by reference in their entirety.

[0112] Within the interior of the otoscope 1000 is a light source (not shown) such as an incandescent lamp or at least one LED, which is disposed in a lower portion of the instrument head 1010. A bundle of optical fibers (not shown) are coupled to the light source and directed as a ringlet at the distal end of the conical insertion portion in order to effectively illuminate the target of interest. The handle 1008 includes an interior compartment that retains at least one battery (not shown) for energizing the light source. A series of optical elements are disposed within the interior of the instrument head 1010 and aligned along an optical axis with a separate optical train being provided within the confines of an eyepiece 1024, the latter being releasably attached to the otoscope 1000 in order to create an optical viewing mode.

[0113] According to this embodiment an adapter 1020, which is provided at a proximal end of the otoscope 1000, permits attachment of the eyepiece 1024. The adapter 1020 includes a set of magnets (not shown) that permits releasable and interchangeable attachment of the eyepiece 1024 or a smart device 1050, as described below. As noted, the eyepiece 1024 includes an interior retaining a series of optical elements that are suitably aligned with optical elements provided in the interior of the instrument head 1010. According to this specific embodiment, the eyepiece 1024 is defined by a housing 1027 that is coextensive with the handle 1008 of the otoscope 1000, including a substantially planar distal facing surface 1029.

[0114] With further reference to FIG. 10(a), the adapter 1020 is attached to or according to this embodiment is directly integrated as a part of the device housing 1004. More specifically, the adapter 1020 is defined by a planar section 1022 which is disposed within a rear receiving slot 1036 of the device housing 1004. This planar section 1022 includes a proximal face surface 1026 having at least one recessed slot (not shown) that permits the selective engagement of a smart device 1050, FIG. 10(b). In accordance with prior embodiments discussed, such as depicted in FIGS. 2(a)-2(f), an attachment device includes at least one retaining slot that receives an interface plate. The smart device 1050 is then positioned in relation to the alignment fixture and the camera of the smart device 1050 is aimed at an optical target of the alignment fixture until centered in the display of the smart device 1050. Upon centering and as previously discussed, the smart device 1050 is then engaged with the supported interface plate(s), the latter having an adhesive layer to provide securement. The indexing and positioning of the interface plate(s) guarantees proper alignment of the smart device 1050 to the otoscope 1000 and more specifically between the interface plate(s) and the at

least one recessed slot (not shown) formed in the proximal facing surface **1026** of the adapter **1020**. The at least one magnet (not shown) is provided in the adapter **1020** in alignment with the recessed slot(s) to releasably secure the smart device **1050**.

[0115] According to this embodiment, the adapter **1020** is supported for pivotal movement from the rear receiving slot **1036** of the device housing **1004** about the optical axis of the device **1000**. This pivotability permits the attached smart device **1050** to assume a plurality of adjustable mounting orientations enabling the position of the smart device **1050** to be changed selectively. Advantageously, this latter feature permits enhanced operation and versatility.

[0116] In terms of operation, the herein described system can be used initially in an optical viewing mode as depicted in FIG. **10(a)** with the eyepiece **1024** being releasably engaged with the proximal facing surface **1026** of the adapter **1020**. The eyepiece **1024** is releasably attached and can be released from the adapter **1020** by disrupting the magnetic attachment. As shown in FIG. **10(b)**, the smart device **1050**, having an attached interface plate(s) (not shown) can then be interchangeably attached in lieu of the eyepiece **1024** by engaging the interface plate with the recessed receiving slot of the adapter **1020**. The magnets according to this embodiment are directly aligned with the recessed receiving slot on the adapter **1020** to insure attachment. In this latter mode, the camera of the smart device **1050** is aligned with the optical axis of the otoscope **1000** and the smart device **1050** is further configured to assume a plurality of mounting configurations based on the pivotal connection of the adapter **1020** with the remainder of the otoscope **1000**.

[0117] In either operational mode, the user inserts the speculum tip element **1014** a predetermined distance into the outer ear of a patient and the image of the intended target, as illuminated by the contained light source is viewed or transmitted directly along the optical axis to either the eyepiece **1024** or the smart device **1050** for viewing on the display **1054**, FIG. **10(b)**.

[0118] Another medical examination system is depicted in FIGS. **11(a)-11(b)**. According to this embodiment, the medical diagnostic or examination device used is an ophthalmoscope **1100** defined by a housing **1104** having a handle portion **1108** and an instrument head **1110**. The instrument head **1110** is defined by a distal end **1112** that receives an elastomeric eye cup **1116** configured to engage against the patient and a proximal end that includes an adapter **1120**. The interior of the instrument head **1110** includes an optical and illumination system that is configured to view the eye (e.g., the retina) of a patient (not shown) including a defined optical axis extending between the distal and proximal ends of the device **1100**. The adapter **1120**, which is similar to that previously described in the prior embodiment, is configured to interchangeably receive either an eyepiece **1124**, FIG. **11(a)**, or a smart device **1050**, FIG. **11(b)**, respectively.

[0119] As in the prior otoscopic version, the adapter **1120** is defined by a planar section **1122** which is disposed within a rear receiving slot of the device housing **1104**. This planar section **1122** includes a proximal or rear face surface **1126** having at least one recessed slot (not shown) that permits the selective engagement of a smart device **1050**. In accordance with prior embodiments discussed, such as depicted in FIGS. **2(a)-2(f)**, an alignment fixture includes at least one retaining slot that receives an interface plate. The smart

device **1050** is then positioned in relation to the alignment fixture and the camera of the smart device is aimed at an optical target of the alignment fixture until centered in the display of the smart device. Upon centering and as previously discussed, the smart device is then engaged with the supported interface plate(s), the latter having an adhesive layer to provide securement. The indexing and positioning of the interface plate(s) guarantees proper alignment of the smart device **1050** to the ophthalmoscope **1100** and more specifically between the interface plate(s) and the at least one recessed slot formed in the rear facing surface **1126** of the adapter **1120**. At least one magnet (not shown) is provided in the adapter **1120** in alignment with the recessed slot(s) to releasably secure the smart device **1050**.

[0120] According to this embodiment, the adapter **1120** is supported for pivotal movement from the rear receiving slot **1136** of the device housing **1104** about the optical axis of the device **1100**. The adapter **1120** includes a distal engagement portion (not shown) that is disposed over a proximally extending end (not shown) of the instrument head **1110** in overlaying relation. This pivotability feature permits the attached smart device **1050** to assume a plurality of adjustable mounting orientations about the optical axis wherein the position of the smart device **1050** can be changed selectively upon attachment to the adapter **1120** without otherwise disturbing optical alignment. For example, the engagement portion can include at least one or more detents (not shown) to provide specific mounting orientations (e.g., each 90 degrees to create four (4) mounting orientations). Advantageously, this latter feature permits enhanced operation and versatility.

[0121] With reference to FIGS. **12(a)** and **12(b)**, there is shown another embodiment of a medical examination system that permits pivotal movement of an attached smart device. This system includes a medical examination device (i.e., an ophthalmoscope **1200**) having a cylindrical handle portion **1206** with an instrument head **1210** attached to an upper part of the handle portion **1206**. The instrument head **1210** is defined by a distal end **1211** and an opposing proximal end **1213**, the distal and proximal ends **1211**, **1213** defining an aligned optical axis of the assembly. The adapter **1220**, according to this embodiment, is defined by a substantially planar section having a distal facing surface **1226** and a proximal facing surface **1228**. The proximal facing surface **1228** includes at least one recessed slot (not shown) that is configured for receiving an interface plate (not shown) attached to the front facing side of a smart device **1050**, in a manner as previously described. According to this embodiment, the distal facing surface **1226** of the adapter **1220** includes at least one magnet directly aligned with the recessed slot, as well as a distal engagement portion including an open upper end and a channel that is configured to receive an eyepiece portion of the instrument head **1210**. The eyepiece portion according to this embodiment includes a necked portion including a proximal lip that axially secures the adapter **1220** once attached to the device **1200**.

[0122] When attached, the necked portion can be slidably engaged within the defined channel with the proximal lip being retained within the channel. In at least one variation, the channel and the proximal lip are configured to permit the adapter (and attached smart device) to assume a plurality of mounting orientations, such as shown in FIGS. **12(a)** and **12(b)**, as well as FIGS. **13(a)** and **13(b)** depicting another stand-alone medical device, i.e., an otoscope **1300** having a

handle portion **1306** downwardly extending from an instrument head **1310** having respective distal and proximal ends **1311**, **1313**. As in the preceding, the otoscope **1300** can be similarly configured with the same or similarly configured adapter **1320** that permits the further attachment of a smart device that, upon attachment, can be oriented in various orientations based on a pivotal connection between the medical device and the adapter. As in the preceding, the adapter **1320** is a planar section having a distal facing surface **1326**, a proximal facing surface **1328** and a distal engagement portion (not shown) that is sized to overlay the proximal eyepiece end of the instrument head **1310**.

[0123] With reference to FIGS. **14(a)**-**15(c)**, an adapter **1500** in accordance with another embodiment is herein described. The adapter **1500** is preferably fabricated from a lightweight structural material, such as a moldable plastic, having a supporting member or body **1504** that includes a forward or front facing side **1507** and a rear facing side **1509**, respectively. The adapter **1500** is further configured with a device connection portion **1512** extending from the front facing side **1507** that is configured for attaching the adapter **1500** to a medical examination device. The adapter **1500** is further configured such that a smart device **1550** can be releasably or otherwise attached to the rear facing side **1509** of the supporting member **1504**. A center portion **1520** located on the rear facing side **1509** is sized for accommodating an interface plate (not shown) that is attached to the smart device **1550** (e.g., a smart phone). The interface plate can be properly located and positioned on the smart device **1550** by means of a fixture such as shown in FIGS. **2(a)**-**2(f)** or a similar technique for purposes of aligning the camera of the smart device **1550** with the optical system of the medical examination device, as further discussed herein. A set of magnets **1511** provided in the center portion **1520** releasably secures the smart device **1550** in position on the adapter **1500**.

[0124] According to this embodiment, the device connection portion **1512** is defined by an outer surface **1515** which is parallel to the front facing surface **1507** with a shaped recess **1530** formed between the surfaces **1507**, **1515** that is configured for releasable engagement with a proximal receiving portion **1564**, FIG. **15(c)**, of a medical examination device **1560**, FIG. **15(c)**. A portion of the outer surface **1515** is cutout as shown by **1517**, the cutout portion **1517** being aligned with a through opening **1519** formed in the supporting member **1504**. One end of a release lever **1524** is disposed in relation to the device attachment portion **1512**, wherein the opposite end of the lever **1524** is accessed by a user to move the lever **1524** between undepressed and depressed positions as shown in FIGS. **14(a)** and **14(c)**, respectively. The end of the release lever **1524** disposed in relation to the device connection portion **1512** is engaged by a spring-loaded pin **1540**, partially shown, that is movable into and out of the shaped recess **1530** of the device connection portion **1512**. A stop **1544** disposed on the front facing side **1507** of the adapter **1500** provides a limit for movement of the release lever **1524** for the depressed position.

[0125] The design of the adapter **1500** enables a plurality of smart devices, such as smart phones, each being different in terms of overall footprint to be releasably attached in a specific orientation. As noted and for locating the smart phone according to this version, an interface plate such as previously described above is placed specifically on the

front facing side of the smart device **1550** before releasably securing the smart device **1550** to the rear facing side **1509** of the adapter **1500**. When attached in this manner, the camera aperture **1554** of the smart device **1550** is aligned with the through opening **1519** of the adapter **1550**.

[0126] Referring to FIGS. **15(a)**-**15(c)**, the adapter **1500** is shown as attached to a medical examination device **1560** that includes an instrument head or housing **1568** having a proximal receiving portion **1564**. The proximal receiving portion **1564** according to this embodiment is a substantially cylindrical portion that extends rearwardly from the proximal end of the instrument head **1568**. The receiving portion **1564** further includes a channel **1572**, the latter preferably having a plurality of flats (not shown in this view, but shown as **1430** in a similar medical device shown in FIG. **22(b)**). The formed recess **1530** is aligned so that the adapter **1500** can be slid over the proximal receiving portion **1564** (in a direction into and out of the plane of the drawing). When engaged, the upper surface **1515** engages the channel **1572** and the formed recess **1530** is engaged by an outer ringed portion **1575** of the proximal receiving portion **1564**. When engaged, the through opening **1519** of the adapter **1500** is aligned with the optical axis of the medical examination device, including a set of eyepiece lenses **1580**, **1582** disposed in the interior of the proximal receiving portion **1564**. According to this embodiment, the adapter **1500** can assume one of a plurality of mounting orientations by placing the device connection portion **1512** of the adapter **1500** and more specifically the shaped recess **1530** relative to the proximal end of the medical device **1560**.

[0127] In operation and when the adapter **1500** is not attached, the medical device **1560** can be used in an optical viewing mode to view the target of interest through the proximal end, which includes a brow rest **1590**. The medical device **1560** can be alternatively used in an electronic imaging mode when the adapter **1500** is attached in which the aperture **1554** of the attached smart device **1550** is aligned with regard to the convergence point of the optics of the medical device **1560** such that the smart device **1550** receives a focused image of the medical target of interest. According to this embodiment, the adapter **1500** enables the attachment of one of a plurality of disparate smart devices and in which the attached smart device **1550** is fully aligned with the optical system of the medical device **1560**. Each of the above operating modes can be realized without modification to the medical device **1560** by the inclusion or removal of the adapter **1500**. That is, no additional optical module is required.

[0128] In addition to being configured to receive one of a plurality of different smart devices, the herein described adapter **1500** can be used with a plurality of disparate medical diagnostic instruments, each having a proximal end and receiving portion as described for purposes of attachment. These instruments can include, but are not limited to a ophthalmoscope, an otoscope, a colposcope, a dermatoscope, a rhinoscope, an anoscope or other hand-held medical examination device. For example and in a wellness examination, the adapter **1500** (and attached smart device **1550**) can be interchangeably used with an otoscope and an ophthalmoscope for viewing the ears and the eyes, respectively, using the display of the connected smart device **1550**. It will be understood, however, that the connective features

of this embodiment is an example wherein other suitable configurations are possible for enabling the above-described functions.

[0129] With reference to FIGS. 16-19, a number of optical configurations are depicted based on the various operating modes of the herein described examination system and as typified by the preceding structural embodiments. For purposes of this discussion, these schematic diagrams pertain to otoscopes and ophthalmoscopes in keeping with the embodiments previously discussed. It should be understood that other versions could be contemplated.

[0130] In certain ophthalmoscopes, optical adjustments can be accomplished in the removable eyepiece of the instrument. For purposes of interchangeability and additional operating modes for the herein described examination system and when a smart device was used in the combination with the ophthalmoscope during tests, it was determined that the device needed a focus range of about ± 10 diopters to accommodate all patients, while the imaging system of known smart devices typically only had a focus range of about ± 3 diopters. Based on the foregoing, it was concluded that there is a need to move the focus adjustment to the patient end (distal) of the instrument to permit focusing in both operational modes of the system; that is either with or without a smart device being attached.

[0131] FIGS. 16 and 17 herein present schematic views of the optical system of the ophthalmoscope 1200 that is configured to provide focusable adjustment of an optical element (objective lens) retained within the instrument head (not shown). First and with reference to FIG. 16, a focusable objective lens 1230 is disposed within the instrument head distally of a beam splitter 1234 and a set of focusing or imaging lenses 1238, each commonly aligned along a defined optical axis 1244. An image sensor 1248 of a smart device attached to the proximal end of the medical device 1200 is also aligned with above optical elements. The beam splitter 1234 is configured to receive illumination from an off-axis light source 1260 such as an LED or an incandescent bulb, the light emitted by this source 1260 being directed to the eye 1280 of a patient (shown schematically) while further permitting reflected light from the patient's eye 1280 to be transmitted and focused at the camera sensor 1248 by the focusing lenses 1238.

[0132] By optionally making the objective lens 1230 axially movable according to this embodiment, an increased focus range can be achieved. In this configuration, the autofocus function of the attached smart device should be disabled. The optical system of the instrument 1200 and more specifically the contained objective lens 1230 can be optionally adjustable according to one version using a focusing mechanism, such as a focusing knob (not shown) provided on the instrument head. Details relating to one example of a focusing mechanism for use in a medical examination device is more completely described in U.S. Pat. No. 7,399,275, previously incorporated by reference. The focusable objective lens can according to one embodiment be adjusted ± 20 diopters, or minimally ± 10 diopters.

[0133] In lieu of the smart device, an optical layout is presented in FIG. 17 that again includes the objective lens 1230, the beam splitter 1234 and the focusing or imaging lenses 1238 each commonly disposed along the defined optical axis 1244 of the device 1200 extending through the distal and proximal ends of the instrument head along with

the aligned optical train of an attached eyepiece, such as shown. In this version, the optical train of the attached eyepiece includes a plurality of fixed eyepiece lenses 1288 and a distal aperture stop 1292, each also aligned along the defined optical axis 1244 for viewing by the eye 1296 of the doctor. As in the previous example, the objective lens 1230 contained within the instrument head is axially movable to increase the focusing range of the device 1200.

[0134] Similar arrangements can be provided in another medical examination or diagnostic device. Referring to FIGS. 18 and 19, imaging and optical (eyepiece) modes are shown schematically for an otoscope 1300 that is defined by a distal lens 1332 disposed in relation to the speculum tip element shown partially as 1336, the latter being releasably attached to the distal end of the instrument head. The distal lens 1332 according to this embodiment is covered by a plano window 1338 wherein a field stop 1342 is provided in relation to a focusable objective lens 1346, which in this version is a doublet defined by a first lens 1347 and a second lens 1348. The first distalmost lens 1347 is defined by a distal plano surface and an opposing concave surface. The second adjacent lens 1348 of this doublet is defined by a distal concave surface and an opposing plano surface. Each of the above optical elements are commonly aligned along a defined optical or imaging axis 1350 extending through the distal and proximal ends with the instrument having an attached speculum tip element 1336, also shown schematically according to these examples. In the version shown in FIG. 18, the system includes an optically aligned smart device, shown diagrammatically as 1354, the device including a camera aperture as well as an image sensor disposed and aligned along the defined optical axis 1350, such as through use of an interface plate and adapter as described with regard to FIGS. 12(a)-15(c).

[0135] As shown in FIG. 19, the otoscope 1300 alternatively receives the attached eyepiece, which includes a set of fixed eyepiece optics 1364 and an aperture stop 1368 that is aligned with the eye of the doctor or caregiver along the defined optical or imaging axis of the assembly. In each depicted version, the focusable objective lens 1346 is disposed adjacent the proximal end of the instrument head (not shown) and aligned with the camera lens and the image sensor of the attached smart device or the eyepiece. A focusing mechanism can also be provided, such as described, by way of example, in previously incorporated U.S. Pat. No. 7,399,275. In terms of operation, an image of the tympanic membrane, shown schematically as 1312, is transmitted through a plano window at the distal end of the conical insertion portion and through an adjacent distal lens through a field stop and then to the focusable objective lens 1346, which condenses the image taken through either the attached eyepiece to the doctor's eye 1362 or smart device. It should be noted that the optical systems described are merely exemplary and other optical systems can be similarly aligned, for example, with an adapter such as 1500 to permit separate operating modes.

[0136] With additional reference to FIGS. 16 and 17, FIG. 20 illustrates an optical layout of the corresponding off-axis illumination system. Light from the contained light source 1260, such as an LED or an incandescent bulb is directed through a condenser lens 1264 along a defined illumination axis 1268 and reflected from the angled surface of the beamsplitter 1234. This light is then further directed through the objective lens 1230 and is focused at the eye of the

patient **1280**. According to this version, a series of fixation lights **1270** are provided at the distal end of the instrument head. The number of fixation lights used can be varied. According to one example, at least two fixation lights can be provided that are diametrically opposed about the distal aperture of the instrument **1200** that are separately operated from the contained illumination source **1260**. In terms of operation, the caregiver would move the device toward the eye of the patient and activate one of the fixation lights **1270**. The patent would be requested to concentrate his or her vision on the fixation light **1270**. By including multiple fixation lights, different portions of the retina can be examined by requesting the patient focus on the fixation lights in sequence and obtain measurements. In one example, a ringlet of several fixation lights could be disposed in which the images obtained using a smart device or other can be stitched and effectively cover a larger portion of the retina (15-30 degrees or more, enabling the determination of diabetic retinopathy. In another version, various other eye-related diagnoses can be obtained such as, but not limited to hypertension (artery-to-vein ratio), macular degeneration, glaucoma, diabetes, and those relating to retinal detachments.

[0137] With reference to FIG. 21, each of the herein described instruments can be provided for access to a user in kit form, by defining a mounting unit **1800** that includes a plurality of slots **1808** formed in a support surface **1804** for accommodating various stand-alone medical diagnostic or examination devices **1814**, as well as interchangeably mounted smart devices, adapters and eyepieces. Each of the various embodiments that are depicted can be provided for mounting to either a wall or similar structure (not shown) or can be mounted to other fixturing such as a movable cart in which the mounting can be permanent to releasable depending on the application. The mounting unit according to at least one version can include a supporting frame that is filled with a soft compliant material. The number of shaped slots formed in the filled compliant material can be sized to receive, for example a pair of medical diagnostic or examination devices and accessories such as eyepieces and the like. The medical devices **1814** can be stored by positioning the distal end of the medical devices within the shaped slots **1808** with a portion of the devices **1814** being directly inserted into the slots **1808** and remaining portion being accessible, as needed, for removal by a user. The mounting units **1800** can be appropriately shaped with either the mounting surface **1804** or the supporting surfaces of the units **1800** being angled to provide additional versatility. In the depicted version, the mounting unit **1800** is configured to accommodate various forms of stand-alone medical devices, including versions previously discussed with reference to FIGS. 5(a)-6(d). It will be readily apparent to the person of sufficient skill in the field that other modifications and variations are possible, including versions in which the batteries of each of the retained instruments can be charged.

[0138] FIGS. 22(a) and 22(b) herein depict another medical examination device made in accordance with aspects of the present invention and more specifically an ophthalmoscope **1400**. More specifically, the ophthalmoscope **1400** is defined by a handle portion **1406** (partially shown) and an instrument head **1410** that is releasably connected to a necked upper portion **1409** of the handle portion **1406**. A light source **1415** forming a portion of an illumination system is powered by batteries (not shown) that are con-

tained in the handle portion **1406**. Optics are contained and aligned along respective optical and illumination axes within the interior of the instrument head **1410**. The illumination axis extends upwardly from the contained light source **1415** through a number of optical elements **1417** including a rotatable aperture wheel **1420** formed in a lower portion of the instrument head **1410** in which light is directed to a distal end **1412** of the instrument head **1410** for directing to the eye of a patient (not shown). The optical system includes a series of optical elements **1419** that are aligned along an optical axis extending through the distal end **1412** and a proximal end **1416** of the instrument head **1410**. A rotatable diopter wheel **1424** is also disposed along the defined optical axis near the proximal end **1416** of the device **1400**. Additional details relating to an optical and illumination system useful with this design can be found in U.S. Patent Application Publication No. 2016/0073875A1 and U.S. Patent Application Publication No. 2015/0103317A1, the entire contents of which are herein incorporated by reference.

[0139] The proximal end **1416** of the herein described instrument **1400** can include an interface that permits the attachment of an adapter, such as previously described with regard to FIGS. 14(a)-15(c). More specifically, the proximal end **1416** of the instrument **1400** is defined by an outer lipped portion **1426**, as well as a channel **1430** disposed between the lipped portion **1426** and a rear wall **1431** of the instrument head **1410**. An adapter **1500**, FIGS. 14(a)-14(c), as previously discussed, is defined by a supporting member having respective front and rear facing surfaces. The rear facing surface of the adapter **1500** includes a recessed area that is positioned to receive at least one interface plate of an attached smart device in a releasable fashion. As in the prior described embodiment, the adapter **1500** is further defined by an open-ended engagement portion that is sized and configured to engage the proximal end **1416** of the instrument **1400** with the lipped portion **1426** of the proximal end **1416** fitting within a formed channel of the open-ended device engagement portion and the channel **1430** of the proximal end fitting engaging a shoulder of the engagement portion. According to this embodiment, the channel **1430** is defined by four substantially flat sides to enable the adapter **1500** to be fitted in a plurality of mounting orientations. Alternatively, the channel can be defined by a cylindrical or other shaped surface. According to one version, detents can be provided to enable rotation of the attached smart device to a plurality of mounting orientations while still maintaining the optical alignment between the camera of the attached smart device and the optical system of the instrument **1400**. Other suitable configurations such as flats in the channel can be contemplated for providing similar capabilities.

PARTS LIST FOR FIGS. 1-22(B)

- [0140] 10 stand-alone medical diagnostic or examination device (ophthalmoscope)
- [0141] 14 instrument housing
- [0142] 16 distal end
- [0143] 18 proximal end
- [0144] 20 frame or supporting structure
- [0145] 24 parallel channels or slots
- [0146] 32 smart device
- [0147] 100 alignment fixture
- [0148] 100A alignment fixture
- [0149] 104 interface plate
- [0150] 105 hole, interface plate

[0151]	106 upper side, interface plate	[0215]	509 magnetic interface
[0152]	107 slot, interface plate	[0216]	510 instrument head
[0153]	108 raised platform	[0217]	511 magnet
[0154]	109A planar support surface	[0218]	600 medical diagnostic or examination device
[0155]	110A slot	[0219]	603 distal end, device
[0156]	111A pinhole	[0220]	604 body or housing
[0157]	112 upper or top surface	[0221]	605 back or proximal surface, device
[0158]	116 legs	[0222]	608 handle
[0159]	117 support flange	[0223]	609 magnetic interface
[0160]	118 optical target	[0224]	610 instrument head
[0161]	118A optical target	[0225]	611 magnet
[0162]	120 elongate slot	[0226]	700 otoscope
[0163]	130A x-axis adjustment assembly	[0227]	704 handle portion
[0164]	134A y-axis adjustment assembly	[0228]	706 upper necked portion
[0165]	137A screw adjustment member	[0229]	708 instrument head
[0166]	138A spring-loaded adjustment or support block	[0230]	710 eyepiece
[0167]	139A spring-loaded adjustment or support block	[0231]	711 distal end
[0168]	140 smart device	[0232]	712 conical insertion portion
[0169]	140A smart device	[0233]	713 slotted portion or slot
[0170]	141A screw adjustment member	[0234]	720 adapter
[0171]	143A beam-like member	[0235]	724 distal engaging portion
[0172]	144 display	[0236]	727 gusset
[0173]	144A display	[0237]	728 proximal supporting portion
[0174]	145A beam-like member	[0238]	732 resilient fingers
[0175]	146 camera, smart device	[0239]	736 recessed slot
[0176]	148 target	[0240]	738 interface plate
[0177]	148A target	[0241]	740 through opening
[0178]	149A image of optical target	[0242]	750 smart device
[0179]	160 otoscope	[0243]	754 display
[0180]	164 housing	[0244]	758 connector or connector portion
[0181]	169 rear or proximal opening	[0245]	800 ophthalmoscope
[0182]	176 rear or proximal facing surface	[0246]	804 handle portion
[0183]	180 spaced magnets	[0247]	806 necked portion
[0184]	198 calibration target	[0248]	808 instrument head
[0185]	200 stand-alone medical examination device	[0249]	810 eyepiece
[0186]	204 first interface plate	[0250]	813 slot or slotted portion
[0187]	207 rear facing side, medical device	[0251]	920 adapter
[0188]	208 second interface plate	[0252]	924 distal engaging portion
[0189]	214 magnet	[0253]	928 proximal supporting portion
[0190]	216 facing surface	[0254]	929 open end
[0191]	217 magnet	[0255]	930 guide rails
[0192]	220 smart device	[0256]	932 resilient fingers
[0193]	223 front facing surface	[0257]	958 connector or connector portion
[0194]	300 medical diagnostic or examination device	[0258]	1000 otoscope
[0195]	303 distal end, device	[0259]	23063301.1
[0196]	305 back or proximal surface	[0260]	1004 housing
[0197]	309 magnetic interface	[0261]	1008 handle
[0198]	311 magnet	[0262]	1010 instrument head
[0199]	320 eyepiece	[0263]	1012 distal end
[0200]	324 housing, eyepiece	[0264]	1014 speculum tip element
[0201]	326 proximal end, eyepiece	[0265]	1015 actuator knob
[0202]	328 focusing knob, eyepiece	[0266]	1020 adapter
[0203]	360 smart device	[0267]	1022 planar section, adapter
[0204]	364 display, smart device	[0268]	1024 eyepiece
[0205]	400 medical diagnostic or examination device	[0269]	1026 proximal facing or face surface
[0206]	403 distal end, device	[0270]	1027 housing, eyepiece
[0207]	405 back or proximal surface, device	[0271]	1029 distal facing surface, eyepiece
[0208]	409 magnetic interface	[0272]	1036 slot, receiving
[0209]	412 magnet	[0273]	1050 smart device
[0210]	500 medical diagnostic or examination device	[0274]	1054 display
[0211]	503 distal end, device	[0275]	1100 ophthalmoscope
[0212]	504 body or housing	[0276]	1104 housing
[0213]	505 back or proximal surface, device	[0277]	1108 handle portion
[0214]	508 handle	[0278]	1110 instrument head

[0279] 1112 distal end
 [0280] 1116 elastomeric eye cup
 [0281] 1120 adapter
 [0282] 1122 planar section
 [0283] 1124 eyepiece
 [0284] 1126 rear facing surface, adapter
 [0285] 1136 rear slot
 [0286] 1200 ophthalmoscope
 [0287] 1206 handle portion
 [0288] 1210 instrument head
 [0289] 1211 distal end
 [0290] 23063301.1
 [0291] 1213 proximal end
 [0292] 1220 adapter
 [0293] 1226 distal facing or face surface, adapter
 [0294] 1228 proximal facing surface, adapter
 [0295] 1230 objective lens
 [0296] 1234 beam splitter
 [0297] 1238 focusing/imaging lenses
 [0298] 1244 optical axis
 [0299] 1248 image sensor
 [0300] 1260 light source
 [0301] 1264 condenser lens
 [0302] 1268 illumination axis
 [0303] 1270 fixation lights
 [0304] 1280 eye, patient
 [0305] 1284 image sensor
 [0306] 1284 eyepiece
 [0307] 1288 fixed lenses
 [0308] 1292 aperture stop
 [0309] 1296 doctor's eye
 [0310] 1300 otoscope
 [0311] 1306 handle portion
 [0312] 1310 instrument head
 [0313] 1311 distal end
 [0314] 1313 proximal end
 [0315] 1320 adapter
 [0316] 1326 distal facing surface
 [0317] 1328 proximal facing surface
 [0318] 1332 distal lens
 [0319] 1336 speculum
 [0320] 1338 plano window
 [0321] 23063301.1
 [0322] 1342 field stop
 [0323] 1346 focusable objective lens
 [0324] 1348 second lens
 [0325] 1350 optical axis
 [0326] 1354 smart device
 [0327] 1362 doctor's eye
 [0328] 1364 fixed eyepiece lenses
 [0329] 1368 aperture stop
 [0330] 1400 ophthalmoscope
 [0331] 1406 handle portion
 [0332] 1409 upper necked portion
 [0333] 1410 instrument head
 [0334] 1412 distal end
 [0335] 1415 light source
 [0336] 1416 proximal end
 [0337] 1417 optical elements
 [0338] 1419 optical elements
 [0339] 1420 aperture wheel
 [0340] 1424 diopter wheel
 [0341] 1426 lipped portion
 [0342] 1430 channel

[0343] 1431 rear wall, instrument head
 [0344] 1500 adapter
 [0345] 1504 supporting member or body
 [0346] 1507 forward or front facing side, adapter
 [0347] 1509 rear facing side, adapter
 [0348] 1511 magnets
 [0349] 1512 device connection portion
 [0350] 1515 outer surface
 [0351] 1517 cutout portion, outer surface
 [0352] 23063301.1
 [0353] 1519 through opening, supporting member
 [0354] 1520 center portion
 [0355] 1524 release lever
 [0356] 1530 shaped recess
 [0357] 1540 spring-loaded pin
 [0358] 1544 stop
 [0359] 1550 smart device
 [0360] 1554 aperture, camera
 [0361] 1560 medical examination device
 [0362] 1564 proximal receiving portion
 [0363] 1568 housing, device
 [0364] 1572 channel
 [0365] 1575 outer ringed portion
 [0366] 1580 eyepiece lens
 [0367] 1582 eyepiece lens
 [0368] 1590 browrest
 [0369] 1600 medical examination device
 [0370] 1604 proximal end
 [0371] 1608 shoulder, annular
 [0372] 1612 channel
 [0373] 1616 interior
 [0374] 1620 optical element
 [0375] 1624 seal
 [0376] 1628 opening, end
 [0377] 1700 medical examination device
 [0378] 1704 proximal end
 [0379] 1708 shoulder, annular
 [0380] 1712 channel
 [0381] 1716 interior
 [0382] 1720 optical element
 [0383] 1722 optical element
 [0384] 1726 opening, end
 [0385] 1800 mount
 [0386] 1804 support surface
 [0387] 1808 slots

[0388] The invention is inclusive of combinations of the aspects described herein. References to “a particular aspect” (or “embodiment” or “version”) and the like refer to features that are present in at least one aspect of the invention. Separate references to “an aspect” or “particular aspects” or the like do not necessarily refer to the same aspect or aspects; however, such aspects are not mutually exclusive, unless so indicated or as are readily apparent to one of skill in the art. The use of singular or plural in referring to “method” or “methods” and the like is not limiting. The word “or” is used in this disclosure in a non-exclusive sense, unless otherwise explicitly noted.

[0389] The invention has been described in detail with particular reference to certain preferred aspects thereof, but it will be understood that variations, combinations, and modifications can be effected by a person of ordinary skill in the art within the intended spirit and scope of the invention.

1. An adapter for interconnecting a smart device with a medical examination device, said adapter comprising:

- a distal connecting portion for enabling releasable attachment to a proximal end of the medical examination device;
 - a proximal connecting portion configured to support the smart device, the smart device having an integrated camera and a display; and
 - one or more interface plates secured to a front facing side of the smart device, wherein the proximal connecting portion is configured to engage the one or more attached interface plates such that the camera is aligned with an optical axis of the medical examination device upon attachment of the distal connecting portion to the proximal end of the medical examination device.
2. The adapter according to claim 1, in which the distal connecting portion includes an opening configured for alignment with the optical axis of the medical examination device when the adapter is attached to the medical examination device.
 3. The adapter according to claim 1, further comprising a lever configured for releasing the adapter from the medical examination device.
 4. The adapter according to claim 3, in which the distal connecting portion includes a spring-loaded pin that is movable into and out of a defined recess sized to engage the proximal end of the medical examination device, the lever being movable to a position enabling release of the adapter from the medical examination device.
 5. The adapter according to claim 1, in which the adapter is rotatably movable to a plurality of mounting orientations about the optical axis when the distal connecting portion is attached to the proximal end of the medical examination device.
 6. The adapter according to claim 1, in which the adapter is configured to position a camera aperture of the smart device at a convergence point of an optical system of the medical examination equivalent to that of a viewer's eye using an eyepiece of the medical examination device.
 7. The adapter according to claim 1, in which the adapter is configured for releasable attachment to one or more of a group of medical examination devices, the group including an otoscope, an ophthalmoscope, a dermatoscope, a rhinoscope and a colposcope.
 8. The adapter according to claim 1, wherein the one or more interface plates are made from a metal, wherein the adapter further comprises at least one magnet disposed on the proximal connecting portion for releasably securing the one or more interface plates.
 9. The adapter according to claim 1, wherein the adapter is configured to support a selected one of a plurality of smart devices and optically align the camera of the selected smart device with the optical axis of the medical examination device upon attachment.
 10. The adapter according to claim 1, wherein the distal connecting portion is configured for attachment to at least one of an otoscope and an ophthalmoscope.
 11. An adapter comprising:
 - a planar support surface configured to releasably retain a smart device, the smart device having an integrated camera and a display;
 - a device connecting portion distally extending from the planar support surface and having a formed opening,

- the device connecting portion being configured for releasable attachment to a proximal end of a medical examination device; and
 - one or more interface plates positioned on the smart device such that when the device connecting portion is attached to the proximal end of the medical examination device, the camera of the smart device is aligned with an optical axis of the medical examination device.
12. The adapter of claim 11, in which the device connecting portion is configured to enable a supported smart device to assume a plurality of rotatable mounting orientations about the optical axis of the medical examination device to which the adapter is attached.
 13. The adapter according to claim 11, including a lever for releasing the adapter from the medical examination device.
 14. The adapter according to claim 11, further comprising at least one magnet positioned on the planar support surface for engaging one or more of the interface plates.
 15. A method for configuring a smart device for a medical examination of a patient, the smart device comprising a housing having an integrated camera and display, the method comprising:
 - using an alignment device, positioning one or more interface plates on the smart device;
 - securing the smart device to a proximal connecting portion of an adapter; and
 - attaching a distal connecting portion of the adapter to a proximal end of the medical examination device, wherein the secured smart device is automatically aligned with an optical axis of the medical examination device.
 16. The method according to claim 15, further comprising:
 - positioning the smart device on a mounting surface of the alignment device;
 - aligning the camera of the smart device with an optical target on the alignment device in which the optical target is centered in the display of the smart device; and
 - attaching the one or more interface plates through one or more openings provided on the mounting surface of the alignment device.
 17. The method according to claim 15, further comprising rotating the adapter about the optical axis of the medical examination device to enable the secured smart phone to assume one of a plurality of orientations.
 18. The method according to claim 15, wherein the smart device is one of a plurality of disparately sized smart devices.
 19. The method according to claim 15, wherein the medical examination device is one or more of a group of medical examination devices including an otoscope, an ophthalmoscope, a dermatoscope, a colposcope, and a rhinoscope.
 20. The method according to claim 15, further comprising rotating the adapter relative to the medical examination device to enable the attached smart device to assume one of a plurality of rotational configurations.

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