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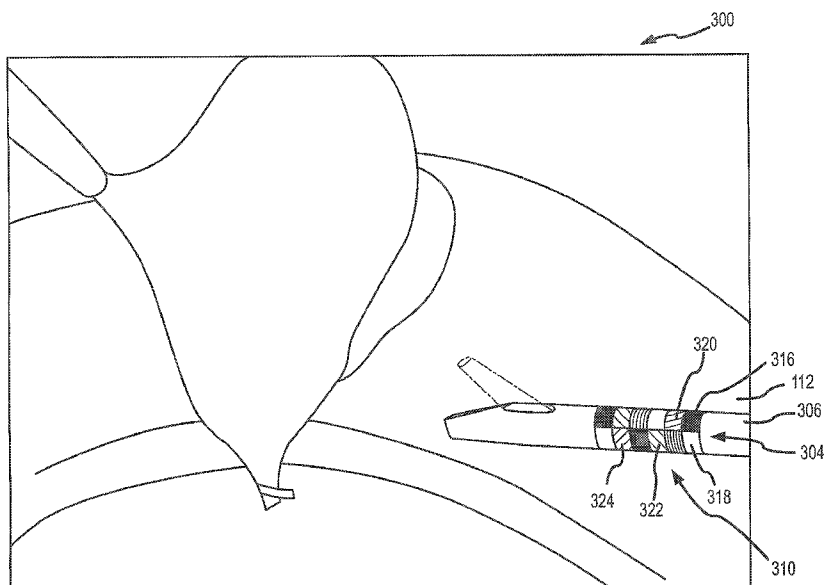
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(54) Title: METHOD AND APPARATUS FOR CALIBRATING AN ENDOSCOPE SYSTEM



(57) Abstract: An endoscope system and method includes an endoscope tip coupled to an endoscope console for providing images of anatomical features imaged using the endoscope system. The system also includes a calibration device having known optical properties. The calibration device is imaged using the endoscope system, and data corresponding to the image is obtained. This data are compared to data corresponding to the known optical properties of the calibration device. Based on this comparison, calibration data corresponding to imaging errors of the endoscope system are obtained. The calibration data are used to calibrate the endoscope system.

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## METHOD AND APPARATUS FOR CALIBRATING AN ENDOSCOPE SYSTEM

### TECHNICAL FIELD

[001] This invention relates to endoscope systems, and, more particularly, to insuring that endoscope images accurately show anatomical features imaged with endoscope systems.

### BACKGROUND

[002] Endoscope systems have been in general use for many years for non-invasively viewing anatomical features such as tissues and organs inside the human body. Endoscope systems typically include an endoscope tip having a flexible or rigid insertion tube having a headpiece mounted at its proximal end and a viewing window at its distal end. The headpiece of an endoscope tip having a flexible insertion tube normally includes controls, such as wheels or levers, connected to the distal end of the insertion tube by control wires to steer the end of the insertion tube in different directions. By manipulating the controls, an endoscopist can direct the viewing window at the distal end of the insertion tube over a wide range of directions to view tissues and organs located adjacent the distal end of the endoscope tip. The insertion tube also normally includes an illumination device for directing light into the body in the vicinity of the distal end of the insertion tube. The illumination device is typically an optical fiber extending from a light source at the proximal end of the insertion tube to an illumination window at the distal end of the insertion tube. However, the illumination may also be a light source mounted at the distal end of the insertion tube and powered with electricity coupled through wires extending through the insertion tube. Endoscope tips also include a viewing device to allow the endoscopist to view anatomical features, such as tissues and organs, through the viewing window.

[003] Endoscope systems may be used to simply view anatomical features, or they may be used to non-invasively conduct various diagnostic or surgical procedures within the body. Endoscope tips used for this purpose often include a biopsy channel extending through the insertion tube from an access port at the proximal end of the insertion tube to an opening at the distal end of the insertion tube. Biopsy and surgical instruments attached to the distal end of catheters may be fed through the biopsy channel

of the endoscope tip and out the biopsy channel opening to position the instruments adjacent the viewing window of the endoscope tip. A biopsy or surgical procedure can then be performed by such techniques as manipulating the endoscope tip controls, advancing or retracting the endoscope tip within the body, advancing or retracting the catheter within the biopsy channel, or manipulating an actuator that is mechanically coupled to the biopsy or surgical instrument. Endoscope tips that do not have biopsy channels can also be used to perform biopsy or surgical procedures. In such cases, one or more biopsy or surgical instruments are introduced into the body by suitable means, such as by using a laparoscopic catheter. The biopsy or surgical instruments are then positioned within the field of view of the endoscope tip viewing window.

[004] To improve performance, specialized endoscope tips have been developed to best accomplish their intended function. For example, upper endoscope tips are used for examination of the esophagus, stomach and duodenum, colonoscopes are used for examining the colon, angioscopes are used for examining blood vessels, bronchoscopes are used for examining the bronchi, laparoscopes are used for examining the peritoneal cavity, and arthroscopes are used for examining joint spaces. Instruments to examine the rectum and sigmoid colon, known as flexible sigmoidoscopes, have also been developed. The discussion of endoscope tips herein generally applies to these and other types of endoscope tips, and the term "endoscope tip" as used herein is meant to encompass all these and other such devices.

[005] As mentioned above, endoscope tips include some form of viewing device for allowing anatomical features to be viewed through viewing windows. One type of viewing device uses a fiber-optic bundle extending from the viewing window at the distal end of the insertion tube to a viewing window on the headpiece. The fiber-optic bundle optically couples images throughout the length of the insertion tube. Another type of viewing device uses a miniature video camera positioned behind the viewing window at the distal end of the insertion tube. Wires extending from the video camera through the insertion tube couple power to the camera and video signals from the camera. Still another type of viewing devices uses a beam scanning device positioned behind the viewing window. Such scanned beam endoscope tips are a fairly recent innovation.

[006] Regardless of which type of viewing device is used by an endoscope system, the image obtained by using the endoscope system may not accurately show the size, shape, color or other property of the anatomical features being viewed with the endoscope system. For example, it may be difficult to accurately assess the size of an

internal object, such as a tumor, using any of the above-mentioned endoscope types. It may also be difficult to accurately show the true color of tissues or organs. For endoscope tips using optical fibers to view an image, the brightness of the image may be affected by light attenuation in the optical fiber. The color of the image obtained using an endoscope system may be affected, for example, by the spectral properties of the illuminating light or the spectral transfer properties of the optical fiber or video camera. Endoscope tips using cameras and beam scanners suffer from additional problems not encountered in endoscope tips using an fiber-optic bundle, such as the true contrast or sharpness of an endoscopically obtained image. And even endoscope tips using a fiber-optic bundle will suffer from these limitations if images obtained using the endoscope system are converted to digital form.

[007] There is therefore a need for an image calibration apparatus and method that allows an endoscope system to be calibrated so that it can accurately portray anatomical features.

#### SUMMARY

[008] A endoscope method and system allows an endoscope system to obtain images that accurately portray anatomical features being imaged by the endoscope system. The endoscope system includes an endoscope tip that is positioned so that the internal anatomical features are within a field of view of the endoscope tip, and an image of the internal anatomical features are obtained. Either before or after the image of the internal anatomical features are obtained, a calibrating device having at least one known optical property is placed in the field of view of the endoscope tip, and an image of the calibrating device is obtained using the endoscope system. Calibration device data corresponding to the at least one known optical property of the calibration device is used with the image of the calibration device to provide calibration data. The calibration data is used to program the endoscope system and method to ensure that the endoscopically obtained image accurately portrays the imaged internal anatomical features.

#### BRIEF DESCRIPTION OF THE DRAWINGS

[009] Figure 1 is schematic isometric view of an endoscope system that can be used with a calibration device according to one example of the invention.

- [010] Figure 2 is schematic cross-sectional view of the distal end of one type of an endoscope insertion tube that can be used with a calibration device according to an example of the invention.
- [011] Figure 3 is schematic cross-sectional view of the distal end of another type of an endoscope insertion tube that can be used with a calibration device according to an example of the invention.
- [012] Figure 4 is schematic cross-sectional view of the distal end of still another type of an endoscope insertion tube that can be used with a calibration device according to an example of the invention.
- [013] Figure 5 is an isometric view showing a calibration device according to one example of the invention in use with an endoscope system.
- [014] Figure 6 is a flowchart showing one method for using a calibration device according to one example of the invention.
- [015] Figure 7 is an isometric view showing a calibration device according to another example of the invention.
- [016] Figure 8 is an isometric view showing a calibration device according to still another example of the invention that can be inserted into the biopsy channel of an endoscope tip.

#### DETAILED DESCRIPTION OF THE EMBODIMENTS

- [017] An endoscope system 10 that can be used with calibration devices according to various examples of the invention is shown in Figure 1. The endoscope system 10 includes an endoscope tip 100 having a flexible insertion tube 102 extending from a headpiece 108. As is well known in the art, the insertion tube 102 includes a viewing device for conveying an image from a distal end 104 to a proximal end 106 of the insertion tube 102, which is attached to the headpiece 108. A number of different viewing devices can be used. For example, the distal end 104 of the insertion tube 102 may contain a lens positioned behind a viewing window 110 that is optically coupled to the headpiece 108 through a fiber-optic bundle (not shown in Figure 1). The fiber-optic bundle can extend to an eyepiece (not shown in Figure 1) projecting from the headpiece 108 that can be fitted with an optical-electrical converter (not shown) to transform the optical image into corresponding electrical signals. However, in the endoscope system 10 shown in Figure 1, the viewing device is an imager 116, such as a miniature video

camera, a scanned beam imager, or other imaging device, mounted at the distal end 104 of the insertion tube 102. The imager 116 is electrically coupled to a console 120 by electrical wires 124 extending from the imager 116 to the headpiece 108 through the insertion tube 102 and then to the console 120. The console 120 includes a viewing monitor 126 on which an endoscopic image may be viewed, and controls 128 for adjusting the image shown in the monitor 126.

**[018]** Regardless of which viewing device is used, the endoscope insertion tube 102 may also include an illumination device (not shown in Figure 1) for illuminating anatomical features to be viewed with the endoscope system 10. These structures can take the form of, for example, a light source mounted at the distal end 104 of the insertion tube 102, with the light source being powered through wires extending from the headpiece 108 through the insertion tube 102. Alternatively, a fiber-optic bundle can be connected to a light source (not shown) and coupled to the headpiece 108 via a fiber-optic bundle (not shown). This illuminating fiber-optic bundle is coupled to another fiber-optic bundle (not shown) that extends through the insertion tube 102 to its distal end 104. In either case, light may be directed from the distal end 104 of the insertion tube 102 to the anatomical features that are to be imaged. The spectral properties of the light from the light source may affect the accuracy of which the colors in an endoscopic image are portrayed.

**[019]** If the endoscope tip 100 has a flexible insertion tube, such as the endoscope tip 100 shown in Figure 1, the insertion tube 102 may also contain control cables (not shown) symmetrically positioned within the insertion tube 102. As explained above, such control cables move the distal end 104 of the insertion tube 102 in two orthogonal axes to steer the endoscope tip's field of view. The control cables are anchored near the distal end 104 of the insertion tube 102, and they extend along the length of the insertion tube 102 to knobs 130. In use, the knobs 130 are rotated to retract and extend oppositely positioned control cables.

**[020]** Although not required for imaging anatomical features, the endoscope tip 100 may also include auxiliary tubes or channels extending from the headpieces 108 to the distal end 104 of the insertion tube 102 for performing a variety of functions. One of these tubes is a wash channel (not shown) by which pressurized water can be injected through a nozzle (not shown) at the distal end 104 of the insertion tube 102 to clean the lens 108. Another channel (not shown) is used to instill air or CO<sub>2</sub> gas to distend the hollow organ and permit visual inspection. These channels are selectively opened by actuating respective trumpet valves 134 projecting from the headpiece 108. Regardless of

whether or not an endoscope tip has these channels, it can be used with various calibration devices in accordance with the invention to ensure that an endoscopic image accurately portrays imaged anatomical features.

[021] The endoscope tip 100 may also include a biopsy channel (not shown in Figure 1) extending from an access port 140 to an opening 144 at the distal end 104 of the insertion tube 102. The biopsy channel is normally used to pass various biopsy and other devices (not shown in Figure 1), both diagnostic and therapeutic, to the distal end 104 of the insertion tube 102 to perform specific functions. As explained in greater detail below, the biopsy channel can be used to pass to calibration devices according to various examples of the invention to the field of view of the endoscope tip 100 in order to calibrate the endoscope system 10.

[022] As mentioned above, a variety of endoscope tips may be used with the image calibration system and method according to various examples of the invention. One such endoscope tip 150 shown in Figure 2 couples an image through an optical fiber 160 extending from a distal end 164 of an insertion tube 166. The optical fiber 160 extends to an optical-electrical converter (not shown in Figure 2), which may be mounted in the headpiece 108 (Figure 1). The optical-electrical converter transforms the optical image into corresponding electrical signals, which are coupled to the console 120 through the wires 124.

[023] The endoscope tip 150 also includes a second fiber-optic bundle 168 through which light is coupled to illuminate the field of view of the endoscope tip 150. A biopsy channel 170 also extends through the insertion tube 166 to an opening 174 at the distal end 164 of the insertion tube 166. As explained in greater detail below, a calibration device (not shown in Figure 2) is attached to the distal end of a catheter (not shown in Figure 2) to position the calibration device adjacent the fiber-optic bundle 160 so it can be viewed through the endoscope tip 150.

[024] A portion of another endoscope tip 180 that can be used with the image calibration system and method according to various examples of the invention is shown in Figure 3. The endoscope tip 180 includes a miniature video camera 184 of conventional design mounted in a distal end 186 of an insertion tube 190 behind a viewing window 194. Wires 196 extend from the video camera 184 through the insertion tube 190 to the headpiece 108 (Figure 1) and to the console 120, as described above. The endoscope tip 180 also includes a fiber-optic bundle 198 that couples illumination light to the field of view of the endoscope tip 180. Unlike the endoscope tip 150 shown in Figure 2, the

endoscope tip 180 does not include a biopsy channel through which calibration devices may be passed. Therefore, as explained further below, the calibration devices are introduced into the field of view of the endoscope tip 180 through either the same body orifice or incision through which the endoscope tip 180 is inserted or through a different orifice or incision.

[025] Still another example of an endoscope tip 200 that can be used with an image calibration system and method according to various examples of the invention is shown in Figure 4. The endoscope tip 200 includes an insertion tube 202 having a distal end 206 containing a scanning module 210. The scanning module 210 includes a micro-electro-mechanical (MEMS) scanner 214 and associated components, and an illumination optical fiber 218 mounted in the insertion tube 202 by a ferrule 220. The endoscope tip 200 also includes a beam shaping optical element 224 and a transparent dome 228 affixed to the distal end 206 of the insertion tube 202, which may be hermetically sealed to protect the scanning module 210.

[026] In operation with the calibration system and method, the distal end 206 of the insertion tube 202 is inserted into a body cavity. The illumination optical fiber 218 transmits a beam 230 to the scanning module 210 and is shaped by the beam shaping optical element 224 to form a selected beam shape. After shaping, a shaped beam 234 is transmitted through an aperture in the center of the MEMS scanner 214, reflected off a first reflecting surface 238 of the interior of the dome 228 to the front of the scanner 214, and then reflected off of the scanner 214 and through the dome 228 to provide a scanning beam 240. The scanning beam 240 is scanned across a field-of-view (FOV) and reflected off of the interior of a body cavity. At least a portion of the reflected light from the FOV (*e.g.*, specular reflected light and diffuse reflected light also referred to as scattered light) is collected by the detection optical fibers 218. The reflected light collected by the detection optical fibers 218 may be converted to an electrical signal by an optical-electrical converter 260, which may be a set of photodiodes. The converter 260 outputs a signal that is converted to image data by circuitry in the console 120 (Figure 1). The image data is used to generate an image that may be viewed on the monitor 126 of the console 120.

[027] According to one example of the invention, the endoscope tip 200 may be calibrated in the same manner as the endoscope tip 180 of Figure 3 by placing a calibration device (not shown) having at least one known optical property in the field of view of the endoscope tip 200. Electronic circuitry in the console 120 uses the image of



the calibration device to obtain calibration data. This calibration data that is used to ensure that images of anatomical features obtained using the endoscope tip 200 accurately portray the anatomical features.

[028] A calibration device 300 according to one example of the invention is shown in Figure 5. The calibration device 300 is in the form of a label 304 attached to a laparoscopic instrument 306, although it may alternatively be attached to other devices that are inserted either through a biopsy channel of an endoscope tip, an orifice or incision through which the endoscope tip is inserted, or some other orifice or incision. Calibration targets 310 are printed or otherwise placed on the label 304. In the example shown in Figure 5, the calibration targets 310 includes a black patch 316, a contrasting white patch 318, a red patch 320, a green patch 322 and a blue patch 324. The label 304 is preferably formed from a durable material that will withstand normal surgical instrument handling, including sterilization by heating or using a sterilization chemicals such as gluteraldehyde, which is typically used to disinfectant endoscope tips. The label 304 may be, for example, a printable transfer ceramic label available from Dai Nippon. Additionally, calibration targets subject to aging may be imaged under known conditions and their aged (*e.g.*, faded) calibration values stored in a database.

[029] One method 330 for using the calibration device 300 will now be explained with reference to the flowchart of Figure 6. Image properties of an endoscope system, such as its gain, color balance, sharpness, contrast, etc. are set to initial values in an initialization step 332. The initial values set in step 332 may be factory standard settings, settings determined for particular endoscope system or model of endoscope system, and/or settings determined from a previous use of the endoscope system, or any combination thereof.

[030] An endoscopic image is then captured at step 334 by video imaging, still imaging or some other means. After the image is captured at step 334, the image is analyzed at step 336. The analysis step 336 initially includes analysis to determine if the calibration device 300 is present in the field of view of the endoscope tip. The result of this determination is used at step 338 to determine how next to proceed.

[031] If the calibration device 300 is found not to be present at step 338, the image capture step 334 is repeated. Optionally, when step 338 determines that the calibration device 300 is not present in the field of view of the endoscope tip, an internal recalibration step 340 may be performed. This internal recalibration step 340 may include, for example, adjustment of the gain in the console 120 based on a comparison of

overall or location-specific image brightness of internal body tissues or organs in the field of view of the endoscope tip. Thus, even when there is no calibration device present in the endoscope tip's field of view, circuitry in the console 120 can recognize if the image is too light or "washed out" and either reduce detector sensitivity, decrease illumination power output, or modify the image data to reduce brightness. If, on the other hand, the recalibration step 340 determines that the image is too dark, circuitry in the console 120 can increase detector sensitivity, increase illumination power output, or modify the image data to increase brightness. Methods for providing local calibration without a calibration device are described in PCT Patent Application No. PCT/US/2004/19996 entitled "Scanning Endoscope," which is hereby incorporated by reference.

[032] If the determination is made at step 338 that the calibration device 300 is present in the field of view of the endoscope tip, then a calibration step 344 is performed. Calibration data is obtained in the calibration step 344 by comparing the image of the calibration device captured at step 334 with calibration device data corresponding to the known optical properties of the calibration device 300. The calibration device data is provided to the console 120 by suitable means. For example, the calibration device data can be entered into the console 120 using the controls 128, and the entered calibration device data are stored in the console 120. The calibration device data may also be encoded into the calibration device 300 itself and read by the console 120 from an image of the calibration device 300 captured at step 334, or it may be provided to the console 120 by other means. Regardless of how the calibration device data is provided to the console 120, the console 120 compares the calibration device data to data corresponding to the image captured at step 334. Any differences in such data are indicative of deviations of the captured image data from correct image data, and these differences correspond to the calibration data. For example, the image data captured at step 334 may result in an image viewed on the monitor 126 having a color balance, contrast, brightness, sharpness, etc. that does not match the true color balance, contrast, brightness, sharpness, etc. of the calibration device 300. The calibration data corresponds to these difference between the captured image data and the calibration device data. Once the calibration data has been obtained by the above-described or other means, the calibration procedure shown in Figure 6 is complete.

[033] After the calibration data have been obtained, the console 120 uses the calibration data to either modify the operation of the circuitry in the console 120. More specifically, the calibration data can be used to adjust the color balance, contrast,

brightness, sharpness, etc. of the endoscope system 10 so that the image displayed on the monitor 126 accurately shows the anatomical feature.

[034] Another example of a calibration device 350 is shown in Figure 7. The calibration device 350 includes machine-readable indicia 352 as well sets 356, 358, 360 and 362 of calibration patches in respective colors. The machine readable indicia 352, which may be used as a “finder pattern” either to determine the presence of the calibration device during analysis at step 336 or to determine the location of calibration patches 356-362. Also, as mentioned above, the machine-readable indicia 352 may also encode calibration device data indicative of the known optical properties of the calibration device 350, such as its center wavelength, breadth,, brightness, calibration patch Lambertian characteristics, etc. Alternatively or additionally, a serial number corresponding to the calibration device 350 may be encoded in the machine-readable indicia 352. The serial number can then be used to access calibration device data indicative of the known optical properties of the calibration device 350, which are stored in a database. According to some embodiments, the database may be resident in the console 120. The use of the machine-readable indicia 352 for this purpose has the advantage of allowing calibration devices themselves to be re-calibrated if their known optical properties change for various reasons, such as because of aging, damage or other effects.

[035] With further reference to Figure 7, the machine readable indicia 352 shown therein includes the data string: `[]>[RS]06[GS]YR32G29B30XX[RS]EOT`. The non-printable records separator “[RS]” ASCII character indicates what character will be used to separate messages within the symbol. The “06” indicates the first message in the symbol follows ANSI standard format “06,” which specifies the use of FACT data identifiers to identify data field contents. The non-printable group separator “[GS]” ASCII character indicates what character will be used to separate data fields within the first (“06”) message string. The first (and only) data identifier “Y” indicates the field is a user-defined data structure. Within that field, “R32” indicates the red patches have absolute reflectance of 32 units, “G29” indicates the green patches have an absolute reflectance of 29 units, and the “B30” indicates the blue patches have an absolute reflectance of 30 units, understand the conditions, respectively. The “XX” characters are used to indicate a particular pattern of patches. The next non-printable records separator “[RS]” indicates the end of the message, and the “[EOT]” non-printable “end-of-text” ASCII character indicates the end of the structured data. This data structure is simply one

example of a data structure that can be encoded in the machine-readable indicia 352, and other data structures may, of course, be used.

[036] A calibrating device 400 according to another example of the invention is shown in Figure 8. The calibrating device includes a cylindrical body 404 to which a calibration label 408 is attached. The cylindrical body 404 is sized and shaped to pass through a biopsy channel of an endoscope tip (not shown in Figure 8). The label is printed with indicia 410 having known optical properties. The cylindrical body 404 is attached to the distal end of a catheter 414 through a flex joint 418. A pair of control cables extend through the catheter 414 and are attached to opposite surfaces of the body 404.

[037] In operation, the cylindrical body 404 is first inserted into the biopsy channel. The catheter 414 is fed into the biopsy channel until the cylindrical body 404 protects from an opening at the distal end of the channel. Finally, the control cables are alternately retracted and extended to pivot the cylindrical body 404 within the field of view of the endoscope tip.

[038] From the foregoing it will be appreciated that, although specific embodiments of the invention have been described herein for purposes of illustration, various modifications may be made without deviating from the spirit and scope of the invention. For example, the teachings disclosed herein are generally applicable for use in scanned beam imagers such as bar code scanners in addition to scanned beam endoscope tips. Accordingly, the invention is not limited except as by the appended claims.

CLAIMS

What is claimed is:

1. A method of ensuring that an image of internal anatomical features obtained by an endoscope system having an endoscope console and an endoscope tip accurately portrays the anatomical features, the method comprising:

positioning an endoscope tip so that the internal anatomical features are within a field of view of the endoscope tip;

using the endoscope system to obtain an image of the internal anatomical features;

introducing a calibrating device having at least one known optical property into the field of view of the endoscope tip;

using the endoscope system to obtain an image of the calibrating device;

providing calibration device data corresponding to the at least one known optical property of the calibration device;

using the image of the calibration device and the calibration device data to provide calibration data; and

using the calibration data to program the endoscope system.

2. The method of claim 1 wherein the act of using the calibration data to program the endoscope system comprises setting at least one selected from the group consisting of a gamma curve, a grayscale curve, a gain, a zero point, a color balance and white point.

3. The method of claim 1 wherein the endoscope tip comprises an optical endoscope tip having an optical fiber extending from a viewing window at the distal end of the endoscope tip to a proximal end of the endoscope tip.

4. The method of claim 1 wherein the endoscope tip comprises a video endoscope tip having a video camera mounted behind a viewing window at the distal end of the endoscope tip, the endoscope tip further comprising wires extending from the video camera to a proximal end of the endoscope tip.

5. The method of claim 1 wherein the endoscope tip comprises a scanned beam endoscope tip having a beam scanning mechanism mounted behind a viewing window at the distal end of the endoscope tip, the endoscope tip further

comprising wires extending from the beam scanning mechanism to a proximal end of the endoscope tip.

6. The method of claim 1 wherein the endoscope includes a biopsy channel extending the length of the endoscope tip from an access port at its proximal end to an opening at its distal end, and wherein the act of introducing a calibrating device having at least one known optical property into the field of view of the endoscope tip comprises:

attaching the calibrating device to a distal end of a catheter; and  
inserting the calibrating device into the biopsy channel of the endoscope tip; and

advancing the catheter into the biopsy channel of the endoscope tip until the calibrating device is within the field of view of the endoscope tip.

7. The method of claim 6 wherein the catheter includes at least one control cable structured to steer the distal end of the catheter in at least one direction, and wherein the method further comprises manipulating the at least one control cable to steer the calibrating device to a position within the field of view of the endoscope tip.

8. The method of claim 1 wherein the act of introducing a calibrating device having at least one known optical property into the field of view of the endoscope tip comprises:

forming an orifice or incision into a region of a body being imaged by the endoscope system;

mounting the calibrating device to a distal end of an elongated support;  
and

using the support to insert the calibrating device through the orifice or incision into the region of the body being imaged by the endoscope system until the calibrating device is within the field of view of the endoscope tip.

9. The method of claim 8 wherein the elongated support to which the calibrating device is mounted comprises a biopsy or surgical instrument.

10. The method of claim 1 wherein the calibration device comprises:  
a body portion; and

a label attached to the body portion, the label bearing an indicia having at least one known optical property.

11. The method of claim 1 wherein the act of providing calibration device data comprises:

encoding the calibration device data in the calibration device; and  
using the endoscope system to read the calibration device data encoded in the calibration device.

12. A method of obtaining calibration data indicative of a calibration error in an endoscope system, the method comprising:

introducing within a body cavity a calibrating device having at least one known optical property into the field of view of the endoscope system;  
using the endoscope system to obtain an image of the calibrating device;  
providing calibration device data corresponding to the at least one known optical property of the calibration device; and  
using the image of the calibration device and the calibration device data to obtain the calibration data.

13. The method of claim 12 wherein the endoscope system comprises an optical endoscope tip having an optical fiber extending from a viewing window at the distal end of the endoscope tip to a proximal end of the endoscopetip.

14. The method of claim 12 wherein the endoscope system comprises a video endoscope tip having a video camera mounted behind a viewing window at the distal end of the endoscope tip, the endoscope tip further comprising wires extending from the video camera to a proximal end of the endoscope tip.

15. The method of claim 12 wherein the endoscope system comprises a scanned beam endoscope tip having a beam scanning mechanism mounted behind a viewing window at the distal end of the endoscope tip, the endoscope tip further comprising wires extending from the beam scanning mechanism to a proximal end of the endoscope tip.

16. The method of claim 12 wherein the endoscope tip includes a biopsy channel extending the length of the endoscope tip from an access port at its

proximal end to an opening at its distal end, and wherein the act of introducing a calibrating device having at least one known optical property into the field of view of the endoscope system comprises:

attaching the calibrating device to a distal end of a catheter; and  
inserting the calibrating device into the biopsy channel of the endoscope tip; and

advancing the catheter into the biopsy channel of the endoscope tip until the calibrating device is within the field of view of the endoscope system.

17. The method of claim 16 wherein the catheter includes at least one control cable structured to steer the distal end of the catheter in at least one direction, and wherein the method further comprises manipulating the at least one control cable to steer the calibrating device to a position within the field of view of the endoscope system.

18. The method of claim 12 wherein the act of introducing a calibrating device having at least one known optical property into the field of view of the endoscope system comprises:

forming an orifice or incision into a region of a body being imaged by the endoscope system;

mounting the calibrating device to a distal end of an elongated support;  
and

using the support to insert the calibrating device through the orifice or incision into the region of the body being imaged by the endoscope system until the calibrating device is within the field of view of the endoscope system.

19. The method of claim 18 wherein the elongated support to which the calibrating device is mounted comprises a biopsy or surgical instrument.

20. The method of claim 12 wherein the calibration device comprises:  
a body portion; and  
a label attached to the body portion, the label bearing an indicia having at least one known optical property.

21. The method of claim 12, further comprising storing the obtained calibration device data in the endoscope system.



22. A method of calibrating a system having an endoscope tip connected to an endoscope console, the method comprising:

positioning an endoscope tip so that the internal anatomical features are within a field of view of the endoscope system;

using the endoscope system to obtain an image of the internal anatomical features;

providing calibration data derived from comparing an image of a calibration device obtained using the endoscope system and calibration device data corresponding to at least one known optical property of the calibration device; and

using the calibration data to calibrate the endoscope system.

23. The method of claim 22 wherein the act of using the calibration data to calibrate the endoscope system comprises adjusting the optical properties of the endoscope system so that the obtained endoscopically obtained image accurately portrays the internal anatomical features.

24. The method of claim 22 wherein the endoscope tip comprises an optical endoscope tip having an optical fiber extending from a viewing window at the distal end of the endoscope tip to a proximal end of the endoscope tip.

25. The method of claim 22 wherein the endoscope tip comprises a video endoscope tip having a video camera mounted behind a viewing window at the distal end of the endoscope tip, the endoscope tip further comprising wires extending from the video camera to a proximal end of the endoscope tip.

26. The method of claim 22 wherein the endoscope tip comprises a scanned beam endoscope tip having a beam scanning mechanism mounted behind a viewing window at the distal end of the endoscope tip, the endoscope tip further comprising wires extending from the beam scanning mechanism to a proximal end of the endoscope tip.

27. A system for obtaining an accurate image of an internal anatomical feature, comprising:

a calibration device having at least one known optical property; and

an endoscope system, comprising:

an endoscope tip having a viewing device structured to provide an electrical signal indicative of an image of an object image in a field of view of the endoscope tip; and

an endoscope console coupled to receive the electrical signal from the endoscope tip, the endoscope console being structured to receive calibration device data indicative of the at least one known optical property of the calibration device, the endoscope console further being structured to generate calibration data using the calibration device data and data corresponding to an image of the calibration device obtained with the calibration device in the field of view of the endoscope tip, the console further being structured to use the calibration data to calibrate the endoscope system.

28. The system of claim 27 wherein the endoscope tip comprises an optical endoscope tip having an optical fiber extending from a viewing window at the distal end of the endoscope tip to a proximal end of the endoscope tip.

29. The system of claim 27 wherein the endoscope tip comprises a video endoscope tip having a video camera mounted behind a viewing window at the distal end of the endoscope tip, the endoscope tip further comprising wires extending from the video camera to a proximal end of the endoscope tip.

30. The system of claim 27 wherein the endoscope tip comprises a scanned beam endoscope tip having a beam scanning mechanism mounted behind a viewing window at the distal end of the endoscope tip, the endoscope tip further comprising wires extending from the beam scanning mechanism to a proximal end of the endoscope tip.

31. The system of claim 27 wherein the endoscope tip includes a biopsy channel extending the length of the endoscope tip from an access port at its proximal end to an opening at its distal end, and wherein the calibrating device is structured to be inserted into the biopsy channel, the system further comprising a catheter having a distal end to which the calibration device is attached.

32. The system of claim 31 wherein the catheter comprises at least one control cable structured to steer the distal end of the catheter in at least one direction.

33. The system of claim 27 wherein the calibration device comprises an elongated support and a label attached to the elongated support.

34. The system of claim 33 wherein the elongated support comprises a biopsy or surgical instrument.

35. The system of claim 27 wherein the calibration device comprises:  
a body portion; and  
a label attached to the body portion, the label bearing an indicia having at least one known optical property.

36. The system of claim 27 wherein the calibration device data are encoded in the calibration device.

37. The system of claim 27 wherein the calibration device data are programmed in the console.

38. A calibration device for calibrating an endoscope, comprising:  
a calibration tag bearing markings having at least one known optical property; and  
an elongated support attached to the calibration tag.

39. The calibration device of claim 38 wherein the at least one known optical property comprises at least one property selected from the group consisting of a gamma curve, a grayscale curve, a gain, a zero point, a color balance and white point.

40. The calibration device of claim 38 wherein the elongated support comprises a catheter having at least one control cable structured to steer the calibration tag in at least one direction.

41. The calibration device of claim 38 wherein the elongated support comprises a biopsy or surgical instrument.

42. The calibration device of claim 38 wherein the calibration tag comprises:  
a body portion; and  
a label attached to the body portion, the label bearing an indicia having at least one known optical property.

43. The calibration device of claim 38 wherein the calibration device encodes data indicative of an optical error in an endoscope system.

44. The calibration device of claim 38 wherein the calibration tag and elongated support are impervious to sterilizing temperatures.

45. The calibration device of claim 38 wherein the calibration tag and elongated support are impervious to sterilizing chemicals.

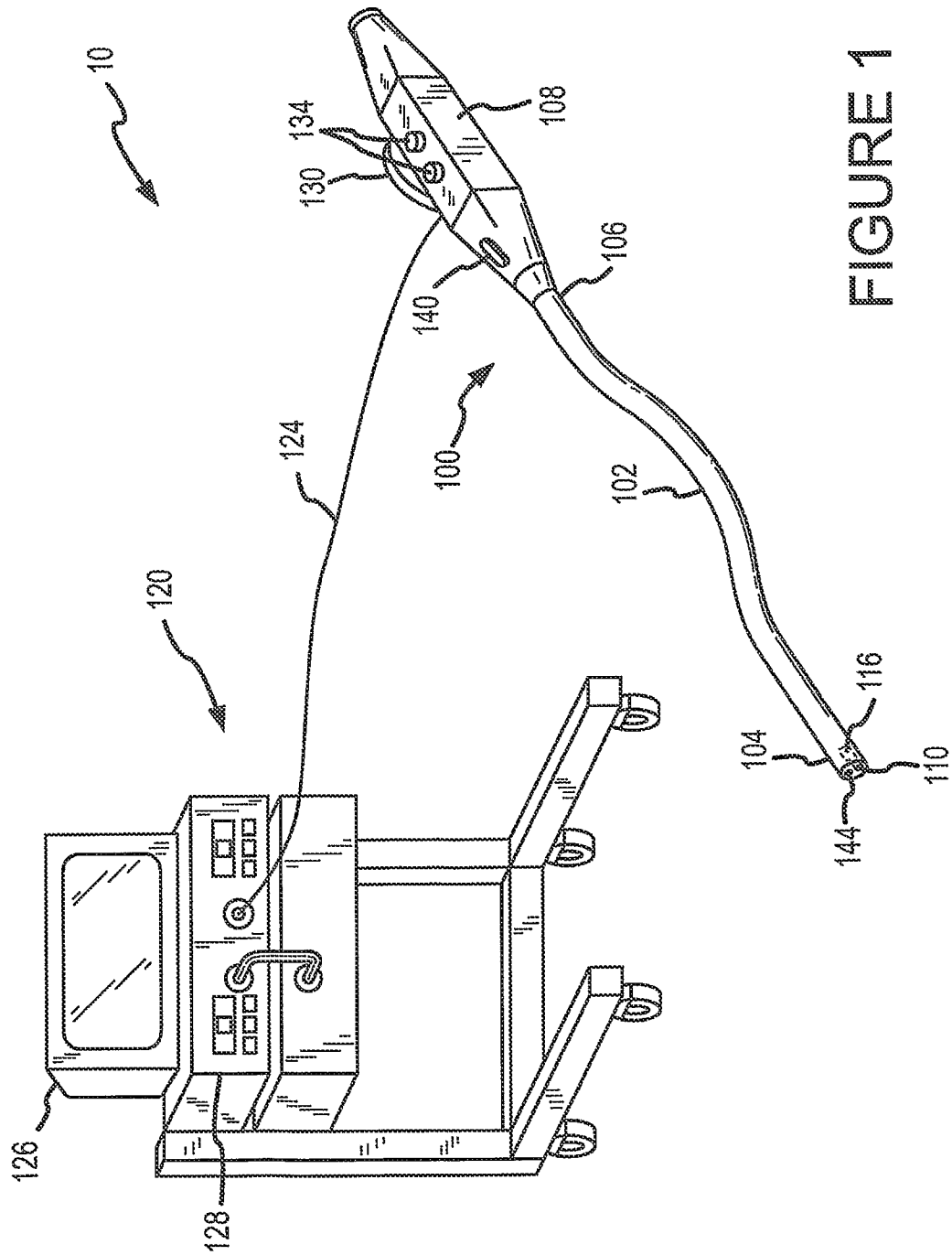


FIGURE 1

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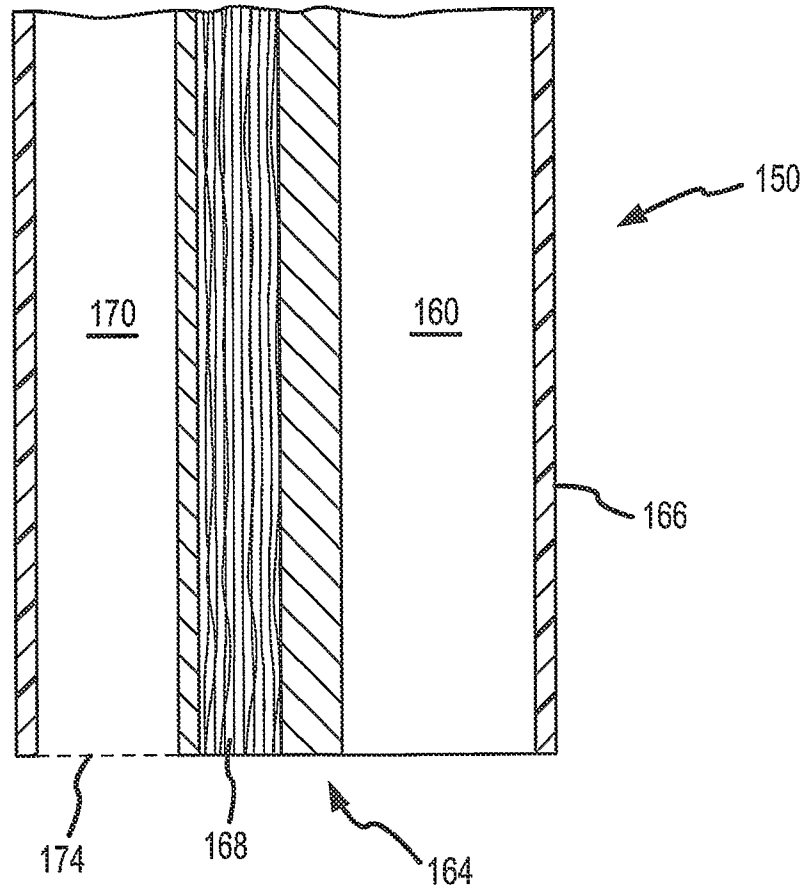


FIGURE 2

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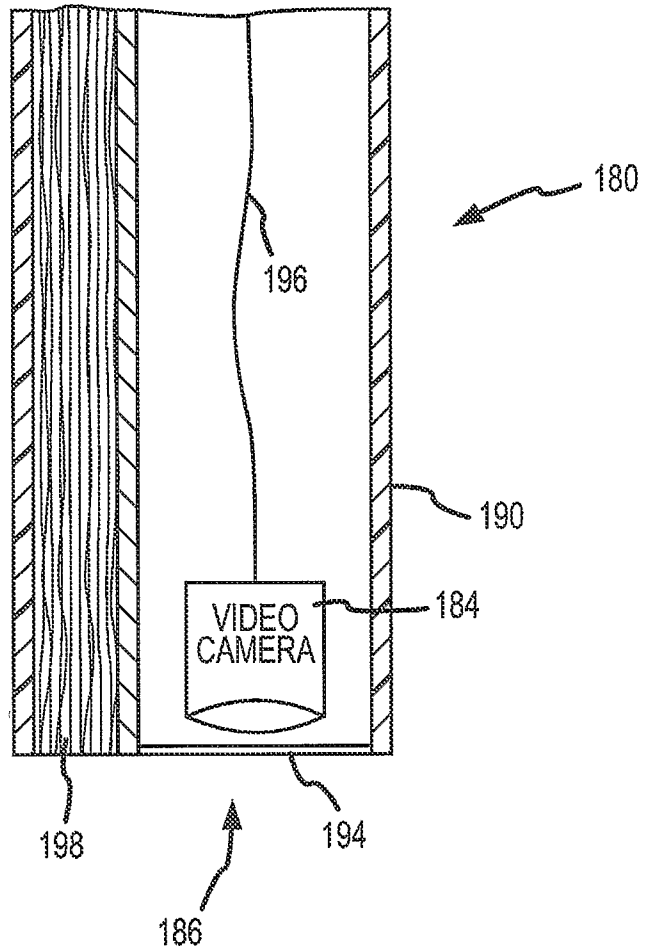


FIGURE 3

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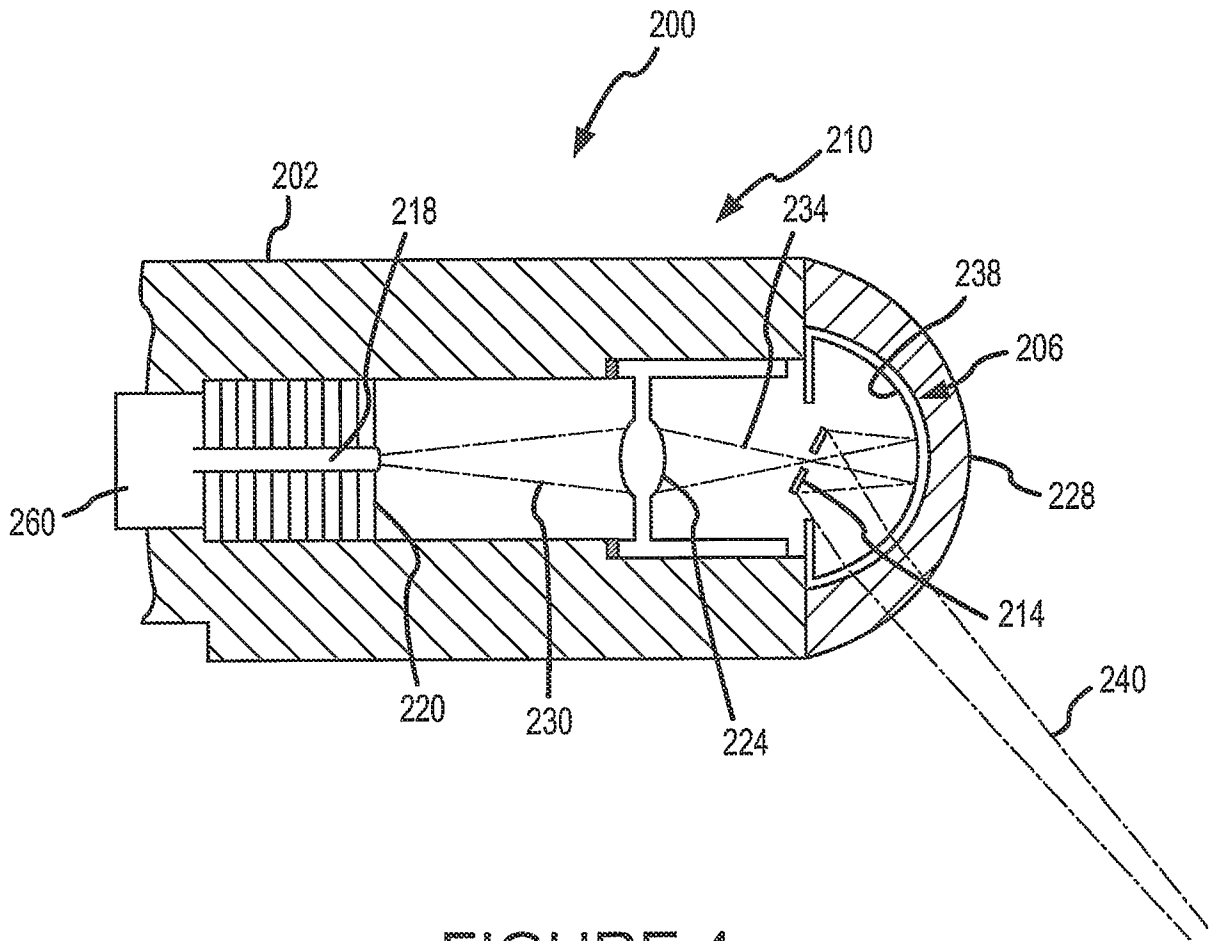


FIGURE 4





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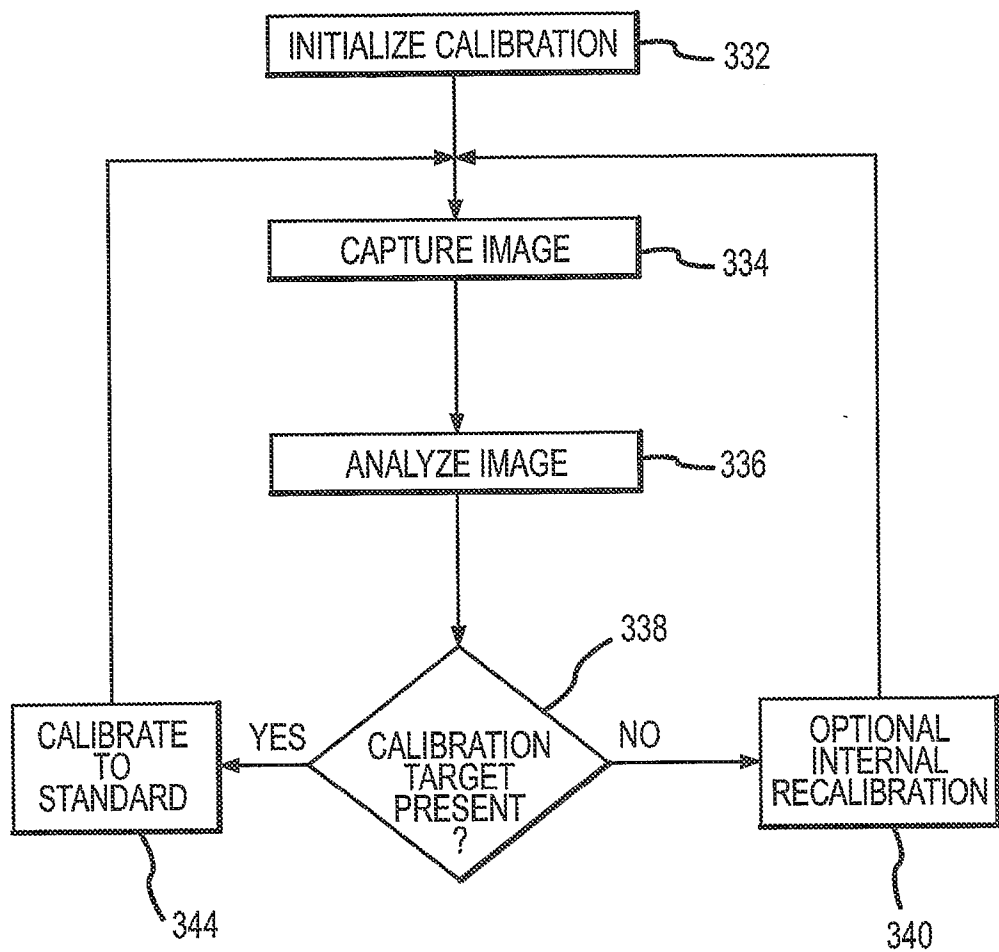


FIGURE 6

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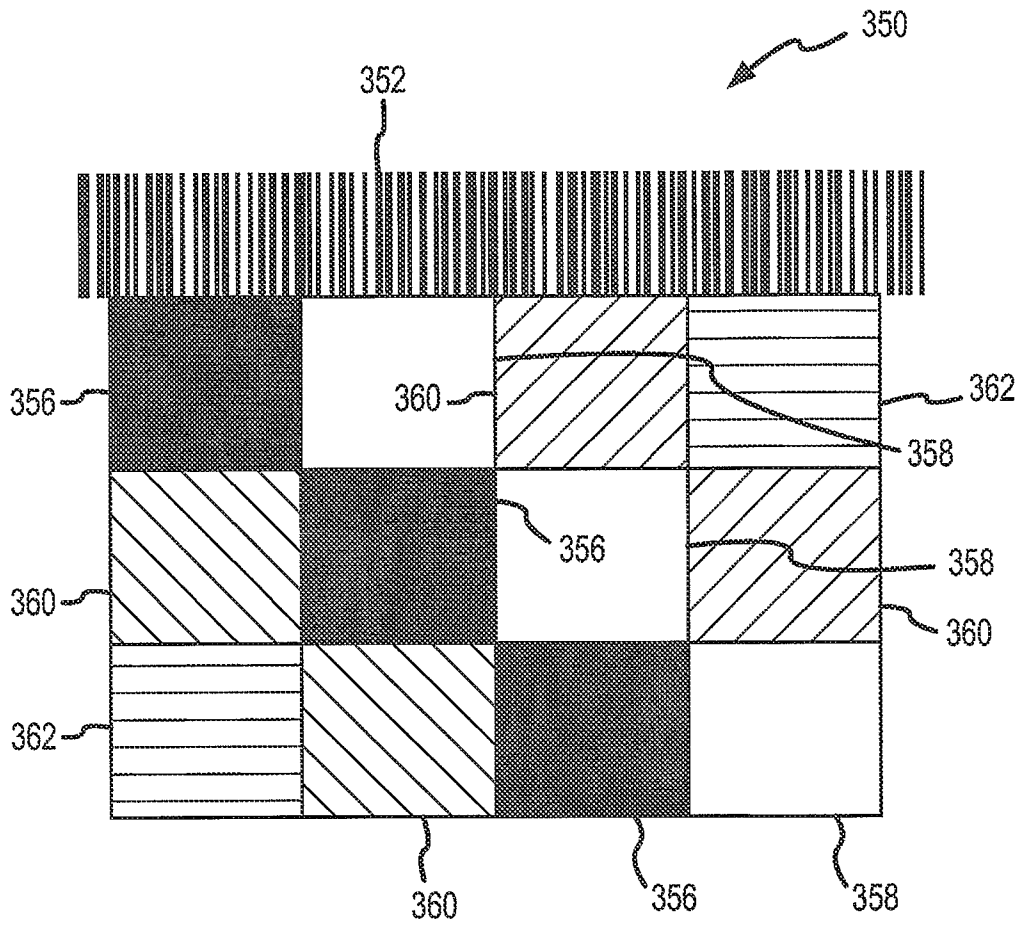


FIGURE 7

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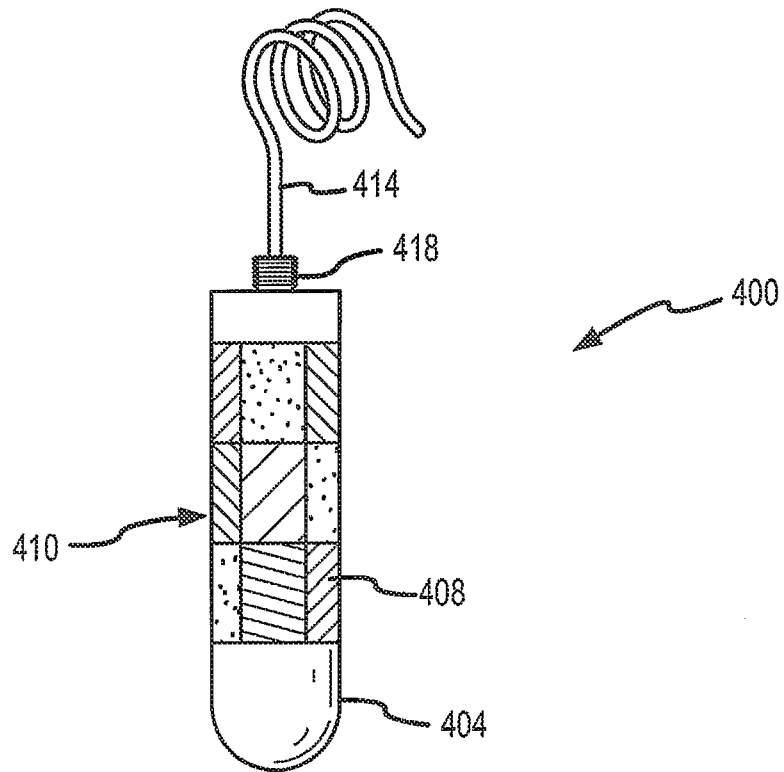


FIGURE 8