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(54) **Optical volume sensor**

Optischer Volumenssensor

Capteur optique de volume

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(56) References cited:
GB-A- 2 087 550 US-A- 5 279 294

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Description

FIELD OF THE INVENTION

[0001] The present invention relates generally to volume measurement devices, and, more particularly, to an optical volume sensor for measuring the volume of a drop of blood.

BACKGROUND OF THE INVENTION

[0002] It is often necessary to quickly and inexpensively measure the volume of an object. One example of a need for volume measurement is in connection with a blood glucose monitoring system where it may be necessary to measure the volume of a drop of blood.

[0003] Those who have irregular blood glucose concentration levels are medically required to regularly self-monitor their blood glucose concentration level. An irregular blood glucose level can be brought on by a variety of reasons including illness such as diabetes. The purpose of monitoring the blood glucose concentration level is to determine the blood glucose concentration level and then to take corrective action, based upon whether the level is too high or too low, to bring the level back within a normal range. The failure to take corrective action can have serious implications. When blood glucose levels drop too low - a condition known as hypoglycemia - a person can become nervous, shaky, and confused That person's judgment may become impaired and that person may eventually pass out. A person can also become very ill if their blood glucose level becomes too high - a condition known as hyperglycemia. Both conditions, hypoglycemia and hyperglycemia, are both potentially life-threatening emergencies.

[0004] One method of monitoring a person's blood glucose level is with a portable, hand-held blood glucose testing devices. Such a device is known from US-A-5 279 294. A prior art blood glucose testing device 100 is illustrated in FIG. 1. The portable nature of these devices 100 enables the users to conveniently test their blood glucose levels wherever the user may be. The glucose testing device contains a test sensor 102 to harvest the blood for analysis. The device 100 contains a switch 104 to activate the device 100 and a display 106 to display the blood glucose analysis results. In order to check the blood glucose level, a drop of blood is obtained from the fingertip using a lancing device. A prior art lancing device 120 is illustrated in FIG. 2. The lancing device 120 contains a needle lance 122 to puncture the skin. Some lancing devices implement a vacuum to facilitate the drawing of blood. Once the requisite amount of blood is produced on the fingertip, the blood is harvested using the test sensor 102. The test sensor 102, which is inserted into a testing unit 100, is brought into contact with the blood drop. The test sensor 102 draws the blood to the inside of the test unit 100 which then determines the concentration of glucose in the blood. Once the results of the test are displayed on the display 106 of the test unit 100, the test sensor 102 is discarded. Each new test requires a new test sensor 102.

[0005] One problem associated with some lancing devices is that the requisite amount of blood for accurate test results is not always obtained. Roughly thirty percent of lances to do not produce enough blood for accurate analysis. The amount of blood obtained from each lance varies between zero and ten microliters ("μl") For an accurate result, at least two μl of blood must be obtained. If less than this amount is produced, the test results may be erroneous and a test sensor is wasted. More serious an issue, however, is that the user may be relying on inaccurate results. Obviously, because of the serious nature of the medical issues involved, erroneous results are not preferred.

[0006] Another problem associated with conventional lancing devices is that there is no mechanism to let the user know whether the correct amount of blood has been obtained for accurate analysis. Typically, the test units come with instructions containing a graphical illustration of the actual size of the blood drop required for accurate testing. However, this visual comparison is subjective and often produces inconsistent results. To insure the requisite amount of blood is produced, users often overcompensate by squeezing or otherwise manipulating their fingers to produce larger than necessary drops of blood. However, this adds more time to the overall testing process and also results in an increased amount of wasted blood.

[0007] The inconsistent results produced by conventional lances has impeded the integration of the lancing device, the harvesting device, and the blood glucose analysis device into a single unit. Because the analysis may begin even though the requisite amount of blood has not been obtained, it appears problematic to combine the lancing with the actual harvesting due to the potentially inaccurate results.

SUMMARY OF THE INVENTION

[0008] According to the present invention, there is an optical sensor for determining the volume of an object. One application of the optical sensor is for use in a blood glucose monitoring system which integrates the lancing device, the harvesting device, and the blood glucose analysis device into a single unit. In accordance with the present invention, the optical sensor comprises a source of light and a light sensor adapted to measure an amount of light reflected off the side and off the top of a drop of blood, according to claim 1.

BRIEF DESCRIPTION OF THE DRAWINGS

[0009] Other objects and advantages of the invention will become apparent upon reading the following detailed description in conjunction with the drawings in which:

FIG. 1 is a top view of a prior art blood glucose testing device;

FIG. 2 is a top view of a prior art lance;

FIG. 3 is an optical design for a optical volume sensor wherein light ray traces are shown illuminating a blood drop according to one embodiment of the present invention;

FIG. 4 is an optical design for an optical volume sensor wherein light ray traces are shown reflected off a blood drop according to one embodiment of the present invention;

FIG. 5 is a plot of the intensity distribution of the light reflected off the side and off the top of a blood drop according to one embodiment of the present invention;

FIG. 6 is a plot of the modeled volume measurements of an optical volume sensor versus the actual modeled volumes according to one embodiment of the present invention;

FIG. 7 is an optical design for an optical volume sensor wherein light ray traces are shown reflected off a blood drop according to an alternative embodiment of the present invention, and

FIG 8 is a perspective view of an integrated glucose monitoring device according o one embodiment of the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0010] Referring now to FIG. 3, a design for an embodiment of an optical volume sensor 200 is shown. The volume of a drop of blood 202 is determined by illuminating the blood drop 202 and measuring the amount of light reflected off one side 204 of the blood drop and off a top 206 of the blood drop 202. The blood drop 202 is illuminated by reflecting light from a light source 208 through a series of imaging optics, along light paths 210, 212 onto the side 204 and the top 206 of the blood drop 202. The light directed along the light path 210 illuminates the side 204 of the blood drop 202. The light directed along the light path 212 illuminates the top 206 of the blood drop 202. The side illumination light path 210 has edges 210a, 210b and the top illumination light path 212 has edges 212a, 212b.

[0011] The source of light 208 has a wavelength of about 800 nanometers ("nm"). A source of light having a wavelength greater than 750 nm is desirable to avoid significant variation in blood and skin reflectance seen at visible wavelengths from 450 to 750 nm. Utilizing a source of light 208 having a wavelength greater than 750 nm results in a more consistent amount of light reflected off the blood drop 202. The light source 208 is an incandescent light source but can also be one or more light emitting diodes ("LEDs").

[0012] Light emitted from the light source 208 is reflected off a beam splitter 214 down through a side view lens 216 and a top view lens 218. In one embodiment of the present invention, the beam splitter 214 is a fifty percent beam splitter 214 causing approximately half of the incoming light to be transmitted through the beam splitter 214 and the remaining approximately half of the incoming light to be reflected by the beam splitter towards the side view lens 216 and the top view lens 218. Thus, in FIG. 3, half of the light incoming from the source of light 208 passes through the beam splitter 214 and the other half of the light is reflected downward along the side illumination light path 210 and the top illumination light path 212. The light transmitted though the beam splitter 214 is labeled with preference number 220.

[0013] The light reflected by the beam splitter 214 that is directed along the side illumination light path 210 passes through the side view lens 216 to a mirror 222 which directs the light onto the side 204 of the blood drop 202. The side view lens 216 expands the light so that the light when directed off the mirror 222 over-illuminates the blood drop 204 causing some of the light to be cast upon a white surface 238 disposed adjacent to the blood drop 202.

[0014] The light reflected by the beam splitter 214 that is directed along the top illumination light path 212 passes through the top view lens 218 and a wedge lens 224 onto the blood drop 202. The wedge lens 224 directs the light onto the top 206 of the blood drop 202. Similar to the side view lens 216, the top view lens 218 expands the light so that the light when directed though the wedge lens 224 over-illuminates the blood drop 202 causing some of the light to be cast upon an area of skin 236 upon which the blood drop has formed.

[0015] When the light comes into contact with the blood drop 202 a portion of that light is absorbed by the blood drop 202 while a portion of the light is reflected off the blood drop 202. Accordingly, the light reflected off the blood drop 202 is less intense than the light illuminating the blood drop 202. The light not coming into contact with the blood drop 202 due to over-illumination is reflected off the skin 236 and off the white surface 238. The white surface 238 has reflectance properties similar to the skin 238. Both the skin 236 and the white surface 238 are more reflective than the blood drop 202. Due to the absorption by the blood drop 202, the light reflected off the blood drop 202 is less intense than the light reflected off the skin 236 and the white surface 238. The blood drop 202 absorbs approximately fifteen percent more light than the skin 236 and the white surface 238. Therefore, the light reflected off the blood drop 202 is approximately fifteen percent less intense than the light reflected off the skin 236 and the white surface 238. It is this amount of the less-intense light reflected off the blood drop 202 which is indicative of the height and the diameter of the blood drop 202.

[0016] Referring now to FIG. 4, the light paths 230, 232 of the light reflected off the side 204 and off the top 206 of the blood drop 202, respectively, are illustrated. The side reflected light path 230 has edges 230a, 230b and the top reflected light path 232 has edges 232a, 232b.

The light reflected off the side 204 and off the top 206 of the blood drop 202 is directed along the side reflected light path 230 and the top reflected light path 232, respectively, to a light sensor 234. The side reflected light path 230 has edges 230a, 230b and the top reflected light path has edges 232a, 232b.

[0017] The light reflected off the side 204 of the blood drop 202 and off the white surface 238 is directed by the mirror 222 back through the side view lens 216. The side view lens 216 brings the side reflected light into focus and images the side reflected light onto the light sensor 234. The side view lens 216 also prevents any scattering of the light directed along the side reflected light path 230. In an alternative embodiment of the present invention, the side view lens 216 can be excluded.

[0018] The light reflected off the top 206 of the blood drop 202 and off the skin 236 is directed by the wedge lens 224 through the top view lens 218 onto the light sensor 234. The function of the top view lens 218 is similar to the side view lens 216 in that it brings the top reflected light into focus and images the top reflected light onto the light sensor 234. The top view lens 218 also prevents any scattering of the top reflected light. In an alternative embodiment of the present invention, the side view lens 218 can be excluded.

[0019] The light directed along the side and top reflected light paths 230, 232 is transmitted through the beam splitter 214 to the light sensor 234. The beam splitter 214 transmits a portion of the reflected light to the light sensor 234, while reflecting a portion of the light. In the embodiment wherein the beam splitter 214 is a fifty percent beam splitter, about half of the reflected light is transmitted to the light sensor 234.

[0020] The light sensor 234 measures the intensity of the reflected light and communicates this information to a processor (not shown). The light reflected off the blood drop 202, the skin 236, and the white surface 238 as well as any external light will be detected by the light sensor 234. The intensities of the light reflected off the blood drop 202, the skin 236, and the white surface 238 are a function of the intensity of the light source 208 and the absorptivity of the blood 202, the skin 236, and the white surface 238. Preferably, there is-significant contrast between the light reflected off the blood drop 202 and the light reflected off the skin 236 and/or the white surface 238 due to the skin 236 and the white surface 238 being more reflective than the blood drop 202. Specifically, in the embodiment of the optical volume sensor 200 wherein the light source 234 is an approximately 800 nm light source, the light reflected off the blood drop 202 is approximately fifteen percent less intense than the light reflected off the skin 236 and the white surface 238. Any external light detected by the sensor 234 is expected to have an intensity much less than the light reflected off the blood drop 202, the skin 236, and the white surface 238. The light falling within the expected range of light reflected off the blood drop 202 will be indicative of the height and diameter of the blood drop 202.

[0021] In the present invention, the light sensor 234 is a 1 x 128 pixel line array light detector. Each pixel of the line array light detector individually measures the intensity of light. In operation, the two light paths 230, 232 are directed onto the line array light detector 234. Both light paths 230, 232 will contain light reflected off the blood drop 202 along with light reflected off the skin 236 or the white surface 238 on either side. Accordingly, the less intense light (reflected off the blood drop 202) is surrounded by the more intense light (reflected off the skin 236 and the white surface 238). The width of the less intense light that is reflected off the side 204 and off the top 206 of the blood drop 202 is indicative of the height and diameter of the blood drop 202, respectively. Each pixel correlates to a fixed distance. Accordingly, the more pixels which detect light having an intensity of light reflected off the blood drop 202, the larger the blood drop 202 is. In the embodiment of the optical volume sensor 200 illustrated in FIGS. 3 and 4, the spatial resolution for one pixel viewing the blood drop is 25 micrometers ("μm") for the height and 50 μm for the diameter. For example, if thirty pixels detect light reflected off the side 204 of the blood drop 202, the blood drop 202 has a height of approximately 750 μm or 0.75 millimeters ("mm"), and if 60 pixels detect light reflected off the top 206 of the blood drop 202, the blood drop 202 has a diameter of 3000 μm or 3 mm.

[0022] The design for the optical volume sensor shown in FIGS. 3 and 4 was modeled with LightTools software, manufactured by Optical Research Associates located in Pasadena, California. The blood drop 202 was modeled as a spherical lambertian. The light source 208 was modeled as a 800 nm light source.

[0023] FIG. 5 shows the intensity distribution of a two μl blood drop on the line array detector. The side view (blood drop height) is shown on the left-hand side of the plot and the top view (blood drop diameter) is shown on the right-hand side of the plot. The drop in intensity on both the left and right side of the plot correlates to the less intense light reflected off the side 204 and off the top 206 of the blood drop 202. The magnitude of each drop in intensity represents the difference in intensities between the light reflected off the blood drop 202 and the light reflected off the skin 236 or the white surface 238.

[0024] Once the height and diameter of the blood drop are determined, the approximate volume of the blood drop 202 is calculated using the following algorithm:

$$Volume = \frac{1}{2}(Height) \times (Diameter)^2$$

Under the above example where the height is 0.75 mm and the diameter is 3 mm the volume of the blood drop is approximately 3.4 μl.

[0025] Using the above algorithm, the optical volume sensor was also modeled with LightTools software for a number of blood drops having volumes ranging from 0.5

to 4.5 μl FIG. 6 is a plot of the volumes calculated using the above algorithm versus the actual modeled blood drop volumes. FIG. 6 shows that the modeled optical volume sensor was able to determine the blood volume with good correlation to the actual modeled volume.

[0026] An alternative embodiment of the optical volume sensor 200 is illustrated in FIG. 7. In the embodiment illustrated in FIG. 7, the light source 208 is disposed above the blood drop 202. Disposing the light source 208 obviates the need for the beam splitter 208 (FIGS. 3 and 4) because it is not necessary to reflect the illuminating light (FIG. 3) or to transmit the reflected light (FIG. 4).

[0027] Referring now to FIG. 8, one application of the present invention is in an integrated blood glucose monitoring system 300 which integrates a lance 302, a test sensor 304 for blood harvesting, and a blood glucose analyzer into a single instrument. The lance 302 comprises a needle which is used to puncture a user's skin in order to obtain a drop of blood. The test sensor 304 is used to harvest the blood drop from the user's fingertip for analysis. The blood glucose monitoring system 300 is activated with a switch 306. After the user's skin is lanced using the lancing component 302 of the system 300, the volume of the blood on the user's skin is measured with an optical volume sensor 300 (FIGS. 3 and 4) to insure the requisite amount of blood is obtained before analysis begins. Once a sufficient amount of blood has been obtained, the test sensor 304 harvests the blood so that the blood glucose level may be analyzed. The results of the analysis are communicated to the user via a display 308.

[0028] While the invention is susceptible to various modifications and alternative forms, specific embodiments thereof have been shown by way of example in the drawings and will be described in detail herein. It should be understood, however, that it is not intended to limit the invention to the particular forms disclosed, but, to the contrary, the intention is to be defined by the appended claims.

Claims

1. An optical sensor (200) for measuring the volume of a drop of blood (202) comprising:

    a source of light (208) adapted to illuminate a side (204) and a top (206) of the drop of blood (202);
    a light sensor (234) adapted to measure an amount of light reflected off the side (204) and off the top (206) of the drop of blood (202); and
    means for directing light reflected off the side (204) and the top (206) of the drop of blood (202) to the light sensor (234), wherein the amount of light reflected off the side (204) and the top (206) of the drop of blood (202) correlates to a height and a transverse dimension of the drop of blood (202).

2. The optical sensor (200) of claim 1 wherein the light has a wavelength greater than about 750 nanometers.

3. The optical sensor (200) of claim 2 wherein the wavelength is about 800 nanometers.

4. The optical sensor (200) of one of the claims 1 to 3 wherein the source of light (208) comprises an incandescent light.

5. The optical sensor (200) of one of the claims 1 to 3 wherein the source of light (208) comprises a plurality of light emitting diodes.

6. The optical sensor of one of the claims 1 to 5 wherein the means for directing comprises a mirror (222) being adapted to direct light reflected off the side (204) of the drop of blood (202) to the light sensor (234).

7. The optical sensor (200) of claim 6 wherein the means for directing further comprises a first lens (216) disposed between the mirror (222) and the light detector (234), the first lens (216) being adapted to image the reflected light directed from the mirror (222) onto the light sensor (234).

8. The optical sensor (200) of claim 7 wherein the means for directing light comprises a second lens (224) being adapted to direct light reflected off the top (204) of the drop of blood (202) to the light sensor (234).

9. The optical sensor (200) of claim 8 wherein the second lens (224) is a wedge lens.

10. The optical sensor (200) of claim 8 wherein the means for directing light reflected further comprises a third lens (218) disposed between the second lens (224) and the light sensor (234), the third lens (218) being adapted to image the reflected light directed from the second lens (224) onto the light sensor (234).

11. The optical sensor (200) of one of the claims 1 to 5wherein the means for directing light comprises:

    a mirror (222) being adapted to direct light reflected off of the side (204) of the drop of blood (202) to the light sensor (234);
    a first lens (216) disposed between the mirror (222) and the light detector (234), the first lens (216) being adapted to image the reflected light directed from the mirror (222) onto the light sensor (234);
    a second lens (234) being adapted to direct light

reflected off the top (206) of the drop of blood (202) to the light sensor (234); and
a third lens (218) disposed between the second lens (224) and the light sensor (234), the third lens (218) being adapted to image the reflected light directed from the second lens (224) onto the light sensor (234).

12. The optical sensor (200) of claim 11 wherein the second lens (224) is a wedge lens.

13. The optical sensor (200) of one of the claims 1 to 12 wherein the light sensor (234) comprises a 1 by 128 pixel line array light detector.

14. The optical sensor (200) of one of the claims 1 to 13 wherein the drop of blood (202) is generally semi-spherical in shape.

15. The optical sensor (200) of one of the claims 1 to 14 further comprising a white surface (238) disposed adjacent to the drop of blood (202), the white surface (238) being significantly more reflective than the drop of blood (202).

Patentansprüche

1. Optischer Sensor (200) zum Messen des Volumens eines Blutstropfens (202), umfassend:

eine Lichtquelle (208), die eingerichtet ist, eine Seite (204) und eine Oberseite (206) des Blutstropfens (202) zu beleuchten;
einen Lichtsensor (234), der eingerichtet ist, eine Lichtmenge zu messen, die von der Seite (204) und von der Oberseite (206) des Blutstropfens (202) reflektiert wird; und
Mittel zum Lenken von Licht, das von der Seite (204) und der Oberseite (206) des Blutstropfens (202) reflektiert wird, zum Lichtsensor (234), wobei die Lichtmenge, die von der Seite (204) und von der Oberseite (206) des Blutstropfens (202) reflektiert wird, mit einer Höhe und einer Querabmessung des Blutstropfens (202) korreliert.

2. Optischer Sensor (200) nach Anspruch 1, wobei das Licht eine Wellenlänge von mehr als etwa 750 Nanometern aufweist.

3. Optischer Sensor (200) nach Anspruch 2, wobei die Wellenlänge etwa 800 Nanometer beträgt.

4. Optischer Sensor (200) einem der Ansprüche 1 bis 3, wobei die Lichtquelle (208) ein Glühlicht umfasst.

5. Optischer Sensor (200) nach einem der Ansprüche 1 bis 3, wobei die Lichtquelle (208) eine Mehrzahl von lichtemittierenden Dioden umfasst.

6. Optischer Sensor einem der Ansprüche 1 bis 5, wobei das Mittel zum Lenken einen Spiegel (222) umfasst, der eingerichtet ist, Licht, das von der Seite (204) des Blutstropfens (202) reflektiert wird, zum Lichtsensor (234) zu lenken.

7. Optischer Sensor (200) nach Anspruch 6, wobei das Mittel zum Lenken ferner eine erste Linse (216) umfasst, die zwischen dem Spiegel (222) und dem Lichtdetektor (234) angeordnet ist, wobei die erste Linse (216) eingerichtet ist, das reflektierte Licht, das vom Spiegel (222) gelenkt wird, auf dem Lichtsensor (234) abzubilden.

8. Optischer Sensor (200) nach Anspruch 7, wobei das Mittel zum Lenken von Licht eine zweite Linse (224) umfasst, die eingerichtet ist, Licht, das von der Oberseite (204) des Blutstropfens (202) reflektiert wird, zum Lichtsensor (234) zu lenken.

9. Optischer Sensor (200) nach Anspruch 8, wobei die zweite Linse (224) eine Keillinse ist.

10. Optischer Sensor (200) nach Anspruch 8, wobei das Mittel zum Lenken von reflektiertem Licht ferner eine dritte Linse (218) umfasst, die zwischen der zweiten Linse (224) und dem Lichtsensor (234) angeordnet ist, wobei die dritte Linse (218) eingerichtet ist, das reflektierte Licht, das von der zweiten Linse (224) gelenkt wird, auf dem Lichtsensor (234) abzubilden.

11. Optischer Sensor (200) nach einem der Ansprüche 1 bis 5, wobei das Mittel zum Lenken von Licht umfasst:

einen Spiegel (222), der eingerichtet ist, Licht, das von der Seite (204) des Blutstropfens (202) reflektiert wird, zum Lichtsensor (234) zu lenken;
eine erste Linse (216), die zwischen dem Spiegel (222) und dem Lichtdetektor (234) angeordnet ist, wobei die erste Linse (216) eingerichtet ist, das reflektierte Licht, das vom Spiegel (222) gelenkt wird, auf dem Lichtsensor (234) abzubilden;
eine zweite Linse (224), die eingerichtet ist, Licht, das von der Oberseite (206) des Blutstropfens (202) reflektiert wird, zum Lichtsensor (234) zu lenken; und
eine dritte Linse (218), die zwischen der zweiten Linse (224) und dem Lichtsensor (234) angeordnet ist, wobei die dritte Linse (218) eingerichtet ist, das reflektierte Licht, das von der zweiten Linse (224) gelenkt wird, auf dem Lichtsensor (234) abzubilden.

12. Optischer Sensor (200) nach Anspruch 11, wobei die zweite Linse (224) eine Keillinse ist.

13. Optischer Sensor (200) nach einem der Ansprüche 1 bis 12, wobei der Lichtsensor (234) einen 1 mal 128 Pixel-Line Array-Lichtdetektor umfasst.

14. Optischer Sensor (200) nach einem der Ansprüche 1 bis 13, wobei der Blutstropfen (202) allgemein eine semisphärische Form aufweist.

15. Optischer Sensor (200) nach einem der Ansprüche 1 bis 14, ferner umfassend eine weiße Fläche (238), die angrenzend an den Blutstropfen (202) angeordnet ist, wobei die weiße Fläche (238) signifikant reflektierender ist als der Blutstropfen (202).

Revendications

1. Capteur optique (200) pour mesurer le volume d'une goutte de sang (202) comprenant :

une source de lumière (208) destinée à illuminer une face (204) et le sommet (206) de la goutte de sang (202) ;
un capteur de lumière (234) adapté pour mesurer une quantité de lumière reflétée par la face (204) et le sommet (206) de la goutte de sang (202), et
des moyens pour diriger la lumière reflétée par la face (204) et le sommet (206) de la goutte de sang (202) vers le capteur de lumière (234), où la quantité de lumière reflétée par la face (204) et le sommet (206) de la goutte de sang (202) est corrélée à une hauteur et une dimension transversale de la goutte de sang (202).

2. Capteur optique (200) selon la revendication 1, où la lumière a une longueur d'onde supérieure à 750 nanomètres.

3. Capteur optique (200) selon la revendication 2, où la longueur d'onde est d'environ 800 nanomètres.

4. Capteur optique (200) selon l'une des revendications 1 à 3, où la source de lumière (208) comprend une lumière à incandescence.

5. Capteur optique (200) selon l'une des revendications 1 à 3, où la source de lumière (208) comprend une série de diodes émettrices de lumière.

6. Capteur optique (200) selon l'une des revendications 1 à 5, où les moyens pour diriger la lumière comprennent un miroir (222) destiné à diriger la lumière reflétée par la face (204) et le sommet (206) de la goutte de sang (202) vers le capteur de lumière (234).

7. Capteur optique (200) selon la revendication 6, où les moyens pour diriger la lumière comprennent en outre, une première lentille (216) disposée entre le miroir (222) et le détecteur de lumière (234), la première lentille (216) étant destinée à produire une image de la lumière reflétée dirigée du miroir (222) vers le capteur de lumière (234).

8. Capteur optique (200) selon la revendication 7, où les moyens pour diriger la lumière comprennent une deuxième lentille (224) destinée à diriger la lumière reflétée par le sommet (204) de la goutte de sang (202) vers le capteur de lumière (234).

9. Capteur optique (200) selon la revendication 8, où la deuxième lentille (224) est une lentille cunéiforme.

10. Capteur optique (200) selon la revendication 8, où les moyens pour diriger la lumière comprennent en outre, une troisième lentille (218) disposée entre la deuxième lentille (224) et le capteur de lumière (234), la troisième lentille (218) étant destinée à produire une image de la lumière reflétée dirigée de la deuxième lentille (224) vers le capteur de lumière (234).

11. Capteur optique (200) selon l'une des revendications 1 à 5, où les moyens pour diriger la lumière comprennent :

un miroir (222) destiné à diriger la lumière reflétée sur la face (204) de la goutte de sang (202) vers le capteur de lumière (234) ;
une première lentille (216) disposée entre le miroir (222) et le détecteur de lumière (234), la première lentille (216) étant destinée à produire une image de la lumière reflétée dirigée du miroir (222) vers le capteur de lumière (234) ;
une deuxième lentille (224) destinée à diriger la lumière reflétée par le sommet (206) de la goutte de sang (202) vers le capteur de lumière (234), et
une troisième lentille (218) disposée entre la deuxième lentille (224) et le capteur de lumière (234), la troisième lentille (218) étant destinée à produire une image de la lumière reflétée dirigée de la deuxième lentille (224) vers le capteur de lumière (234).

12. Capteur optique (200) selon la revendication 11, où la deuxième lentille (224) est une lentille cunéiforme.

13. Capteur optique (200) selon l'une des revendications 1 à 12, où le capteur de lumière (234) comprend un détecteur de lumière en ligne à 1 pixel par 128.

14. Capteur optique (200) selon l'une des revendications 1 à 13, où la goutte de sang (202) est généralement de forme semi-sphérique.

15. Capteur optique (200) selon l'une des revendications 1 à 14, comprenant en outre, une surface blanche (238) disposée de manière adjacente à la goutte de sang (202), la surface blanche (238) étant significativement plus réflective que la goutte de sang (202).

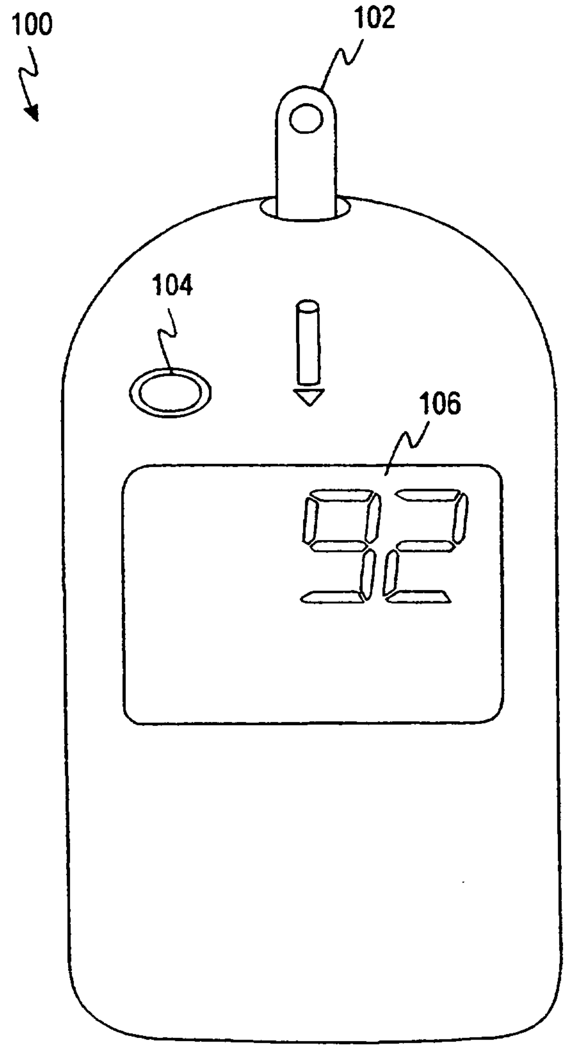

FIG. 1
(Prior Art)

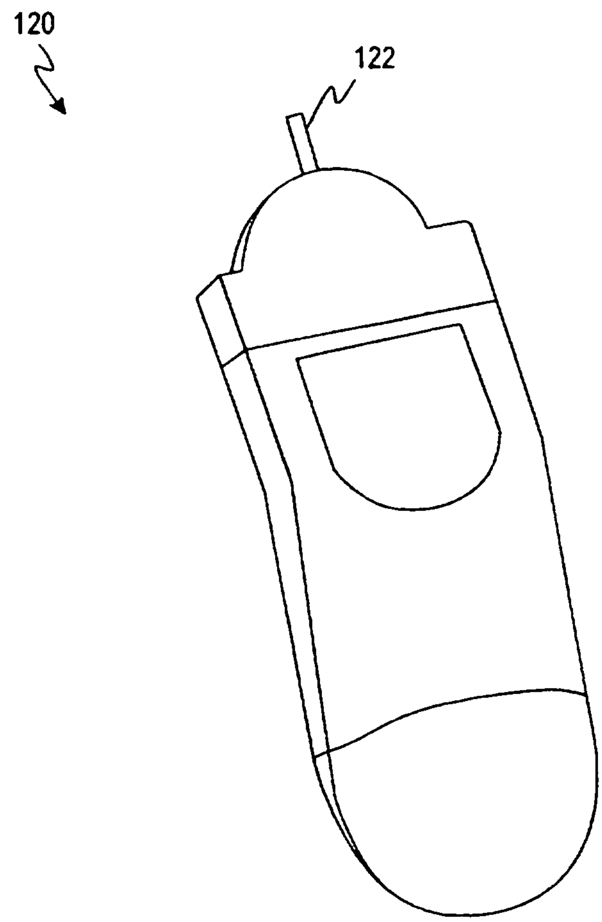

FIG. 2
(Prior Art)

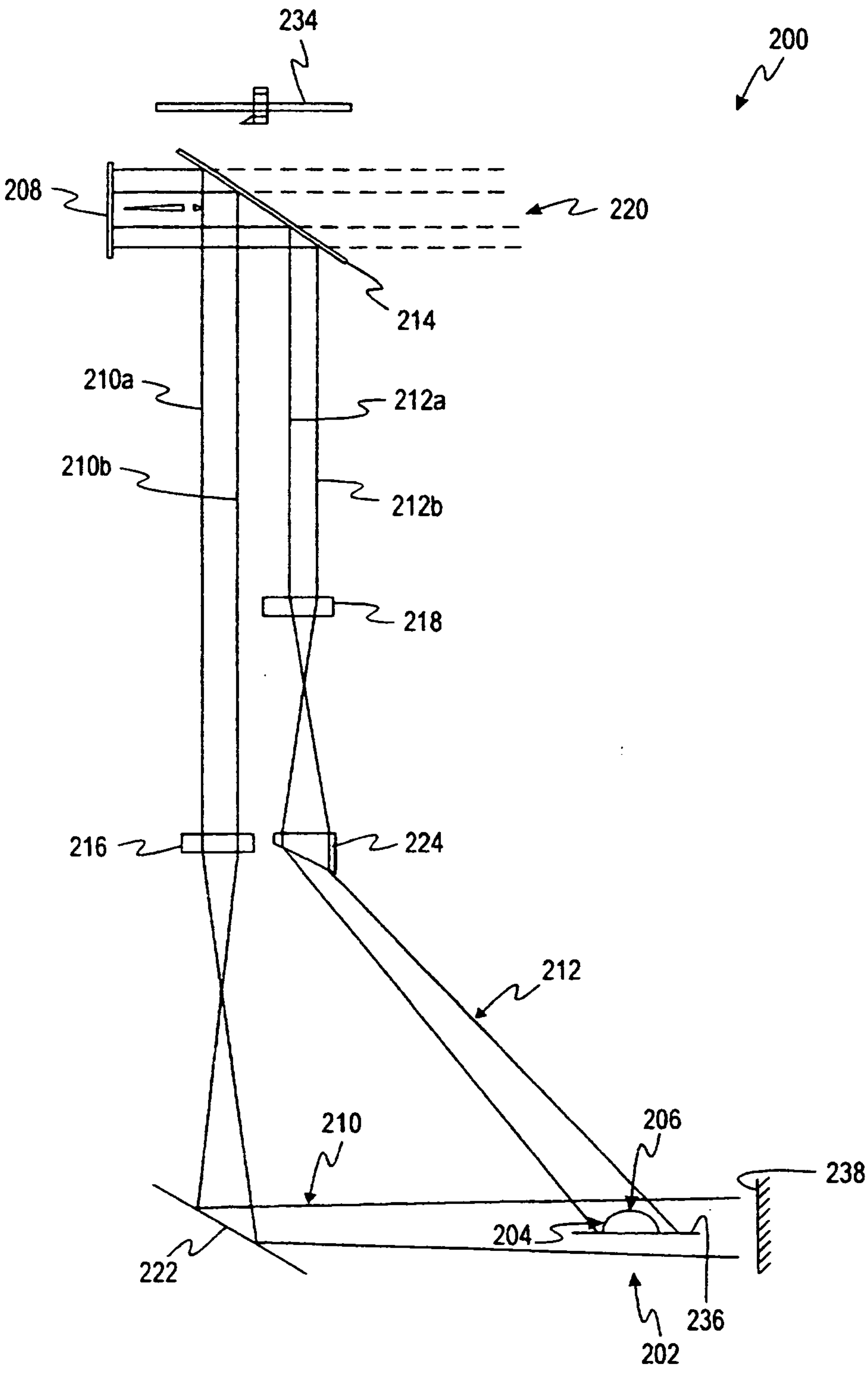
234
200
208
220
214
210a
212a
210b
212b
218
216
224
212
210
206
238
204
222
236
202

FIG. 3

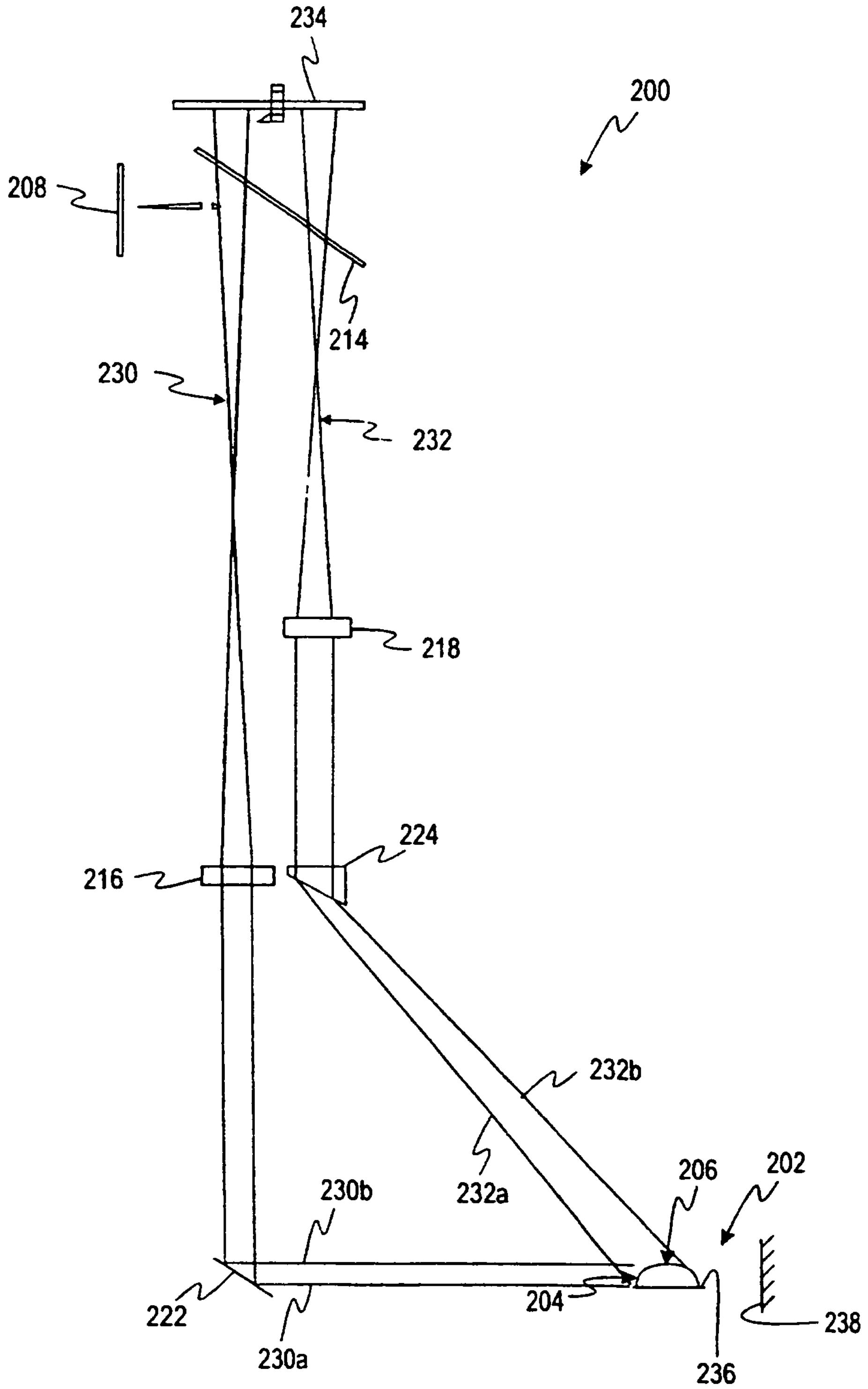
234
200
208
214
230
232
218
224
216
232b
232a
206
202
230b
222
204
238
230a
236

FIG. 4

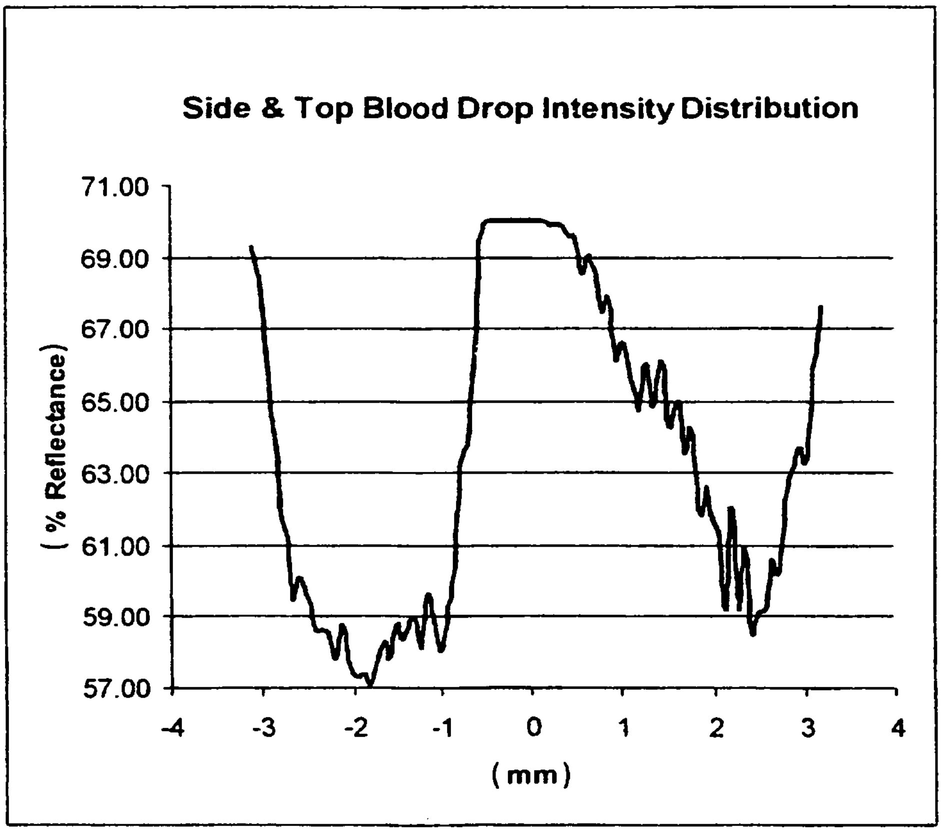
Side & Top Blood Drop Intensity Distribution
71.00
69.00
67.00
65.00
63.00
61.00
59.00
57.00
(% Reflectance)
-4
-3
-2
-1
0
1
2
3
4
(mm)

FIG. 5

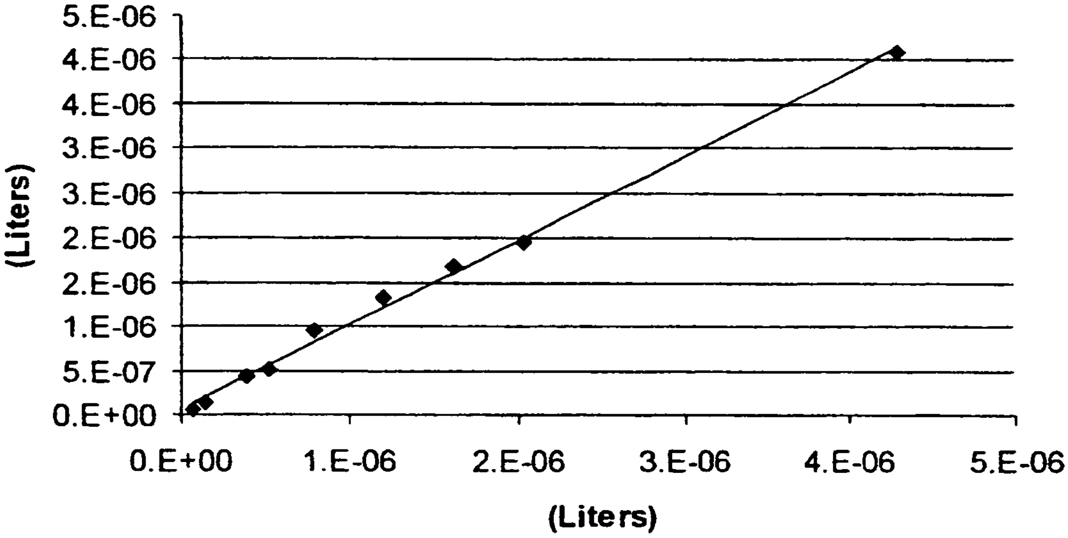
5.E-06
4.E-06
4.E-06
3.E-06
3.E-06
2.E-06
2.E-06
1.E-06
5.E-07
0.E+00
(Liters)
0.E+00
1.E-06
2.E-06
3.E-06
4.E-06
5.E-06
(Liters)

FIG. 6

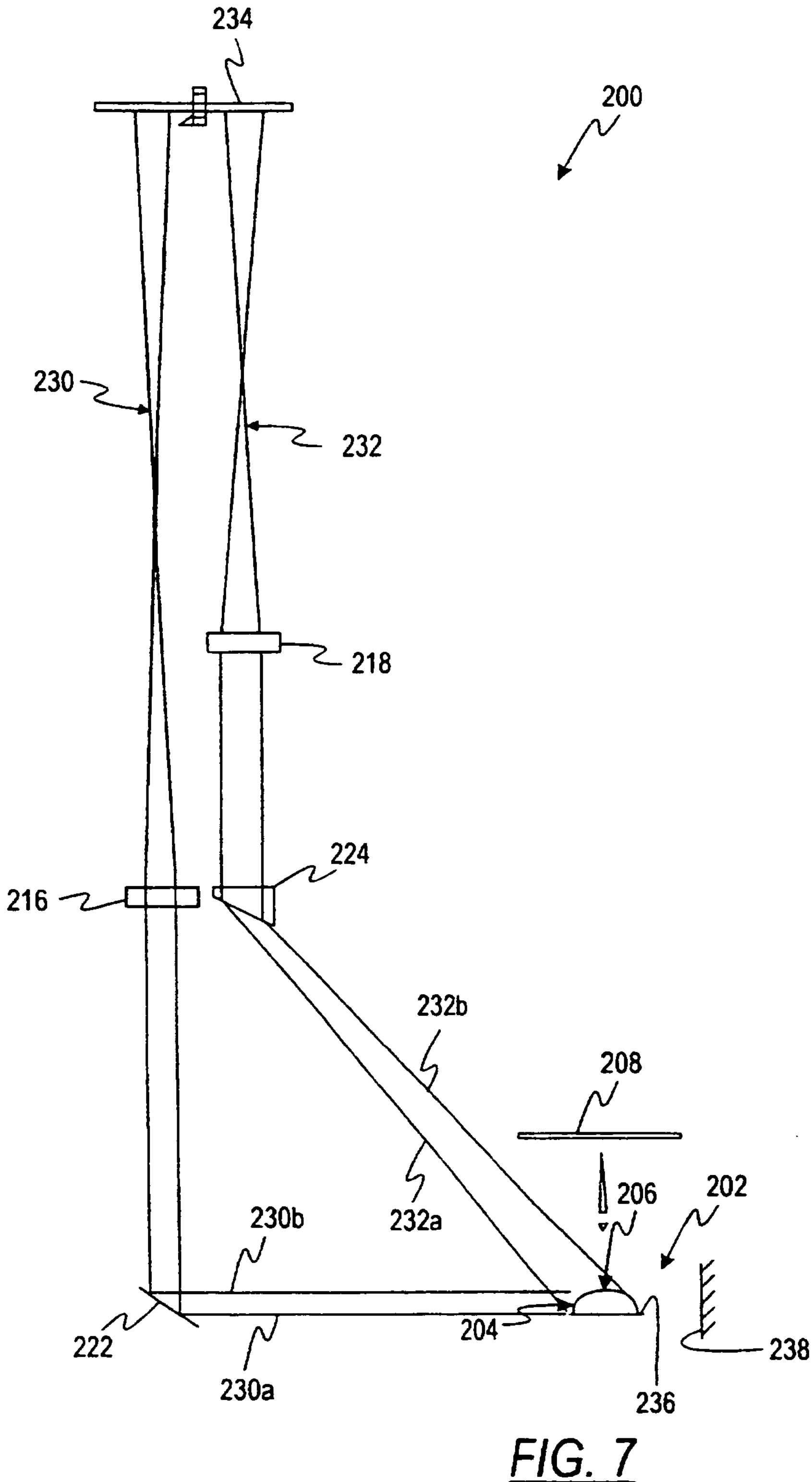
234
200
230
232
218
224
216
232b
208
206
202
230b
232a
222
204
230a
236
238

FIG. 7

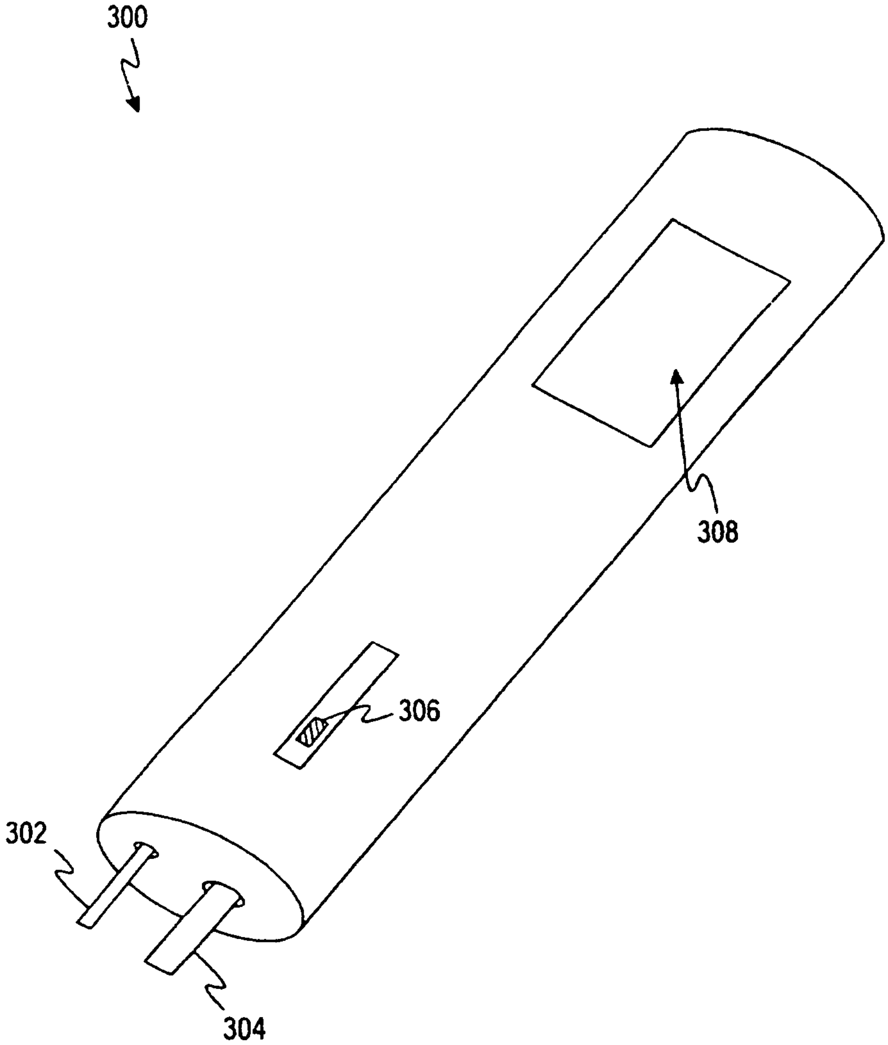

FIG. 8

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- US 5279294 A **[0004]**

专利名称(译)	光学音量传感器		
公开(公告)号	EP1134561B1	公开(公告)日	2016-05-11
申请号	EP2001104494	申请日	2001-03-01
[标]申请(专利权)人(译)	拜尔公司		
申请(专利权)人(译)	拜耳公司		
当前申请(专利权)人(译)	ASCENSIA糖尿病护理控股公司		
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发明人	DOSMANN, ANDREW J.		
IPC分类号	A61B5/145 A61B5/15 A61B5/1455 G01F17/00 G01B11/08 A61B5/00 A61B5/1459 G01B11/02 G01N33/66		
CPC分类号	G01F17/00 A61B5/14532 A61B5/1455 A61B5/150022 A61B5/150358 A61B5/150412 A61B5/150503 A61B5/15186 A61B5/157 G01N21/8483		
代理机构(译)	COHAUSZ & FLORACK		
优先权	09/523716 2000-03-13 US		
其他公开文献	EP1134561A2 EP1134561A3		
外部链接	Espacenet		

摘要(译)

一种用于测量物体体积的光学传感器，该物体具有顶部和侧面。光学传感器包括光源和光传感器，光传感器适于测量从物体侧面和物体顶部反射的光量，其中从物体的侧面和顶部反射的光的测量量与物体的高度和直径。至少一个光学装置适于将从物体侧面反射的光引导到光传感器，并且至少一个光学装置适于将从物体顶部反射的光引导到光传感器。

$$Volume = \frac{1}{2}(Height) \times (Diameter)^2$$