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(54) Blood testing apparatus having a laser source

Bluttestgerät mit Laserquelle

Appareil d'analyse de sang comprenant une source laser

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Description

Field of the Invention

[0001] The invention relates to a blood testing apparatus for determining an analyte, such as fructosamine, lactate, cholesterol, specifically glucose, from minimal quantities amounts of blood extracted immediately prior from a user, and more particularly to creating a cut with a laser source to oridyce a blood sample, and then using the laser source to coagulate the wound.

[0002] The invention deals with blood testing apparatus of the kind that are configured with a membrane-like test means defining a field of measurement, said test means being wetted with the minimal amount of blood extracted and including test reagents, having an evaluation device comprising electronics working optically, preferably using reflectance analysis, or electronically and having a display device, where the aforementioned components form a complete system which can be manipulated as a single apparatus.

[0003] A diagnostic apparatus of this type is known from U.S. patent 4,787,398. This blood glucose monitoring apparatus comprises a housing structure with a push-rod arrangement to actuate a lancing element and having an evaluation device and a display device. For each measurement, a replaceable unit must be positioned in the housing structure, comprising the lancet and a test means to be wetted with blood in the form of a test strip. This replaceable unit is discarded after each use.

[0004] Using this as the point of departure, the object of the present invention is to further develop a blood testing apparatus which has fewer components to be manipulated individually and is thus easier to operate and more user friendly.

[0005] A blood testing apparatus known from EP 0 449 525 A1 similarly comprises an integral release device for a lancing element. Before each use, a new lancing element has to be manually inserted into the release device as part of the blood extraction device and then a test strip has to be inserted into the apparatus.

[0006] U.S. patent 4,627,445 shows a complete system for a glucose measuring apparatus in the aforesaid sense. But before each measurement a new replaceable unit of lancing element and test means has to be assembled to a body and removed afterwards.

[0007] U.S. patent 5,951,492 shows a similar device. According to this publication, a disposable unit comprises a capillary tube on the upper end of which a test strip is provided which is exposed to the minimal quantity of blood extracted. The capillary tube is configured at its lower end with a lancing element. Again, before and after each measurement a new disposable unit of the type just described must be installed or removed. According to a further embodiment, a transverse slot is provided in the area of the face of the apparatus facing the user, through which a porous test membrane with a carrier can be inserted, which is then penetrated by the lancing element in the lancing procedure.

[0008] U.S. patent 6,503,209 describes a blood withdrawal and analysis system which uses a laser energy source to create an incision in the epidermis of a patient. WO 02/41779 also describes a blood testing apparatus for testing a blood sample for determining an analyte.

[0009] According to one example, U.S. patent 5,971,941 shows a complete system in the aforesaid sense, where a cartridge with unused strip-like test means is inserted into a housing and a suitable test means can then brought into a suitable operating position by means of a driver. Through a triggering device, which forms part of the blood extraction device, a lancet contained in a suitable test strip is urged outward by mean of a pushrod to pierce the surface of the user's skin so that capillary blood can be obtained for analysis. More detailed information on how the analysis is performed cannot be obtained from this publication. According to a further embodiment described in this publication, a cylindrical disposable attachment or insert is described which has a lancet and a tablet-shaped test membrane with an opening for the lancing device. This attachment or insert is then inserted into a recess of a pushrod arrangement which forces the lancing element outward to extract blood. Once again, before and after each test procedure the disposable unit must be installed or removed.

SUMMARY OF THE INVENTION

[0010] The object, explained at the beginning, to create a user-friendly improvement of a blood testing apparatus of this type which ensures a safe supply of blood for the test means with the smallest possible quantity of blood, is achieved wider the invention through a plurality of test means which can be inserted into the apparatus and brought into an operating position to perform several measurements in succession where they can interact with the evaluation device. Advantages are achieved by the embodiment indicated by claim 1. Further advantages are achieved by the embodiments indicated by the dependent claims.

[0011] Under the invention, installation or removal before and after each test, measurement or analysis procedure is to be avoided. For this reason, a plurality of test means and preferably a number of lancing elements corresponding exactly to number of test means is furnished in the blood testing apparatus, which can be brought into the operating position in succession and then interact with the blood extraction device when it is actuated or released. A lancing element located in the operating position is driven through the membrane-like test means and pierces the surface of a user's skin, so that the minimal quantity of blood obtained directly wets the membrane-like test means without having to penetrate capillary tubes or slots, which in turn require quantities of blood. Any number of switching and driving means powered mechanically or by an electric motor are

conceivable to move the test or lancing means to the operating position and to actuate the lancing means. The number of test means, which are preferably handled as a unit, and advantageously of the lancing means as well, is preferably 5 to 75, and specifically 14 - 28. The numbers 14 and 28 correspond to a 2 or 4-week rhythm if one analysis is made per day.

[0012] After the evaluation and display of the result of the analysis, or of the blood glucose level, the specific test means is moved from its operating position and the next succeeding test means is brought into the operation position preferably immediately.

[0013] The lancing element could be withdrawn from the test means again before this process. It proves to be advantageous if the lancing element remains in the test means following the lancing procedure and can be removed with it from the operating, position to position a new test means. The lancing element can also be retracted far enough so hat it does not project beyond a finger rest area in the apparatus. However, this is not absolutely necessary.

[0014] In accordance with a further aspect of the invention, it is conceivable that the lancing element is connected to the membrane-like test means before the lancing procedure and can be inserted with it into the apparatus and moved to the operating position The lancing element can already be inserted into the test means or be stuck through it.

[0015] Following a lancing and measurement procedure, spent lancing elements and test means can be ejected individually or together, or they can be taken to a storage and disposal position.

[0016] In a further aspect of the invention, the test means are disposed on a carrier which is movable, preferably rotatable, with respect to a housing base and inserted with the carrier into the housing base of the apparatus. The test means can then be brought in succession to the operating position by rotating the carrier or moved from the operating position to a storage and disposal position.

[0017] The test means are advantageously so disposed on the carrier that their specific surface normal runs in a radial direction with respect to the rotatable carrier. Furthermore, the carrier preferably has an annular configuration and is carried rotatably about the center of the ring.

[0018] Protection against dirt, contamination and the effects of humidity is preferably provided. The carrier can be configured advantageously as a closed cartridge. The carrier can then have apertures which can be closed or withdrawn in the manner of a window or diaphragm to interact with the drive mechanism and allow the lancing element to extend to perform the lancing procedure or allow blood to reach the test means. As further protection, particularly against humidity, the test means can alternatively or additionally be encased in foil covers which can be removed in the operating position.

[0019] The blood extraction device is advantageously housed inside the annulus with the several lancing elements. It is conceivable that a release device, which is known in the art and described in the aforementioned publications, is housed within the annulus. For example, a pushrod-like driver arrangement is implemented, which operates on the side of a lancing element away from the body when located in the operating position such that the lancing element pierces the skin surface of a user. It would also be conceivable that a specific lancing element in the operating position is held in a wedging arrangement between the opposably movable jaws of the driving organ, so that by moving the driving organ forward and back the lancing element can be extended to the outside of the apparatus and retracted again. In any case, the drive unit of the blood extraction device, which thrusts a specific lancing element through the membrane-like test means into the skin surface of a user, forms a part of the housing or base apparatus as does the evaluation and display device The membrane-like test means and the lancing elements, on the other hand, represent disposable elements which are inserted in a predetermined configuration, such as being located on a carrier, into the housing base.

[0020] It proves furthermore to be advantageous if, as already mentioned, the lancing, elements, on a rotatable carrier, preferably on the same carrier as the test means, are inserted into the blood testing apparatus. By rotating the carrier or carriers, a specific lancing element is similarly brought into the operating position, namely into a position where it is struck by the driving organ of the blood extraction device or is gripped in a wedging arrangement and can be moved suddenly to perform the lancing procedure.

[0021] It proves to be of overall advantage if the blood testing apparatus has a basically circular disc-shaped outer contour, as it can thus be gripped and held comfortably in the user's hands.

[0022] In a further aspect of this inventive idea, the apparatus has oppositely located a lancing position for positioning the skin surface to be pierced and a release position to trigger the lancing procedure by manually actuating a release button.

[0023] The apparatus is advantageously held by a user holding the apparatus with two fingers at the lancing position and at the release button. The release button has an advantageous ergonomic shape for grasping by the thumb of a user. It preferably has a pressure point which must be overcome in order to initiate the lancing operation. For safety reasons, it proves to be advantageous if the lancing operation can only initiated when both fingers have taken up their correct position. This could be implemented through contact sensors or through a pressure point mechanism.

[0024] It must be pointed out that instead of a needle or lancet-shaped lancing element, which is moved preferably suddenly in the direction of the skin surface of a user to perform the lancing procedure in a manner known in the art, for example, by releasing a spring-tensioned

driving device, a laser beam can also be used. The required source of laser light is among the non-disposable system components of the blood testing apparatus. With this solution as well, a specific test means can be furnished with an opening through the laser beam can pass.

[0025] In accordance with a further inventive aspect, the blood testing apparatus can be configured in the style of a wrist watch, that is to say it can have a housing base modeled after a wrist watch casing. A viewing side of the blood testing apparatus can then have a face as with a familiar watch, or a digital display. The digital display can be configured to display time and/or additional functions and to display data or information gathered by the blood testing apparatus as needed.

[0026] It can prove further advantageous if the blood testing apparatus has a removable, preferably upwardly pivotable, cover which has access to the interior of the blood testing apparatus, specifically to insert or replace the carrier for the test means and/or lancing elements. In the design of the external appearance of the blood testing apparatus in the style of a wrist watch, or even in the style of a pocket watch, it can prove advantageous if the removable or upwardly pivotable cover simultaneously comprises the face or some other time display device which is raised or pivoted upward with the cover.

[0027] In accordance with another inventive aspect, the cover when opened can reveal a view of a display device in the blood testing apparatus, which can be located either on the inward facing side of the raised cover or is revealed by the removal or upward pivoting of the cover. It can further prove to advantageous if a second removable or upwardly pivotable cover is furnished under the first removable or upwardly pivotable cover, which second cover permits or closes off access to the interior of the blood testing apparatus. This second cover could then contain the display device for the blood testing apparatus on its outer side, which can serve simultaneously as a time display. To read the data and information gathered by the blood testing apparatus, the first cover is opened so that a user can view the display device on the exposed viewing side of the second cover, or on the inner side of the first cover. The second cover is opened only to replace the test means or lancing elements.

[0028] In an aspect of the blood testing apparatus in the style of a wrist watch casing, it proves advantageous if a finger rest is furnished at the "6 o'clock" or "12 o'clock" position to perform the lancing process to draw a minimal amount of blood, or in the respective areas where the watch strap attaches. This permits convenient operability, which also has a positive effect on good wetting function, since the particular test means (when the test means are arranged essentially perpendicular to the radial direction) is aligned horizontally when the blood is extracted, which promotes even wetting.

[0029] In one embodiment of the present invention, a blood testing apparatus is provided that has a test member and a laser source configured to produce a wound from which blood flows. The laser source produces at least a cutting wavelength, and a coagulation wavelength. Electronics for analysis and a display are provided. The test member, laser source, electronics and display form a glucose monitoring system that is integrated in a single apparatus.

[0030] Additional features, details and advantages of the invention can be found in the appended claims and the drawing and the description to follow of a preferred embodiment of the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

[0031]

Figure 1 shows a schematic arrangement of an example blood testing apparatus;

Figure 2 shows a sectional view of the blood testing apparatus from Figure 1;

Figure 3 shows an exploded view of a second example of a blood testing apparatus;

Figure 4 shows an exploded view of the carrier for test means and lancing elements;

Figure 5 shows an isometric view of the assembled blood testing apparatus from Figure 3;

Figure 6 shows an isometric view of a third aspect of a blood testing apparatus in accordance with the invention;

Figure 7 shows an isometric view of the blood testing apparatus from Figure 6 with the first cover raised;

Figure 8 shows an isometric view of the blood testing apparatus from Figure 7 with the first and second covers raised and

Figure 9 shows an isometric view corresponding to Figure 8 of a fourth aspect of the blood testing apparatus in accordance with the invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0032] Figures 1 and 2 show a schematic view of a blood testing system, where Figure 1 represents a view into the interior with the cover removed and Figure 2 represents a schematic sectional view. The blood testing apparatus in the form of a blood glucose measuring apparatus, identified as a whole with the reference numeral 2, comprises a housing base 4 and a removable cover 6. A blood extraction device 8 with a drive mechanism 10 and a lancing element in the form of a needle is accommodated in the interior of the housing base 4. The blood extraction device 8 interacts with a release button

14 on the narrow outer side of the disc-shaped housing base 4. The drive mechanism comprises a driving spring, and a return spring 16, 18, both of which are indicated only schematically. Through mechanical coupling and control means 20, pressing the release button 14 and overcoming a pressure point mechanism 22 releases the drive mechanism 10, so that under the pre-load of the driving spring 16 a plunger 24 moves radially outward at speed, wedging the lancing element 12 between jaws 26 and driving it radially outward and immediately afterward retracting it again slightly under the effect of the return spring 18. The lancing element 12 penetrates forward briefly across the finger rest 28 lying radially opposite the release button on the outside of the housing base 4, which defines a lancing position, and briefly pierces the skin surface of a user with predetermined speed and depth of penetration to allow a minimal quantity of blood to escape.

[0033] According to the invention instead of a lancing element, a laser source is utilized. In one specific embodiment, the laser source is a green diode laser. The green diode laser can have a tubular laser casing with a first opening end and a second opening end, a heat sink sealably mounted at the first opening end of the laser casing.

[0034] The green diode laser can have a semiconductor chip supported by the heat sink for emitting a pumping radiation, and an optical resonant cavity supported within the laser casing. The optical resonant cavity is a lasing medium to optically communicate with the semiconductor chip for a light amplification of fundamental frequency, and an intracavity frequency doubler to optically communicate with the lasing medium for frequency doubling of the fundamental frequency, wherein an input facet is formed at the lasing medium for the pumping radiation entering therein, an output facet is formed at the intracavity frequency doubler for the frequency-double beam exiting therefrom. The optical resonant cavity is defined between the inner and output facets.

[0035] The green diode laser can include an IR blocking filter mounted at the second opening end of the laser casing to optically communicate with the output facet, and a photodiode supported within the laser casing at a position that when the laser beam exits the output facet, the IR blocking filter reflects a portion of the laser beam towards the photodiode such that the photodiode is adapted for detecting the laser beam from the IR blocking filter as a feedback for controlling a power output of the optical resonant cavity. The lasing medium as a non-limiting example, Nd:YAG, Nd:YVO_4,Nd:$GdVO_4$. and the like.

[0036] As a non-limiting example, the intracavity frequency doubler can be KTP, KDP, LBO, BBO, ADP, LilO3, or another non-linear material that is able to efficiently produce an output that is twice the frequency of the signal applied to its input.

[0037] In one embodiment, the lasing medium and the intracavity frequency doubler are combined together, wherein the input facet of the lasing medium is coated with a coating having a high transmissivity at a wavelength of 808 nm and a high reflectance at wavelength of 1064 nm and 532 nm while the output facet of the intracavity frequency doubler is coated with a coating having a high transmissivity at a wavelength of 532 nm and a high reflectance at a wavelength of 1064 nm.

[0038] The photodiode can have a light detecting surface for receiving the laser beam from the IR blocking filter. The light detecting surface of the photodiode can be coated with a coating having a high transmissivity at a wavelength of 532 nm and a high reflectance at wavelength of 1064 nm and 808 nm. Alternatively, a lens filter having a high transmissivity at a wavelength of 532 nm, and a high reflectance at wavelength of 1064 nm and 808 nm can be covered on the light detecting surface of the photodiode.

[0039] As the lancing element 12 moves outward at speed, a membrane-like test means 30, which is located in a manner to be described in greater detail in the immediate vicinity behind the finger rest 28, is penetrated by the lancing element 12. The blood emanating from the skin surface then directly wets the outwardly facing surface of the membrane-like test means 30, which is furnished with reagents.

[0040] As can be seen from the Figures, a plurality of test means 30 is furnished with the lancing elements allocated to each of the test means 30. The test means 30 and the lancing elements 12 are located on an annular carrier 32, for example, eight or ten pairs of test means 30 and lancing elements 12 are located around the circumference or partial circumference of the annular carrier 32. With the cover 6 removed, the carrier 32 can be inserted into a locating device 34 of complementary shape which can be rotated around the center of the ring. Embodiments would also be conceivable in which the cover 6 does not need to be removed in order to insert the carrier 32, but which have a recess open to the top to insert a cassette-type closed carrier 32. This provides protection against dirt, contamination and the effects of humidity. The carrier 32 can have available apertures which can be closed and withdrawn like a window or diaphragm in order to interact with the drive mechanism and allow the lancing means to extend to the outside to perform the lancing procedure or to allow blood to reach the test means. As further protection, specifically against humidity, the test means could alternatively or additionally be covered with foil wrappers which can be removed in the operating position.

[0041] As can be seen from the Figures, the membrane-like test means 3 0 are disposed such that they are disposed with their surface normal in the radial direction with respect to the center of the ring. By actuating a sliding button 36 on the outside of the housing base 4, the locating device 34, and with it the carrier 32 positioned in it and held frictionally in place, are rotated into a discrete further angular position, so that the pairs of test means 30 and lancing elements 12 are brought in suc-

cession into an operating position in which the lancing element 12 can interact with the drive mechanism 10. In this way the blood glucose measuring apparatus is prepared by insertion of the preferably cassette-type carrier 32 with a number, for example, of ten test means 30 and lancing elements 12 for ten measurements. Following a measurement, the button 36 only has to be actuated to bring the next pair of test means 30 and lancing element 12 into the operating position. Additional installation and removal steps before and after a particular measuring procedure are not required. Spent test means 30 and test elements are brought in a clockwise direction with the carrier 32 to a storage or disposal position, which follows the operating position. It would also be conceivable to furnish an ejection mechanism which ejects a particular spent pair for disposal, which is regarded as less preferred since proper disposal must take place immediately. The protected arrangement of the spent pairs inside the cassette-type carrier 32 is preferred instead. After the predetermined number of tests are performed, the cassette-type-like carrier 32 is removed and disposed of and replaced with a new one.

[0042] Because the lancing element 12 penetrates the membrane-like test means 30 in the lancing process, preferably in its center, the test means 30 is ensured of being positioned in immediate proximity to the point of penetration on the skin surface of the user. The blood emanating there is immediately and, most importantly, evenly deposited on the test area of the test means 30, even when only small quantities of blood are available.

[0043] In the aspect shown, the lancing elements 12 are disposed on the carrier 32 such that they perforate the center of the test means 30 when the drive mechanism 10 acts against them. To achieve this, it can prove to be advantageous if the lancing elements 12 are disposed in such a way on the carrier 12 that the point has penetrated into the accompanying test means 30, at least partially in the direction of their thickness. This acts as an aid to positioning. A continuous guide opening can also be furnished in the test means 30. The diameter of the guide opening should preferably be smaller than the outside diameter of the lancing element 12 to prevent blood from penetrating through a gap between the outer surface of the lancing element 12 and the guide opening toward the back side of the test means 30.

[0044] An evaluation device 38 known in the art is also furnished in the interior of the glucose measuring apparatus. An optical, preferably reflectance analysis unit, is indicated schematically in Figure 2. The evaluation device 38 can comprise a light source 40 and a sensor 42 for the reflectance measurement of the change of color of the back side of the membrane-like test means 30, where the analysis reaction 38 of the glucose contained in the blood sample with the test or proof reagents takes place (enzymatic redox reaction). The principles of an optical analysis device are described, for example, in EP-A-0 654 659 and EP-A-0 475 692.

[0045] In the case where the electrochemical measurement principle is applied, the optical evaluation device is dispensed with. The enzymatic redox reaction is quantified instead through the detection of electrical current or voltage at an electrode (described, for example, in EP-A-0 552 223).

[0046] The evaluation device 38 comprises in a known way electronics for analysis which interact with a display device 44 which indicates, for example, in the form of an LCD display the test result, perhaps the blood glucose content. By means of the evaluation device, additional evaluation and display functions and comparisons with previously stored measurement or evaluation data could be performed, saved if necessary and their result displayed.

[0047] The blood testing apparatus under the invention thus represents a complete system which does not require the separate manipulation of test strips or lancets during the blood glucose measurement. By inserting the cassette-type carrier 32 with test means 30 and lancing elements 12, the apparatus is prepared for a specific number of measurements, for which no additional installation or removal steps or the separate manipulation of additional aids is required.

[0048] Figures 3 to 5 show a second aspect of the blood testing apparatus, where components identical to the first aspect are identified with the same reference numeral. In accordance with this aspect, the blood testing apparatus has a housing base 4 modeled after or approximating the basic shape of a wrist watch casing, where the dimensions, specifically the depth of the housing base 4, can be enlarged compared with traditional wrist watch casings. Further indicated are installation areas 45 for a specifically flexible pin of a normal watch strap. A dome-shaped centering means 46 is depicted in the interior of the housing base 4, which appears cuboid in plan view but which has two segmental side sections 48 which are configured concentric to an axis of rotation 50 and provide a positioning aid when inserting a carrier 32 for test means 30 and lancing elements 12. Further, a servo motor 52 (not shown in detail) is housed in the centering means 46.

[0049] The servo motor 52 can serve to move the carrier 32 to move a spent test means 30 from an operating position to a disposal position and simultaneously to position a still unused test means 30 in the operating position. It is not entirely excluded that the servo motor 52 can also serve to power the only schematically represented drive mechanism 10. The drive coupling of the servo motor 52 with the carrier 32 could, for example, be formed through a pinion gear, crown wheel, bevel gear or miter gear connection between a rotatingly driven wheel of the servo motor 52 and correspondingly configured, specifically sprocket-shaped matching gear means or the carrier 32.

[0050] As shown in Figures 3 and 4, the carrier 32 is configured in the shape of an annular disc-shaped cassette 54. The cassette comprises a lower housing section 56 with an annular disc-shaped floor section 58 with a

circular access opening 60 and with circumferential wall section 62 running cylindrically on the outer periphery. The test means 30 are furnished in appropriate recesses 64 in the circumferential wall section 62 in a concentric arrangement around the axis of rotation 50. A similarly shaped upper housing section 68, which comprises a number of radially aligned lancing elements 12 corresponding to the number of test means 30, can be inserted into the lower housing section 56. Spring means 69 can also be seen, specifically in the form of closed loops, which hold the lancing elements 12. When the skin surface of a user is pierced, these spring elements 69 are tensioned and are able to retract the particular lancing element 12 again following the penetration through the drive mechanism 10. This arrangement of lancing elements 12 is located radially outside the aforementioned opening 60 and thus radially outside the dome-shaped centering means 46, which simultaneously comprises the drive mechanism 10 which is disposed radially inside the arrangement of lancing elements 12. The lower housing section 56 and the upper housing section 68 inserted into it are joined together so that they cannot turn and can be rotated in common as a carrier 32 around the axis 50 to bring test means 30 and lancing elements 12 into the operating position, or shift them from the operating position to a disposal position.

[0051] The button 36 schematically represented in Figure 3 is linked to the drive mechanism 10 to actuate it. The control rod 66 suggested there running radially runs either above or below the carrier 32. As mentioned, the actuation of the drive mechanism 10 could also be achieved with a motor, preferably electrically controlled.

[0052] Finally the blood testing apparatus comprises a cover 6 which can be modeled after the face of an electronic watch and can have a display device 44, for example, in the form of an LCD display. This cover then forms the viewing side of the blood testing apparatus, as can be seen from Figure 5.

[0053] Figure 6 shows an isometric view corresponding to Figure 5 of a blood testing apparatus with a watch face 68 on the viewing side of a pivotally articulated cover 6. It should also be mentioned that a finger rest 28 is furnished at the "6 o'clock" position with reference to the face 68, which forms the operating position in which the skin surface is briefly penetrated by the lancing element 12 when the drive mechanism 10 is released. This arrangement proves to be advantageous insofar as the user (standing) can place the hand on the stomach when performing the lancing procedure and then position the thumb of the other hand on the finger rest 28. When the lancing process is triggered in this position, the membrane-like test means 30 is disposed essentially horizontally and the minimal amount of blood can wet the test means following gravity.

[0054] Figure 7 shows the blood testing apparatus from Figure 6 with the first cover 6 pivoted up so that the view of the upper side of a second cover 7 is uncovered where, in accordance with this embodiment, the display device 44 for the blood testing apparatus is located. The display device 44 for the blood testing apparatus is thus separated spatially from the face 68 or the display unit for time. Naturally, the display device 44 could also serve to display time.

[0055] Figure 8 shows the blood testing apparatus from Figure 7 with the second cover 70 likewise raised so that access to the housing base 4 for inserting and removing a carrier cartridge is possible.

[0056] Finally, Figure 9 shows an isometric view corresponding to Figure 8 of a further embodiment, according to which the display device 44 for blood analysis is furnished on the inner side of the first cover 6.

Claims

1. A blood testing apparatus comprising:

at least one test member (30);
a humidity cover (4, 6) positioned around the at least one test member (30), the humidity cover (4, 6) being at least partially removable (6);
a laser source (8), configured to produce a wound from which blood flows, the laser source (8) producing at least a cutting wavelength and a coagulation wavelength, the laser source (8) including an IR blocking filter that reflects a portion of the laser beam towards a photodiode such that the photodiode is adapted for detecting the laser beam from the IR blocking filter as a feedback for controlling a power output of an optical resonant cavity;
electronics for analysis, the electronics further including an evaluation device (38) that provides for comparisons with previously stored measurements or evaluation data with the evaluation device (38) storing a current test measurement, and
a display (44), wherein the test member (30), laser source (8), electronics and display (44) form a glucose monitoring system (2) that is integrated in a single apparatus; **characterised in that** the laser source is configured to coagulate the wound, by means of the laser source producing the coagulation wavelength, wherein the test member (30) includes an opening (28) from which a beam from the laser can pass through.

2. The apparatus of claim 1, wherein the laser source is a green diode laser.

3. The apparatus of claim 2, further comprising:

a tubular casing for the laser, the casing comprising a first opening end, a second opening end and a heat sink sealbly mounted at the first

opening end of the casing;
a semiconductor chip supported by the heat sink for emitting a pumping radiation; and
the optical resonant cavity is supported within the laser casing, the optical resonant cavity being a lasing medium capable of optically communicating with the semiconductor chip to amplify the fundamental frequency.

4. The apparatus according to claim 3, further comprising:

an intracavity frequency doubler capable of optically communicating with the laser frequency for doubling of the fundamental frequency; and
wherein an input facet is formed at the lasing medium for the pumping radiation entering therein, an output facet is formed at the intracavity frequency doubler for the frequency-double beam exiting therefrom; and
the optical resonant cavity is defined between the inner and outer facets.

5. The apparatus of claim 4, wherein:

the IR blocking filter is mounted at the second opening end of the laser casing to optically communicate with the output facet; and
the photodiode is supported within the laser casing such that when the laser beam exits the output facet, the IR blocking filter reflects a portion of the laser beam towards the photodiode.

6. The apparatus of any preceding claim , wherein the photodiode can have a light detecting surface for receiving the laser beam from the IR blocking filter, preferably the light detecting surface is:

(i) coated with a coating having a high transmissivity at a wavelength of 532 nm and a high reflectance at wavelength of 1064 nm and 808 nm; or
(ii) covered with a lens filter having a high transmissivity at a wavelength of 532 nm, and a high reflectance at wavelength of 1064 nm and 808 nm.

7. The apparatus of any one of claims 3 to 6, wherein the lasing medium is selected from Nd:YAG; Nd:YVO4; and Nd:GdVO4.

8. The apparatus of any one of claims 4 to 6, wherein the intracavity frequency doubler can be KTP, KDP, LBO, BBO, ADP, or UIO3.

9. The apparatus of any one of claims 4 to 8, wherein the lasing medium and the intracavity frequency doubler are combined together, and wherein the input facet of the lasing medium is coated with a coating having a high transmissivity at a wavelength of 808 nm and a high reflectance at wavelength of 1064 nm and 532 nm, and the output facet of the intracavity frequency doubler is coated with a coating having a high transmissivity at a wavelength of 532 nm and a high reflectance at a wavelength of 1064 nm.

10. The apparatus of any preceding claim, wherein the laser source (8) is (i) a single diode laser source; or (ii) includes a first diode laser and a second diode laser.

11. The apparatus of any preceding claim, wherein the cutting wavelength is 532 nm and the coagulation wavelength is 1064 nm.

12. The apparatus of any preceding claim, further comprising:

a plurality of test members (30), wherein the plurality of test members (30), laser source (8), electronics and display (44) form a glucose monitoring system (2) that is integrated in a single apparatus.

13. The apparatus of claim 12, wherein the plurality of test members (30) are arranged radially around an axis of rotation (50) of a rotatable, disposable device (32) having a circumferential wall section that runs cylindrically on an outer periphery, each of the test member (30) and the at least one laser source (8) having a longitudinal axis that is substantially perpendicular relative to the axis of rotation, and wherein the test members (30) are disposed with surfaces normal in a radial direction with respect to a center of the rotatable, disposable device (32).

Patentansprüche

1. Bluttestvorrichtung, umfassend:

mindestens ein Testelement (30);
eine Feuchtigkeitsabdeckung (4, 6), die um mindestens ein Testelement (30) herum angeordnet ist, wobei die Feuchtigkeitsabdeckung (4, 6) mindestens teilweise abnehmbar (6) ist;
eine Laserquelle (8), die konfiguriert ist, um eine Wunde zu erzeugen, aus der Blut fließt; wobei die Laserquelle (8) mindestens eine Schneidwellenlänge und eine Koagulationswellenlänge produziert, wobei die Laserquelle (8) einen IR-Sperrfilter umfasst, der einen Anteil des Laserstrahls in Richtung einer Photodiode derart reflektiert, dass die Photodiode für das Erfassen des Laserstrahls von dem IR-Sperrfilter als Rückkopplung zur Steuerung einer Leistungs-

abgabe eines optischen Hohlraumresonators eingerichtet ist;
Elektronik zur Analyse, wobei die Elektronik ferner eine Auswerteeinrichtung (38) aufweist, die Vergleiche von vorher gespeicherten Messungen oder Bewertungsdaten mit der Auswerteeinrichtung (38), die eine aktuelle Testmessung speichert, ermöglicht, und
eine Anzeige (44), wobei das Testelement (30), die Laserquelle (8), die Elektronik und die Anzeige (44) ein Glukoseüberwachungssystem (2) bilden, das in einer einzigen Vorrichtung integriert ist;
dadurch gekennzeichnet, dass die Laserquelle konfiguriert ist, die Wunde mittels der Laserquelle, welche die Koagulationswellenlänge produziert, zu koagulieren, wobei das Testelement (30) eine Öffnung (28) aufweist, durch die ein Strahl des Lasers sich hindurchbewegen kann.

2. Vorrichtung nach Anspruch 1, wobei die Laserquelle ein grüner Diodenlaser ist.

3. Vorrichtung nach Anspruch 2, ferner umfassend:

ein rohrförmiges Gehäuse für den Laser, wobei das Gehäuse ein erstes Öffnungsende, ein zweites Öffnungsende und einen Kühlkörper, der abdichtend an dem ersten Öffnungsende des Gehäuses befestigt ist;
einen Halbleiterchip, der durch den Kühlkörper gestützt wird, zum Aussenden einer Pumpstrahlung; und
der optische Hohlraumresonator innerhalb des Lasergehäuses gelagert ist, wobei der optische Hohlraumresonator ein Lasermedium ist, das zur optischen Kommunikation mit dem Halbleiterchip zur Verstärkung der Grundfrequenz in der Lage ist.

4. Vorrichtung nach Anspruch 3, ferner umfassend:

einen Intracavity-Frequenzverdoppler, der zur optischen Kommunikation mit der Laserfrequenz zur Verdopplung der Grundfrequenz in der Lage ist; und wobei eine Eintrittsfacette an dem Lasermedium für das Eintreten der Pumpstrahlung darin ausgebildet ist, wobei eine Austrittsfacette an dem Intracavity-Frequenzverdoppler für das Austreten des Frequenz-Doppelstrahls daraus ausgebildet ist; und
der optische Hohlraumresonator zwischen der Eintritts- und der Austrittsfacette definiert ist.

5. Vorrichtung nach Anspruch 4, wobei:

der IR-Sperrfilter an dem zweiten Öffnungsende des Lasergehäuses befestigt ist, um optisch mit der Austrittsfacette zu kommunizieren; und
die Photodiode innerhalb des Lasergehäuses derart gelagert ist, dass, wenn der Laserstrahl aus der Austrittsfacette austritt, der IR-Sperrfilter einen Anteil des Laserstrahls in Richtung der Photodiode reflektiert.

6. Vorrichtung nach einem der vorhergehenden Ansprüche, wobei die Photodiode eine lichterfassende Oberfläche zum Empfangen des Laserstrahls von dem IR-Sperrfilter aufweisen kann, wobei die lichterfassende Oberfläche vorzugsweise:

(i) mit einer Beschichtung überzogen ist, die eine hohe Durchlässigkeit bei einer Wellenlänge von 532 nm und einen hohen Reflexionsgrad bei Wellenlängen von 1064 nm und 808 nm aufweist; oder
(ii) mit einem Linsenfilter abgedeckt ist, das eine hohe Durchlässigkeit bei einer Wellenlänge von 532 nm und einen hohen Reflexionsgrad bei Wellenlängen von 1064 nm und 808 nm aufweist.

7. Vorrichtung nach einem der Ansprüche 3 bis 6, wobei das Lasermedium ausgewählt ist aus Nd:YAG; Nd:YVO_4; und Nd: $GdVO_4$.

8. Vorrichtung nach einem der Ansprüche 4 bis 6, wobei der Intracavity-Frequenzverdoppler KTP, KDP, LBO, BBO, ADP, oder UIO3 sein kann.

9. Vorrichtung nach einem der Ansprüche 4 bis 8, wobei das Lasermedium und der Intracavity-Frequenzverdoppler miteinander kombiniert sind, und wobei die Eintrittsfacette des Lasermediums mit einer Beschichtung überzogen ist, die eine hohe Durchlässigkeit bei einer Wellenlänge von 808 nm und einen hohen Reflexionsgrad bei Wellenlängen von 1064 nm und 532 nm aufweist; und die Austrittsfacette des Intracavity-Frequenzverdopplers mit einer Beschichtung überzogen ist, die eine hohe Durchlässigkeit bei einer Wellenlänge von 532 nm und einen hohen Reflexionsgrad bei einer Wellenlänge von 1064 nm aufweist.

10. Vorrichtung nach einem der vorhergehenden Ansprüche, wobei die Laserquelle (8) (i) eine einzelne Diodenlaserquelle ist; oder (ii) einen ersten Diodenlaser und einen zweiten Diodenlaser aufweist.

11. Vorrichtung nach einem der vorhergehenden Ansprüche, wobei die Schneidwellenlänge bei 532 nm ist und die Koagulationswellenlänge bei 1064 nm ist.

12. Vorrichtung nach einem der vorhergehenden Ansprüche, ferner umfassend:

mehrere Testelemente (30), wobei die mehreren Testelemente (30), die Laserquelle (8), die Elektronik und die Anzeige (44) ein Glukoseüberwachungssystem (2) bilden, das in einer einzigen Vorrichtung integriert ist.

13. Vorrichtung nach Anspruch 12, wobei die mehreren Testelemente (30) radial um eine Rotationsachse (50) einer drehbaren Einwegvorrichtung (32) angeordnet sind, die einen Umfangswandabschnitt aufweist, der zylindrisch auf einem Außenumfang verläuft, wobei jedes der Testelemente (30) und die mindestens eine Laserquelle (8) eine Längsachse aufweisen, die im Wesentlichen senkrecht relativ zu der Drehachse ist, und wobei die Testelemente (30) mit den Oberflächen in einer radialen Richtung senkrecht in Bezug auf ein Zentrum der drehbaren Einwegvorrichtung (32) angeordnet sind.

Revendications

1. Appareil d'analyse de sang comprenant :

au moins un élément d'analyse (30) ;
un couvercle anti-humidité (4, 6) positionné autour de l'au moins un élément d'analyse (30), le couvercle anti-humidité (4, 6) étant au moins partiellement amovible (6) ;
une source laser (8), configurée pour générer une blessure à partir de laquelle du sang s'écoule, la source laser (8) générant au moins une longueur d'onde d'incision et une longueur d'onde de coagulation, la source laser (8) comportant un filtre bloquant les IR qui réfléchit une partie du faisceau laser vers une photodiode de telle sorte que la photodiode est adaptée pour détecter le faisceau laser provenant du filtre bloquant les IR comme un retour servant à réguler une puissance de sortie d'une cavité optique résonante ;
une électronique d'analyse, l'électronique comportant en outre un dispositif d'évaluation (38) qui permet des comparaisons avec des mesures préalablement stockées ou des données d'évaluation avec le dispositif d'évaluation (38) stockant une mesure d'analyse en cours ; et
un afficheur (44), l'élément d'analyse (30), la source laser (8), l'électronique et l'afficheur (44) formant un système de surveillance du glucose (2) qui est intégré dans un seul appareil ;
caractérisé en ce que la source laser est configurée pour coaguler la blessure, au moyen de la source laser générant la longueur d'onde de coagulation, l'élément d'analyse (30) comportant une ouverture (28) depuis laquelle un faisceau provenant du laser peut traverser.

2. Appareil selon la revendication 1, dans lequel la source laser est une diode laser verte.

3. Appareil selon la revendication 2, comprenant en outre :

une enveloppe tubulaire pour le laser, l'enveloppe comprenant une première extrémité d'ouverture, une deuxième extrémité d'ouverture et un dissipateur thermique monté de façon étanche à la première extrémité d'ouverture de l'enveloppe ;
une puce semi-conductrice soutenue par le dissipateur thermique pour émettre un rayonnement de pompage ; et
dans lequel la cavité optique résonante est soutenue à l'intérieur de l'enveloppe du laser, la cavité optique résonante étant un milieu actif capable de communiquer optiquement avec la puce semi-conductrice pour amplifier la fréquence fondamentale.

4. Appareil selon la revendication 3, comprenant en outre :

un doubleur de fréquence intracavité capable de communiquer optiquement avec la fréquence laser pour un doublement de la fréquence fondamentale ; et
dans lequel une facette d'entrée est formée au niveau du milieu actif pour le rayonnement de pompage y entrant, une facette de sortie est formée au niveau du doubleur de fréquence intracavité pour le faisceau de fréquence double en sortant ; et
la cavité optique résonante est définie entre les facettes interne et externe.

5. Appareil selon la revendication 4, dans lequel :

le filtre bloquant les IR est monté à la deuxième extrémité d'ouverture de l'enveloppe du laser pour communiquer optiquement avec la facette de sortie ; et
la photodiode est soutenue à l'intérieur de l'enveloppe du laser de telle sorte que lorsque le faisceau laser sort par la facette de sortie, le filtre bloquant les IR réfléchit une partie du faisceau laser vers la photodiode.

6. Appareil selon une quelconque revendication précédente, dans lequel la photodiode peut avoir une surface de détection de lumière destinée à recevoir le faisceau laser provenant du filtre bloquant les IR, la surface de détection de lumière étant de préférence :

(i) recouverte par un revêtement ayant une transmissivité élevée à une longueur d'onde de

532 nm et un facteur de réflexion élevé à une longueur d'onde de 1064 nm et 808 nm ; ou
(ii) recouverte par un filtre à lentille ayant une transmissivité élevée à une longueur d'onde de 532 nm et un facteur de réflexion élevé à une longueur d'onde de 1064 nm et 808 nm.

7. Appareil selon l'une quelconque des revendications 3 à 6, dans lequel le milieu actif est choisi parmi le Nd:YAG, le Nd:YVO_4, et le Nd:$GdVO_4$.

8. Appareil selon l'une quelconque des revendications 4 à 6, dans lequel le doubleur de fréquence intracavité peut être du KTP, du KDP, du LBO, du BBO, de l'ADP, ou de l'UIO_3.

9. Appareil selon l'une quelconque des revendications 4 à 8, dans lequel le milieu actif et le doubleur de fréquence intracavité sont combinés, et dans lequel la facette d'entrée du milieu actif est recouverte d'un revêtement ayant une transmissivité élevée à une longueur d'onde de 808 nm et un facteur de réflexion élevé à une longueur d'onde de 1064 nm et 532 nm, et la facette de sortie du doubleur de fréquence intracavité est recouverte d'un revêtement ayant une transmissivité élevée à une longueur d'onde de 532 nm et un facteur de réflexion élevé à une longueur d'onde de 1064 nm.

10. Appareil selon une quelconque revendication précédente, dans lequel la source laser (8) (i) est une source à une seule diode laser ; ou (ii) comporte une première diode laser et une deuxième diode laser.

11. Appareil selon une quelconque revendication précédente, dans lequel la longueur d'onde d'incision est de 532 nm et la longueur d'onde de coagulation est de 1064 nm.

12. Appareil selon une quelconque revendication précédente, comprenant en outre :

une pluralité d'éléments d'analyse (30), la pluralité d'éléments d'analyse (30), la source laser (8), l'électronique et l'afficheur (44) formant un système de surveillance du glucose (2) qui est intégré dans un seul appareil.

13. Appareil selon la revendication 12, dans lequel la pluralité d'éléments d'analyse (30) est disposée radialement autour d'un axe de rotation (50) d'un dispositif rotatif jetable (32) ayant une section de paroi circonférentielle qui court cylindriquement sur une périphérie extérieure, chacun des éléments d'analyse (30) et l'au moins une source laser (8) ayant un axe longitudinal qui est sensiblement perpendiculaire à l'axe de rotation, et dans lequel les éléments d'analyse (30) sont disposés avec des surfaces normales dans une direction radiale par rapport à un centre du dispositif rotatif jetable (32).

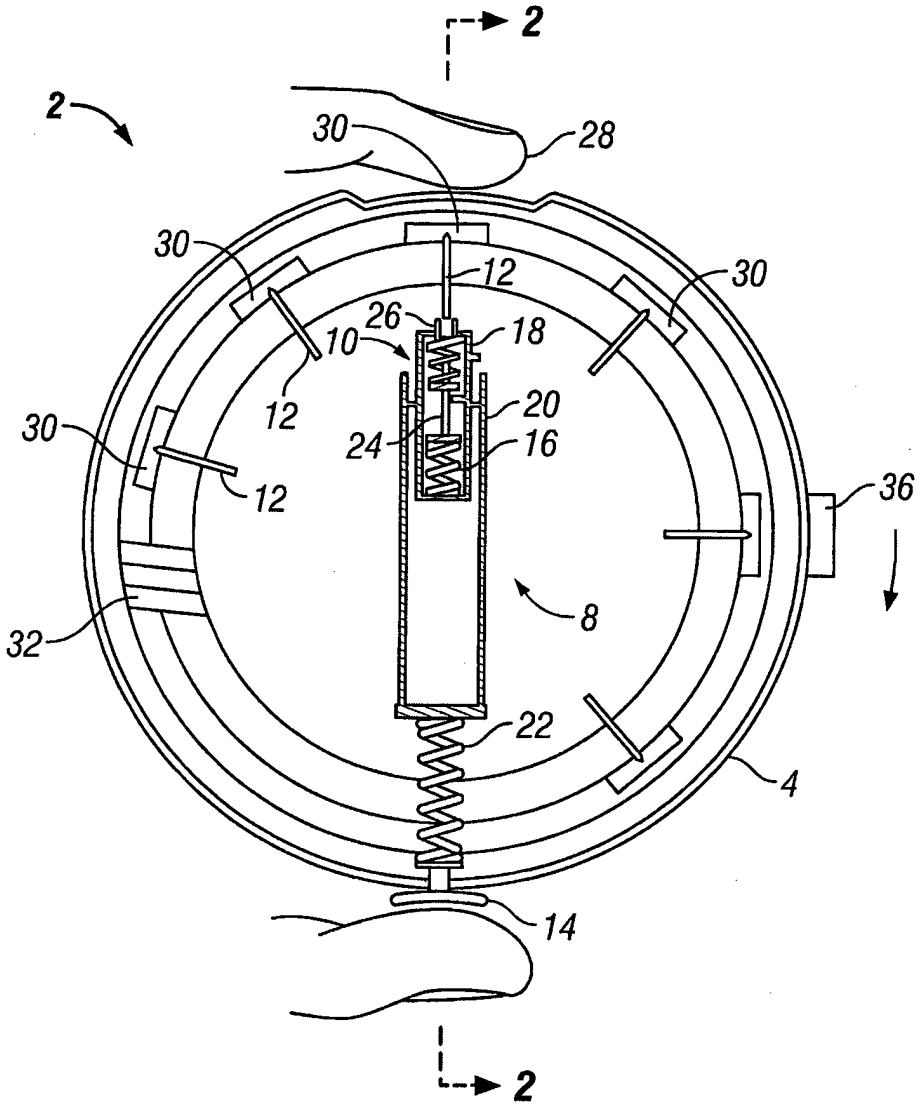
2
2
30
28
30
12
30
26
10
18
12
20
24
16
30
12
36
32
8
22
4
14
2

FIG. 1

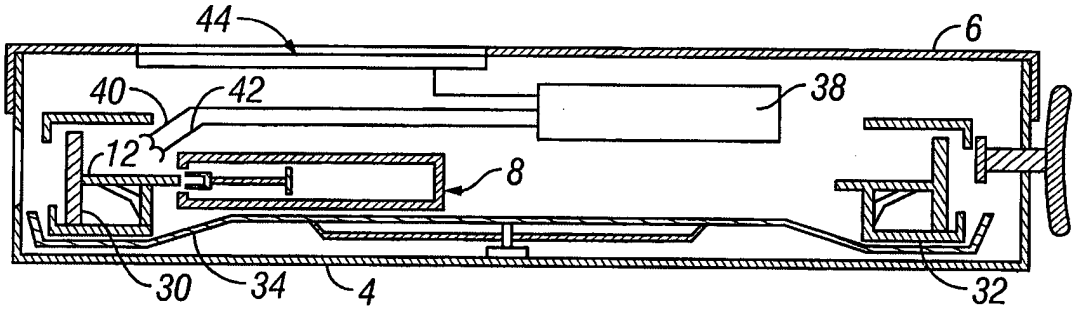
44
6
40
42
38
12
8
30
34
4
32

FIG. 2

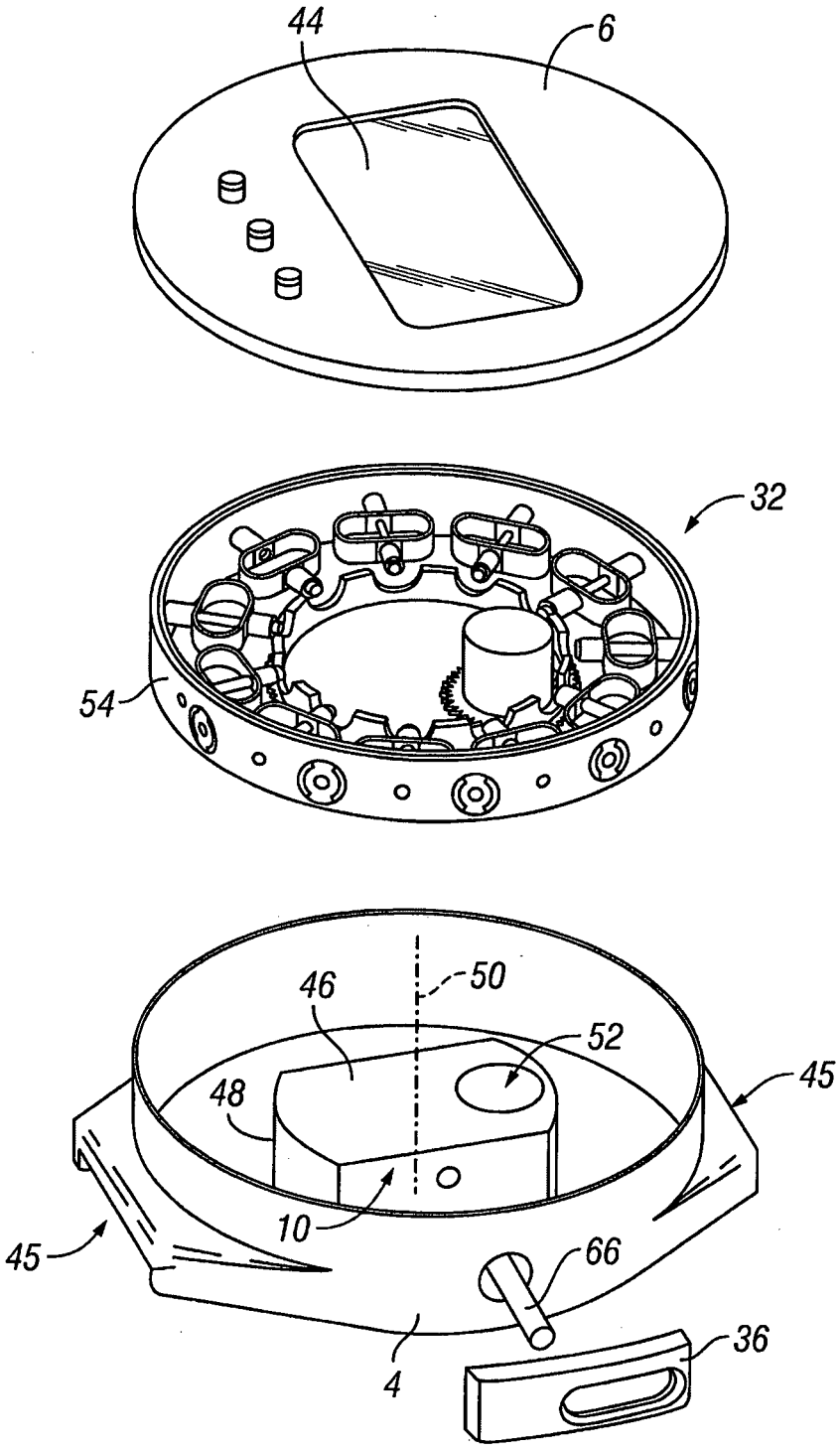

FIG.3

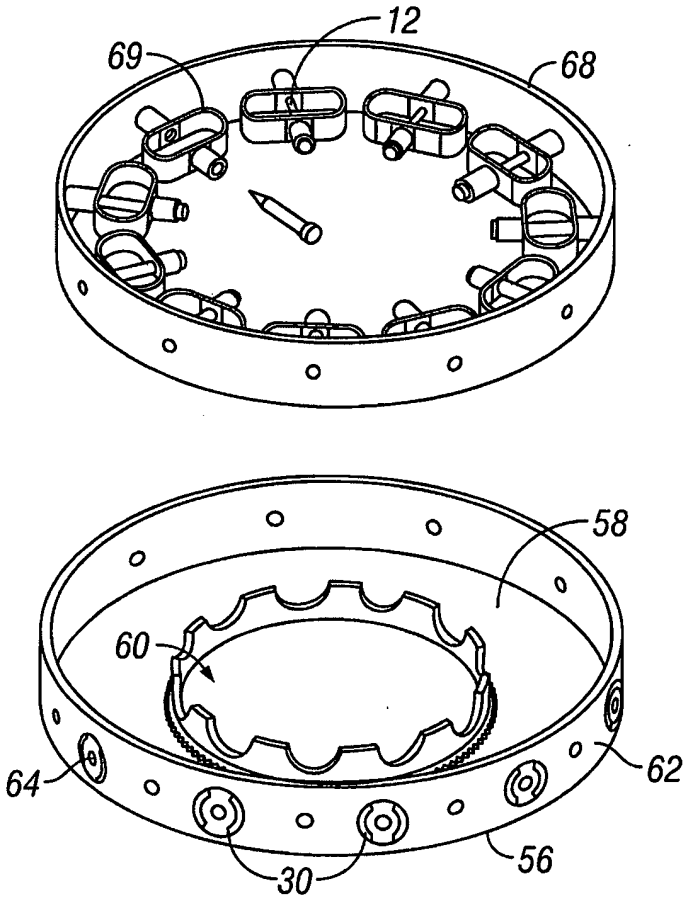

FIG. 4

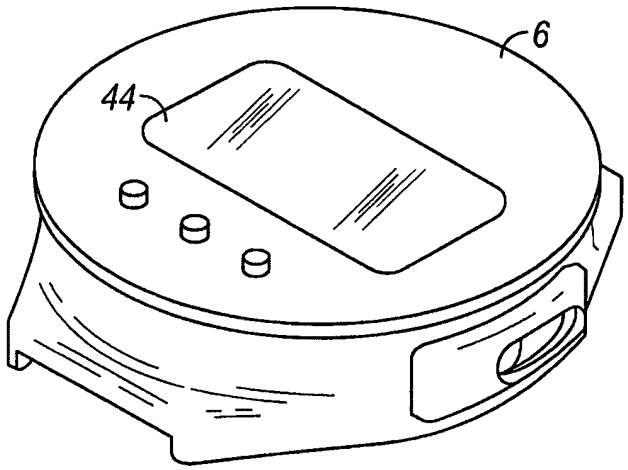

FIG. 5

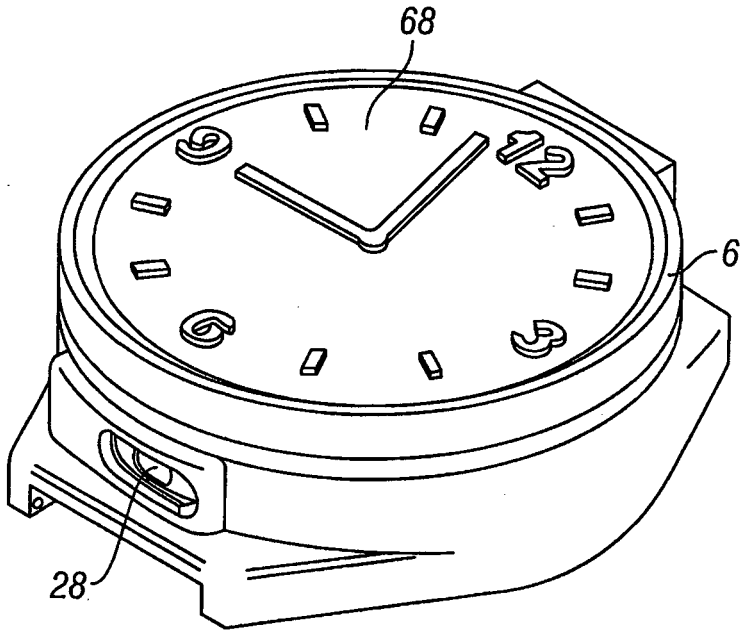

FIG. 6

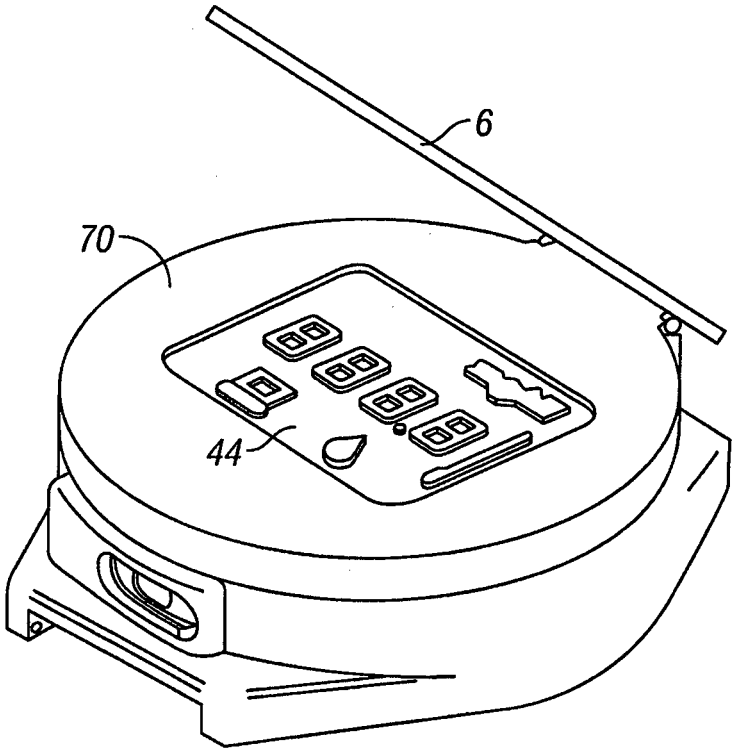

FIG. 7

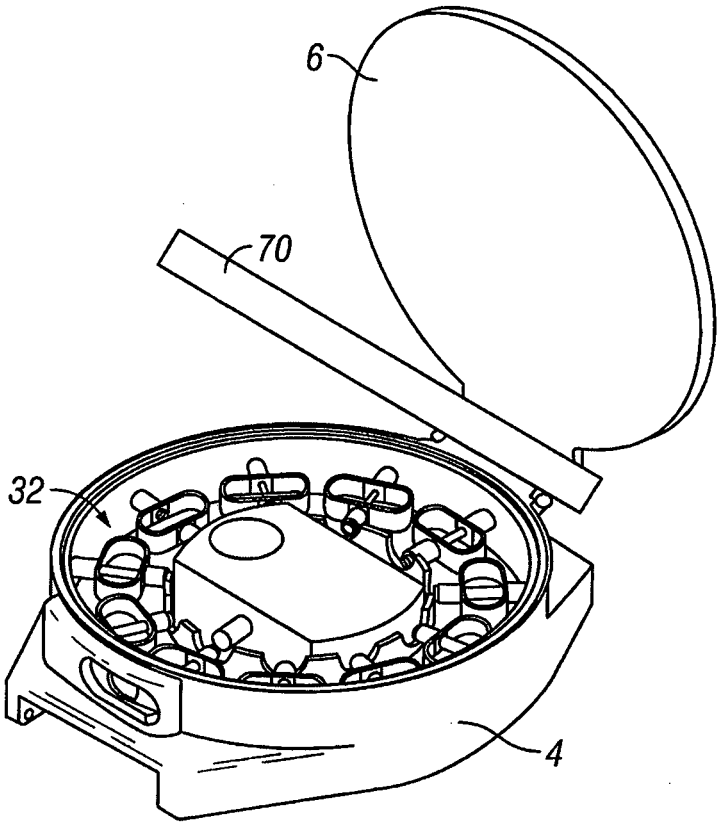

FIG. 8

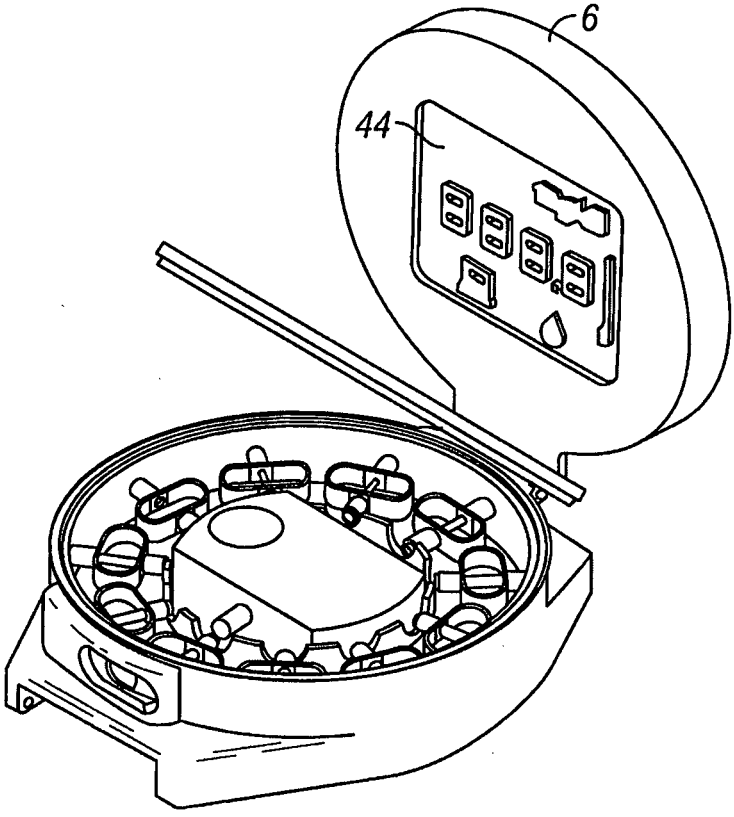

FIG. 9

REFERENCES CITED IN THE DESCRIPTION

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专利名称(译)	具有激光源的血液检查装置		
公开(公告)号	EP2278919B1	公开(公告)日	2015-11-04
申请号	EP2009735425	申请日	2009-04-23
[标]申请(专利权)人(译)	佩利坎技术公司		
申请(专利权)人(译)	PELIKAN科技股份有限公司.		
当前申请(专利权)人(译)	SANOFI-AVENTIS DEUTSCHLAND GMBH		
[标]发明人	FREEMAN DOMINIQUE M WURSTER THOMAS MALOWANIEC KRZYSZTOF D DIEKMANN CHRISTOPH		
发明人	FREEMAN, DOMINIQUE, M. WURSTER, THOMAS MALOWANIEC, KRZYSZTOF, D. DIEKMANN, CHRISTOPH		
IPC分类号	A61B5/157 A61B5/15 A61B5/151 A61B5/145 A61B5/1455 A61B5/00 G01N33/96		
CPC分类号	A61B5/14532 A61B5/1455 A61B5/150022 A61B5/150259 A61B5/150412 A61B5/150503 A61B5/150572 A61B5/15113 A61B5/15117 A61B5/1513 A61B5/15146 A61B5/15151 A61B5/15161 A61B5/15176 A61B5/157 A61B5/681 G01N33/96		
代理机构(译)	朋友SHIPLEY LLP		
优先权	12/108164 2008-04-23 US		
其他公开文献	EP2278919A1 EP2278919A4		
外部链接	Espacenet		

摘要(译)

血液检查装置包括激光源和至少一个检查部件，该激光源被构造成产生血液从其流过的伤口。 湿气罩位于至少一个测试构件处。 防潮罩至少部分可拆卸。 提供电子产品进行分析。 电子设备包括评估装置，用于与先前存储的测量结果进行比较或评估数据，其中评估装置存储当前的测试测量结果。

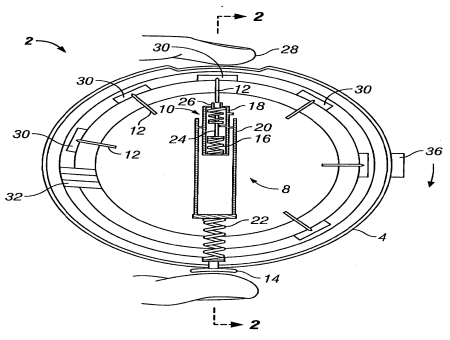

FIG. 1

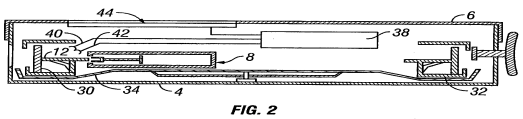

FIG. 2