

Provisional Application for Patent Cover Sheet

This is a request for filing a PROVISIONAL APPLICATION FOR PATENT under 37 CFR 1.53(c)

Inventor(s)

Inventor 1

Remove

Given Name

Middle Name

Family Name

City

State

Country i

Manson

Fei

Hong Kong

CN

All Inventors Must Be Listed – Additional Inventor Information blocks may be generated within this form by selecting the **Add** button.

Add

Title of Invention

LENS MOUNTED OPTICAL SENSOR ARRANGEMENT

Attorney Docket Number (if applicable)

PHCA142355

Correspondence Address

Direct all correspondence to (select one):

☒ The address corresponding to Customer Number

☐ Firm or Individual Name

Customer Number

26389

The invention was made by an agency of the United States Government or under a contract with an agency of the United States Government.

☒ No.

☐ Yes, the invention was made by an agency of the United States Government. The U.S. Government agency name is:

☐ Yes, the invention was under a contract with an agency of the United States Government. The name of the U.S. Government agency and Government contract number are:

Entity Status

Applicant asserts small entity status under 37 CFR 1.27 or applicant certifies micro entity status under 37 CFR 1.29

- ☒ Applicant asserts small entity status under 37 CFR 1.27
- ☐ Applicant certifies micro entity status under 37 CFR 1.29. Applicant must attach form PTO/SB/15A or B or equivalent.
- ☐ No

Warning

Petitioner/applicant is cautioned to avoid submitting personal information in documents filed in a patent application that may contribute to identity theft. Personal information such as social security numbers, bank account numbers, or credit card numbers (other than a check or credit card authorization form PTO-2038 submitted for payment purposes) is never required by the USPTO to support a petition or an application. If this type of personal information is included in documents submitted to the USPTO, petitioners/applicants should consider redacting such personal information from the documents before submitting them to USPTO. Petitioner/applicant is advised that the record of a patent application is available to the public after publication of the application (unless a non-publication request in compliance with 37 CFR 1.213(a) is made in the application) or issuance of a patent. Furthermore, the record from an abandoned application may also be available to the public if the application is referenced in a published application or an issued patent (see 37 CFR 1.14). Checks and credit card authorization forms PTO-2038 submitted for payment purposes are not retained in the application file and therefore are not publicly available.

Signature

Please see 37 CFR 1.4(d) for the form of the signature.

Signature	/James W. Anable/			Date (YYYY-MM-DD)	2014-04-07
First Name	James	Last Name	Anable	Registration Number (If appropriate)	26827

This collection of information is required by 37 CFR 1.51. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 8 hours to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. **DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. This form can only be used when in conjunction with EFS-Web. If this form is mailed to the USPTO, it may cause delays in handling the provisional application.**

Privacy Act Statement

The Privacy Act of 1974 (P.L. 93-579) requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that : (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C. 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether disclosure of these records is required by the Freedom of Information Act.
2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.
3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.
4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).
5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.
6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).
7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.
8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspection or an issued patent.
9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

LENS MOUNTED OPTICAL SENSOR ARRANGEMENT

BACKGROUND

This invention relates generally to devices that use non-invasive electro-optical technology for sensing and measuring physiological parameters. More particularly, the invention relates to arrangements for the mounting of optical sensors in physiological monitoring devices that are worn by a user.

Numerous portable devices have been developed in which optical sensors are used to detect variation in blood flow through arteries or blood volume in subcutaneous tissue. Applications include the monitoring of heart rate, glucose level, apnea, respiratory stress, and other physiological conditions. The optical sensor of such arrangements include one or more light sources that illuminate a targeted portion of the human body and one or more associated optical detectors that receive a portion of the optical energy emitted by the light sources. There are two basic types of such arrangements. In transmissive sensor arrangements, a relatively thin portion of the body such as the tip of the finger or the earlobe is positioned between a light source and a photo detector. Light that passes through the body tissue impinges on the photo detector resulting in an electrical signal that is synchronized to each heartbeat. In reflective sensor arrangements, a sensor that includes one or more light sources located in spaced apart juxtaposition with a photo detector is positioned against a targeted area of the body. Optical energy emitted by the light sources passes through the skin of the targeted tissue region, is scattered, partially absorbed, and is reflected by blood flowing through arteries and other vascular structure. The reflected optical energy is in effect modulated in accordance with blood flow in the targeted area and causes the photo detector to produce a signal pulse that is synchronized to each heartbeat. In both transmissive and reflective arrangements, the signal produced by the photo detectors is processed to display or otherwise provide a real time indication of the monitored physiological parameter.

One area of growing interest of the use of physiological monitors is with respect to personal wellness and/or physical exercise for purposes of fitness training and weight loss. Technological advances relating to optical sensors, signal processing, and display devices have made it possible to realize small, light-weight physiological monitors that can be embodied as armbands or bracelets that are comfortably worn by a user. For

example, the embodiment of the invention described herein provides the optical sensor for a heart rate monitor that is included in a wrist watch.

Providing physiological monitors for wellness and physical exercise applications is subject to numerous design and manufacturing considerations. For example, the electronic circuitry for processing the signal produced by the photo detector and displaying an indication of the monitored parameter must operate at a low power level to provide adequate battery life while simultaneously providing sufficient accuracy. Constraints relating to the physical design of such monitors are not limited to the challenges of packaging the electronics and display units in an arrangement that can be easily and comfortably worn by a user. Special considerations and constraints are present with respect to incorporation of the optical sensor. For example, the light sources and photodiode of the optical sensor must be optically isolated from one another. Otherwise, the photo detector will receive optical energy that is not modulated by heartbeat, which can result in an unwarranted increase in electrical design requirements and/or seriously affect monitoring accuracy and power requirements. Similarly, optimal performance requires that the optical sensor be firmly positioned against the user's skin so that light emitted by an optical source passes through the skin and, additionally, so that ambient light does not reach an associated photo detector. Firmly positioning the optical sensor against the user's skin also is important with respect to preventing movement of the sensor that can affect the accuracy of the monitoring device and/or interrupt its operation. Additionally, the optical sensor should be securely retained by the monitoring device to maintain physical integrity and facilitate satisfactory waterproofing of the entire monitor.

Because of the above mentioned design and manufacturing considerations, as well as others that are known to designers and manufacturers, a need exists for improved techniques for incorporating optical sensor arrangements in physiological monitoring devices. The need is of special significance relative to personal wellness monitors and heart rate monitors that are used during physical exercise. In particular, the manufacturing costs of such devices must be maintained as low as possible to provide a generally affordable and competitive product while without sacrificing product accuracy and quality.

SUMMARY

This summary is provided to introduce a selection of concepts in a simplified form that are further described below in the Detailed Description. This summary is not intended to identify key features of the claimed subject matter, nor is it intended to be used as an aid in determining the scope of the claimed subject matter.

The present invention provides an optical sensor arrangement especially suited for use in physiological monitoring devices that are used for physical training and exercise and/or wellness monitoring. A major aspect of the invention is the mounting of optical sensor light sources and photo detectors in transparent lenses that are installed in the portion of a monitoring device that is placed in contact with the user's skin. In the preferred arrangement, the monitor is embodied as a wrist watch with the light sources being two spaced apart light emitting diodes (LEDs) and the photo detector being a photodiode that is positioned between the two light emitting diodes. In that particular embodiment, the LEDs and the photodiode are positioned by and mounted to a printed circuit board that is installed in the interior of the watch and the lenses are installed in the watch caseback. Portions of the caseback extend inwardly to contact the printed circuit in the region between the LEDs and the photodiode to prevent light emitted by the LEDs from being directly coupled to the photodiode. In the most preferred embodiments, a pliant opaque layer of tape or sponge-like material that is located on the printed circuit board is contacted by the inwardly extending portions of the caseback to further ensure optical isolation of the photodiode.

DESCRIPTION OF THE DRAWINGS

The foregoing aspects and many of the attendant advantages of this invention will become more readily appreciated as the same become better understood by reference to the following detailed description, when taken in conjunction with the accompanying drawings, wherein:

FIGURE 1 depicts the front view of a physiological monitor in the form of wrist watch that displays a user's heart rate and that employs an optical sensor arrangement configured in accordance with this invention;

FIGURE 2 is a rear view of the wrist watch of FIGURE 1 which generally depicts an optical sensor configured in accordance with the invention;

FIGURE 3 is a perspective view of the caseback component of the watch shown in FIGURES 1 and 2, showing openings for containing the components of the optical sensor arrangement of the invention;

FIGURE 4 is a perspective view showing the portion of the caseback of FIGURE 3 that resides inside the wrist watch of FIGURE 1;

FIGURE 5 schematically depicts two optical sensor light sources and a photo detector that are mounted to a printed circuit board that is installed in the caseback shown in FIGURES 3 and 4;

FIGURE 6 is a partial cutaway of the caseback of FIGURE 3 and the printed circuit arrangement of FIGURE 5 indicating placement of lenses in the caseback and, in addition, joiner of the case back with the combined circuit board and optical sensor arrangement of FIGURE 5;

FIGURE 7 is a cross-sectional view illustrating the caseback assembled with the circuit board mounted light sources and optical detector arrangement of FIGURE 5; and

FIGURE 8 is a partial cutaway view of the assembled caseback illustrating in greater detail the mounting of the lenses and the manner in which the light sources are optically isolated from one another.

DETAILED DESCRIPTION

Shown in FIGURE 1 is a watch 10 that incorporates an optical sensor and components for processing and displaying a user's heart rate and other information that is related to exercise or physical training sessions. In the arrangement of FIGURE 1, the watch case 12 houses a display unit such as a dot matrix liquid crystal display 14. Extending from opposite edges of the watch case 12 are elastomeric bands 16 that allow the watch 10 to be snugly secured to the user. Switches 18 that extend along the narrow edges of the watch case 12 are operable for setting the time display and establishing the operational mode of the heart rate monitor. Small icons are located in the upper portion of the display 14 to indicate operational aspects of watch 10. In the depicted arrangement, icon 20a is illuminated whenever the watch is energized to indicate battery condition; icon 20b is illuminated when display 14 indicates the time of day; icon 20c and 20e are illuminated when watch 10 is operating in the exercise mode and heart rate is being displayed; and icon 20d is illuminated when watch 10 is operating in the exercise mode and the exercise duration is being recorded. As also is indicated in FIGURE 1, the

user's heart rate is prominently displayed in the central region of display 14 with the same display region displaying time when used as a conventional watch.

With reference to FIGURE 2, the back of watch 10 includes a caseback 22 that includes an optical sensor that is configured in accordance with the invention. Specifically, the depicted optical sensor includes two light sources 24 that are spaced apart from one another. In the depicted arrangement, each light source 24 includes a conventionally configured LED 28 that is contained in a lens 30. In that regard, it should be noted that lens 30 is not the same as, nor does it replace, the integral lens of a conventional LED, which is configured to cause emitted light to pass from the end surface of the device. Located between and closely spaced to the light sources is an optical detector 26. In FIGURE 2, optical detector 26 includes a photodiode 32 that is contained by a lens 34.

Lenses 30 and 34 may be formed from mineral glass or plastic that exhibits a high degree of optical transmission at wavelengths of the optical energy emitted by LEDs 28. In some instances it may be possible to form lens 30 and 34 from material that imparts a filtering effect to the lenses. For example, ambient light that reaches photodiode 32 is in effect noise that can seriously affect operation and accuracy of a heart rate monitor. In situations in which LEDs 28 emit light sufficiently removed from the infrared region, it would be advantages to use lenses that block a portion of incident infrared energy to thereby decrease the effect of any ambient light that passes between caseback 22 and the user's tissue.

Caseback 22 of the depicted arrangement is configured so that, the depicted optical sensor is urged firmly against the skin when watch 10 is worn by a user. In that regard, caseback 22 includes an elliptical region 36 that projects outwardly from the surface of caseback 22. Centrally located in elliptical region 36 is a circular raised region 38. The surface of LED lenses 28 and optical detector lens 34 are substantially flush with or extend slightly above the surface of circular region 38.

FIGURES 3 and 4 respectively, illustrate the back and interior of caseback 22 prior to the installation of LEDs 28, LED lenses 30, photodiode 32 and optical detector lens 34. As can be seen in both FIGURES 3 and 4, recesses 40 extend inwardly into the back of caseback 22 for receiving LED lenses 30. The interior of each recess 40 is shaped to closely match the exterior configuration of a lens 30. An opening 42 is located

at the bottom of each recess 40 for receiving an LED 42. Each opening 42 is smaller than the cross-sectional area of the associated recess 40 so that a ledge is formed around the lower periphery of the opening 40. When an LED lens 30 is installed in an opening 40, the bottom of the lens comes into abutment with the ledge and the face of the lens is flush with or projects slightly beyond the rear face of caseback 22.

Similarly, a recess 44 extends inwardly in caseback 22 for receiving optical detector lens 34. The configuration of recess 44 corresponds to that of recesses 40 in that the interior wall of recess 44 is configured to closely match the exterior configuration of optical detector lens 34. An opening 46 is located at the bottom of recess 44 and is dimensioned and arranged so that an inwardly extending ledge is formed at the lower terminus of recess 44. When an optical detector lens 34 is installed in the opening 46, the bottom of the lens comes into abutment with the ledge and the face of the lens is flush with or projects slightly beyond the rear face of caseback 22.

In view of FIGURES 3 and 4 it can be recognized that recesses 40 and 44 establish the position of LED lenses 30 relative to optical detector lens 34. This, in turn, establishes the distance between each LED 28 and photodiode 32. In practice, recesses 40 and 44 are positioned to ensure that sufficient light emitted by LEDs 28 reaches photodiode 32 after being reflected by blood flowing through arteries and other vascular structure.

As also can be seen in FIGURE 3, the rear face of caseback is contoured to generally match the wrist or forearm of the user. Located in each corner of caseback 22 are openings 48 for threaded fasteners (50 in FIGURE 2) that secure caseback 22 to case 12 of FIGURE 1. Additionally, as shown in FIGURE 4, four cylindrical posts 52 that form a rectangular pattern extend upwardly in the interior of caseback 22 for positioning LEDs 28 and photodiode 32 for containment by LED lenses 30 and optical detector lens 34.

FIGURE 5 schematically depicts one arrangement for satisfactorily mounting LEDs 28 and photodiode 32. In the depicted arrangement, LEDs 28 and photodiode 32 are positioned relative to one another by means of a printed circuit board 54 that electrically connects the devices to heart rate circuitry contained in watch 10 (not shown). A relatively thin strip of opaque pliant material 53 (such as tape or a sponge-like polymer) extends between the edges of photodiode 32 and the adjacent edges of

LEDs 28. As described relative to the assembled caseback (FIGURES 7 and 8) the opaque strips 53 prevent light emitted by the LEDs from travelling along the surface of printed circuit board 54 and reaching photodiode 32.

FIGURE 6 is a partially cutaway view of caseback 22 and printed circuit board 54 that illustrates the manner in which the optical sensor is incorporated in caseback 22. In FIGURE 6, LED lenses 30 are installed and sealed in recesses 42 of FIGURES 3 and 4. As previously indicated, the light-emitting surface of each lens 30 is substantially flush with, or extends slightly above the surface of circular raised region 38.

In a like manner, optical detector lens 34 is installed and sealed in recess 44 of FIGURES 3 and 4. Various techniques can be used for bonding LED lenses 30 and optical detector lens 34 to caseback 22. For example, depending in part of the material being used for caseback 22, the lenses can be bonded in place by a curable adhesive, ultrasonic bonding or other techniques. In some applications, insert molding or cold-molding techniques can be employed. As indicated by phantom lines in FIGURE 6, LEDs 28 and photodiode 32 pass into openings 42 and 44 so that LEDs 28 are contained by lenses 42 and photodiode 32 is contained by optical detector lens 34.

FIGURE 7 is a cross-sectional view showing the assembly of caseback 22, LEDs 28, photodiode 32 and the associated lenses 30 and 34. As can be seen in FIGURE 7, printed circuit board 54 (described relative to FIGURES 5 and 6) is positioned on the upper surface of a circuit board 56. Circuit board 56 includes circuitry for detecting and displaying a user's heart rate, the time of day and other information (not shown). Mounting posts 52 (FIGURE 4) maintain circuit boards 54 and 56 in a fixed position within caseback 22. LEDs 28 extend into closely fitting lenses 30 and photodiode 32 extends into a closely fitting photo detector lens 34.

FIGURE 7, alone and in combination with FIGURE 8, illustrates an important feature of the invention - - complete optical isolation of photodiode 32 from LEDs 28. As described relative to FIGURE 3, the recesses 42 for receiving LEDs 28 are smaller than the recesses 40 for receiving LED lenses 30. Likewise, the recess 44 for receiving photodiode 32 is smaller than the recess 46 for receiving the optical detector lens 34. Thus, each combination of LED 28 and LED lens 30 is physically and optically separated from the combination of photodiode 32 and optical detector lens 34 by an inverted T-shaped region 58 that extends downwardly from circular region 38 of caseback 22. In

particular, as is shown in FIGURE 7, the inner edges of LED lenses 30 are separated from the outer edges of optical detector lens 34 by the upwardly extending leg of T-shaped region 58 and the inner edges of LEDs 28 are separated from the outer edges of photodiode 32 by the laterally extending lower leg of region 58. In addition, the bottom surface of inverted T-shaped region 58 presses against the opaque strips 53 (shown and described relative to FIGURE 5) to further ensure that light emitted by LEDs 28 does not reach photodiode 32 without being reflected by a targeted region of the user.

While illustrative embodiments have been illustrated and described, it will be appreciated that various changes can be made therein without departing from the spirit and scope of the invention. For example, those skilled in the art will recognize that the invention can be practiced with a variety of physiological monitoring devices and that various light emitting and photo detecting devices may be employed. In some situations it may be appropriate to use one or more lenses that are configured for receiving more than one optical sensor in a single lens and/ or to use one or more lenses that are configured for receiving more than one light source in a single lens.

CLAIMS

The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:

1. A monitor for sensing and measuring at least one physiological parameter in which a portion of the monitor is configured for contacting a targeted tissue region of a person using the monitor, the monitor including an optical sensor comprising at least one light source for illuminating at least a portion of the targeted tissue region and at least one optical detector for receiving optical energy reflected from the targeted tissue region, at least a portion of the light sources being contained by at least one associated lens that directs light to the targeted region, at least a portion of the optical detectors being contained by at least one associated lens that passes light reflected from the targeted region to the portion of optical detectors that are contained by the lens, each lens located in the portion of the heart rate monitor that is configured for contacting the targeted tissue.

2. The monitor of Claim 1 wherein each light source and each optical detector is associated with and contained by a separate associated lens that individually couples light between the sensor and the targeted tissue region.

3. The monitor of Claim 2, further including a housing having a front face, a rear face, and an interior region defined between the front and rear faces, the portion of the monitor that is configured for contacting a targeted are of a user being included in the rear face of the housing with each lens being received in an associated opening that extends through the rear face of the housing so that light is coupled between the optical sensor and the targeted tissue region.

4. The monitor of Claim 3 wherein the targeted tissue region is located on a person's arm and the monitor is configured to be worn with the rear face of the housing in contact with a person's arm.

5. The heart rate monitor of Claim 4 wherein each light source is a light emitting diode and each optical detector is a photodiode.

6. The monitor of Claim 5 wherein the light emitting diodes and the photodiodes are located in the interior region of the housing and each lens includes a recess sized for receiving and containing an associated one of light emitting diodes and photodiodes.

7. A heart rate monitor in which a portion of the monitor is configured for contacting a targeted tissue region of a person using the heart rate monitor, the monitor including a multi-component optical sensor comprising at least one light source for illuminating at least a portion of the targeted tissue region and at least one optical detector for receiving optical energy reflected from the targeted tissue region, at least a portion of the light sources being contained by at least one associated lens that directs light to the targeted region, at least a portion of the optical detectors being contained by at least one associated lens that passes light reflected from the targeted region to the portion of optical detectors that are contained by the lens, each lens located in the portion of the heart rate monitor that is configured for contacting the targeted tissue.

8. The heart rate monitor of Claim 7 wherein the light sources and the optical detectors of the portion of the optical sensor components are each associated with and contained by separate associated lenses that individually couple light between the associated optical sensor components and the targeted tissue region.

9. The heart rate monitor of Claim 8 wherein the targeted tissue region is located on a person's arm and the monitor is configured to be worn in contact with a person's arm.

10. The heart rate monitor of Claim 9, which includes a housing having a front face, a rear face, and an interior region defined between the front and rear faces, the portion of the heart rate monitor that is configured for contacting the arm of the user being included in the rear face of the housing with each lens being received in an associated opening that extends through the rear face of the housing to facilitate the coupling of light between the optical sensor components and the targeted tissue region.

11. The heart rate monitor of Claim 10 wherein each light source is a light emitting diode and each optical detector is a photodiode.

12. The heart rate monitor of Claim 11 wherein the light emitting diodes and the photodiodes are located in the interior region of the housing and each lens includes a recess sized for receiving and containing an associated one of light emitting diodes and photodiodes.

13. The heart rate monitor of Claim 12 further including a circuit board that is contained within the interior of the housing in spaced apart juxtaposition with the rear

face of the housing, each light emitting diode and each photo detector being mounted to the circuit board and extending into the recess of an associated lens.

14. The heart rate monitor of Claim 13 wherein the optical sensor comprises a single photodiode and two light emitting diodes, with the light emitting diodes being spaced apart from one another and the photodiode being positioned between the light emitting diodes.

15. The heart rate monitor of Claim 14 configured as a wrist watch that further comprises circuitry for processing a signal supplied by the photodiode and for displaying the user's heart rate on the front face of the watch.

16. A heart rate monitor that is worn on the arm of a user comprising:
a housing having a front face, a rear face and an interior region defined between the front and rear face;

one or more light emitters, each operable for directing light energy in a predetermined direction;

a lens structured and arranged for individual reception and containment of each light emitter, each such lens for optically coupling light energy emitted by the retained light emitter to and through a surface of the lens;

one or more optical detectors, each operable for producing an electrical signal representative of light energy that impinges on that optical detector;

a lens structured and arranged for individual reception and containment each light emitter, each such lens including a surface for impingement of light energy, each such lens for directing light energy that impinges on that surface to an associated one of the optical detectors; and

wherein each lens that retains a light emitter and each lens that retains an optical detector is mounted in an associated aperture that is formed the rear face of the housing for detection of a user's heart rate when the monitor is worn on the user's arm with the rear face in contact with tissue of the arm.

17. The heart rate monitor of Claim 16 configured as a wrist watch further comprising circuitry for determining the user's heart rate based on the signals supplied by the one or more optical detectors and for displaying the user's heart rate on the front face of the housing.

18. The heart rate monitor of Claim 17 wherein each light emitter is a light emitting diode and each optical detector is a photodiode.

19. The heart rate monitor of Claim 18 comprising a single photodiode and two light emitting diodes, the light emitting diodes being spaced apart from one another with the single photo detector being located between the two light emitting diodes.

20. The heart rate monitor of Claim 19 including a circuit board that is contained within the interior of the housing in spaced apart juxtaposition with the rear face of the housing, each light emitting diode and each photo detector being mounted to the circuit board and extending through the associated apertures in the rear face of the housing.

21. The heart rate monitor of Claim 20 comprising a single photodiode and two light emitting diodes, the light emitting diodes being spaced apart from one another with the single photo detector being located between the two light emitting diodes.

ABSTRACT

An arrangement for mounting optical sensors in physiological monitoring devices that are worn by a user to sense and measure one or more physiological parameters. In the disclosed arrangements the monitor is embodied as a wristwatch that senses and displays heart rate. Optical lenses that are mounted in the rear face of the watch receive and contain light-emitting diodes and an optical detector that are located in the interior of the watch. The mounting arrangement optically isolates the light emitting diodes from the optical detector while allowing the sensor elements to be firmly positioned against the user's skin. Additionally, the lenses are advantageous with respect to product manufacture, eliminating the prior use of transparent epoxy resin to encapsulate the sensor elements in openings formed in the rear face of the watch.

JWA:ams

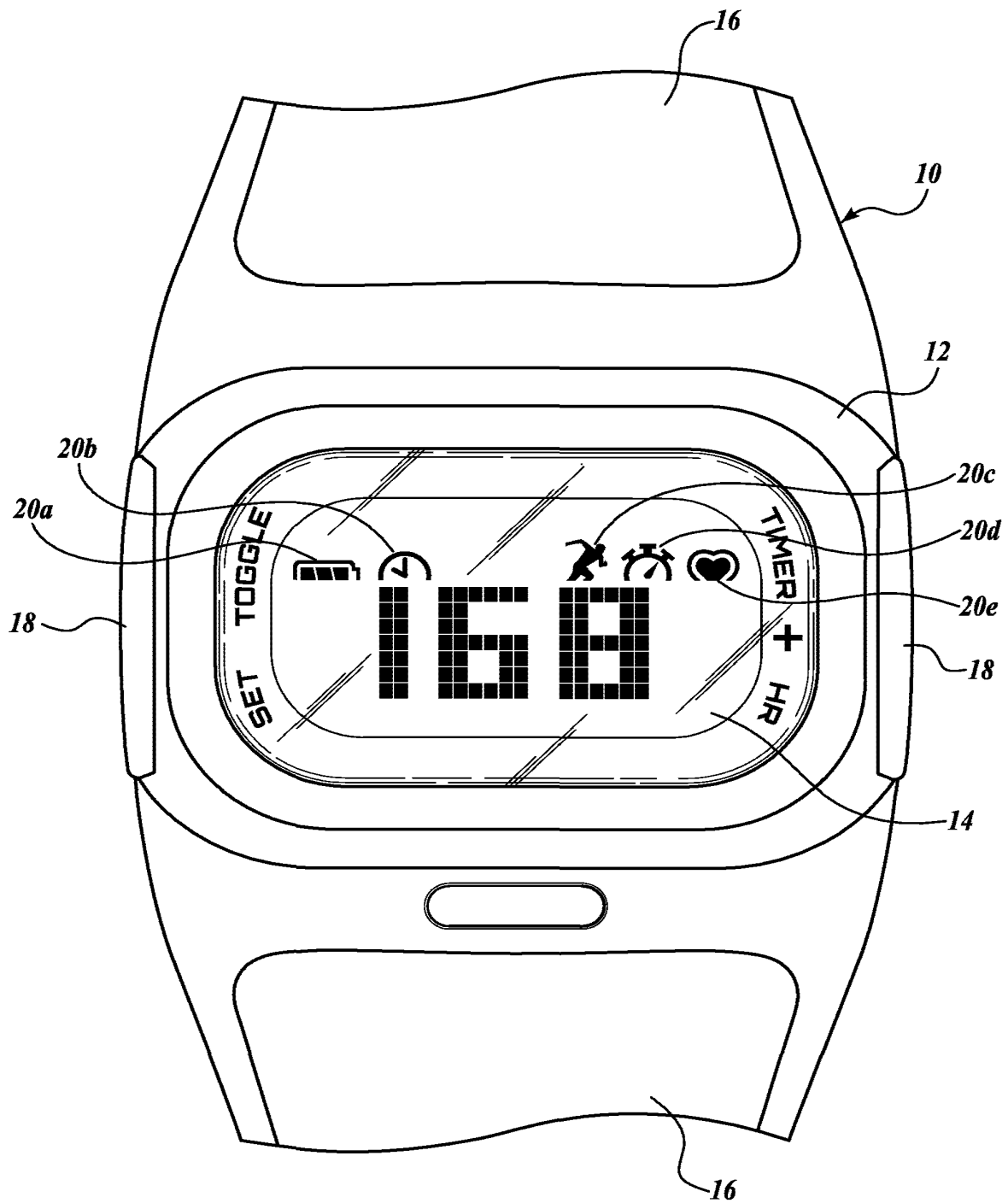
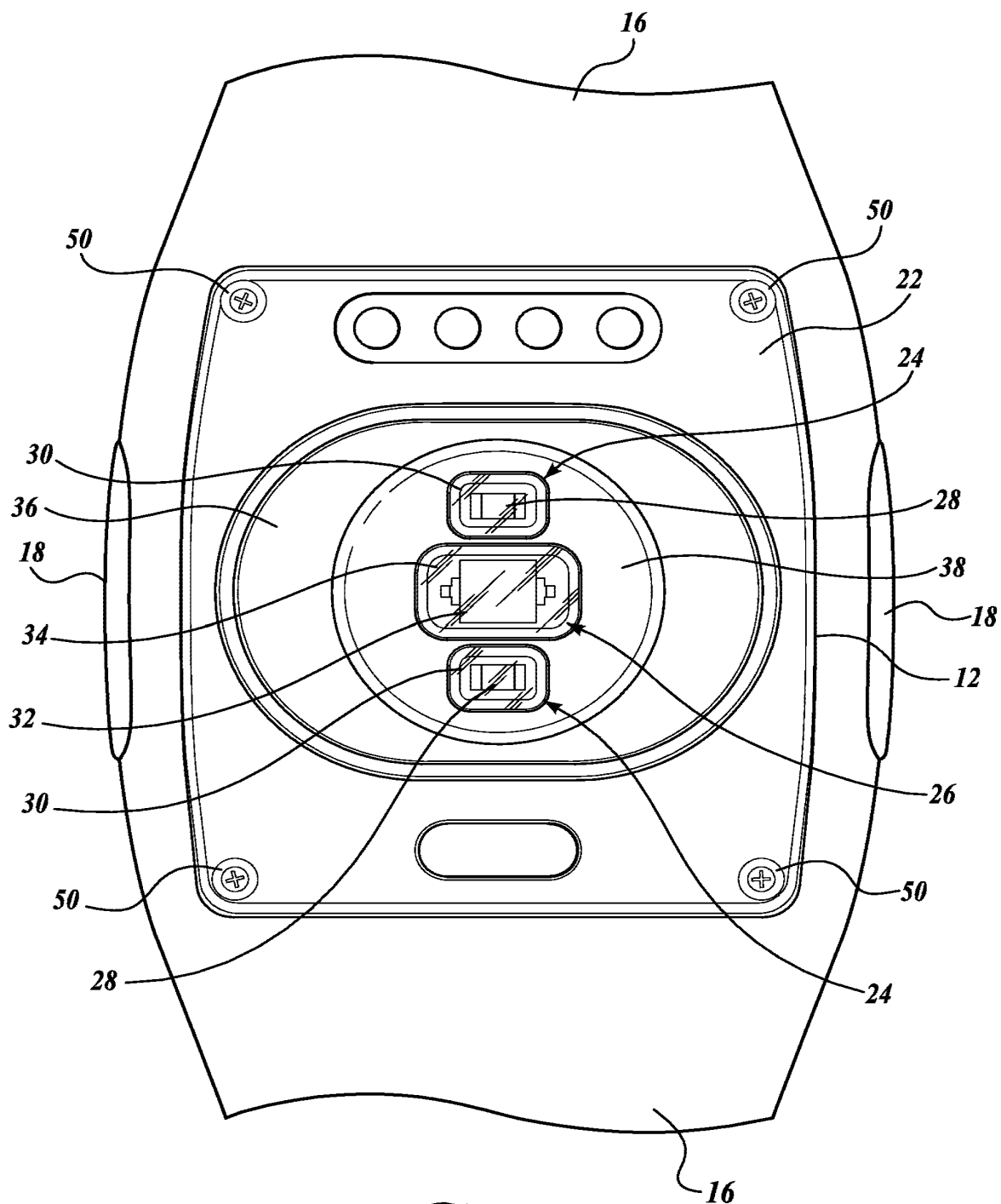


Fig. 1.

*Fig. 2.*

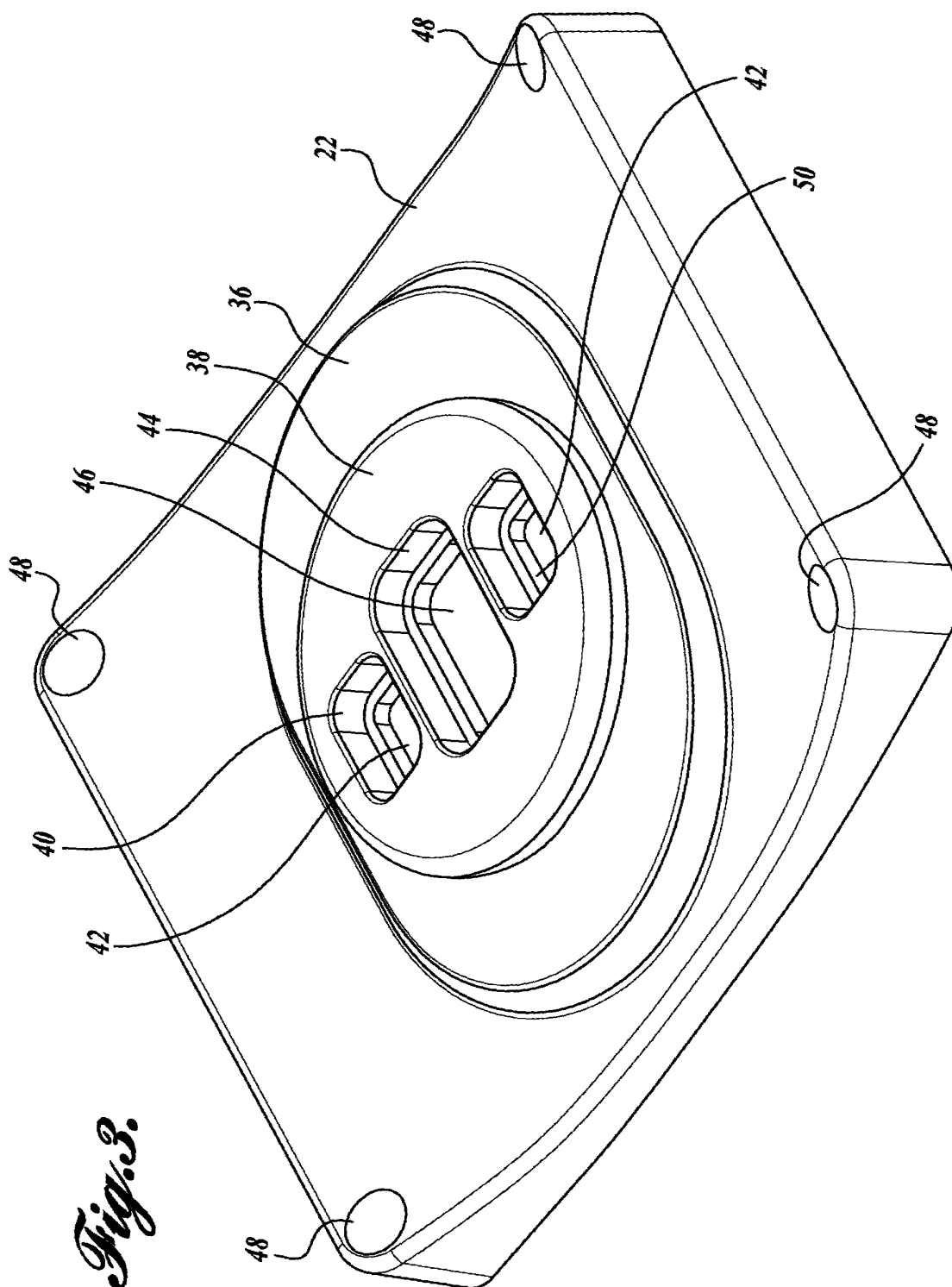


Fig. 3.

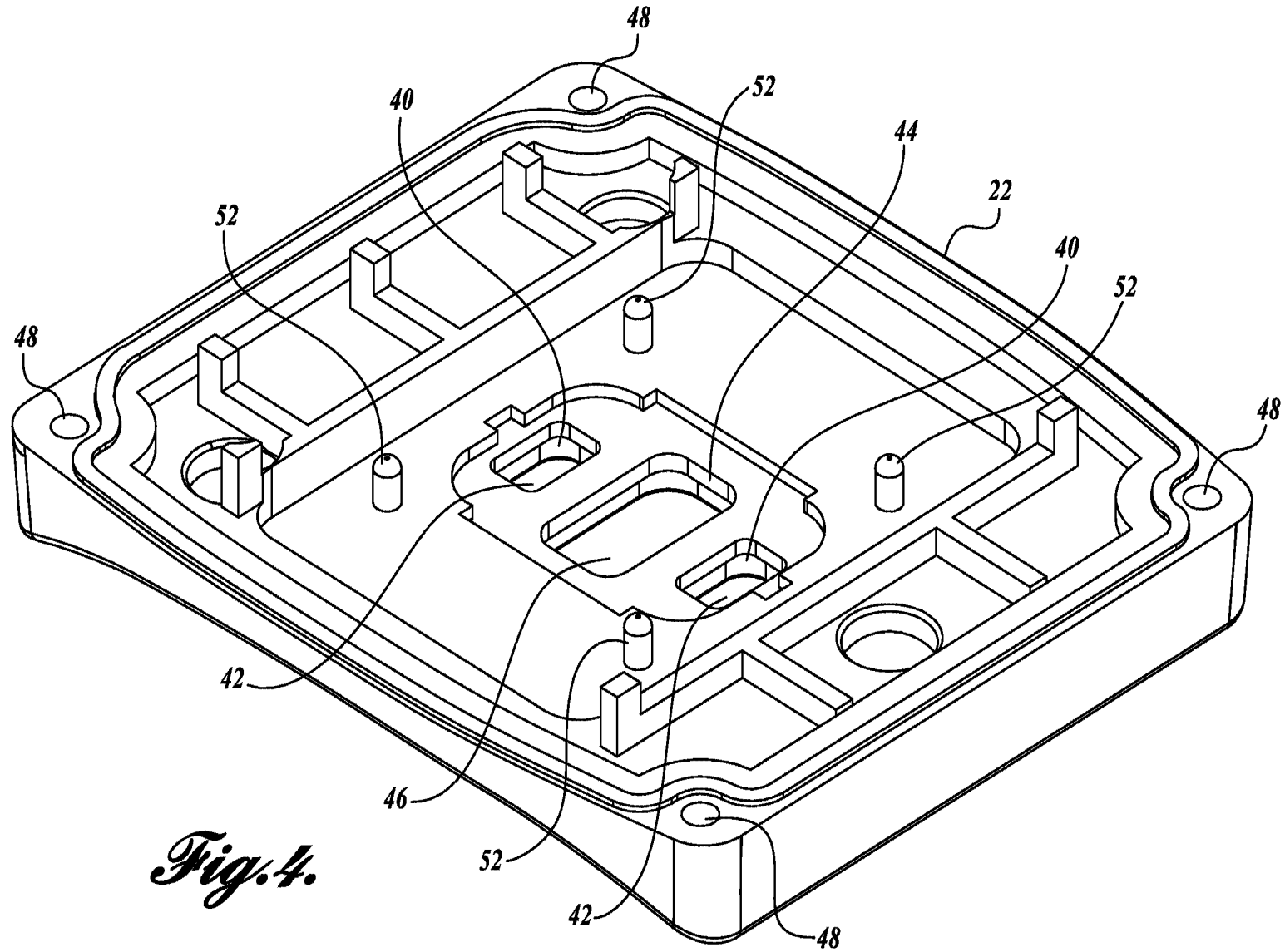


Fig. 4.

4/8

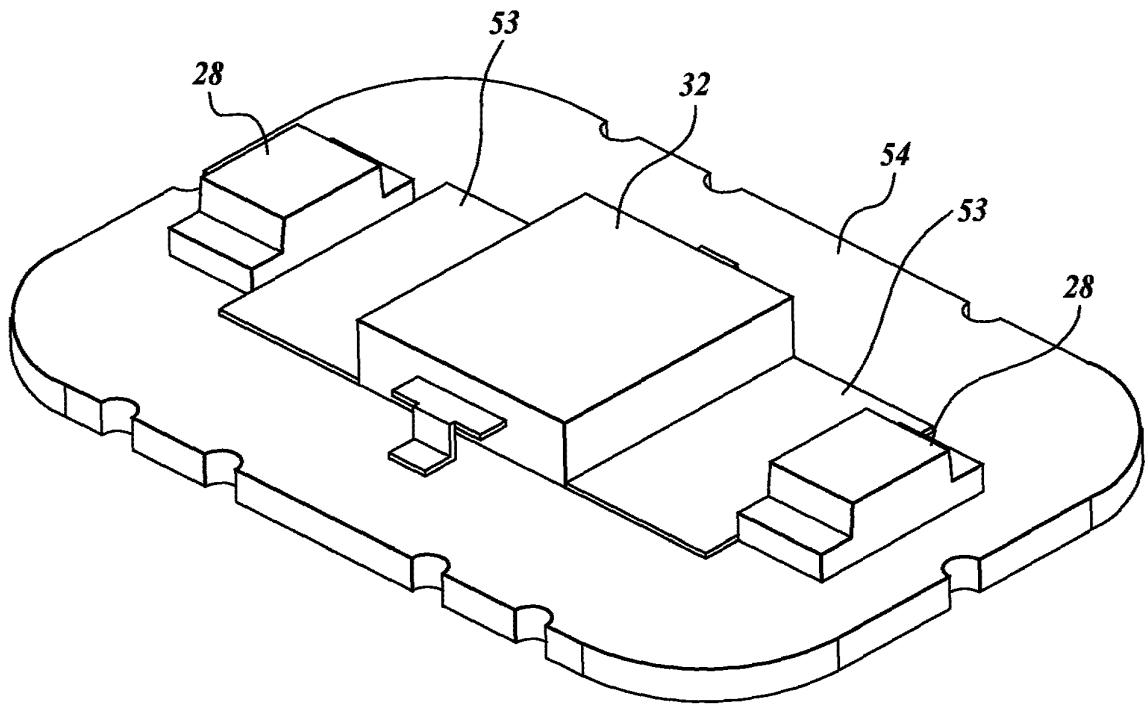


Fig. 5.

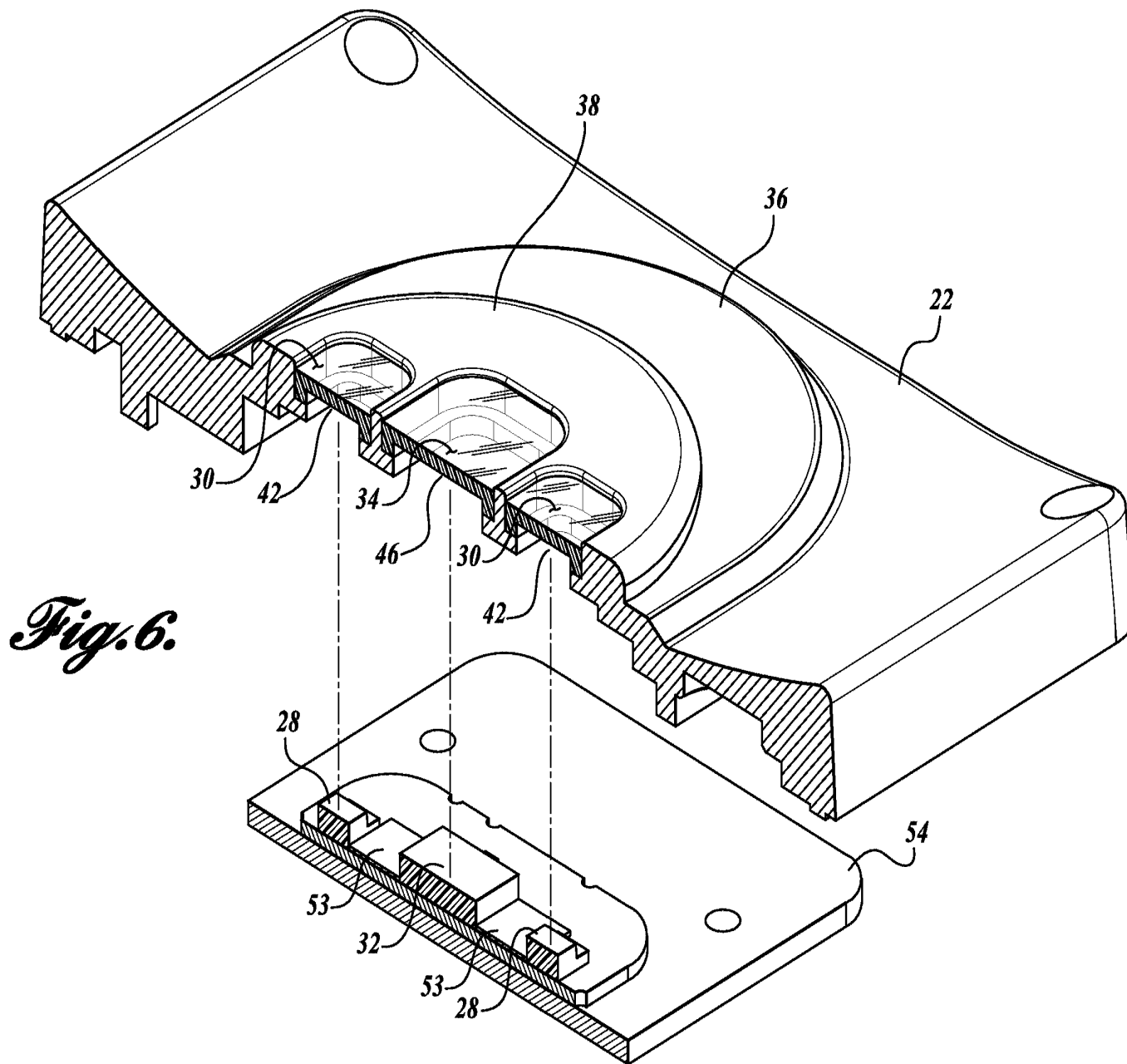


Fig. 6.

8/9

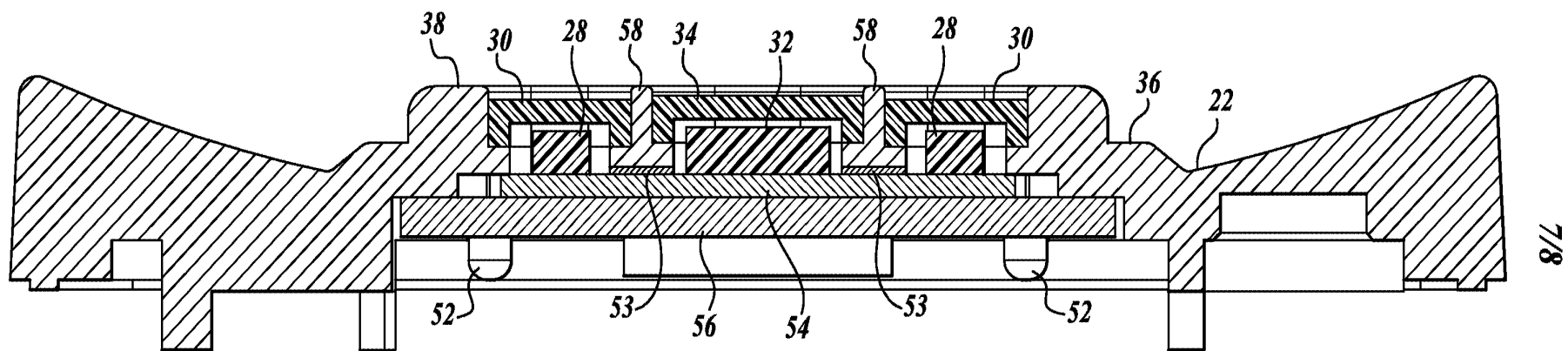
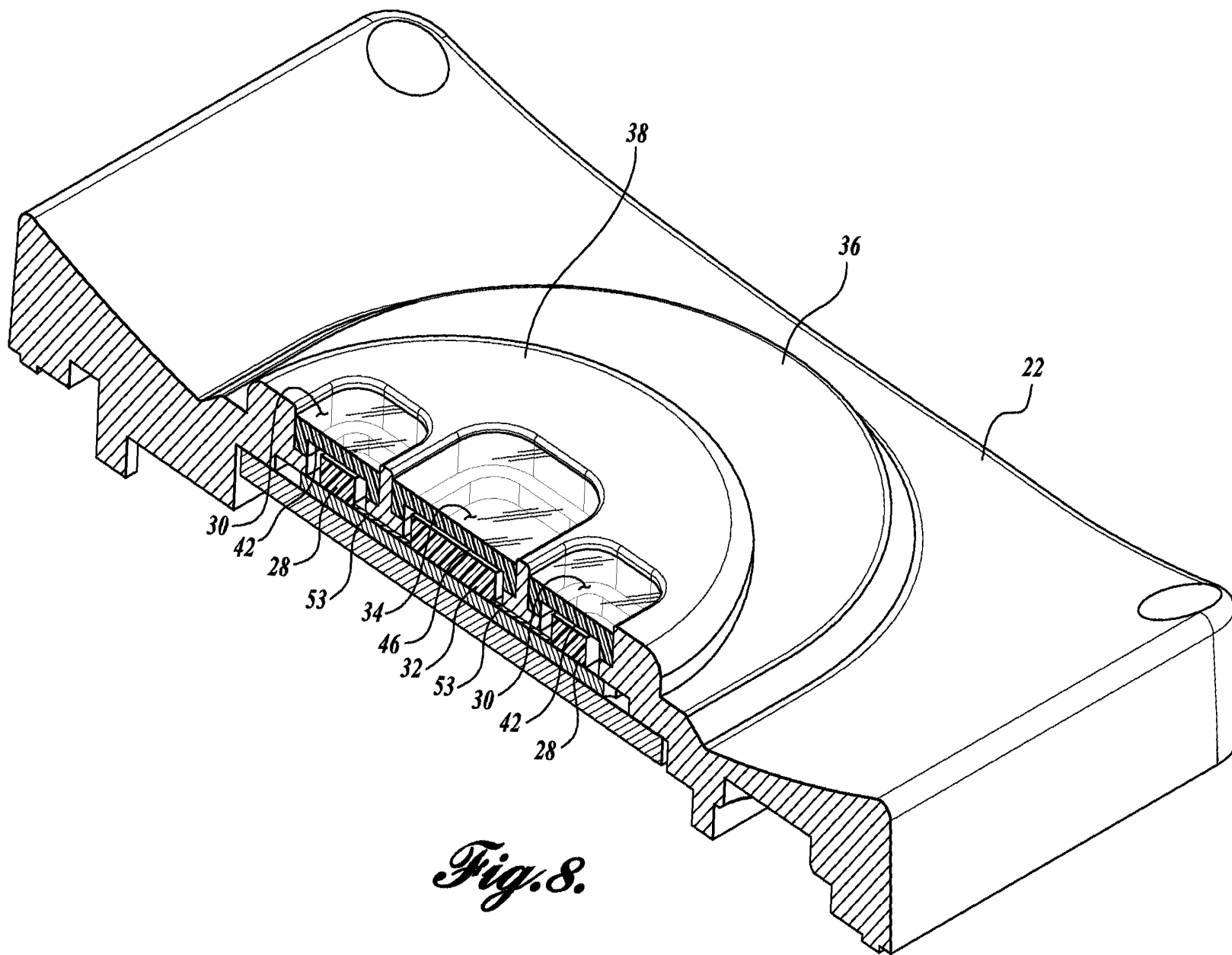


Fig. 7.



8/8

Fig. 8.