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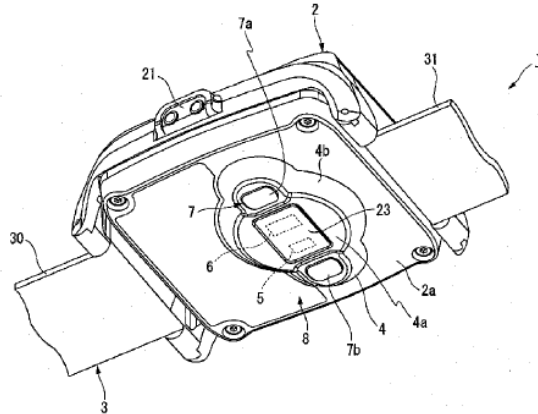
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(54) TITLE OF THE INVENTION: BIOLOGICAL INFORMATION MEASURING DEVICE



(57) Abstract: A biological information measuring device comprising a biological sensor section including a body, a protrusion formed on the lower surface of the body, a means for fixing the body to an arm while directing the lower surface of the body toward the surface side of a biological object, a light emitting section for irradiating light toward the biological object while touching the surface of the biological object, a light receiving section for receiving reflection light from the biological object out of the light irradiated from the light emitting section and producing biological information signal corresponding to the quantity of received light, and means for detecting whether or not the light emitting section and the light receiving section are in contact with the surface of the biological object, and a section provided in the body and detecting biological information based on the biological information signal, characterized in that the biological sensor section is arranged on the lower surface of the protrusion. The biometric information measuring device can be fixed for a long time without giving an unpleasant feeling while enhancing tightness.

(57) Abstract: A biological information measuring device comprising: a biological sensor part including: a main body; a protruding part formed so as to protrude from the lower surface of the main body; a fixing means for mounting the main body to an arm while directing the lower surface of the main body toward the living body surface side; a light-emitting part for emitting light toward the living body while in contact with the living body surface; a light-receiving part for receiving reflected light from the living body out of the light emitted by the light-emitting part and generating a biological

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Attached Documentation

— **International Search Report**

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

information signal corresponding to the amount of received light; and a contact detection means for detecting whether the light-emitting part and the light-receiving part are in contact with the living body surface; and a biological information detection part which is provided on the main body and detects biological information based on the biological information signal; wherein the biological sensor part is disposed on the lower surface of the protruding part. The biological information measuring device enhances adherence and can be worn for a long time without causing discomfort.

SPECIFICATION**BIOLOGICAL INFORMATION MEASURING DEVICE****TECHNICAL FIELD**

- (0001) The present invention relates to a biological information measuring device capable of measuring biological information such as pulse rate while mounted to the wrist (arm).

The present application claims priority based on Japanese Patent Application No. H2004-091942 filed on March 26, 2004, the content of which is incorporated herein.

BACKGROUND ART

- (0002) In response to a growing interest in health management in recent years, various biological information measuring devices capable of measuring various biological information such as pulse rate while mounted to the wrist (arm) or the like have been provided (for example, see Patent Document 1).

- (0003) A biological information measuring device of this type which detects pulse rate, for example, emits light toward a living body while mounted to the wrist, receives reflected light – that is, a reflected signal – from blood vessels with a pulse sensor or the like, extracts a pulse signal corresponding to the pulse from the reflected signal, and calculates the pulse rate. Since the pulse rate can be measured easily while mounted to the wrist, in particular, the device is easily used by the wearer.

Patent Document 1: Japanese Unexamined Patent Application Publication No. 2001-78973 (paragraph Nos. 0011-0031, FIGS. 1-7)

PROBLEM TO BE SOLVED BY THE INVENTION

- (0004) The conventional biological information measuring devices described above are typically used while mounted to the wrist. However, the movement of the user causes muscles to move and changes the thickness (diameter) of the wrist, which leads to the risk that a gap may be formed between the biological information measuring device and the living body surface. This diminishes adherence, which may prevent accurate biological information from being detected. Moreover, since the biological information measuring device is fixed to the wrist, the feeling of pressure on the wrist increases when attached by a band, for example, which makes it difficult to wear for long periods of time.
- (0005) The present invention was conceived in light of such circumstances, and an object thereof is to provide a biological information measuring device which enhances adherence and can be worn for

a long time without causing discomfort.

MEANS FOR SOLVING THE PROBLEM

- (0006) The present invention provides the following means for solving the problem described above.
- (0007) The biological information measuring device comprises: a biological sensor part including a main body, a protruding part formed so as to protrude from a lower surface of the main body, a fixing means for mounting the main body to an arm while directing the lower surface of the main body toward a living body surface side, a light-emitting part for emitting light toward the living body while in contact with the living body surface, a light-receiving part for receiving reflected light from the living body out of the light emitted by the light-emitting part and generating a biological information signal corresponding to an amount of received light, and a contact detection means for detecting whether the light-emitting part and the light-receiving part are in contact with the living body surface; and a biological information detection part which is provided on the main body and detects biological information based on the biological information signal; wherein the biological sensor part is disposed on a lower surface of the protruding part.
- (0008) In the biological information measuring device according to this invention, light is emitted toward the living body from the light-emitting part after the main body is mounted to the wrist (arm) with the fixing means. A portion of the emitted light is absorbed, for example, by hemoglobin in blood vessels, and another portion of the light is reflected by biological tissue. The light-receiving part receives this reflected light and generates a biological information signal such as a pulse signal corresponding to the amount of received light. The biological information detection means then performs prescribed processing on the biological information signal so that biological information such as pulse rate can be detected. In addition, the contact detection means can detect whether the light-emitting part and the light-receiving part are indeed in contact with the living body surface.
- (0009) In particular, when the main body is mounted to the wrist by the fixing means, the protruding part protrudes from the lower surface of the main body, which facilitates contact between the living body surface and the lower surface of the protruding part. That is, the adherence of the biological sensor part is enhanced. Therefore, unlike in conventional configurations, it is unnecessary to fix the main body so as to strongly press (so as to compress) the main body against the living body surface with the fixing part. Accordingly, the device does not cause discomfort, even when worn for a long time. Moreover, since the adherence of the biological sensor part is enhanced, the light-emitting part and the light-receiving part can emit and receive light efficiently. Therefore, biological information can be detected with high precision.
- (0010) In addition, the biological information measuring device according to the present invention is configured so that, in the biological information measuring device of the present invention de-

scribed above, ridged parts are formed so as to protrude from the lower surface of the main body at positions a prescribed distance from side surfaces of the protruding part so as to sandwich at least the protruding part; and a distance between a lower surface of each ridged part and the lower surface of the main body part is set to be equal to or greater than a distance between the lower surface of the protruding part and the lower surface of the main body part.

- (0011) In the biological information measuring device according to this invention, when the main body is mounted to the arm with the fixing means, the living body surface is in contact with the lower surfaces of the ridged parts and the lower surface of the protruding part. At this time, the ridged parts protrude at positions a prescribed distance from the side surfaces of the protruding part so as to sandwich the protruding part, so gaps are formed between the protruding part and the ridged parts. As a result, the living body is in contact with the lower surfaces of the protruding part and the ridged parts while temporarily filling the gaps on both sides sandwiching the protruding part. Accordingly, the adherence between the living body surface and the biological sensor part can be secured more reliably.
- (0012) In particular, since the ridged parts protrude from the lower surface of the main body by a height equal to or greater than that of the protruding part, they come into contact with the living body surface simultaneously with or before the protruding part. As a result, the living body surface can be stably brought into contact with the lower surface of the protruding part in the same state, and the contact pressure can be made constant. Accordingly, biological information can be detected stably over a long period of time.
- (0013) In addition, the biological information measuring device according to the present invention is configured so that, in the biological information measuring device of the present invention described above, the contact detection part includes at least a pair of electrodes and detects whether the light-emitting part and the light-receiving part are in contact with the living body surface based on a potential difference between the pair of electrodes.
- (0014) In the biological information measuring device according to this invention, when the main body is mounted to the arm, the pair of electrodes come into contact with the living body surface so that a discharge occurs through the living body surface. As a result, the potential between the electrodes decreases. By detecting the potential difference between the pair of electrodes, it can be easily and reliably detected whether the light-emitting part and the light-receiving part are indeed in contact with the living body surface. Note that the electrodes need not be a pair, and a plurality of electrodes, for example, may be provided so that contact can be detected based on the potential difference between each of the electrodes.
- (0015) In addition, the biological information measuring device according to the present invention is

configured so that, in the biological information measuring device of the present invention described above, the pair of electrodes are disposed so as to sandwich the light-emitting part and the light-receiving part therebetween.

- (0016) In the biological information measuring device according to this invention, the pair of electrodes are disposed so as to sandwich the light-emitting part and the light-receiving part, so it can be detected whether the light-emitting part and the light-receiving part are in contact with the living body surface with high precision.
- (0017) In addition, the biological information measuring device according to the present invention is configured so that, in the biological information measuring device of the present invention described above, a flexible board which electrically connects the light-emitting part and the light-receiving part to the biological information detection part is provided; and the flexible board is provided inside the main body so as to push the light-emitting part and the light-receiving part toward the lower surface side of the main body with its own elasticity.
- (0018) In the biological information measuring device according to this invention, the light-emitting part and the light-receiving part are always pressed toward the lower surface side of the main body by the elasticity of the flexible board, so when the main body is mounted to the wrist, the light-emitting part and the light-receiving part are in close proximity to the living body surface. Accordingly, it is possible to emit light to and receive light from the living body efficiently, and the detection precision for biological information can be enhanced.
- (0019) In addition, the biological information measuring device according to the present invention is configured so that, in the biological information measuring device of the present invention described above, a display part for displaying detected biological information is provided on an upper surface of the main body.
- (0020) In the biological information measuring device according to this invention, biological information displayed on the display part can be easily viewed, so it is possible to confirm detected biological information or to confirm whether biological information has been detected properly at any time when necessary, which is use-friendly and convenient.
- (0021) In addition, the biological information measuring device according to the present invention is configured so that, in the biological information measuring device of the present invention described above, the fixing means includes first and second bands having base end sides attached to the main body to enable mounting on the arm; and the first and second bands are disposed opposite one another so as to sandwich the main body and are formed from an expandable elastic material.
- (0022) In the biological information measuring device according to this invention, the main body can

be easily and reliably mounted like a wristwatch using the first and second bands. In particular, since both bands are formed from an expandable elastic material, even if the thickness of the wrist changes somewhat due to muscle movement, the amount of change can be absorbed, and gaps or the like can be prevented from forming between the main body and the living body surface. As a result, it is unnecessary to tighten both bands, and the device can be worn for a long time.

- (0023) In addition, the biological information measuring device according to the present invention is configured so that, in the biological information measuring device of the present invention described above, the biological sensor part is disposed at a position offset toward the base end side of the first or second band from a center position of the main body.
- (0024) In the biological information measuring device according to this invention, when the main body is mounted to the wrist like a wristwatch using the first and second bands, even if there is small amount of play relative to the wrist and the main body shifts due to the gravitational effect as a result of this play (for example, when the main body shifts in a state in which the arm is facing downward (ground side) or when the main body shifts in a state in which the back of the hand is on the inside while the arm is positioned horizontally and the upper surface of the main body is held in front of the eyes), the biological sensor part is disposed at a position offset toward the base end side of the first or second band from the center position of the main body, so it is possible to prevent a reduction in the adherence of the biological sensor part.
- (0025) In addition, the biological information measuring device according to the present invention is configured so that, in the biological information measuring device of the present invention described above, a rechargeable battery that can be recharged and a recharging means for recharging the rechargeable battery with power are provided on the main body.
- (0026) In the biological information measuring device according to this invention, the rechargeable battery can be recharged with power from an external source via the recharging means, so it is unnecessary to separately prepare an ordinary battery or the like. Accordingly, the cost of maintaining the product can be reduced.
- (0027) In addition, the biological information measuring device according to the present invention is configured so that, in the biological information measuring device of the present invention described above, a distance between the lower surface of the protruding part and the lower surface of the main body is set to 2 to 4 mm.
- (0028) The biological information measuring device according to this invention is mounted to the wrist while the lower surface of the protruding part protrudes 2 to 4 mm from the lower surface of the main body. As a result, the protruding part can be reliably brought into contact with the living body surface, and the adherence of the biological sensor part can be ensured. That is, when the distance between the lower surface of the protruding part and the lower surface of the main body is

2 mm or smaller, the level difference is small, and a gap is formed relative to the living body surface so that external light can enter easily. In addition, when the distance between the lower surface of the protruding part and the lower surface of the main body is 4 mm or greater, an oppressive feeling arises when the device is worn, while the height causes instability, and external light can easily enter the space between the device and the living body surface when inclined.

- (0029) As described above, setting the distance between the lower surface of the protruding part and the lower surface of the main body to 2 to 4 mm makes it possible to prevent an oppressive feeling and the incidence of external light.
- (0030) In addition, the biological information measuring device according to the present invention is configured so that, in the biological information measuring device of the present invention described above, the protruding part is formed so that an outer periphery thereof is circular.
- (0031) In the biological information measuring device according to this invention, In the biological information measuring device according to this invention, the protruding part is circular, so when the main body is mounted to the wrist, it is pressed against the living body surface with equal force. Therefore, the adherence is good.
- (0032) In addition, the biological information measuring device according to the present invention is configured so that, in the biological information measuring device of the present invention described above, the protruding part is formed so that an outer edge thereof is a curved surface.
- (0033) In the biological information measuring device according to this invention, the outer edge of the protruding part is formed with a curved surface, so when the main body is mounted to the wrist, the adherence can be enhanced even further. Moreover, even when worn for a long time, pressure marks are unlikely to form, so the device is comfortable to wear.
- (0034) In addition, the biological information measuring device according to the present invention is configured so that, in the biological information measuring device of the present invention described above, the protruding part is formed with a curved surface from a center toward an outer edge of the lower surface thereof.
- (0035) In the biological information measuring device according to this invention, the protruding part is formed with a curved surface from the center toward the outer edge of the lower surface thereof, so when the main body is mounted to the wrist, it is mounted in a state in which the living body surface deforms smoothly and the contact pressure of the center part of the lower surface is increased, which further enhances the adherence. Moreover, even when worn for a long time, pressure marks are unlikely to form, so the device is comfortable to wear.
- (0036) In addition, the biological information measuring device according to the present invention is configured so that, in the biological information measuring device of the present invention described above, a diameter of the protruding part is set to not greater than 20 mm.

- (0037) In the biological information measuring device according to this invention, the diameter of the protruding part is not greater than 20 mm, so the protruding part can be easily pressed against the living body surface with a light force.
- (0038) In addition, the biological information measuring device according to the present invention is configured so that, in the biological information measuring device of the present invention described above, the ridged parts are provided at a position 8 mm from side surfaces of the protruding part, and a distance between the lower surface of each ridged part and the lower surface of the main body is set to 4 mm.
- (0039) In the biological information measuring device according to this invention, the ridged parts can be formed in close proximity of 8 mm from the side surfaces of the protruding part and can be kept to a height of 4 mm. Thus, the ridged parts can be formed in a small space, so the size of the main body can be reduced – that is, the size of the entire device can be reduced.

EFFECT OF THE INVENTION

- (0040) According to the biological information measuring device according to the present invention, when the main body is mounted to the wrist with the fixing part, the protruding part protrudes from the lower surface of the main body, so the living body surface and the lower surface of the protruding part come into contact reliably, which enhances the adherence of the biological sensor part. Therefore, unlike in conventional configurations, it is unnecessary to fix the main body so as to strongly press (so as to compress) the main body against the living body surface with the fixing part. Accordingly, the device does not cause discomfort, even when worn for a long time. Moreover, since the adherence of the biological sensor part is enhanced, light can be emitted and received efficiently, and biological information can be detected with high precision.

BRIEF DESCRIPTION OF THE DRAWINGS

- (0041) FIG. 1 is a front view illustrating an embodiment of the biological information measuring device according to the present invention.
- FIG. 2 is a side view illustrating a state in which the biological information measuring device illustrated in FIG. 1 is mounted to the wrist.
- FIG. 3 is a side view illustrating a state in which the biological information measuring device illustrated in FIG. 1 is mounted to the wrist, and is a view from the opposite direction as that illustrated in FIG. 2.
- FIG. 4 is a perspective view illustrating a state in which the biological information measuring device illustrated in FIG. 1 is viewed diagonally from above.
- FIG. 5 is a perspective view illustrating a state in which the biological information measuring device illustrated in FIG. 1 is viewed diagonally from below.
- FIG. 6 is a cross-sectional view of the biological information measuring device illustrated in FIG. 4

along arrows C-C.

FIG. 7 is a cross-sectional view of the biological information measuring device illustrated in FIG. 4 along arrows D-D.

FIG. 8 is a drawing illustrating the shape of another protruding part than that of the biological information measuring device illustrated in FIG. 1, and is a drawing of a case in which the outer periphery of the protruding part is circular.

FIG. 9 is a drawing of a case in which the protruding part illustrated in FIG. 8 is formed so that the outer edge thereof is a curved surface.

FIG. 10 is a drawing of a case in which the protruding part illustrated in FIG. 8 is formed with a curved surface from the center toward the outer edge of the lower surface thereof.

FIG. 11 is a drawing of a case in which the ridged parts are formed so as to sandwich the protruding part illustrated in FIG. 8.

FIG. 12 is a drawing of a case in which the ridged parts are formed so as to sandwich the protruding part illustrated in FIG. 9.

FIG. 13 is a drawing of a case in which the ridged parts are formed so as to sandwich the protruding part illustrated in FIG. 10.

EXPLANATION OF SYMBOLS

- (0042) B: Living body surface, 1: biological information measuring device, 2: housing (main body), 2a: lower surface of main body, 2b: upper surface of main body, 3: fixing means, 4: protruding part, 4a: lower surface of protruding part, 4b: side surface of protruding part, 5: LED (light-emitting part), 6: PD (light-receiving part), 7: contact detection means, 7a, 7b: pair of electrodes, 8: biological sensor part, 9: data processing part (biological information detection part), 11: display part, 13: rechargeable battery, 21: external connection terminal (recharging means), 24: flexible board, 30: first band, 31: second band, 40: ridged part, 40a: lower surface of ridged part

BEST MODE FOR CARRYING OUT THE INVENTION

- (0043) An embodiment of the biological information measuring device according to the present invention will be described hereinafter with reference to FIGS. 1 to 7.
- (0044) As illustrated in FIGS. 1 to 7, a biological information measuring device 1 of this embodiment is a wristwatch-type device which detects pulse rate as a type of biological information while mounted to the wrist (arm) A.
- (0045) This biological information measuring device 1 includes a housing (main body) 2 internally equipped with various electrical parts and electronic parts, and a fixing means 3 for mounting the housing 2 to the wrist A while directing the lower surface 2a of the housing 2 toward a surface B side of a living body. In addition, a protruding part 4 which protrudes from the lower surface 2a is formed on the lower surface 2a of the housing 2.

- (0046) A biological sensor part 8, which includes an LED (Light Emitting Diode) (light-emitting part) 5 for emitting light toward the living body while in contact with the living body surface B side, a PD (Photodetector) (light-receiving part) 6 for receiving reflected light from the living body out of the light emitted by the LED 5 and generating a pulse signal (biological information signal) corresponding to the amount of received light, and a contact detection means 7 for detecting whether the LED 5 and the PD 6 are in contact with the living body surface B, is disposed on the lower surface 4a of the protruding part 4.
- (0047) In addition, a data processing part (biological information detection part) 9 for detecting pulse rate based on the generated pulse signal is provided inside the housing 2.
- (0048) The housing 2 described above is made of plastic or a metal material such as aluminum and is formed with a prescribed thickness into a substantially rectangular shape from a top view, for example. A cover glass 10 with a substantially square shape is fitted into the central portion of the upper surface 2b of the housing 2, and a display part 11 for displaying the aforementioned pulse rate that is detected and various other information is disposed inside the cover glass 10.
- (0049) In addition, as illustrated in FIGS. 6 and 7, a main board 12 is provided inside the housing 2, and the data processing part 9, the display part 11, a rechargeable battery 13 that can be recharged, a memory 14 for recording the pulse rate, a sub-board 15, and various other electronic parts are mounted on or electrically connected to the main board 12.
- (0050) The data processing part 9 includes IC parts such as a CPU, and has a function of detecting the pulse rate by temporarily amplifying the pulse signal generated by the PD6 with an amplifier, performing prescribed processing such as Fast Fourier Transform processing (FFT processing), and then analyzing the processing results. In addition, the data processing part 9 records the detected pulse rate in the memory 14 and displays the pulse rate on the display part 11 based on input from each button 20 described below. Further, the data processing part 9 has a function of comprehensively controlling other components.
- (0051) The display part 11 is a liquid crystal display device such as an LCD (Liquid Crystal Display), for example, and in addition to the pulse rate described above, it has a time display function for displaying the time counted by a crystal resonator (not illustrated), for example, or a function of displaying various other information. For example, the time, date, day of the week, the remaining power of the rechargeable battery 13, or the like can be displayed.
- (0052) In addition, as illustrated in FIGS. 1 and 2, various buttons 20 such as three buttons 20 disposed on the upper surface 2b of the housing 2 and below the display part 11 and one button 2 disposed on the side surface of the housing 2, for example, are provided on the housing 2. Various

operations can be performed by pressing each of these buttons 20. Operations such as starting or stopping the measurement of the pulse rate, switching the display between the pulse rate and time, and sending pulse rate data recorded in the memory 14 to an external device, for example, can be performed.

(0053) Further, an external connection terminal (recharging means) 21 for recharging the rechargeable battery 13 by supplying power from an external device such as a recharger is provided on the side surface of the housing 2. Note that the external connection terminal 21 may be protected by attaching a cover or the like so as to cover the external connection terminal 21. This makes it possible to protect the external connection terminal 21 from water droplets, dust, or the like, which is more preferable. In addition, rather than the external connection terminal 21, a transformer or the like for supplying power to a recharger and to the inside of the housing 2 may be provided so as to recharge the rechargeable battery 13 in a contactless state.

(0054) As illustrated in FIG. 5, the protruding part 4 is formed into a shape combining three circles when viewed from below – that is, a keyhole-like shape formed by combining, with a central circle, two circles having a smaller diameter than the central circle so as to sandwich the central circle from the left and right sides. In addition, the protruding part 4 is formed so that the center position thereof is offset toward the side of a second band 31 described below rather than the center position of the housing 2. As a result, the biological sensor part 8 disposed on the lower surface of the protruding part 4 is similarly disposed at a position offset toward the second band 31 side. In addition, rather than protruding vertically from the lower surface of the housing 2, the protruding part 4 is formed so that the side surface 4b is a sloping surface.

(0055) In addition, as illustrated in FIG. 7, a through-hole 22 passing through the outside and the inside of the housing 2 is formed in the center of the lower surface 4a of the protruding part 4, and a cover glass 23 is fixed to the housing 2 so as to block the through-hole 22. The LED 5 and the PD 6 are disposed adjacent to one another in a direction orthogonal to the longitudinal direction of the housing so as to touch the inside of the glass cover 23. That is, the LED 5 and the PD 6 are configured so as to be dropped into the protruding part 4. As a result, the LED 5 and the PD 6 are as close to the living body surface B as possible.

[0056] At this time, as illustrated in FIG. 6, the LED 5 and the PD 6 are mounted to one end side of a flexible board 24 that is electrically connected to the sub-board 15, and are disposed in a state in which they are pushed toward the lower surface 2a side of the housing 2 by the elasticity of the flexible board 24. This also causes the LED 5 and the PD 6 to be positioned on the lower surface

4a side of the protruding part 4 as much as possible. That is, the LED 5 and the PD 6 are as close to the living body surface B as possible. Note that the sub-board 15 and the flexible board 24 [sic: corrected from "14"] are formed with an integral structure. In addition, the flexible board to which the LED 5 and the PD 6 are mounted may be fixed to the lower surface 2a side of the housing 2 with a fixing member such as double-sided tape.

- (0057) The pulse signal generated by the PD 6 is sent to the data processing part 9 via the flexible board 24, the sub-board 15, and the main board 12.
- (0058) The contact detection means 7 has a pair of electrodes 7a and 7b, and the pair of electrodes 7a and 7b are disposed on the lower surface 4a of the protruding part 4 so as to sandwich the LED 5 and the PD 6. That is, the pair of electrodes 7a and 7b, the LED 5, and the PD 6 are disposed in a row in a direction orthogonal to the longitudinal direction of the housing 2. In addition, the pair of electrodes 7a and 7b are provided so that the tips thereof protrude slightly more than lower surface 4a of the protruding part 4 and are provided so that the base end sides are electrically connected to the sub-board 15.
- (0059) The pair of electrodes 7a and 7b have a function of detecting whether there is contact with the living body surface B based on the potential difference between the electrodes. The data processing part 9 is set to receive the detection result and, for example, when it is detected that there is contact with the living body surface B, to control the operation of the LED 5 so as to emit light from the LED 5. Note that instead of this configuration, it may also be set so as to forego FFT processing when it is detected that there is no contact with the living body surface B, for example.
- (0060) The fixing means 3 has a first band 30 and a second band 31 having base end sides that are attached to the housing 2 to enable mounting to the wrist A. The first band 30 and the second band 31 are provided opposite one another so as to sandwich the housing 2 in the longitudinal direction of the housing 2. In addition, both bands 30 and 31 are made of an expandable elastic material.
- (0061) A buckle 30a and a tongue 30b are attached to the end of the first band 30. In addition, a plurality of insertion holes 31a into which the tongue 30b may be inserted are formed in the second band 31 along the longitudinal direction of the second band 31. As a result, the lengths of the first band 30 and the second band 31 can be adjusted in accordance with the thickness of the wrist A of the user.

- (0062) A case in which the pulse rate is detected by the biological information measuring device 1 configured in this way while mounted to the wrist A will be described hereinafter.
- (0063) First, as illustrated in FIGS. 2 and 3, both bands 30 and 31 are wrapped around the wrist A of the user, and the tongue 30b of the first band 30 is inserted into the insertion hole 31a of the second band 31 in accordance with the size of the wrist A to mount the housing 2 to the wrist A. When the housing 2 is mounted to the wrist A, the protruding part 4 protrudes more than the lower surface 2a of the housing 2, so the living body surface B and the lower surface 4a of the protruding part 4 are in close contact. Therefore, it is unnecessary to mount the housing 2 so as to constrict the wrist A, and it is only necessary to adjust the lengths of both bands 30 and 31 so that they are tightened with a prescribed amount of force. In particular, since the side surface 4b of the protruding part 4 is a sloping surface, the living body surface B deforms smoothly in accordance with the outer shape of the protruding part 4, which facilitates close contact.
- (0064) When the living body surface B and the lower surface 4a of the protruding part 4 are in close contact – that is, when the living body surface B is in contact with the lower surface 4a of the protruding part 4 – the pair of electrodes 7a and 7b come into contact with the living body surface B. In particular, since the pair of electrodes 7a and 7b are disposed so as to protrude slightly more than lower surface 4a of the protruding part 4, they easily come into contact with the living body surface B. When the pair of electrodes 7a and 7b come into contact with the living body surface B, a discharge occurs through the living body surface B so that the voltage between the electrodes drops. Upon receiving this voltage drop (for example, a drop below a given threshold), the data processing part 9 detects that the pair of electrodes 7a and 7b are indeed in contact with the living body surface B. That is, it detects that the biological sensor part 8 including the LED 5 and the PD 6 is indeed in contact with the living body surface B. In particular, since the pair of electrodes 7a and 7b are disposed so as to sandwich the LED 5 and the PD 6, it can be detected with high precision whether the LED 5 and the PD 6 are in contact with the living body surface B.
- (0065) Upon detecting that the LED 5 and the PD 6 are in contact with the living body surface B, the data processing part 9 emits light from the LED 5 toward the living body. A portion of the emitted light is absorbed, for example, by hemoglobin in blood vessels, and another portion of the light is reflected by biological tissue. The PD 6 receives this reflected light, generates a pulse signal (biological information signal) corresponding to the amount of received light, and outputs the signal to the data processing part 9. That is, since the amount of reflected light out of the light emitted from the LED 5 varies depending on fluctuations in blood flow within arteries and arterioles in the wrist A (living body), the PD 6 can receive reflected light corresponding to the pulsation of arteries – that is, pulse waves. As a result, the PD 6 can generate a pulse signal.

- (0066) After amplifying the received pulse signal, the data processing part 9 performs prescribed processing such as FFT processing and analyzes the signal to detect the pulse rate. The data processing part 9 then records the detected pulse rate in the memory 14 and displays the signal on the display part 11 based on the operation of each button 20.
- (0067) Since the user can easily display and confirm the detected pulse rate on the display part 11 by pressing each button 20 as necessary, the device is convenient to use. In addition, the user can also confirm information other than the pulse rate such as the time or the remaining power of the rechargeable battery 13, for example, with the display part 11 by operating each button, which makes it easy to use.
- (0068) Further, as described above, the user mounts the housing 2 to the wrist A by tightening it with a prescribed amount of force using both bands 30 and 31, so even when worn for a long time, the user does not experience an oppressive feeling and therefore does not experience discomfort.
- (0069) In addition, when the user holds something in the hand or performs some kind of operation, for example, the thickness (diameter) of the wrist A (arm) changes due to muscle movement. In this case as well, since the biological sensor part 8 is disposed on the lower surface 4a of the protruding part 4 protruding from the lower surface 2a of the housing 2, it is possible to minimize any reduction in contact (adherence) between the biological sensor part 8 and the living body surface B. In particular, the fact that the first band 30 and the second band 31 are expandable and can expand and contract in accordance with changes in the thickness of the wrist A also makes it possible to suppress decreases in adherence.
- (0070) Accordingly, even if the thickness of the wrist A changes, it is possible to maintain a state in which the LED 5 and the PD 6 are in contact with the living body surface B, so the accurate pulse rate can always be detected. This makes it possible to enhance the pulse rate detection precision. In addition, the fact that the LED 5 and the PD 6 are dropped into the protruding part 4 and are pushed toward the lower surface 2a side of the housing 2 by the elasticity of the flexible board 24 so that they are as close to the living body surface B as possible also makes it possible to detect the pulse rate with high precision.
- (0071) Further, when the display part 11 is held in front of the eyes while the arm is positioned horizontally and the back of the hand is facing inward in order to confirm various information displayed on the display part 11, even if the housing 2 shifts toward the ground side – that is, toward the second band 31 side – due to gravity, the biological sensor part 8 is disposed at a position offset toward the base end side of the second band 31 from the center position of the housing 2, so it is possible to prevent a reduction in contact between the biological sensor part 8 and the living body

surface B. Note that this is also true in a case in which the arm faces the ground side – that is, the arm is dropped downward.

- (0072) In addition, the rechargeable battery 13 can be recharged with power by connecting a recharging cord or the like connected to a recharger to the external connection terminal 21, for example, and it is unnecessary to separately prepare an ordinary battery. Therefore, it is possible to reduce maintenance costs. Note an audio output means such as a buzzer for outputting audio may be provided inside the housing 2 so that when the charged amount of the rechargeable battery 13 drops to nearly "0", a sound is outputted to inform the user of the recharging period (recharging timing).
- (0073) As described above, according to the biological information measuring device 1 of this embodiment, when the main body is mounted to the wrist A with the fixing means 3, the protruding part 4 protrudes from the lower surface 2a of the housing 2, so the living body surface B and the lower surface 4a of the protruding part 4 reliably come into contact, which enhances the adherence of the biological sensor part 8. Therefore, unlike in conventional configurations, it is unnecessary to fix the housing 2 so as to strongly press (so as to compress) the housing against the living body surface B with the fixing part 3. Accordingly, the device does not cause discomfort, even when worn for a long time. Moreover, since the adherence of the biological sensor part 8 is enhanced, light can be emitted and received efficiently, which makes it possible to detect the pulse rate with high precision.
- (0074) Note that the technical scope of the present invention is not limited to the embodiment described above, and various modifications may be applied within a scope that does not depart from the gist of the present invention.
- (0075) For example, in the embodiment described above, the shape of the protruding part 4 was a keyhole-like shape formed by combining three circles, but the protruding part is not limited to this shape and may be any shape as long as it protrudes beyond the lower surface 2a of the housing 2.
- (0076) For example, as illustrated in FIG. 8, the protruding part 4 may be formed so that the outer periphery is circular. In addition, the diameter of the protruding part 4 illustrated in FIG. 8 is set to 20 mm, and the protruding part is formed so that the lower surface 4a of the protruding part 4 and the lower surface 2a of the housing 2 are 3 mm apart from one another.
- (0077) By forming the protruding part 4 into a circle, when the housing 2 is mounted to the wrist A, the protruding part 4 is pressed against the living body surface B with equal force, so there adherence is good. At this time, since the diameter of the protruding part 4 is not greater than 20 mm, the protruding part 4 can be pressed with a light force, which makes it possible to further eliminate any oppressive feeling. Here, the difference between the maximum diameter and the minimum diameter of the wrist is typically 3 mm. Therefore, as illustrated in FIG. 8, by setting the distance

between the lower surface 4a of the protruding part 4 and the lower surface 2a of the housing 2 to 3 mm, it is possible to accommodate changes in the thickness of the wrist, which makes it possible to enhance adherence without creating a gap between the lower surface 4a of the protruding part 4 and the living body surface B. Accordingly, the adherence of the biological sensor part 8 can be improved.

- (0078) Note that although the distance between the lower surface 4a of the protruding part 4 and the lower surface 2a of the housing 2 was set to 3 mm, the distance is not limited to 3 mm and may be set within the range of from 2 mm to 4 mm. When the distance is 2 mm or smaller, the level difference is small, and a gap is formed relative to the living body surface B so that external light can enter easily. In addition, when the distance is 4 mm or greater, an oppressive feeling arises, while the height causes instability, and external light can easily enter the space between the device and the living body surface B when inclined. That is, as illustrated in FIG. 8, setting the distance between the lower surface 4a of the protruding part 4 and the lower surface 2a of the housing 2 to within the range of from 2 mm to 4 mm makes it possible to prevent an oppressive feeling and the incidence of external light.
- (0079) In addition, the protruding part 4 illustrated in FIG. 8 may be formed so that the outer edge thereof is a curved surface, as illustrated in FIG. 9. This makes it possible to further enhance the adherence, and even when worn for a long time, pressure marks are unlikely to form, so the device is comfortable to wear.
- (0080) Further, a curved surface may be formed from the center toward the outer edge of the lower surface 4a of the protruding part 4, as illustrated in FIG. 10. As a result, the device can be mounted in a state in which the living body surface B deforms smoothly and the contact pressure of the center part of the lower surface 4a is increased, which further enhances adherence. Moreover, pressure marks are unlikely to form, so the device is comfortable to wear.
- (0081) In addition, as illustrated in FIG. 11, ridged parts 40 formed so as to protrude from the lower surface 2a of the housing 2 may be provided a prescribed distance – that is, a distance of 8 mm – from the side surfaces 4b of the protruding part 4 so as to sandwich the protruding part 4. Note that the protruding part 4 illustrated in FIG. 11 has the same shape as that illustrated in FIG. 8.
- (0082) Further, the distance between the lower surface 40a of each ridged part 40 and the lower surface 2a of the housing 2 is set to 4 mm, which is slightly higher than the distance (3mm) between the lower surface 4a of the protruding part 4 and the lower surface 2a of the housing 2.
- (0083) With such a configuration, when the housing 2 is mounted to the wrist A, the living body comes into contact with the lower surface 4a of the protruding part 4 and the lower surfaces 40a of the ridged parts 40 while filling the 8 mm gaps formed between the protruding part 4 and the

ridged parts 40. At this time, the ridged parts 40 come into contact with the living body on the outside of the protruding part 4 and make contact before the protruding part 4. Accordingly, the living body can be brought into contact with the lower surface 4a of the protruding part 4 in a stable state, and the contact pressure can be made uniform with respect to the lower surface 4a of the protruding part 4. Therefore, the pulse rate can be detected stably over a long period of time. In addition, the ridged parts 40 may be formed in close proximity to the protruding part 4 – that is, in a small space – so the size can be kept small even when the ridged parts 40 are provided.

(0084) Note that, as illustrated in FIGS. 12 and 13, the ridged parts may also be configured in combination with the protruding part 4 illustrated in FIGS. 9 and 10 described above. In addition, the ridged parts may be formed so as to enclose the perimeter of the protruding part at positions a prescribed distance from the side surfaces of the protruding part.

(0085) Further, in the embodiment described above, pulse rate was given as an example of biological information, but the present invention is not limited to pulse rate as long as biological information is used.

(0086) In addition, although the contact detection means has a pair of electrode, it is not limited to a pair and may also have a plurality of electrodes. In this case, the contact detection means should be set to detect whether there is contact based on the potential difference between each of the electrodes.

(0087) Further, the biological sensor part was configured to be offset toward the base end side of the second band from the center position of the housing, but it may also be formed so as to be offset toward the base end side of the first band side. That is, the design should be made in consideration of the relationship between both bands and the display part.

(0088) In addition, the housing may be provided with an additional function such as a wireless communication means for enabling wireless communication with other electronic devices. This makes it possible to transmit pulse rate data recorded in the memory to an external electronic device and to acquire various information into the memory by means of wireless communication such as Bluetooth.

INDUSTRIAL APPLICABILITY

(0089) According to the present invention, when the main body is mounted to the wrist with the fixing means, the protruding part protrudes from the lower surface of the main body, so the living body surface and the lower surface of the protruding part reliably come into contact, which enhances the adherence of the biological sensor part. Therefore, unlike in conventional configurations, it is unnecessary to fix the main body so as to strongly press (so as to compress) the main body against the living body surface with the fixing part. Accordingly, the device does not cause discomfort, even when worn for a long time. Moreover, since the adherence of the biological sensor part is enhanced,

light can be emitted and received efficiently, and biological information can be detected with high precision.

CLAIMS

- (1) A biological information measuring device comprising:
a biological sensor part including:
a main body;
a protruding part formed so as to protrude from a lower surface of the main body;
a fixing means for mounting the main body to an arm while directing the lower surface of the main body toward a living body surface side;
a light-emitting part for emitting light toward the living body while in contact with the living body surface;
a light-receiving part for receiving reflected light from the living body out of the light emitted by the light-emitting part and generating a biological information signal corresponding to an amount of received light; and
a contact detection means for detecting whether the light-emitting part and the light-receiving part are in contact with the living body surface; and
a biological information detection part which is provided on the main body and detects biological information based on the biological information signal;
wherein the biological sensor part is disposed on a lower surface of the protruding part.
- (2) The biological information measuring device according to Claim 1,
wherein ridged parts are formed so as to protrude from the lower surface of the main body at positions a prescribed distance from side surfaces of the protruding part so as to sandwich at least the protruding part; and
a distance between a lower surface of each ridged part and the lower surface of the main body part is set to be equal to or greater than a distance between the lower surface of the protruding part and the lower surface of the main body part.
- (3) The biological information measuring device according to Claim 1 or 2,
wherein the contact detection part includes at least a pair of electrodes and detects whether the light-emitting part and the light-receiving part are in contact with the living body surface based on a potential difference between the pair of electrodes.
- (4) The biological information measuring device according to Claim 3,
wherein the pair of electrodes are disposed so as to sandwich the light-emitting part and the light-receiving part therebetween.
- (5) The biological information measuring device according to any one of Claims 1 to 4,

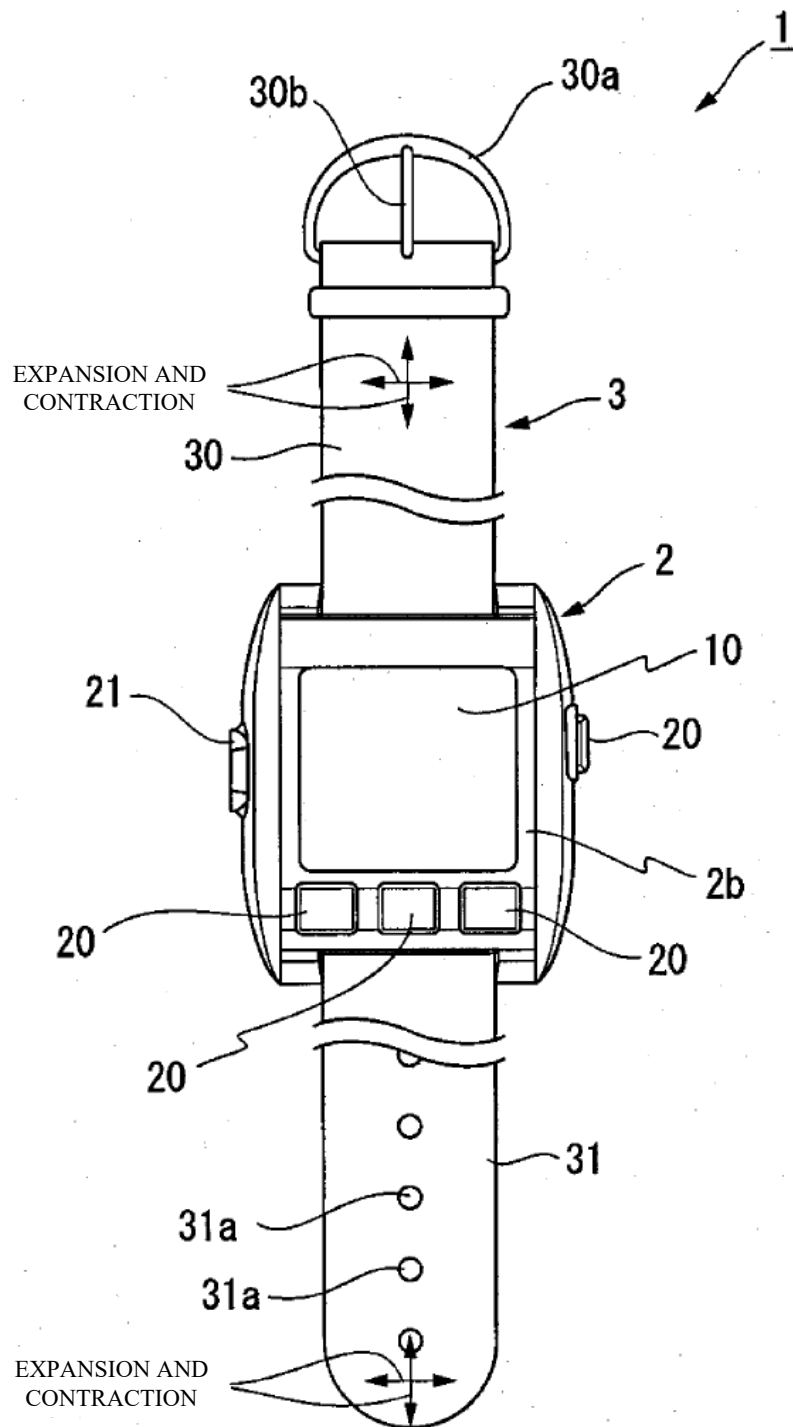
wherein a flexible board which electrically connects the light-emitting part and the light-receiving part to the biological information detection part is provided; and

the flexible board is provided inside the main body so as to push the light-emitting part and the light-receiving part toward the lower surface side of the main body with its own elasticity.

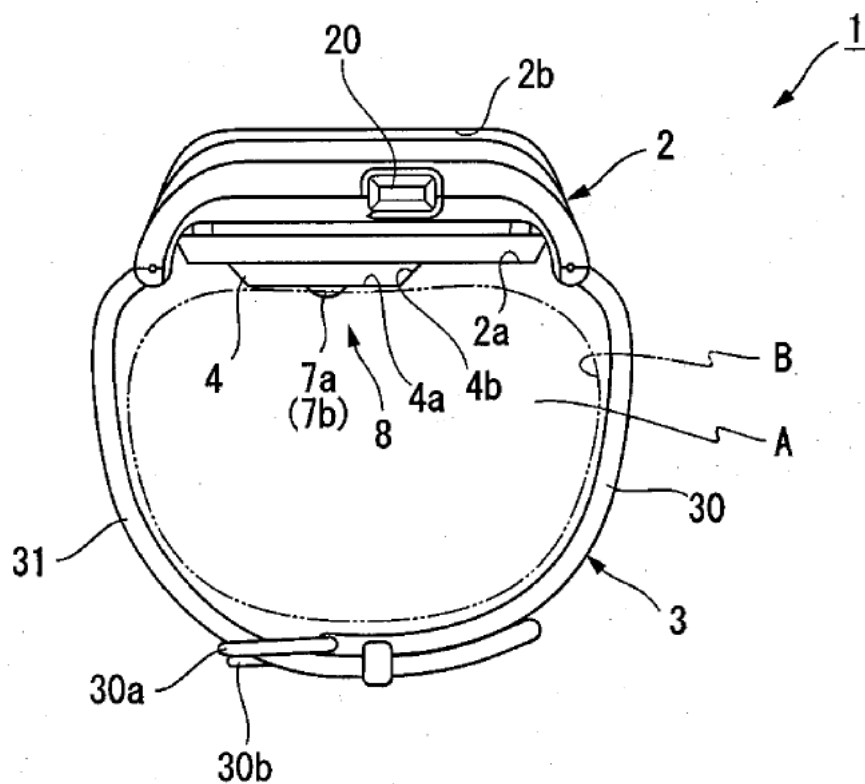
- (6) The biological information measuring device according to any one of Claims 1 to 5, wherein a display part for displaying detected biological information is provided on an upper surface of the main body.
- (7) The biological information measuring device according to any one of Claims 1 to 6, wherein the fixing means includes first and second bands having base end sides attached to the main body to enable mounting on the arm; and
the first and second bands are disposed opposite one another so as to sandwich the main body and are formed from an expandable elastic material.
- (8) The biological information measuring device according to Claim 7, wherein the biological sensor part is disposed at a position offset toward the base end side of the first or second band from a center position of the main body.
- (9) The biological information measuring device according to any one of Claims 1 to 8, wherein a rechargeable battery that can be recharged and a recharging means for recharging the rechargeable battery with power are provided on the main body.
- (10) The biological information measuring device according to any one of Claims 1 to 9, wherein a distance between the lower surface of the protruding part and the lower surface of the main body is set to 2 to 4 mm.
- (11) The biological information measuring device according to any one of Claims 1 to 10, wherein the protruding part is formed so that an outer periphery thereof is circular.
- (12) The biological information measuring device according to Claim 11, wherein the protruding part is formed so that an outer edge thereof is a curved surface.

- (13) The biological information measuring device according to Claim 11,
wherein the protruding part is formed with a curved surface from a center toward an outer edge
of the lower surface thereof.
- (14) The biological information measuring device according to any one of Claims 11 to 13,
wherein a diameter of the protruding part is set to not greater than 20 mm.
- (15) The biological information measuring device according to any one of Claims 2 to 14,
wherein the ridged parts are provided at a positions 8 mm from side surfaces of the protruding
part, and a distance between the lower surface of each ridged part and the lower surface of the main
body is set to 4 mm.

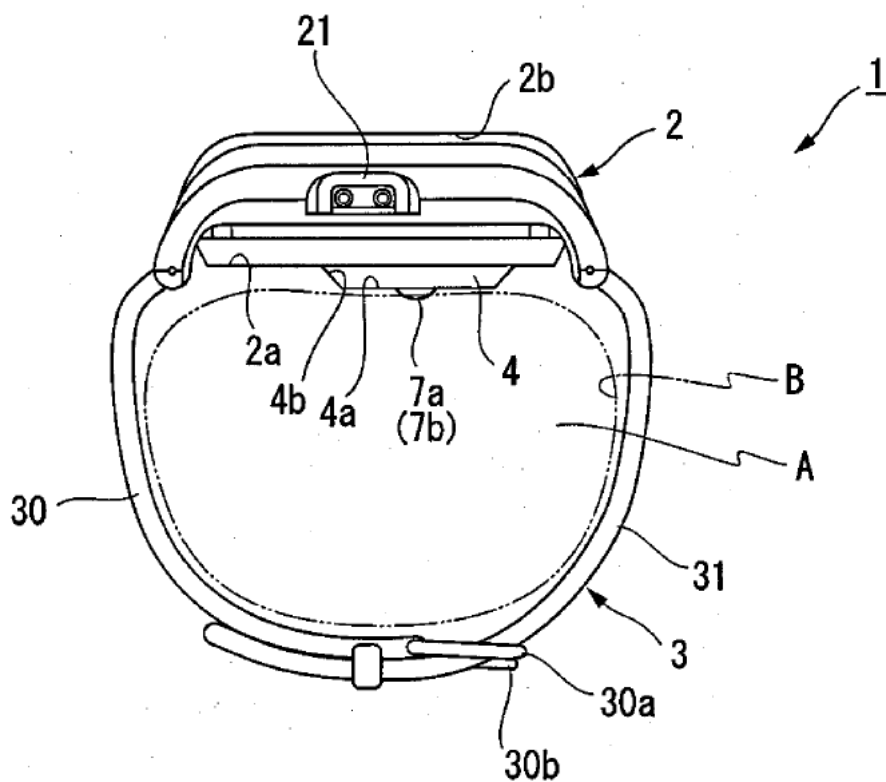
[FIG. 1]



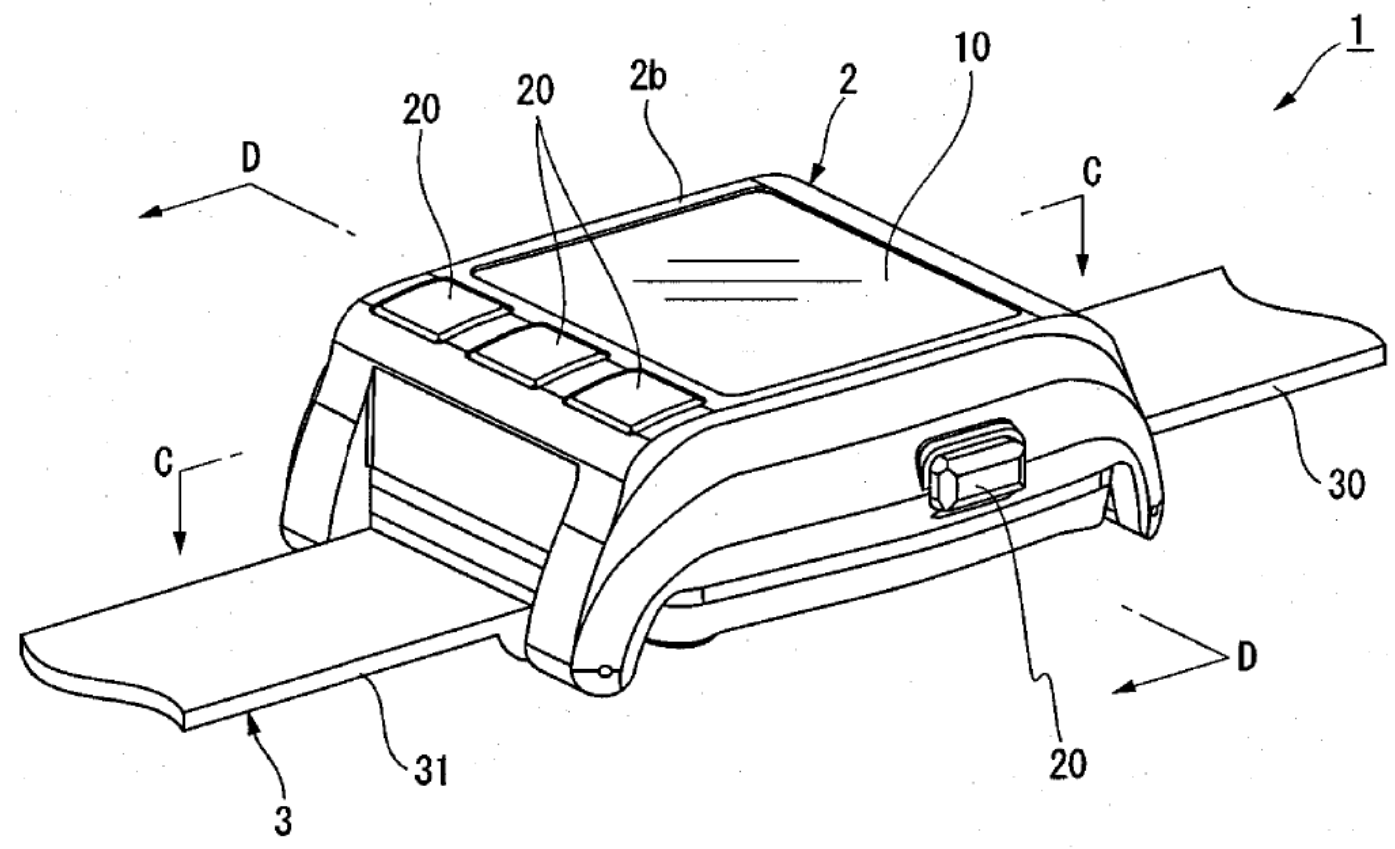
[FIG. 2]



[FIG. 3]

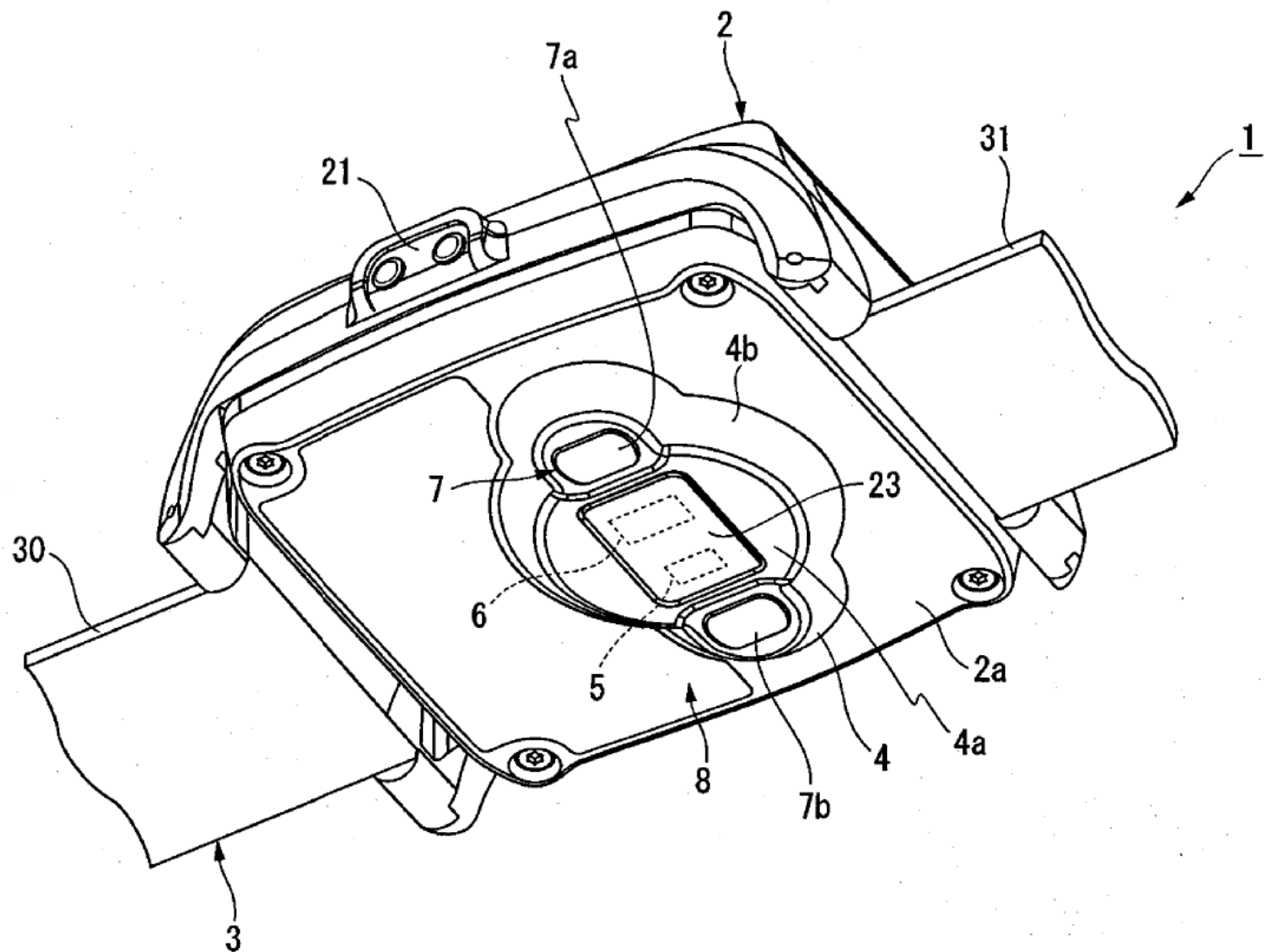


[FIG. 4]

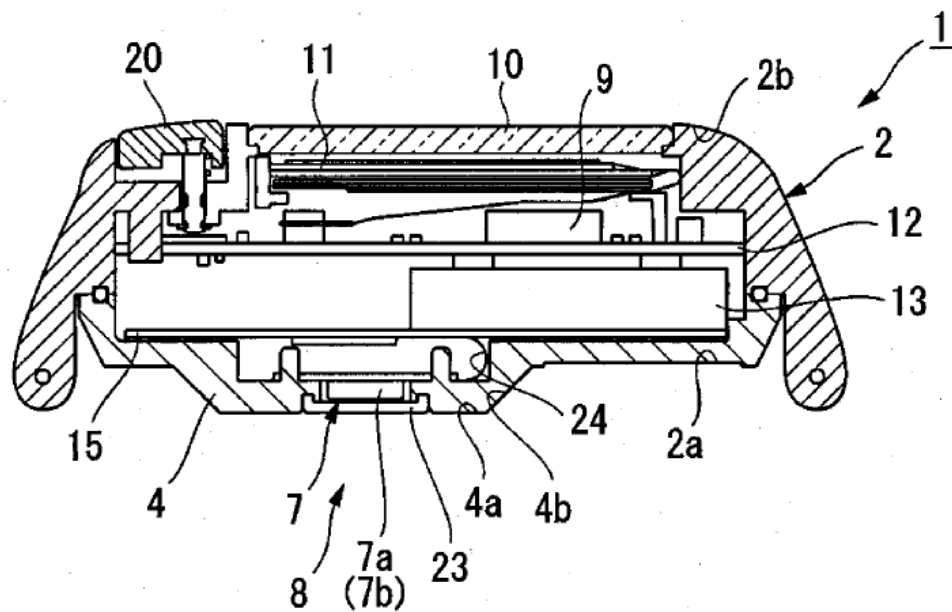


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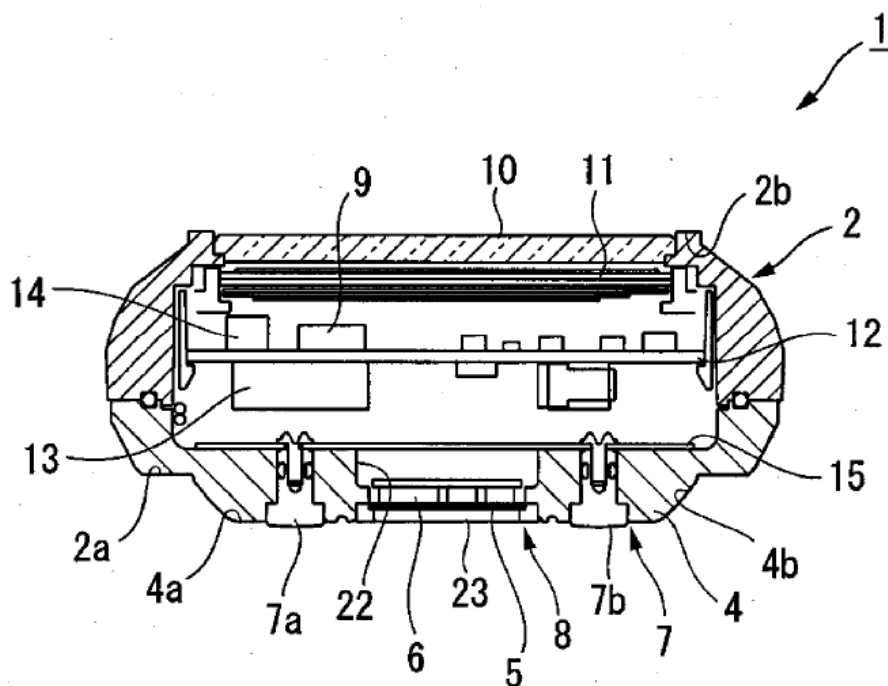
[FIG. 5]



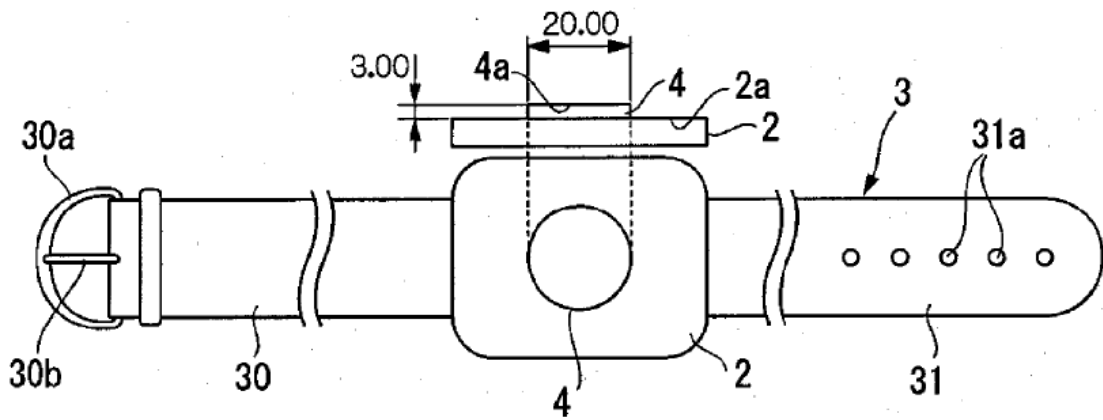
[FIG. 6]



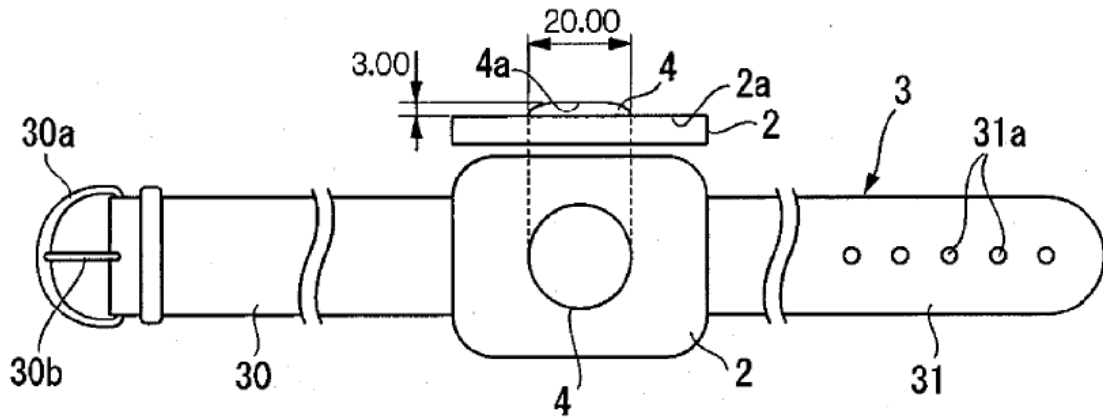
[FIG. 7]



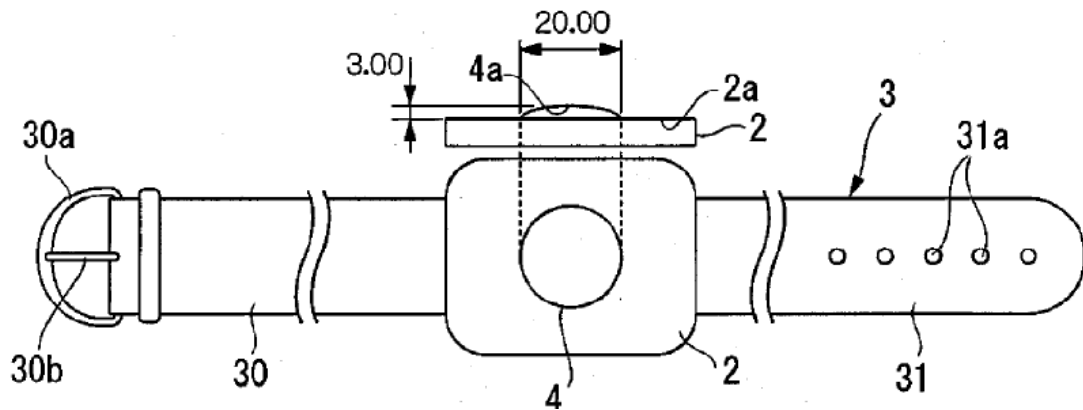
[FIG. 8]



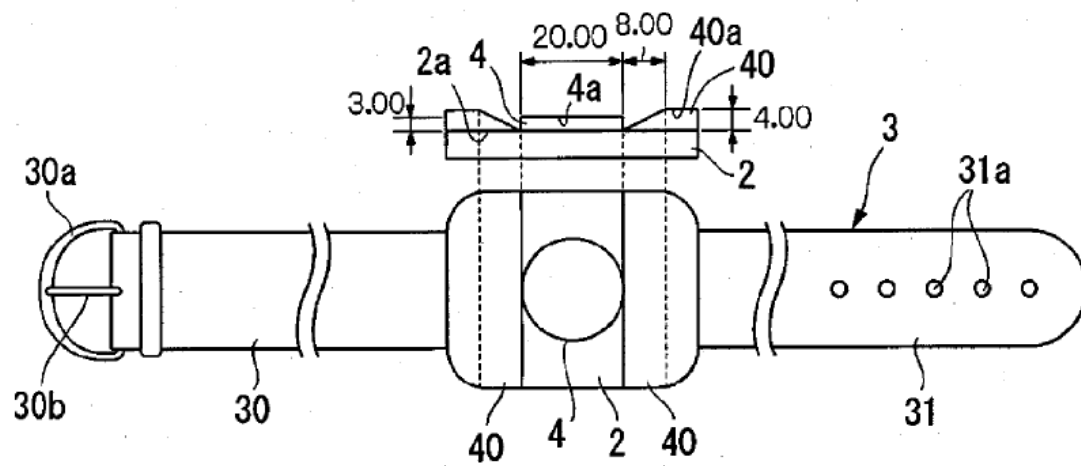
[FIG. 9]



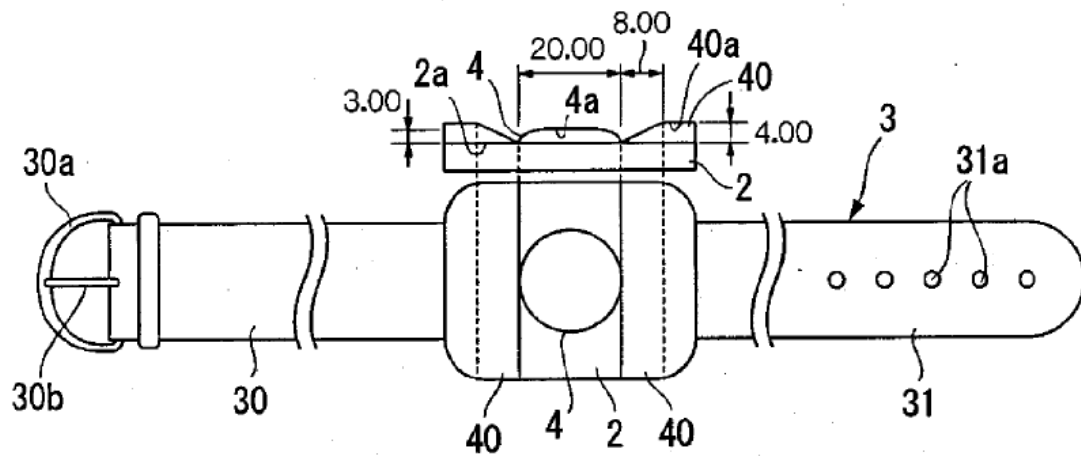
[FIG. 10]



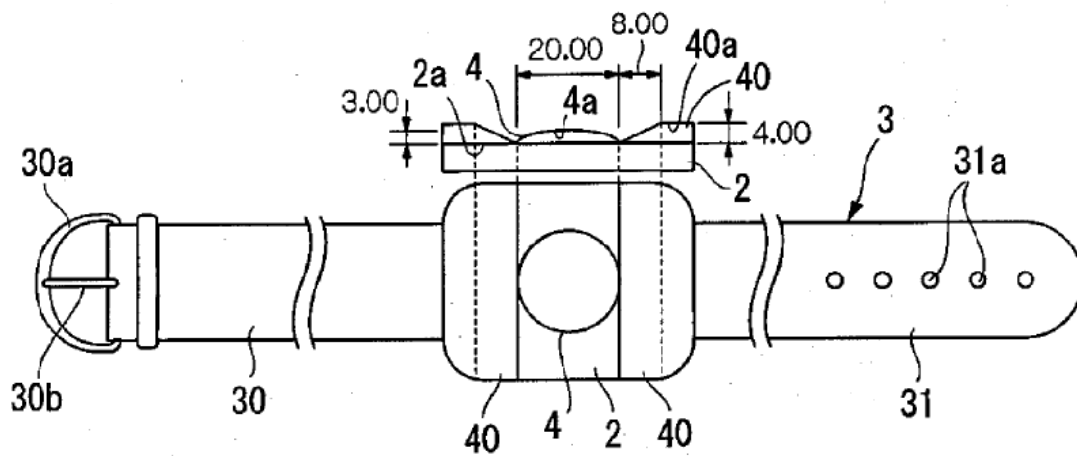
[FIG. 11]



[FIG. 12]



[FIG. 13]



INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2005/002021

A. CLASSIFICATION OF SUBJECT MATTER

Int.Cl.⁷ A61B5/0245

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

Int.Cl.⁷ A61B5/0245

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Jitsuyo Shinan Koho 1922-1996 Toroku Jitsuyo Shinan Koho 1994-2005

Kokai Jitsuyo Shinan Koho 1971-2005 Jitsuyo Shinan Toroku Koho 1996-2005

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y A	JP 11-235320 A (Seiko Epson Corp.), 31 August, 1999 (31.08.99), Full text; all drawings (Family: none)	1-4, 6, 7, 9, 11 5, 8, 10, 12-15
Y A	JP 2003-70757 A (Seiko Instruments Inc.), 11 March, 2003 (11.03.03), Par. Nos. [0021] to [0027]; Figs. 2, 3 & EP 1290975 A1 & US 2003/45802 A1	1-4, 6, 7, 9, 11 5, 8, 10, 12-15
Y	JP 2002-159457 A (Seiko Instruments Inc.), 04 June, 2002 (04.06.02), Par. Nos. [0013] to [0027]; Figs. 4 to 18 (Family: none)	2

☒ Further documents are listed in the continuation of Box C.☐ See patent family annex.

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"&" document member of the same patent family

Date of the actual completion of the international search
02 March, 2005 (02.03.05)Date of mailing of the international search report
22 March, 2005 (22.03.05)Name and mailing address of the ISA/
Japan Patent Office (ISA/JP)
3-4-3 Kasumigaseki, Chiyoda-ku,
Tokyo 100-8915
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Authorized officer

Kosen Ito

2W 9604

Telephone No. 03-3581-1101 Ext. 3290

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INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2005/002021

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	JP 2000-342547 A (Kawasaki Heavy Industries, Ltd., The New Industry Research Organization), 12 December, 2000 (12.12.00), Par. Nos. [0012] to [0013]; Figs. 1 to 4 (Family: none)	9

Form PCT/ISA/210 (continuation of second sheet) (January 2004)



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All statements made of my own knowledge are true and all statements made on information and belief are believed to be true.

A handwritten signature in black ink, appearing to read 'Brian Toth', written over a horizontal line.

Brian Toth