



TRANSLATION CERTIFICATION

Date: June 30, 2025

To whom it may concern:

I, Frank McGee, a translator fluent in the Japanese and English languages, on behalf of Morningside, do solemnly and sincerely declare that the following is, to the best of my knowledge and belief, a true and correct translation of the document(s) listed below in a form that best reflects the intention and meaning of the original text.

The document is designated as:

- JP 3552090 B2

All statements made in this declaration of my own knowledge are true and all statements made on information and belief are believed to be true. I make these statements with the understanding that willful false statements and the like are punishable by fine or imprisonment, or both (18 U.S.C. 1001).

I declare under penalty of perjury that the forgoing is true and correct.

A handwritten signature in blue ink, appearing to read "Frank McGee", written over a horizontal line.

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(54) [Title of the Invention] Biological Signal Detecting Device**(57) [Claims]****[Claim 1]**

A biological signal detecting device, comprising:

an attachment means to be attached to a part of a human body;

a biological signal detecting means provided on the side of the attachment means attached to the body for detecting biological signals from the body;

an attachment detecting means for detecting the attachment/non-attachment of the attachment means to the body; and

a processing changing means for changing the detection processing of biological signals from the body based on the detection results obtained from the attachment detecting means,

wherein the biological signal detecting means comprises a light-emitting element that emits light into the body via the skin, and a light-receiving element that receives light returning from the body and outputs a signal corresponding to the amount of light received, and

the attachment detecting means detects the attachment/non-attachment of the attachment means to the body based on signals outputted by the light-receiving element when the light-emitting element emits light and signals outputted by the light-receiving element when the light-emitting element does not emit light.

[Claim 2]

The biological signal detecting device according to claim 1, wherein the attachment detecting means compares signals outputted by the light-receiving element when the light-emitting element emits light with signals outputted by the light-receiving element when the light-emitting element does not emit light, and detects that the device is not attached when the signals are at the same level, and detects that the device is attached when there is a difference between the signals.

[Claim 3]

The biological signal detecting device according to claim 2, wherein the attachment detecting means compares the DC component of signals outputted by the light-receiving element when the light-emitting

element emits light with the DC component of signals outputted by the light-receiving element when the light-emitting element does not emit light to detect the attachment or non-attachment of the attachment means to the body.

[Claim 4]

The biological signal detecting device according to any of claim 1 to claim 3, wherein the processing changing means stops detecting biological signals with the biological signal detecting means when non-attachment of the attachment means to the body is detected by the attachment detecting means.

[Claim 5]

The biological signal detecting device according to any of claim 1 to claim 3, wherein the processing changing means stops supplying operating power to the biological signal detecting means when the attachment detecting means detects that the attachment means is not attached to the body.

[Claim 6]

The biological signal detecting device according to any of claim 4 to claim 5, wherein the processing changing means resumes detection of biological signals or resumes supply of operating power when a predetermined time has elapsed since stopping detection of biological signals by the biological signal detecting means or stopping the supply of operating power to the biological signal detecting means.

[Claim 7]

The biological signal detecting device according to any of claim 1 to claim 3, further comprising a biological signal processing device that transmits biological signals and performs arithmetic processing on parameters representing the state of the body based on these biological signals, the processing changing means stopping the arithmetic processing of the parameters based on the biological signals in the biological signal processing device while data regarding the attachment or non-attachment of the attachment means to the body is transmitted to the biological signal processing device and the attachment means is detected as being not attached to the body.

[Claim 8]

The biological signal detecting device according to claim 7, wherein the biological signal processing device is provided with a notification means that notifies the examiner when data related to non-attachment of the attachment means to the body is transmitted.

[Detailed Description of the Invention]

[0001]

[Technical Field of the Invention]

The present invention relates to a biological signal detecting device that detects biological signals by attaching an attachment means to an examinee's finger, ear, arm, leg, torso, or neck, etc.

[0002]

[Prior Art]

A biological signal detecting device is known in the art in which, when examining biological signals (such as pulse waves) from an examinee, the examinee operates an operating switch and inserts a finger into the device, and the biological signals detected by a sensor are examined by a biological signal examining device. A biological signal detecting device is also known in the art for use in the long-term examination of biological signals (such as pulse waves) from elderly or infirm persons. In this device, an attachment means is attached to an arm, leg, etc. of the examinee and biological signals detected by the device are transmitted to a biological signal examining device via radio signals, etc.

[0003]

[Problem to Be Solved by the Invention]

However, the prior art described above has the following problem: In the former biological signal detecting device, when the examinee operates the switch without inserting a finger, etc. into the device, the sensor picks up external noise and outputs abnormal signals, causing the biological signal detection device to determine erroneously that something is wrong with the examinee.

[0004]

In the latter biological signal detecting device, if an elderly or infirm person removes the device, the sensor picks up external noise and sends abnormal signals to the biological signal examining device, causing the device to determine erroneously that something is wrong with the examinee. In addition, the latter biological signal detecting device is structurally designed to be powered by a battery, so reducing power consumption is a necessity.

[0005]

It is an object of the present invention to provide a biological signal detecting device that eliminates malfunctions caused by abnormal biological signals detected when the attachment means is not attached.

[0006]

[Means for Solving the Problem]

(Claim 1)

When detecting biological signals from a body, an attachment means is attached to a part of the body (finger, arm, leg, torso, neck, etc.). A biological signal detecting means is provided on the side of the attachment means attached to the body for detecting biological signals from the body. The biological signal detecting means comprises a light-emitting element that emits light into the body via the skin, and a light-receiving element that receives light returning from the body and outputs a signal corresponding to the amount of light received. An attachment detecting means detects the attachment/non-attachment of the attachment means to the body based on signals outputted by the light-receiving element when the light-emitting element emits light and signals outputted by the light-receiving element when the light-emitting element does not emit light. A processing changing means changes the detection processing of biological signals from the body based on the detection results obtained from the attachment detecting means.

[0007]

The biological signal detecting device is configured so that the processing changing means changes the detection processing of biological signals from the body performed by the biological signal detecting means based on the detection results obtained from the attachment detecting means. As a result, abnormal biological signals (noise) can be prevented from being outputted by the biological signal detecting means when the device is not attached to the body, or to prevent erroneous determination of the physiological state of the wearer based on abnormal biological signals. The biological signal detecting device uses a biological signal detection means to detect biological signals, and an attachment detecting means detects whether the attachment means is attached or not attached. As a result, no dedicated sensor is required to detect the attachment state, and the attachment means can be made smaller.

[0010]

(Claim 2)

The attachment detecting means compares the level of signals outputted by the light-receiving element when the light-emitting element emits light with the level of signals outputted by the light-receiving element when the light-emitting element does not emit light (as shown below). When the signals are at the same level, the device detects that the attachment means is not attached, and when there is a difference in the levels of the signals, it detects that the attachment means is attached.

[0011]

When the attachment means is attached to the body, the light-emitting element emits light, which is received by the light-receiving element from inside the body, and when the light-emitting element stops emitting light, the returning light disappears, causing the signal level to drop to approximately zero. When the attachment means is not attached to the body, the light-receiving element receives light from the surrounding area, so the sensor outputs the same level of signal regardless of whether the light-emitting element is emitting light.

[0012]

Because the level of signals outputted by the light-receiving element when the light-emitting element emits light is compared with the level of signals outputted by the light-receiving element when the light-emitting element does not emit light to detect whether the attachment means is attached or not attached, the structure of the attachment detecting means is simple and the biological signal detecting device can be manufactured at low cost.

[0013]

(Claim 3)

The attachment detecting means detects whether or not the attachment means is attached to the body by comparing the DC component of signals outputted by the light-receiving element when the light emitting-element emits light with the DC component of signals outputted by the light-receiving element when the light-emitting element does not emit light (as shown below).

[0014]

When the attachment means is attached to the body, the light-emitting element emits light, which is received by the light-receiving element as light reflected from the surface of the skin and light reflected from inside the body, and a signal waveform is obtained in which the pulsation component is superimposed on the direct current component due to surface reflection. When the light-emitting element stops emitting light, the returning light disappears, causing both the DC component and the pulsation component to disappear, and the signal waveform becomes approximately zero. If the attachment means is not attached, the light-receiving element receives light from the surrounding area, so the sensor outputs a signal waveform with the same DC component level regardless of whether or not the light-emitting element is emitting light.

[0015]

Because the DC component of signals outputted by the light-receiving element when the light-emitting element is emitting light is compared with the DC component of signals outputted by the light-receiving element when the light-emitting element is not emitting light to detect whether the attachment means is attached or not attached, whether or not the attachment means is attached to the body can be accurately detected.

[0016]

(Claim 4)

The biological signal detecting device is configured so that when the attachment detecting means detects that the attachment means is not attached to the body, the processing changing means stops detection of biological signals by the biological signal detecting means. As a result, when the attachment means is not attached to the body, the biological signal detecting means does not detect biological signals, so no abnormal biological signals are outputted and no malfunctions (such as misdiagnosis) occur due to abnormal biological signals.

[0017]

(Claim 5)

The biological signal detecting device is configured so that when the attachment detecting means detects that the attachment means is not attached to the body, the processing changing means stops supplying power to the biological signal detecting means. In other words, when the attachment means is not attached to the body, no operating power is supplied to the biological signal detecting means, thereby reducing unnecessary power consumption and preventing the output of abnormal biological signals.

[0018]

(Claim 6)

The biological signal detecting device is configured so that the processing changing means resumes detection of biological signals or resumes supply of operating power when a predetermined time has elapsed since stopping detection of biological signals by the biological signal detecting means or stopping the supply of operating power to the biological signal detecting means, thereby making the device convenient and easy to use.

[0019]

(Claim 7)

The biological signal detecting device further comprises a biological signal processing device that transmits biological signals and performs arithmetic processing on parameters representing the state of the body based on these biological signals, and the processing changing means stops the arithmetic processing of the parameters based on the biological signals in the biological signal processing device while data regarding the attachment or non-attachment of the attachment means to the body is

transmitted to the biological signal processing device and the attachment means is detected as being not attached to the body.

[0020]

In other words, the biological signal processing device does not perform arithmetic processing of parameters based on biological signals while detecting whether or not the attachment means is attached to the body. As a result, abnormal parameters based on abnormal biological signals outputted during detection of non-attachment are not processed, thereby preventing misdiagnosis.

[0021]

(Claim 8)

The biological signal processing device is provided with a notification means that notifies the examiner when data related to non-attachment of the attachment means to the body is transmitted. As a result, the biological signal observer such as a doctor or caregiver can determine whether the examinee has attached the attachment means based on notification from the notification means.

[0025]

[Embodiments of the Invention]

The first embodiment of the present invention (corresponding to claims 1, 2, 3, 4, 5, and 6) will now be described based on FIG. 1 to FIG. 4. As shown in the figure, the pulse wave monitoring system K comprises a pulse wave detecting device A, which includes an attachment means 1, a sensor 2 serving as the biological signal detecting means, an attachment detecting circuit 3 serving as the attachment means detecting means, an operation control circuit 4 serving as the processing changing means, an amplification circuit 5, a transmission circuit 6, and a timer circuit 7, and a pulse wave monitoring device B for monitoring pulse waves.

[0026]

Attachment means 1 (plastic) is a ring-shaped cylinder with an inner diameter that allows the base 111 of the examinee's finger 11 to fit inside easily and remain securely in place (see FIG. 1). The inner surface of the attachment means 1 is treated (for example, painted black) to prevent light reflection.

[0027]

The sensor 2 has a light-emitting diode 22 and a photodiode 23 arranged in a molded package 21 inside the attachment means 1. The package 21 has a light-transmitting window 221 in the direction of the finger and is made of black plastic.

[0028]

The light emitted by the light-emitting diode 22 passes through the skin of the finger 11 and enters the interior of the finger, reaching the capillaries, where some of the light is absorbed and scattered by reflection before returning from the interior of the finger. The photodiode 23 is positioned at a location where the returning light can be received.

[0029]

The attachment detecting circuit 3 is a circuit that determines whether or not the attachment means 1 has been fitted over a finger 11. The attachment detecting circuit 3 compares the signal waveform obtained from the photodiode 23 when the light-emitting diode 22 emits light with the signal waveform obtained when the light-emitting diode 22 does not emit light (as described later) to determine whether the attachment means 1 has been fitted over a finger 11.

[0030]

As shown in FIG. 3, when the attachment means 1 is fitted over a finger 11 and the light-emitting diode 22 emits light, the photodiode 23 receives light reflected from the skin surface (indicated by the dotted lines) and light reflected from the body (indicated by the solid lines) after hitting the capillaries 12, etc. {FIG. 3 (a) left}, and a signal waveform is obtained in which the direct current component from surface reflection is superimposed with the pulsating component {FIG. 3 (a) right}. Then, when the light-emitting diode 22 stops emitting light {FIG. 3 (b) left}, the returning light disappears, causing both the DC component and the pulsating component to disappear, and the signal waveform becomes approximately zero {FIG. 3 (b) right}.

[0031]

When the attachment means 1 is not fitted over a finger 11, the photodiode 23 receives light from the surrounding area {FIG. 3 (c, d) left}, so that regardless of whether the light-emitting diode 22 emits light or not, the sensor 2 outputs a signal waveform with the same DC component level {FIG. 3 (c, d) right}.

[0032]

Attachment is determined as described in (1) below, but can also be determined as described in (2) below, which simplifies the configuration for determining attachment.

(1) The DC component of the signal waveform outputted by the photodiode 23 when the light-emitting diode 22 emits light is compared with the DC component of the signal waveform outputted by the photodiode 23 when the light-emitting diode 22 does not emit light. When the DC components of the signal waveforms are at the same level {FIG. 3 (c, d)}, it is determined that the attachment means 1 is not fitted over a finger 11, and when the DC components of the signal waveforms are different {FIG. 3 (a, b)}, it is determined that the attachment means 1 is fitted over a finger 11.

[0033]

(2) The signals outputted by the photodiode 23 when the light-emitting diode 22 emits light is compared with the signals outputted by the photodiode 23 when the light-emitting diode 22 does not emit light. When the signals are at the same level {FIG. 3 (c, d)}, it is determined that the attachment means 1 is not fitted over a finger 11, and when there is a difference in the signals {FIG. 3 (a, b)}, it is determined that attachment means 1 is fitted over a finger 11.

[0034]

The operation control circuit 4 is a circuit that controls the operation of the sensor 2, the transmitting circuit 6, and the attachment detecting circuit 3. The operation control circuit 4 determines whether the attachment means 1 is fitted over a finger 11 by means of the attachment detecting circuit 3, and when the attachment detecting circuit 3 determines that the attachment means has been fitted over a finger, it supplies operating power to the transmission circuit 6.

[0035]

The amplification circuit 5 is composed of an operational amplifier, etc. The amplification circuit 5 amplifies the signal waveform (pulse wave) from the sensor 2 converted to a voltage value by a current-voltage conversion circuit 51. The transmission circuit 6 has an oscillation unit, a modulation unit, and a power amplification unit. The transmission circuit 6 modulates the carrier wave with the amplified signal waveform as a weak radio wave and transmits it to the pulse wave monitoring circuit B located at a separate location. The timer circuit 7 is a circuit that stores a pulse wave sampling time or a standby time. The timer circuit 7 supplies operating power to the attachment detecting circuit 3 and the operation control circuit 4 when the pulse wave sampling time arrives or when the standby time (several minutes to several hours) ends and the sampling time begins.

[0036]

The pulse wave monitoring device B is equipped with a reception circuit 81, an analysis circuit 82, a display 83, a recording means 84, and a notification circuit 85, and is installed, for example, in a corner of a hospital room. The reception circuit 81 is a circuit that demodulates pulse waves from modulated waves transmitted by the transmission circuit 6. The analysis circuit 82 is a circuit that analyzes the demodulated pulse waves. The analysis circuit 82 analyzes the pulse rate, pulse interval, pulse waveform, etc., to detect arrhythmias and autonomic nervous system abnormalities. The display 83 can be, for example, a liquid crystal display, which displays the analysis results of the analysis performed by the analysis circuit 82.

[0037]

The recording means 84 is a device that stores pulse waves and analyzed data together with the time of acquisition in a storage medium. The notification circuit 85 is a circuit that notifies, for example, a nurse center when a significant abnormality is detected in the analyzed data.

[0038]

Next, the operation of the pulse wave monitoring system K, which measures the pulse waves of the examinee when appropriate using the pulse wave detecting device A, will be explained with reference to the flowchart in FIG. 4.

[0039]

In step s1, the operation control circuit 4 electrifies the light-emitting diode 22 to cause it to emit light, and the signal waveform from the photodiode 23 amplified by the amplification circuit 5 is detected by the detecting circuit 3.

[0040]

In step s2, the operation control circuit 4 stops supplying power to the light-emitting diode 22 to cause the light-emitting diode 22 to stop emitting light, and the attachment detecting circuit 3 detects the signal waveform from the photodiode 23 amplified by the amplification circuit 5.

[0041]

Note that the transition from standby to step s1 occurs either when the measurement time is reached (and the timer circuit 7 supplies operating power to the attachment detecting circuit 3 and the operation control circuit 4) or when test switch 100 is pressed with a pointed object.

[0042]

In step s3, the attachment detecting circuit 3 determines whether the attachment means is attached. If it is determined that the attachment means has been attached (YES), the process advances to step s4. If it is determined that the attachment means has not been attached (NO), the process advances to step s6. Specifically, the attachment detecting circuit 3 determines whether or not the attachment means has been attached by comparing the DC component of the signal waveform obtained when the light-emitting diode 22 emits light (the signal waveform obtained in step s1) with the DC component of the signal waveform obtained when the light-emitting diode 22 does not emit light (the signal waveform obtained in step s2).

[0043]

In step s4, the operation control circuit 4 electrifies the sensor 2, the amplification circuit 5, and the transmission circuit 6 to detect pulse waves and transmit the detected pulse waves to the pulse wave monitoring device B by means of modulated waves. In step s5, it is determined whether the measurement time (ranging from tens of seconds to several minutes) has elapsed. If the measurement time has elapsed (YES), the process advances to step s6. If the measurement time has not elapsed (NO), the process returns to step s4 and continues detecting and transmitting pulse waves. In step s6, the timer circuit 7 stops supplying power to other circuits. Afterward, when the timer circuit 7 reaches the specified standby time, processing starts again from s1.

[0044]

Next, the advantages of the present embodiment will be described.

[A] The pulse wave detecting device A is configured so that when the attachment detecting circuit 3 detects that the attachment means 1 has been fitted over a finger 11, the operating control circuit 4 supplies operating power to the transmission circuit 6 to transmit pulse waves to the pulse wave monitoring device B. As a result, the problem of the sensor 2 picking up external noise and the transmission circuit 6 transmitting noise to the pulse wave monitoring device B does not occur, and the pulse waves detected by the sensor 2 when the attachment means 1 is fitted over a finger 11 are reliably transmitted to the pulse wave monitoring device B. This makes it possible to prevent erroneous determinations by the pulse wave monitoring device B. There is also no need to operate an operating switch to operate the pulse wave detecting device A when pulse waves are detected, thereby making the device easy to use.

[0045]

[B] The sensor 2, which detects pulse waves, also functions as a sensor for detecting whether or not the attachment means 1 has been fitted over a finger 11. As a result, a dedicated sensor for detecting attachment of the attachment means is not required, and the pulse wave detecting device A can be made smaller.

[0046]

[C] Because the attachment detecting circuit 3 detects whether the attachment means has been attached by comparing the DC component of the signal waveform obtained from the photodiode 23 when the light-emitting diode 22 is emitting light with the DC component of the signal waveform obtained from the photodiode 23 when the light-emitting diode 22 is not emitting light, attachment can be accurately detected using a simple circuit configuration.

[0047]

[D] During standby, the supply of power to circuits other than the timer circuit 7 is cut off, so the pulse waves of an examinee can be monitored over a long period of time without having to replace the battery. In the first embodiment described above, the standby time was kept constant regardless of whether or not the attachment means 1 was attached, but the standby time when the attachment means is not attached may be longer than the standby time when it is attached. In this case, two timers are used to keep the respective standby times, and these timers are switched according to whether or not the attachment means is attached.

[0048]

The second embodiment of the present invention (corresponding to claims 4, 5, 7, and 8) will now be described with reference to FIG. 5 to FIG. 8. As shown in FIG. 5, the pulse wave analyzing system L comprises a pulse wave detecting device C, which includes a finger insertion tube 10 as the attachment means, a sensor 2 and an amplification circuit 5 serving as the biological signal detecting means, an insertion detecting means 30 serving as the attachment detecting means, a power supply circuit 37 constituting a portion of the processing changing means, and a transmission circuit 6, and a pulse wave analyzing device D that analyzes pulse waves. The pulse wave detecting device C is mounted in a portable housing and placed on a table next to the bed on which the examinee is lying when pulse waves are to be examined.

[0049]

The finger insertion tube 10 (made of plastic) is a cylindrical object provided on the upper portion of the pulse wave detecting device C, and has an inner diameter that fits on the base 111 of the examinee's finger 11. The inside of the finger insertion tube 10 is treated (for example, painted black) to prevent light reflection.

[0050]

The sensor 2 comprises a light-emitting diode 22 and a photodiode 23. The light emitted by the light-emitting diode 22 passes through the skin of the finger 11 and enters the interior of the finger, reaching the capillaries 12, where some of the light is absorbed and scattered before returning from the interior of the finger. The photodiode 23 is positioned on the bottom surface of the inner surface of the attachment means 1 so that it can receive the returning light.

[0051]

The amplification circuit 5 is composed of an operational amplifier, etc. The amplification circuit 5 amplifies the signal waveform (pulse wave) of the photodiode 23 converted to a voltage value by a current-voltage conversion circuit 51.

[0052]

The transmission circuit 6 has an oscillation unit, a modulation unit, and a power amplification unit. The transmission circuit 6 modulates the carrier wave with the amplified signal waveform as a weak radio wave and transmits it to the pulse wave analyzing device D located at a separate location.

[0053]

The insertion detecting means 30 comprises a microcomputer 31, a switch 32, a plunger 33, a spring 34, a plunger case 35, and a resistor 36, and determines whether or not a finger 11 has been inserted into the finger insertion tube 10.

[0054]

The switch 32 is configured as shown in FIG. 6, in which electrodes 323, 324 are adhered to the rear surfaces of base films 321, 322, and a spacer film 325 is disposed between them. This switch 32 is fixed above a circular hole 351 described later.

[0055]

The plunger 33 comprises a spherical portion 331 (shaped so as not to damage the finger 11) embedded in a cylindrical portion 13 of the finger insertion tube 10 so as to be vertically displaceable and in contact with the upper surface of the finger 11, and a cylindrical portion 332 into which the spring 34 is fitted. The plunger case 35 is provided in the upper portion of the finger insertion tube 10 and has a circular hole 351 provided on the upper surface of the case from which the cylindrical portion 332 protrudes.

[0056]

The spring 34 normally biases the plunger 33 downward, so the cylindrical portion 332 of the plunger 33 does not press the switch 32, and the electrodes 323, 324 are not rendered conductive, keeping the voltage v high. In this case, the microcomputer 31 determines that a finger 11 has not been inserted into the finger insertion tube 10.

[0057]

When a finger 11 is inserted into the finger insertion tube 10, the plunger 33 moves upward, causing the cylindrical portion 332 to press the switch 32 and rendering the electrodes 323, 324 conductive, thereby causing the voltage v to become low. In this case, the microcomputer 31 determines that a finger 11 has been inserted into the finger insertion tube 10 and outputs a control signal to the power supply circuit 37.

[0058]

The power supply circuit 37 is a circuit that controls the supply of power to the amplification circuit 5, the transmission circuit 6, and the light-emitting diode 22. This power supply circuit 37 starts supplying power when a control signal is inputted from the microcomputer 31. Note that if the finger 11 is removed from the insertion tube 10 during pulse wave analysis, the microcomputer 31 will determine that a finger 11 is not inserted into the insertion tube 10, and the power supply circuit 37 will cut off the supply of power to the amplification circuit 5, the transmission circuit 6, and the light-emitting diode 22.

[0059]

The pulse wave analyzing device D is equipped with a reception circuit 81, an analysis circuit 82, a display 83, and a recording means 84, and is installed, for example, in a corner of a hospital room. The reception circuit 81 is a circuit that demodulates pulse waves from modulated waves transmitted from the transmission circuit 6. The analysis circuit 82 is a circuit that analyzes demodulated pulse waves and constitutes a portion of the processing changing means. This analysis circuit 82 calculates and analyzes parameters representing the current state of the body based on pulse waves (pulse rate, pulse interval, pulse waveform) to detect arrhythmias and autonomic nervous system abnormalities. Note that until the pulse waves are demodulated (while detecting insertion/non-insertion of a finger 11 into the finger insertion tube 10), the analysis circuit 82 does not perform arithmetic processing of the parameters based on the pulse wave.

[0060]

The display 83 can be, for example, a liquid crystal display, and displays the insertion state of a finger 11 and the analysis results analyzed by analysis circuit 82. The recording means 84 is a device that stores pulse waves and analyzed data together with the time of acquisition in a storage medium.

[0061]

Next, the operation of the pulse wave analyzing system L, which analyzes the pulse waves of the examinee using the pulse wave detecting device C, will be explained with reference to the flowchart in FIG. 7.

[0062]

(Operation of Pulse Wave Detecting Device C)

In step S1, the microcomputer 31 determines, based on the voltage v , whether a finger 11 has been inserted into the finger insertion tube 10, and if it is determined that a finger has been inserted (YES),

the process advances to step S2. If it is determined that a finger has not been inserted (NO), the process advances to step S5.

[0063]

In step S2, the power supply circuit 37 begins supplying power to the amplification circuit 5, the transmission circuit 6, and the light-emitting diode 22. This completes the pulse wave detection processing (step S3) and the pulse wave data transmission processing (step S4).

[0064]

In step S5, the power supply circuit 37 stops supplying power to the amplification circuit 5, the transmission circuit 6, and the light-emitting diode 22. Note that power is supplied to the microcomputer 31 and the power supply circuit 37 at all times. Note also that the pulse wave detection processing and pulse wave data transmission processing described above are performed at predetermined intervals (ranging from tens of seconds to tens of minutes) using a timer built into the microcomputer 31.

[0065]

(Operation of Pulse Wave Detecting Device D)

In step S6, it is determined whether a modulated wave is being sent. If a modulated wave is being sent (YES), the process advances to step S7. If a modulated wave is not being sent (NO), the process advances to step S11.

[0066]

The pulse waveform is displayed on the display 83 in step S7, and the process advances to step S8. In step S8, the analysis circuit 82 analyzes the pulse waveform. If it is normal (YES), the process advances to step S9. If it is abnormal (NO), the process advances to step S10.

[0067]

In step S9, as shown in (2) in FIG. 8, "Your pulse is normal" (Display 2) is displayed on the display 83. In step S10, as shown in (3) and (4) in FIG. 8, abnormal conditions (Display 3 and Display 4) such as "You have tachycardia" and "You have bradycardia" and "Noise detected" are displayed on the display 83. In step S11, as shown in (1) of FIG. 8, "Your finger has not been inserted" (Display 1) is displayed on the display 83.

[0068]

Next, an advantage of the present embodiment will be described.

[E] The pulse wave detecting device C in the pulse wave analyzing system L is configured so that when the microcomputer 31 detects the insertion of a finger 11 into the finger insertion tube 10, the operation control circuit 4 supplies operating power to the light-emitting diode 22, the amplification circuit 5, and the transmission circuit 6.

[0069]

Thus, because pulse wave detection and pulse wave transmission are performed after a finger 11 has been inserted, the photodiode 22 does not pick up external noise (surrounding light) and transmit it to the transmission circuit 6, which then transmits the noise to the pulse wave analyzing device D. As a result, the pulse waves detected while a finger 11 is inserted in the finger insertion tube 10 can be reliably transmitted to the pulse wave analyzing device D.

[0070]

This makes it possible to prevent erroneous determinations by the pulse wave analyzing device D. There is also no need for a start switch to start up the pulse wave detecting device C when detecting pulse waves, making the device easier to use. In addition, during standby, no operating power is supplied to the light-emitting diode 22, the amplification circuit 5, and the transmission circuit 6, so standby power consumption by the pulse wave detecting device C can be reduced.

[0071]

Next, the third embodiment of the present invention (corresponding to claims 4, 5, 7, and 8) will be described with reference to FIG. 9. As shown in FIG. 9, the pulse wave analyzing system M comprises a pulse wave detecting device E and a pulse wave analyzing device D (shown in FIG. 5) that analyzes

pulse waves, and differs from the pulse wave analyzing system L in the second embodiment with respect to the following points.

[0072]

An insertion detecting means 300 comprises a microcomputer 31, a reed switch 302, a magnet 303, resistors 304, 305, and a capacitor 306. The reed switch 302 is located slightly inside the upper portion of the finger insertion tube 10, at the connection point of the resistors 304, 305.

[0073]

A magnet 303 is attached to the upper inner side on the entrance side of the reed switch 302. This magnet 303 rotates toward the reed switch 302 when a finger 11 is inserted into the finger insertion tube 10.

[0074]

Normally, the contact of the reed switch 302 is off, so the voltage v is high. In this case, the microcomputer 31 determines that a finger 11 has not been inserted into the finger insertion tube 10.

[0075]

When a finger 11 has been inserted into the finger insertion tube 10, magnet 303 rotates toward the reed switch 302, causing the reed switch 302 to turn on and voltage v to become low. In this case, the microcomputer 31 determines that a finger 11 has been inserted into the finger insertion tube 10.

[0076]

The pulse wave analyzing system M using the pulse wave detecting device E in the present embodiment has the advantage described in [E] above.

[0077]

Next, the fourth embodiment of the present invention (corresponding to claims 4, 5, 7, and 8) will be described with reference to FIG. 10. As shown in FIG. 10, the pulse wave analyzing system N comprises a pulse wave detecting device F and a pulse wave analyzing device D (shown in FIG. 5) that analyzes pulse waves, and differs from the pulse wave analyzing system L in the second embodiment with respect to the following points.

[0078]

The insertion detecting means 300 comprises a microcomputer 31, a film switch 307, resistors 304, 305, and a capacitor 306. The film switch 307 is located slightly inside the upper portion of the finger insertion tube 10 at the connection point of the resistors 304, 305.

[0079]

Normally, the contact of the film switch 307 is off, so the voltage v is high. In this case, the microcomputer 31 determines that a finger 11 has not been inserted into the finger insertion tube 10.

[0080]

When a finger 11 is inserted into the finger insertion tube 10, the contact of the film switch 307 turns on due to pressure, and the voltage v becomes low. In this case, the microcomputer 31 determines that a finger 11 has been inserted into the finger insertion tube 10.

[0081]

The pulse wave analyzing system N using the pulse wave detecting device F in the present embodiment has the advantage described in [E] above.

[0082]

Next, the fifth embodiment of the present invention (corresponding to claims 4, 5, 6, and 7) will be described based on FIG. 11. As shown in FIG. 11, the pulse wave analyzing system O comprises a pulse wave detecting device G and a pulse wave analyzing device D (shown in FIG. 5) that analyzes pulse waves, and differs from the pulse wave analyzing system L in the second embodiment with respect to the following points.

[0083]

The insertion detecting means 300 comprises a microcomputer 31, a thermistor 308, resistors 304, 305, and a capacitor 306. The thermistor 308 is located slightly inside the upper portion of the finger insertion tube 10, and one end is connected to the connection point of the resistors 304, 305.

[0084]

Because the thermistor 308 usually detects the room temperature, the voltage v corresponds to the detected room temperature. In this case, a microcomputer 31 determines that a finger 11 has not been inserted into the finger insertion tube 10.

[0085]

When a finger 11 is inserted into the finger insertion tube 10, thermistor 308 is warmed by the body temperature, causing voltage v to change. In this case, the microcomputer 31 determines that a finger 11 has been inserted into the finger insertion tube 10.

[0086]

The pulse wave analyzing system O using the pulse wave detecting device G in the present embodiment has the advantage described in [E] above.

[0087]

Next, the sixth embodiment of the present invention (corresponding to claims 4, 5, 7, and 8) will be described based on FIG. 12. As shown in FIG. 12, the pulse wave analyzing system P comprises a pulse wave detecting device H and a pulse wave analyzing device D (shown in FIG. 5) that analyzes pulse waves, and differs from the pulse wave analyzing system L in the second embodiment with respect to the following points.

[0088]

The insertion detecting means 9 comprises a microcomputer 90, electrodes 91, 92, resistors 93, 94, and a capacitor 95. The electrodes 91, 92 are disposed centrally on both inner sides of the entrance to the finger insertion tube 10, slightly inside, and one end of each electrode is connected to the connection point of the resistors 93, 94.

[0089]

Normally, the resistance between the electrodes 91, 92 is infinite, so the voltage v is approximately equal to the power supply voltage. In this case, microcomputer 90 determines that a finger 11 has not been inserted into finger insertion tube 10.

[0090]

When a finger 11 has been inserted into the finger insertion tube 10, the voltage at the connection point of the resistors 93, 94 is divided by resistor 93 and the electrical resistance between the electrodes 91, 92 (the electrical resistance of the finger), causing the voltage v to decrease. In this case, the microcomputer 31 determines that a finger 11 has been inserted into the finger insertion tube 10.

[0091]

The pulse wave analyzing system P using the pulse wave detecting device H in the present embodiment has the advantage described in [E] above.

[0092]

Next, the seventh embodiment of the present invention (corresponding to claims 4, 5, 7, and 8) will be described based on FIG. 13. As shown in FIG. 13, the pulse wave analyzing system Q comprises a pulse wave detecting device I and a pulse wave analyzing device D (shown in FIG. 5) that analyzes pulse waves, and differs from the pulse wave analyzing system L in the second embodiment with respect to the following points.

[0093]

The insertion detecting means 9 comprises a microcomputer 90, electrodes 91, 92, and an oscillation circuit 96.

[0094]

Electrodes 91, 92 are disposed centrally on both inner sides slightly inside the entrance to the finger insertion tube 10. The oscillation circuit 96 is a circuit that oscillates at a predetermined frequency (high frequency) determined by a coil (not shown) and the capacitors of the electrodes 91, 92.

[0095]

When a finger 11 is inserted into the finger insertion tube 10, the capacitance between the electrodes 91, 92 changes, causing the oscillation frequency of the oscillation circuit 96 to change. In this way, the microcomputer 31 determines that a finger 11 has been inserted into the finger insertion tube 10.

[0096]

The pulse wave analyzing system Q using the pulse wave detecting device I in the present embodiment has the advantage described in [E] above.

[0097]

Next, the eighth embodiment of the present invention (corresponding to claims 4, 5, 7, and 8) will be described based on FIG. 14. As shown in FIG. 14, the pulse wave analyzing system R comprises a pulse wave detecting device J and a pulse wave analyzing device D (shown in FIG. 5) that analyzes pulse waves, and differs from the pulse wave analyzing system L in the second embodiment with respect to the following points.

[0098]

The insertion detecting means 9 comprises a microcomputer 90, electrodes 901, 902, 903, and a skin potential detecting circuit 904.

[0099]

The electrodes 901, 903 are arranged slightly inside on the upper portion from the entrance to the finger insertion tube 10. The other electrode 902 is arranged slightly inside on the lower portion from the entrance to the finger insertion tube 10. The skin potential detecting circuit 904 is composed of an operational amplifier and amplifies the voltage between the electrodes.

[0100]

When a finger 11 is inserted into the finger insertion tube 10, a voltage of several tens of mV is generated between the electrodes 901, 902 due to the skin voltage, so the microcomputer 90 determines that a finger 11 has been inserted into the finger insertion tube 10.

[0101]

The pulse wave analyzing system R using the pulse wave detecting device J in the present embodiment has the advantage described in [E] above.

[0102]

In addition to the embodiments described above, the present invention includes the following aspects.

a. The transmission of pulse waves from the biological signal detecting device to a biological signal monitoring device may be performed wirelessly using light, radio waves, ultrasonic waves, etc., or may be performed using a wired connection.

[0103]

b. The transmitting means may stop transmission to the biological signal monitoring device by blocking or short-circuiting the signal waveform from the sensor when the attachment means is not attached.

[0104]

c. The attachment means may be a rubber band or tube, or may be shaped to adhere to the body.

[Brief Description of the Drawings]

[FIG. 1] FIG. 1 is a diagram used to explain the structure of the pulse wave detecting device in the pulse wave monitoring system according to the first embodiment of the present invention.

[FIG. 2] FIG. 2 is a block diagram of the pulse wave monitoring system according to the first embodiment of the present invention.

[FIG. 3] FIG. 3 is a diagram used to explain the differences in signal waveforms obtained when a light-emitting diode is turned ON and OFF while the attachment means is attached to a finger and not attached.

[FIG. 4] FIG. 4 is a flowchart showing the operation of the pulse wave detecting device in the pulse wave monitoring system according to the first embodiment of the present invention.

[FIG. 5] FIG. 5 is a diagram used to explain the structure of the pulse wave detecting device and the analyzing device in the pulse wave analyzing system according to the second embodiment of the present invention.

[FIG. 6] FIG. 6 is a cross-sectional view of the structure of the switch 32 used in the pulse wave detecting device of the pulse wave analyzing system according to the second embodiment of the present invention.

[FIG. 7] FIG. 7 is a flowchart showing the operation of the pulse wave detecting device in the pulse wave analyzing system according to the second embodiment of the present invention.

[FIG. 8] FIG. 8 is a table used to explain the display of the analyzing device in the pulse wave analyzing system according to the second embodiment of the present invention.

[FIG. 9] FIG. 9 is a diagram used to explain the structure of the pulse wave detecting device in the pulse wave analyzing system according to the third embodiment of the present invention.

[FIG. 10] FIG. 10 is a diagram used to explain the structure of the pulse wave detecting device in the pulse wave analyzing system according to the fourth embodiment of the present invention.

[FIG. 11] FIG. 11 is a diagram used to explain the structure of the pulse wave detecting device in the pulse wave analyzing system according to the fifth embodiment of the present invention.

[FIG. 12] FIG. 12 is a diagram used to explain the structure of the pulse wave detecting device in the pulse wave analyzing system according to the sixth embodiment of the present invention.

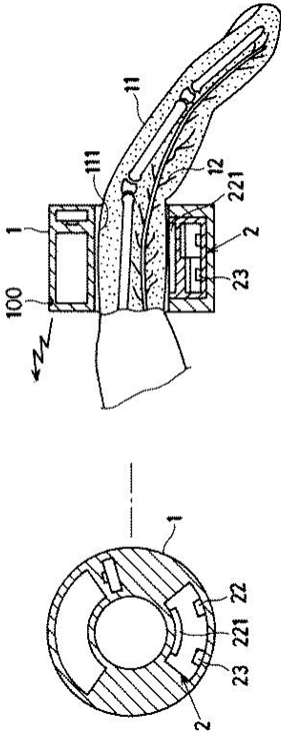
[FIG. 13] FIG. 13 is a diagram used to explain the structure of the pulse wave detecting device in the pulse wave analyzing system according to the seventh embodiment of the present invention.

[FIG. 14] FIG. 14 is a diagram used to explain the structure of the pulse wave detecting device in the pulse wave analyzing system according to the eighth embodiment of the present invention.

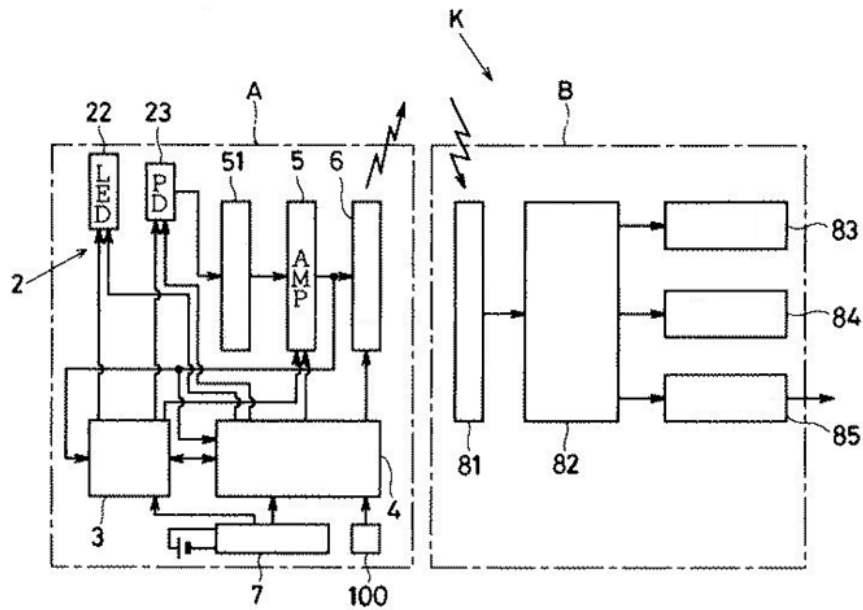
[Reference Numbers]

- 1: Attachment means
- 2: Sensor (biological signal detecting means)
- 3: Attachment detecting circuit (attachment detecting means)
- 4: Operation control circuit (processing changing means)
- 11: Finger
- 22: Light-emitting diode (light-emitting element)
- 23: Photodiode (light-receiving element)
- 30: Insertion detecting means (attachment detecting means)
- 32: Switch (detection unit)
- 33: Plunger (pressure-applying unit)
- 37: Power supply circuit (processing changing means)
- 82: Analysis circuit (processing changing means)
- 83: Display device (notification means)
- 308: Thermistor (heat-sensitive element)
- A, C, E, F, G, H, I, J: Pulse wave detecting device (biological signal detecting device)
- B: Pulse wave monitoring device (biological signal processing device)
- D: Pulse wave analyzing device (biological signal processing device)

[FIG. 1]



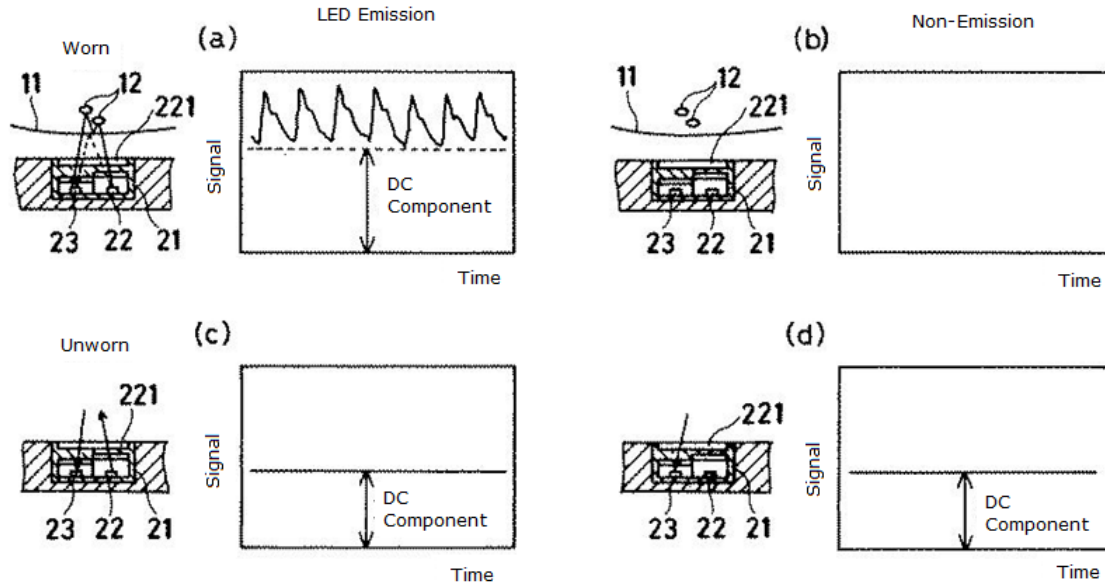
[FIG. 2]



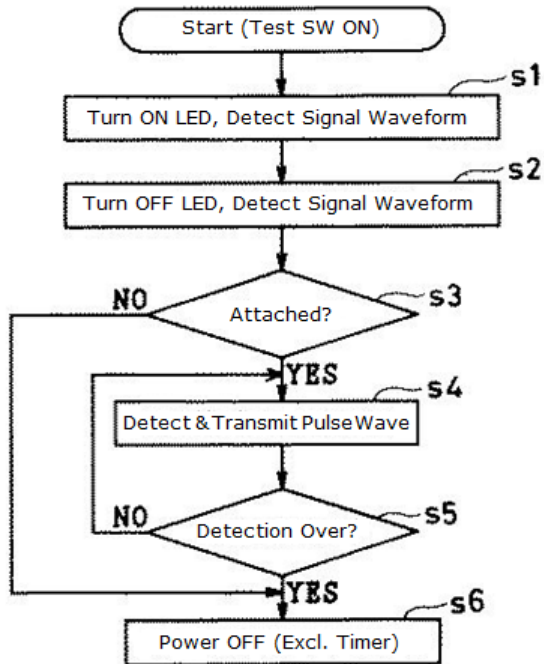
3: Attachment detecting circuit
 4: Operation control circuit
 6: Transmission circuit
 7: Timer circuit
 51: Current-voltage conversion circuit

B: Monitoring device
 81: Reception circuit
 82: Analysis circuit
 83: Display
 84: Recording means
 85: Notification circuit

[FIG. 3]



[FIG. 4]

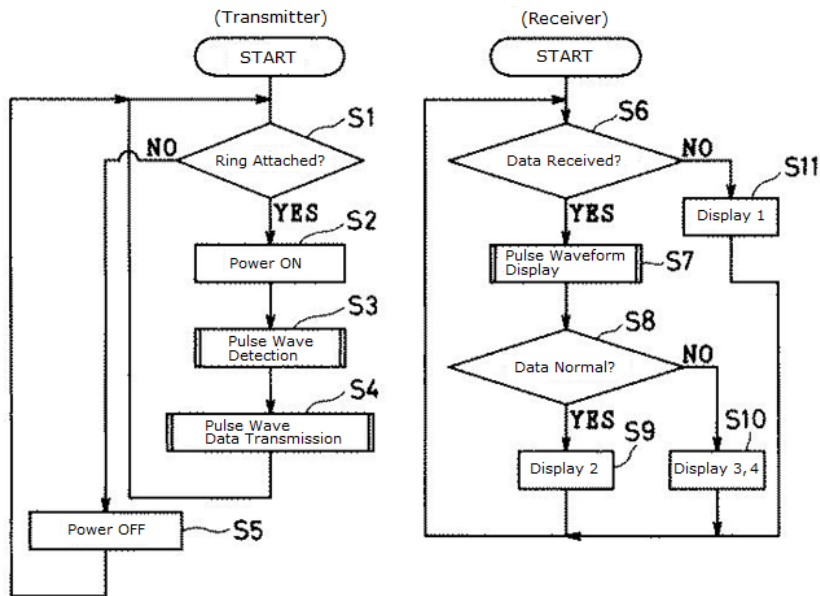


81: Reception circuit
 82: Analysis circuit
 83: Display
 84: Recording means
 85: Notification circuit

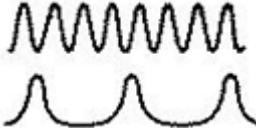
6: Transmission circuit
 31: Microcomputer
 37: Power supply circuit
 51: Current-voltage conversion circuit

A cross-sectional view of a multi-layered structure 32. The structure consists of several horizontal layers. From top to bottom, the layers are: a thin white layer (321), a thin white layer (323), a central layer (325) with a white rectangular core and hatched side regions, a thin white layer (324), and a bottom white layer (322). An arrow points from the label 32 to the top of the structure.

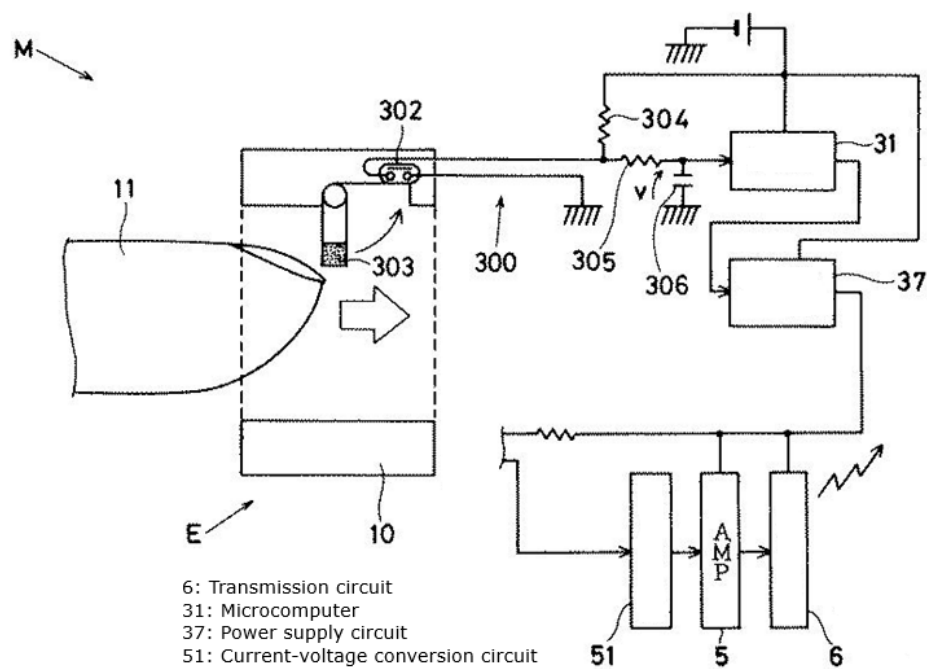
[FIG. 7]



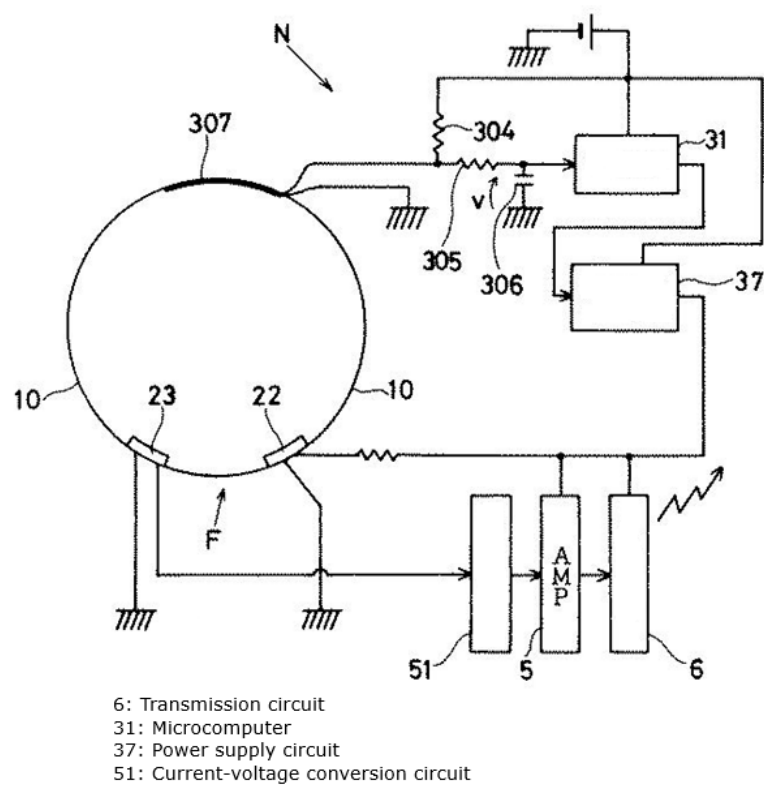
[FIG. 8]

	Pulse Waveform on Display	Display on Receiver End
(1) Ring Not Worn		Display 1 Your finger has not been inserted.
(2) Normal Pulse		Display 2 Your pulse is normal.
(3) Noise Overlap Due to Movement		Display 4 Your pulse could not be measured due to noise. You are moving.
(4) Tachycardia or Bradycardia When Pulse is Abnormal		Display 3 You have tachycardia. You have bradycardia.

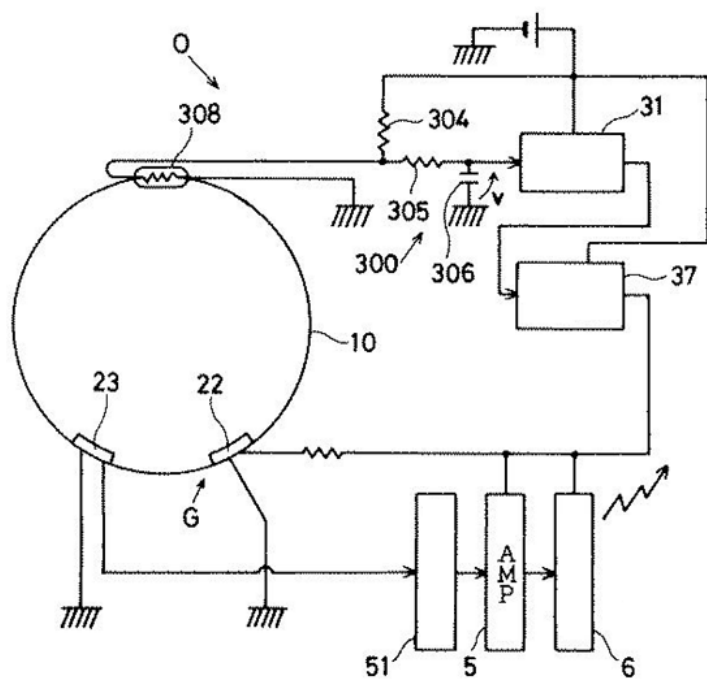
[FIG. 9]



[FIG. 10]

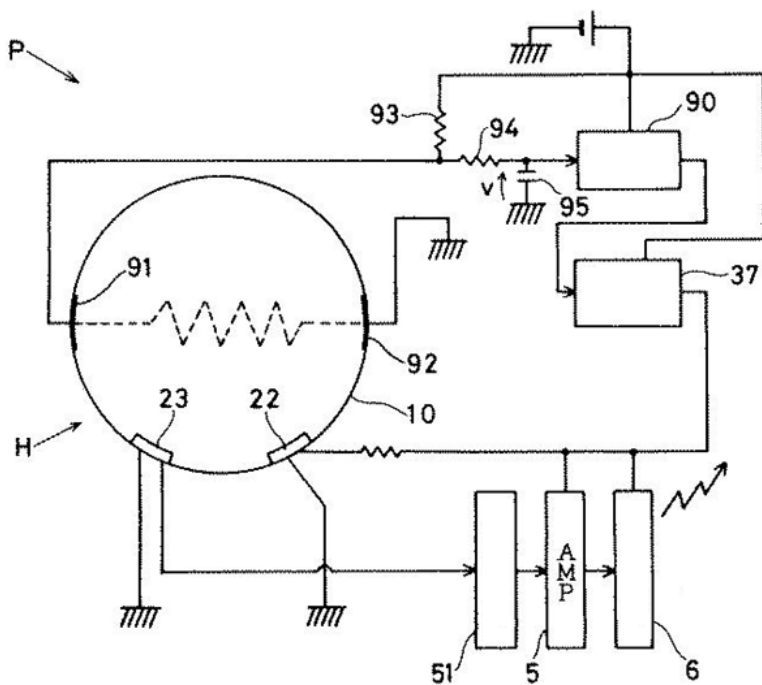


[FIG. 11]



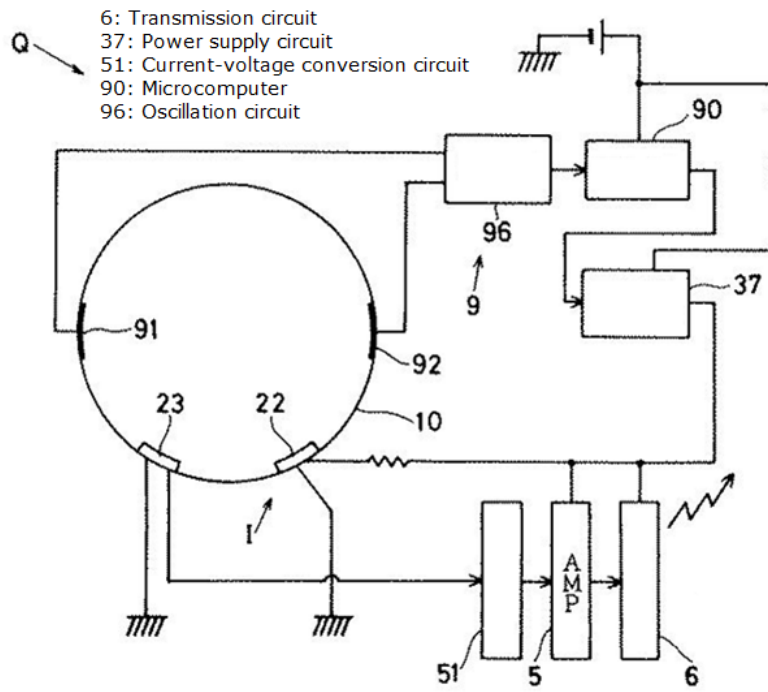
6: Transmission circuit
 31: Microcomputer
 37: Power supply circuit
 51: Current-voltage conversion circuit

[FIG. 12]

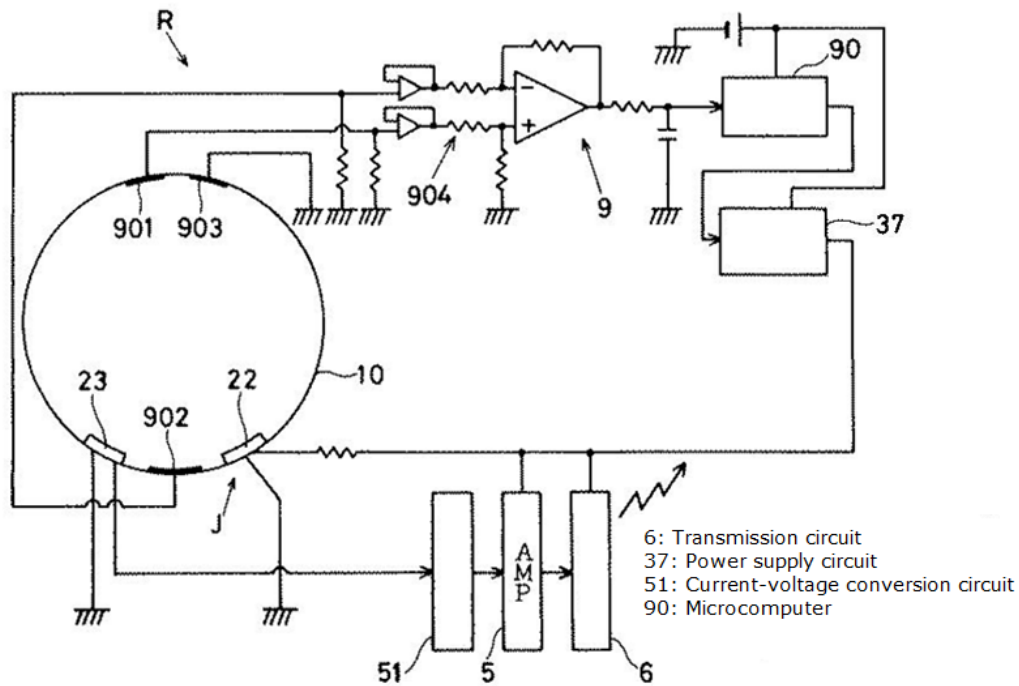


6: Transmission circuit
 37: Power supply circuit
 51: Current-voltage conversion circuit
 90: Microcomputer

[FIG. 13]



[FIG. 14]



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(56) Cited Documents: S59-025732 (JP, A)
 H07-171137 (JP, A)
 H03-039005 (JP, U)
 H01-27533 (JP, A)
 H01-27532 (JP, A)
 S57-185307 (JP, U)

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