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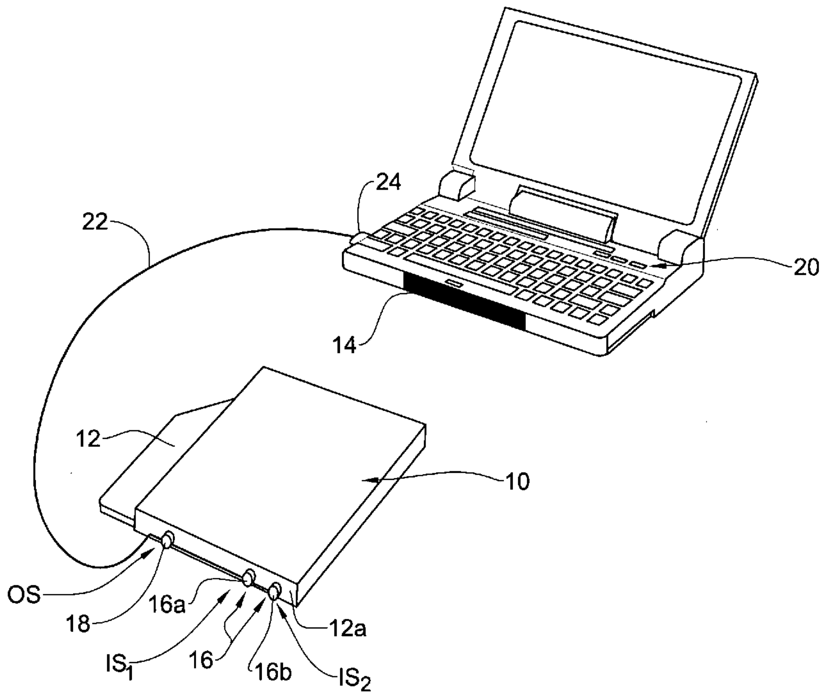

(57) Abstract: A medical instrument is presented. The medical instrument comprises a housing, a first communication utility in the housing for receiving input signal indicative of physiological signals, and a second communication utility for communicating with a computer. The housing is configured for removable installment in a compact disc drive bay of a computer.

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Medical Instrument

FIELD OF THE INVENTION

The invention concerns a medical instrument that is adapted for receiving physiological signals from the body of a subject and which is adapted for communication with a computer for the purpose of analysis, storage and display of the recorded signal or a processed product thereof.

BACKGROUND OF THE INVENTION

It is a trend is modern medicine to transfer many of the medical and diagnostic procedures hitherto performed in hospitals or specialized clinics, to a doctor's office. Additionally, there is also a trend to switch medical instruments from a stand-alone configuration into a configuration in which they are integrated with a computer. For this the instrument has to be provided with some means for interfacing with the computer. For a doctor's office use as well as for use in the medical facility without specialized computer technicians, such interfacing should be designed to be relatively simple.

Hitherto, computer-interfacing medical instruments were typically provided as separate units connectable to a computer via one of the computer's standard communication ports.

SUMMARY OF THE INVENTION

The present invention provides a new design for a medical instrument of the kind that is adapted to receive signals representative of physiological signals and transmit them, typically after initial processing, to a computer. In accordance with the invention such a medical instrument is provided with a housing configured such that it can be installed in a compact disc (CD) drive bay of a computer, typically a portable computer, e.g. of the kind usually referred to as *"laptop"* or *"notebook"* computers.

Thus, in accordance with the present invention there is provided a medical instrument comprising a housing, a first communication utility in the housing for receiving input signal indicative of physiological signals and a second communication utility for communicating with a computer, said housing being configured for removable installment in a CR drive bay of a computer.

The term *"medical instrument"* means to denote any instrument that is intended to record physiological signals and includes, but not limited to, medical instruments intended to record cardiovascular parameters. In addition, the medical instrument may be adapted for recording of brainwaves, parameters of the skin, parameters indicative of tissue composition, sound signals from various body parts, etc. As will be appreciated, the invention is widely applicable and is not limited for the aforementioned medical applications.

The first communication utility comprises, according to an embodiment of the invention, one or more signal receivers, and optionally initial signal conversion or amplifier stage. Also, according to some embodiments of the invention, the medical instrument may also comprise an emitting utility for outputting a signal, e.g. a stimulating signal, to a subject body, such as a signal generator for emitting a low voltage electrical stimulation signal for inducing evoked potentials in nerves or muscles, an ultrasound transducer for emitting an ultrasound signal, a laser for emitting a light signal, and others.

Said second communication utility may, according to one embodiment of the invention, have a port disposed on a face of the housing which is externally accessible when the instrument is in said bay. Said second communication utility, according to such embodiments, may communicate with the computer via a wired or wireless communication connection arrangement.

According to other embodiments of the invention, said second communication utility is on a face which, once the instrument is in said bay, is internal, and is adapted for connection to a communication port that is within said bay, e.g. a communication port that is adapted for communication with standard computer accessories.

According to an embodiment of the invention, said housing is configured for installment in the bay of a portable computer. Typically, such housing is configured for installment in a bay intended for a CD disc-drive. According to an embodiment of the invention, the housing also houses a processor utility for processing the input signal and generating an output signal corresponding thereto for communicating to the computer. According to some embodiments of the invention, said processing utility is adapted also for receiving control signals from the computer. According to other embodiments of the invention, the medical instrument also comprises an application software utility, e.g. a software utility which is intended to permit the computer to integrate with said instrument.

A medical instrument, according to an embodiment of the invention, is adapted for use in determining one or more cardiovascular parameters. The cardiovascular parameters may be one or more of the following: ECG, blood pressure, stroke volume, heart rate or cardiac output.

According to an embodiment of the invention, the first communication utility comprises two or more signal receivers, each for receiving an input signal indicative of a different physiological parameter. According to a specific embodiment, said first communication utility comprises a first receiver for receiving a signal indicative of a parameter relating to cardiac output, a second receiver for receiving a signal indicative of an ECG and a third receiver for receiving a signal indicative of blood pressure.

BRIEF DESCRIPTION OF THE DRAWINGS

In order to understand the invention and to see how it may be carried out in practice, a preferred embodiment will now be described, by way of non-limiting example only, with reference to the accompanying drawings, in which:

Fig. 1 is a schematic illustration of a medical instrument in accordance with an embodiment of the present invention;

Fig. 2A is a block diagram illustrating the main elements within the medical instrument in accordance with an embodiment of the invention and its connectivity to external measurement unit and to a host computer; and

Fig. 2B exemplifies more specifically an embodiment of the bioimpedance unit of the medical instrument of Fig. 2A.

DETAILED DESCRIPTION OF EXEMPLARY EMBODIMENTS

Reference is made to **Fig. 1** illustrating schematically an example of a medical instrument **10** according to the present invention. The medical instrument of the present invention is designated as a so-called Medical Gear In Contrivance (MEGIC) device. Instrument **10** includes a housing **12** configured for removable installment in a standard CD drive bay **14** of a computer, e.g. that of a portable computer such as a Laptop. Housing **12** includes a first communication utility **16** for receiving one or more input signals, two such signals $\mathbf{IS_1}$ and $\mathbf{IS_2}$ being considered in the present specific but not limiting example, and includes a second communication utility **18** for communicating with a computer **20**. Input signal(s) is/are indicative of physiological signal(s).

It should be noted that generally the first communication utility may be formed by a single port for receiving one or more input signals. In the present example, two such ports **16A** and **16B** are shown. The use of multiple receiving ports might be associated with concurrent receipt of multiple different input signals, or with a need for selective operation of either one of them, for example when the other is being corrupted, as the case may be.

Second communication utility **18** also may be formed by one or more ports – one such port being shown in the present example. Second communication utility **18** is adapted for communication via a connection unit **22** to a communication port **24** of the computer. In the present example, such a connection unit is a wire-based connector, but it should be understood that wireless communication can be used as well.

In the present example, the ports of first and second communication utilities **16** and **18** are located on a face **12A** of the housing which is externally accessible once the instrument is in the computer bay. It should however be noted that at least some of the ports of the first and second communication utilities, typically that associated with connection to the computer's utilities, may be located on a face of the housing which is internal once the instrument is in the bay. A connection base in a computer, such as that known as a laptop or notebook computer, is generally equipped with standard internal communication ports adapted for connection with counterpart connectors in computer accessories which are intended for installment in such ports. According to embodiments of the present invention, the medical instrument may be fitted with corresponding connection ports which then connect into the standardized connection ports within the base.

Housing **12** includes a processor utility (not shown in Fig. 1, and described further below with reference to Fig. 2A) for processing the input signal(s) $\mathbf{IS_1}$, $\mathbf{IS_2}$ and generating an output signal **OS** to the computer. The processor utility features are appropriately set for the requirements of various applications of the invention, for monitoring various physiological parameters of individuals.

In some embodiments of the invention, the processor utility of the medical instrument operates as an application program interface utility between the computer and external measurement unit(s), while the data processing is mainly carried out by the computer. For example, the processor utility can perform the signal amplification, filtering, etc. In some other embodiments, the processor utility is installed with a certain software product operating to perform the entire medical data processing, and the computer serves for displaying the processing results and provides a user interface for operating the medical instrument, data storage, etc. In yet another embodiment of the invention, medical instrument **10** includes an application software utility configured for the so-called distributed data processing in integration with said computer.

In a specific non-limiting example of the invention, medical instrument **10** is adapted for use in determining one or more cardiovascular parameters of a patient. The cardiovascular parameters may be one or more of the following parameters: ECG, blood pressure, stroke volume, heart rate or cardiac output.

Reference is made to **Figs. 2A and 2B** showing schematically the internal components of a medical instrument according to an embodiment of the invention. **Fig. 2A** shows the components of the processor utility **100** of a medical instrument, according to an embodiment of the invention and **Fig. 2B** shows more specifically a bioimpedance unit of the processor utility.

Processor utility **100** includes a bioimpedance unit **30** constituting a signal receiver, and a microcontroller **32**. Bioimpedance unit **30** is connected at its input end to input port **16A** of the medical instrument and is connected at its output end **33** to microcontroller **32**. Bioimpedance unit **30** is configured for receiving and performing the processing of an electrical output IS_1 from an electrodes' unit **35A** on a patient **P** for determining the patient's cardiac parameters, such as stroke volume. In a non-limiting example, processor utility **100** also includes another signal receiver **34** for receiving, via an input port **16B**, an input signal $\mathbf{IS_2}$ from an ECG-related electrodes' unit **35B**. In the present example different input signals are received by different input ports, but it should be understood that this is an optional solution, and all the signals can be input through the same port. Also, in this example, the medical instrument receives, through either one of ports **16A** and **16B**, an input signal $\mathbf{IS_3}$ from a non-invasive blood pressure (NIBP) measurement unit **36** (wire or wireless).

The outputs of microcontroller **32** are connected to an output port (**18** in Fig. 1) of the medical instrument connected to a HOST processor **40** of the computer (**20** in **Fig. 1**). This connection may be implemented via an isolation data unit **42** (such as opto-isolators HCPL2611HP), and via a Driver circuit **44** (such as the driver RS232C or USB) and suitable interface utility **46**. Alternatively the connection may be through dedicated port in the instrument that connects to a standardized connection port in the bay. These connection elements may be part of the medical instrument and/or the computer. As indicated above, the connection between the medical instrument and the computer may be wire-based or wireless. In the latter case, the medical instrument and the computer are appropriately provided with IR and/or RF and/or acoustic transmitter/receiver. Such communication techniques are known *per se* and therefore need not be described in detail herein. The medical instrument of the illustrated embodiment is power supplied (e.g. +5V) from the HOST processor via an isolating DC/DC circuit **48** and feeding a power supply unit **50** which stabilizes the voltage value. In the present not limiting example, the processing is a distributed processing, namely bioimpedance unit **30** and local microcontroller **32** perform certain initial processing (as will be described below with reference to Fig. 2B), while HOST processor **40** performs the final processing, which includes analysis of the measured signal, selection of a model (which is stored in a memory utility of either computer **20** or medical instrument **10**) for calculation, and calculation of the desired parameter(s). For example, the cardiac parameter(s) may be calculated based on the models utilizing the $\Delta R/R$ volumetric parameter and the $((dR/dt) \cdot T)$

blood velocity parameter. To this end, the known Frinerman formula (see US Patent No. 5,469,859 assigned to the assignee of the present application) and the *dR/dt*-based equation [Kubicek et al. Biomed. Eng. 1974, 9:410-16] can be used for the stroke volume calculation. The principles of these bioimpedance measurement techniques are known *per se* and therefore need not be specifically described.

An example of the construction and operation of bioimpedance unit **30** will now be described with reference to **Fig. 2B**. As indicated above, this is a specific but not limiting example of the invention configured for use in determination of one or more cardiac parameters of a patient. Bioimpedance unit **30** includes a current source **52** for supplying electrical current to electrodes' unit **35A**, and a direct digital synthesizer (DDS) generator **54**, which is in turn operated by microcontroller **32**. The provision of DDS generator **54** is associated with the following: a human body behaves, from an electrical point of view, as a resistance-capacitance (RC) impedance; the value of impedance is influenced by the injection current frequency; the DDS generator operates to control this frequency to be about 32KHz. Microcontroller **32** operates the DDS generator to control the stability of the output frequency and amplitude of a sinusoidal signal from the DDS generator, which signal operates current source **52**. Bioimpedance unit **30** preferably includes a leadoff detector **56**, which is used to sense the absence of a contact between the electrode and the body (for bioimpedance electrodes and preferably also for ECG electrodes).

A read voltage signal $\mathbf{IS_1}$ from electrodes' unit **35A** is input to a high precision instrumentation amplifier **58**. This input signal $\mathbf{IS_1}$ is proportional to the human body impedance *Z* (i.e. an integral bioimpedance). An output of instrumentation amplifier **58** is connected to a first input of a synchronous detector **60**. The latter operates to rectify the integral bioimpedance signal, and to provide simultaneous derivation of the active component *R* of the integral bioimpedance signal vector. This component *R* is directly proportional to the resistive component of the lead (resistance of the blood system). Linearity of the synchronous detector

60 simplifies the calibration process and reduces it to a single-step initial adjustment of the medical instrument (instead of a per cycle calibration). An output of detector **60** is connected to a low frequency filter **62** which may for example be a low pass Bessel filter. Filter **62** cuts off high frequency components, for example above 32 KHz, and delivers an operating signal, which has the active bioimpedance component (DC) *R*, and the waveform bioimpedance signal (AC) ΔR. The operating signal is input to an R SCALE AMPLIFIER **64** and to a Bioamplifier and Filter **66**. Amplifier **64** produces an output signal proportional to the active bioimpedance component *R* and transmits the same to an input ADC (Analog-to-Digital Converter) of the microcontroller **32**. Bioamplifier and Filter **66** separates from the operating signal the waveform ΔR component. The output of the Bioamplifier and Filter **66** is connected to another input ADC of microcontroller **32**. The latter communicates with HOST processor (**40** in **Fig. 2A**) of the computer.

Thus, the present invention provides a novel medical instrument configured to be installable in a standard computer bay, typically a disc drive bay. The medical instrument is preferably constructed as an application program interface for communicating with a measurement unit, such as electrode unit(s), and for communicating with a computer processor.

It should be understood that the invention is not limited to the above-described examples of determining cardiovascular parameters, but may be used for determining any other physiological parameters. To this end, the processor utility of the medical instrument is installed with suitable hardware and/or software products to be responsive to predetermined input signals and process them to produce desired output.

CLAIMS:

1. A medical instrument comprising a housing, a first communication utility in the housing for receiving input signal indicative of physiological signals and a second communication utility for communicating with a computer, said housing being configured for removable installment in a compact disc (CD) drive bay of a computer.

2. A medical instrument according to Claim 1, wherein said first communication utility and said second communication utility has a port on a face of the housing which is externally accessible once the instrument is in said bay, said second communication utility is adapted for communication via a connection unit to a communication port of the computer.

3. A medical instrument according to Claim 1 or 2, wherein said first communication utility is on a face of the housing which is externally accessible once the instrument is in said bay and said second communication utility is on a face which is internal once the instrument is in said bay and adapted for connection to a communication port that is within said bay.

4. A medical instrument according to any one of Claims 1-3, wherein said housing houses a processor utility for processing the input signal and generating an output signal corresponding thereto for communicating to the computer.

5. A medical instrument according to Claim 4, wherein said processor utility is adapted for receiving control signal from the computer.

6. A medical instrument according to Claim 4 or 5, comprising an application software utility.

7. A medical instrument according to any one of Claims 1-6, for use in determining one or more cardiovascular parameters.

8. A medical instrument according to Claim 7, wherein said cardiovascular parameters are selected from ECG, blood pressure, stroke volume, heart rate, cardiac output and cardiac output derivatives.

9. A medical instrument according to any one of Claims 1-8, wherein said first communication utility comprise two or more signal receivers each for receiving an input signal indicative of a different physiological parameter.

10. A medical instrument according to Claim 9, comprising a first receiver for receiving signal indicative of a parameter relating to cardiac output, a second receiver for receiving a signal indicative of ECG and a third receiver for receiving a signal indicative of blood pressure.

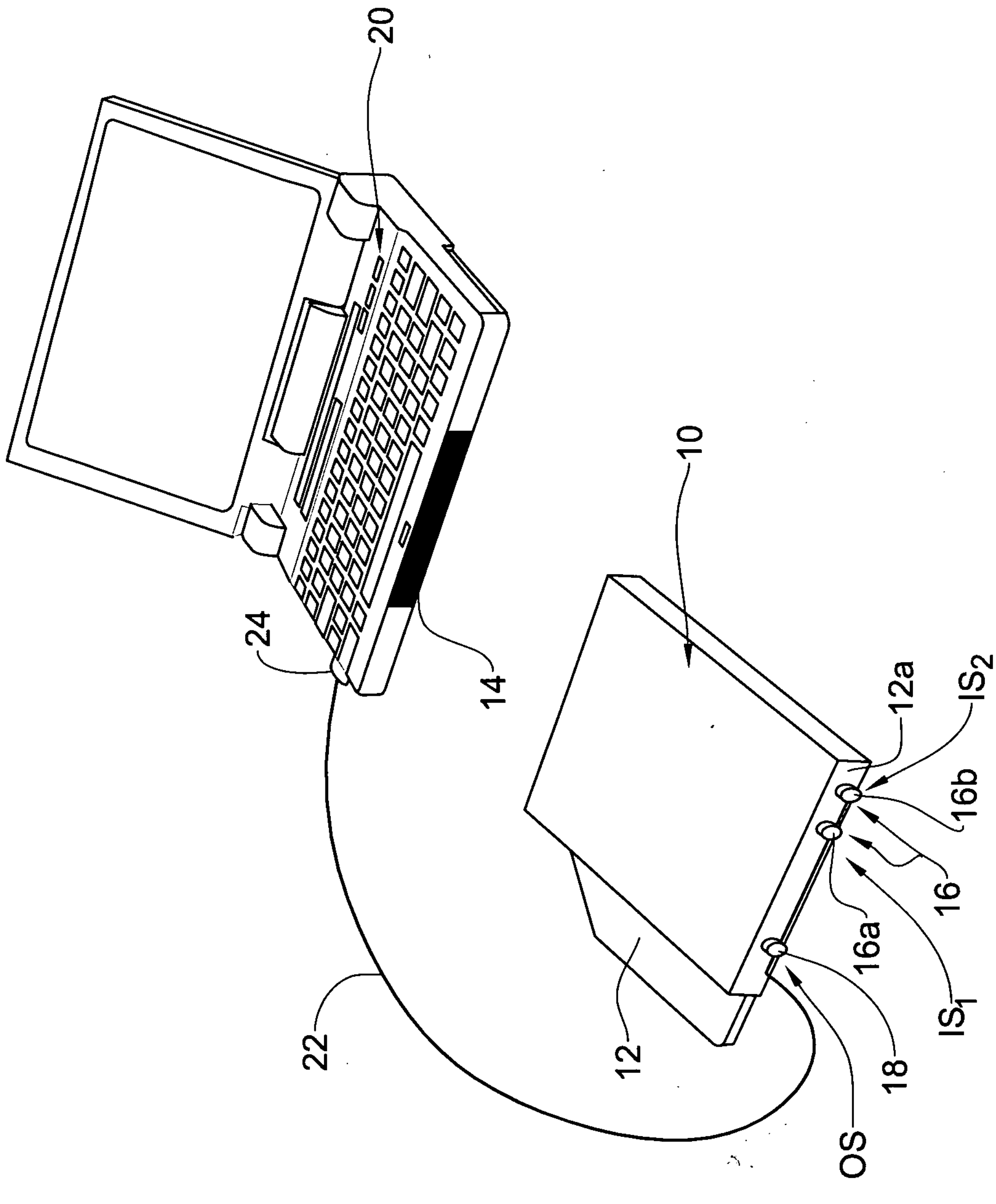

FIG. 1

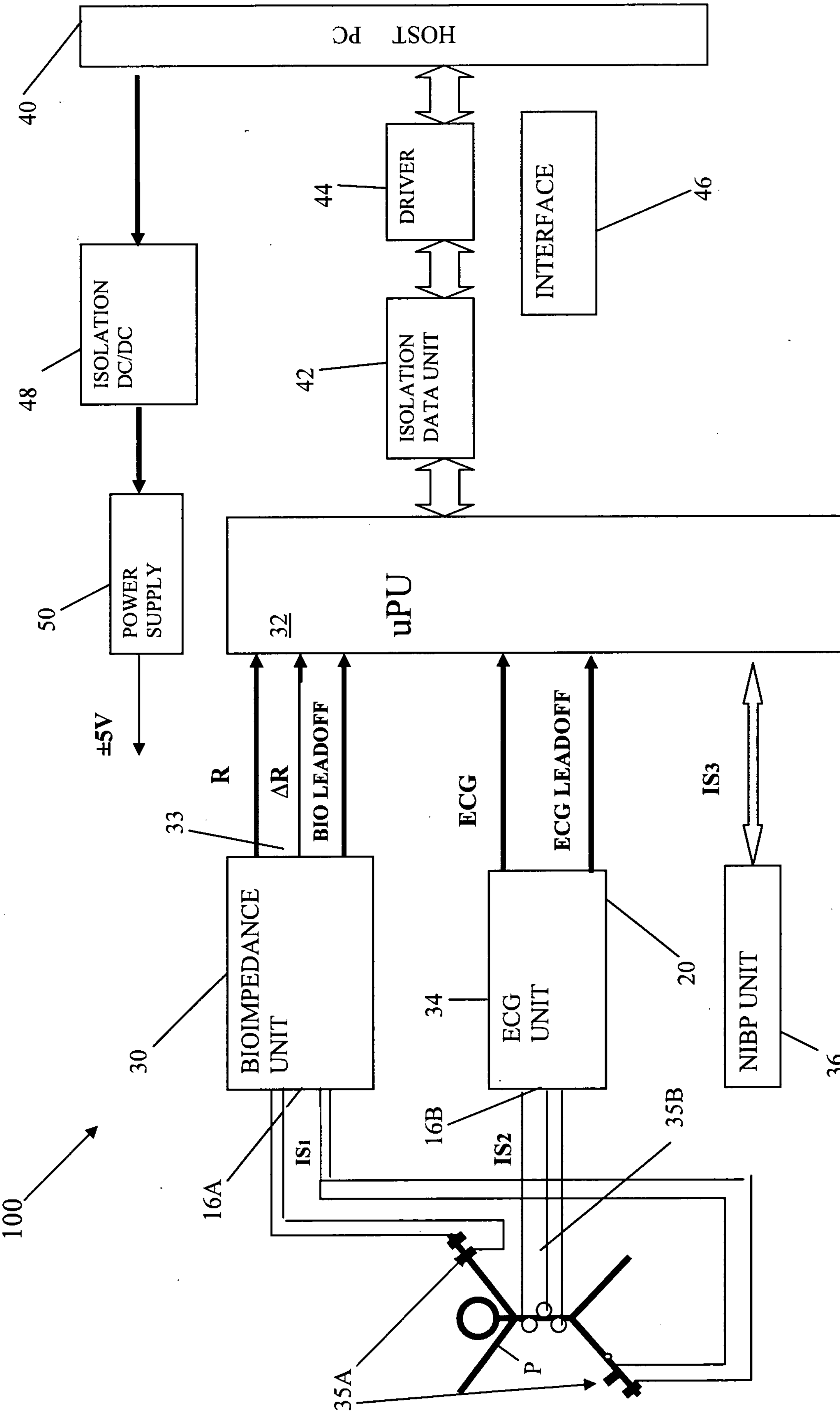
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FIG. 2A

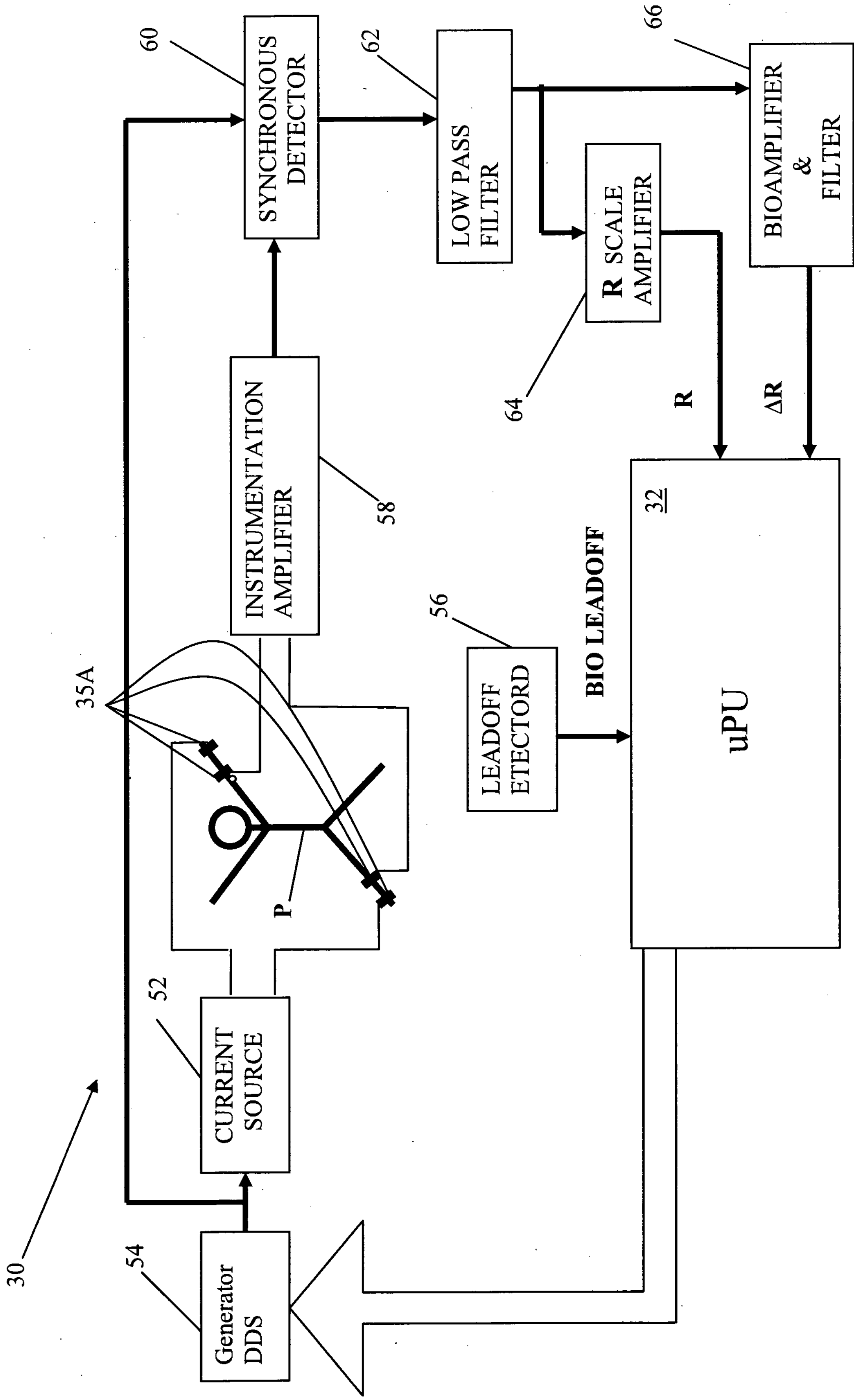
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FIG. 2B