US 20010030077A1

(19) United States

(12) Patent Application Publication (10) Pub. No.: US 2001/0030077 A1

Watson (43) Pub. Date: Oct. 18, 2001

(54) STETHOSCOPE WITH ECG MONITOR

(76) Inventor: **Richard L. Watson**, McPherson, KS (US)

Correspondence Address:
SHERMAN D PERNIA, ESQ., PC
1110 NASA ROAD ONE
SUITE 450
HOUSTON, TX 77058-3310 (US)

(21) Appl. No.: **09/758,627**

(22) Filed: **Jan. 10, 2001**

Related U.S. Application Data

(63) Non-provisional of provisional application No. 60/175,355, filed on Jan. 10, 2000.

Publication Classification

(51) **Int. Cl.**[7] **A61B 7/02**

(52) **U.S. Cl.** **181/131**; 381/67

(57) **ABSTRACT**

A electronic stethoscope head is combined with a standard stethoscope air tube headset assembly to provide a personally portable ECG stethoscope system for auscultating a living body. The electronic stethoscope head comprises a stethoscope body having a chest-bell, an air tube connector (or connectors), and a display module mounted to it. The chest-bell has a rim for contacting the body, and a base adapted to attach to the stethoscope body. An electrode assembly having at least two electrodes is disposed on the rim of the chest-bell to contact the body during auscultation and receive electrical signals from the body. The electrical signals are conducted to the display module. The display module is mounted on the stethoscope body, and receives and processes the electrical signals and display a representation of the electrical signals on a view screen, like an LCD display screen. An air passage is disposed within the stethoscope body to provide air pressure communication between the chest-bell and the air tube connector(s). The air tube connector(s) provide for attaching the electronic stethoscope head to a standard stethoscope air tube headset assembly.

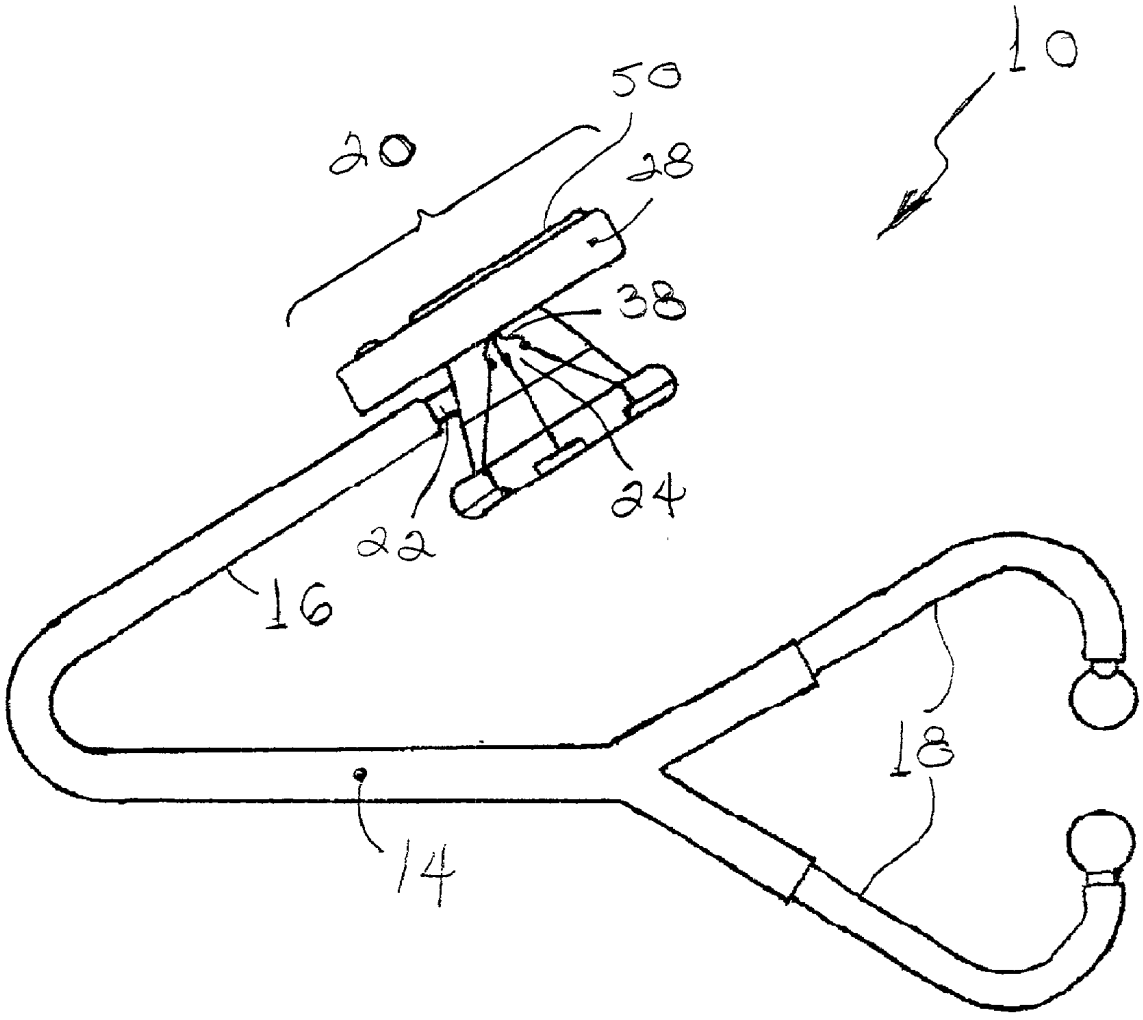

Fig. 1A

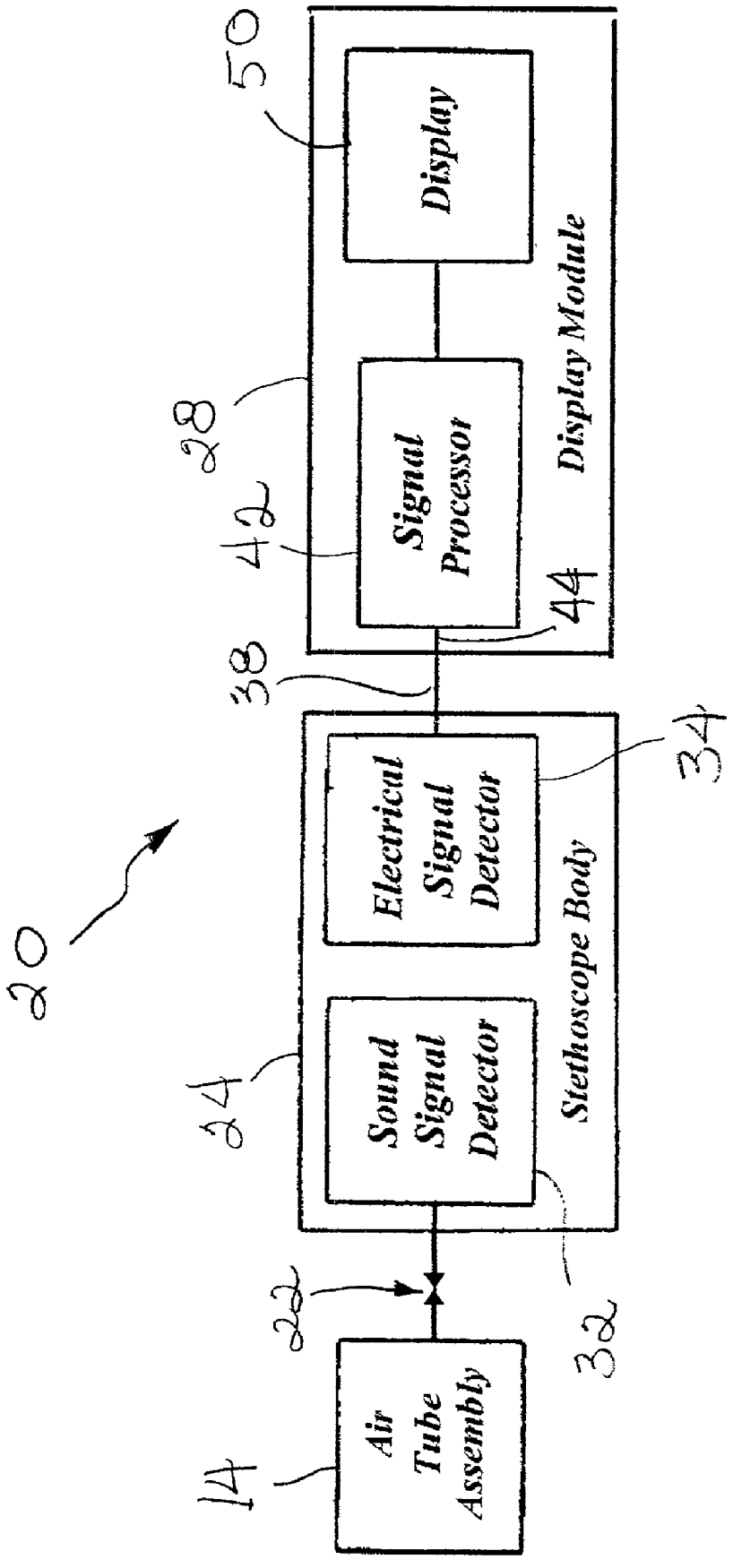
20
14
Air Tube Assembly
22
24
Sound Signal Detector
Electrical Signal Detector
34
32
Stethoscope Body
38
28
42
Signal Processor
44
Display Module
50
Display

Fig. 1B

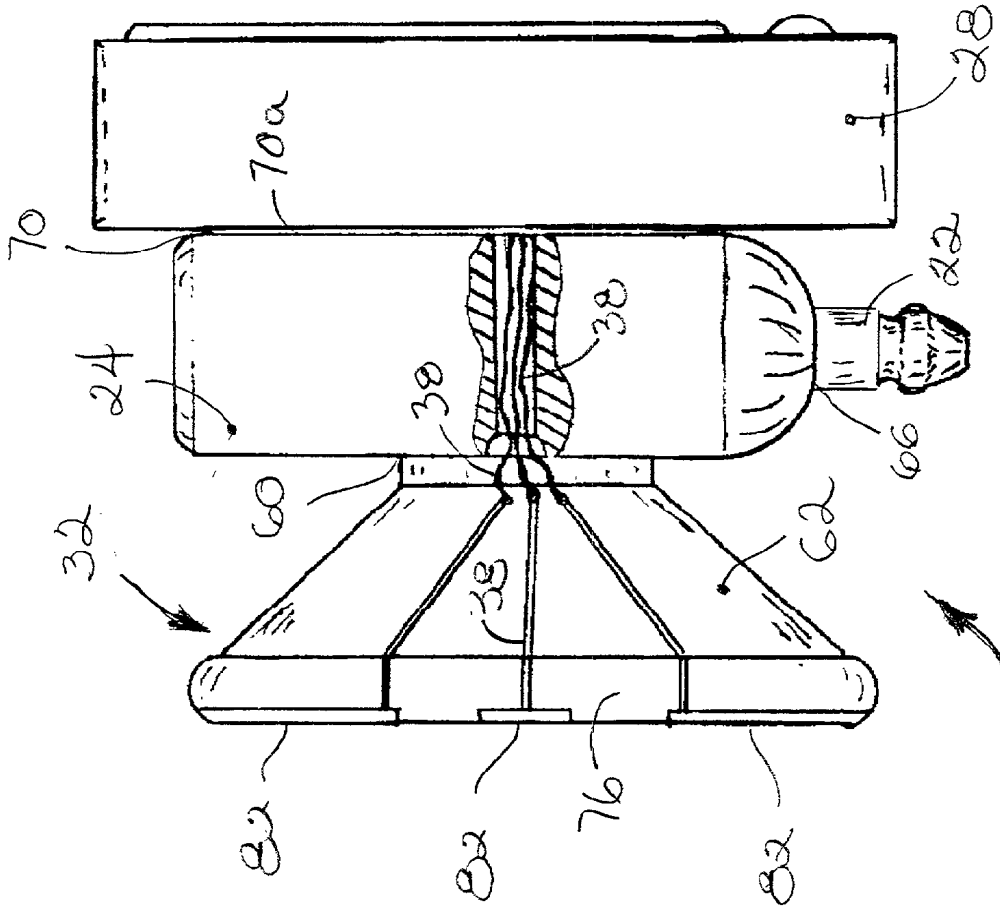

Fig. 2A

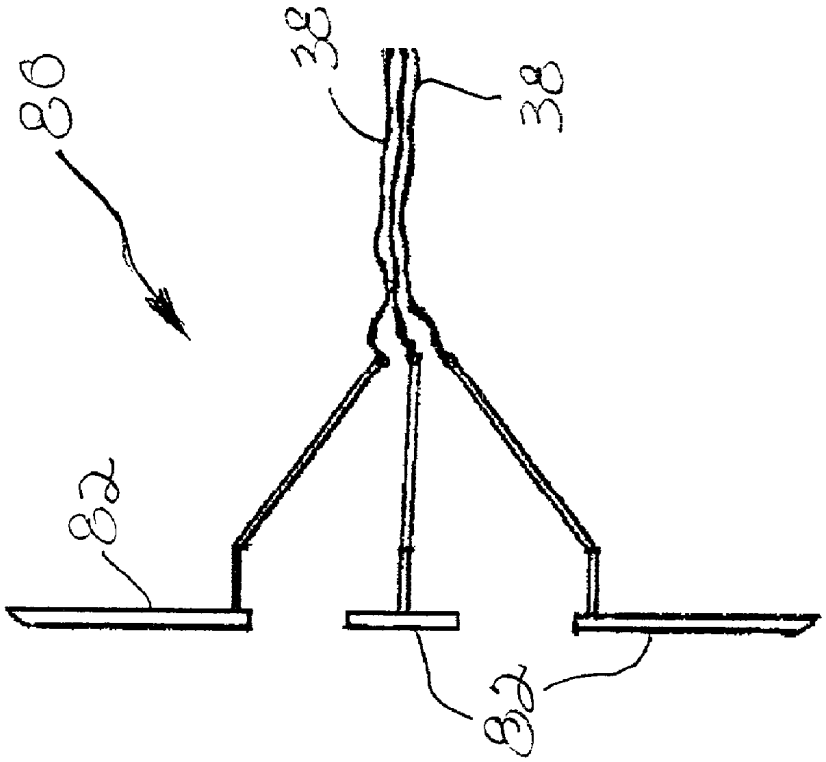

Fig. 2B

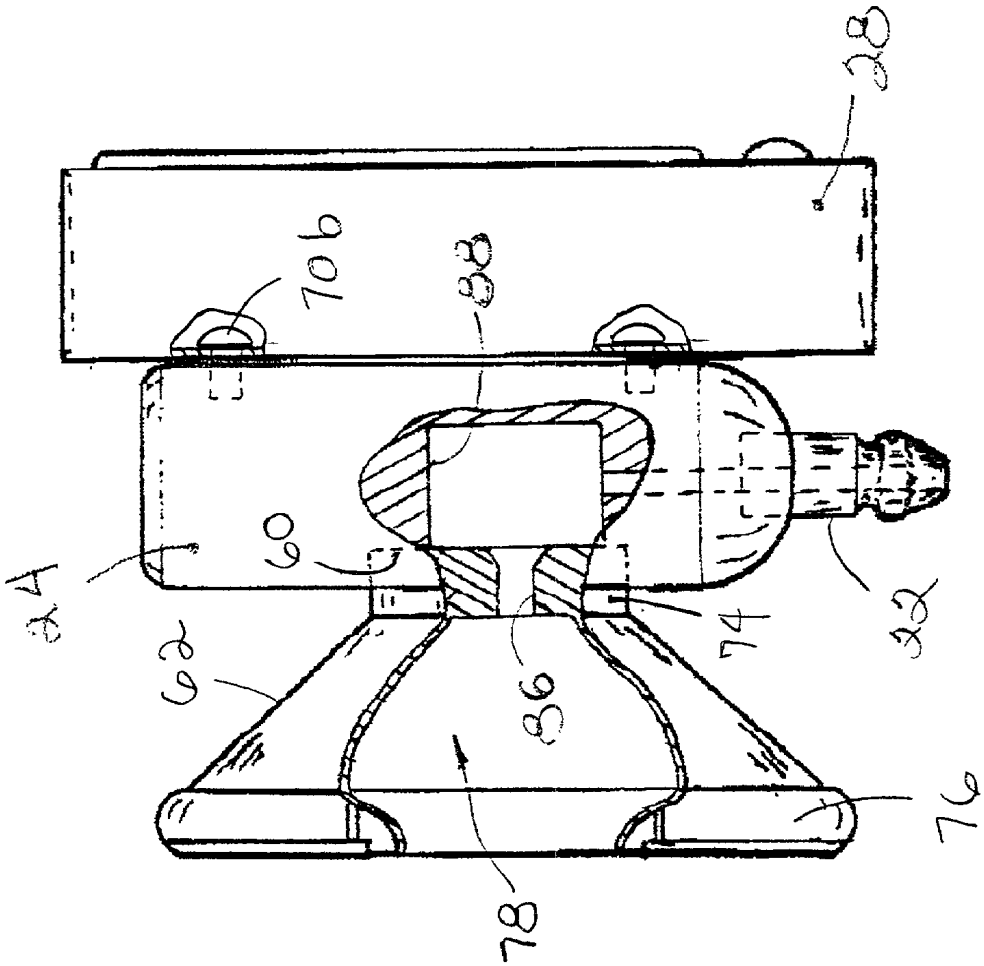

FIG. 3

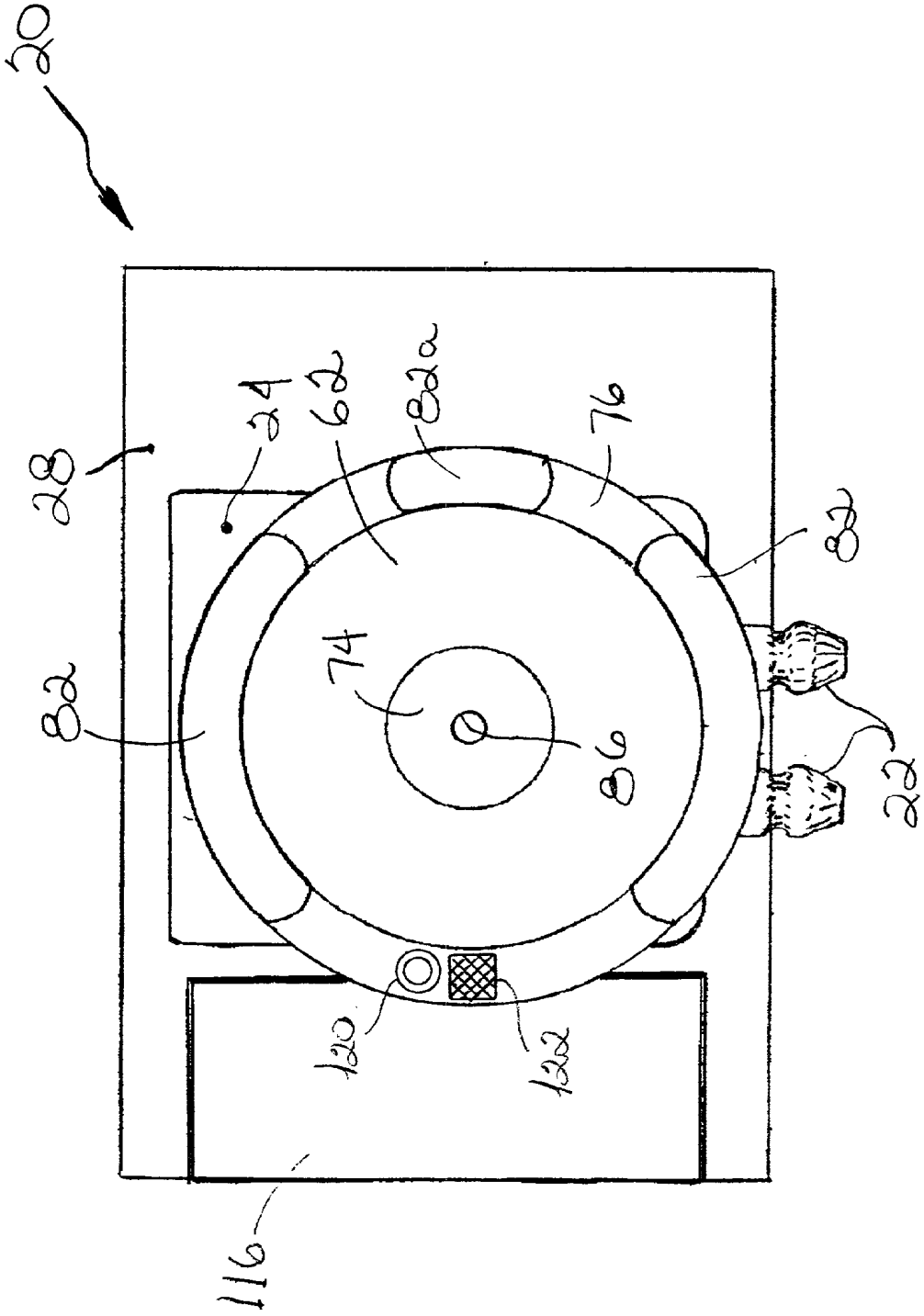

Fig. 4

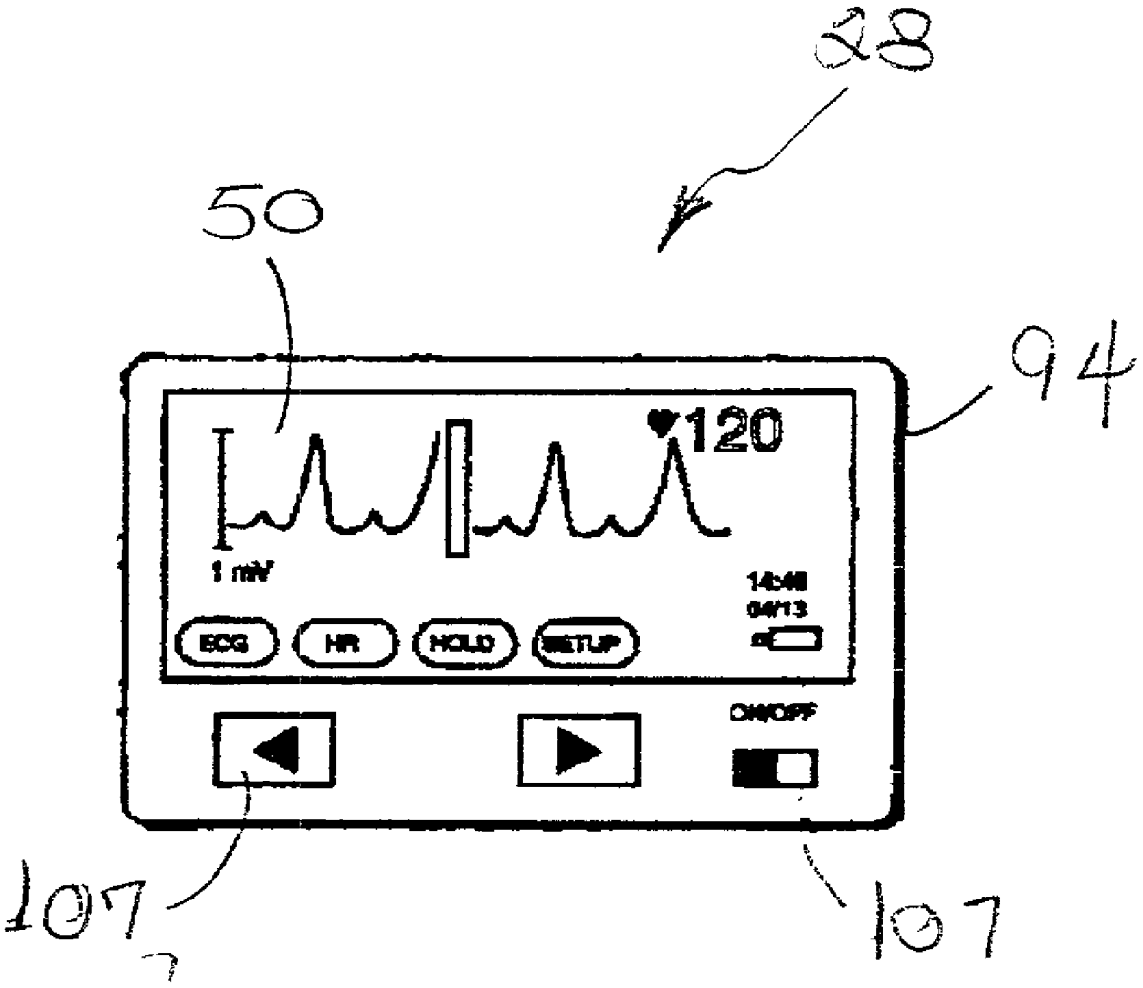

Fig. 5A

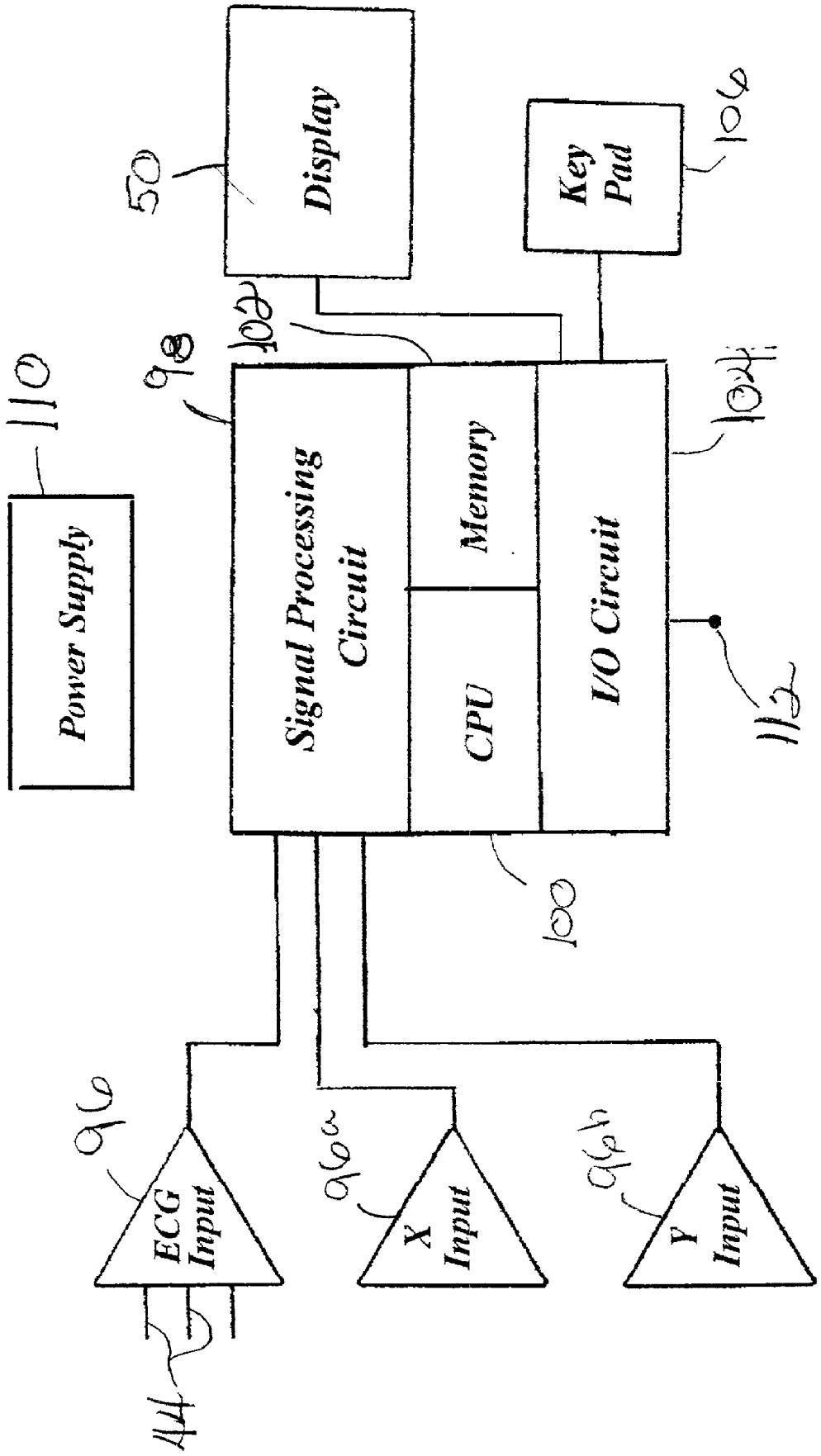
Display
50
Key Pad
106
102
98
110
Power Supply
Signal Processing Circuit
Memory
CPU
I/O Circuit
104
112
100
96
ECG Input
96a
X Input
96b
Y Input
44

Fig. 5B

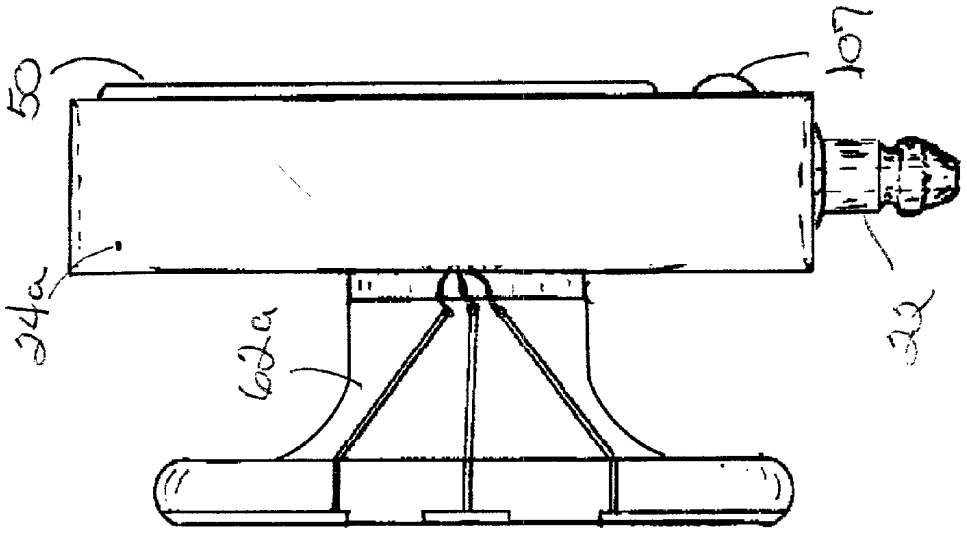

Fig. 6C

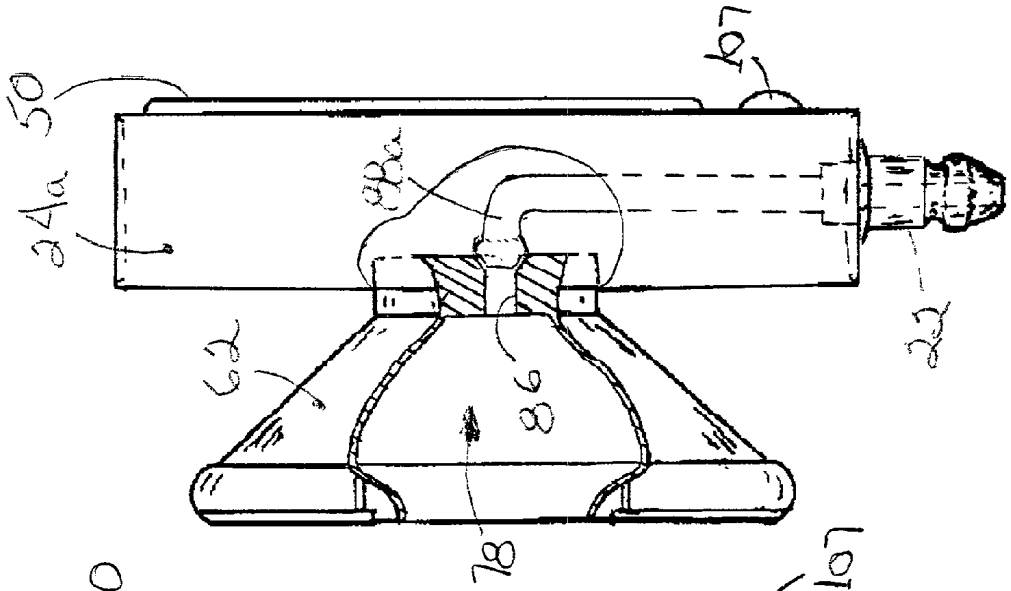

Fig. 6B

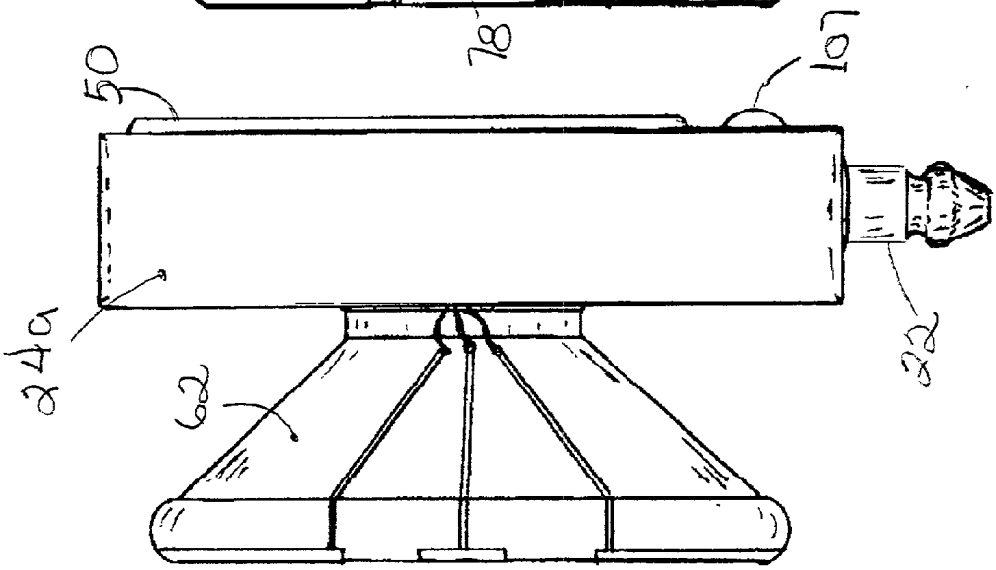

Fig. 6A

STETHOSCOPE WITH ECG MONITOR

FIELD OF THE INVENTION

[0001] The present invention is in the field of apparatuses having a specific structure adapted to be placed on the living body. More specifically, the invention relates to devices detecting heart beat audio and electric signals for display in evaluating a condition of a living body.

BACKGROUND OF THE INVENTION

[0002] The stethoscope has been an enduring instrument and symbol of the practice of western medicine for many decades. Although the classic air column stethoscope is still prevalently used for auscultation of heart and lung conditions, it has known limitations, and the field has been motivated to develop alternatives to circumvent some of the limitations. The advent in electronics of integrated micro-circuits and micro-CPUs, and advances in medical and related technologies have facilitated this development.

[0003] One of the limitations sought to be overcome is the dependance of the air column stethoscope (a simple chest-bell pickup channeling body sounds via an air column to the user's ears) on the energy contained in the sound as produced by the body for sufficient propagation of the information conveyed by the sound. The application of microphone pickups and electronic amplifiers to stethoscopes facilitated auscultation that otherwise would be limited by weak body sounds. For example, Yamada (U.S. Pat. No. 4,072,822) discloses a two-way stethoscope which permits hearing both direct and amplified sounds from the human body.

[0004] Other examples of amplified stethoscopes for auscultation of body sounds include Deno (U.S. Pat. No. 4,598,417), and Durand et al. (U.S. Pat. No. 5,602,924).

[0005] Taking a different tack to address the problem, Eisenberg et al. (U.S. Pat. No. 4,792,145) incorporate microprocessor technology in an electronic stethoscope system to provide a processed or conditioned audio representation of a detected body sound. The audio representation produced by the Eisenberg device also includes body sounds that were originally inaudible.

[0006] Although these devices may be useful for their intended purposes and may overcome some of the limitations of the classic air column stethoscope's dependance on the inherent energy contained in the original body sound, they do not address the issue that aural auscultation alone may not be sufficient to perform an adequate diagnosis, particularly of heart condition.

[0007] In view of this limitation, the field has been further motivated to develop stethoscopes that provide waveform representation, particularly of heart sounds, in addition to aural presentations. An example of such a device is disclosed by Bredesen et al. (U.S. Pat. No. 5,213,108). Bredesen describes a display module device that is electronically coupled to microphone in a stethoscope. The Bredesen device receives, digitizes and stores heart sound data, and displays waveforms of the heart sounds on an LCD screen. Such sound waveform devices may also be useful for their intended purpose, however, diagnosing a heart condition using auditory data alone, even when displayed as a waveform, still has its limitations.

[0008] In response, the field has developed electronic stethoscopes that detect and display as waveforms both audio (heart sound) and ECG (heart electrical activity), as well as presenting the heart sounds aurally. Little et al. (U.S. Pat. No. 4,362,164) describe a stethoscope having a detector head that includes a microphone and is selectably connectable to either a conventional chest-bell or an electrode chest-bell. The electrode chest-bell is adapted to pickup electric heart signals, and the microphone to pickup body sounds. The electrode and microphone signals are sent to a separate monitoring unit to display both ECG and phonocardiographic waveforms. The conventionally detected body sounds are transmitted via air column tube directly to the user's ears. However, the Little device, and others like it, require connectivity (either via interconnect cable of wireless transmission) between the stethoscope and a separate display unit, and they are not easily transported about a physician's or other care staff's person. Again, although these devices also may be useful for their intended purpose, they too have their limitations.

[0009] Therefore, it would be beneficial to have an alternative electronic stethoscope that is easily transportable about a care givers' person, and adapted for monitoring and displaying heart sounds and heart electrical activity, as well as serving the usual auscultation purposes of the conventional stethoscope.

SUMMARY OF THE INVENTION

[0010] The present invention is personally portable ECG stethoscope system for auscultating a living body. The system is an electronic stethoscope head combined with a standard stethoscope air tube headset assembly. The electronic stethoscope head comprises a stethoscope body on which is mounted a sound signal detector (chest-bell), an electrical signal detector and a display module. The present ECG stethoscope system is easily transportable about a medical care givers' person, and adapted for monitoring and displaying heart sounds and heart electrical activity, as well as serving the usual auscultation purposes of the conventional stethoscope. The system is self-contained and does not require ancillary equipment to be connected or linked to the stethoscope to accomplish its utility.

[0011] The stethoscope body incorporates means for mounting three other components of the electronic stethoscope head: the first mounting means being a chest-bell mount adapted for receiving and mounting a chest-bell, the second mounting means being an air tube connector adapted for connecting one or more air tubes to the stethoscope body, and the third mounting means being a display module mount adapted for attaching a display module to the stethoscope body. The chest-bell serves as the sound signal detector. Typically, a chest-bell has a rim for contacting the sound detector to the living body, a base where the sound detector is mounted to the stethoscope body and through which body sounds are propagated to be sent to the air tube assembly.

[0012] The ECG stethoscope head includes an electrode assembly. The electrode assembly has at least two ECG electrodes which are incorporated into the rim of the chest-bell, and disposed to contact the dermis of living body and receive heart electrical signals during auscultation. Electrical leads connect the ECG electrodes disposed on the rim of the chest-bell with the display module and serve to conduct the heart electrical signals to the display module.

[0013] The display module is attached to or mounted on the stethoscope body by the display module mounting means. Mounting the display module to the stethoscope body can be accomplished by any of a number of means known to one of ordinary skill in the art, including using fasteners or adhesives. Alternatively, the stethoscope body is adapted to incorporate the display module, by having the stethoscope body house the display module. The display module is in electrical communication with the electrical leads of the ECG electrodes, and receives and processes the heart electrical signals from the electrodes. The display module produces display data from the electrical signals and sends the data to a view screen (e.g., an LCD screen) to provide a visual representation (waveform) of the heart electrical signals.

[0014] The air passage disposed within the stethoscope body provides air pressure communication between the interior of the chest-bell and the air tube connector mounted on the stethoscope body. The air tube connector serves as the attachment point via which the stethoscope head attaches to a standard stethoscope air tube assembly to provide air pressure communication of the body sounds to the ear pieces of the stethoscope.

[0015] The display module of the present invention comprises a housing containing a electrical signal processor and a view screen. The signal processor receives heart electrical signals, processes them and outputs screen data to the view screen. The view screen receives the screen data and presents it on the view screen. The view screen presentation includes a waveform presentation of the heart electrical signal. The electric signal processor further comprises a signal processing circuit and a power supply. The signal processing circuit is operatively connected to the electrode leads to receive heart electrical signals from the electrodes. The signal processing circuit processes the signals to produce view screen data and selectively communicates the screen data to the view screen. Which of the screen data is sent to the view screen to be presented is controlled by the signal processing circuit, and is selectable by a user via function keys on the surface of the display module proximate the view screen. A battery power supply is contained within the display module. The power supply is in operative communication with the signal processing circuit and the view screen to provide them with electrical power.

[0016] Utilizing the basic structure and elements of the present electronic stethoscope head, it is possible to include other sensor and diagnostic modalities features. For example, blood hemoglobin oxygen saturation (SAO_2) sensor technologies are presently available that can be incorporated into the rim of the chest-bell. The electrical signals from the SAO_2 sensor can be conducted to and analyzed by the signal processor and displayed on the view screen of the present invention in much the same manner as the electrical signals from the ECG electrodes.

BRIEF DESCRIPTION OF THE DRAWINGS

[0017] **FIG. 1A** is a schematic representation of the personally portable ECG stethoscope system of the present invention.

[0018] **FIG. 1B** is a block diagram illustrating the relationship between the principle elements of the personally portable ECG stethoscope system.

[0019] **FIG. 2A** is a side elevation of the stethoscope head of the present invention showing the body, the chest-bell and the display module. The body includes a partial cutaway showing a pathway of the electrode wires from the bell electrodes, through the body and into the display module.

[0020] **FIG. 2B** is side view of the electrode assembly and signal leads removed from the drawing of **FIG. 2A**.

[0021] **FIG. 3** is a partial cutaway through the side elevation of the stethoscope head of the present invention showing the body, the chest-bell and the display module. Also shown is the air pressure pathway from the chest-bell, through the stethoscope body and to the aural output ports that connect to the air column tubes of the stethoscope ear pieces.

[0022] **FIG. 4** is a front elevation of the stethoscope head of the present invention showing first the chest-bell, with the body behind it and then the display module.

[0023] **FIG. 5A** is a front of a prior art display module adaptable for use in the present invention.

[0024] **FIG. 5B** is a block diagram of the circuit functions and general connectivity of the display module.

[0025] **FIGS. 6A and 6B** are side elevations of the stethoscope head showing the body serving as a housing for the display module. The body includes a partial cutaway of the bell and housing showing the air pressure pathway of the from the base of the bell, through the body housing and to the air tube connector(s).

[0026] **FIG. 6C** is a side elevation of the stethoscope head illustrating one of a variety of alternative chest-bells that can be practiced in the present invention.

DETAILED DESCRIPTION OF THE INVENTION

[0027] The present invention is a personally portable ECG stethoscope system for the auscultation of a living body. The system includes an electronic stethoscope head and standard air tube assembly. Referring now to the drawings, the details of certain preferred embodiments of the present ECG stethoscope system are graphically and schematically illustrated. Like elements in the drawings are represented by like numbers, and any similar elements are represented by like numbers with a different lower case letter suffix.

[0028] As shown in **FIGS. 1A and 1B**, the present personally portable ECG stethoscope system **10** is the combination of a standard aural stethoscope headset (air tube **16** and ear piece **18**) assembly **14** and an electronic stethoscope head **20** connected together at an air tube connector **22**. As shown in **FIG. 1**B, the electronic stethoscope head **20** comprises a stethoscope body **24** and a display module **28**. The stethoscope body **24** includes a sound signal detector **32** and an electrical signal detector **34**. Electrical signal leads **38** conduct signals from the electrical signal detector **34** to the display module **28**. A signal processor **42** in the display module **28** has its input **44** in electrical communication with the signal leads **38**. The signal processor **42** processes the received electrical signals into a condition suitable for input to a view screen display. The conditioned or view screen data is communicated to the view screen display **50** for visual presentation to the user.

[0029] As shown in **FIGS. 2A and 3**, the stethoscope body **24** has first, second and third mounting means. The first mounting means **60** is adapted for receiving and mounting a sound signal detector **32** to the stethoscope body **24**. The second mounting means **66** is adapted to receive an air tube connector **22** for connecting one or more air tubes **16** to the stethoscope body **24**. The third mounting means **70** is adapted for attaching the display module **28** to the stethoscope body **24**.

[0030] In the preferred embodiment shown in **FIG. 3**, the sound detector **32** (of **FIG. 1B**) is a chest-bell **62**. The first mounting means **60** is a receptacle set into the surface of the stethoscope body **24** and receives the chest bell **62**. The chest-bell **62** has a base **74**, an opening rim **76**, and an interior space **78** between the base **74** and the rim **76**. The base **74** of the chest-bell **62** is adapted to be tightly received and held by the first mounting means **60** of the stethoscope body **24**. Methods for tightly holding the base **74** in the first mount **60** are known to and adaptable by one of ordinary skill in the art for practice in the present invention. Such methods include adhesives, threaded interfaces and various screw or pin fasteners.

[0031] As shown in **FIG. 2**B, an electrode assembly **80** is associated with the chest-bell **62**. The electrode assembly **80** has at least two electrodes **82**. In the preferred embodiment shown in the figures, the electrode assembly **80** has three electrodes **82** which are disposed on the rim **76** of the chest-bell **62** to contact the living body during auscultation. An electrical lead **38** is connected to each electrode **82**. The electrodes **82** receive heart electrical signals when the rim **76** of the chest-bell is press against the dermis over the heart region of the living body. In the preferred three electrode embodiment, one of the electrodes serves as the reference electrode **82***a* (see **FIG. 4**). The electrical leads **38** communicate the electrical signal from the electrodes **82** to the display module **28**.

[0032] A display module **28** is attached to the display module mount **70** of the stethoscope body **24**. The display module mounting means **70** can be accomplished by a number of means known to the ordinary skilled artisan for attaching adjoining or abutting surfaces. Examples of such means include an adhesive **70***a* between abutting surfaces of the stethoscope body **24** and the display module **28** as depicted in **FIG. 2**A, and fasteners **70***b* passing through one and into the other of the stethoscope body **24** and the display module as shown in **FIG. 3**. The display module **28** is in electrical communication with the signal electrodes **82** by way of the electrical leads **38**. The electrical leads **38** are connected to the signal input **44** of the display module **28**, allowing the display module **28** to receive, processes and display a waveform representation of the electrical signals on a view screen **50**.

[0033] As shown in **FIG. 5**, the display module **28** comprises a housing **94** that contains the signal processor **42** for receiving, processing and outputting view screen data, and a view screen **50** for receiving and presenting the view screen data (see **FIG. 1B**). Miniature display module suitable for practice in the present electronic stethoscope head **20** are known in the art and are readily adaptable for practice in the present invention by the ordinary skilled artisan without undue experimentation. For example, Su-yeuh (U.S. Pat. No. 6,160,480) discloses a wrist watch display module for visually presenting heart rate data that it receives as a wireless input signal. A more specific example is Arcelus (U.S. Pat. No. 6,149,602), which discloses a wrist watch-like display module for visually presenting ECG data, which is also practicable in the present invention.

[0034] As shown in **FIG. 5**B, the display module **28** incorporates an ECG signal input circuit **96**, including signal filter/amplifier circuitry. Optionally, other input circuits **96***a*, **96***b* for receiving electrical signals for other detectors (e.g., SAO_2 and blood sugar detectors) may be provided in the display module **28**. Also included in the display module is a signal processing circuit **98**, a computer processing unit (CPU) **100** with memory **102**, an input/output (I/O) circuit **104**, a view screen **50**, and a key pad **106**. A power supply **110** is in operative communication with the circuits of the display module to provide electrical power as needed. The electric signal inputs **44** to the ECG input circuit **96** are operatively connected to the electrode leads **38** of the electrode assembly **80** to receive heart electrical signals from the electrodes **82**. The ECG input circuit **96** conditions the input signal as necessary and conducts it to the signal processing circuit **98** which further conditions and digitizes the heart electrical signal. The digitized heart signals are then conducted under the control of the CPU and memory circuits to the view screen display **50** for visual display, or to the I/O port **112** for export from the electronic stethoscope head **20** to a peripheral device (not shown). Peripheral devices can include printers, data storage devices, signal display equipment and other devices. While in use, the present invention does not have a physical connection to any peripheral device. Control of the signals (view screen data) conducted to the display **50** is selectable by user via function keys **107** (see FIGS. **6**A-C) on the key pad **106**.

[0035] In the preferred embodiment, the power supply **110** is a rechargeable power supply, and more particularly, a rechargeable battery power supply. In the preferred embodiment, the batteries of the power supply **110** are easily replaceable, and as shown in **FIG. 4, a** battery access hatch **116** is provided on the display module **28** to access the power supply **110** to change the battery.

[0036] In an alternative preferred embodiment shown in **FIG. 6**A, the stethoscope body **24** itself is adapted as the display housing **94**, thus integrating the signal processor **42** and the view screen **50** with the stethoscope body **24***a*. **FIG. 6B** exemplifies how an air pressure passage **88***a* may be accomplished in the integrated stethoscope body **24***a*. Other means of integrating the signal processor **42** and view screen display **50** of the display module **28** with the stethoscope body **24** are readily accomplishable by the ordinary skilled artisan. Additionally, as shown in **FIG. 6**C, chest-bells **62***a* of various different existing configurations are also adaptable for practice in the present invention by the ordinary skilled artisan.

[0037] The basic structural features and elements of the present electronic stethoscope head **20**, is adaptable to optionally include other sensor and diagnostic modalities features in the rim **76** of the chest-bell **62**. Specifically, micro-sizes sensors that are operative upon contact with the dermis of a living body are especially adaptable for practice with the stethoscope head **20** of the present invention. For example, SAO_2 sensor technologies are presently available that can be incorporated into the rim of the present chest-bell

62. **FIG. 4** shows the IR emitter **120** and the reflected IR detector **122** of an SAO_2 sensor mounted on the rim of the chest-bell **62**. The electrical signals from an SAO_2 sensor can be conducted to and analyzed by the signal processor and displayed on the view screen of the present invention in much the same manner as the electrical signals from the ECG electrodes **82**. Blood sugar sensors are another micro technology that is adaptable for practice in the present invention using the already disclosed scheme of electrical signal leads **38** communicating with the inputs **44** to the signal processor **42** of the present invention.

[**0038**] To provide for use of the present ECG stethoscope system **10** as a typical air column, aural stethoscope, an air passage **88** is disposed within the stethoscope body **24** to provide air pressure communication between the interior space **78** of the chest-bell **62** mounted on the stethoscope body **24** and one or more air tube connectors **22**, also mounted on the stethoscope body **24**. See **FIG. 3** and **FIG. 6B**. The interior space **78** of the chest-bell **62** is in air pressure communication with the air passage **88** via an aperture **86** in the base **74** of the chest-bell **62**. The air tube connector(s) **22** attaches the electronic stethoscope head **20** to a standard stethoscope air tube assembly **14**, thus providing for the use of the present system **10** as a typical air column stethoscope.

[**0039**] While the above description contains many specifics, these should not be construed as limitations on the scope of the invention, but rather as exemplifications of one or another preferred embodiment thereof. Many other variations are possible, which would be obvious to one skilled in the art. Accordingly, the scope of the invention should be determined by the scope of the appended claims and their equivalents, and not just by the embodiments.

What is claimed is:

1. A personally portable ECG stethoscope system for auscultating a living body, the system including an electronic stethoscope head and standard air tube assembly, the electronic stethoscope head comprising:

a stethoscope body having a first a second and a third mounting means, the first mounting means being a chest-bell mount adapted for receiving and mounting a chest-bell, the second mounting means being an air tube connector adapted for connecting one or more air tubes to the stethoscope body, and the third mounting means being a display module mount adapted for attaching a display module to the stethoscope body;

a chest-bell having a base, an opening rim for contacting the living body, and an interior space between the base and the rim, with the base adapted to attach to the first mounting means of the stethoscope body;

an electrode assembly having at least two electrodes and electrical leads connected to the electrodes, the electrodes disposed on the rim of the chest-bell to contact the living body during auscultation and receive electrical signals from the living body, and the electrical leads in electrical communication with a display module to conduct the electrical signals to the display module;

a display module attached to the display module mount of the stethoscope body, the display module in electrical communication with the electrical leads of the electrodes and the display module for receiving, processing and displaying a representation of the electrical signals; and

an air passage disposed within the stethoscope body, the passage providing air pressure communication between the interior of the chest-bell mounted on the stethoscope body and the air tube connector, the air tube connector for attaching the stethoscope head to a standard stethoscope air tube assembly.

2. The electronic stethoscope head of claim 1, wherein the display module comprises a housing containing a electrical signal processor for receiving, processing and outputting view screen data, and a view screen for receiving and presenting the view screen data.

3. The display module of claim 2, wherein the stethoscope body is adapted as the housing containing the electric signal processor and the view screen.

4. The display module of claim 2, wherein the electric signal processor comprises a signal processing circuit and a power supply, the signal processing circuit operatively connected to the electrode leads to receive electrical signals from the electrodes, the signal processing circuit receiving electrical signals from the electrodes, processing the signals to produce view screen data and selectively communicating the view screen data to the view screen, and the power supply in operative communication with the signal processing circuit and the view screen to provide electrical power.

5. The electric signal processor of claim 4, wherein the power supply is a battery power supply.

6. The electric signal processor of claim 4, wherein the power supply is a rechargeable power supply.

* * * * *

专利名称(译)	有ECG显示器的听诊器		
公开(公告)号	US20010030077A1	公开(公告)日	2001-10-18
申请号	US09/758627	申请日	2001-01-10
[标]申请(专利权)人(译)	沃森RICHARD大号		
申请(专利权)人(译)	沃森RICHARD L.		
当前申请(专利权)人(译)	沃森RICHARD L.		
[标]发明人	WATSON RICHARD L		
发明人	WATSON, RICHARD L.		
IPC分类号	A61B5/00 A61B5/0408 A61B5/044 A61B7/04 A61B7/02		
CPC分类号	A61B5/04085 A61B5/044 A61B5/1455 A61B5/742 A61B7/04		
优先权	60/175355 2000-01-10 US		
外部链接	Espacenet USPTO		

摘要(译)

电子听诊器头与标准听诊器空气管耳机组件相结合，以提供用于听诊活体的个人便携式ECG听诊器系统。电子听诊器头包括具有胸钟的听诊器主体，空气管连接器（或多个连接器），以及安装在其上的显示模块。胸钟具有用于接触身体的边缘，以及适于附接到听诊器主体的基部。具有至少两个电极的电极组件设置在胸腔的边缘上，以在听诊期间接触身体并从身体接收电信号。电信号被传导到显示模块。显示模块安装在听诊器主体上，并接收和处理电信号，并在诸如LCD显示屏的视图屏幕上显示电信号的表示。空气通道设置在听诊器主体内，以在胸钟和空气管连接器之间提供气压连通。空气管连接器用于将电子听诊器头连接到标准听诊器空气管耳机组件。

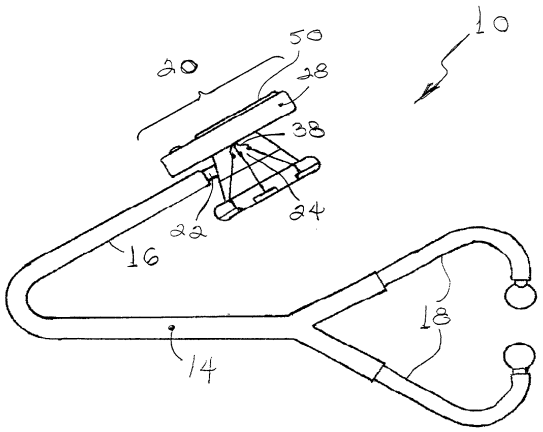

Fig. 1A