Feb. 1, 1966 M. E. CROSLIN 3,233,041

AUDIO CARDIOSCOPE

Filed July 25, 1962 2 Sheets-Sheet 1

FIG. 1

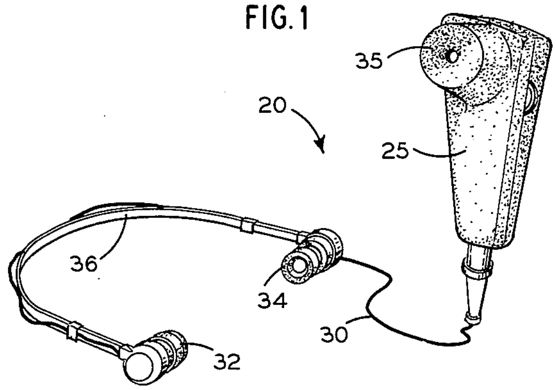

FIG. 2

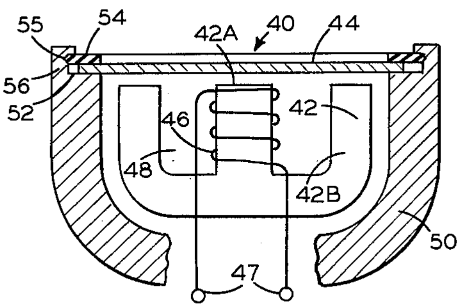

FIG. 3

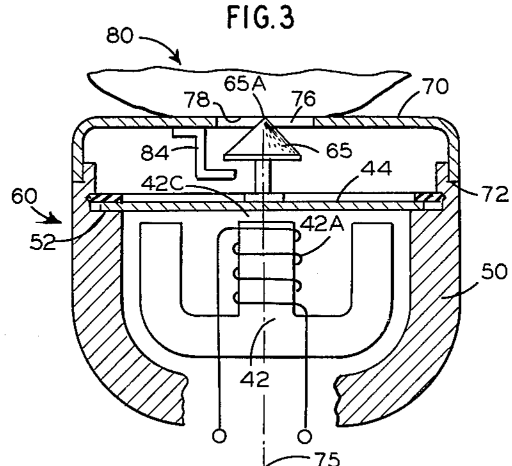

FIG. 3A

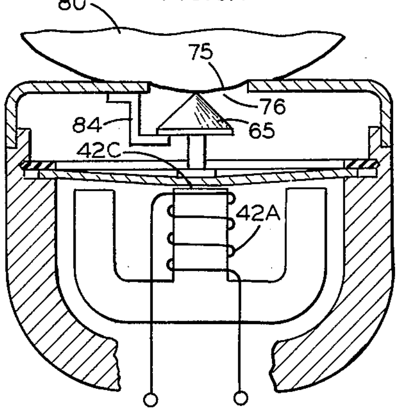

FIG. 4

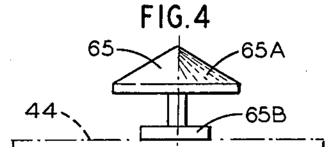

FIG. 5

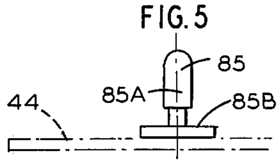

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FIG. 6

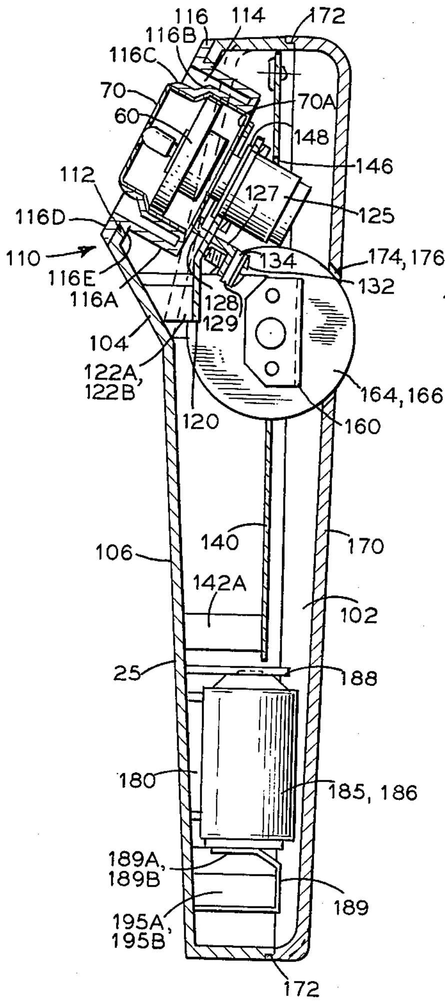


FIG. 7

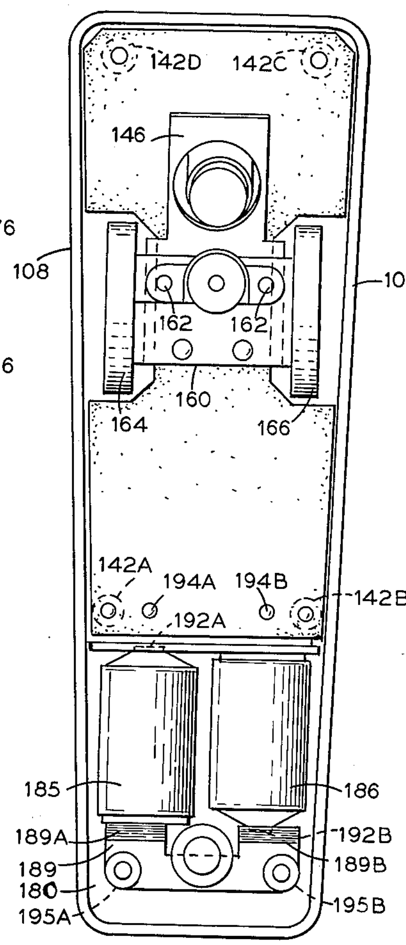
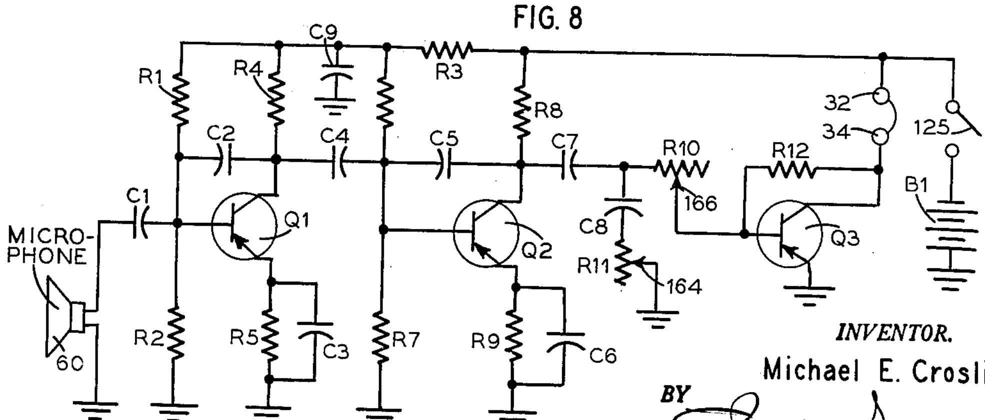


FIG. 8



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3,233,041
AUDIO CARDIOSCOPE

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Filed July 25, 1962, Ser. No. 212,334
6 Claims. (Cl. 179—1)

This invention relates to stethoscopes and particularly to electronic stethoscopes, or audio-cardioscopes, which utilize a microphone or sound-sensitive transducer for performing the auscultation or examination of the chest and back for internal sounds that characterize and record the condition of internal organs. By the use of such a sound-responsive transducer, a signal may be derived which may then be amplified for better hearing.

The primary object of the invention is to provide a stethoscope which will convert the internal body sounds into an electrical signal which may then be utilized to operate a suitable receiver to reproduce a sound corresponding substantially to the original sound as detected.

To be suitable for use in a stethoscope, the sound-responsive transducer, or microphone, should be substantially linear in its response to vibrations from a range of practically zero to an upper limit of about 800 cycles per second. The transducer should actually be able to detect frequencies as low as two cycles per second.

The transducer must be relatively light in weight since it must be handled and manipulated for positioning at different parts of the body with relative ease. The transducer and its housing must therefore be relatively light in weight. The transducer must therefore be relatively small, and one of the characteristics of the smaller transducer is that its range of operation tends to be in a higher frequency range. That is one of the problems that must therefore be overcome in utilizing and applying a microphone as an acousto-magnetic transducer in a stethoscope. Another problem that is encountered in small microphones utilizing the fixed core magnet and a voice coil with a sound-responsive vibratable armature that varies the reluctance of an air gap between the core and the armature, is that the armature which must be of relatively thin magnetic material will have a resonance characteristic that will peak somewhere within the operating range desired for the device in a stethoscope.

Another object of the invention and one of the important features thereof, is the provision of a modified transducer, in which the armature as the sound-responsive element, is appropriately mass-loaded so the resonance characteristic of such mass-loaded armature will be shifted to the region below two cycles per second, so that the response characteristic of the transducer will not be distorted by the resonance characteristic of the vibratable armature.

Another object of the invention is to provide a stethoscope with a transducer and related amplifier, which will be automatically placed in operating condition when the transducer is placed against a selected area of a human body being examined, and which will automatically disconnect and de-energize the circuitry of the transducer and the amplifier when the transducer is removed from the contact area of the human body, thereby preventing a needless drain on the battery supply utilized with the stethoscope of the present invention.

Another object of the invention is to provide a transducer in which the vibratable armature of the transducer is directly physically coupled to the human body under examination, so that sound vibrations from the human body are transmitted directly and physically to the vibratable armature, without any intervening air columns as is found in the present conventional air-type stethoscope.

A feature of the invention is the disposition of the

auxiliary mass loading on the vibratable armature in position where it may also be utilized as the coupling means for physically and sonically coupling the vibratable armature of the transducer to a small area of the human body adjacent the region of the body under examination.

A further object of the invention, and an important feature thereof, is the utilization of the auxiliary mass both as a coupling and as a positioning element for the vibratable armature, to place the vibratable armature in a more efficient operating position adjacent the polar elements of the core, in order to reduce the air gap between the core and the armature to a minimum dimension, thereby increasing the sensitivity and efficiency of the transducer.

A further feature of the invention is the disposition of the auxiliary mass on the vibratable armature in the form of a co-axial projection from the armature, formed symmetrically around the axis and shaped with its front end of relatively small area, either as a point or as a curved surface, to establish a minimum area of contact on the skin of the human body to which the transducer may be applied during examination.

Another object of the invention is to provide in the amplifying system for the transducer, means for varying the frequency response of the amplifier, in order to accentuate a certain range of frequencies, as a tone control device, and also to provide a simple means whereby the examining physician may also selectively vary the amplification of the amplifying system by a simple operation of a dial by his thumb on a simple rotary control knob available at the rear surface of the transducer housing alongside the handle.

As another feature of the invention, it has been found that the use of aluminum for the auxiliary mass and coupling element between the vibratable armature and the human body being examined has provided best results.

The general arrangement of the elements of the stethoscope, and the features of construction of the microphone and of the housing for supporting and manipulating the microphone transducer to position the transducer at any selected part of a human body are described in the following specification and shown in the accompanying drawings, in which

FIGURE 1 is a perspective view showing the various elements of the stethoscope in accordance with the present invention;

FIGURE 2 is a schematic sectional view of the microphone transducer, unmodified;

FIGURE 3 is a schematic view of the microphone of FIGURE 2 as modified in accordance with the principles of this invention to add an auxiliary mass to the vibrating armature or membrane of the microphone, showing the relative positions of the elements before the microphone is pressed against a human body;

FIGURE 3A is a view similar to FIGURE 3 showing how the skin of the human body engages the front end point of the auxiliary mass to press that auxiliary mass and the armature diaphragm or membrane towards the core to the limited extent permitted by a stop element;

FIGURE 4 is a side elevational view of one form of auxiliary mass shown in its co-axial application to the vibratable armature of the microphone;

FIGURE 5 is a modified form of the auxiliary mass shown in its application to the armature which may be in the form of a disc for the microphone;

FIGURE 6 is a side elevational view of the housing for the transducer and the amplifier components, with the side wall of the housing broken away to expose and show the various components within the housing;

FIGURE 7 is a rear elevational view of the housing unit of FIGURE 6 with the rear wall broken away to expose the components supported within said housing;

FIGURE 8 is a circuit diagram of the system.

As shown in FIGURE 1, a stethoscope 20, constructed in accordance with the principles of this invention, is shown as comprising a manually operable handle housing 25 containing a microphone for placement against a human body to be examined, and containing further the components of an amplifier system including batteries for amplifying an electrical signal generated at the microphone by sounds emanating from the human body. A cable of conductors 30 carries the amplified signal from the components within the housing 25 to the ear pieces shown as two receivers 32 and 34 supported on a suitable bail 36 to support the two receivers 32 and 34 in appropriate positions for insertion in the examining physician's ears.

The housing 25 is provided with an opening 35 adjacent its front upper end directly behind which is supported the microphone transducer by means of which the sounds within a human body are heard and caused to generate a signal voltage in a suitable voice coil for subsequent amplification and reconversion into sound signals at the two ear piece receivers 32 and 34. The lower end of the housing 25 is formed in appropriate shape and dimensions to serve as a handle for manipulating the housing 25 to press the upper end 35 to any portion of the human body at which the auscultation or listening operation is to be performed.

In FIGURE 2 is shown schematically the general basic construction of a microphone of the type utilized, designated at 40, and shown comprising a circular magnetic core 42, an armature 44, which for the present purposes consists of a circular diaphragm or disc, with a voice coil 46 disposed in the annular well 48 between the core center post 42A and the concentric annular ring portion 42B. The terminals of the voice coil 46 are represented at the terminal posts 47. The core 42 is supported and enclosed in a concentric housing 50 of non-magnetizable metal such as brass, to avoid any magnetic interference with the operation of the permanent magnet core 42B and the magnetizable disc 44. The brass housing 50 is provided with a suitable shoulder or ledge 52 to support the rim of the diaphragm disc or armature 44. The armature disc 44 is preferably relatively free at its outer circular edge and is held against displacement or falling out of its seat by a simple washer 54 of any suitable material that may be snapped into position in the groove 55 in the side wall 56 adjacent the ledge of the brass housing 54 of the microphone.

As was previously mentioned, the dimensions of the microphone should be relatively small, in order to present a minimum of weight together with all of the other components in the housing handle which must be manipulated by the physician with relative freedom.

For example in the microphone utilized in the present invention, the overall dimensions of the assembly as shown in FIG. 2, are 0.775 inch diameter of the housing bracket 50 and 0.240 inch depth of the housing 50.

In FIGURE 3 is shown schematically, the elements entering into the modified microphone 60 constructed in accordance with the principles of the present invention. In addition to the elements shown in the basic microphone assembly 40 in FIGURE 2, the modified microphone 60 of FIGURE 3 includes additionally an auxiliary mass 65 secured to the diaphragm 44 in a position where the mass projects co-axially from the center of the disc 44, in the manner shown. A positioning and pressure plate 70 is shown supported on the brass housing 50. For simplicity, the pressure plate 70 is shown resting on an outer ledge 72 concentric around the main axis 75 of the transducer 60.

The pressure plate 70 is provided with an opening 76 symmetrical about the axis 75. The co-axial dimension of the auxiliary mass 65 is such as to bring the front end point 65A of the mass into the opening 76 to a plane at

which the point 65A will be engaged and pressed backward by the surface 78 of the skin of the human body 80 against which the front pressure plate 70 of the microphone is pressed during the auscultation examination.

In the normal position of the diaphragm 44 of the microphone 60, the mass 65 is in raised or forward position, at which time the air gap 42C between the armature diaphragm disc 44 and the center core pole 42A is maximum. Under such free condition, the mass 65 in its forward position is also forwardly spaced from a limit stop element 84 which limits the backward movement of the mass 65 when pressed against the skin of the body 80, so the air gap 42C may be reduced to a minimum while assuring the existence of an air gap at 42C between the armature 44 and the polar element 42A. The limit stop 84 is shown for simplicity as mounted on the pressure plate 70, but may be equally well mounted on the top surface of the brass housing 50 as a support.

When the microphone of FIGURE 3 is pressed against the body 80 during examination, the surface of the skin at 78 will project into the opening 76 of the pressure plate 70 a small distance, as indicated in FIGURE 3A, sufficiently to accomplish the inward movement of the mass 65 to engage the limit stop 84 and to press the diaphragm 44 to closer spacing to the polar element 42A.

By way of example, when the diaphragm 44 is thus pressed to the pole 42A for operating condition, the air gap spacing between the diaphragm and the pole 42A is of the order of 0.002 to 0.005 inch. The limit stop 84 represents schematically one way of assuring such air gap spacing. Other procedures may be resorted to for assuring such air gap spacing, such as copper plating the end face of the polar element 42A so the center of the armature 44 may actually by physically placed against the polar element 42A and separated therefrom by the non-magnetic layer of copper or the like.

FIGURE 4 shows a side elevation of the auxiliary mass element 65 co-axially secured to and mounted on the armature diaphragm or disc 44 so the auxiliary mass 65 is essentially an integral part of the diaphragm. The dimension of the auxiliary mass 65 may be realized from the fact that the top button 65A is 0.700 inch in diameter and the base 65B is 0.280 inch in diameter.

In FIGURE 5 is shown another form of mass which has been successfully employed in the modified microphone of this invention. This second modification 85 of the mass element as shown in FIG. 5 has a total height of 0.250 inch, the same as the mass 65 in FIG. 4, and the base 85B is also of the same diameter as the base 65B, namely 0.280 inch. The tip 85A has a diameter of 0.120 inch, with the curvature at the front end on a radius of 0.060 inch. While the two auxiliary mass buttons 65 and 85 may be formed of any suitable sound-conducting material that will convey the sound waves from the human body being examined to the vibratable armature disc 44, the use of aluminum alloy 2024–T4 in the dimensions specified have provided excellent results. A second aluminum alloy 5052 H–34 has also exhibited excellent characteristics in connection with the magnetic diaphragm 44.

In each case the auxiliary mass 65 or 85 of FIG. 4 or FIG. 5 has served a double purpose. First the auxiliary mass has increased the effective mass of the assembly of the vibratable disc and the auxiliary mass button sufficiently to shift the resonance characteristic of the assembly of the vibratable disc and the auxiliary mass to a relatively low frequency value beyond the lower limit of the desired range of operation for the desired detection and observation of the sounds within the human body.

For example, in a microphone unit as shown in FIG. 2, with the dimensions previously specified the range of effective operation was between 30 cycles at the lower end of the range and 3,000 cycles at the upper end of the range. A resonance peak occurred at about 500 cycles per second, which was practically at the mid-point of the desired range of operation for an auscultation examination.

However, with the application of the auxiliary mass button **65** as shown in FIG. 3, the resonance region was actually shifted to a point below 2 cycles per second, thereby rendering the operation of the microphone when modified as in FIG. 3, substantially linear over the range desired for complete auscultation examination.

FIGURE 6 shows an internal side view of the microphone housing **25** which has an upper cavity **100** and a lower cavity **102**. The upper cavity **100** is provided with an outwardly inclined front wall **104** which blends into the bottom front wall **106** and two side walls **107** and **108** to define a hollow tapered boss **110** inclined at an obtuse angle to define and locate a front supporting flange **112** upon which the microphone transducer **60** may be suitably coaxially supported to enable the lower handle portion of the housing **25** to be easily manipulated to press the microphone assembly **60** against a human body while leaving the fingers of the hand free to move the housing unit and the microphone without frictionally engaging the body by the fingers of the hand.

The front flange **112** defines an opening **114** for supporting a rubber cup **116** that is cylindrical in shape and serves to support the microphone assembly in slightly projected position to permit the auxiliary mass button of the microphone to be engaged by the skin in the area of the human body against which the pressure plate **70** is pressed.

The cup **116** referred to as a rubber cup may be made of any other suitable material, such as, for example, Teflon, or vinyl plastics, which may be molded or shaped to provide a suitable support for the microphone with a characteristic that will be appropriate to damp any vibrations that might arise in or be transmitted through the housing **25**.

The rubber cup **116** for supporting the transducer assembly **60** is shown as consisting of an external cylinder **116A** and an internal re-entrant cylinder **116B** terminating in a front ring portion **116C** of reduced diameter for tightly gripping the side wall of the front pressure plate **70** of the microphone assembly **60**. The outer cylinder of the transducer cup **116** terminates in a front seating flange **116D** an a ring wedge **116E** which cooperates with the flange **116D** to grip the flange **112** which circles and defines the opening **114** through which the microphone assembly **60** projects for engagement with a body to be examined.

A bracket **120** is secured and anchored to two bosses **122A** and **122B** secured to or integrally formed on the inside of the housing **25**. The bracket **120** carries the microphone assembly **60** and a single-pole single-throw switch **125** co-axially disposed behind the microphone assembly **60**, so the slight pressure employed to press the transducer front pressure plate against a human body will be sufficient to operate the switch **125**. That switch may be of any conventional type that may be operated by a short axial movement of an operating pin, with appropriate leverage arm to multiply the short movement of the complete microphone assembly in its supporting rubber cup **116**.

As previously indicated in the description of FIGURE 3, a suitable stop element is provided for the auxiliary mass button **85** shown in this FIGURE 6, and further pressure movement of the entire microphone assembly **60** within its supporting cup then provides the additional movement necessary to operate the switch **125**.

The backward movement of the transducer assembly **60** to operate the switch **125** is also limited by a suitable stop pin so that the front pressure plate **70** will remain suitably engaged with the area of the body being examined without moving backwards sufficiently to enable the front surface of the flange **116** to engage the surface of the body.

The stop pin for limiting the backward movement of the microphone assembly **60** is shown by an auxiliary bracket **127** pivotally mounted on the main bracket **120** for the entire microphone and switch assembly. The auxiliary bracket **127** is pivotally supported on the main bracket **120** and is provided with a front fork **128** and a tail piece **129** which supports an adjustable threaded screw **132** that is held in position against casual displacement by means of a lock washer **134**.

The components that comprise the amplifier are mounted on a small component board or panel **140** which is secured at its four corners to four bosses **142A, 142B, 142C** and **142D** formed on the inner surface of the front wall of the housing **25**, as may be seen upon reference to FIGS. 6 and 7.

The component board **140** is provided with an opening or window **146** to leave an open space to accommodate the housing for the switch **125** at the rear of the microphone assembly **60**. This switch **125** is held in fixed position on the supporting bracket **120** by any suitable means indicated as a lock washer **148**, to hold the front end of the switch at its operating button spaced a short distance at the back of the microphone assembly, so the lost motion movement backward of the microphone assembly when pressed against a human body will be sufficient to operate the switch button to close the switch **125** against the conventional reaction spring which normally holds the switch in open position.

The backward motion of the microphone assembly **60** to operate the switch **125** is accomplished by means of the pivoted arm **128** previously referred to.

On the component board or panel **140** is also mounted a U-shaped bracket **160** which is suitably secured to and mounted on the component board **140** by a couple of screws **162**. The bracket **160** serves to support two control knobs **164** and **166** for two separate variable resistors of the amplifier circuit, which will be illustrated in FIGURE 8, to provide individual control of tone or frequency range and control of gain for the amplifying system.

As shown in FIGURE 6 the main housing and control handle **25** is provided with a rear cover **170** which nests on and fits over the rear peripheral rim edge of the front part of the housing **25** as indicated by the shoulder rim **172**. That rear cover **170** is provided with two openings **174** and **176** of which only one is shown in FIGURE 6, but which are appropriately disposed to permit the control knobs **164** and **166** to extend backward through those two openings **174** and **176** to be accessible for operation by the thumb of the operator conducting the auscultation.

The lower part of the housing and handle **25** is provided with a lower compartment **180** to receive two dry cell batteries **185** and **186** that are to supply power for the stethoscope.

The lower compartment **180** is separated from the upper compartment of the housing **25** by a wall **188**. At the lower part of the compartment **180** a flexible U-shaped contact **189** is provided having two seating contacts **189A** and **189B** against which the ends of the two respective batteries **185** and **186** may be seated to establish electrical contact. The opposite ends of the two batteries **185** and **186** engage corresponding contact elements **192A** and **192B** which are connected to fixed electrical terminals **194A** and **194B** shown in dotted outline behind the component board **140**. The U-shaped contact **189** is shown suitably supported on two bosses **195A** and **195B**.

As will now be understood, upon referring to FIGURE 3, FIGURE 3A and FIGURE 6, upon pressure of the front plate **70** of the microphone assembly **60** against the human body indicated at **80**, the first reaction will occur as in FIGURE 3A to cause the small area of the human skin **78** to enter the opening **76** to press the button **65** backward slightly to lower the armature or diaphragm **44** closer to its related core **42**.

Small additional pressure of the microphone assembly **60** against the body being examined, will then take up some of the resiliency of the rubber supporting cup **116** to enable the rear pressure plate **70A** to press against the fork **128** of the bracket **127** to the extent permitted by the adjustable back screw **134** in the tail piece of the bracket **127**, whereupon the pressure against the front bracket piece **128** will operate the switch **125** from its normal open position to closed position to close the circuit through the switch. The circuit through the switch will thus remain closed so long as the pressure is maintained by the examining operator on the microphone assembly **60** by pressure on the housing **25**.

The pressure required on the microphone assembly **60** to operate the switch **125** will be very little, and particularly less than will move the front face of the pressure plate **70** backward sufficiently to permit the front face of the flange **116D** to reach and engage the surface of the human body being tested.

The pressure required to operate the microphone for operation of the stethoscope to close the switch **125** which then connects the amplifier into circuit with the microphone will be sufficiently small so that it may be readily accomplished by the examining physician without any stress that would be distractive.

At the same time, the tone control and the gain control knobs **164** and **166** may be readily operated by the thumb of the examining physician so that he may adjust the amplifier to adjust its sensitivity in the frequency range and in the gain in order to enable the examining physician to obtain optimum conditions for aural observation of the signal representative of the sound for which he is listening.

In FIGURE 8 is shown a simple diagram of the amplifier. The power microphone **60** when operated by the external sound generates the signal which is then supplied through a coupling capacitor C–**1** to the input or base circuit of a first transistor Q–**1**. Bias voltage for the base emitter circuit is derived from a voltage divider including two resistors R–**1** and R–**2** energized through a load-limiting resistor R–**3** from the battery B–**1** corresponding to the two cells **185** and **186** shown in FIGURES 6 and 7.

Transistor Q–**1** is also provided with collector resistor R–**4** and an emitter resistor R–**5** provided with a by-pass capacitor C–**3**. A capacitor C–**2** is connected between the base and the collector electrodes of Q–**1**. A coupling capacitor C–**4** couples the Q–**1** collector to the base of a second transistor Q–**2**. The bias for the base emitter circuit of Q–**2** is provided by a voltage divider including two resistors R–**6** and R–**7**, with the base of Q–**2** connected to the juncture point between those two resistors. A small capacitor C–**5** is disposed between the base terminal and the collector terminal of Q–**2**, for isolation purposes. The transistor Q–**2** is provided with a collector resistor R–**8** and an emitter resistor R–**9**, which latter is provided with a by-pass capacitor C–**6**.

The collector terminal of the transistor Q–**2** is coupled to the input or base terminal of a third transistor Q–**3** through a coupling capacitor C–**7** and a variable resistor or poteniometer R–**10** which is to serve as a volume control, and is controlled by the gain control knob of FIGURES 6 and 7.

A tone control circuit is provided including a capacitor C–**8** and a variable resistor potentiometer R–**11** connected as shown to the output of the coupling capacitor C–**7**. That tone control resistor R–**11** is controlled by the knob **164** shown in FIGURES 6 and 7.

The output of the transistor Q–**3** from its collector terminal is fed into a pair of headphone receivers corresponding to receivers **32** and **34** of FIGURE 1. A resistor R–**12** provides bias voltage for the transistor Q–**3** through the headphones **32** and **34**.

The switch shown connecting the battery B–**1** to the power buss line for the amplifier system corresponds to the switch **125** shown in FIGURE 6.

Since transistors are utilized in the amplifier system, instantaneous operation of the system is available upon closure of the switch **125**. In this case, since vacuum tubes are not employed, no heating up time is required for the filaments, and the switch **125** may be utilized so that the stethoscope is in operation automatically only when the microphone is pressed against a human body sufficiently to close the switch. Upon removal of the microphone from one area of a body to be placed against a subsequent area of the body the switch automatically opens and disconnects the battery from the various resistors which would otherwise cause an unnecessary drain on those batteries. The automatic feature of connecting the battery to the microphone and the amplifier is one of the important features of this invention.

The large capacitor C–**9** is provided as a by-pass to keep the alternating current signals out of the battery to further assure its long life.

The values of the resistors and of the capacitors and the identification of the transistors that have been employed in a system, embodying the invention, as shown, are as follows:

R 1	22 K. ohms	C–1	10. mfd.
R 2	3.9 K	C–2	0.02.
R 3	1.5 K	C–3	100.
R 4	10. K	C–4	10.
R 5	2.7 K	C–5	0.01.
R 6	39. K	C–6	100.
R 7	10. K	C–7	10.
R 8	8.2 K	C–8	2.
R 9	2.7 K	C–9	100.
R 10	25. K		
R 11	25. K	B–1	10.4 volts.
R 12	100. K		

The invention thus described provides a simple electrically operated stethoscope in which particularly a very small light weight microphone has been modified to prevent the occurrence of any resonance conditions in the microphone within the range of frequencies to be covered in an auscultation examination of a human body.

Obviously, the microphone as modified herein to shift the natural or resonance frequency of a microphone diaphragm to a region beyond the range under examination, provides a feature that may be advantageously utilized in many other applications where vibration problems or frequency problems are to be studied.

The invention therefore is not limited in any way merely to the application illustrated nor to the specific details of construction that are shown merely by way of example, since it is clear that the invention may be varied and modified in various ways without departing from the spirit and scope of the invention as set forth in the appended claims.

What is claimed is:

1. An audio cardioscope or electronic stethoscope, comprising
   an electromagnetic microphone transducer to be placed against a human body being examined, said transducer including
      a magnetic core,
      a vibratable armature,
      and a coil on the core to develop an output voltage in response to vibration of the armature;
   an amplifier to be energized by the output voltage from said transducer and serving to develop an amplified output signal related to the frequency of the output voltage from the transducer;
   a head-phone receiver to be energized by the amplified output signal from said amplifier;
   and means supported on and associated with said vibratable armature of said transducer for physically coupling the mass of the human body to said armature during auscultation of said human body, said means including a button of sound conducting material supported co-axially on said vibratable armature

and shaped to have a front end of relatively point form for engaging such human body, and further including a pressure plate having a bore co-axial with the point of said button to limit the amount of protrusion of the engaged skin axially against said button, and further including means for limiting inward axial movement of said button to maintain at least a minimum air gap between said armature and the core.

2. An electronic stethoscope, as in claim 1, in which said coupling means between the transducer armature and the human body consists of a mass element secured to the armature at a central area of symmetry closely adjacent the mass center of the armature and shaped to expose a projecting front end of minimal area for engaging a point on the human body to be examined by auscultation, whereby a limited amount of the skin where engaged will protrude into the opening and press the mass element to shift the armature center towards the core to define a smaller initial air gap.

3. An electronic stethoscope, as in claim 2, including, additionally,

a stop element to limit the shifting movement of the armature towards the core and to hold the armature center at such fixed limit stop point whereby the human body serves to hold the center region of the armature at fixed spacing of the air gap.

4. An electronic stethoscope comprising

a microphone to be applied to the surface of a human body to be examined, and including means for generating a signal according to a sound affecting the microphone;

a signal amplifier to amplify the signal from the microphone;

sound reproducing means to be energized by the signal from the amplifier;

and electrical switch means for controlling the energization of the amplifier, said electrical switch means being operable to closed position by the pressure of applying the microphone to the surface of the body being examined, and said electrical switch being normally returnable to open position by release of said applying pressure.

5. An electronic stethoscope as in claim 4, including a supporting cup of rubbery material for supporting the microphone and for providing a small amount of lost motion for the microphone as the microphone is pressed against a human body for auscultation, said lost motion being sufficient to operate said switch means.

6. An electronic stethoscope, as in claim 5, in which said supporting cup consists of a first cylinder anchored to a structure and a second cylinder reentrant to said first cylinder and supporting the microphone, said double cylinder construction of rubbery material having sufficient resiliency to provide the necessary lost motion to effect the switch operation.

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