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(19) **United States**(12) **Patent Application Publication**
Rajesh(10) **Pub. No.: US 2016/0106318 A1**(43) **Pub. Date: Apr. 21, 2016**(54) **NON-INVASIVE DIAGNOSTIC DEVICE
BASED ON AUDIOMETRIC ANALYSIS***A61B 7/00* (2006.01)*A61B 5/08* (2006.01)*A61B 5/02* (2006.01)(71) Applicant: **Palani Rajesh**, Tamil Nadu (IN)(52) **U.S. Cl.**CPC *A61B 5/0051* (2013.01); *A61B 5/08*(2013.01); *A61B 5/02* (2013.01); *A61B 7/003*(2013.01); *A61B 7/04* (2013.01); *A61B 5/0022*(2013.01); *A61B 5/742* (2013.01); *A61B**5/4306* (2013.01); *A61B 5/4244* (2013.01);*A61B 5/7282* (2013.01)(22) PCT Filed: **May 5, 2014**(86) PCT No.: **PCT/IN2014/000301**

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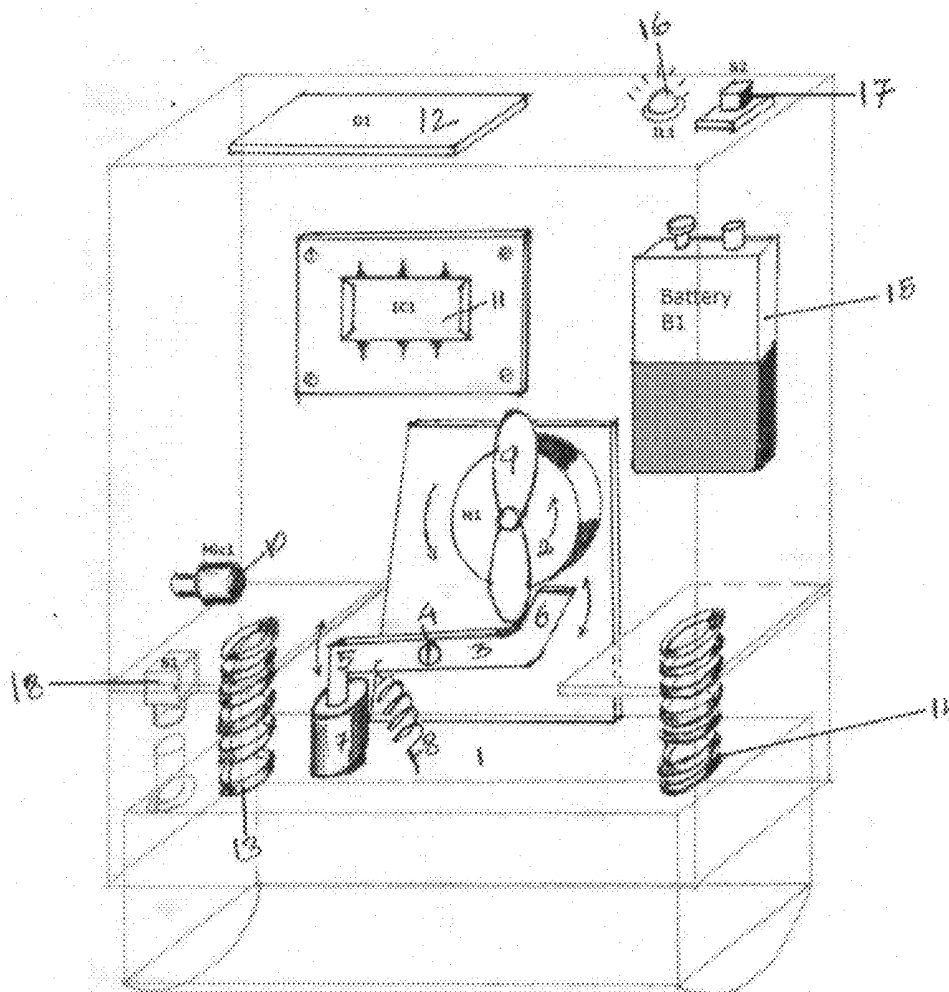
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ABSTRACT(30) **Foreign Application Priority Data**

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The handheld device is useful in the diagnosis of diseases and medical conditions based on audiometric analysis of resonated sound. This device has a mechanism to create a sound with the particular characteristics, a mechanism to transmit the sound into the human body at the given anatomical surface area, a system to pick up or receive the resonated sound, an audiometric analyser and a display to display the results based on the audiometric analysis of resonated sound.



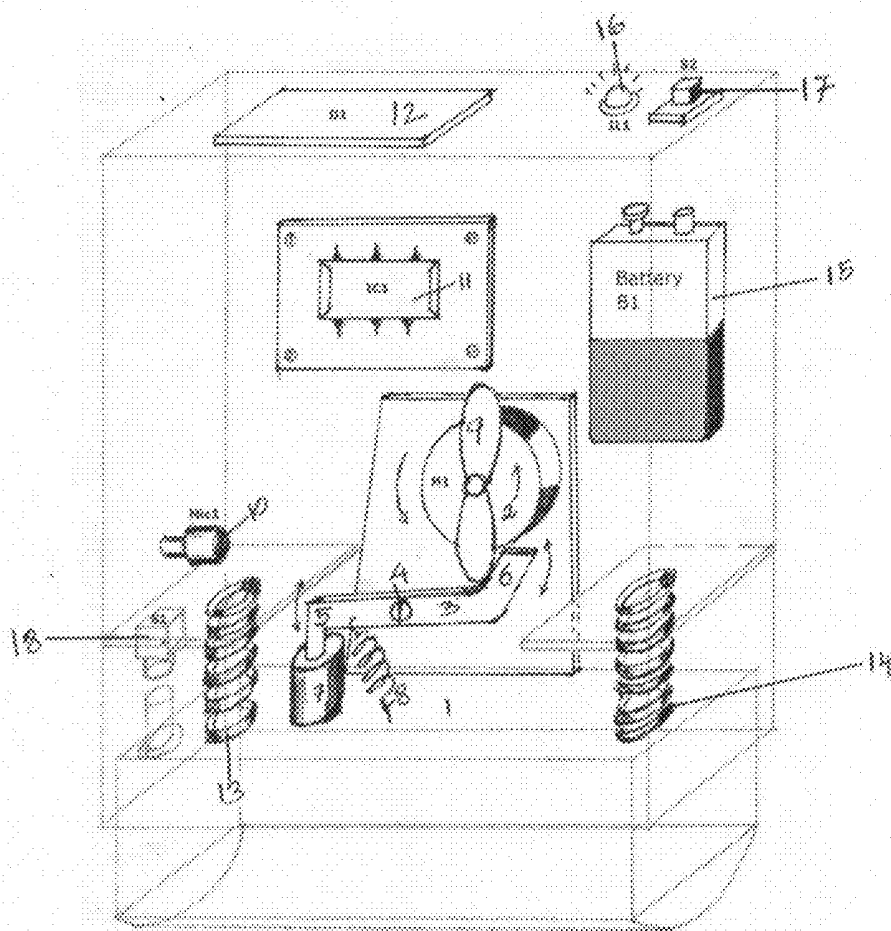


Figure – 1

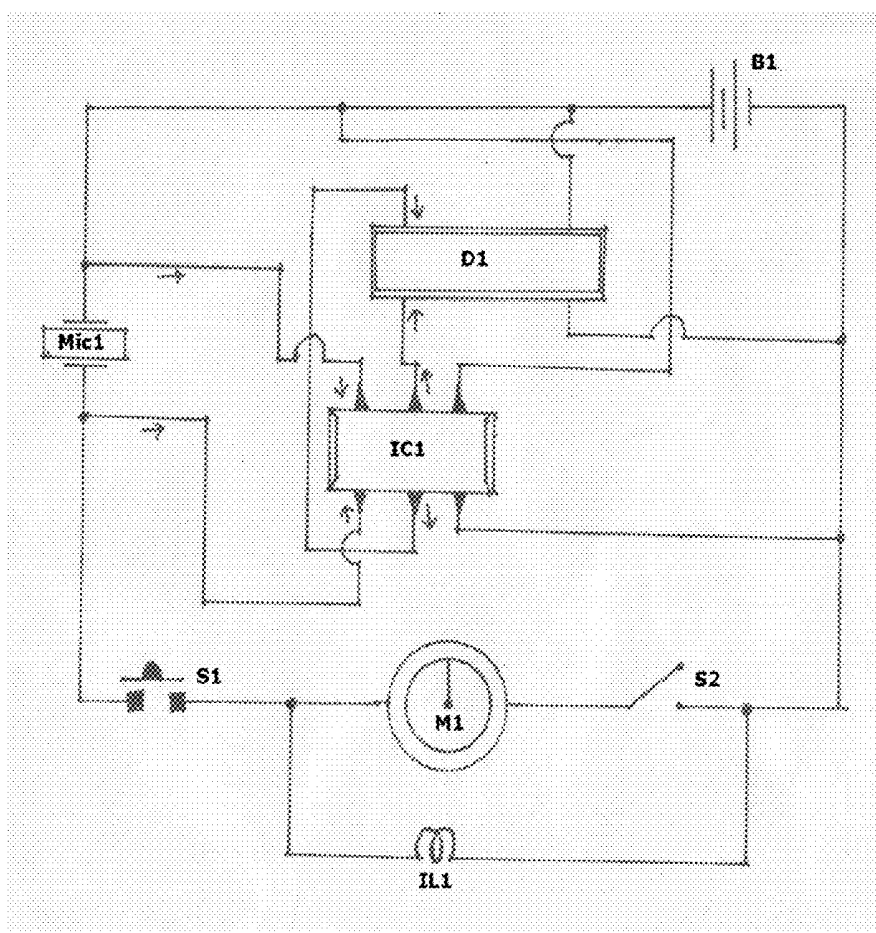


Figure – 2

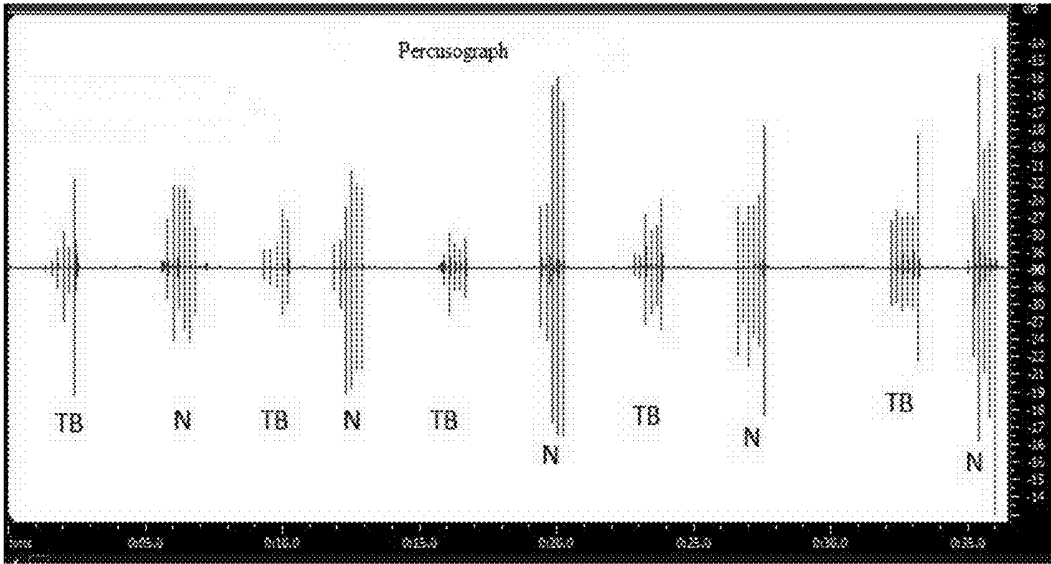


Figure – 3

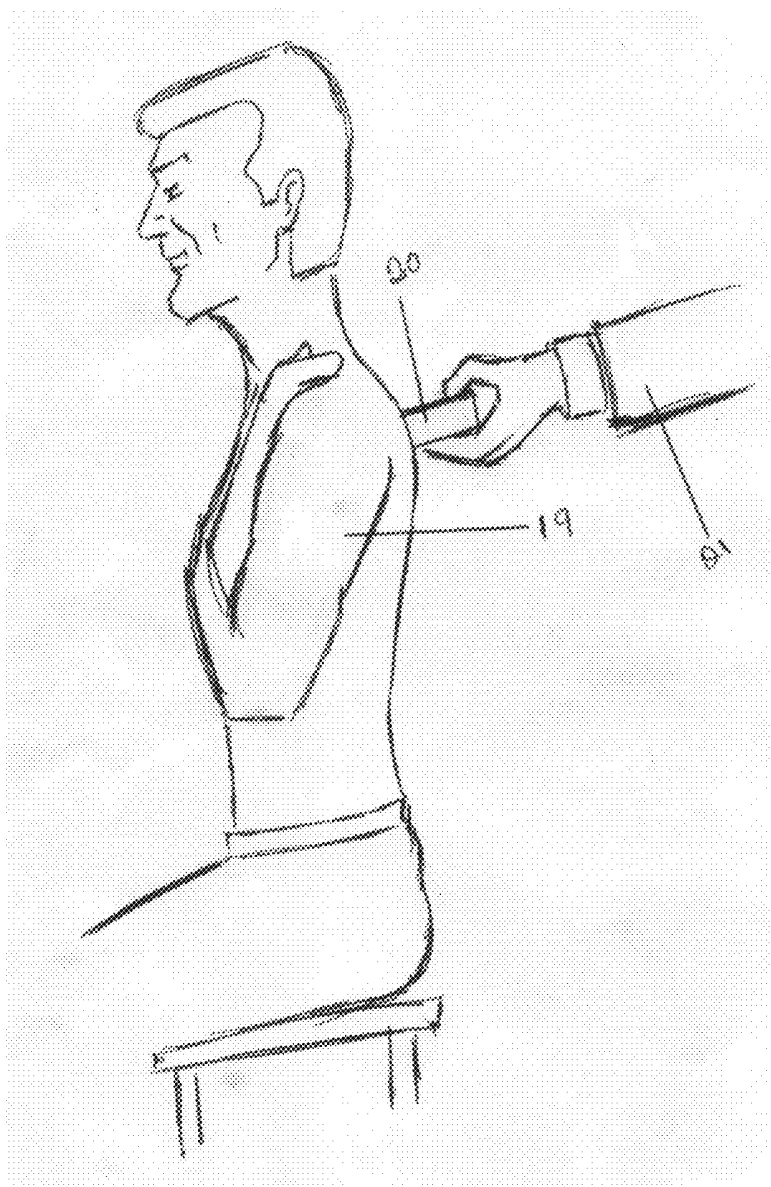


Figure – 4

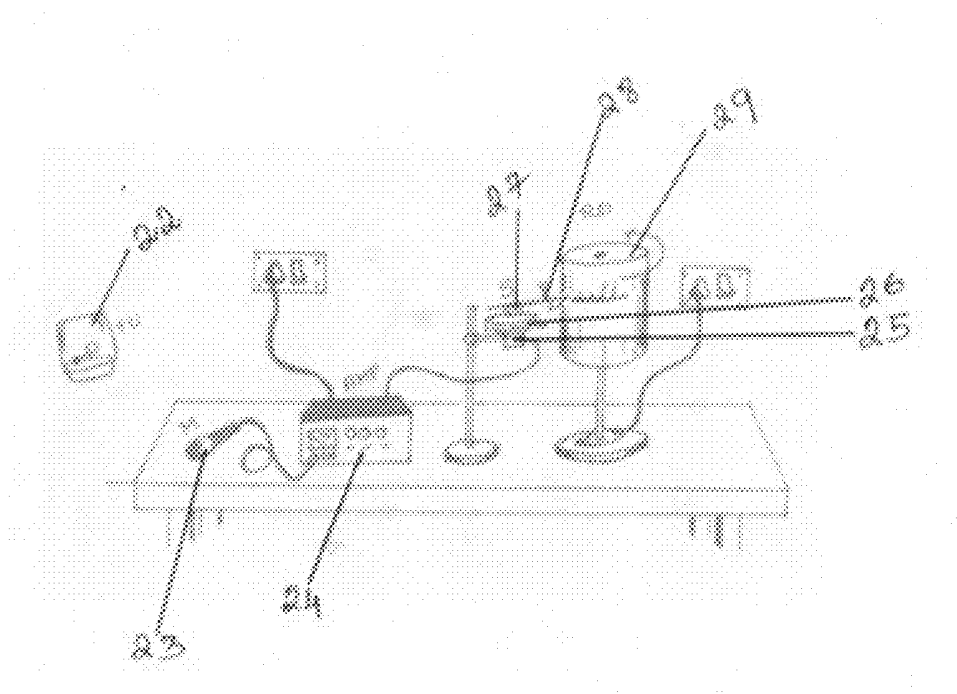


Figure – 5

S. No	TB (Units in dB)	Normal (Units in dB)
1	-28	-20
2	-28	-20
3	-29	-16
4	-28	-20
5	-27	-19

Table – 1

NON-INVASIVE DIAGNOSTIC DEVICE BASED ON AUDIOMETRIC ANALYSIS

TECHNICAL FIELD

[0001] When a sound is transmitted into the human body, the resonated sound depends on the underlying medical condition. The following specification describes the invention of a hand held device that will help in the diagnosis of all the possible medical conditions and diseases based on the audiometric analysis of resonated sound upon transmitting a standardized sound with the particular characteristics into the human body. Further, this specification describes the invention of a hand held device that will help in diagnosis and epidemic screening of respiratory diseases including tuberculosis in Human Beings. The invention is also further related to creating and transmitting the standard percussion sounds on the specified area of human body, and differentiating the subjects with pulmonary tuberculosis of both sputum positive and sputum negative from the normal subjects based on the analysis of audiometric variations of resonated sounds. However for the audiometric analysis, ultrasound is not considered in this invention but uses the audible sound that can be resonated and picked up using a microphone and/ or a diaphragm that can be placed firmly on the surface of the human body for audiometric analysis.

BACKGROUND OF THE INVENTION

[0002] When a sound is transmitted into the human body, the resonated sound depends on the underlying medical condition. There are many medical conditions and diseases that can be diagnosed based on the audiometric analysis of the resonated sound. One such disease is tuberculosis which is explained here.

[0003] Tuberculosis is a deadly, chronic, infectious disease which is generally caused by *Mycobacterium tuberculosis*. It is also the leading cause of death in patients infected with HIV. It is a bigger problem in many developing countries, with about 9.5 million new cases and 3 million deaths each year. India has the highest burden of this disease with about 2 million new cases a year.

[0004] Presently tuberculosis is diagnosed based on examination of sputum sample under the microscope, or by culturing the sample. A chest x ray may also help in the diagnosis. Recently Gene Xpert technique is used to diagnose this deadly disease. However, the microscope exam is not 100% reliable; sputum culturing is time consuming and takes weeks to get the result. Although Gene Xpert is capable of producing the results in minutes, it is very expensive and not commonly available. Also the above mentioned diagnostic tools do not come handy as a hand held device.

[0005] Also in the developing countries there is a need for the cost effective, improved, quicker, handy diagnostic and screening tool that will help in the diagnosis and epidemic screening of tuberculosis. The proposed invention fulfils this need and further provides related advantages.

[0006] Although percussion technique for some diseases is manually performed by some clinicians as a part of the clinical examination, it has its own limitations mainly due to limited human abilities and skills. This invention overcomes these limitations and also includes all other possible medical conditions and diseases that can be diagnosed based on the accurate audiometric analysis of resonated sounds.

[0007] Although in some diagnostic devices ultrasound is used, this invention does not use ultrasound.

OBJECTS OF THE INVENTION

[0008] An object of this invention is to propose a handheld device that will help in the diagnosis of diseases and medical conditions based on audiometric analysis of resonated sound

[0009] A further object of this invention is to propose a diagnostic handheld device that will help in the diagnosis and/ or epidemic screening respiratory diseases including pulmonary tuberculosis.

[0010] Also the further object of this invention is to propose a diagnostic handheld device which is economical and easy to handle.

[0011] A still further object of this invention is to propose a diagnostic handheld device based on the analysis of audiometric variations of different resonance sounds obtained from normal subjects and subjects with pulmonary tuberculosis of both sputum positive and sputum negative and related conditions like pneumonia.

[0012] Another object of this invention is to propose a diagnostic handheld device which can be used in epidemic screening of tuberculosis.

[0013] Still another object of this invention is to propose a diagnostic handheld device which helps in fast detection of tuberculosis.

[0014] Yet in another object of this device is to propose a diagnostic device which is non-invasive.

[0015] Yet another object of this invention is to propose the modified version of this device (hereafter called Percusogram) that is capable of analysing the percussion sounds and creating the audiometric graphs (hereafter called Percusograph) of the percussion sounds and also be able to print these graphs that will help in the diagnosis of tuberculosis and related conditions like pneumonia.

[0016] Yet still another object of this invention is to propose a diagnostic device which can be used in telemedicine using communication system.

SUMMARY OF INVENTION

[0017] This invention has five aspects:

[0018] 1. A mechanism to create sound with the particular characteristics.

[0019] 2. A mechanism to transmit the sound into the human body at the given anatomical surface area., example: At the right 5th inter-costal space on mid clavicular line.

[0020] 3. A system to pick up or receive the resonated sound.

[0021] 4. Software to do audiometric analysis.

[0022] 5. A display to display the results based on the audiometric analysis of resonated sound.

[0023] In the first aspect of the invention there is a mechanism to create a sound of the particular characteristics

[0024] In one form of this invention there is a mechanism to create the percussion sounds of the particular characteristics

[0025] In another form of this invention a mechanism to produce the percussion sounds can be done using an electric motor and a tapping lever with a hammer as shown in FIG. 1. In this embodiment, this figure also shows the mechanism to transmit the sound into the human body at the given surface, a mechanism to pick up or receive the resonated sound using

a microphone, an audiometric analyser and a display to display the results based on the audiometric analysis of resonated sound.

[0026] Yet in another form of this invention, the mechanism to produce the percussion sounds can be done using the torsion spring to store the energy reserve that turns the gears which moves the lever with hammer. This torsion spring can be manually powered.

[0027] Yet in another form of this invention the mechanism to produce the percussion sounds can be done using an hollow induction coil and an iron rod fitted with the hammer that moves inside the hollow induction coil up and down, and strikes the base to create a sound when the electric current is passed into the induction coil intermittently.

[0028] Yet in another form of this invention the mechanism to produce the percussion sounds can be done using an hollow induction coil and an iron rod which acts as a shaft, fitted with the hammer moves inside the hollow induction coil up and down, and strikes the base to create a sound when the electric current is passed into the induction coil intermittently.

[0029] Yet in another form of this invention the sound producing mechanism uses vibrator to produce sound.

[0030] Yet in another form of this invention the mechanism to produce the percussion sounds can be done using a spring system with the lever fitted with the hammer along with locking and releasing system to create sound.

[0031] Yet in another form of this device, a diaphragm can be placed firmly on the given surface of the body to pick up the resonated sound and vibrations whose signals are amplified for audiometric analysis.

[0032] Yet in another form of this device, it uses dedicated software to diagnose cardiovascular diseases.

[0033] Yet in another form of this device, it uses dedicated software to use in Oncology practice.

[0034] Yet in another form of this device, it uses dedicated software to diagnose Hepatic diseases and conditions.

[0035] Yet in another form of this device, it uses dedicated software to use in Obstetrics and Gynaecology practice.

[0036] Yet in form of this device, it uses dedicated software to diagnose abdominal diseases and conditions.

[0037] Yet in another form of this device, a telecommunication system is included with this device to transmit the data which can be used in telemedicine and epidemiology.

[0038] Yet in another form of this invention this device can function as described in the above embodiments as a standalone or in combination with each other.

BRIEF DESCRIPTIONS OF DRAWING

[0039] FIG. 1 shows the mechanism of the device with its different components.

[0040] FIG. 2 is the circuit diagram showing different components of this device.

[0041] FIG. 3 is an audiometric graph of percussion sounds (Percusograph) obtained in a subject with right pulmonary tuberculosis

[0042] FIG. 4 shows the application of this device on a subject by a doctor/technician.

[0043] FIG. 5 shows the basic form of this invention

[0044] Table 1 shows the audiometric variations of percussion sounds recorded from a normal left lung (control) and a right lung (test) with tuberculosis in a subject with pulmonary tuberculosis.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0045] In the first aspect of the invention there is a mechanism to create a sound of the particular characteristics

[0046] In some embodiment of this invention there is a mechanism to create the percussion sounds of the particular characteristics

[0047] In one of the embodiments of this invention a mechanism to produce the percussion sounds can be done using an electric motor and a tapping lever with a hammer as shown in FIG. 1. In this embodiment, this figure also shows the mechanism to transmit the sound into the human body from the given surface, a mechanism to pick up or receive the resonated sound using a microphone, an audiometric analyser and a display to display the results based on the audiometric analysis of resonated sound.

[0048] In another embodiment of this invention, the mechanism to produce the percussion sounds can be done using the torsion spring to store the energy reserve that turns the gears which moves the lever with hammer. This torsion spring can be manually powered.

[0049] Yet in another embodiment of this invention the mechanism to produce the percussion sounds can be done using an hollow induction coil and an iron rod which acts as a shaft, fitted with the hammer moves inside the hollow induction coil up and down, and strikes the base to create a sound when the electric current is passed into the induction coil intermittently.

[0050] Yet in another embodiment of this invention the mechanism to produce the vibrating sounds with the particular characteristics can be done using an hollow induction coil and an iron rod fitted with the hammer that moves inside the hollow induction coil up and down, and strikes the base to create a sound when the electric current is passed into the induction coil continuously.

[0051] Yet in another embodiment of this invention the sound producing mechanism uses vibrator to produce sound.

[0052] Yet in another embodiment of this invention the mechanism to produce the percussion sounds can be done using a spring system with the lever fitted with the hammer along with locking and releasing system to create sound.

[0053] Yet in another embodiment of this device, a diaphragm can be placed firmly on the given surface of the body to pick up the resonated sound and vibrations whose signals are amplified for audiometric analysis.

[0054] Yet in another preferred embodiment of this device, a telecommunication system is included with this device to transmit the data which can be used in telemedicine and epidemiology.

[0055] Yet in another preferred embodiment of this device, it uses dedicated software to diagnose cardiovascular diseases.

[0056] Yet in another preferred embodiment of this device, it uses dedicated software to use in Oncology practice.

[0057] Yet in another preferred embodiment of this device, it uses dedicated software to diagnose Hepatic diseases and conditions.

[0058] Yet in another preferred embodiment of this device, it uses dedicated software to use in Obstetrics and Gynaecology practice.

[0059] Yet in another preferred embodiment of this device, it uses dedicated software to diagnose abdominal diseases and conditions.

[0060] Yet in another embodiment of this invention this device can function as described in the above embodiments as a standalone or in combination with each other.

[0061] One of the preferred embodiments is described in FIG. 1 using the electrical motor

[0062] FIG. 1 shows the arrangements of different components and the mechanism of the device. It has got the planar sliding base 1 which substitutes the finger in a manual percussion technique which is pressed firmly on the body of the subject. Upon Base 1, Motor 2 (M1) and the Lever 3 is mounted with the pulley 4 in the middle. Base 1 got two surfaces; inner and outer surface, Lever 3 got two ends; end 5 and end 6. These two ends 5 and 6 move up and down like a see saw. At end 5, a hammer 7 which substitutes the tapping finger in manual percussion technique is fitted. Motor 2 is fitted with the twin blade 9 that pushes down the end 6 of the lever 3. While the end 6 is pushed down, it pushes the other end 5 of the lever upwards against the tension of the spring 8. Once the rotating blade releases the end 6 of the lever, hammer 7 strikes the inner surface base 1 creating the percussion sound which is transmitted through the body of the subject when the device is pressed on the body of the subject in such a way the outer surface of base 1 comes in contact with the skin. The force with which the hammer 7 taps on the base 1 depends on the tension of the Spring 8. Resonated percussion sound signals are sent by the Microphone 10 (Midi) which is mounted near the hammer 7 to the Processor 11 (IC1). Processor 11 is programmed in a way to analyse the audiometric variations of these sound signals and sends the output to display 12 (D1). Sliding planar base 1 slides up and down to a limited distance against the tension of the springs 13 and 14. This spring system 13, 14 determines the adequate force given over the device when pressed on the skin of the subject at the predefined anatomical locations like supra-clavicular, clavicular, infra-clavicular, intercostals spaces, supra-scapular, scapular, infra-scapular, auxiliary regions of the body. This spring arrangement 13, 14 together with the predefined material of hammer 7, base 1 and tension of spring 8 help in creating the standard percussion sounds which will vary depending on the disease conditions. Indicator green light 16 gets illuminated when press switch 18 is activated by applying adequate force while pressing the device on the body of the subject against the spring system 13, 14. Switch 17 is used to activate the Motor 2. This device also has a battery 15 for power supply

[0063] FIG. 2 is a circuit diagram of the proposed handheld device. Motor M1 is inhibited by S1 press switch and S2 switch. S1 press switch is activated when the adequate force is applied over the device while pressing upon the body of the subject at predefined anatomical locations. One the S1 press switch is activated indicator green light (IL1) gets illuminated after which by enabling the S2 switch motor M1 is activated. The circuit has a processor IC1 which receives the signals from Mic 1. The function of this processor is to record, analyse the audiometric variations of different percussion sounds produced in subjects thereby differentiating subjects with pulmonary tuberculosis and other related conditions like pneumonia and send output signals to the display D1 which displays the results. The considerations of audiometric variations may include pitch, loudness, quality, frequency and other measurable qualities of sound. This circuit also has a battery B1 for power supply.

[0064] In another form of using this technology, FIG. 3 shows the Computerised Percusograph (audiometric graph of

percussion sounds obtained by analysing in computer) of percussion sounds produced in the subject with pulmonary tuberculosis on his right lung. TB is the waves produced by the percussion sounds through resonance of right lung with tuberculosis and N is the waves produced by the percussion sounds through resonance of normal left lung. The difference in terms of the decibels in two different set of waves TB and N of this graph should be noted. The proposed term for this form of technology is Percusography, the proposed term for the graph obtained in this method is Percusograph and the term for the proposed dedicated electronic equipment is Percusogram.

[0065] FIG. 4 shows the application of this device 20 on a subject 19 sitting in an up-right position by a doctor/technician 21.

[0066] FIG. 5 shows the basic form of recording the audiometric graphs (Percusographs) of percussion sounds. Percussion sounds from the basic tapping unit 22 (which is a handheld device without processor and display but capable of producing standard percussion sounds) are recorded and amplified by an amplifier 24 through a microphone 23 and sent to speaker 25 which is mounted on a stand. There is sheet of latex 26 covered over the speaker such that it vibrates depending on the sound produced by the speaker. These vibrations are recorded on the moving graph like smoke drum 29 by a pointer 28 which is fitted to a cork 2 and mounted on the latex sheet 26 covering, the speaker 25.

[0067] Table 1 shows audiometric variations of resonated sounds produced by the normal left lung (N) VS the resonated sounds produced by the right lung with tuberculosis (TB) in a patient with tuberculosis. These sounds were recorded with consent through manual percussion technique as a part of clinical examination from a 60 year old tuberculosis patient as diagnosed by clinical presentation, sputum analysis and x-rays. Recorded percussion sounds are analysed in an audiometric analyser.

I claim:

1. The non-invasive device to diagnose all possible diseases and medical conditions based on audiometric analysis of resonated sounds.

2. The non-invasive device to diagnose all possible diseases and medical conditions based on audiometric analysis of resonated sound that comprises:

- i. A mechanism to create sound with the particular characteristics.
- ii. A mechanism to transmit the sound into the human body at the given anatomical surface area.
- iii. A system to pick up or receive the resonated sound.
- iv. A software to do audiometric analysis of the resonance sounds.
- v. A display to display the results based on the audiometric analysis of resonated sound.

3. The non-invasive device as claimed in claim 2, further comprising the telecommunication system that can be used in telemedicine and screening of diseases.

4. The non-invasive device as claimed in claim 2, further comprising a dedicated software to diagnose respiratory diseases.

5. The non-invasive device as claimed in claim 2, further comprising a dedicated software to diagnose and to screen for tuberculosis disease in human beings.

6. The non-invasive device as claimed in claim 2, further comprising a dedicated software to diagnose cardiovascular diseases.

7. The non-invasive device as claimed in claim 2, further comprising a dedicated software to use in Oncology practice.

8. The non-invasive device as claimed in claim 2, further comprising a dedicated software to diagnose Hepatic diseases and conditions.

9. The non-invasive device as claimed in claim 2, further comprising a dedicated software to use in Obstetrics and Gynaecology practice.

10. The non-invasive device as claimed in claim 2, further comprising a dedicated software to diagnose abdominal diseases and conditions.

11. All the different types of dedicated hardware's, technology and software's that can be created for the non-invasive device as claimed in claim 2.

12. The non-invasive device that can function as standalone or in combination as claimed from claim 1 to claim 10.

* * * * *

专利名称(译)	基于听力测定分析的非侵入式诊断设备		
公开(公告)号	US20160106318A1	公开(公告)日	2016-04-21
申请号	US14/786989	申请日	2014-05-05
[标]申请(专利权)人(译)	拉杰什帕拉尼		
申请(专利权)人(译)	拉杰什，帕拉尼		
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发明人	RAJESH, PALANI		
IPC分类号	A61B5/00 A61B7/04 A61B7/00 A61B5/08 A61B5/02		
CPC分类号	A61B5/0051 A61B5/08 A61B5/02 A61B7/003 A61B5/7282 A61B5/0022 A61B5/742 A61B5/4306 A61B5/4244 A61B7/04 A61B9/00		
优先权	2038CHE2013 2013-05-07 IN		
其他公开文献	US9962088		
外部链接	Espacenet USPTO		

摘要(译)

该手持设备可用于基于共振声音的听力分析来诊断疾病和医疗状况。该装置具有产生具有特定特征的声音的机制，在给了解剖表面区域将声音传送到人体的机构，用于拾取或接收共振声音的系统，听力分析器和显示器以显示结果基于共振声的听力分析。

