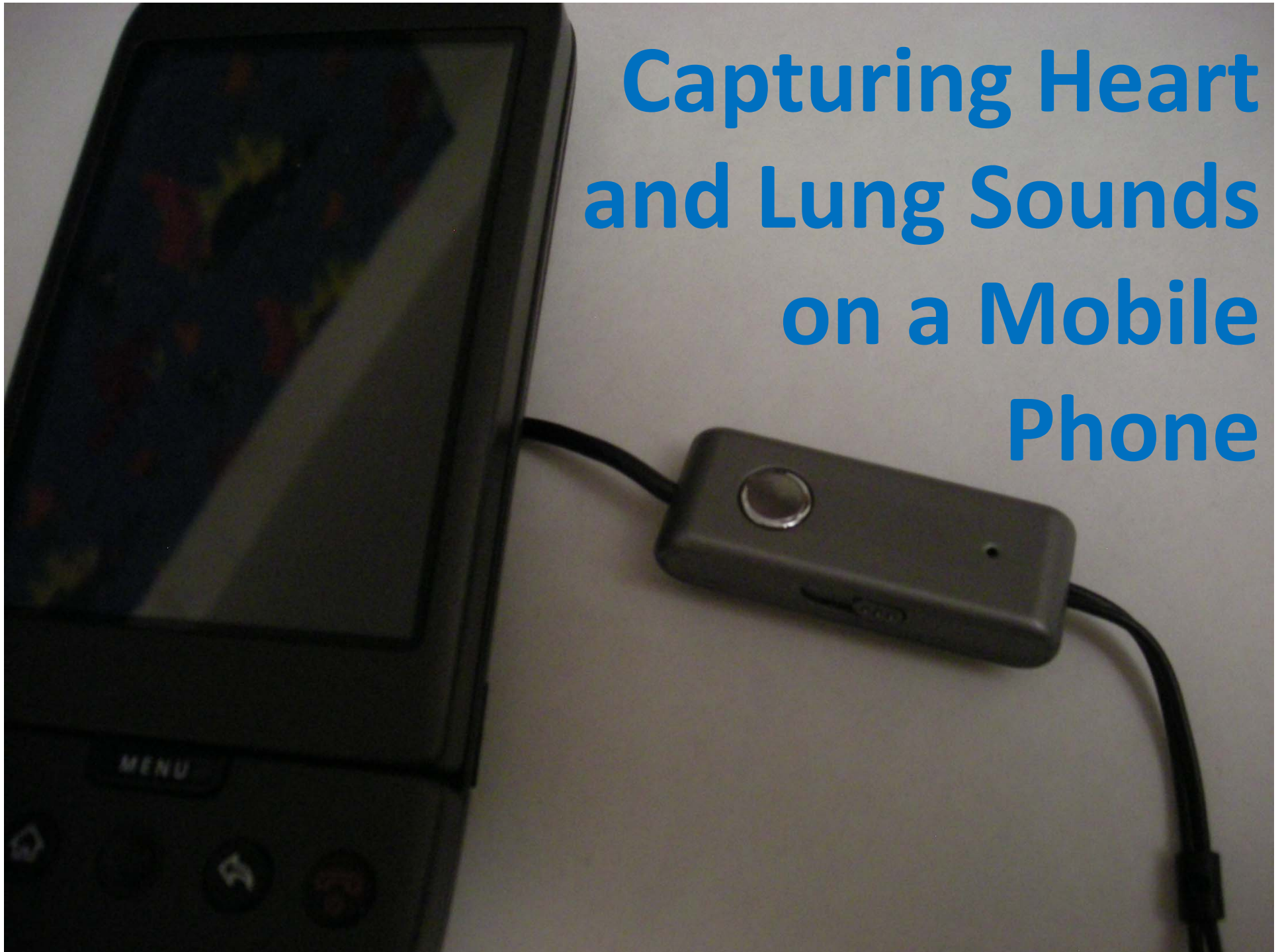


# Capturing Heart and Lung Sounds on a Mobile Phone



## HOMEMADE STETHOSCOPIES

A *stethoscope* is a hollow tube that makes it easier to listen for sounds inside a person's chest or belly: breathing in the lungs, heartbeats, and gurgling in the belly.

The best stethoscopes are made of metal and plastic, and can be expensive.



But a simple stethoscope can be made of a hollow tube of bamboo, wood, or clay.

mouth  
open—  
breathing  
deeply



To use it, press your ear firmly to one end while holding the other end flat against the person's back.

Check the lungs by listening on the person's back in 6 places.

Then listen to the front between the shoulders and neck.

Compare what you hear in one place with what you hear in the same place on the other side.



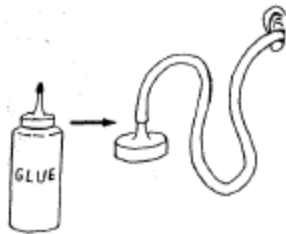
**Breathing sounds you may hear with the stethoscope:** Long, high-pitched squeaks are *wheezes*, often a sign of asthma. Lower-pitched sounds, like silk or thin paper being rubbed against itself, are *rales*, often a sign of pneumonia. The lack of normal breathing sounds in one area, but not everywhere, usually means pneumonia in one part of a lung—or advanced tuberculosis.

**Heart sounds:** Also listen to the person's heart on the front of the chest where it beats hardest. There should be **two sounds for each pulse**. In an older person, a third sound may mean heart disease, especially if he has swollen feet or is short of breath (see *WTND*, p. 325). In a child, an extra sound may mean he has had rheumatic fever (*WTND*, p. 310). If he is sickly he should see a doctor.

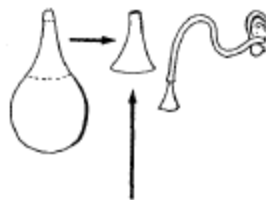
**Belly sounds:** In a severely ill person, the absence of normal gurgles in the belly is probably a sign of acute abdomen (see *WTND*, p. 93).

#### OTHER KINDS OF HOMEMADE STETHOSCOPES:

Use the top of a narrow-necked plastic bottle and a piece of rubber tube.



Or cut off the top of a rubber suction bulb.



This piece can also be used for looking in people's ears.



are especially useful for listening to the heartbeats of unborn babies (see *WTND*, p. 252).

# Early Stethoscopes

Four photos of early stethoscopes from [Medical Antiques Online](#) removed due to copyright restrictions.

# Stethoscope Anatomy

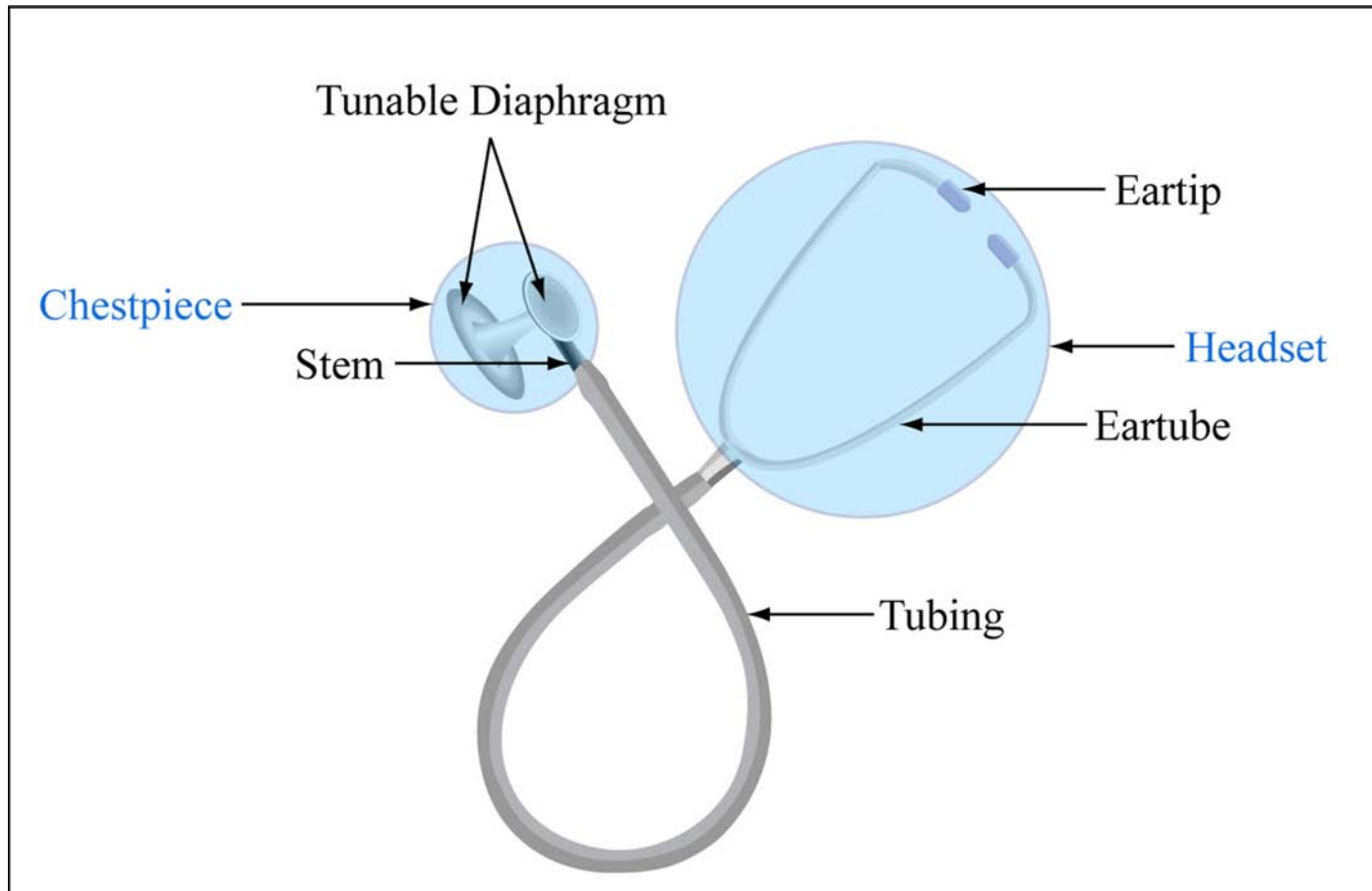


Image by MIT OpenCourseWare.

Littmann Cardiology Stethoscope

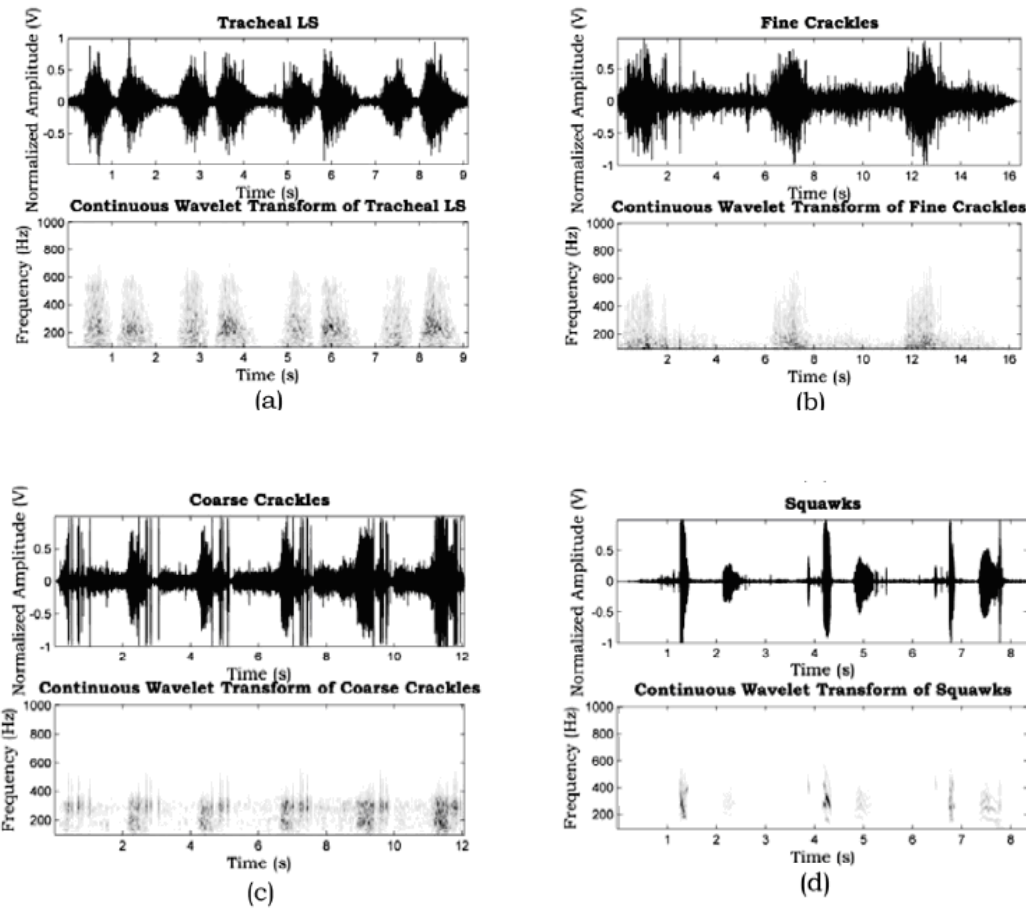




Courtesy of [Science by Email](#), produced by CSIRO in partnership with [mecu](#) and the [Department of Agriculture Fisheries and Forestry](#) Used with permission.

<http://www.csiro.au/helix/sciencemail/activities/Stethoscope.html>

# Later...can do signal processing on the sound for automated disease detection



Images of lung sounds data removed due to copyright restrictions. See Hadjileontiadis, Leontios *J. Lung Sounds: An Advanced Signal Processing Perspective*. San Rafael, CA: Morgan & Claypool, 2009. ISBN: 9781598297102.



# Key Things to Think About

- What type of plastic will the diaphragm be made of? (Overhead transparency, old plastic packaging)
- How to attach the diaphragm to the funnel or rest of the chestpiece?
- How to attach stethoscope to mic?
- Is the sound being amplified (large surface to small hole)?

## CHEST PIECE SIZE

If the chest piece is too large, it loses contact with the body surface, because the latter is curved outward in configuration. In this case, sounds are not only picked up inefficiently but sounds are actually lost through the openings between the chest piece and the body surface. Currently the chest piece of a stethoscope is almost uniformly between **45 and 50 mm in diameter** irrespective of manufacturers.

## CHEST PIECE MATERIAL

The material comprising the chest piece plays an important role in efficiency of picking up sounds. Sounds propagate within the air or materials, and eventually disappear as they are converted into thermal energy. The fact is, sounds are not attenuated within **heavy metals**, while they are easily attenuated within light metals and plastics. It is our policy to use **stainless steel and titanium** for the chest piece of stethoscopes priced high, and to use aluminum and plastics for those priced low.

## TUBING

The binaural tubing is also important in terms of efficiency of the stethoscope. The larger its internal diameter is, the **shorter and the thicker walled** it is, the better the efficiency of a stethoscope is.

## EAR PIECE

It is more important to make a **good fit** of the ear pieces with your ears. When the fitting is bad, auscultatory sounds leak out, and at the same time ambient noises come in, making diagnostic auscultation difficult. As to the component material of the ear piece, **hard materials** are superior to soft materials because the latter absorb and attenuate auscultatory sounds.

Stethoscopes rely on **airtight seals** to transmit sound.

**Stainless steel** is the best, zinc alloys and aluminum are also used..

Removable **non-chill rims** are standard.

**Diaphragm** should be made from **high quality PE compound film**, a resin with high flexibility, and high fidelity with **minimal susceptibility to deforming** and aging. Typical sizes are 35mm for adult use, 25mm for pediatric use, and 45mm for cardiology.

**Short vs. long tubing** only makes small detectable difference in acoustical performance. Longer tubes drapes better around the neck, give more freedom when working with patients, and may reduce stress on the lower back while examining supine patients.

**Tubes** are made in a single dip molding process with **PVC(polyvinylchloride)** . **Thin tubes can cause distortion**, cause loss in the signal, and can pick up external noises. The single tube splits into two separate tubes at the ear piece..



Photos and designs by Katherine Kuan.

# Assignment

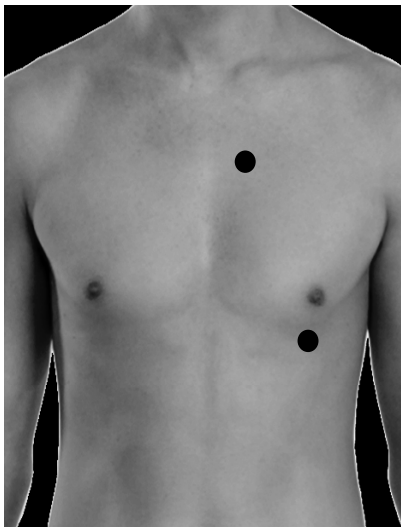
1. Make a device that can amplify (without electronics) heart and lung sounds for recording on a cell phone
2. Email recording to yourself, or use USB cord to transfer it to the computer
3. Convert to WAV format using [http://download.cnet.com/PeonySoft-WAV-Converter/3000-2140\\_4-10911514.html](http://download.cnet.com/PeonySoft-WAV-Converter/3000-2140_4-10911514.html)
4. Look at its waveform in MATLAB

```
y = wavread('hello.wav');  
plot(y)
```
5. Can you see the heart beats or breaths? (May be hard to tell without further signal processing)

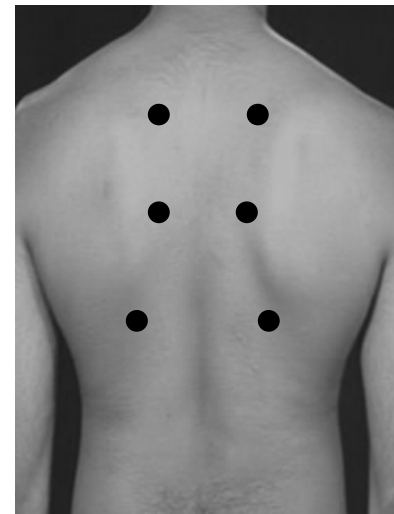
# Testing Your Device

Check that the heartbeats/breaths are audible from someone listening on the computer (full volume, with headphones)

Heart sounds: Try the pulmonary and mitral locations



Lung Sounds: Try the trachea (over the front of the throat) and the 6 locations on the back of the chest



Courtesy of Arcot Chandrasekhar. Used with permission.

# Resources

- Low-Cost Technologies in Rural Areas

<http://www.healthwrights.org/books/HHWL/HHWLchapt16.pdf>

- Make a Homemade Stethoscope

<http://www.csiro.au/helix/sciencemail/activities/Stethoscope.html>

- What Makes a Good Stethoscope

[http://reviews.ebay.com/Stethoscope-Basics-What-makes-a-Good-Stethoscope\\_W0QQugidZ10000000004429816](http://reviews.ebay.com/Stethoscope-Basics-What-makes-a-Good-Stethoscope_W0QQugidZ10000000004429816)

- All about Stethoscopes

<http://www.asahi-net.or.jp/~ig2s-kzm/allabout.html>

# Some Patents (Many more found online)

<http://www.freepatentsonline.com/20060283656.pdf>

<http://www.freepatentsonline.com/6378648.pdf>

<http://www.freepatentsonline.com/4239089.pdf>

<http://www.freepatentsonline.com/3109508.pdf>

[http://www.patentstorm.us/patents/pdfs/patent\\_id/4458778.html](http://www.patentstorm.us/patents/pdfs/patent_id/4458778.html)



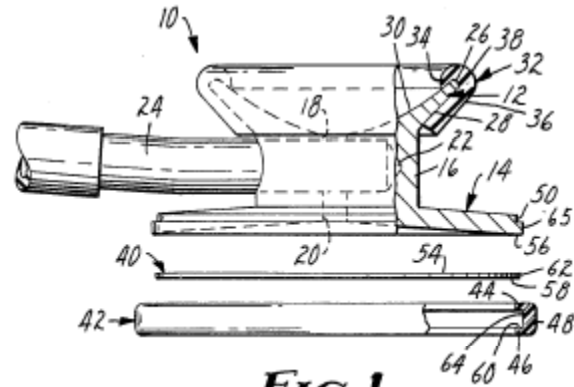


FIG. 1

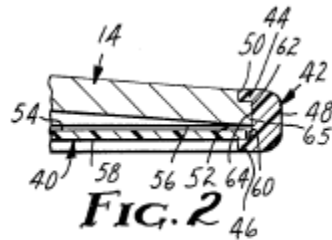


FIG. 2

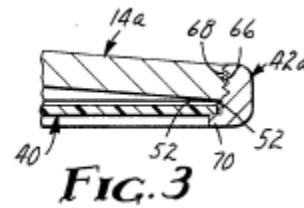
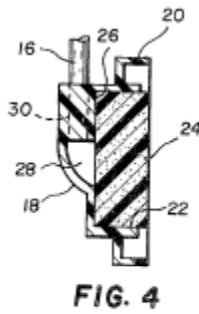
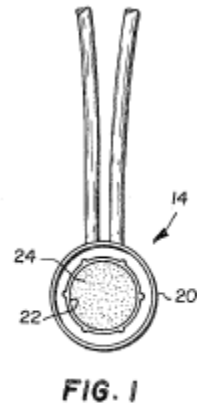
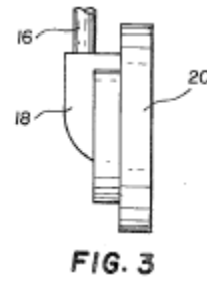
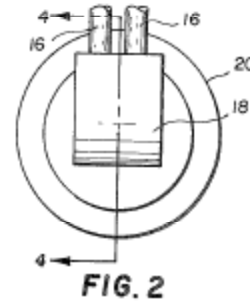
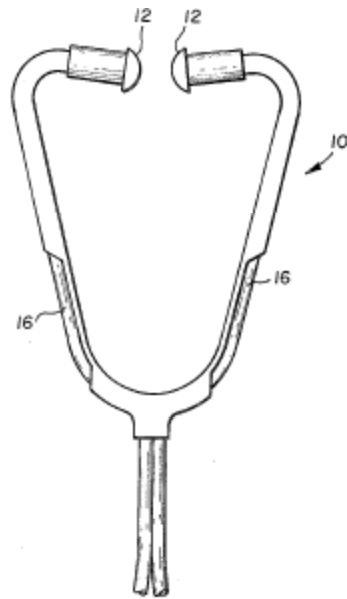


FIG. 3



Nov. 2, 1965

G. F. MACHLUP

3,215,224

STETHOSCOPE WITH O-RING CONSTRUCTION

Filed Oct. 9, 1964

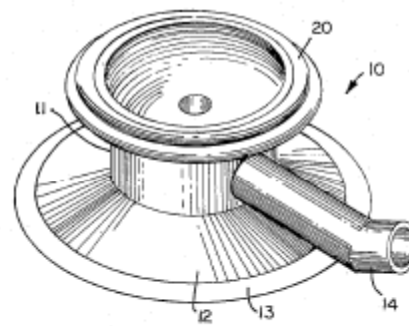
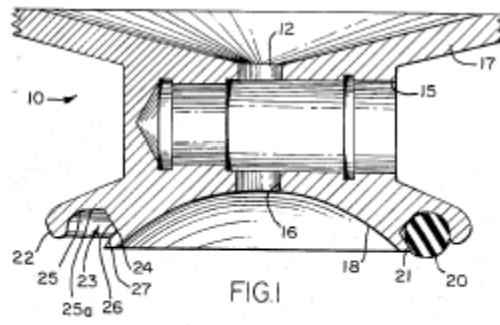


FIG. 2

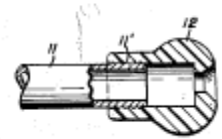
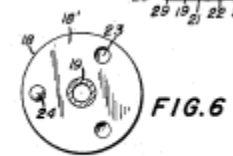
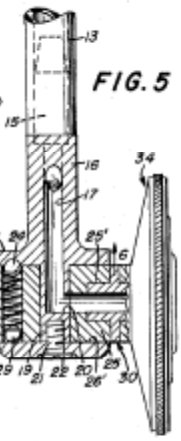
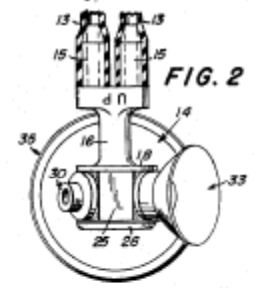
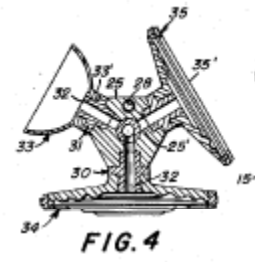
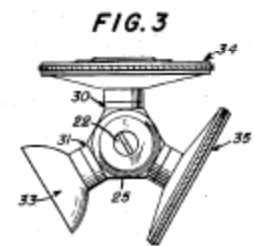
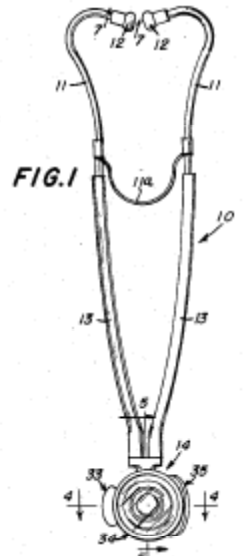
Nov. 5, 1963

R. CEFALY  
ACOUSTIC STETHOSCOPE

3,109,508

Filed Feb. 11, 1960

3 Sheets-Sheet 1



INVENTOR  
**RALPH CEFALY**  
 BY *Beale & Jones*  
 ATTORNEYS

Nov. 5, 1963

R. CEFALY  
ACOUSTIC STETHOSCOPE

3,109,508

Filed Feb. 11, 1960

3 Sheets-Sheet 2

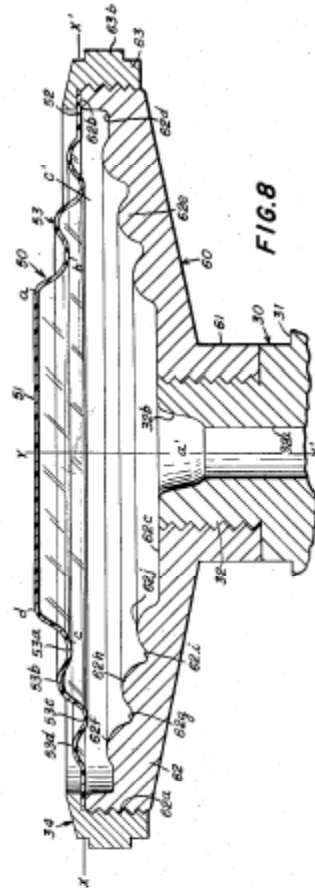


FIG. 8

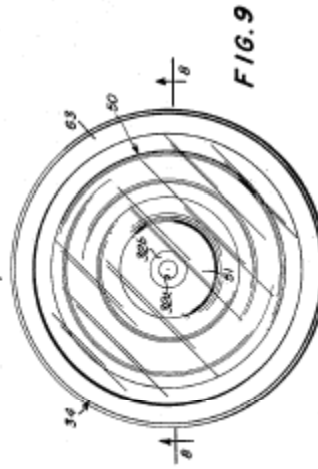


FIG. 9

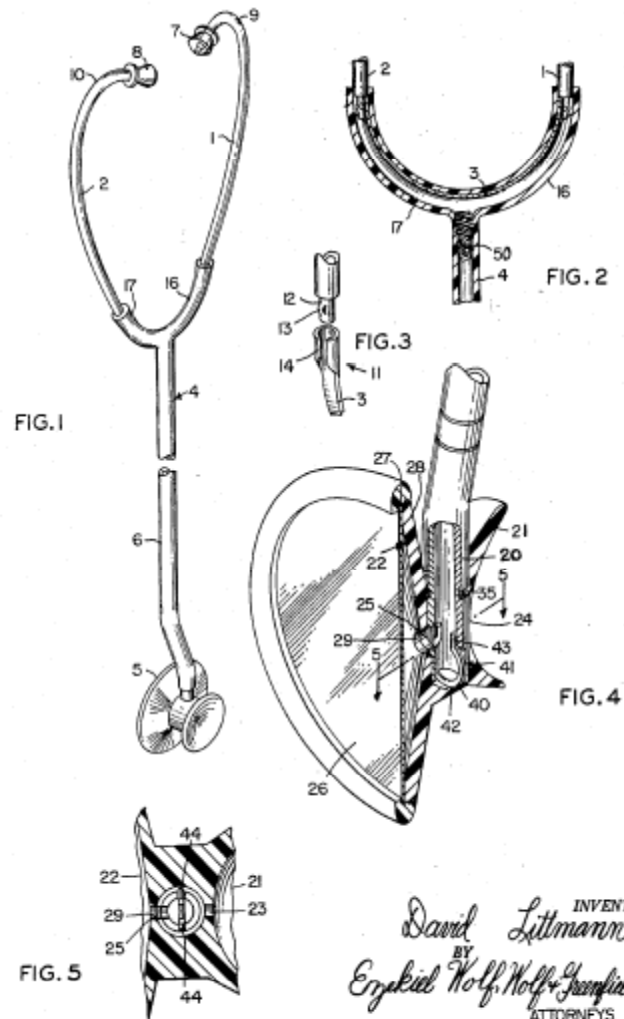
INVENTOR  
**RALPH CEFALY**  
BY *Beadle & Jones*  
ATTORNEYS

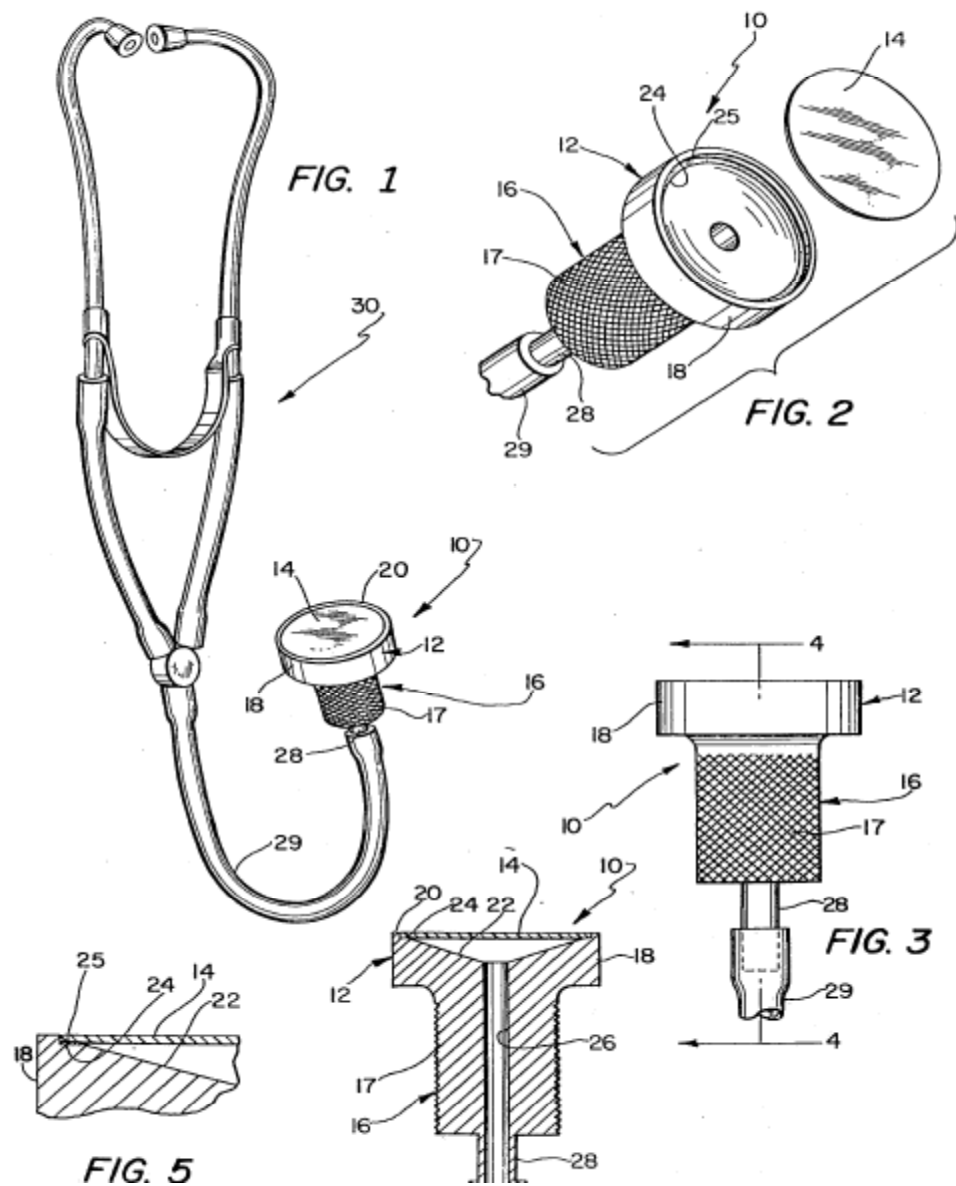
Oct. 29, 1963

D. LITTMANN  
STETHOSCOPE

3,108,652

Filed June 16, 1960





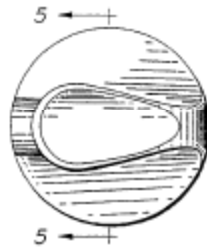


FIG. 1

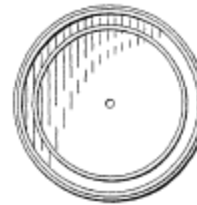


FIG. 2



FIG. 3



FIG. 4

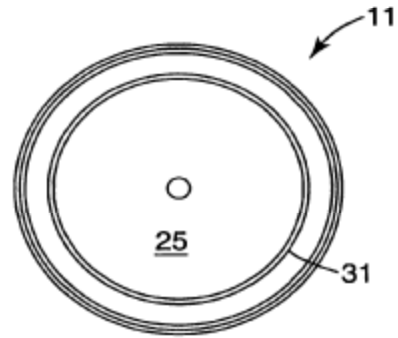


FIG. 5

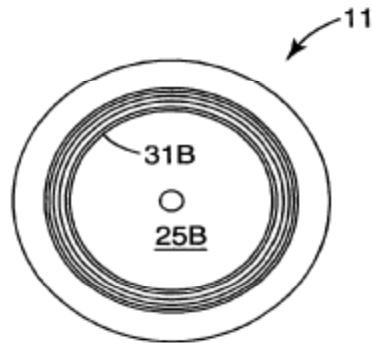


FIG. 6

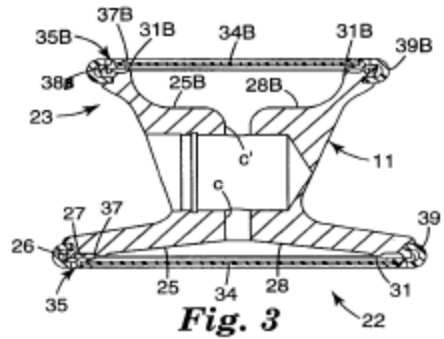




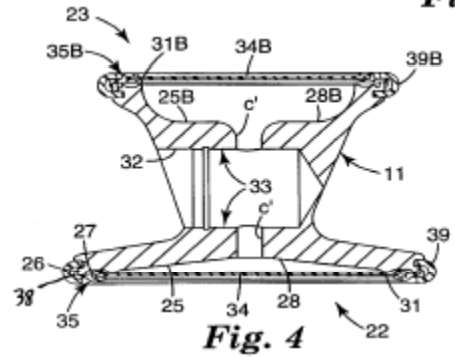
**Fig. 6**



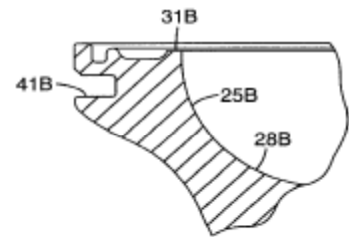
**Fig. 7**



**Fig. 3**



**Fig. 4**



**Fig. 5**

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EC.710 D-Lab: Medical Technologies for the Developing World  
Spring 2010

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