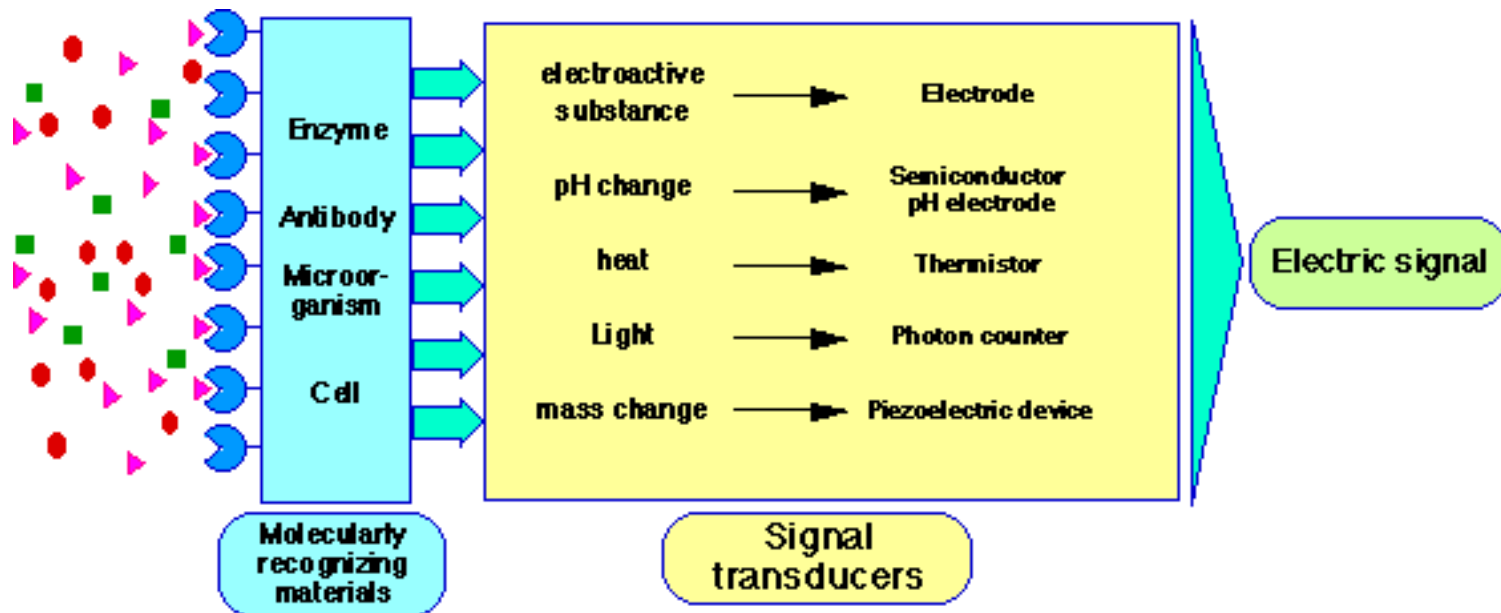


## Bio Sensors



## Principle of Biosensors

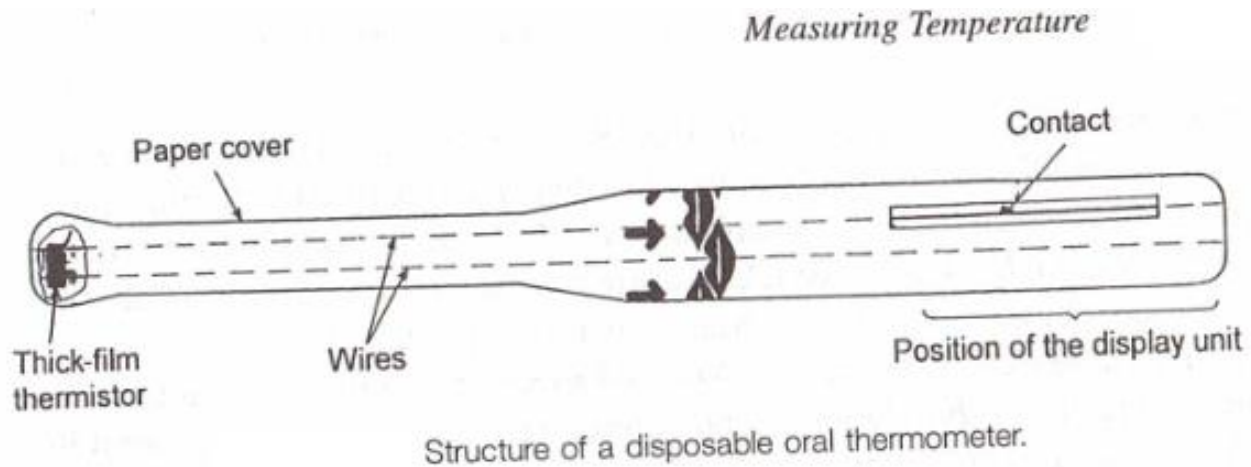
## Body Temperature Measurement

- Traditionally place to measure is mouth or armpit
- Can also be measured from ear by utilizing thermal radiation
- Body thermal distribution can be measured by infra red cameras
- Blood temperature can be measured by using thin thermocouple sensor invaded through the skin

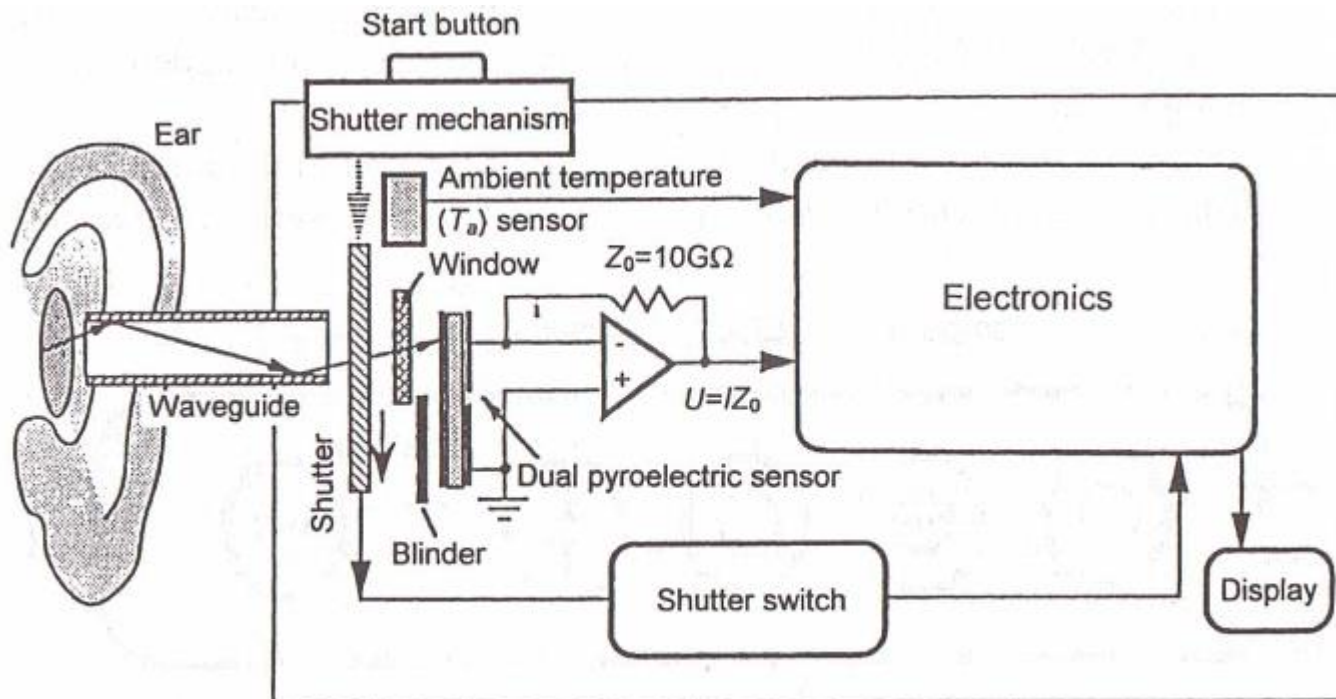
## Electrical Responses

- ECG, Electro-Cardiogram, Heart activity
- EMG, Electro-Myogram, Muscle movement
- EOG, Electro-Oculogram, Eye movement
- EEG, Electro-Encephalogram
- GSR, Galvanic Skin Response

# Disposable Oral Thermometer

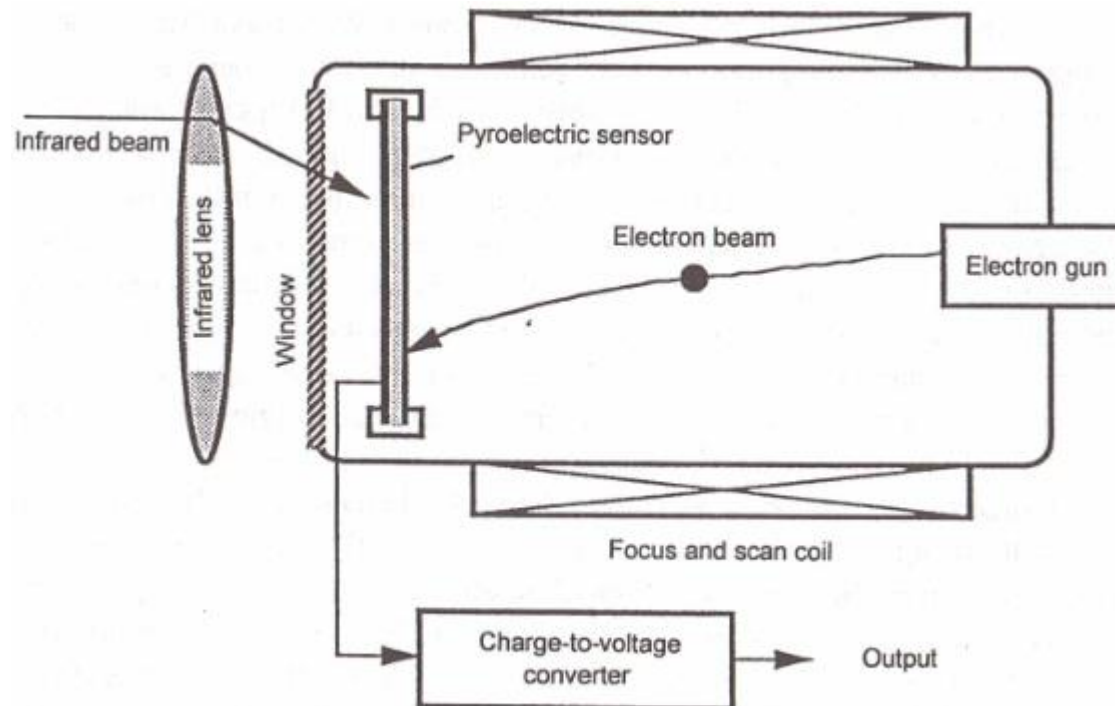


## Thermal Radiation Based Ear Thermometer



Block diagram of a pyroelectric radiation ear thermometer.

## Camera, Measuring Thermal Radiation



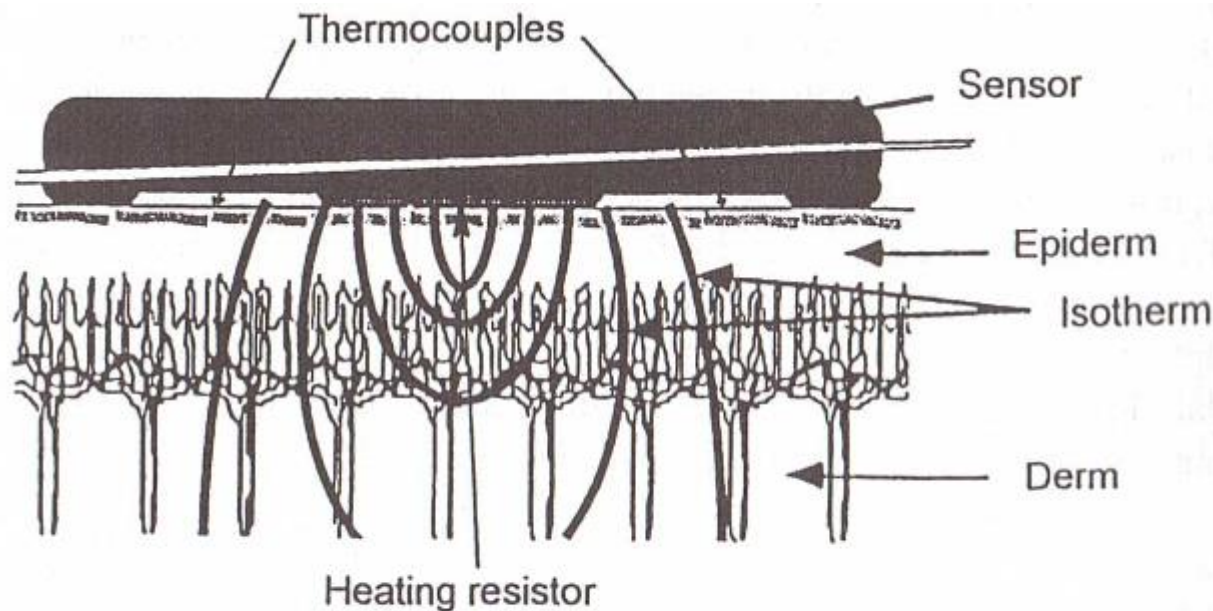
Structure of the pyroelectric vidicon camera.



## Blood Flow Measurement

- Blood flow in big vessels and sometimes in heart is important part of diagnostics
- Basically similar technology can be also used to measure respiratory air flow

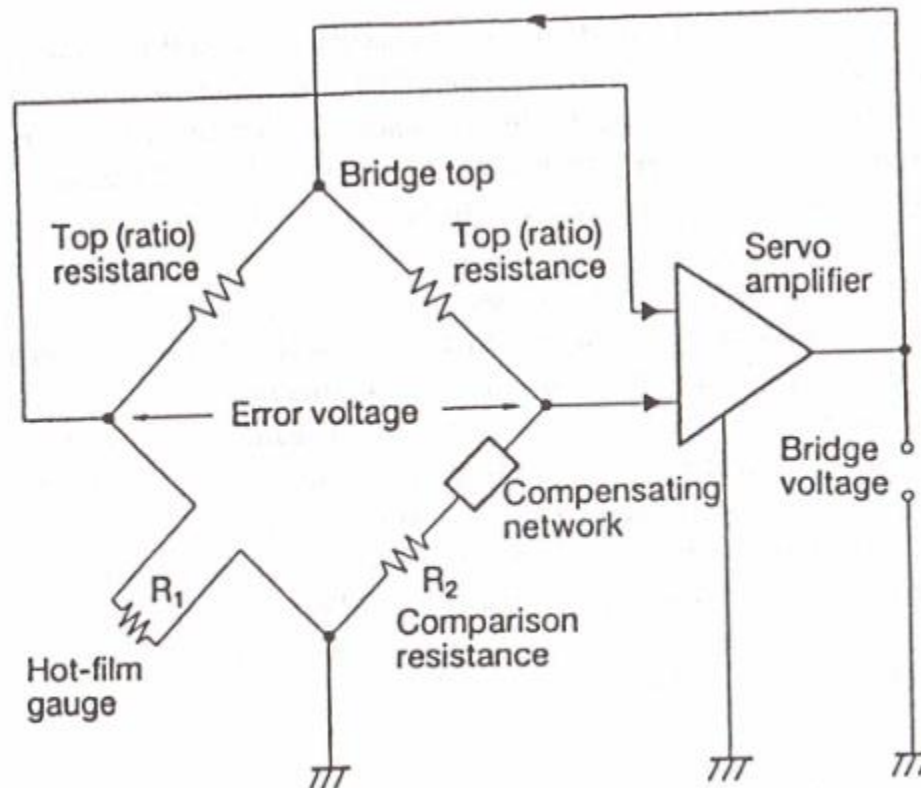
# Noninvasive Sensor for Blood Flow Measurement



Cross section of the skin blood-flow (SBF) sensor with an isotherm system generated in the skin.



## Blood Flow Measurement Bridge

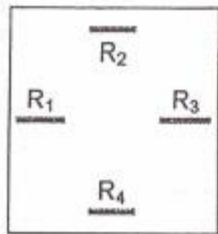


Schematic circuit diagram of the constant temperature hot-film anemometer used for blood-flow measurements.

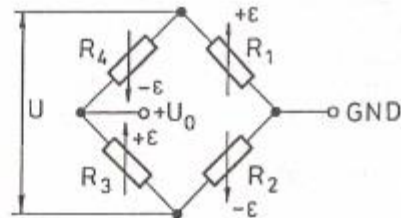
## Blood Pressure Measurement

- On the skin blood pressure can be done by using piezo resistive silicon based pressure sensors. Signal response is formed in traditional differential amplifier.
- Similar miniature size sensors can be utilized in invasive measurements under the skin

# Blood Pressure Sensor

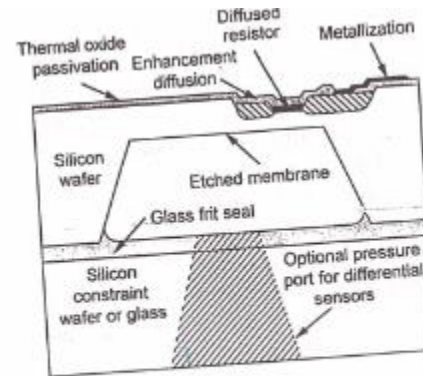


(a)

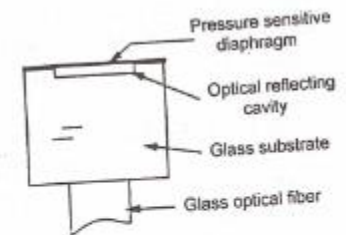


(b)

(a) Typical resistor layout structure and (b) circuit connection of the piezoresistive pressure sensor membranes.



(a)



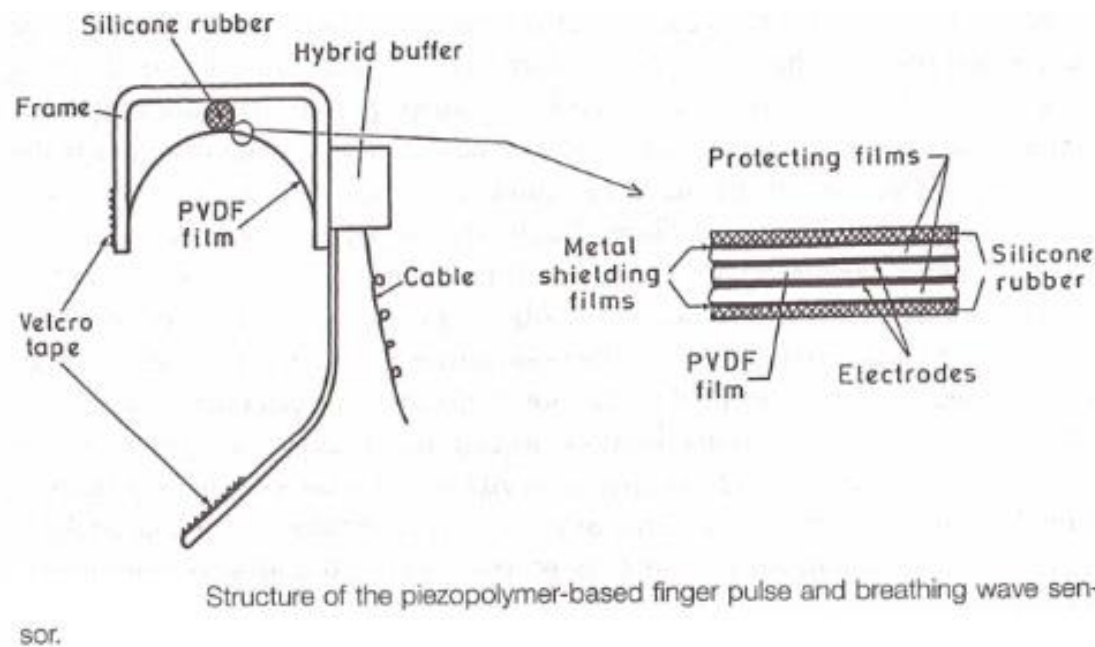
(b)

Pressure sensor structures based on silicon diaphragms: (a) piezoresistive and (b) optical fiber version. [Reprinted with permission]

## Spirometry

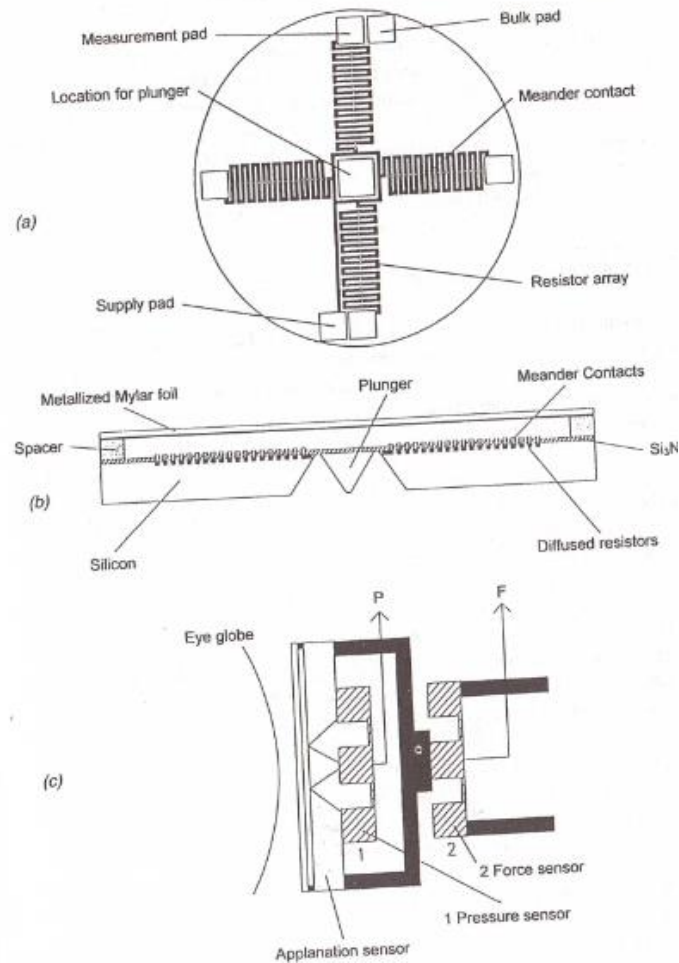
- The performance of lungs can be measured by utilizing pressure sensors which make it possible to measure e.g. respiratory air flow
- Sensors based on piezoelectrical features of PVDF (polyvinylidene difluoride) are also used for lungs measurements
- Miniature size silicon based mechanical sensors are used in internal pressure measurements of eye

# Breath Measurement

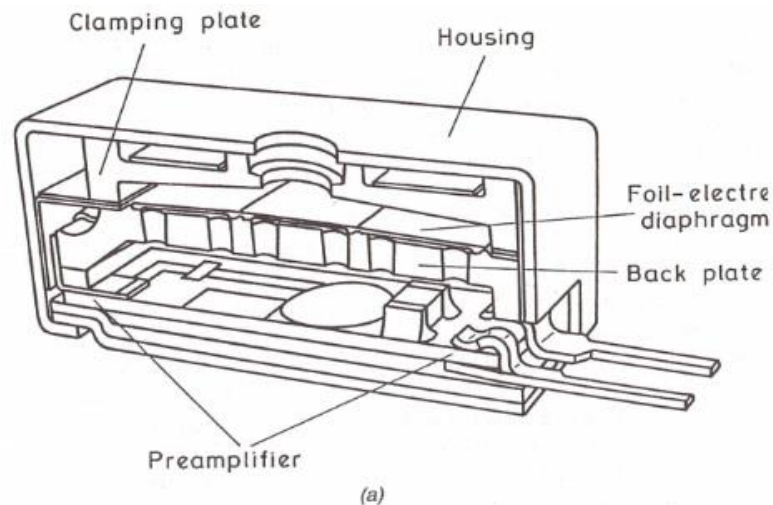




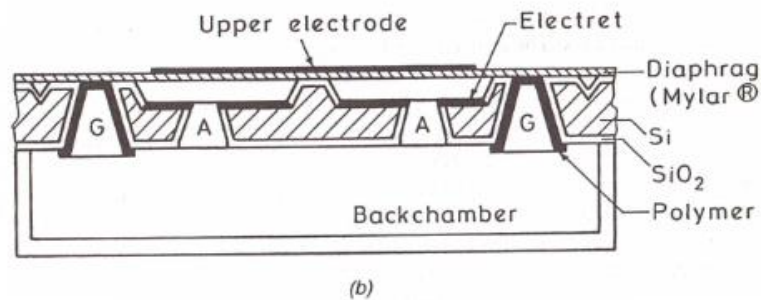
# Internal Eye Pressure Measurement



## Acoustic Sensor in Hearing Aid



© 1989 IEEE



Miniature microphone structures for hearing aid appliances:

- Hearing aid is a special application for acoustic sensors

# Sensors in Ultrasonic Imaging

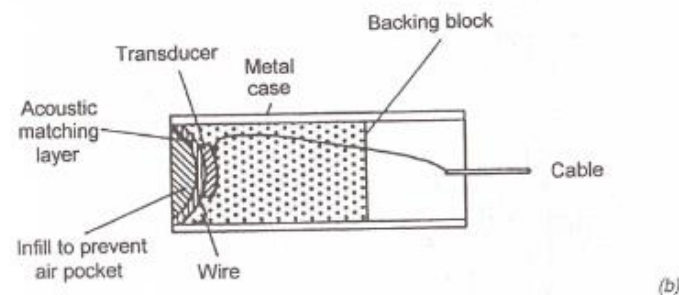
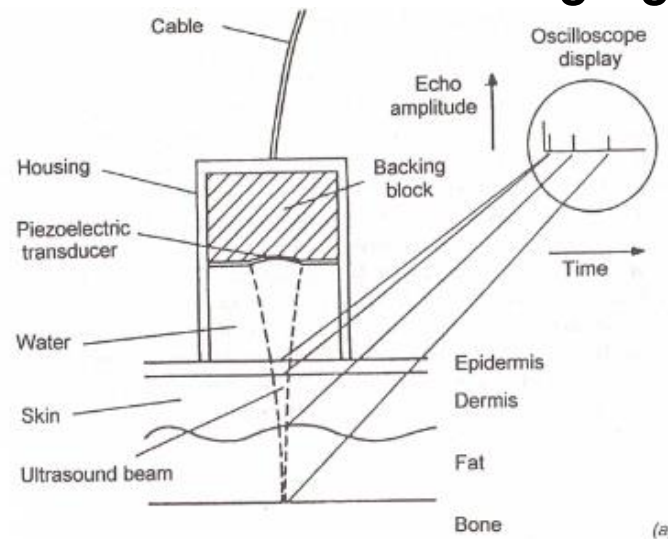
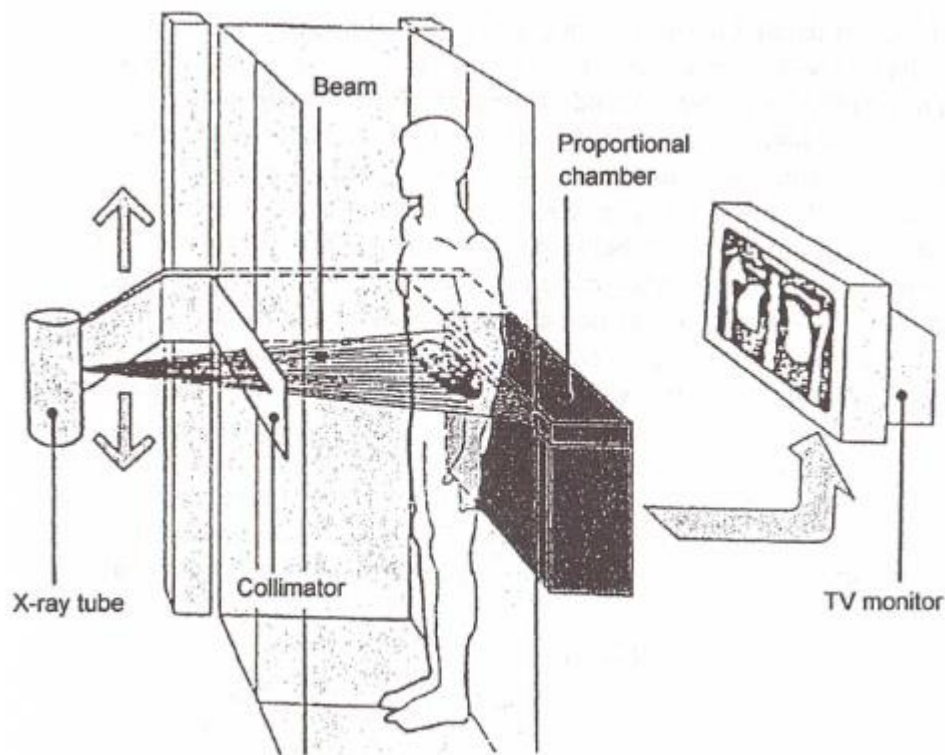


Illustration of A-mode ultrasound imaging

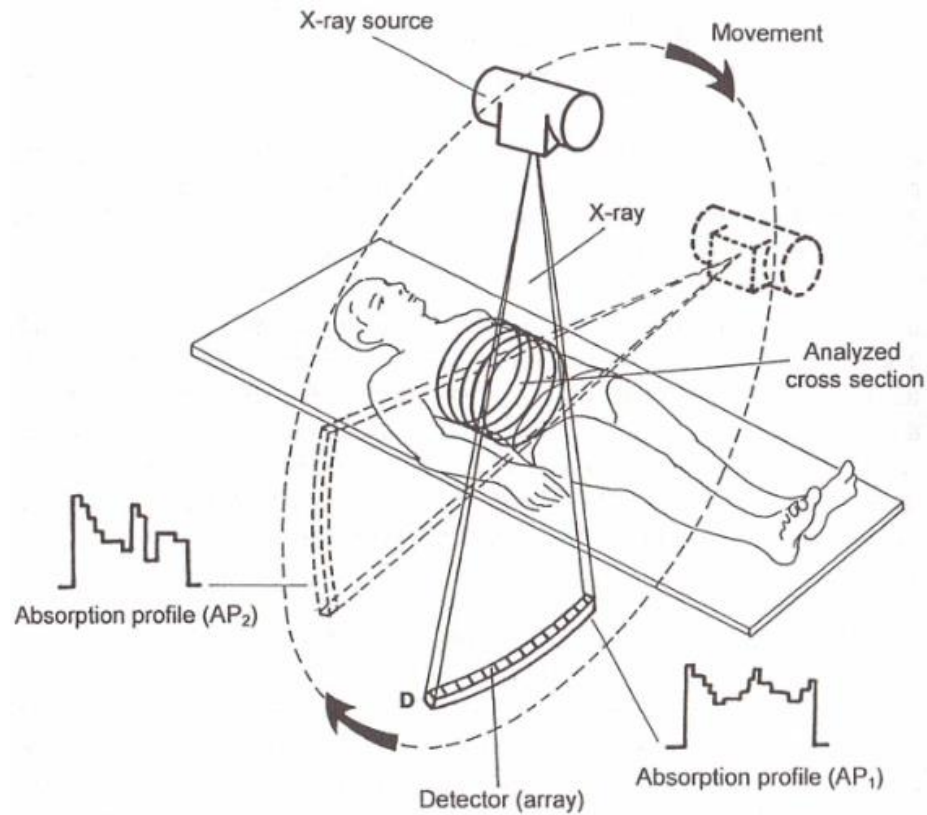
# X-ray Imaging



X-ray image formation using Charnak detector and X-ray scanning.



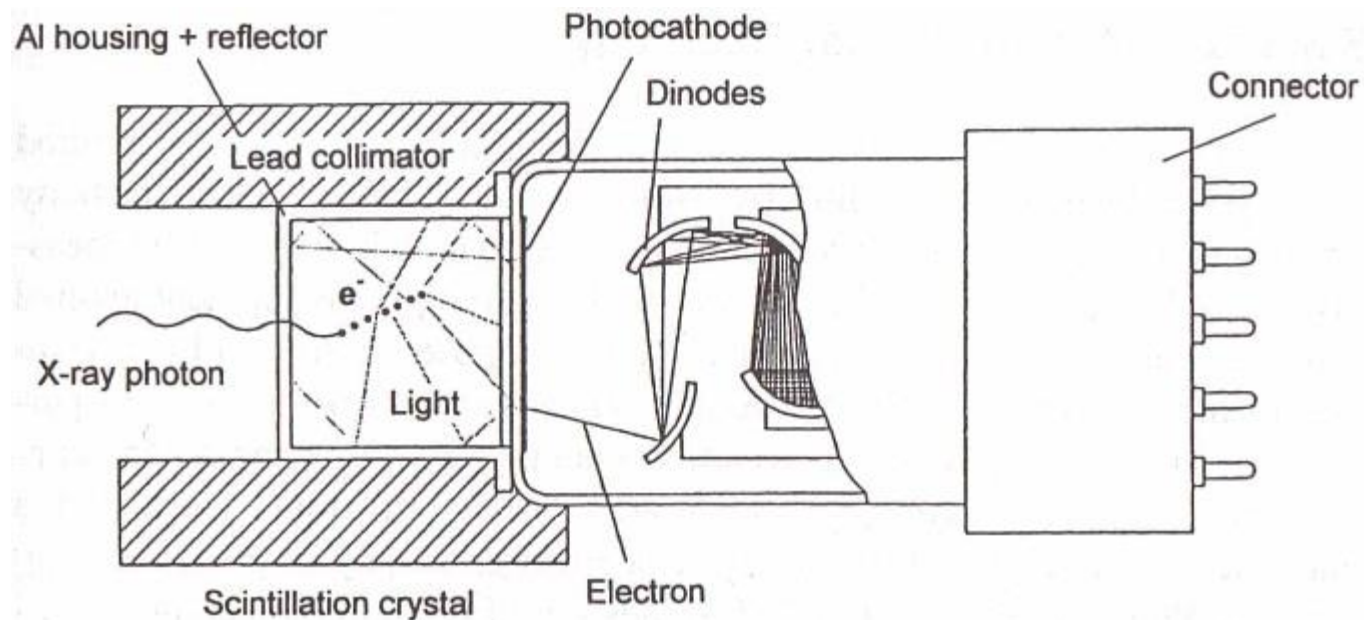
# X-ray Imaging



Principle of X-ray computed tomography.



## X-ray Imaging, Sensor



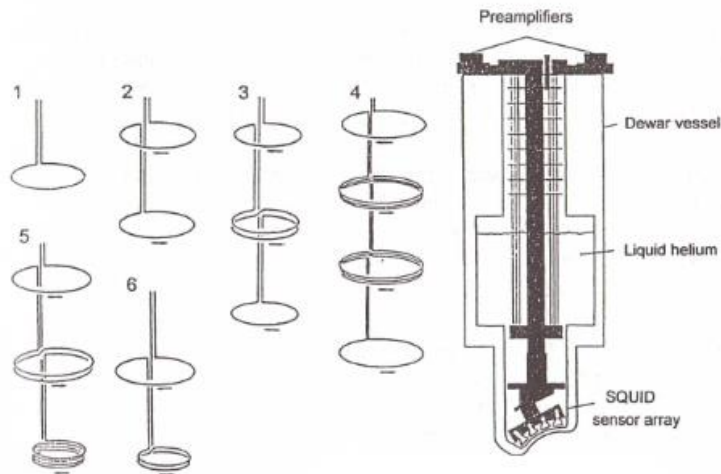
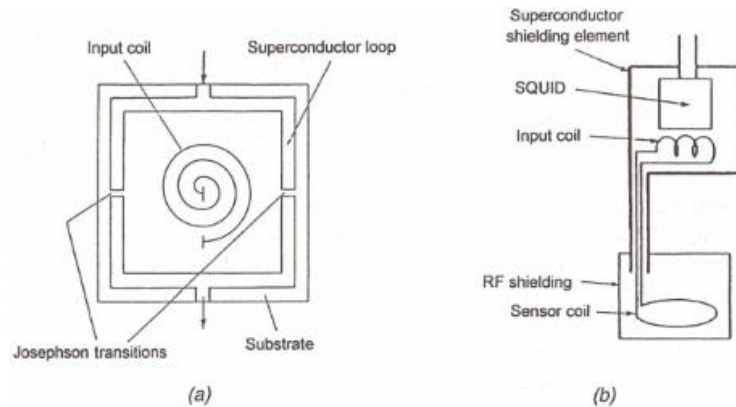
Structure of the classical X-ray detector used in CT—photo-electron multiplier with scintillator crystal and collimator.

# Electrochemical Sensors

- Used often to measure oxygen in blood
- Also used to measure pH (power of Hydrogen)

## STUDY MATERIAL

# MRI (Magnetic Resonance Imaging)



Detector chamber and its components for measuring biomagnetism: