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Date: 31/12/2020

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~~Sensors and Actuators for Biomedical Applications~~  
Sensors used for biomedical

1) Sensors and Actuators for Biomedical Applications:

Sensors used in bio-medicine are known as Biomedical sensors. Biomedical sensors are special electronic devices that can transduce biomedical signals into easily measurable electric signals. They are the product of the integration of electronic information technology and biomedicine.

Biomedical Sensors are classified according to the quantity to be measured and are typically categorized as physical, electrical and chemical depending on their specific applications. Examples of Biomedical Sensors are Heart Sound Sensor, Blood flow Sensor, Respiration Sensor, Blood pressure Sensor and Oxygen and Carbon dioxide Sensor for blood.

2) Primary Sensing Element: This is an element that is sensitive to the measured variable. The physical quantity under measurement, called the measurand, makes its first contact with the primary sensing element of a measurement system. Primary sensing element may have a non-electrical input and output such as a manometer, spring or may have an electrical input and output such as a rectifier. Example of a primary sensing element is the thermometer bulb that contains mercury in a thermometer and the Bourdon tube in a Bourdon Pressure Gauge.

i) Variable Converts Conversion Element: After passing through the primary sensing element, the output is in the form of an electrical signal, may be voltage, current, frequency etc, which may or may not be accepted to the system. For performing the desired operation, it may be necessary to convert this output to

some other suitable form while retaining the information content of the original signal. Many instrument do not require any variable conversion unit, while some others require more than one element.

(ii) Manipulation Element: Sometimes it is necessary to change the signal level without changing the information contained in it for the acceptance of the instrument. The function of the variable manipulation unit is to manipulate the signal presented to it while preserving the original nature of the signal.

(iv) Data Transmission Element: The data transmission elements are required to transmit the data containing the information of the signal from one system to another.

v) Data Presentation Elements: The function of the data presentation element is to provide an indication or recording of in a form that can be evaluated by an unaided human sense or by a controller. The information regarding measurement is to be conveyed to the personnel handling the instrument or the system for monitoring, controlling or analysis purpose.

~~So~~ Taking the Clinical Thermometer for example, its following parts can be classified as follows:

- i) Thermometer bulb containing mercury: Primary Sensing Element and Variable Conversion Element
- ii) Capillary Tube: Variable Manipulation Element and Data Transmission Element.
- iii) Calibrated Thermometer Stem: Data presentation Element.

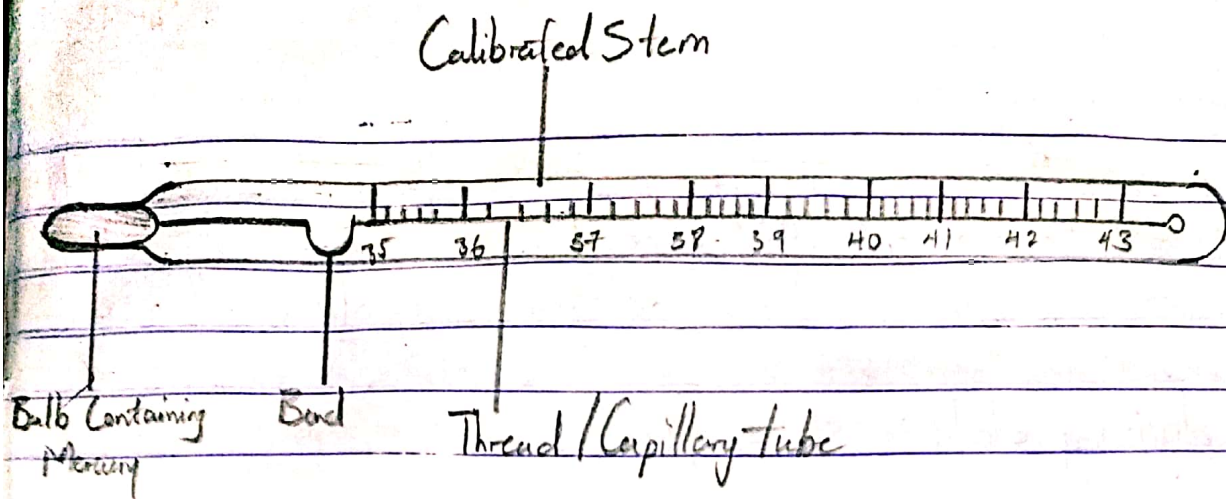


Fig 2.1: A Clinical Mercury Thermometer

3) Sphygmomanometer: A sphygmomanometer is a device that measures blood pressure. It is composed of an inflatable rubber cuff, which is wrapped around the arm. A measuring device indicates the cuff pressure (could be digital or analog). A bulb inflates the cuff and a valve releases pressure. A stethoscope is then used to listen to arterial blood flow sounds. A sphygmomanometer measures blood pressure as systolic over diastolic pressure, the systolic pressure being the ~~rise~~ high pressure that is caused by blood being forced through the arteries as the heart beats and the diastolic pressure being the low pressure that is followed when the heart's ventricles prepare for another beat. There are two main types of Sphygmomanometer namely: electronic and manual, under the manual ~~cat~~ category, we have the Mercury and Aneroid Sphygmomanometers.

ii) Stethoscope: The Stethoscope is an acoustic medical device for auscultation, or listening to internal sounds of an animal or human body. It typically has a small disc-shaped resonator that is placed against the skin, and one or two tubes connected to two ears. A stethoscope can be used to listen to the sounds made by the heart, lungs or intestines, as well as blood flow in arteries and veins. In combination with a manual sphygmomanometer, it is commonly used when measuring

blood pressure. There are two types of stethoscopes: the traditional acoustic and the electronic stethoscope. Under the electronic stethoscope there are two broad categories in which all other stethoscopes are classified under and these are: the amplifying and digitizing electronic stethoscopes.