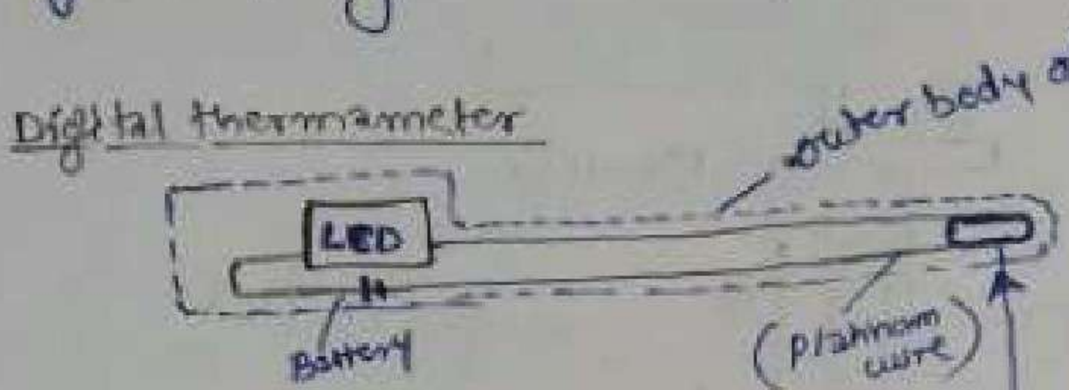
Measurement of ~~Thermistor~~ Temperature Using Thermistor

Thermistor :- Thermistor is a heat sestive device whose resistance changes rapidly with temperature.



$I = \frac{V}{R}$

LCD - Liquid Crystal Display

↳ These are made up of oxides of some metals

↳ Basically have Bead, disk and of Rod Shape

↳ The property (resistance changes rapidly with temp.) of thermistors are used in two ways :-

↳ ① For Measurement of temp.
↳ ② For Protection against temp.

First Ex:- For Measurement of temp.

As an ex we use digital thermometer, when we keep outer body of thermometer in our mouth or in Air, the thermister goes to that temperature if hot, resistance will increase

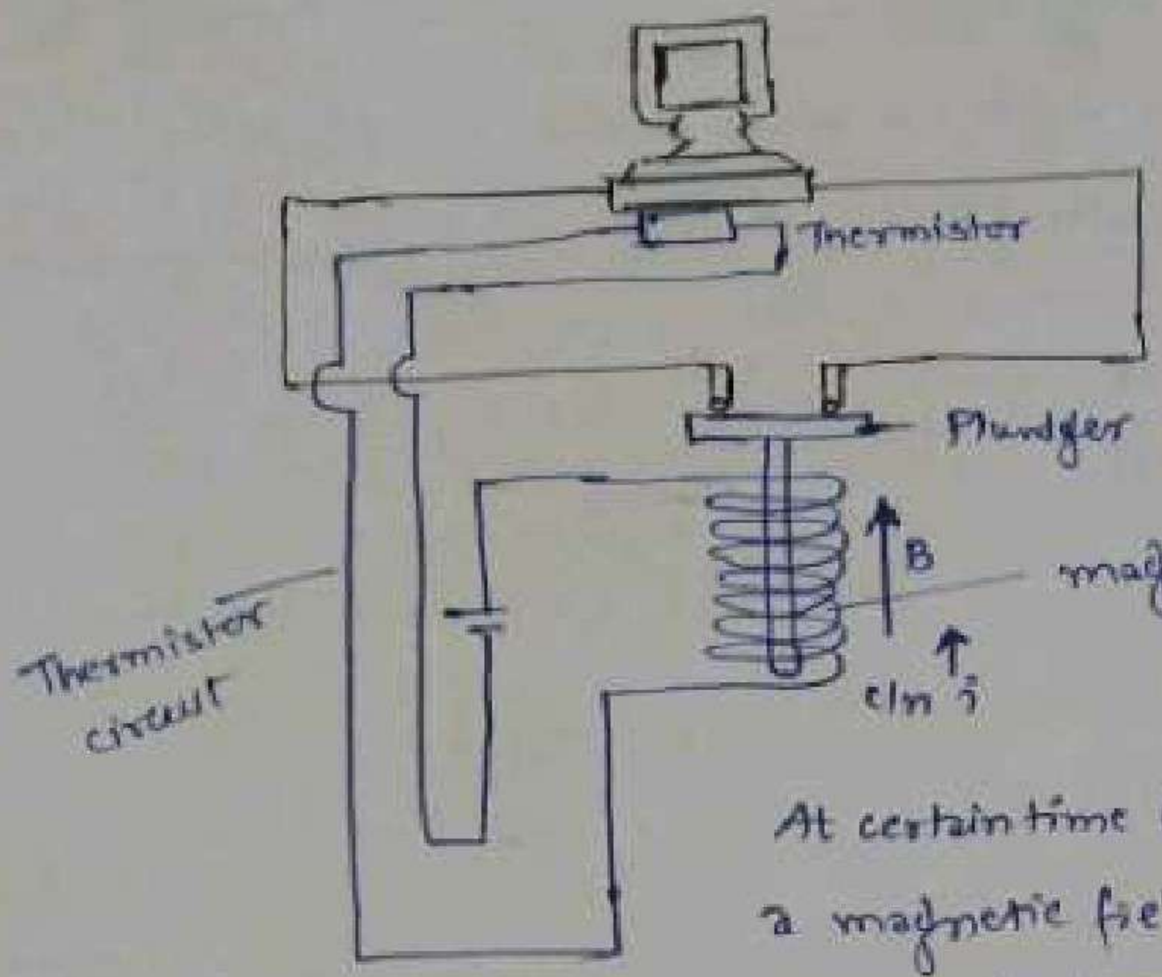
if cold or temp. lower, then resistance will decrease

If Resistance is large then there is a effect in current

Ohm's Law $\boxed{I = \frac{V}{R}}$ ↳ Resistance increase, c/n will decrease
↳ Resistance decrease, c/n will increase

Resistance increases, the c/n will decrease and in resultant this variation was displayed as a temperature on LCD

Second Ex. for protection against temp.



At certain time c/n i is flowing and due to c/n a magnetic field is generated and due to magnetic field, it lift the plunger and the circuit completed and appliances switched on.

Now due to some fault Computer system (Appliances) get heated up, due to which thermister also heated.

If thermister heated, then very quickly its resistance changes and the registance increase, when the resistance increases flow of c/n i decreases,

Now if the c/n decreases in thermister circuit, the magnetic field also decreases, So if the magnetic field is less it is not sufficient to lift the plunger.

The moment it fall back the circuit is broken, our device or appliances stop getting c/n and switched off.

This is automatic switching of system

↳ Now system get cold, as system cold, thermister also get cold it seems registance get less, ∵ Resistance is inversely proportional to c/n

so c/n get high

$$I = \frac{V}{R}$$

↳ Now again c/n high — magnetic field generated, which lift the plunger and circuit completed, c/n get flow, appliances switched on

Thermocouples

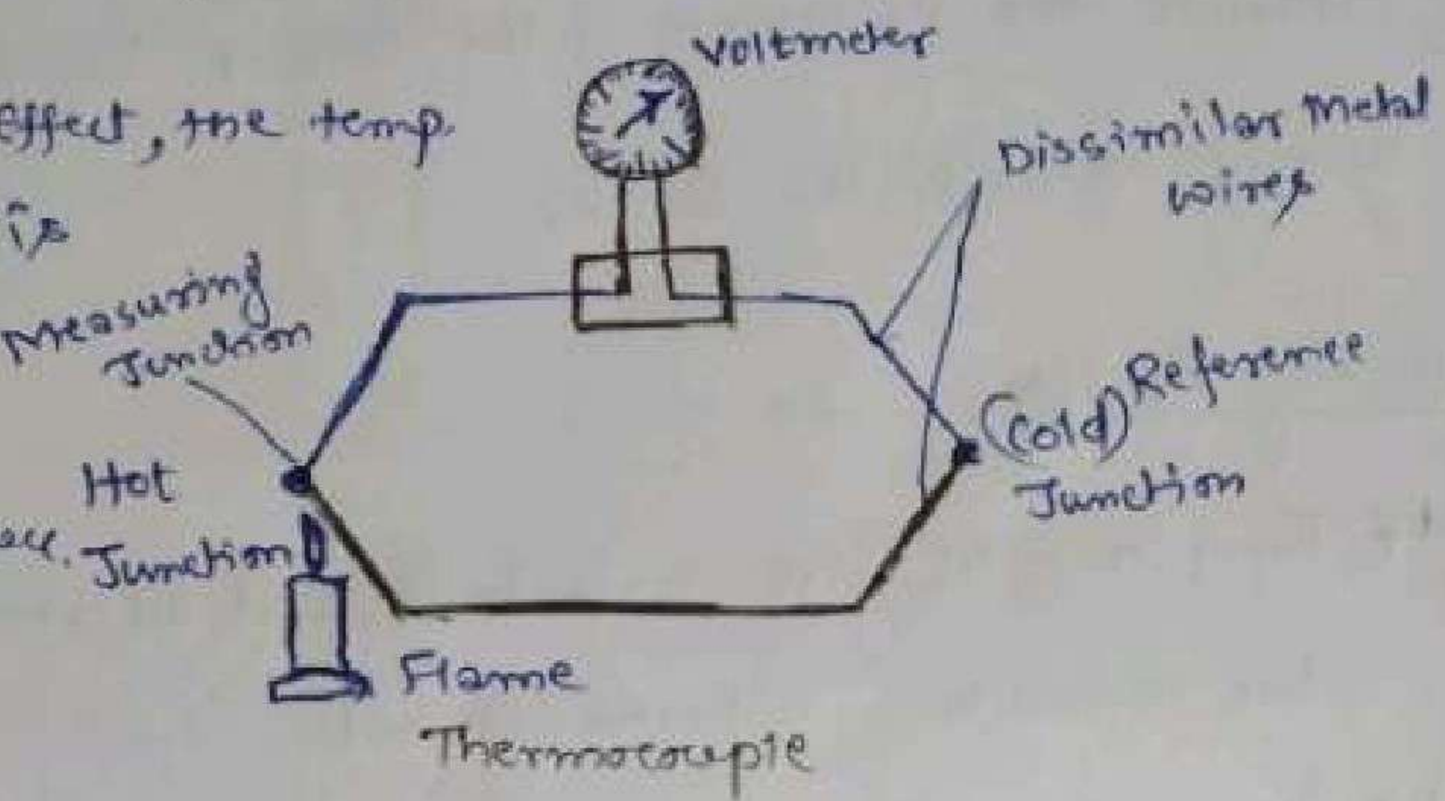
↳ The thermocouple is a sensor used to measure temperature.

↳ The thermocouple are made up of two wires of different metals, joined together at one end to form a junction.

↳ The thermocouple outputs in a millivolts.

The working principle of thermocouple depends on "SEEBECK EFFECT"

As per the principle of SEEBECK effect, the temp. difference bet^n beten the junction is measured out in volt, with the help of voltmeter because electric c/n flow due to temp. differ.



Types of thermocouple

Types	Temp. Range	Metal Used
J	0°c to 750°c	Iron Constantan
K	-200°c to 1250°c	Nickel-chromium / Nickel-Aluminium
E	-200°c to 900°c	Nickel-chromium / Constantan
T	-250°c to 350°c	Copper Constantan

Note:- Generally in a production Company we use thermocouple in Boiler or furnace to measure the temp. difference.

Thermocouple is used to measure high temp.

Resistance Temperature Detector (RTD)

↳ The term RTD stands for Resistance Temperature Detector

↳ RTD is a Temperature Sensor that is used to Measure Temperature By Associating the Resistance of the RTD Element with Temperature

↳ RTD is a passive device, External Electronic Devices are used to Measure the Resistance of the Sensor By passing a small Electrical current through the sensor.

Working Principle

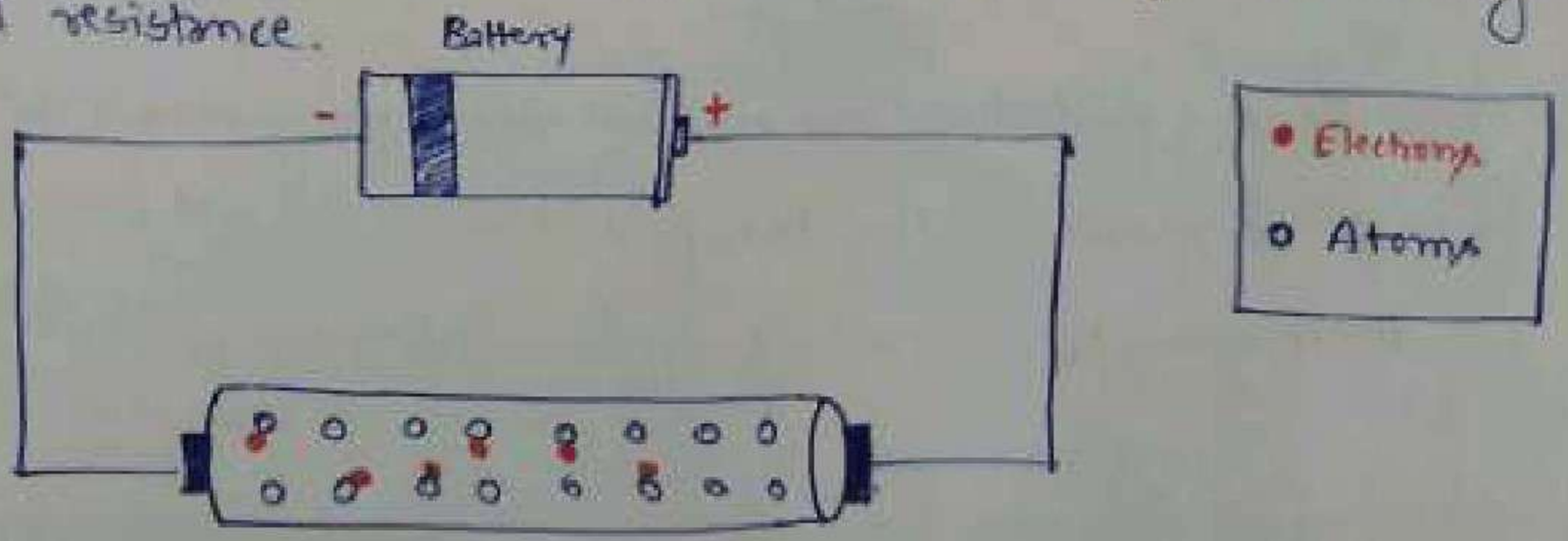
↳ Every material have atoms in it and all atoms have some energy due to which it vibrates slightly.

↳ When a battery is connected to a conductor or material, c/n flows to a Conductor.

↳ Since the flow of current is due to the flow of Electrons, these electrons frequently collide through the vibrating atoms of the Conductor.

↳ These collisions decreases the speed of Electrons, this property of a material due to which it opposes the flow of c/n through it is called resistance.

↳



↳ How, when we heat the conductor, the atoms of the conductors absorbs heat energy, as a result there vibrations increases.

↳ Because of this increase in vibrations, the collisions of Electrons with atoms also increases and so it becomes very difficult for Electrons across the conductor and hence the resulting o/p current decreases.

↳ RTD works on principle of measurement which states that resistance of a material changes with temperature, as a temperature of a material increases the metal resistance to the flow of electricity also increases.

PARTS OF RTD

① RTD Sensing Element

Sensing element is the actual temp. sensing unit is located at the tip of the temperature sensor on the end that is exposed to the process temperature.

↳ Sensing element which is constructed of metals like platinum, nickel, copper or tungsten respond to the process temperature by generating a measurable resistance

② Lead Wires

↳ Lead wires are attached to the sensing element and then pass through the sensor sheath

↳ Lead wires connect the sensing element either directly to the DCS or to a temperature transmitter connected to a DCS

③ Sensor sheath

↳ The sensor sheath is constructed of metal and house most of the component parts of the temperature sensor.

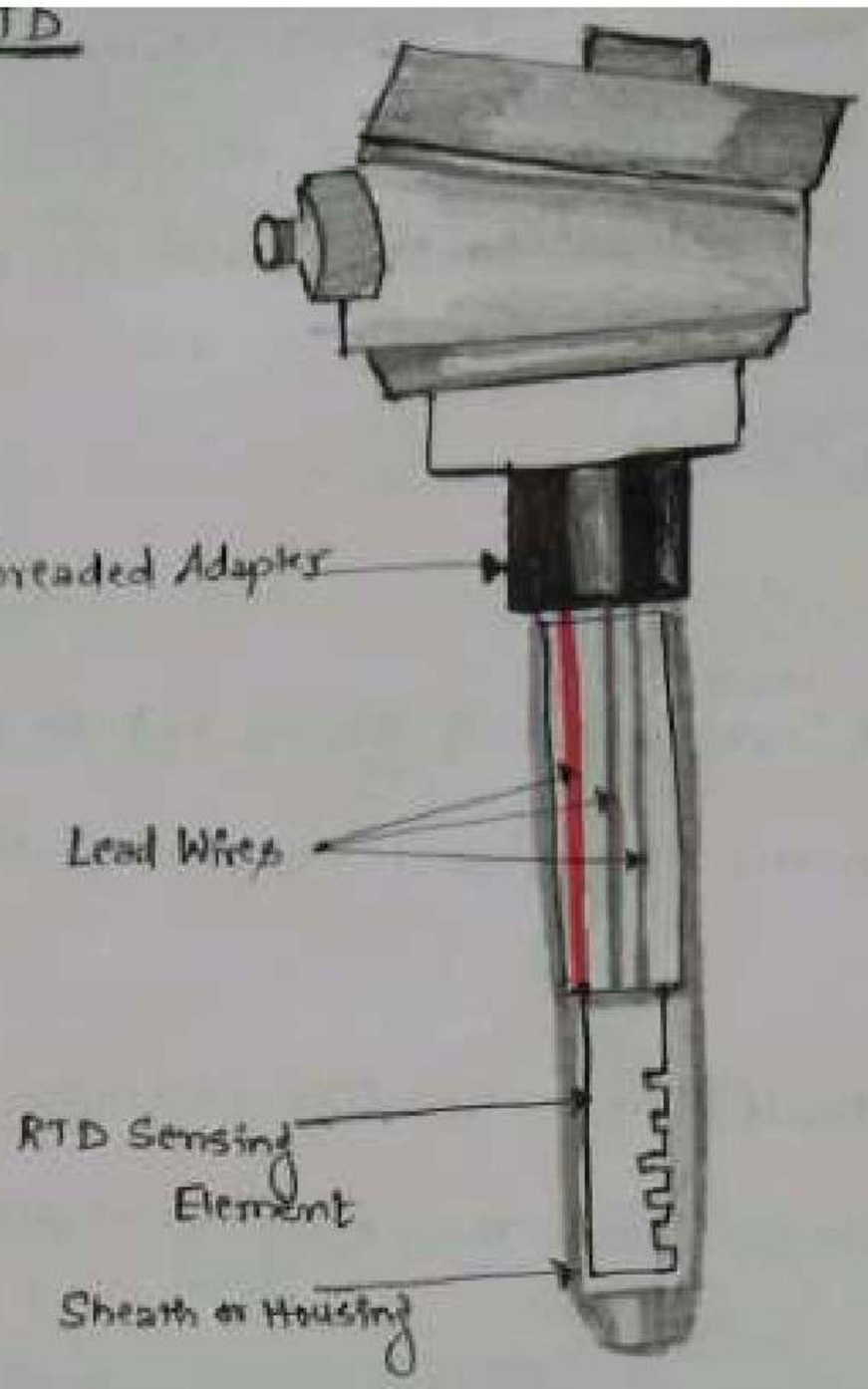
↳ The sensor packing typically magnesium oxide surrounds the sensing element and is contained within the sensor sheath

↳ The sensor packing decreases the impact of process vibration on the sensing element and thus ensures a more accurate measurement

④ Threaded Adapter

Threaded Adapter is welded over the rear housing of the sensor sheath. One end of the threaded adapter threads into a thermowell or directly into the process piping, the other end typically threaded into a temperature transmitter

WORKING OF RTD



For Ex:- Suppose we want to monitor the temperature of an oven

↳ To do this work the probe of an RTD is inserted into the oven.

↳ Due to the temp. of oven, the resistance of the sensing element of the RTD varies correspondingly.

↳ The RTD gives output of resistance in ohms but that is not a standard s that can be transmitted into the control room.

↳ So we have to convert that change in resistance, to a change in voltage a this can be done using Wheatstone bridge

↳ These Wheatstone bridge circuits are built into the transmitter PLC, DCS or PID Controller.

↳ RTD may be located hundreds of feet away from the bridge circuit.

↳ Two types of Wheatstone bridge circuit configuration are mainly used

① Null Balance Bridge

② Deflection Bridge

Null Balance Bridge:- In null balance bridge the resistance R_1 and R_2 are known and R_3 is an adjustable resistor.

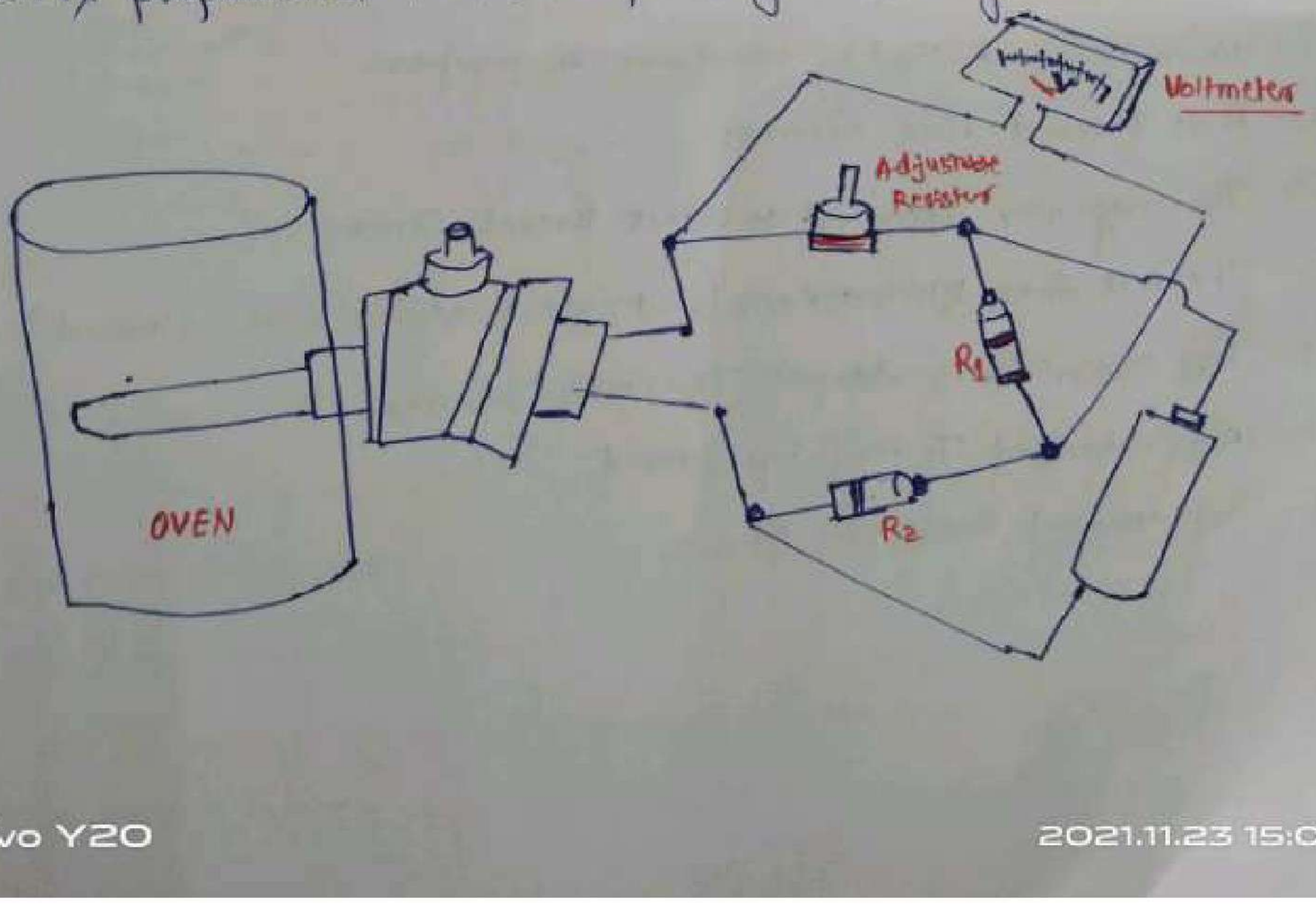
The Resistor R_3 is initially adjusted in order to obtain zero volt in the voltmeter. In this condition the bridge is said to be Null Balanced.

↳ This would be the 0 or set point on the RTD temperature output.

↳ As the RTD is inserted into the oven, the RTD temperature increases and correspondingly the voltage indicated by the voltmeter also increases.

Deflection Bridge:- In deflection bridge all three resistors are fixed and not adjusted and output voltage varies corresponding to the temperature of RTD.

If a voltage transducer replaces the voltmeter if 4 to 20 ma signal which is proportional to the temp. range can be generated.



Thermal Imaging :-

Therm
↳ Heat

If we create an image with the help of heat then this process is known as thermal imaging.

↳ Thermal imaging is the technique of using the heat given off by an object to produce an image.

↳ It is an infrared imaging science

↳ Initially it was developed for military use in the late 1950s and in 196 by Texas Instruments, Hughes Aircraft and Honeywell

↳ In recent times it is being used in firefighting, medical, security an many other industrial applications,

1913: First Civil application of Thermal Detecting

1929: First IR Electronic Camera Invented

1945 :- Near-Infrared Used by World war-II Snipers

1947 :- First Infrared Line scanner

1982 :- Thermography Approved to Detect Breast Cancer

1987 :- Thermal Goes Mainstream (— movie predator was released)

1990 :- Fire Departments Adopts Thermal Cameras

2010 :- IR-Embedded Testing Equipment

2016 :- First thermal Smartphones.

Measurement of position using Hall Effect Sensor

↳ Edwin Hall discover it in 1879

↳ Hall Effect sensors are used as RPM/ speed sensor and to detect positions.

↳ As Crankshaft and Camshaft position Sensors.

↳ Also to check Accelerator pedal position, Throttle valve position

↳ Used in Hall Effect Switches

↳ They also known as Active speed Sensor as they need power supply to function

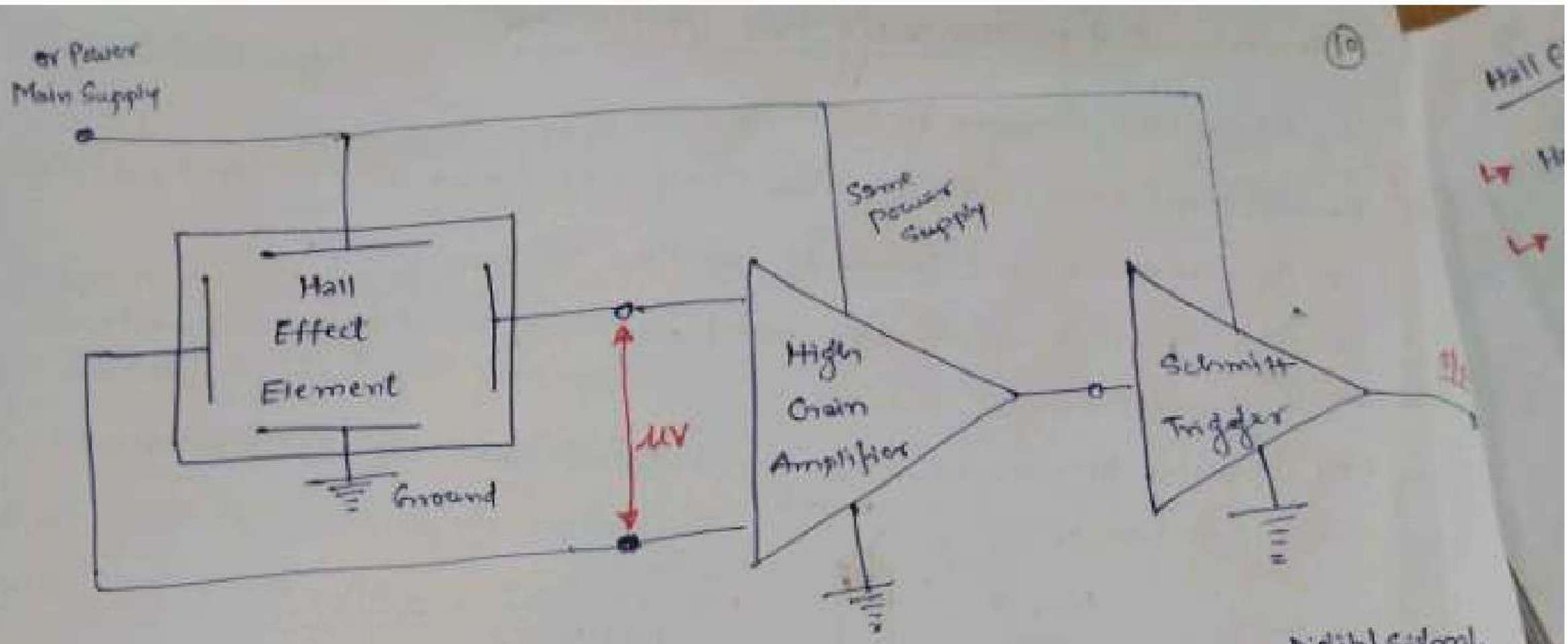
Hall Effect :-

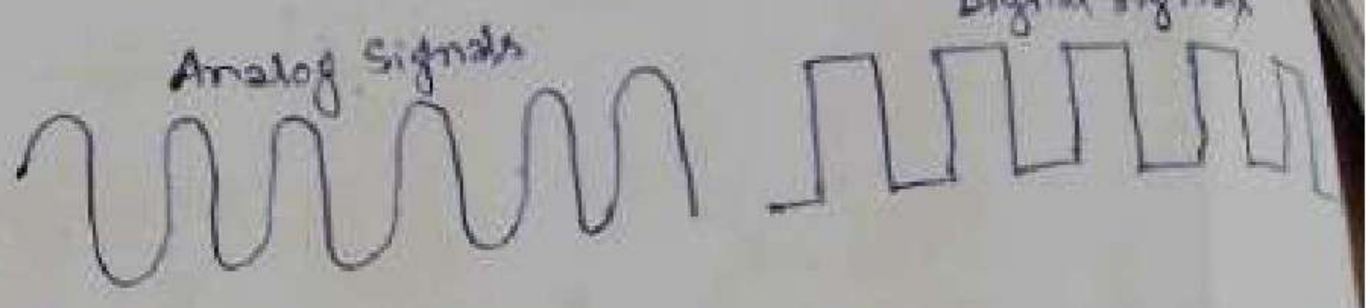
↳ Consider a semiconductor metal plate connect it with battery or DC supply

So Current Constantly flow from one direction to another direction.

↳ Now if we put a magnet near this metal, so charges get deflected and due to this deflection the metal one end is positively charged and other end is negatively charged

↳ Now If we put a probe of voltmeter on both the side of metals, it will provide some voltage into the voltmeter and i.e known as Hall Voltage



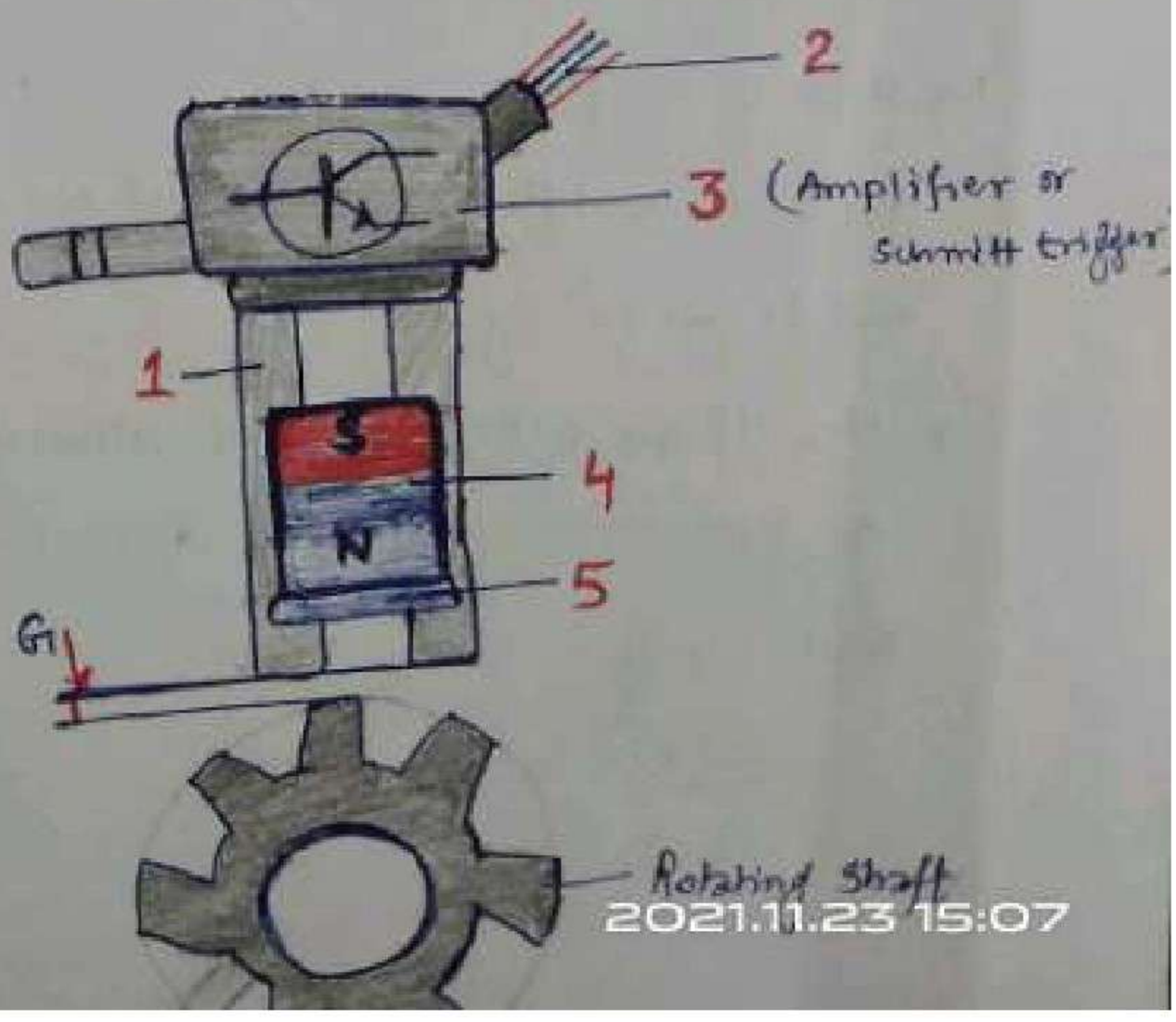


The output received is very low in μV or mV so it can be amplify by using High Gain Amplifier, which produces output in analog signals, but most of the vehicles used digital signals, so for the Conversion from analoge to digital Schmitt trigger is used.

Hall Effect Speed Sensor

1. Sensor housing
2. Wiring
3. Internal Electronics
4. Magnet
5. Hall Effect Element
6. Air Gap

As the shaft rotate it will cut the magnetic field due to which the o/p of Hall Effect Sensor will change which can be provide the digital output



Hall Effect Speed sensor Troubleshooting -

↳ Hall sensor generally consists of 3 wires (supply, ground, signal)

↳ Check power supply and ground connection. Usually 5V (in some cases can be 12V). (Also refer manufacturer manual)

↳ Check air gap (G) as per manufacturer specification and for foreign objects (dust or anything else)
↳ which reduces the air gap

↳ Check cleanliness of sensor pins. (rusting / moisture / dirt)

↳ Check wiring of signal wire and signal on oscilloscope when gear running.

Proximity Sensors :-

Proximity sensors are sensors that detect movement or Presence of an objects without making physical with the object and Converts that captured Information into an Electrical Signal.

↳ Proximity sensors detect the presence of an object, without touching it.

↳ As these sensors are non-contact sensors they do not cause any damage to the object.

↳ Proximity sensors do not use any type of physical moving parts, instead they allow signals to transmit through them, when something that is being monitored comes in close proximity of the sensing area.

↳ There are many types of proximity sensors and they each sense the presence of an objed in their own distinct ways.

↳ Two most commonly used proximity sensors
① Capacitive Proximity Sensor
② Inductive Proximity Sensors

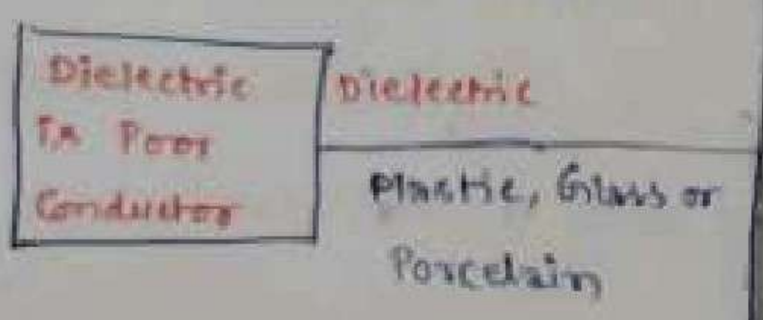
④ Capacitive Proximity Sensors

Capacitive proximity sensor is based on the principle of a parallel Plate Capacitor.

↳ Parallel plate Capacitor consists of two parallel plates that are separated by a dielectric material which is poor conductors of electricity such as plastic, Glass or Porcelain

↳ The two parallel plates are conductive and they are usually made of Aluminium, Titalum or other metals.

↳ A metal plates typically have equal amount of positively and negatively charged particles, which means it is electrically neutral



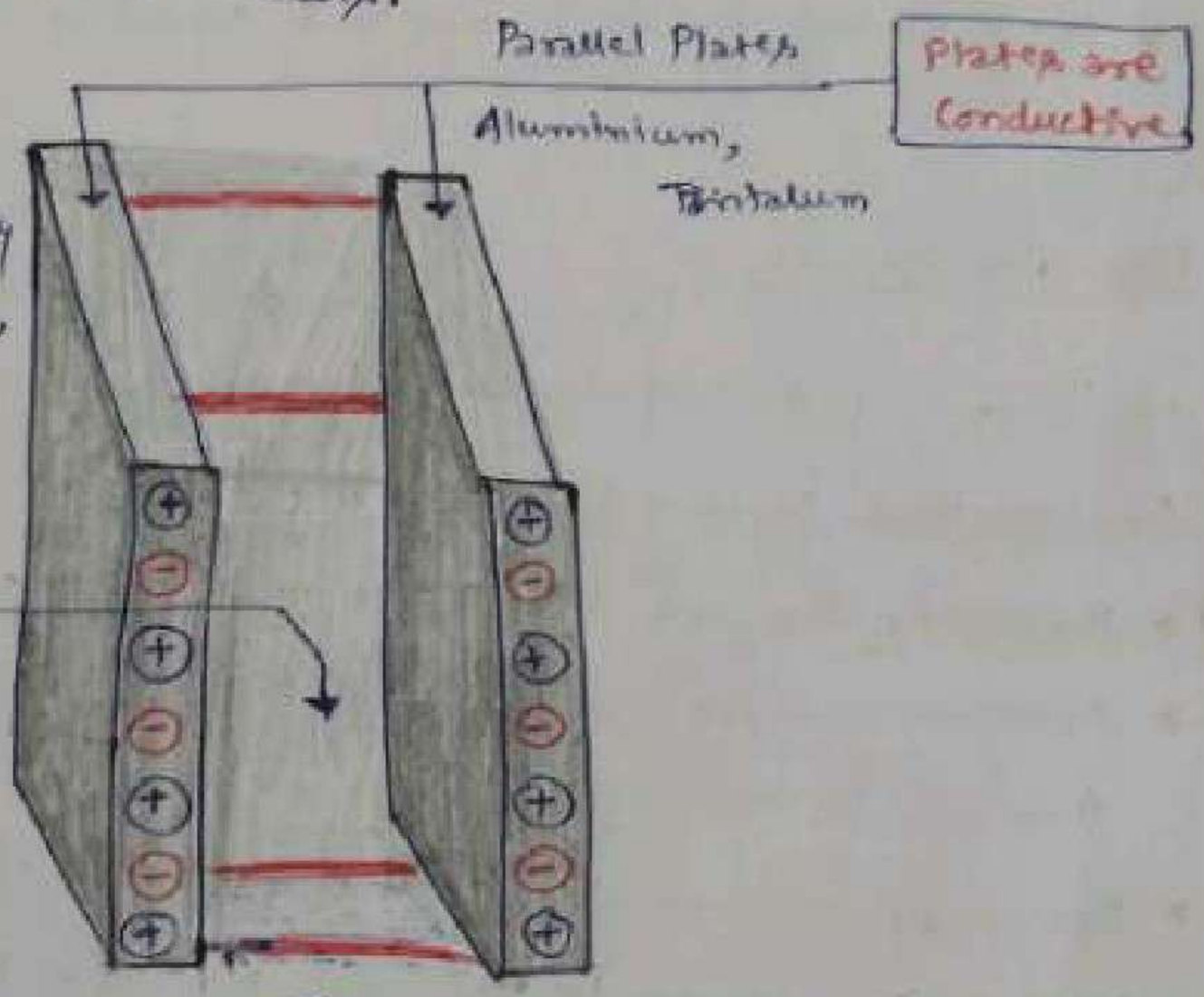


Fig:-①

↳ Normally metal plates are electrically Neutral

Fig ②

↳ If we connect a power source or a battery to the capacitor, a large no. of electrons start moving from the negative terminal of the battery, through the conductive wire.

↳ When these electrons reach the right side plate of the capacitor, the dielectric material will strongly oppose the movement of electrons from the right side plate to left side plate.

→ As a result no. of electrons that is the negative charge carriers on the right side plate of the capacitor will be higher than the no. of protons, that is positive charge carriers

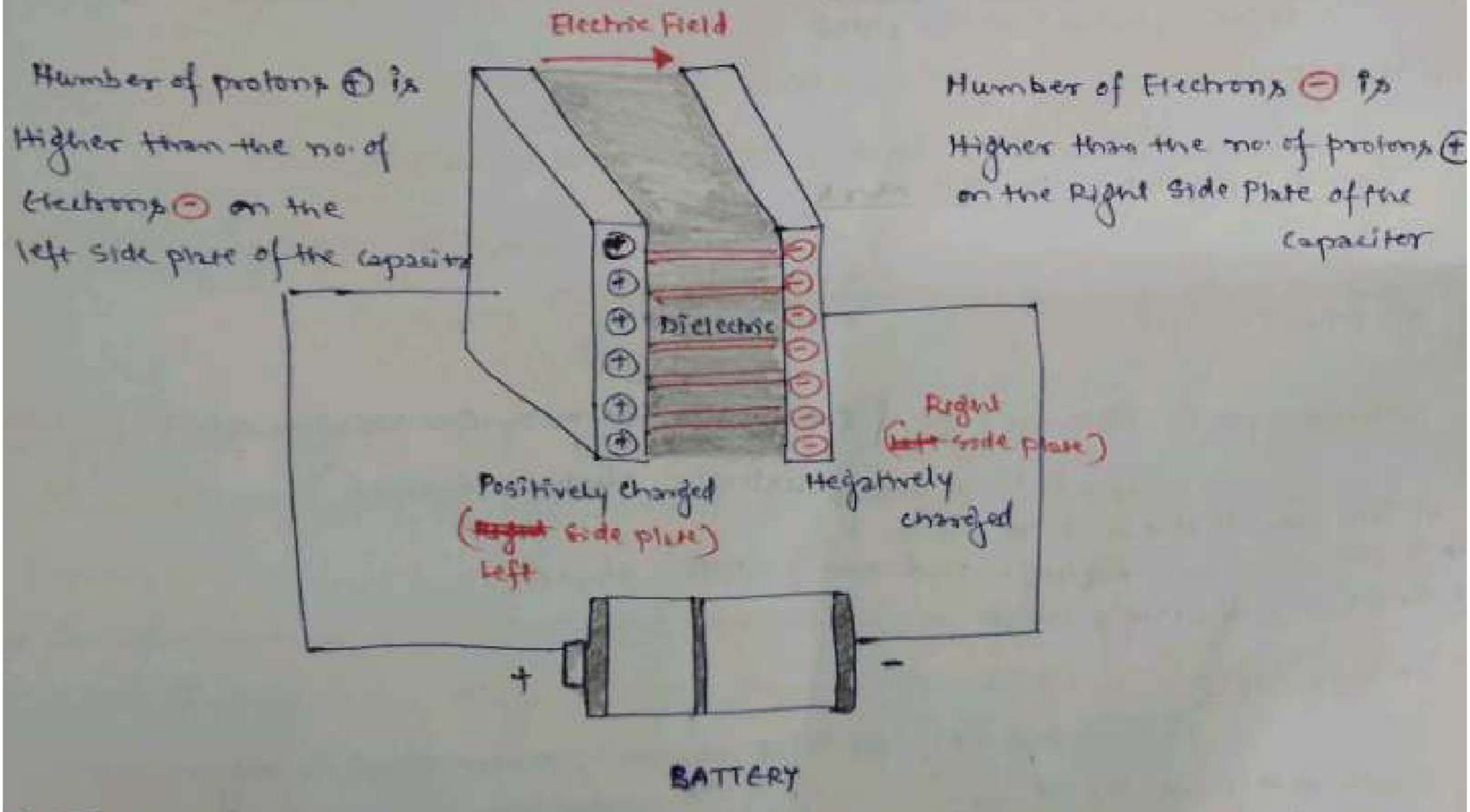
↳ Due to this the right side plate of the capacitor becomes negatively charged.

↳ At the same time the electrons on the left side plate experience a strong attractive force from the positive terminal of the battery.

↳ As a result the electrons leave from left side plate and will be attracted towards the positive terminal of the battery

↳ Due to this the number of protons (+) will be higher than the no. of electrons (-) in the left side plate and as a result, the left side plate of the capacitor becomes positively charged.

This is how the charging of capacitor takes place.



↳ The Right side plate has now developed a net negative charge and the left side plate has developed an equal net positive charge.

↳ This creates an electric field with an attractive force between them, which charge of the capacitor

- The ability of a capacitor to store Electric charge when a voltage is applied is called Capacitance

- Quantity Measuring the ability of a Dielectric Material to store charge is called Dielectric Constant

Capacitance of a Capacitor

- Directly proportional to the dielectric Constant of the material bet^n two plates
- Inversly proportional to the distance bet^n two plates

Types of Capacitive proximity Sensors

① Dielectric Type

② Conductive Type

Dielectric type :- Dielectric type of capacitive proximity sensor can detect any target that has a dielectric constant greater than air.

↳ Two capacitor plate inside the sensor.
↳ It will sense both metallic and non metallic objects.
↳ Air act as a dielectric material

Conductive type :-

In Conductive type capacitive proximity sensor there is only one capacitor plate inside the sensor.
↳ The target itself becomes the other plate of the parallel plate capacitor
↳ The Air bet^n Sensor and target act as dielectric medium
↳ The plate inside the sensor is connected to an oscillator circuit that is used to generate an electrostatic field

Inductive Proximity Sensor

Inductive Proximity sensors are used to detect metal targets.

An inductive proximity sensors has four main components

① Coil ② Oscillator ③ Trigger Circuit ④ Output Circuit

① Coil :- The coil generates necessary electromagnetic field a cup shaped magnetic core holds the coil.

This core is necessary to concentrate the coil's magnetic field on the front area of the sensor.

② Oscillator :- The oscillator is generally an LC oscillator. It produces (Inductor Capacitor) radio frequency which helps to generate an electromagnetic field.

③ Trigger Circuit :- The trigger circuit senses the change in amplitude of oscillation and gives the signal to the output circuit.

④ Output Circuit :- The output circuit has a transistor after receiving the signal the transistor switches on and gives an output.

Working principles of Inductive Proximity Sensor

Inductive proximity sensors operates on the basis of Faraday's law of Inductance.

↳ According to Faraday's law of inductance when an electrically conducting object is placed in a Magnetic field then an Electric Current called Eddy Current will be generated in the object

↳ According to Lenz's Law the Eddy Current creates a magnetic field in a conductor and this Eddy Current magnetic field opposes the magnetic field which created it.

Working

→ The proximity sensor is installed in the area where we need to sense the presence of an electrically conductive target object.

↳ When the sensing coil in the oscillation circuit is supplied with an alternating current, a changing magnetic field is created around the coil.

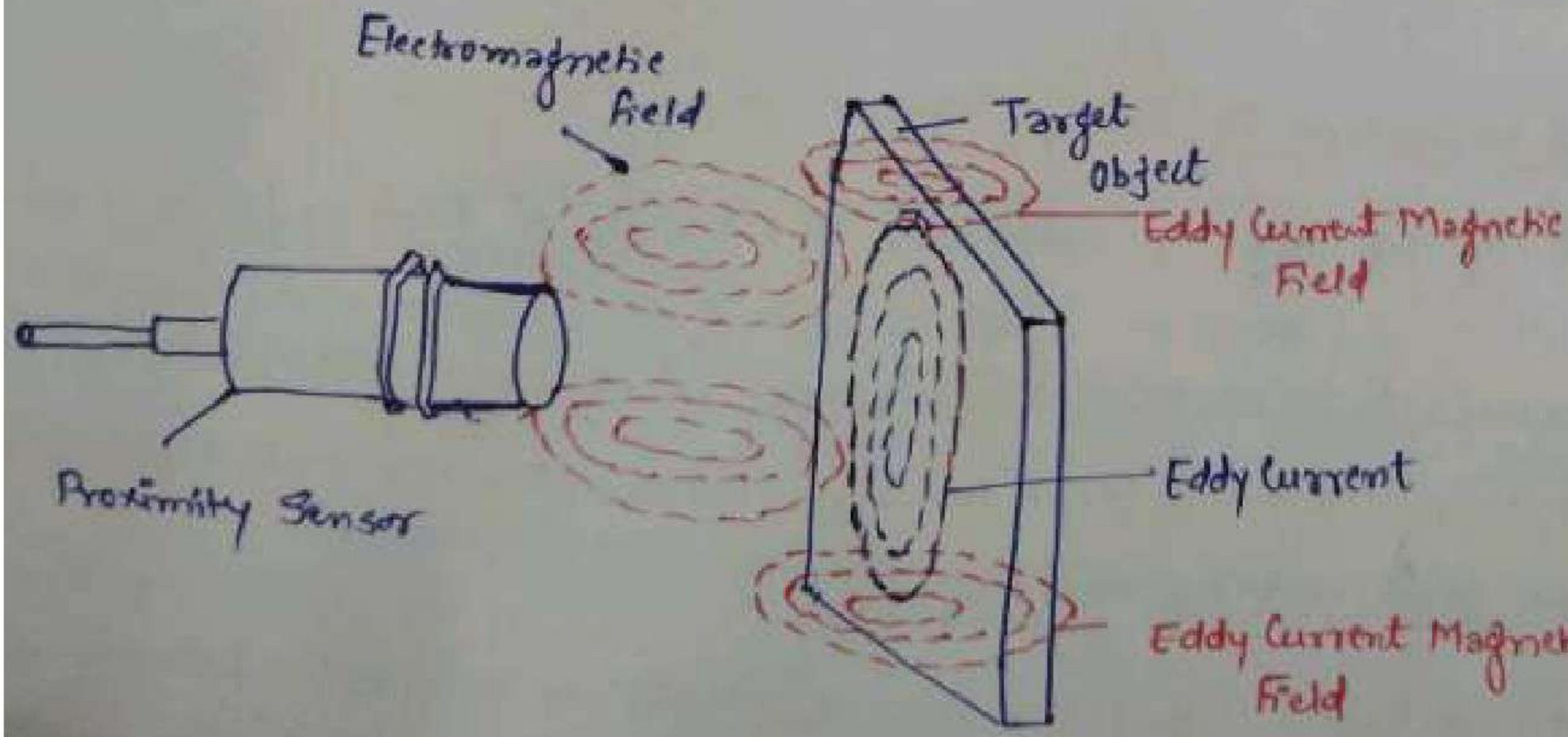
↳ When the target object enters this electromagnetic field some of the electromagnetic energy is transfered to the object. According to Faraday's law of induction, an electric current called Eddy current will be generated in the object.

↳ This Eddy current produces another magnetic field called Eddy current magnetic field and it opposes the magnetic field which created it.

↳ As the eddy current magnetic field opposes the magnetic field of the coil, the intensity of the magnetic field of the coil reduces.

↳ As the target comes very close to the sensor the eddy current increases, decreasing the amplitude of the electromagnetic field.

The trigger circuit monitors the amplitude and when the amplitude goes below a predetermined level the output state of the sensor switches from its normal condition.



Use of proximity Sensor as Accelerometer and Vibration Sensor

Vibration :- Vibration can be defined as the mechanical oscillation about an equilibrium position of a machine or component

Or

Simply the back and forth motion of a machine or component.

↳ Vibration in industrial equipment is sometimes part of the normal operation but sometimes it can be a sign of trouble.

↳ In machine monitoring we are dealing with two types of vibration

① Axial (Thrust) Vibration

② Radial Vibration

↳ "Axial" Vibration is a longitudnal shafting vibration or parallel to the shaft of a motor, For Ex:- A shaft misalignment could cause axial vibration

↳ "Radial" Vibration occurs as a force applied outward from the shaft.
For Ex:- If there is a deformed fan blade, as the fan spins, the deformed fan blade would pull outwardly on the shaft of the motor causing radial vibration

Different types of sensors to monitor vibration ← Accelerometer Sensor, Strain Gauge, Eddy Current

① **Accelerometer :-** Accelerometers are devices that measure the vibration or acceleration of motion of a structure.

↳ They have a transducer that converts mechanical force caused by vibration or a change in motion into an electrical current using the piezoelectric effect.

↳ Two types of piezoelectric accelerometer

① High Impedance

② Low Impedance

High Impedance Accelerometer :- It produce an electrical charge, which is connected directly to the measurement instruments.

They requre special accomodations and instrumentation, so they are found in laboratories or high temp applications.

Low Impedance Accelerometer :-

Low Impedance accelerometer have a Charge accelerometer as its front end as well as a built-in microcircuit and transistor that converts that charge into a low impedance voltage. This type of accelerometer easily interfaces with standard instrumentation which makes it commonly used in the industry.

Strain Gauge Sensor :-

Strain gauge is a sensor whose resistance varies with applied force; It converts force, pressure, tension, weight etc into a change in electrical resistance which can then be measured.

When external forces are applied to a stationary object, stress and strain are the results.

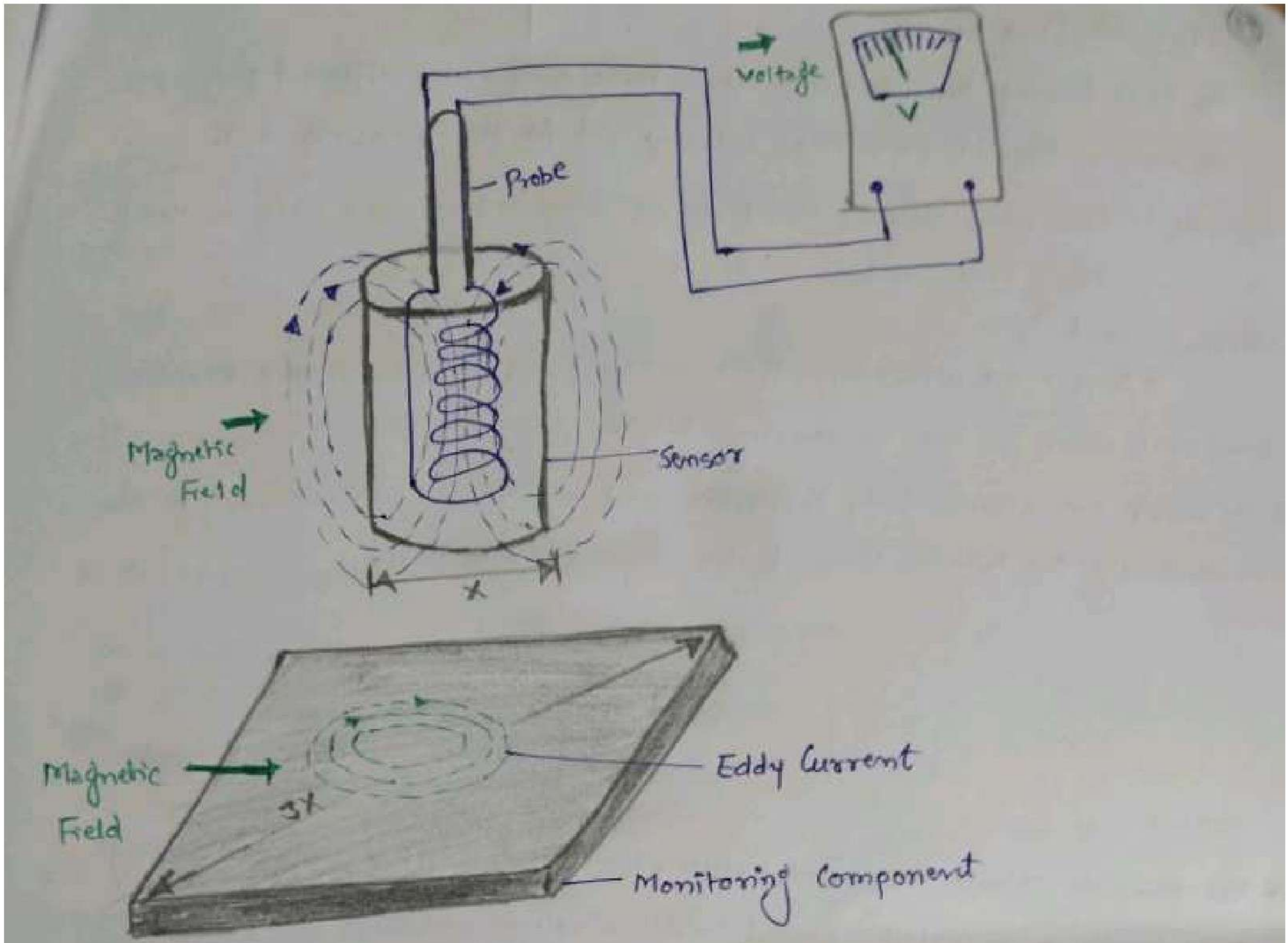
↳ When there is a strain applied to any metallic wire, the length of the wire increases and the diameter decreases. This increase in length and decrease in diameter will change the resistance of the wire, which will give us our measurement of strain on our machine component

Eddy Current or Capacitive Displacement Sensor :-

Eddy Current Sensors are non-contact devices that measure the position and/or change of position of a conductive component. These sensors operate with magnetic fields.

↳ The Sensors has the probe, which creates an alternating current at the tip of the probe. The alternating current creates small currents in the component we are monitoring called Eddy Currents

* The Sensor monitors the interaction of these two magnetic fields. As the field interaction changes, the sensor will produce a voltage proportional to the change in the interaction of the two fields.



↳ When using Eddy Current Sensors it is important for the component to be at least three times larger than the sensor diameter for normal operation otherwise, advanced calibration would be required.

Key Factors of choosing Vibration Sensors

1. Range
2. Accuracy
3. Environment Conditions
4. Shape of the Measuring Surface

Ultrasonic Flow Sensor

The fluid flowing through pipes often have completely different properties. Therefore a different principles are required for the measurement.

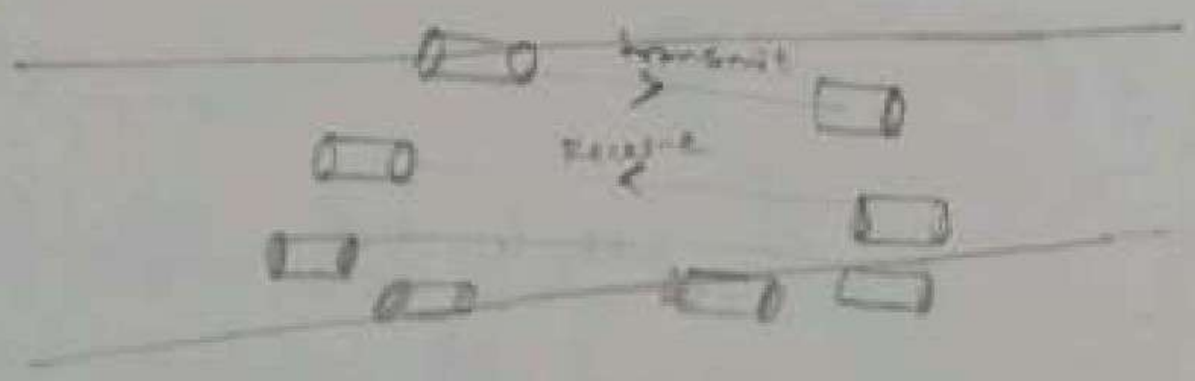
Principle :- Flow measurement based on the difference in transit time method using ultrasound.

Working Method

↳ Inside the ultrasonic flow meter pairs of sensors are fitted across from each other in the measuring tube.

↳ Each sensor can alternatively transmit and receive an ultrasonic signal.

↳ Simultaneously the transit time of the signal measured.



↳ The ultrasonic signals are generated with piezoelectric crystals applying voltage, Conventionally a piezoelectric crystal creates a voltage when an ultrasonic signal impacts the sensors.

↳ By increasing the no. of sensors pairs its possible to accurately detect and mathematically calculate flow profile distortions over the entire pipe cross section.

↳ When there is no flow the signal transit time are same in upstream and down stream.

↳ Once the fluid start flowing in the measuring tube, the ultrasonic signals are accelarated in the direction of the flow and deaccelarated against the flow.

↳ As a result the ultrasonic signals must have different transit times. Less time in the direction of flow and more time against the flow.

↳ Therefore the differential transit time measured by the sensors is directly proportional to the flow velocity in the pipe.

Note:- The sensors do not necessarily have to be fitted into the pipe wall,

There is a clamp on system for ex:-

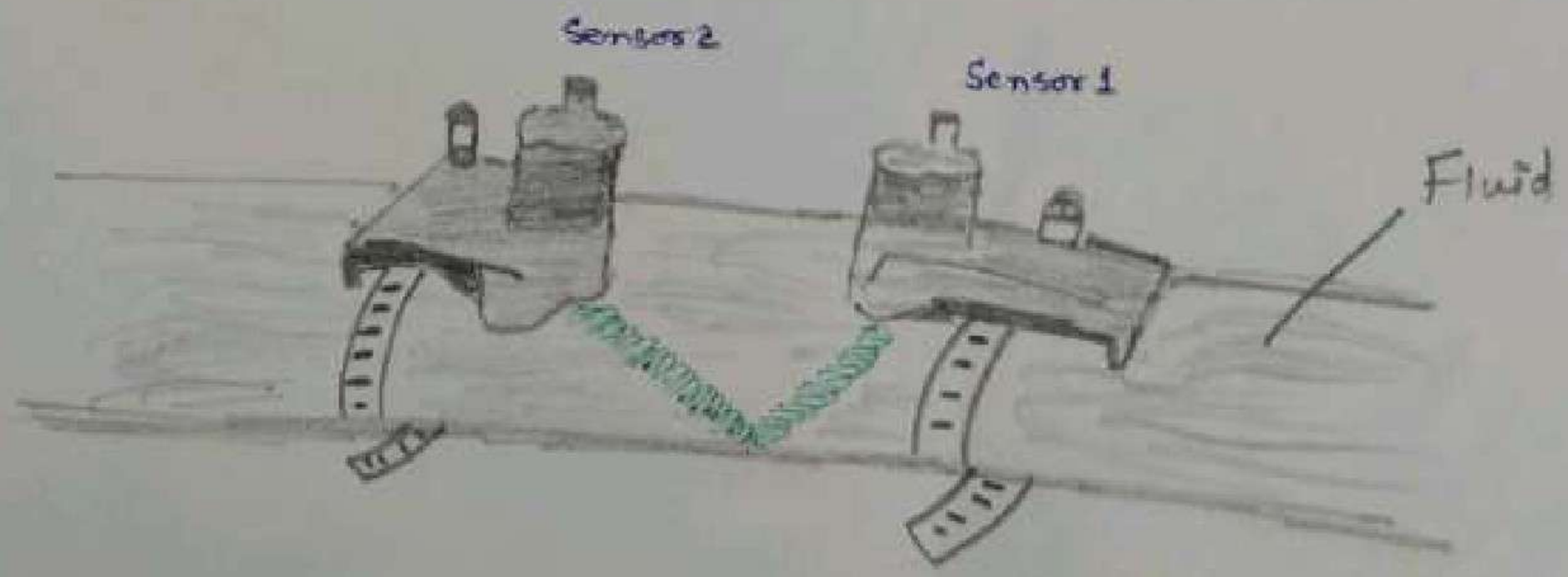
The sensors are fitted directly onto the outside of the pipe, they can be electro fitted at any time without interrupting the process.

↳ With clamp on sensors the ultrasonic signals is passed directly through the pipe wall and into the fluid, the signal continous flow through the fluid is reflected on the opposite pipe wall and them measured by the second sensors.

↳ The clamp on design is unique because flow rates can be measured in very large pipes upto 4 meters in diameter, this possibility increases the areas of application.

For Ex: in the water; a hydroelectric industries

↳ Flexible mounting, process safety and cost effectiveness are the distinct advantage of ultrasonic flow measurement.



Level Sensor :-

Level Sensors can be broken into two classifications

1. Point Level Measurement.
2. Continuous level measurement.

Point level Measurement

Point level measurement indicates when a product is present at a certain point for eg: High level and Low level in a water tank

The Sensors for point level indication are "Capacitance", "Optical", "Conductivity", "Vibrating" or Tuning Fork and "float Switch".

Continuous level Measurement

Continuous level measurement indicates the continuous level of a product as it rises and falls.

The Sensors for Continuous level indication are "Ultrasonic" and "Radar" or Microwave.