Piezoelectricity

Piezoelectricity : is the electric charge that accumulates in certain solid materials (such as crystals, certain ceramics, and biological matter such as bone, DNA and various proteins) in response to applied mechanical stress.

The word piezoelectricity means electricity resulting from pressure. It is or (derived from the Greek piezo piezein, which means to squeeze or press

The piezoelectric effect is understood as the linear electromechanical interaction between the mechanical and the electrical state in crystalline .materials

The piezoelectric effect is a reversible process.

The first demonstration of the direct piezoelectric effect was in 1880 by the brothers Pierre Curie and Jacques Curie.

They combined their knowledge of pyroelectricity with their understanding of the underlying crystal structures that gave rise to pyroelectricity to predict crystal behavior, and demonstrated the effect using crystals of tourmaline, quartz, topaz, cane sugar, and Rochelle salt (sodium potassium tartrate tetrahydrate) and Quartz.

The Curies, however, did not predict the converse piezoelectric effect. The converse effect was mathematically deduced from fundamental thermodynamic principles by Gabriel Lippmann in 1881.The Curies immediately confirmed the existence of the converse effect,and went on to obtain quantitative proof of the complete reversibility of electro-elasto-mechanical deformations in piezoelectric crystals

The most common example of pizoelectric matirial :

-Lead(II) titanate
-Lead zirconate titanate (PZT)
-Barium titanate
-Rochelle salt, also called Sodium Potassium Tartrate Tetrahydrate

-Quartz

-Lithium niobate (LiNbO3)

-Lithium tantalate (LiTaO3)

Essential properties of piezoelectric materials :

-High value of the dielectric constant

-Presence of spontaneous polarization in some zones (domains)

-Presence of hysteresis loop in polarization-electric field

- Dielectric constant increases with increase of temperature

-Ferroelectric properties disappear above a special point in dielectric constant - temperature curve (Curie point)

- Appearance of the residual polarization and a double electric layer on the surface of sintered samples after

-Exposure to a strong electric field, which causes the display of the piezoelectric effect in the material (conversion of the mechanical energy into an electrical one and vice versa

Pizoelectric matiral

QUARTZ

ROCHELLE CRYSTAL

LEAD ZIRCONATE TITANATE (PZT)

Lead zirconate titanate is an intermetallic inorganic compound with the chemical formula Pb[ZrxTi1-x]O3 (0≤x≤1).

Also called PZT, it is a ceramic perovskite material that shows a marked piezoelectric effect, meaning that the compound changes shape when an electric field is applied.

It is used in a number of practical applications such as ultrasonic transducers and piezoelectric resonators[disambiguation needed]. PZT is a white solid that is insoluble in all solvents

Being piezoelectric, PZT develops a voltage (or potential difference) across two of its faces

when compressed (useful for sensor applications), or physically changes shape when an external electric field is applied (useful for actuator applications).

The dielectric constant of PZT can range from 300 to 3850, depending upon orientation and doping.

- **Being pyroelectric, this material develops a voltage difference across two of its faces under changing temperature conditions; consequently, PZT can be used as a heat sensor. PZT is also ferroelectric, which means it has a spontaneous electric polarization (electric dipole) that can be reversed in the presence of an electric field.**
- **The material features an extremely large dielectric constant at the morphotropic phase boundary (MPB) near x = 0.52.[2]**
  - **Some formulations are ohmic until at least 250 kV/cm (25 MV/m), after which current grows exponentially with field strength before reaching avalanche breakdown; but PZT exhibits time-dependent dielectric breakdown — breakdown may occur under constant-voltage stress after minutes to hours, depending on voltage and temperature, so its dielectric strength depends on the time scale over which it is measured.**
- **Other** formulations have dielectric strengths measured in the 8–16 MV/m range

ROCHELLE SALT

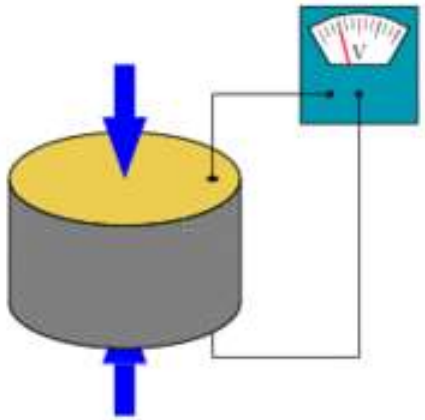
Rochelle salt, also called Sodium Potassium Tartrate Tetrahydrate, a crystalline solid having a large piezoelectric effect (electric charge induced on its surfaces by mechanical deformation due to pressure, twisting, or bending), making it useful in sensitive acoustical and vibrational devices. Like other piezoelectric materials,

Like other piezoelectric materials, Rochelle salt crystals ($KNaC_4H_4O_6 \cdot 4H_2O$) become strained when subjected to electric fields.

They decompose at moderately high temperatures (55° C [131° F]) and require protection against moisture. Piezoelectric deformation is directly proportional to the applied electric field and reverses as the polarity of the applied field is reversed.

These basic properties are put to use in electromechanical transducers such as ultrasonic generators, microphones, and phonograph pickups and in electromechanical resonators. See also tartaric acid.

Piezoelectric sensor



A piezoelectric disk generates a voltage when deformed (change in shape is greatly exaggerated)

A piezoelectric sensor is a device that uses the piezoelectric effect, to measure changes in pressure, acceleration, temperature, strain, or force by converting them to an electrical charge. The prefix piezo- is Greek for 'press' or 'squeeze'.

They have been successfully used in various applications, such as in medical, aerospace, nuclear instrumentation, and as a tilt sensor in consumer electronics[1] or a pressure sensor in the touch pads of mobile phones. In the automotive industry.

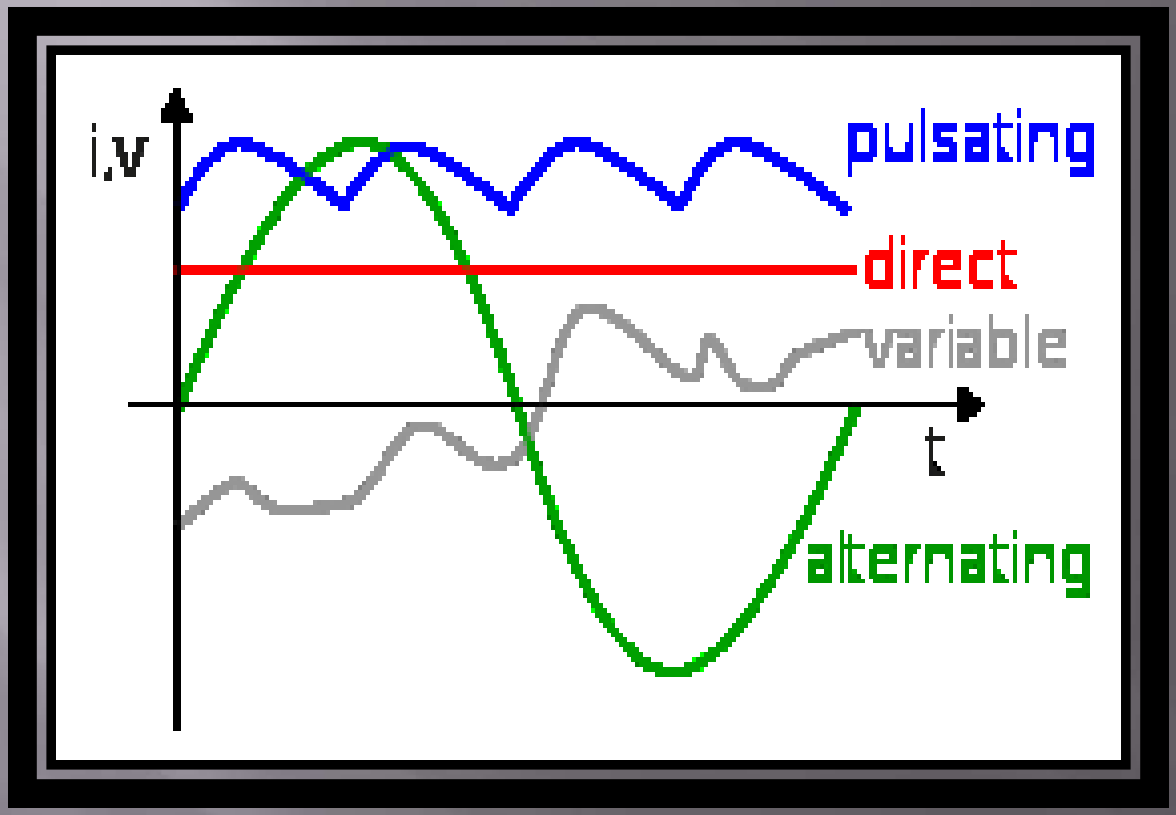
Alternating current (AC)

Alternating current AC : is an electric current which periodically reverses direction, in contrast to direct current (DC),

which flows only in one direction.

Alternating current is the form in which electric power is delivered to businesses and residences, and it is the form of electrical energy that consumers typically use when they plug kitchen appliances, televisions, fans and electric lamps into a wall socket.

A common source of DC power is a battery cell in a flashlight. The abbreviations *AC* and *DC* are often used to mean simply *alternating* and *direct*, as when they modify *current* or *voltage*



Alternating current (green curve). The horizontal axis measures time; the vertical, current or voltage.

Direct current (DC)

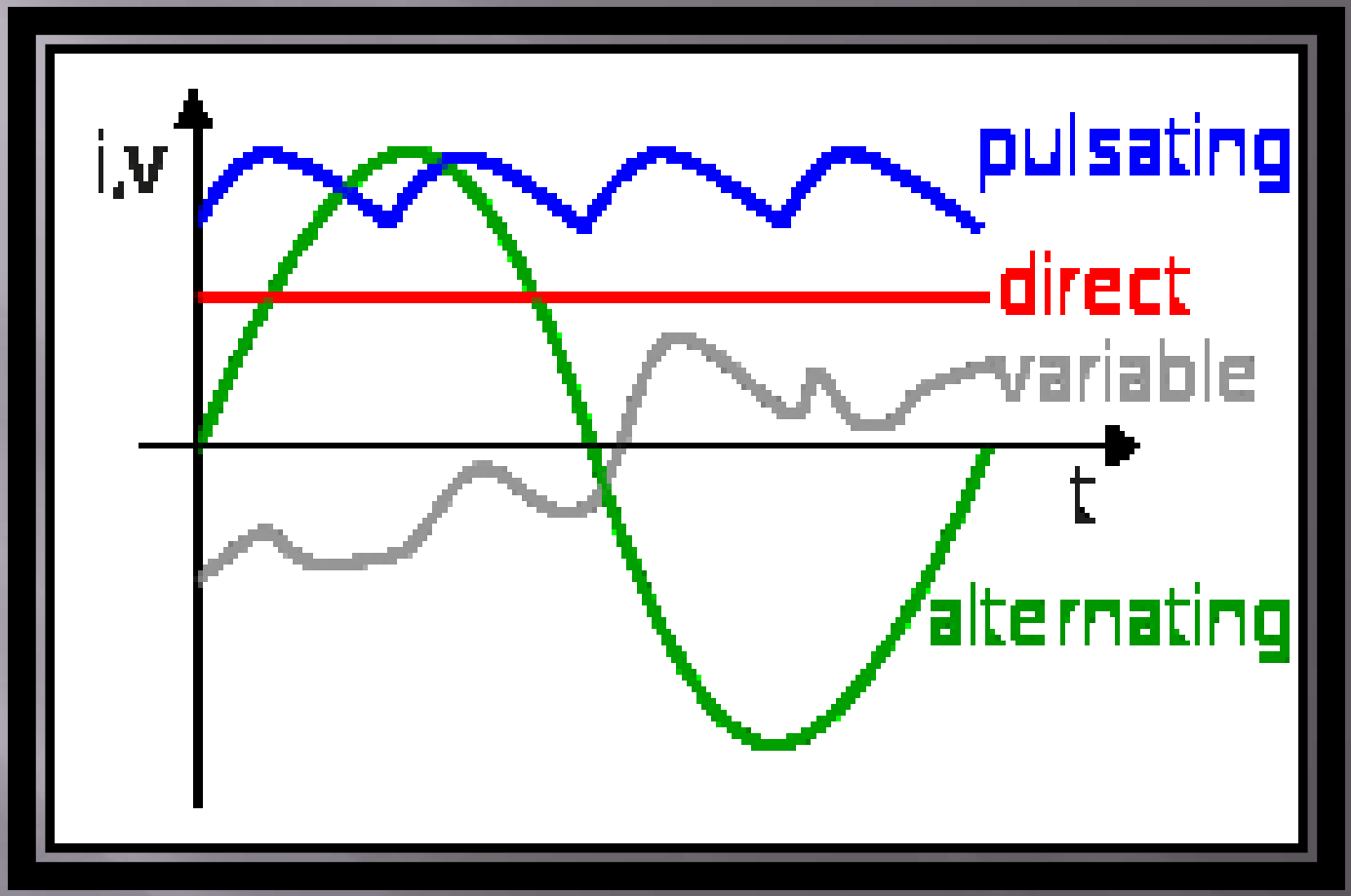
Direct current (DC) is the unidirectional flow of **electric charge**.

A **battery** is a good example of a DC power supply.

Direct current may flow in a **conductor** such as a wire, but can also flow through **semiconductors**, **insulators**, or even through a **vacuum** as in **electron or ion beams**.

The electric current flows in a constant direction, distinguishing it from **alternating current** (AC).
A **term formerly used** for this type of current was galvanic current

Direct current may be obtained from an alternating current supply by use of a rectifier, which contains electronic elements (usually) or electromechanical elements (historically) that allow current to flow only in one direction. Direct current may be converted into alternating current with an inverter or a motor-generator set.



Direct Current (red line). The vertical axis shows current or voltage and the horizontal 't' axis measures time and shows the zero value.

Power inverter

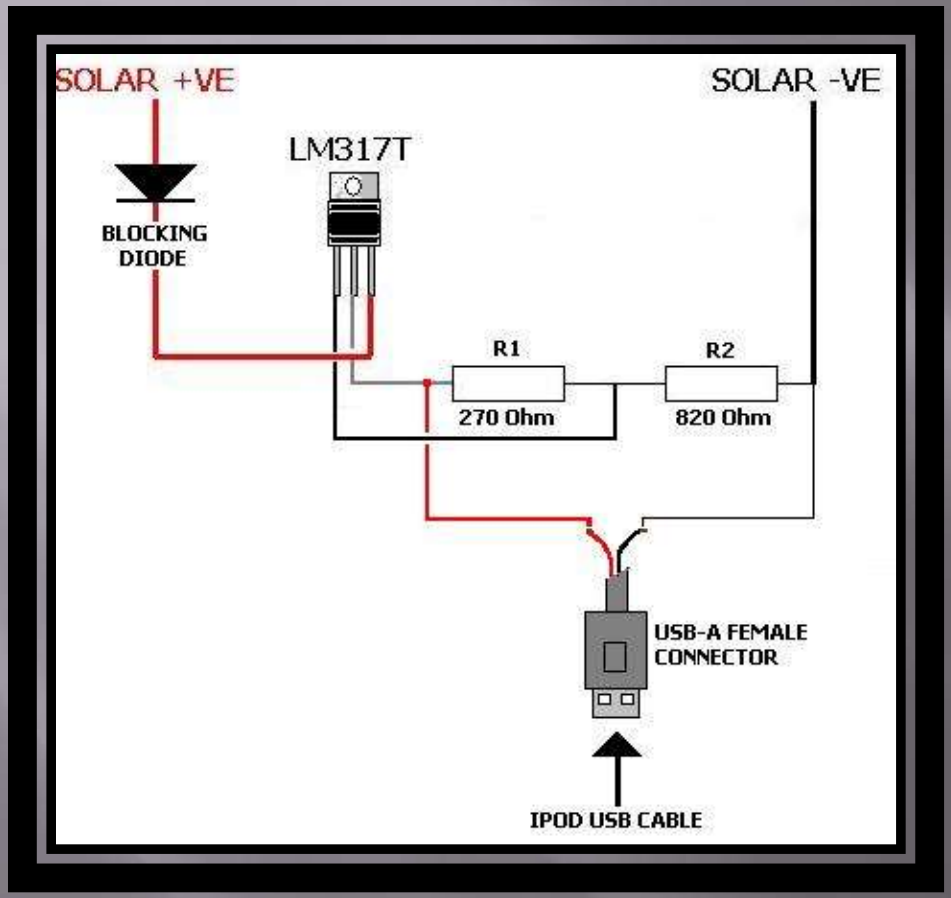
- A power inverter, or inverter : is an electronic device or circuitry that changes direct current (DC) to alternating current (AC).
- The input voltage, output voltage and frequency, and overall power handling depend on the design of the specific device or circuitry.
- The inverter does not produce any power; the power is provided by the DC source.
- A power inverter can be entirely electronic or may be a combination of mechanical effects (such as a rotary apparatus) and electronic circuitry. Static inverters do notse moving parts in the conversion process

Power Inverter

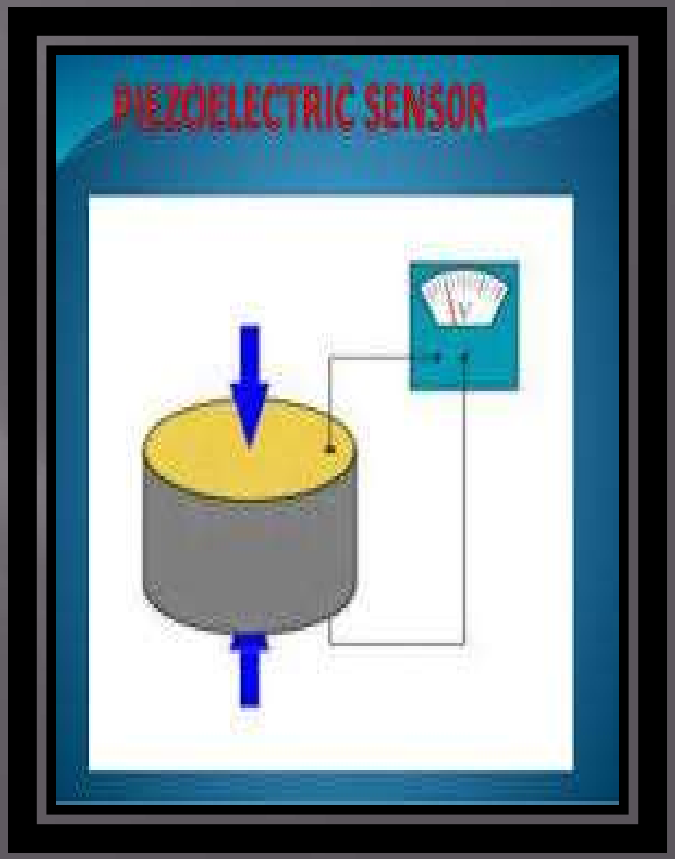
APPLICATION

-Phone Screen

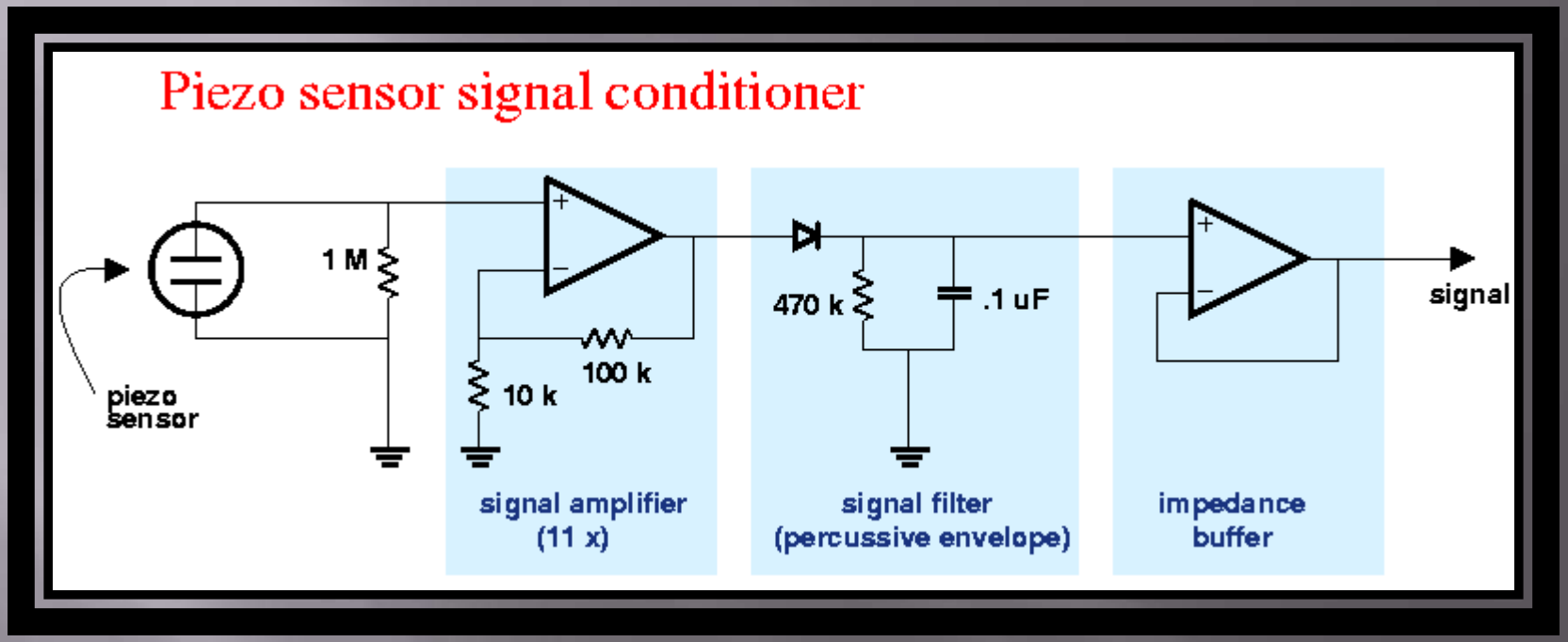
We used .. Integrated Circuit, inverter, sensor piezoelectric , Circle charging



CIRCLE CHARGING



SENSOR PIZOELECTRIC

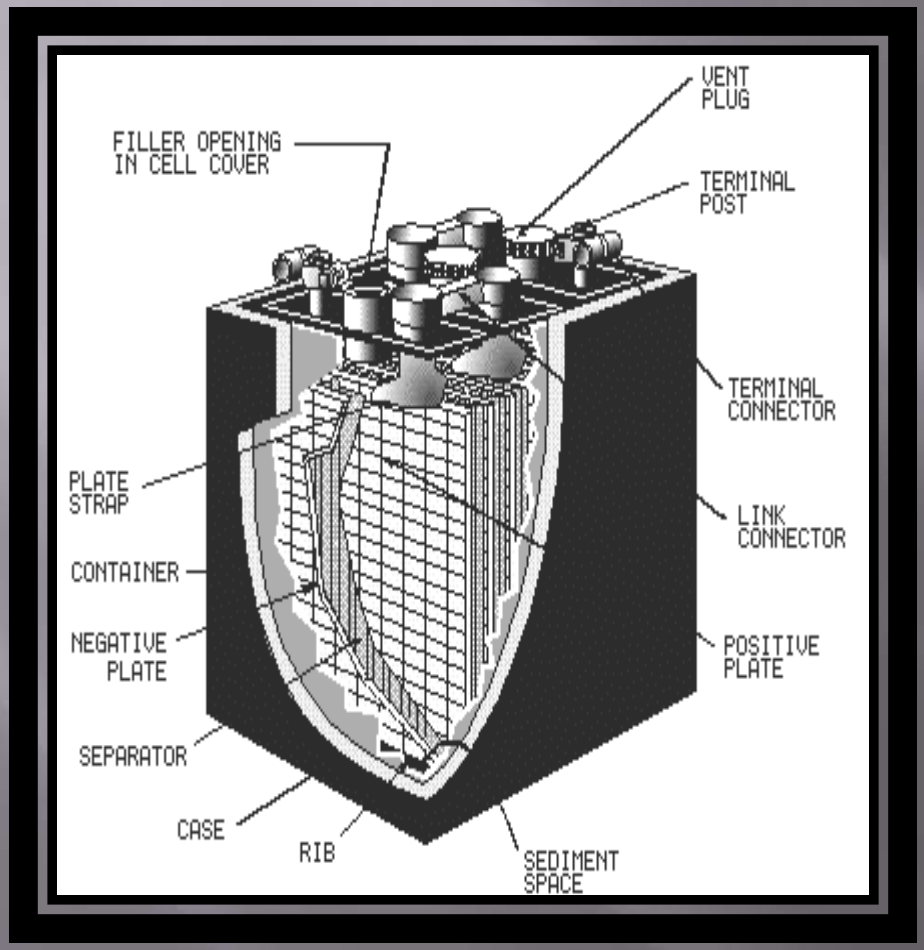


PIZEOELECTRIC SENSOR

-Industrial Bumps :

We used .. Storage batteries , inverter

Storage batteries



Bumps